Light Up!

2011 monitoring report

Prepared for:

RoadSafe
Inner Melbourne Community Road Safety Council

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SKM

Contents

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Executive Summary

RoadSafe Inner Melbourne Community Road Safety Council (RSMI CRSC) commissioned Sinclair Knight Merz (SKM) to undertake monitoring of the Light Up! campaign undertaken by RoadSafe and its member municipalities, Bicycle Victoria, VicRoads and Victoria Police.

The Light Up! campaign is an engagement activity with cyclists in inner Melbourne. The engagement consisted of an intervention combined with a research component. Both components involved intercept surveys of cyclists at night, combined with complementary communications via traditional and social media. In 2011 four sites were selected for the engagement, each of which involved interviewing cyclists during the evening on one night in late June or early July:

- Canning Street (Carlton)
- St Kilda Road (Melbourne)
- Fitzroy Street (St Kilda), and
- Napier Street (Fitzroy).

A total of 257 surveys were at least partially completed across the four sites, of which 109 were with cyclists who had lights and a further 148 who did not have lights (or whose lights were uncompliant).

The purpose of the survey was to obtain the answers to three research questions:

What proportion of riders has no lights or inadequate lights?

- Video observations at each of the four sites found that around 9% of bicycles have no front light, a further 8% have a light which is unlikely to meet the visibility requirement (200 m) and 83% front lights that were sufficiently visible. By comparison, 7% of bicycles did not have rear lights, 16% had a rear light that was insufficiently visible and 77% that were sufficiently visible.
- Of those riders who did not have lights (or had lights which were non-compliant) 40% had no lights, 30% had only a rear light and 8% had only a front light.

What influences lighting compliance?

- Riding for journeys to or from work (i.e. commuting) increases the likelihood of having lights; 88% of riders with lights were commuting compared with 62% of those without lights.
- The frequency of riding at night time does not influence lighting compliance.
- While there is no difference between males and females, there is a strong bias towards younger people being more likely to ride without lights. 52% of those without lights were aged under 30, compared with 25% of those with lights who were aged under 30.
- Those without lights are more likely to ride mountain bikes than those with lights; 33% of those without lights and 17% of those with lights rode mountain bikes.

- Travel time does influence the likelihood of having lights; the average riding time for those with lights was 33 minutes, compared with 23 minutes for those without lights. Furthermore, the proportion making short trips (defined as trips less than or equal to 15 minutes) was 41% for those without lights compared with 15% for those with lights.
- The road rule requirement for visibility at 200 m does not appear to strongly influence lighting compliance, at least insofar as the requirement is not known by 84% of respondents.
- The most frequently cited reasons for not having lights were: battery dead/flat (27%), stolen (17%) and broken (16%) lights. Only 8% of those without lights said they never used lights and 6% said they had not planned on riding at night.
- 61% of those who had broken or stolen lights, or a low or dead battery, said this had happened in the past week (although there is a risk such self reporting may be biased). Over two thirds (68%) of riders in this situation indicated they simply had not yet got around to replacing their lights.
- 30% of those without lights did not change their riding as a result of having no lights. However, 29% said they rode at least partly on footpaths while 20% rode slower and 18% took a different route in order to complete their trip.
- Awareness of an elevated risk of injury does not in itself appear to deter riding without lights; 72% of those without lights acknowledged that it greatly increased their risk of injury.

When buying lights, what features does a rider look for and to whom do they turn for information?

- Those with lights tend to buy lights regularly; 17% had bought lights in the past month and 56% had done so in the past six months.
- 42% of riders with lights said they bought new lights in order to replace broken or stolen lights, while a further 37% bought new lights in order to have brighter lights.
- When buying new lights to replace broken or stolen lights most (82%) did so within a week, and most referred to their bicycle shop (64%) for advice on the most appropriate purchase.
- 79% of respondents identified brightness as an important criteria in selecting a light, followed by price (32%) and battery life (18%).

A number of recommendations are made to refine the survey design and engagement activity in future years. Among these recommendations is a focus on the importance of frontal visibility (because of the greater likelihood of colliding with a motor vehicle on the frontal aspect) and of the merits of multiple lights and locating lights on different parts of the rider (frame, body and helmet). To ensure such engagements provide evidence-based advice a research activity to identify exactly which lighting strategies are most effective is warranted, as is further qualitative research into why riders ride without lights.

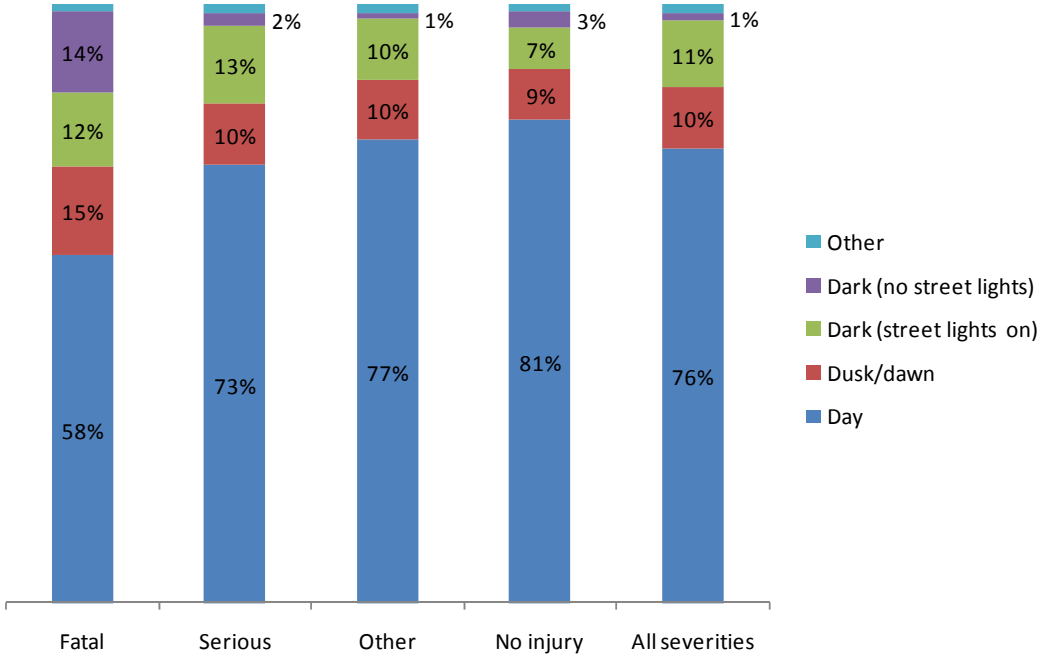
1 Introduction

RoadSafe Inner Melbourne commissioned Sinclair Knight Merz (SKM) to undertake monitoring of the Light Up! campaign undertaken by RoadSafe and its member municipalities, Bicycle Victoria, VicRoads and Victoria Police.

1.1 Risks of night time riding

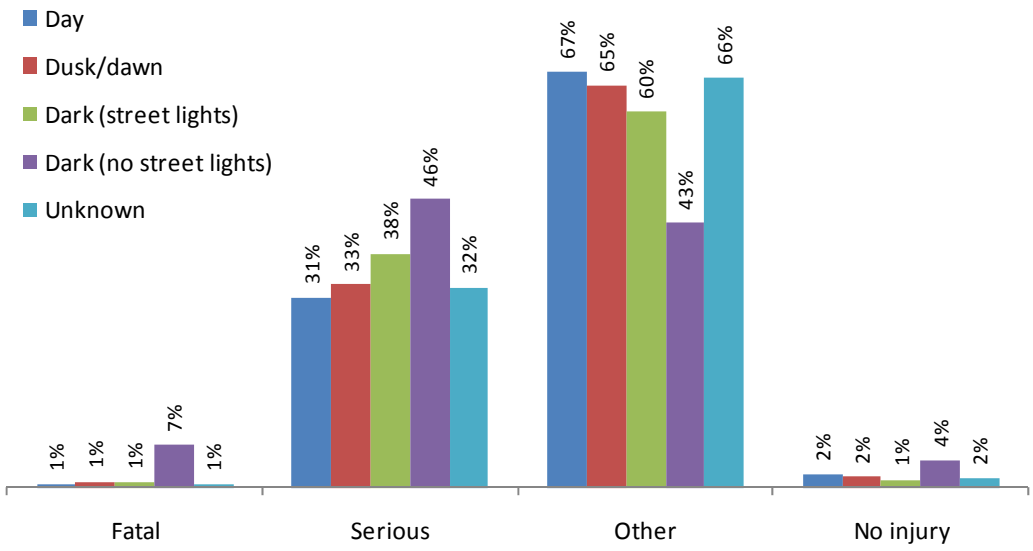
The Victorian Road Safety Road Rules (2009) r. 259 requires that a bicycle ridden at night or in hazardous weather conditions should have a flashing or steady white light that is clearly visible for at least 200 m in front of the bicycle and a flashing or steady red light that is visible for at least 200 m behind. While there is a paucity of data demonstrating the safety benefits of meeting this requirement, there is clear anecdotal support for the notion that visibility of cyclists is critical to their safety in mixed traffic environments. Further, there is evidence that suggests that night time injuries are disproportionate to the amount of cycling that occurs at night. Rodgers (1995) found in the USA that only 12% of cyclists report riding at night but that 35% of cyclist deaths occur at night. Similarly, Owens and Sivak (1996) found that 79% of all fatal collisions involving cyclists and pedestrians in the USA occurred during low-light conditions. These findings are not dissimilar to the Victorian situation, where 26% of cyclist fatalities occur at night and a further 15% occur in twilight (Figure 1.1). The proportion of serious and other injury severity crashes that occur at night is somewhat less than for fatal injuries – around 15% and 11% respectively occur at night. What is not known is how much cycling occurs at night time; it would appear to reasonable to expect that less than 26% of cycling trips occur at night and so at least fatal injuries are over-represented.

■ Figure 1.1: Visibility at time of crash by cyclist injury severity (source: VicRoads CrashStats 2000 - 2009)



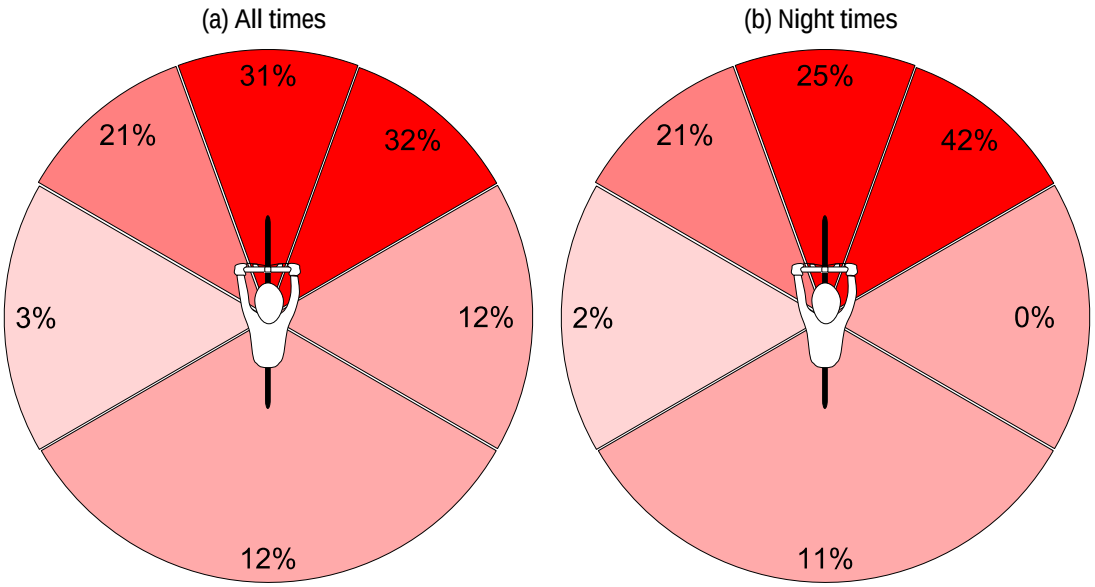
Given a collision, the likelihood of severe or fatal injury outcomes for a cyclist are much greater in dark conditions where there are no street lights (Figure 1.2). This is likely to be an artefact of the types of roads which are unlit (often rural high speed roads) and the resulting collision modes (e.g. hit from behind) rather than the light conditions *per se*.

■ Figure 1.2: Cyclist injury severity by time of day (source: VicRoads CrashStats 2000-2009)



The VicRoads CrashStats dataset provides a means of estimating the aspect from which an object (often, but not always, a vehicle) and a rider collide. This data, analysed for 2000 to 2009 crash data, shows that 32% of crashes occur to the front right of the rider and another 31% directly in front (Figure 1.3). At night times the proportion of crashes involving vehicles to the front right is even greater – at around 42% of all injury crashes (these are largely right through and cross traffic crashes where another vehicles comes across the rider from the right).

- Figure 1.3: Crash aspect for riders in collisions with objects (all severities)



There is an extensive literature to suggest that in many motor vehicle and cyclist collisions at least one party did not see the other until the collision occurred. For example, Herslund and Jørgensen (2003) found in a sample of self-reported near accidents in Denmark that the drivers were often looking in the direction of the cyclist but failed to see them, even in good visibility. The case of these errors of judgement do not appear to be sensory but rather related to perception and cognition; in the UK a study found looked-but-failed-to-see on the part of the driver was a primarily contributing factor in 17% of collisions with cyclists during daytime but only 14% during night time (Brown, 2005). Furthermore, the incidence of looked-but-failed-to-see was 32% higher in locations with street lighting. Without knowing the lighting present on the bicycle it is difficult to draw conclusions with regard to this data, other than to emphasise that *visibility* requires that (a) the eye be able to physically detect the rider (i.e. sensory perception), that (b) the driver correctly identifies the object as a cyclist, and (c) the driver responds appropriately. The humans' tendency for selective attentiveness (i.e. to look out only for what one *expects* to see, or anticipates as a threat) means that a cyclist may not be *seen* even if they are *visible*.

While the implications of this research for cyclist lighting are not definitive, it may be speculated that lighting which is both visible (in a physical sense) and draws a motorist to

recognise the object as a cyclist (as opposed to a stationary object or perhaps a motorist) will be most effective. Such speculation may be supported by the findings of research investigating the use of 'bio-motion' reflective strips. By locating reflectors on moving parts of the cyclist (particularly the ankles) research suggests that drivers detect cyclists much sooner than reflective material located on stationary parts of the body such as the back (Wood et al., 2010). It is possible this is a result both of the human eyes' tendency to be drawn to moving objects, but also that the motion of ankles when riding are distinctive from other objects on or near a roadway.

1.2 Background to the campaign

The Light Up! campaign is an engagement activity with cyclists in inner Melbourne to encourage greater attention to the need for appropriate lighting after dark and in poor weather. While the main campaign activity involved stopping cyclists in the evening, both those with and without lights, the primary objective was not enforcement. Instead, the engagement model adopted for the intervention was predicated on:

a. Stopping all cyclists along a route, irrespective of whether they had lights or not
b. Undertaking a rapid visual inspection of lights on the rider and bicycle
c. Conducting a rapid (2 – 3 minutes) survey on perceptions and motivations with regards to lighting and obtaining demographic and trip information
d. Provide information materials and an incentive (free front and/or rear lights for those without lights, and spoke lights or reflective anklets for those with lights), and
e. Complementing the above with wider messaging through Bicycle Victoria's RideOn magazine, website and social media.

The concept of engagement is central to the campaign; by understanding the motivations and hindrances to having lights the project team can tailor future messaging. Furthermore, the one-on-one engagement allows for the project team to reinforce the messages about lighting without coercion through threat of enforcement. Instead, the objective was one of positive engagement to reinforce desired behaviours and encourage riders to see the limitations to undesirable behaviours.

The Light Up! campaign was first undertaken in 2010 at four sites, with each site subject to the campaign for one night. A survey report was prepared following the 2010 campaign, the findings from which form the basis for the monitoring activity described in the present report.

1.3 Objectives

The objectives of the monitoring program described in this report were as follows:

a. understand the level of lighting compliance,
b. understand the motivations for varying levels of compliance,
c. understand the hindrances to achieving compliance by those without lights, and
d. understand the choices and strategies adopted by those who do ride with lights.

As the monitoring only occurred at one point in time (i.e. during the engagement interviews) it is not possible to evaluate how, and whether, riders altered their lighting behaviours or strategies after the engagement.

1.4 Research questions

Three research questions guided the monitoring activity described in this report:

- What proportion of riders have no lights or inadequate lights?
- What influences lighting compliance?
- When buying lights, what features does a rider look for and to whom do they turn for information?

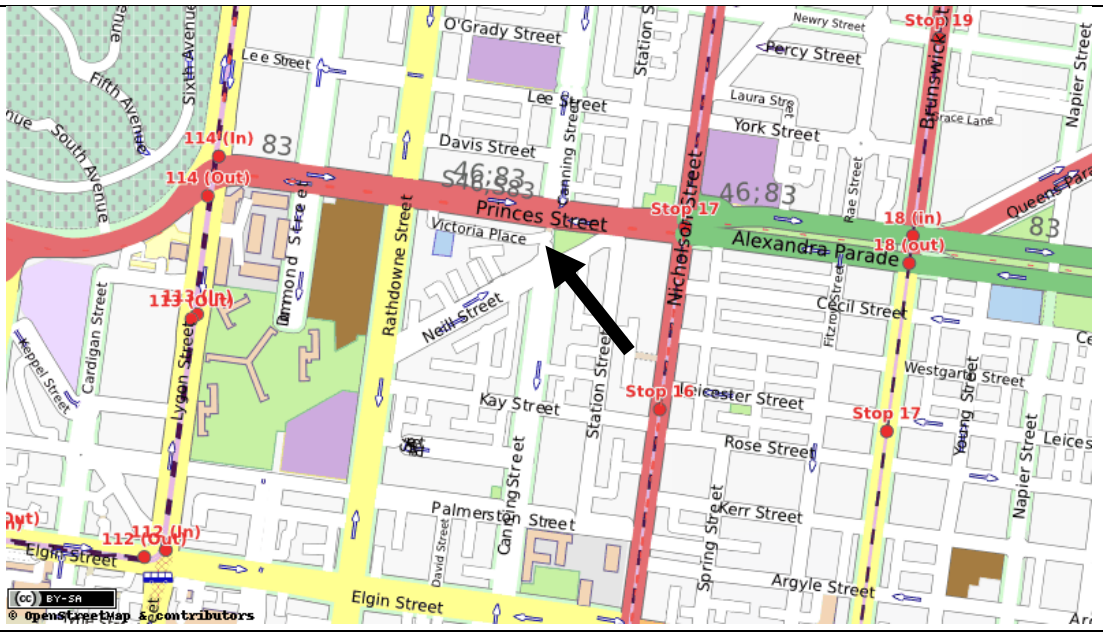
These research questions are the focus of this report.

1.5 Site selection

Four sites were selected for the engagement. These sites were selected on the basis that they are known to have high numbers of commuter cyclists and were, with the exception of St Kilda Road and Fitzroy Street, subject to the Light Up! campaign in 2010.

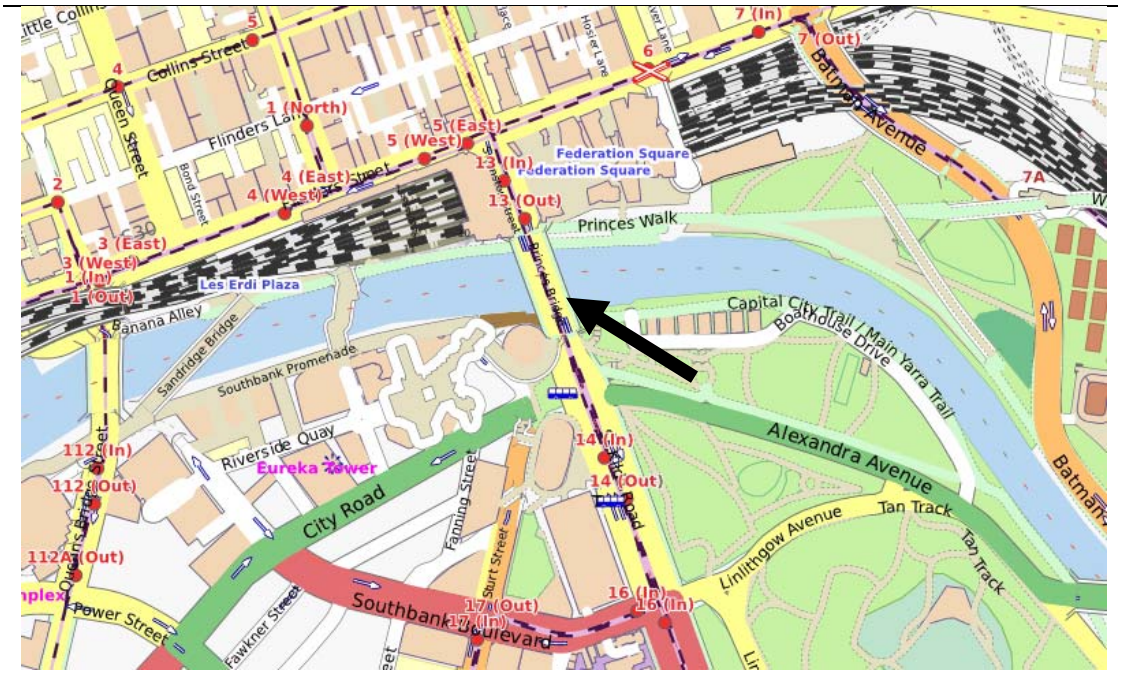
■ Figure 1.4: Canning Street (Carlton)

Date:	Wednesday 22 June 2011
Weather:	Min temp. 7.3° Max temp. 13.9° Rain 4.2 mm Sunset 5:08pm



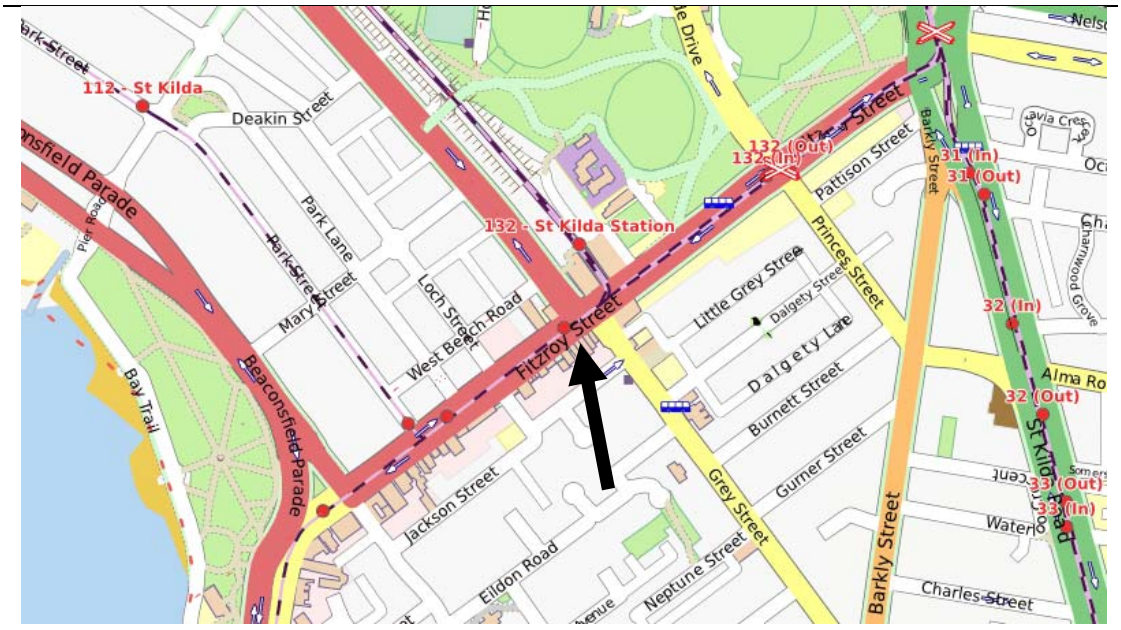
- Figure 1.5: St Kilda Road (Melbourne)

Date:	Thursday 23 June 2011
Weather:	Min temp. 9.4° Max temp. 16.2° Rain 0.2 mm Sunset 5:08pm



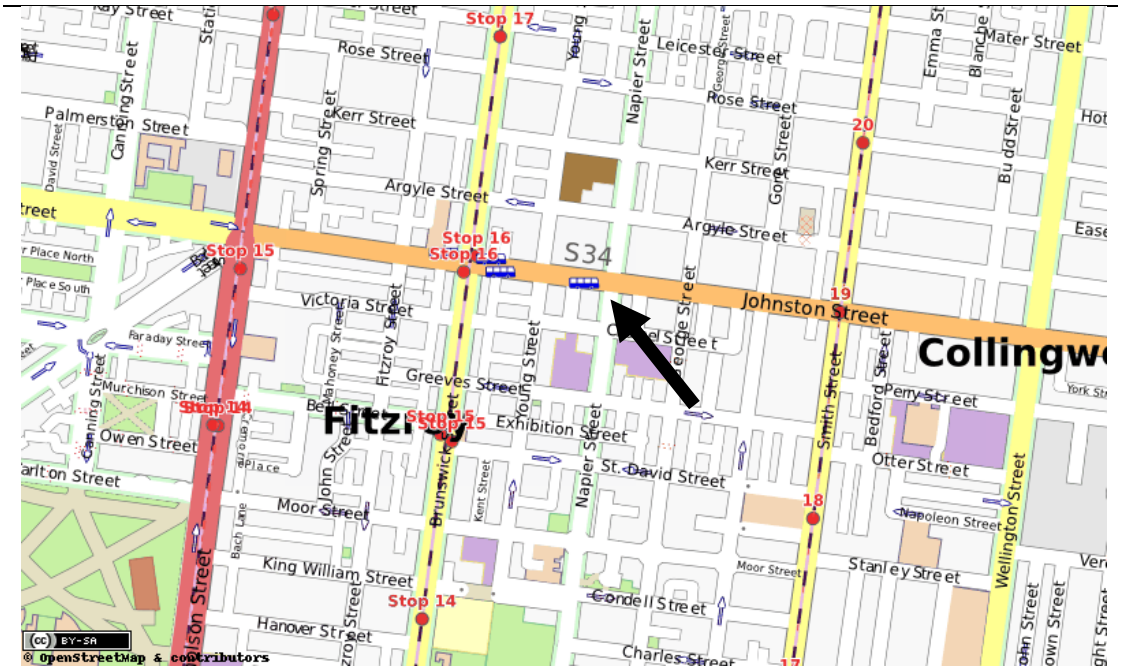
- Figure 1.6: Fitzroy Street (St Kilda)

Date:	Thursday 30 June 2011
Weather:	Min temp. 6.5° Max temp. 17.6° Rain 0.0 mm Sunset 5:11 pm



- Figure 1.7: Napier Street (Fitzroy)

Date:	Thursday 7 July 2011
Weather:	Min temp. 6.4° Max temp. 11.5° Rain 2.4 mm Sunset 5:14pm



2 Methodology

The engagement methodology was essentially unchanged from 2010. Staff and volunteers from Councils, Bicycle Victoria and Victoria Police stopped and interviewed cyclists at each of the four sites. Riders were provided with information materials and an incentive (a spoke light) as a gesture of thanks for their cooperation. This was consistent with the engagement model; to develop a rapport with riders in order to better understand their motivations and lighting behaviours.

2.1 Sampling

Almost all cyclists were stopped along the corridor during the intervention. Police assistance was provided to ensure the safety of the interview team, riders and other road users during the engagement. This had the additional benefit of ensuring that virtually all riders passing the interview point stopped for the engagement. Further, police were located ahead of the interview point to minimise the likelihood that riders without lights diverted or turned around to avoid the interview[1]. As such, aside from Fitzroy Street, we have confidence the sample is not biased by riders diverting around the interview location.

Wherever possible all riders passing the interview point were interviewed. However, during busy times when all interviews were preoccupied conducting interviews cyclists *with* lights were waved through without conducting the survey. This approach means the survey totals for riders with and without lights is biased. However, the characteristics of the riders in either group are not biased in this approach as those waved through were essentially selected at random.

The survey was largely administered by the interviewer, although at very busy times respondents were occasionally asked to complete the survey themselves. In a survey such as this, where respondents report on their behaviour and the socially desirable response is clear (i.e. to have lights) there will invariably be some bias as respondents report what they perceive to be the socially desirable response, rather than their real behaviour. Video monitoring of lighting compliance eliminated this risk in determining overall compliance, but for some responses –particularly the self reported time that respondents had not had lights, there is likely to be some bias. To what extent such a bias is present is not possible to ascertain; however, the possibility should be borne in mind when considering the results presented in this report.

2.2 Video observations

Video cameras were setup to observe cyclists travelling through the interview point. The cameras were setup as follows:

[1] In practice this approach ensured very few, if any, cyclists could avoid the interview site at Canning Street, St Kilda Road and Napier Street. However, the visibility of the Police van and availability of alternative routes at Fitzroy Street meant that cyclists could readily avoid this site.

- A camera was located approximately 200m upstream of the interview point to observe the rear lights of cyclists in the vicinity of the interview point
- A camera was located at the interview point facing upstream to observe the front lights of cyclists approaching the interview point.

The purpose of these cameras was threefold:

- to determine the proportion of cyclists who had front and/or back lights that were visible at 200 m,
- to measure the lighting strategies adopted by cyclists (for example, the number of lights used, whether they were static or flashing and where they were attached on the bicycle or to the cyclist's helmet or body), and
- to make a qualitative assessment of the visibility of cyclists with the varying lighting strategies.

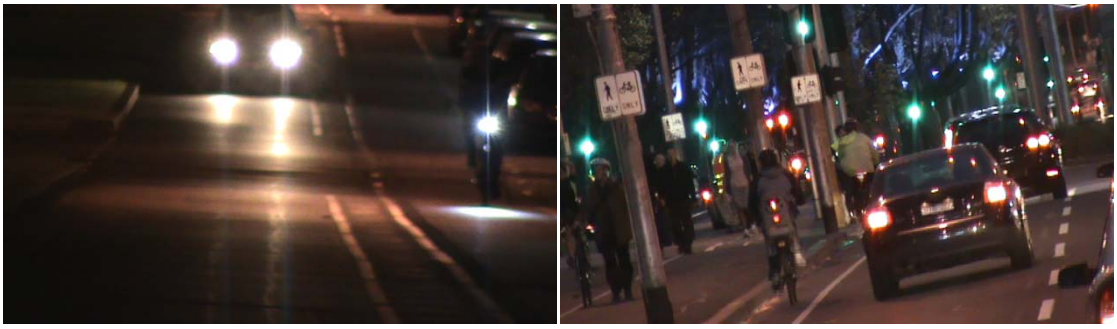
The former of these issues was particularly important given that the survey sample was inherently biased towards cyclists without lights.

It is important to note that video cameras do not replicate human eyesight, particularly under night conditions. The cameras tend to have a higher sensitivity to light than typical human eyesight, meaning that a light visible on the camera recording may not be visible to the naked eye. As such, the proportion of cyclists who are visible at 200 m is likely to be ***overestimated*** in this study. To what extent this overestimation occurs is not altogether clear; as such, this estimate should be treated with caution. Similarly, the qualitative assessment of the visibility of the cyclists will be influenced by the differing sensitivity of the cameras and the judgement of the observer. Conspicuity against a background is also an important factor. Examples of what was defined as 'dim', 'adequate' and 'bright' are given in Figure 2.1. Again, such classifications should be treated with caution and considered to serve as a broad indication only. It is assumed in this analysis that lights that are classified as dim at 200 m would not meet the legal requirement.

- Figure 2.1: Typical screenshots showing different brightness levels

- Dim

- Adequate



- Bright

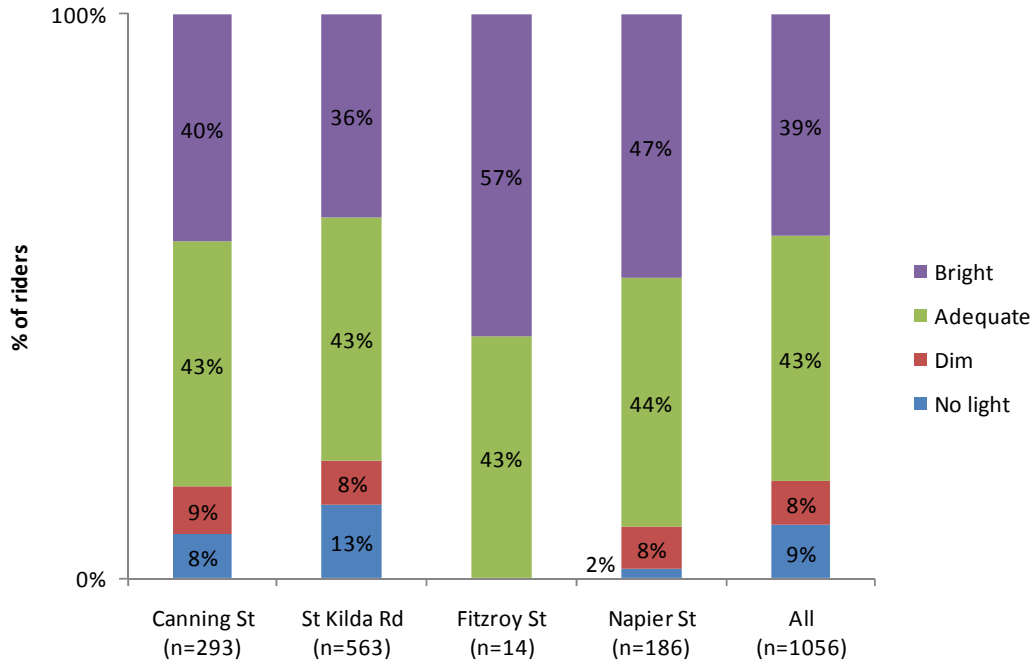
3 Results

In this section results from the survey and video observations are presented. Discussion of the results is deferred until Section 4. The sample from the four sites was pooled together for the survey data, in part because of the relatively low sample sizes at each individual site and also because of incomplete surveys meant 32% of the surveys could not be definitively assigned to a specific site.

3.1 Compliance

The proportion of cyclists with no front lights and lights of varying (subjective) brightness at a distance of 200 m are shown in Figure 3.1 for the four sites. The proportion of riders without lights varied from none (Fitzroy Street[2]) through to 13% on St Kilda Road. A further 8 to 9% of riders had lights which were classified as dim (and so unlikely to meet the 200 m requirement).

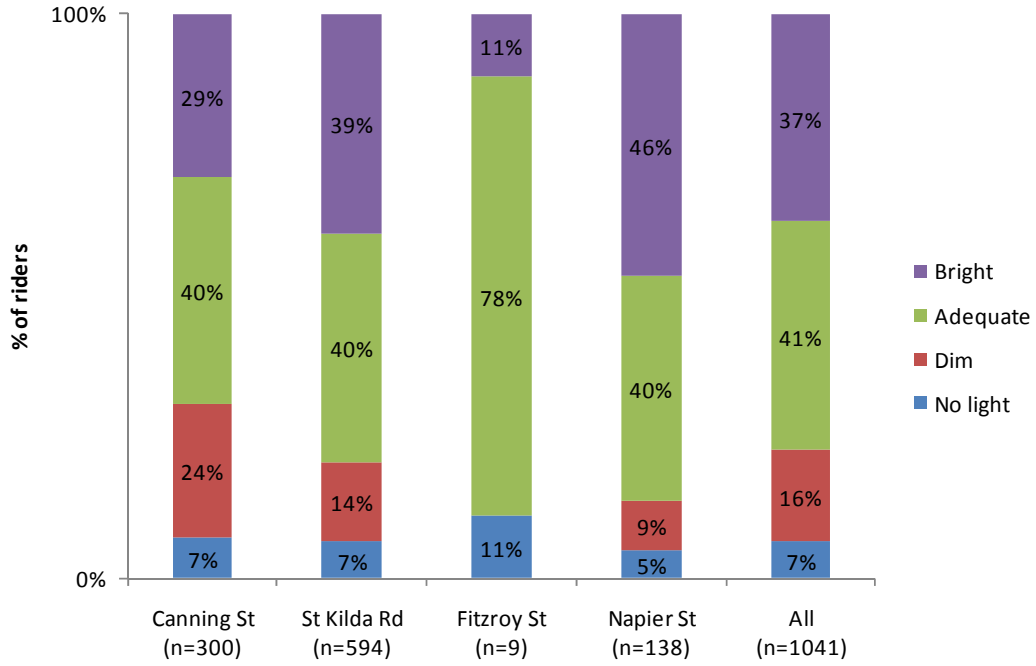
- Figure 3.1: Front light compliance by site



The proportion of riders without rear lights was somewhat smaller than those without front lights; and was between 5 and 7% (Figure 3.2).

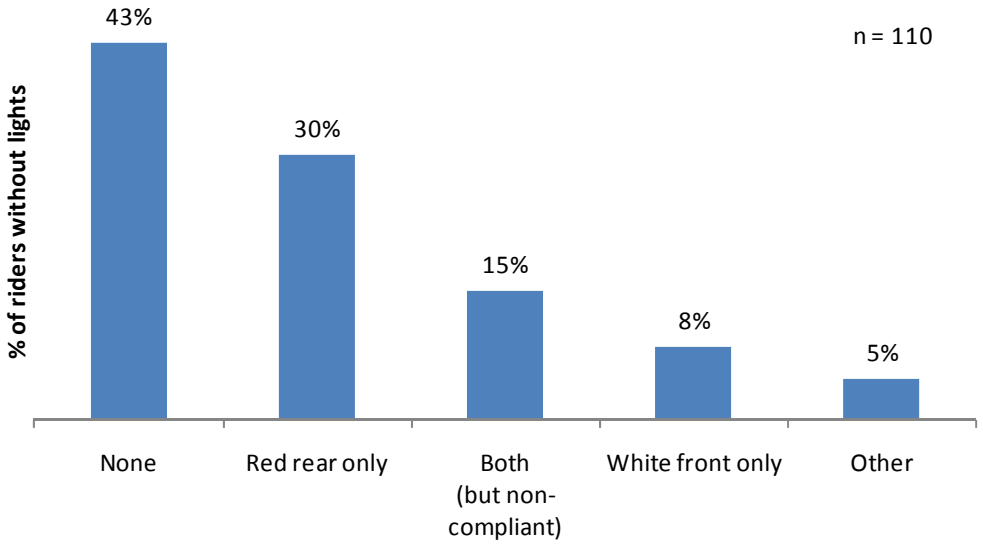
[2] Only 48 minutes of footage was available from Fitzroy Street due to attempted theft of the camera. Furthermore, the sample is likely to be biased as the police van was visible for a long distance from either direction and there were ample 'escape' routes cyclists without lights may have taken.

■ Figure 3.2: Rear light compliance by site



While the videos provided a good indication of overall light compliance it was not possible to match front and rear lighting on each bicycle; for example, it was not possible to ascertain whether those who did not have front lights did not also have rear lights. The intercept survey redressed this shortcoming. A total of 257 surveys were undertaken, although not all were completed. 109 surveys (42%) were with riders with lights and a further 148 (58%) were without lights. Of those interviewed who were deemed to be without lights, the largest group (43%) had neither front or rear lights (Figure 3.3). A further 30% had only a red rear light and 8% had only a white front light, suggesting that riders with inadequate lights see a rear light as most important. 15% had both lights, but were either very dim, attached to the rider (rather than the bicycle, as required by law) or otherwise non-compliant.

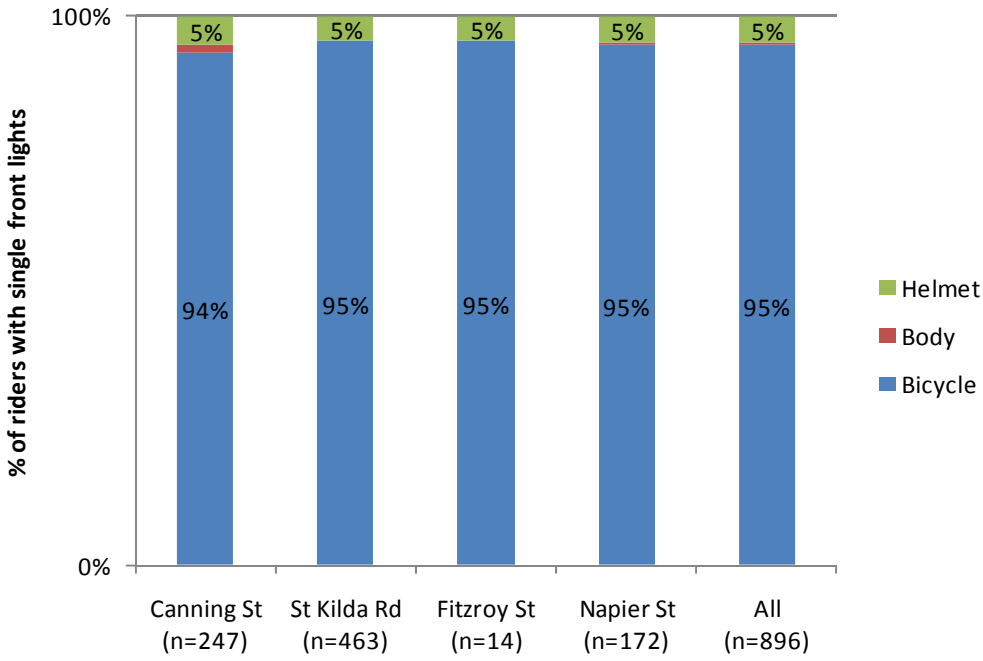
■ Figure 3.3: Lighting compliance of those who were without lights



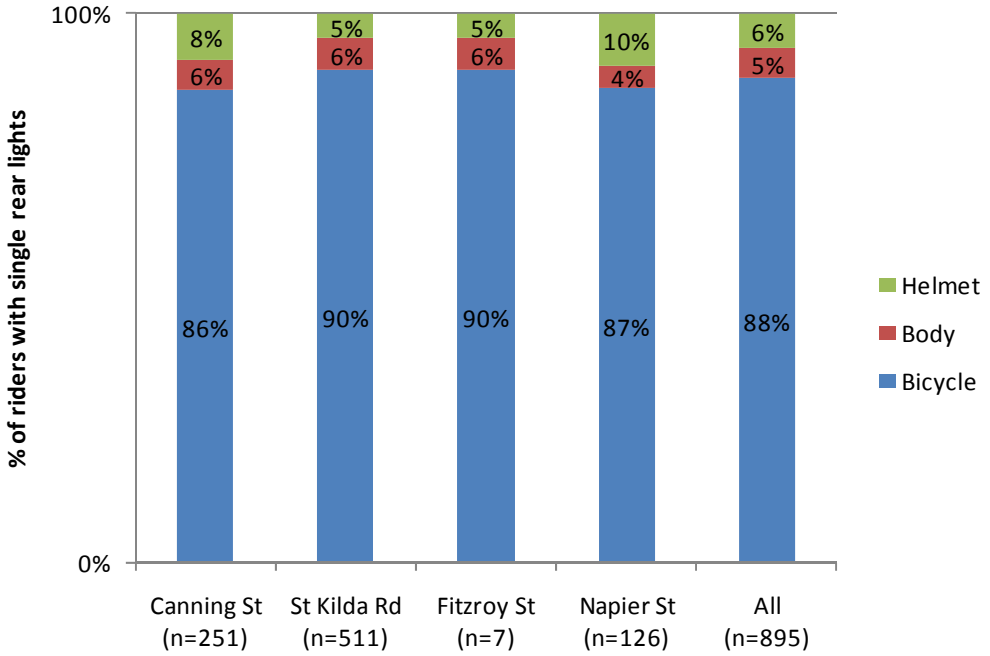
3.1.1 Mounting location

The location of lights for each rider was classified into bicycle, body and helmet mounts. For both front and rear lights, the majority were located on the bicycle frame (Figure 3.4 and Figure 3.5). Around 5% of riders had only a front light on their helmet, and 6% had only a rear light on their helmet and a further 5% had only a rear light on their body.

■ Figure 3.4: Front light location (single front light only)



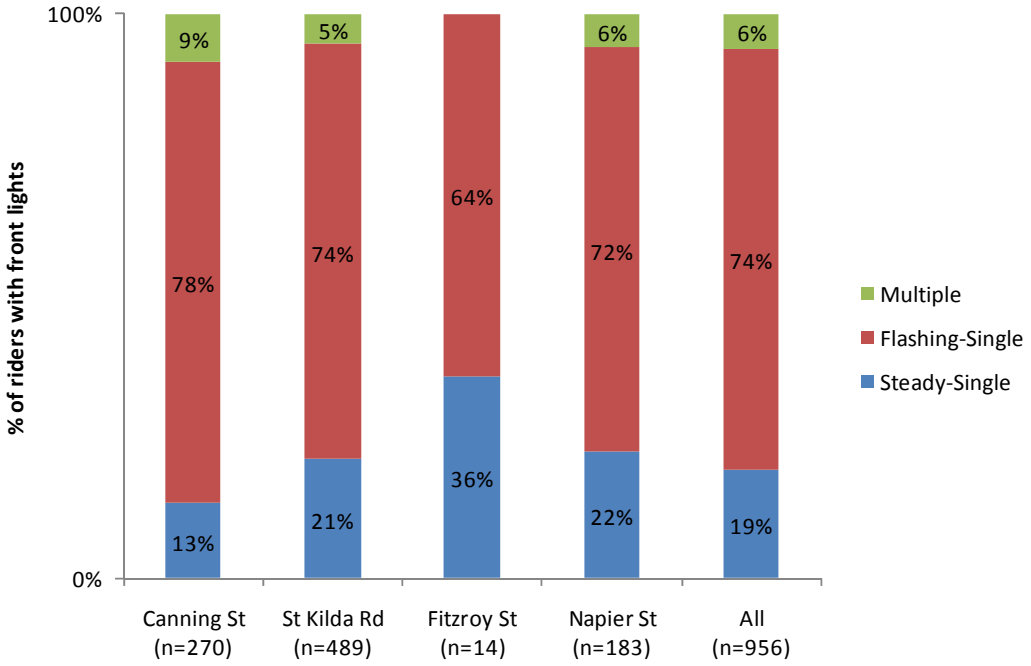
■ Figure 3.5: Rear light location (single rear light only)



3.1.2 Multiple and flashing lights

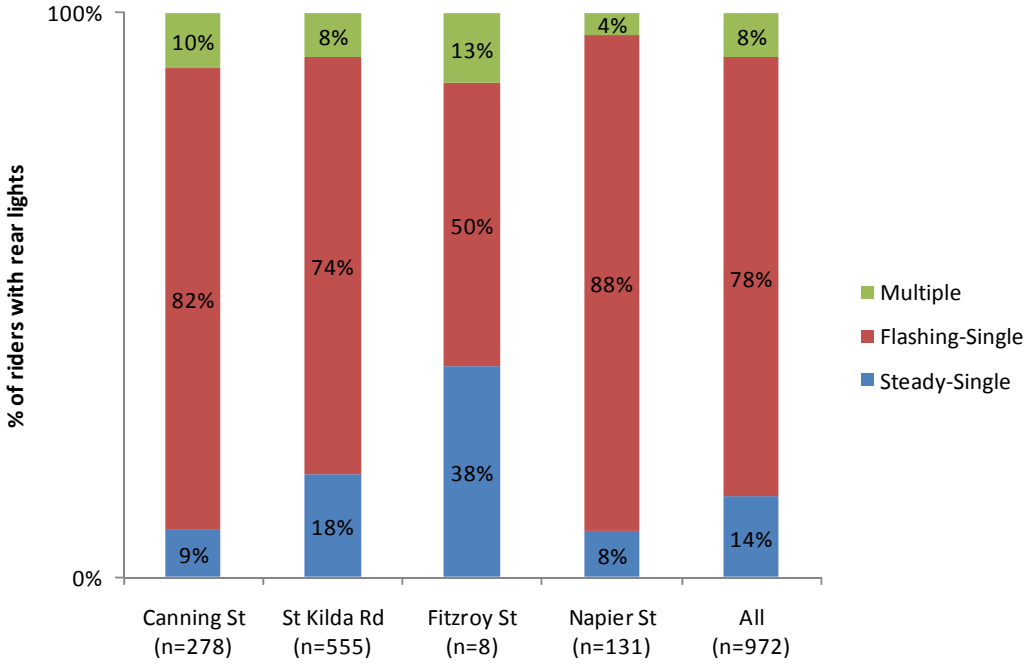
Of those with front lights around three quarters had a single flashing front light and most of the remainder had a single steady light (Figure 3.6). For the small proportion that had multiple front lights the most common strategy was two flashing front lights on the handlebar.

■ Figure 3.6: Front light strategies by site



Of those with rear lights a similar proportion adopted a flashing light strategy as those with front lights (Figure 3.7). Of the small minority that had multiple lights the most common strategy was one flashing light on the bicycle and another on the helmet.

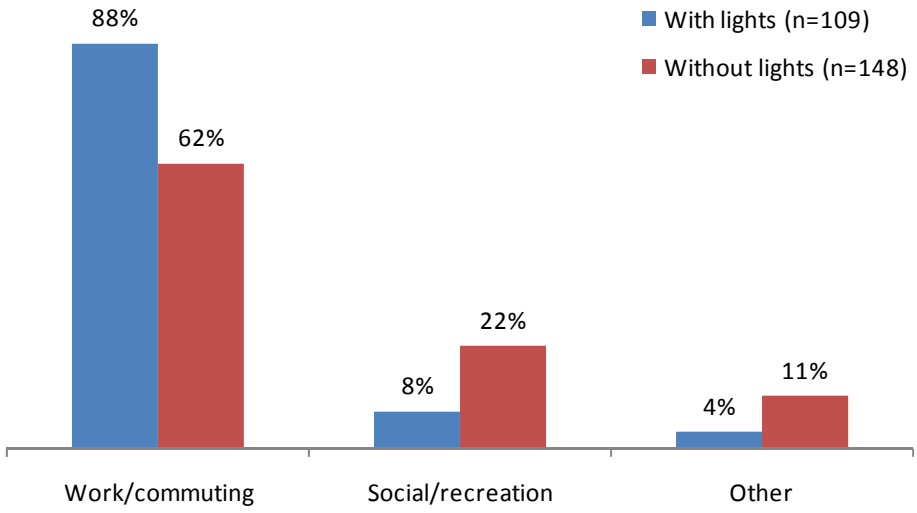
■ Figure 3.7: Rear light strategies by site



3.2 Characteristics of those with and without lights

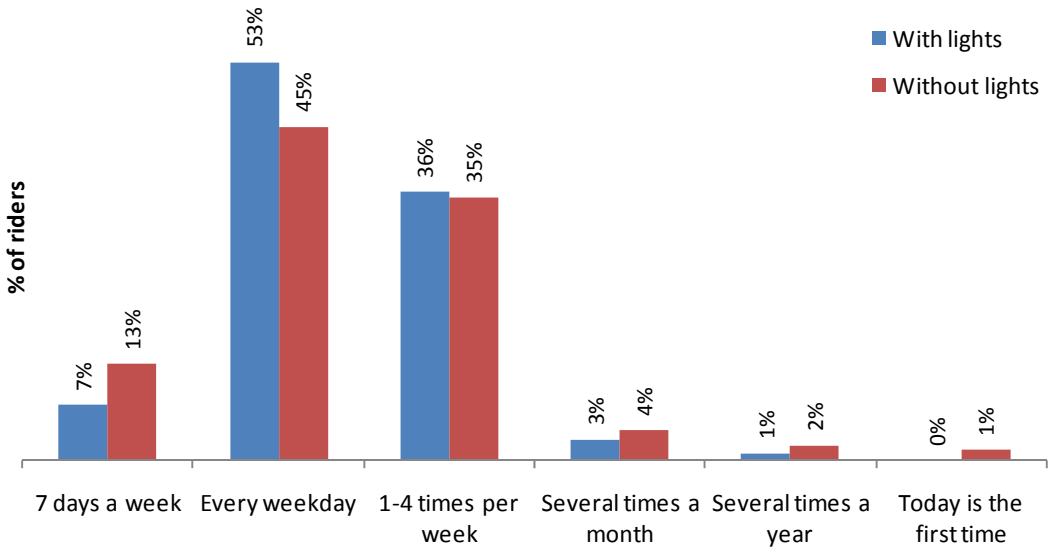
The proportion of riders with lights who were riding for commuting with lights (88%) was significantly higher than those without lights (62%).

- Figure 3.8: Trip purpose



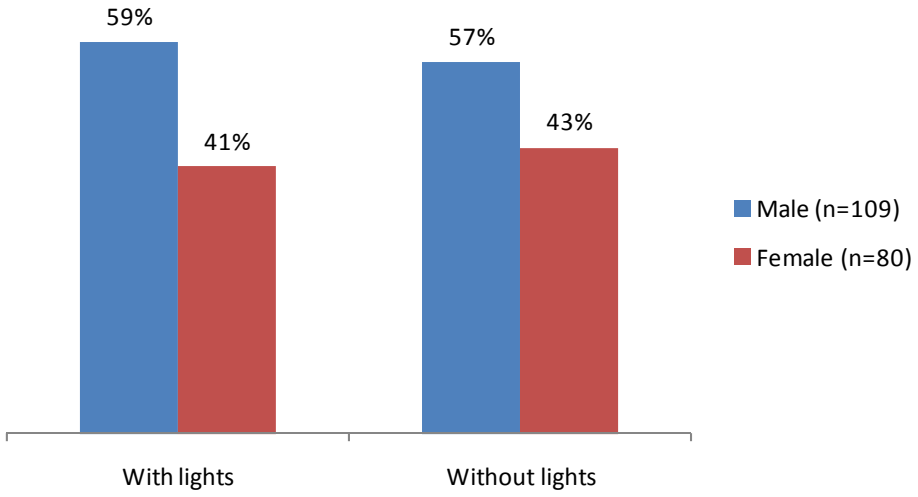
There is no significant difference in the regularity of riding at night time between those with and without lights (Figure 3.9). 61% of those with lights and 57% of those without lights ride at night at least every weekday, although this difference is not statistically significant (p=0.308).

- Figure 3.9: Frequency of riding at night time



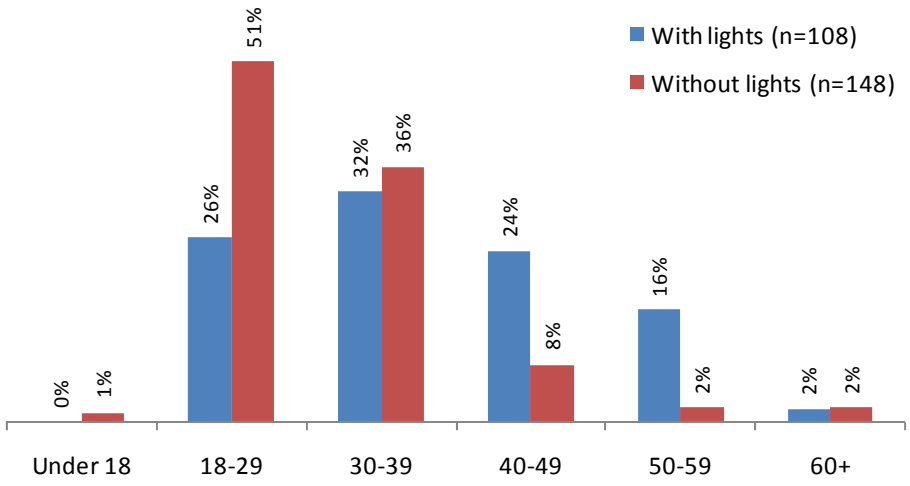
There is no significant difference between the genders for riders with and without lights (Figure 3.10)[3].

■ Figure 3.10: Gender distribution



By contrast, there is a strong bias towards younger riders riding without lights (Figure 3.11). 52% of those without lights were aged under 30, compared with 25% of those with lights.

■ Figure 3.11: Age distribution

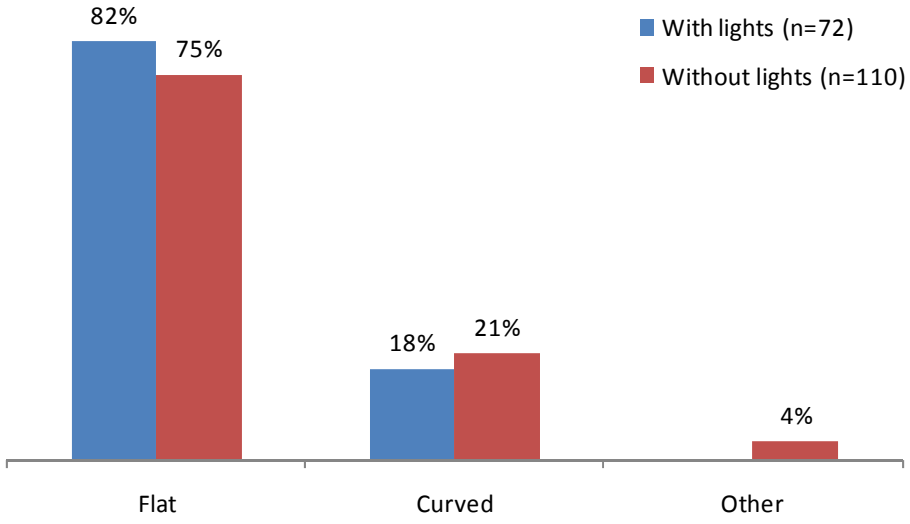


The type of bicycle ridden was classified according to the handlebar type (flat, curved (i.e. road racer) or other) and by the type of tyres (road, mountain and other). There was no significant difference in the handlebar type between those with and without lights (Figure

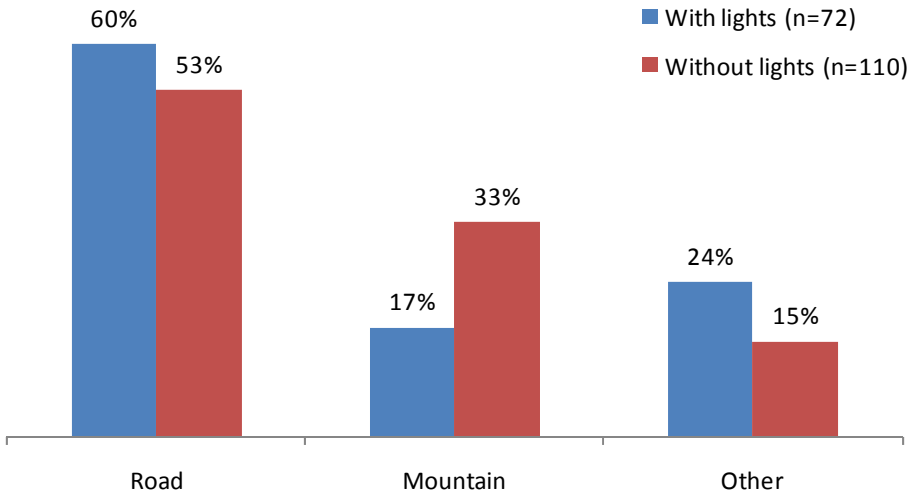
[3] The surveys cannot be used as a means to measure lighting compliance, as those without lights were intentionally oversampled compared to those with lights. As such, within group measures are biased (e.g. proportion of males and females with and without lights). However, between group comparisons within each survey group remain valid as no sampling bias was present for demographic characteristics.

3.12), but there a statistically significant difference between the proportion of mountain bikes in each group (Figure 3.13).

■ Figure 3.12: Handlebar type



■ Figure 3.13: Bicycle type



The average trip time varied considerably between the groups; those with lights had an average riding time of 32.9 minutes compared with 23.2 minutes for those without lights (Table 3.1). Furthermore, 41% of riders without lights were making a trip shorter than 15 minutes compared with 15% of those with lights[4].

[4] These results are different to those reported in the 2010 monitoring report, where no difference was reported in average travel distance between those with and without lights. It is possible the smaller sample sizes in the 2010 monitoring, combined with the use of distance (which is typically harder to report than time) explain the different results.

■ Table 3.1: Trip time comparison

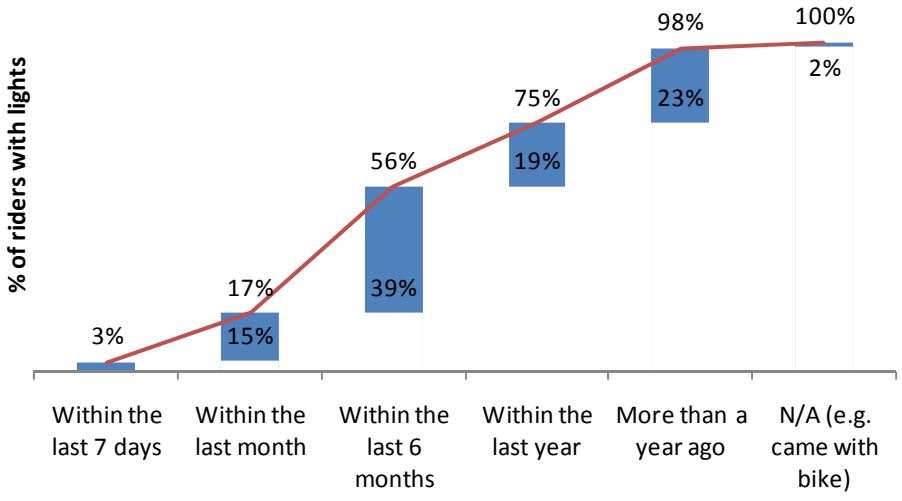
	With lights	Without lights
Average	32.9 mins	23.2 mins
No. of obs.	104	148
Std. error	2.4 mins	1.5 mins
p-value [1]	0.0007	
% ≤ 15 minutes	15%	41%
p-value	0.0000	

(1) As the sample variances differ between the two groups, an unequal samples t-test was used. The p-value is the probability of rejecting the hypothesis that the sample means are identical. As the value is well below a 95% significance level of 0.05, we conclude the difference is statistically significant.

3.3 Riders with lights

Riders with lights were asked about when they last bought lights and the process they went through to decide upon a set of lights. Three quarters of those with lights had purchased lights within the last year (Figure 3.14), and 56% had done so within the past six months. 87% of riders had lights prior to this most recent purchase.

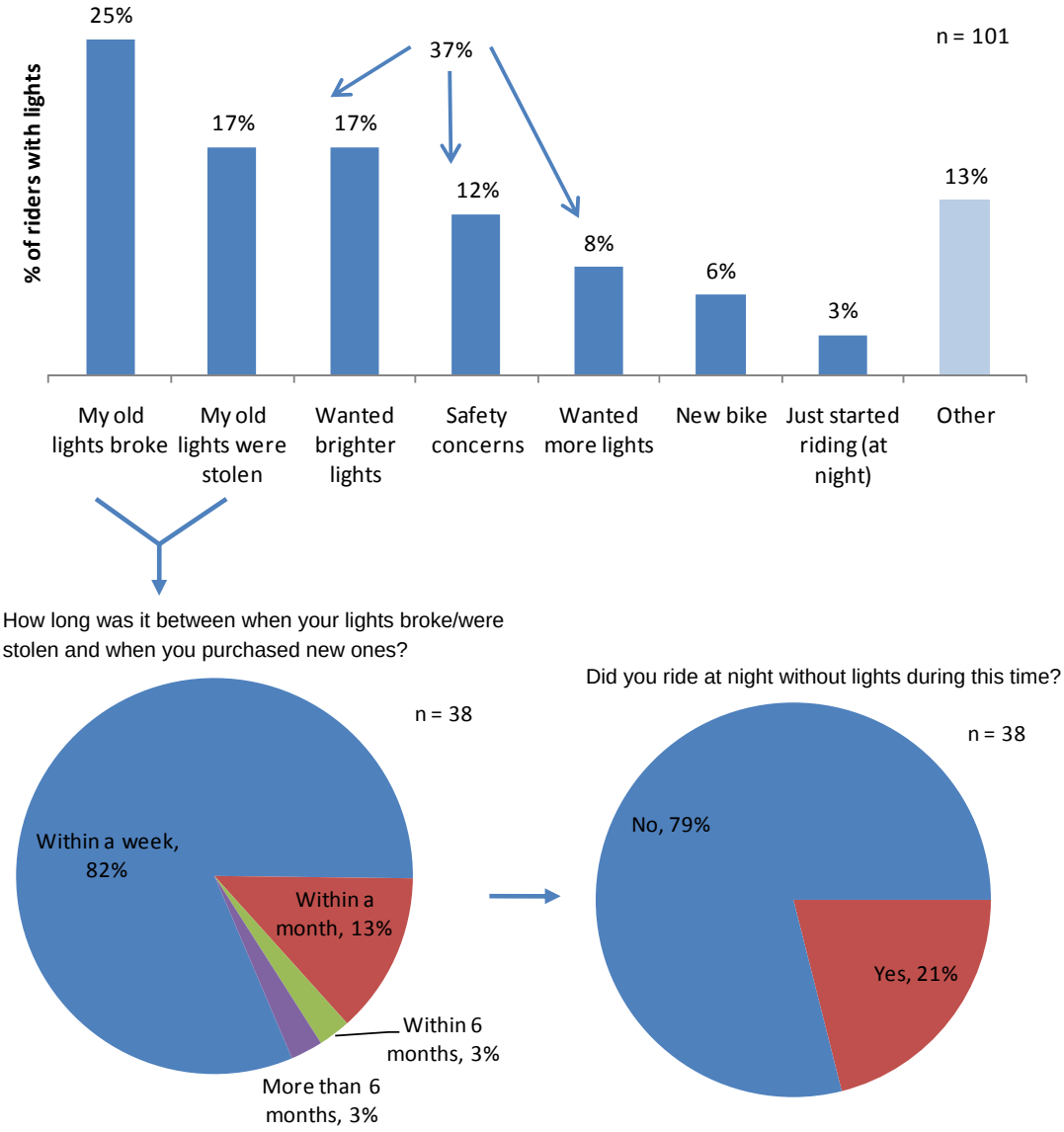
■ Figure 3.14: When did you most recently buy lights for your bike?



A quarter of riders indicated their principal reason for purchasing new lights was after their old lights broke, while a further 17% said their lights had been stolen (Figure 3.15). Taken together, those wanting brighter or more lights or having safety concerns represented 37% of riders. No rider identified an impulse purchase as their primary motivation, suggesting riders are making a considered choice to (a) buy lights, and (b) to choose between the options. Further, those whose motivation was a broken or stolen light tended to replace the

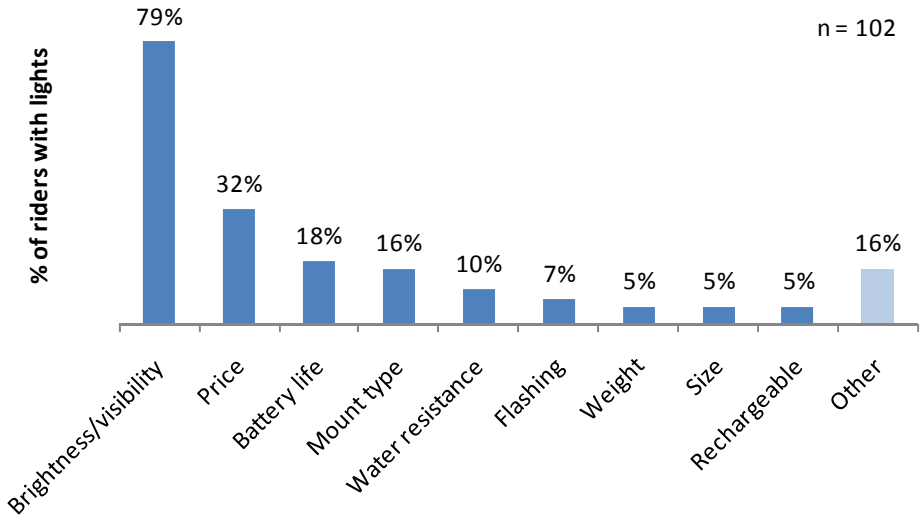
light very promptly, usually within a week. Four fifths of riders avoided riding without lights while they were in the process of buying new lights.

■ Figure 3.15: What led you to purchase new lights?



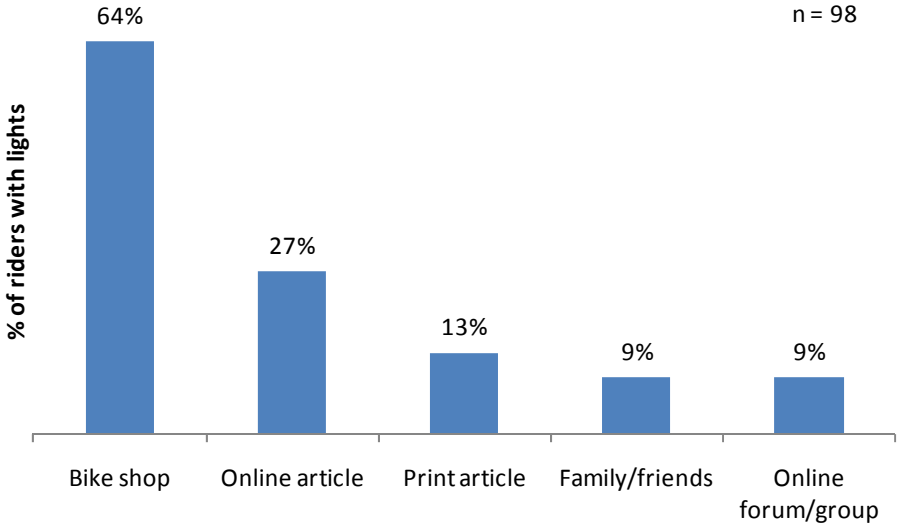
Most riders (79%) identified brightness or visibility as the main feature they looked for in a new light, with price and battery life also being significant features (Figure 3.16).

■ Figure 3.16: What were the most important features in deciding which lights to purchase? (multi-response)



The most commonly cited source of information about light options was bike shops, with online and print articles also providing information to riders (Figure 3.17).

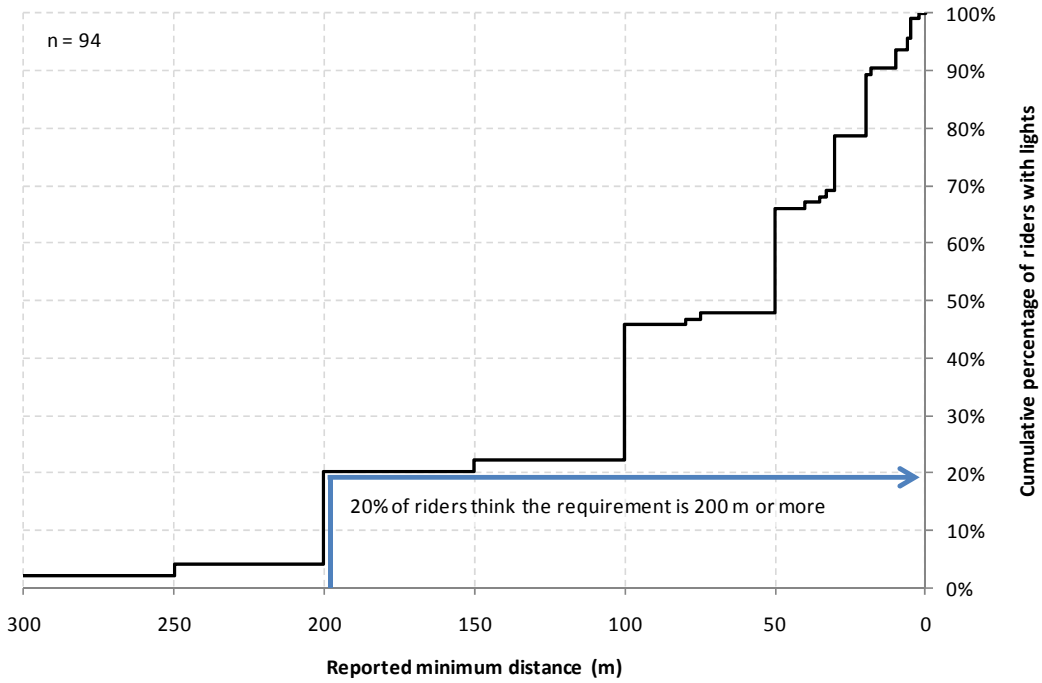
■ Figure 3.17: Where did you get information about light options? (multi-response)



The road rules stipulate that a bicycle light be visible from 200 m. 16% of riders with lights were aware of this rule, and a further 4% thought the distance was more than 200 m (Figure 3.18)[5]. 46% of riders thought the distance was 100 m or more and 66% thought it was 50 m or more.

[5] These results are not dissimilar to the 2010 survey, where only 2 of 32 respondents (6.3%) were awareof the 200 m requirement.

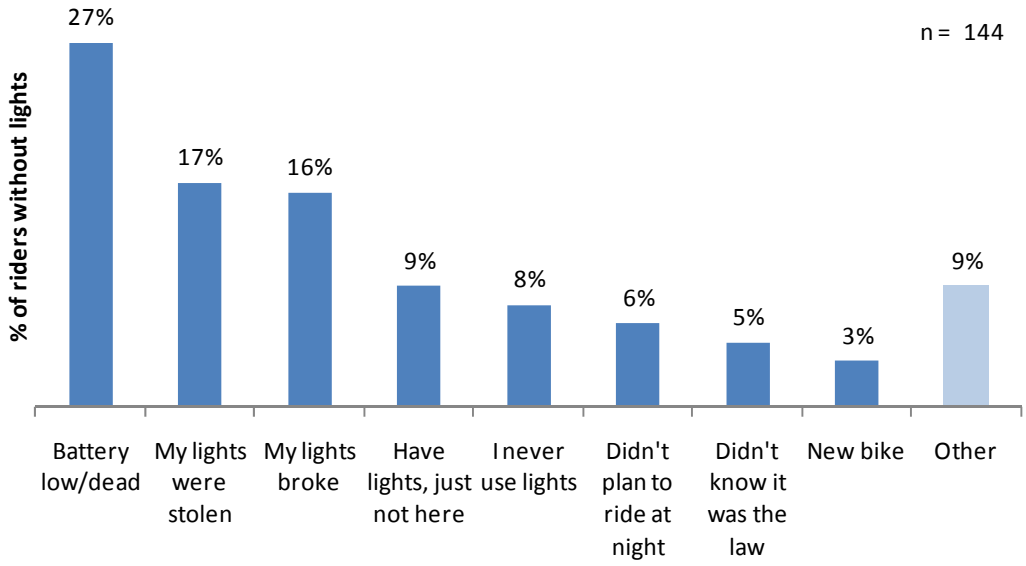
■ Figure 3.18: Reported minimum legal light distances



3.4 Riders without lights

Those without lights, or with lights which were too dull or otherwise non-compliant, were asked why they were missing one or more lights (Figure 3.19). The most commonly cited reason was a low or dead battery (27%), followed by stolen (17%) and broken lights (16%). Only a small proportion indicated they never used lights (8%) or had not planned on riding at night (6%).

■ Figure 3.19: Why are you missing one or more lights?

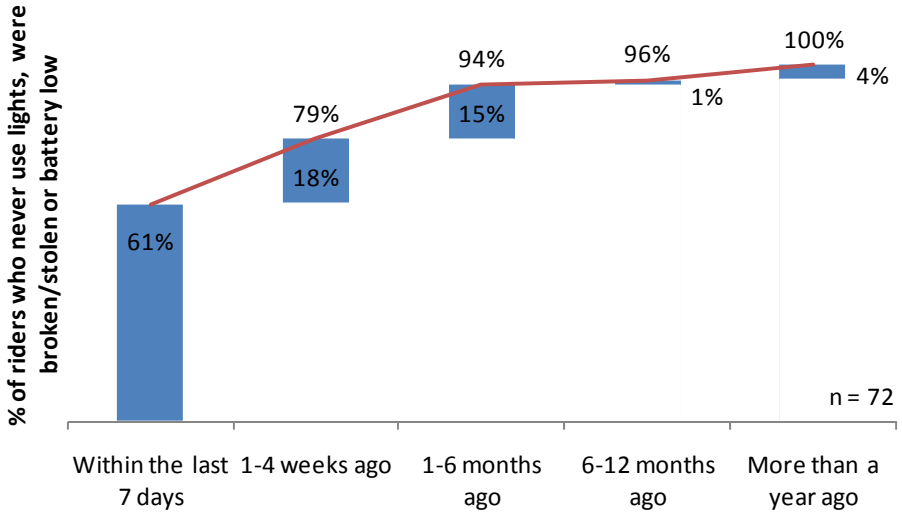


Of the 11 riders who did not have lights, and indicated they never used lights at night, the reasons for not using lights were cited as follows:

- Only a short trip (3 riders)
- Haven't got around to buying lights (2 riders)
- It is safe without, too expensive, borrowing a friend's bike, don't usually ride at this time and laziness (all 1 rider each).

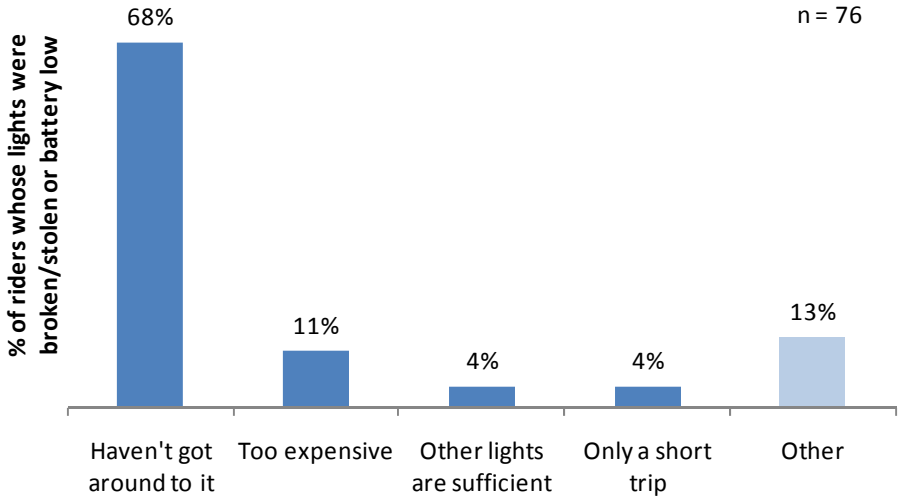
Almost two thirds of those who indicated they had broken or stolen lights, or a low or dead battery, reported that this had occurred in the past week (Figure 3.20).

■ Figure 3.20: How long ago were your lights broken or stolen, or the battery go flat?



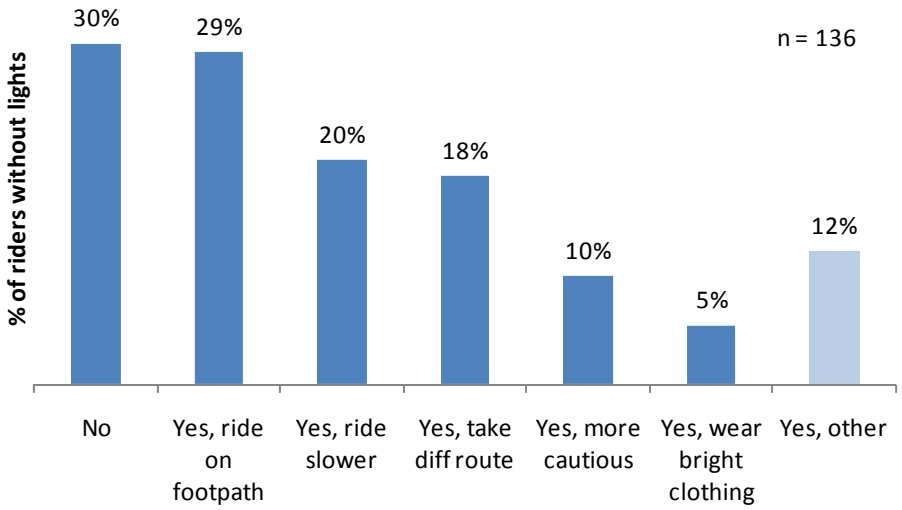
Two thirds of riders who had broken or stolen lights, or a low or dead battery indicated they simply had not gotten around to buying lights (Figure 3.21).

■ Figure 3.21: Why haven't you replaced your lights?



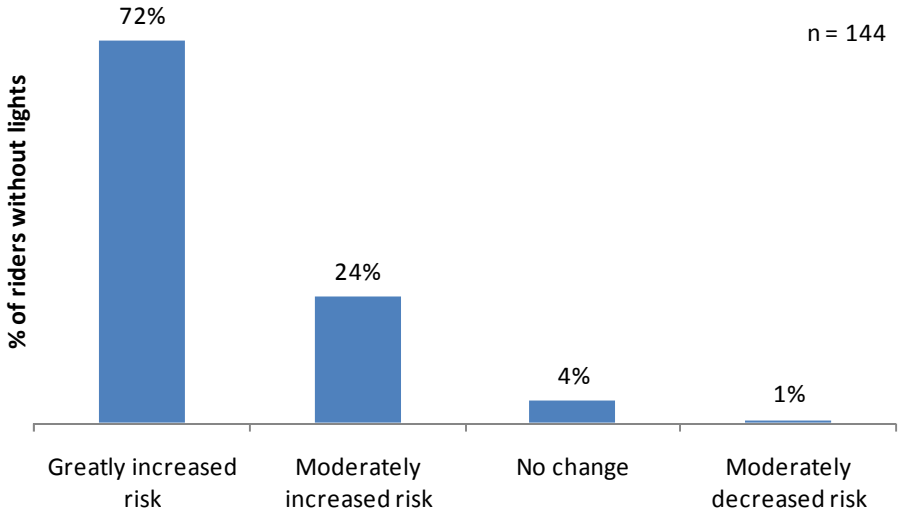
30% of riders without lights said they did nothing differently as a result of not having lights (Figure 3.22). Others rode at least part of their route on the footpath (29%), slower (20%) or took a different route (18%). Only 5% said they compensated for not having lights by wearing bright clothing.

- Figure 3.22: Is there anything you do differently because you don't have lights? (multi-response)



Despite choosing not to ride with lights, almost three quarters of riders without lights agreed there was a greatly increased risk of doing so and a further 24% agreed there was a moderately increased risk (Figure 3.23).

- Figure 3.23: What influence do you think riding without lights has on your risk of being involved in a crash?



4 Discussion

In this section we present our interpretation of the data obtained in this monitoring activity, and present recommendations for future years of the Light Up! engagement activity.

4.1 What proportion of riders have no lights or inadequate lights?

Just under 10% of riders did not have either a front or rear light (or were missing both). This proportion did not appear to differ greatly across the sites (at least, not to a statistically significant level or beyond what we may imagine represents avoidance by riders who saw the police in advance). That a marginally lower proportion of riders did not have rear lights (7%) compared with front lights (9%), and that if a rider was intercepted with only one light they were far more likely to have a rear light than front light, appears to reflect the widely held view in the community that it is rear aspect visibility which is most important.

4.2 What influences lighting compliance?

Lighting compliance appeared to be influenced by a number of factors:

- Riding for commuting increases the likelihood of having lights, and so an emphasis on the geographically and temporally dispersed non-commuting travel purposes may be required to redress non-light compliance (although this would be much more difficult logistically).
- Longer trips increase the likelihood of having lights, although trip length is highly correlated with trip purpose and so it is not clear whether trip purpose or travel time (or a combination) is contributing to the higher levels of compliance.
- Younger adults are far less likely to have lights than older riders.
- Those with mountain bikes, which *may* represent the less costly segment of the bicycle market, are less likely to have lights. For many of these riders the price of lights was noted as significant in their decision not to have lights. Alternatively, a lower proportion of commuters may ride mountain bikes.

The factors which did not appear to influence lighting compliance are also revealing:

- There is no observable difference in lighting compliance levels between males and females.
- The frequency of riding at night does not influence lighting compliance, nor is there a significant proportion of riders without lights who had not intended to ride at night. In other words, riders without lights are making the predetermined decision to schedule their travel at night time and to do so on a regular basis without lights (it appears to be a planned behaviour).
- As knowledge of the legal requirement of 200 m visibility is known by only a fifth of riders, it appears to play only a limited role in encouraging riders to have highly visible lights (by contrast the presence of a rule to have lights at all, and occasional enforcement by Police, is probably widely known and would appear to encourage

some greater level of compliance – as demonstrated by the attempts some riders without lights made to evade the interview point).

An additional message that appears to come from the survey data is that there is significant churn in the group of riders without lights. As many had broken or stolen lights, and indicated they intended to purchase new lights very soon, there appears to be significant variation over time as individuals move from the lights to non-lights group and back again. There appears to be merit here in considering what measures are required to reduce the incidence of broken and stolen lights in the first instance, perhaps supported by encouraging riders to have backup lights for the inevitable situation where their primary lights are broken or stolen. Technology is clearly playing a role here, as the energy efficiency and battery capacity of lights improve (reducing the incidence of flat batteries) and mounts are improved.

4.3 When buying lights, what features does a rider look for and to whom do they turn for information?

Riders appear to buy lights regularly; 56% of those with lights interviewed had done so in the past six months. This is probably motivated by the rapid technological progress coupled with reducing prices, increase in the number of 'new' riders over recent years and the level of reported broken and stolen lights. As newer lights tend, on average, to be more reliable this regular churn may result in brighter and sturdier lights in the bike fleet over time.

There was widespread recognition that brightness and visibility was an important selection criteria for lights, although price and battery life was also considered important. As was explored in the 2010 Light Up! monitoring study, there exists no clear objective way for a rider to assess a lights' brightness. A number of riders in the present study referred to the Ride On magazine review undertaken annually by Bicycle Victoria as a significant input to their decision process, as this test provided some objective basis upon which to make a judgement[6].

There appears to be a consensus among riders that flashing lights increase their visibility (given that three quarters of riders chose to operate their lights in a flashing mode) and that the most convenient location for a light is on the frame. Only a minority (between 5 and 10%) of riders chose multiple light strategies, in which case one light was usually located on the frame and another on either the body or helmet. There is a paucity of evidence on which strategy, or strategies, is most effective at increasing rider visibility. There is, for example, an argument that the most effective location for a rear light is on the frame as this is more in-line with most vehicle windscreens. However, given the overall limited data on lighting visibility there would appear to be a case for further research which can then lead to focussed advice on the 'best' options.

[6] Four referred to the Ride On article explicitly, with an additional 13 mentioning magazine or newspaper articles in general.

4.4 Recommendations

In this section we discuss briefly recommendations both for refinements to the survey design, to the engagement method and one avenue that may be useful for developing more evidence-based guidance on the most appropriate lighting strategy.

4.4.1 Survey design

The fieldwork team provided feedback on the survey design which is useful for refinement of the survey instrument in future years. These recommendations are as follows:

- The date, time and location attributes may be best located at the start of the form, as interviewers can complete this section while waiting to start the interview. The rider attributes (demographics and bicycle type) may also be located at the start, as these can largely be completed by the interviewer prior to commencement of the interview proper.
- As the location was not filled in on a significant proportion of the survey forms it would be reasonable to either (a) fill in the location field at the start of a fieldwork session, or (b) provide a checkbox or code option so the interviewer can quickly enter the location.
- Refine the 'other' field codes; there were a large proportion of 'other' entries which can be readily classified and incorporated as explicit fields in the next survey. Furthermore, a number of riders offered extensive qualitative views on their lighting decisions; more space for 'other' fields may allow for a more in-depth interview.
- Consider whether BV membership is a contributing factor to greater lighting compliance; it would be feasible to ask whether riders are BV members (see also Section 4.4.2).
- Email addresses were often undecipherable; entering each letter in a box in capitals may increase readability (as may the use of other input devices, such as tablets or smartphones).
- Allow for situations where the rider has borrowed a bike from a friend or colleague and so has little to no knowledge of the lighting decisions of the bike owner.
- Originating and destination suburb or postcode may provide useful complementary origin-destination trip data.
- Reinforce the message to riders at the start that the survey is short and there is an incentive for their participation.
- Alter the wording of the purpose fields should be clarified. Commuting may be better defined as "riding to or from work". "Social/recreation" may be interpreted as cycling as recreation or to other recreational activities (e.g. gym, park). Instead, it would be preferable to separate this category into "riding for fitness", "riding to visit friends" and "going out for the evening".

4.4.2 Engagement method

The engagement was generally well received by riders, and the feeling was that riders both with and without lights left the engagement better informed and more likely to ensure compliance with the lighting requirement. However, a number of adjustments to the engagement may further improve the effectiveness of the messaging:

- Engage more fully with BV members, where the rider says they are a member, and reinforce that the engagement is supported by BV; the strong affiliation of BV members may be leveraged to encourage more engagement among riders more generally with regard to appropriate lighting. That the BV Ride On lights review was regularly cited suggests there is already greater engagement by BV members.
- To encourage further dissemination of the messages present each rider with a business card with a unique ID and invitation to invite others to participate in an online survey (with an appropriate incentive). The online survey, while not providing an unbiased survey sample, would serve to further spread the message beyond those who were interviewed directly. An incentive to the rider who invites the most participants may help encourage the message to be spread.
- There was a lack of clarity around the requirement for lighting on a bicycle compared with on the rider themselves (particularly the helmet). Future engagements should encourage riders to consider the pros and cons (including the legal status) of lighting solutions which are attached to the rider but not to the bike.
- An alternative incentive, particularly for those with lights, may be one of the various reflective tape products which are widely available (and cost effective).
- There also appears to be some misunderstanding about the relative merits of front and rearward visibility. Targeted messages that demonstrate to riders that it is the frontal aspect that represents the greatest risk may be useful.

4.4.3 Research on effective lighting strategies

While there is good evidence to suggest that reflectors located on moving parts of the body (so called biomotion) significantly increase the distance at which drivers detect the presence of cyclists, there is only very limited evidence on how various lighting strategies affect the ability of drivers to detect cyclists. A controlled fieldwork trial using a sample of drivers and cyclists may offer some insight into the most effective lighting strategies. The variables that could be trialled may include:

- steady, flashing and strobing lights,
- impact in combination with reflective strips or tape on the frame, body or helmet,
- height of light on the cyclist (e.g. frame compared with helmet)
- effect of locating lights on cyclist ankles or in the spokes,
- impact on forward, side and rear aspect visibility, and
- influence of background lighting such as street lighting, shop lighting and other vehicles.

The latter influence is of particular interest, as most previous lighting and reflector trials with pedestrians and cyclists were undertaken in controlled conditions with little to no background lighting. The night time urban environment varies markedly from this controlled condition, with numerous light sources all serving to confuse the situation for a driver seeking to maintain lane tracking and avoid other cars, cyclists and pedestrians.

A measure of effectiveness widely used is the distance in advance of meeting the rider at which the driver reports having spotted the rider. The more effective lighting strategy would be the one which has the greatest distance at which drivers detect the rider.

4.4.4 Motivations for riding without lights

There remains a significant knowledge gap in understanding exactly why those without lights choose to ride. There are probably two distinct groups here: (1) those without lights on a short term basis (have had their lights lost or stolen, or their batteries are flat) and (2) those who never have lights. There are a number of hypotheses that could be tested here, including:

- Do those without lights on a short term basis ride anyway because it is a habitual activity and they are unaware of their alternatives, or see them as unviable?
- Do those who never have lights understand their legal obligations to have lights, do they know the requirement but consider the likelihood of being caught very low, or do they instead feel the risk (although elevated) is not sufficiently great to motivate them to buy lights?

These types of issues are best explored in focus groups, where riders in these groups are recruited from the Light Up! activity. Two focus groups, each with 6 – 10 individuals from these groups of riders may usefully explore these questions in far more depth than could be achieved in an intercept survey.

5 References

Brown, I.D. (2005) “Review of the ‘Looked but Failed to See’ Accident Causation Factor”, prepared for the UK Department for Transport. Road Safety Research Report No. 60.

Herslund, M.-B. and Jørgensen, N. O. (2003) “Looked-but-failed-to-see-errors in traffic”. Accident Analysis and Prevention 35, pp. 885-891.

Victorian Government (2010) “Road Safety Road Rules 2009”, S.R. No. 94/2009, version incorporating amendments as at 9 February 2010.

Wood, J. M., Tyrell, R. A., Maszalek, R., Lacherez, P., Carberry, T., Chu, B. S. and King, M. J. (2010) “Cyclist visibility at night: Perceptions of visibility do not necessarily match reality”. Journal of the Australasian College of Road Safety, 21 (3).

Appendix A: Survey forms

With lights survey

We're conducting a survey of riders to understand your perception of bicycle lights. Responses are completely anonymous and you will not be penalised as a result of your answers.

Q1. What is the main purpose of your current trip? (*tick one only*)

- Work/commuting ☐1
- Tertiary education (university/TAFE) ☐2
- School (primary, secondary) ☐3
- Restaurant/take away ☐4
- Social/recreation (e.g. fitness) ☐5
- Personal business (e.g. hairdresser) ☐6
- Shopping ☐7
- Other – please specify:

_____

_____ ☐8

Q2. What time did you start this bike trip?

_____ : _____ AM/PM

Q3. And how long will this bike trip take you?

_____ minutes

Q4. How often do you ride at this time of day? (*tick one only*)

- 7 days a week ☐1
- Every weekday ☐2
- 1 – 4 times per week ☐3
- Several times a month ☐4
- Several times a year ☐5
- Today is the first time ☐6

Q5. When did you most recently buy lights for your bike? (*tick one only*)

- Within the last 7 days ☐1
- Within the last month ☐2
- Within the last 6 months ☐3
- Within the last year ☐4
- More than a year ago ☐5
- Not applicable (e.g. came with bike) ... *Go to Q12*... ☐6

Q6. Did you have lights before this? (*tick one only*)

- Yes ☐1
- No ☐2
- Not applicable (e.g. first bike) ☐3

Q7. What led you to purchase new lights? (*tick one only*)

- My old lights broke ... *Go to Q8* .... ☐1
- My old lights were stolen ... *Go to Q8* .... ☐2
- Wanted more lights (e.g. 3rd light) ... *Go to Q10* ... ☐3
- Wanted brighter lights ... *Go to Q10* ... ☐4
- New bike ... *Go to Q10* ... ☐5
- Just started riding (at night) ... *Go to Q10* ... ☐6
- Safety concerns ... *Go to Q10* ... ☐7
- Impulse purchase ... *Go to Q10* ... ☐8
- Other _____ _____ *Go to Q10* ... ☐9

Q8. How long was it between when your lights broke/were stolen and when you purchased new ones? (*tick one only*)

- Within a week ☐1
- Within a month ☐2
- Within 6 months ☐3
- More than 6 months ☐4

Q9. Did you ride at night without lights during this time? (*tick one only*)

- Yes ☐1
- No ☐2

Q10. What were the most important features in deciding which lights to purchase? (*tick up to three options*)

Brightness ..... ☐1
Weight ..... ☐2
Battery life ..... ☐3
Mount type ..... ☐4
Size ..... ☐5
Water resistance ..... ☐6

Other _____

_____ ..☐7

Q11. Where did you get information about light options? (*tick all that apply*)

Family/friends ..... ☐1
Bike shop ..... ☐2
Magazine/newspaper article ..... ☐3
Online article ..... ☐4
Online forum/group ..... ☐5

Other _____

_____ ..☐6

Q12. The law specifies a minimum distance over which bicycle lights need to be clearly visible. What do you think that distance is? _____ metres

(*Only after interviewee provides response, provide actual distance*).

Q13. What is your age? (*tick one only unless 'wouldn't say' also ticked*)

Under 18 ..... ☐1
18 - 29 ..... ☐2
30 - 39 ..... ☐3
40 - 49 ..... ☐4
50 - 59 ..... ☐5
60 or older ..... ☐6
Wouldn't say (*also tick estimated age*) ..... ☐7

Q14. We may like to ask you more questions about riding and lights, would you please provide your email address?

_____

_____

Confirm email.

Thank you for your help completing this survey.

DO NOT READ OUT, FILL IN BY OBSERVATION

Time _____ : _____ Date ____/____/____ Location _____

1. LIGHTS IN USE

Front: White ..... ☐1
None ..... ☐2
Other colour ..... ☐3

Back: Red ..... ☐1
None ..... ☐2
Other colour ..... ☐3

2. GENDER

Male ..... ☐1
Female ..... ☐2

3. BIKE TYPE

Handlebars: Flat ..... ☐1
Curved ..... ☐2
Other ..... ☐3

Tyres: Road ..... ☐1
Mountain ..... ☐2
Other ..... ☐3

Without light(s) survey

We're conducting a survey of riders to understand your perception of bicycle lights. Responses are completely anonymous and you will not be penalised as a result of your answers.

Q1. What is the main purpose of your current trip? (*tick one only*)

- Work/commuting ☐1
- Tertiary education (university/TAFE) ☐2
- School (primary, secondary) ☐3
- Restaurant/take away ☐4
- Social/recreation (e.g. fitness) ☐5
- Personal business (e.g. going to a hairdresser) ☐6
- Shopping ☐7
- Other – please specify:

_____

_____ ☐8

Q2. What time did you start this bike trip?

_____ : ____ AM/PM

Q3. And how long will this part of your trip take you?

_____ minutes

Q4. How often do you ride at this time of day? (*tick one only*)

- 7 days a week ☐1
- Every weekday ☐2
- 1 – 4 times per week ☐3
- Several times a month ☐4
- Several times a year ☐5
- Today is the first time ☐6

Q5. I notice you are missing a front/a back/both front and back light(s). Why is this? (*tick one only*)

- I never use lights ... *Go to Q6* ... ☐1
- My lights broke ... *Go to Q8* ... ☐2
- My lights were stolen ... *Go to Q8* ... ☐3
- Battery low/dead ... *Go to Q8* ... ☐4
- I have working lights, just not here ... *Go to Q10* ... ☐5
- I didn't plan to ride at night ... *Go to Q10* ... ☐6
- I didn't know it was missing ... *Go to Q10* ... ☐7
- Other _____

_____ *Go to Q9* ... ☐7

Q6. Why don't you ever use lights? (*tick one only*)

I don't need lights:

- Other lights are sufficient for me to be seen (e.g. cars, streetlights) ☐1
- Other people don't use lights ☐2
- It is safe to ride in this area without lights ☐3
- It's only a short trip ☐4
- Other _____

_____ ☐5

- They are too expensive ☐6
- I haven't gotten around to buying them ☐7
- Other _____

_____ .. ☐8

Q7. Go to Q10.

Q8. How long ago did that happen? (*tick one only*)

Within the last 7 days ☐1
Between 1 and 4 weeks ago ☐2
Between 1 and 6 months ago ☐3
Between 6 and 12 months ago ☐4
More than a year ago ☐5

Q9. Why haven't you replaced your lights? (*tick one only*)

I don't need lights:
Other lights are sufficient for me to be seen (e.g. cars, streetlights) ☐1
Other people don't use lights ☐2
It is safe to ride in this area without lights ☐3
It's only a short trip ☐4
Other _____ _____ . ☐5
They are too expensive ☐6
I haven't gotten around to buying them ☐7
Other _____ _____ .. ☐8

Q10. Is there anything you do differently because you don't have lights? (*tick all that apply*)

No ☐1
Yes, ride on the footpath ☐2
Yes, take a different route ☐3
Yes, ride slower ☐4
Yes, wear brighter clothing ☐5
Yes, other _____ _____ .. ☐6

Q11. What influence do you think riding without lights has on your risk of being involved in a crash? (*tick one only*)

Greatly increased risk ☐1
Moderately increased risk ☐2
No change ☐3
Moderately decreased risk ☐4
Greatly decreased risk ☐5

Q12. What is your age? (*tick one only unless 'wouldn't say' also ticked*)

Under 18 ☐1
18 - 29 ☐2
30 - 39 ☐3
40 - 49 ☐4
50 - 59 ☐5
60 or older ☐6
Wouldn't say (*also tick estimated age*) ☐7

Q13. We may like to ask you more questions about riding and lights, would you please provide your email address?

_____

_____

Confirm email.

Thank you for your help completing this survey.

DO NOT READ OUT, FILL IN BY OBSERVATION

Time _____ : _____ Date ____/____/____ Location _____

1. LIGHTS IN USE
Front: White ☐1 None ☐2 Other colour ☐3
Back: Red ☐1 None ☐2 Other colour ☐3

2. GENDER
Male ☐1
Female ☐2

3. BIKE TYPE
Handlebars: Flat ☐1 Curved ☐2 Other ☐3
Tyres: Road ☐1 Mountain ☐2 Other ☐3