

## CHAPTER 13

### UNDERSTANDING CYCLING BEHAVIOUR IN BOOMTOWN PERTH

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#### INTRODUCTION

In Australia, participation rates for cycling vary substantially across states and territories, yet have risen steadily over the past ten years, despite infrastructure planning and construction struggling to keep pace (Australian Bicycle Council, 2015a). This situation has led to increased confrontation between cyclists, vehicles and pedestrians. One of the main impediments to effective cycling infrastructure planning is the availability of detailed information about cycling behaviour in an urban environment. To date, the acquisition of cycling information in the Perth metropolitan area has relied on static, mechanical counters or a limited range of bicycle surveys. Whilst these methods provide some information about the number of cyclists and the use of cycling infrastructure, both methods are limited in their ability to provide information about the broader spatial movement of cyclists throughout the urban landscape, particularly with regard to road usage. The advent of smartphone fitness applications (e.g. STRAVA, MapMyRide, etc.), which record an individual's spatial movements and other associated information, provides a source of data including a more detailed understanding of cyclists' movements throughout the urban landscape.

The act of cycling offers a range of benefits – an environmentally sensitive mode of travel, physical fitness and enjoyment derived from the activity itself. In Australian cities, where

populations and vehicle traffic congestion are burgeoning, cycling is often the fastest mode of transport for journeys on congested roads (Australian Bicycle Council, 2010).

This chapter provides an overview of cycling in Western Australia (WA) and the Perth metropolitan area in particular. The mode share for recreational and commuting cyclists is presented before describing the organisations responsible for cycling planning and management. The chapter concludes with a case study analysing the use of mobile phone fitness applications, namely STRAVA, to identify the use of cycling and road infrastructure by cyclists within the Perth metropolitan area.

### AN OVERVIEW OF CYCLING ACTIVITY IN PERTH

The benefits of cycling for communities and for individuals can be substantial, ranging from reduced traffic congestion, a reduction in environmental impacts and improved community wellbeing to potential health benefits such as lower rates of obesity and diabetes (Heart Foundation, 2014). However, participation rates for particular types of cycling activity in Perth are still relatively low, particularly for travel-to-work journeys (1.3 per cent) and it is still regarded as a marginal form of transport compared with cars and public transport. Could cycling ever become a mainstream form of transport, competing with cars and public transport for a substantial portion of trips or will it remain a niche transport mode linked with the weekend recreational cyclist, the middle-aged male in lycra (MAMIL) and the fixed-gear urban hipster? What infrastructure, policies and cultural shifts need to be put in place before the cycling participation rates in Perth are as high as those found in cycle-friendly cities such as Copenhagen and Amsterdam?

#### *Cycling Rates*

One of the aims of the WA Bike Network Plan (Department of Transport, 2014) is to double the number of cycling trips within

five years. This could be a difficult target to achieve given that benchmarking current cycling participation and activity rates in Perth is missing, mainly because there are so many different types of cycling and cyclists. In addition, the number of monitoring sites within the Perth metropolitan area is small (less than thirty) and concentrated within the Perth CBD and major principal shared paths. Thus, many of the informal recreational or mountain bike rides would not be recorded on the fixed counter devices. Cycling is a term used to represent travel-to-work journeys, recreational and leisure cycling, mountain or trail cycling as well as sports cycling; hence different strategies will need to be put in place to increase participation rates for all of these very different activities. Most of us therefore, at some stage in our lives, have cycled and could be regarded as cyclists.

The National Cycling Participation Survey is a biennial survey that commenced in 2011. It provides data on cycling participation for each state and territory in Australia but is based on a small sample size. Whilst 20,879 individuals representing 8,375 households participated nationally, only 934 individuals representing 408 households took part in the 2015 survey in WA. Overall, cycling participation rates have declined nationally from 40.2 per cent in 2011 to 36.3 per cent in 2015 for those who had cycled in the previous twelve months, and from 18.2 per cent to 17.4 per cent over the same time period for those who had cycled in the previous week (Australian Bicycle Council, 2015a). In WA, however, of the 934 participants, 23 per cent had ridden a bike in the previous week and 43.3 per cent in the previous twelve months, suggesting higher cycling participation rates. This potentially represents approximately 592,000 people riding a bike in Western Australia every week (Australian Bicycle Council, 2015b). The survey also found that 77 per cent of participants had cycled at least once in the previous month for recreation and 44 per cent for transport purposes. In addition, 62 per cent of all households in Western Australia had access to at least one bicycle in working order.

The population census undertaken by the Australian Bureau of Statistics (ABS) also contains information about travel-to-work journeys. The 2011 Census recorded a figure of 1.3 per cent of all travel-to-work journeys undertaken by bicycle in Perth. This compares with 2.7 per cent of all travel-to-work journeys undertaken by bicycle in Canberra and 1.5 per cent in Melbourne. The figure for Perth indicates a 49.8 per cent increase in cycling travel-to-work journeys between 2001 and 2011, yet that figure is dwarfed by the 73 per cent of all travel-to-work journeys undertaken by a sole-occupant car driver (ABS, 2011).

Mountain-biking is an increasingly popular activity in Western Australia with a range of off-road opportunities and internationally recognised bike trails, such as the Munda Biddi Trail stretching 1,030 kilometres from Mundaring to Albany through forest, agricultural and coastal landscapes. The WA Mountain Bike Strategy 2015–2020 (WestCycle, 2014) found that almost 19 per cent of all WA residents owned a mountain bike. However, of those using a mountain bike there were clear age and gender differences with only 12 per cent female riders compared with 88 per cent male riders, and over 80 per cent aged between twenty-six to fifty years of age. One of the aims of the WA Mountain Bike Strategy is to increase participation overall, but there is clear potential for increasing the numbers of female mountain bikers and for those in the under twenty-six and post-fifty year age groups.

Thus, it would appear that cycling for leisure and recreational purposes is a popular activity in WA, compared with other Australian capital cities, whilst cycling as a journey-to-work mode appeals to a small minority of commuters.

### ***Cycling Organisations, Plans and Strategies***

Cycling planning and management is undertaken by many public and private organisations including government departments and agencies as well as not-for-profit groups. Whilst much of the cycling planning and management activity is undertaken by state

and local government authorities, a number of organisations operate at the Commonwealth level. Perhaps the most important is the Department of Infrastructure and Regional Development, which has the overarching Commonwealth responsibility for transport matters in Australia. In addition, Australian Bicycle Council, Bureau of Infrastructure, Transport and Regional Economics (BITRE), Austroads and Infrastructure Australia also undertake activities aimed at providing technical advice on the requirements for cycling and coordinating the implementation of the Australian National Cycling Strategy.

In WA, transport matters are the responsibility of a number of government organisations including the Department of Transport, Main Roads and Transperth. The Department of Transport published the Western Australian Bicycle Network Plan 2014–2031 (WABN Plan) in 2014 (Department of Transport, 2014), with the stated target of doubling the number of bike trips in WA in the first five years. The WABN Plan outlines a number of objectives, including ‘to provide a high-quality, interconnected bicycle network, encouraging cycling to build active and healthy communities and improve the level of safety for cyclists’ (ibid.). Whilst these are impressive objectives, the level of state government funding is still relatively low compared with funding for the road network with only \$2 million allocated per annum for work on upgrading the Perth Bicycle Network, \$2 million per annum allocated to the Regional Bike Network and \$7.5m allocated for cycling infrastructure in the Perth CBD from 2012/13 to 2015/16 (Department of Transport, 2014).

The Office of the Auditor General Western Australia undertook a review of cycling participation and infrastructure planning for the Perth metropolitan area in 2015 (*Safe and Viable Cycling in the Perth Metropolitan Area*, Office of the Auditor General Western Australia, 2015). The report found a number of key issues that restricted or reduced cycling activity rates throughout the region. These included:

- priority arterial cycling routes were incomplete;

- cycle routes through the Perth Central Business District (CBD) were minimal;
- the local cycle network was inconsistent and unconnected;
- incomplete data and analysis available on cyclists' movements and crashes limited cycle infrastructure planning; and
- gaps in planning had the potential to delay growth in cycling activity rates and hence the social, health and environmental benefits that cycling could provide.

However, local government authorities and not-for-profit groups also contribute to bicycle planning and management. A local bike plan is not a statutory requirement of the *Planning and Development Act 2005* (Government of WA, 2005), yet many local government authorities have chosen to produce them anyway. Two of the more bike-friendly local government authorities, City of Vincent and City of Fremantle, have both produced local area bike plans, namely the City of Fremantle Local Bicycle Plan 2014–2018 (City of Fremantle, 2014) and the City of Vincent Bike Plan 2013 (Aurecon, 2013). The City of Fremantle aims to be the most bike-friendly city in the whole of Australia by investing heavily in cycling infrastructure and doubling the cycling participation rate from 2.8 per cent to 5.8 per cent by 2018. Interestingly, the plan recognises that existing or potential cyclists have different experiences and competencies, so a variety of strategies need to be put in place accordingly. Four main types of cyclists were identified.

1. **Strong and fearless:** Cyclists who tend to cycle most days and feel extremely safe and confident on any type of road.
2. **Enthused and confident:** People who generally ride most days and feel safe on the roads, including commuters and recreational cyclists.

3. **Interested but concerned:** People who don't commute to work but would be willing to cycle if they felt safer.
4. **No way, no how:** People who have no access to a bicycle and are not interested in cycling.

To encourage cycling participation rates for all four groups, the document suggests including the construction of new bike paths and sealed shoulders, as well as the introduction of free bike hire and bike share schemes.

Other cycling advocacy, recreational and training organisations operate in Perth such as Bicycling Western Australia, Bicycle User Groups (BUGs) and social and training groups, including Chain Reaction Training, Over 55 Cycling Club and the West Australian Institute of Sport (WAIS). Whilst some of the groups have a sports training emphasis, others are geographically based or focus on a particular demographic group.

To summarise, despite increasing awareness and enthusiasm, current cycling activity and participation levels in Perth are still relatively low when compared with more cycle-friendly cities elsewhere. It will take many years before participation rates reach the mode share in Copenhagen and Amsterdam, but state and local government departments, community groups and activists are working together to create a more cycling-friendly travel environment.

### ***Bicycle Network in Perth***

There are three types of cycling infrastructure considered by the Department of Transport to make up the Perth Bicycle Network: Principal Shared Paths, Recreational Shared Paths and Local Bicycle Routes. Principal Shared Paths, or PSPs, are a specific type of shared path primarily catering to commuting cyclists. There are approximately 201 kilometres of PSPs and they are generally of a higher standard for cycling and designed to have fewer pedestrians. These paths are situated along freeways and

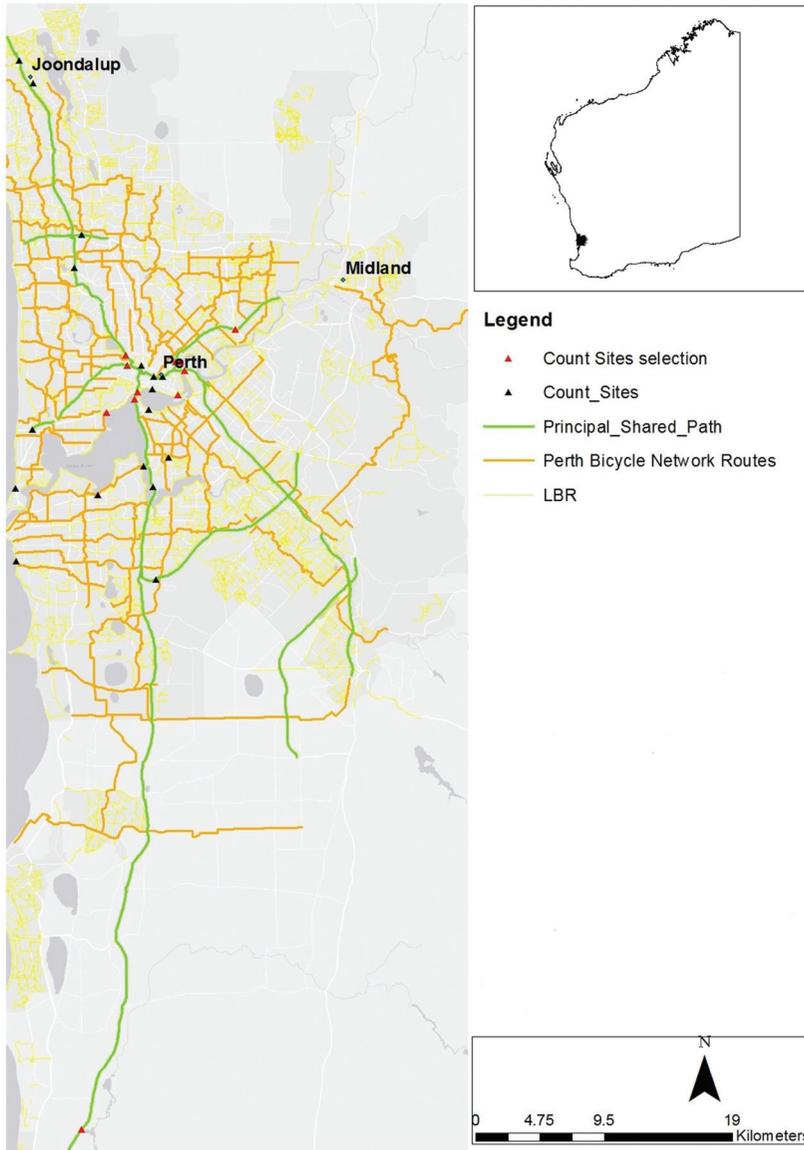


Figure 1: Principal Shared Path, Local Bicycle Routes and Perth Bicycle Network routes for the Perth Metropolitan Region. Note: Department of Transport (DoT) fixed counters for the Perth metropolitan area are designated by black triangles and the red triangles represent the sites used in the Perth Bicycle Network counts.

railway reserves in order to achieve direct routes between centres. Recreational Shared Paths (RSPs) are non-specific cycling paths, equally used by pedestrians and people on rollerblades, skateboards, and wheelchairs for recreation. They are located predominantly along river foreshores and coastal strips and some parklands, and are designed as linkages rather than direct routes to end-point destinations. However, some RSPs function as commuter routes due to their locations. Construction and maintenance of RSPs is usually the responsibility of local government authorities. In addition, Shared Paths (SPs) form part of the RSP network. SPs are similar to RSPs in that cyclists share them with pedestrians, however, they are not restricted to coastal and foreshore areas. Local Bicycle Routes (LBRs) generally use the local street system and avoid major roads. The majority are on-road, some with marked bike lanes, together with short sections of shared paths, e.g. through parkland to link the on-road segments.

The map in Figure 1 shows the Perth Bicycle Network Routes that are the preferred pathways for travel between regions and key activity centres. They are comprised of PSP, LBR and RSP components.

## DATA COLLECTION TECHNIQUES

Two main sources of data inform cycling behaviour in WA: passive counting methods and surveys (either interviews, mail outs, web surveys or web/mobile applications). They are described in more detail in the following sub-sections.

### *Department of Transport Fixed Counters*

Since 2008 the Western Australian Department of Transport (DoT) has had in place eleven automated bike counters at various positions throughout the metropolitan area, with the addition of seventeen new counters in August 2012. These counters are active twenty-four hours a day, all year round and can therefore provide daily count data. The counters are fixed in place on the PSP network as well as

on some of the RSP network (Figure 2). These mechanical counters can differentiate between pedestrians, cycles and other vehicles (i.e. motorised scooters). They provide continuous information on volume of traffic as well as the average speed of different user types. Due to their location on the PSP network, these fixed counters provide information predominantly on the movement of cyclists using path infrastructure (i.e. commuting cyclists). Data from fixed counters has shown an average increase in cycling between 2010 and 2013 of 27 per cent. The busiest site, Kwinana Freeway (Narrows West) PSP, increased from approximately 650,000 bicycle counts in 2010 to in excess of 870,000 bicycle counts in 2013.

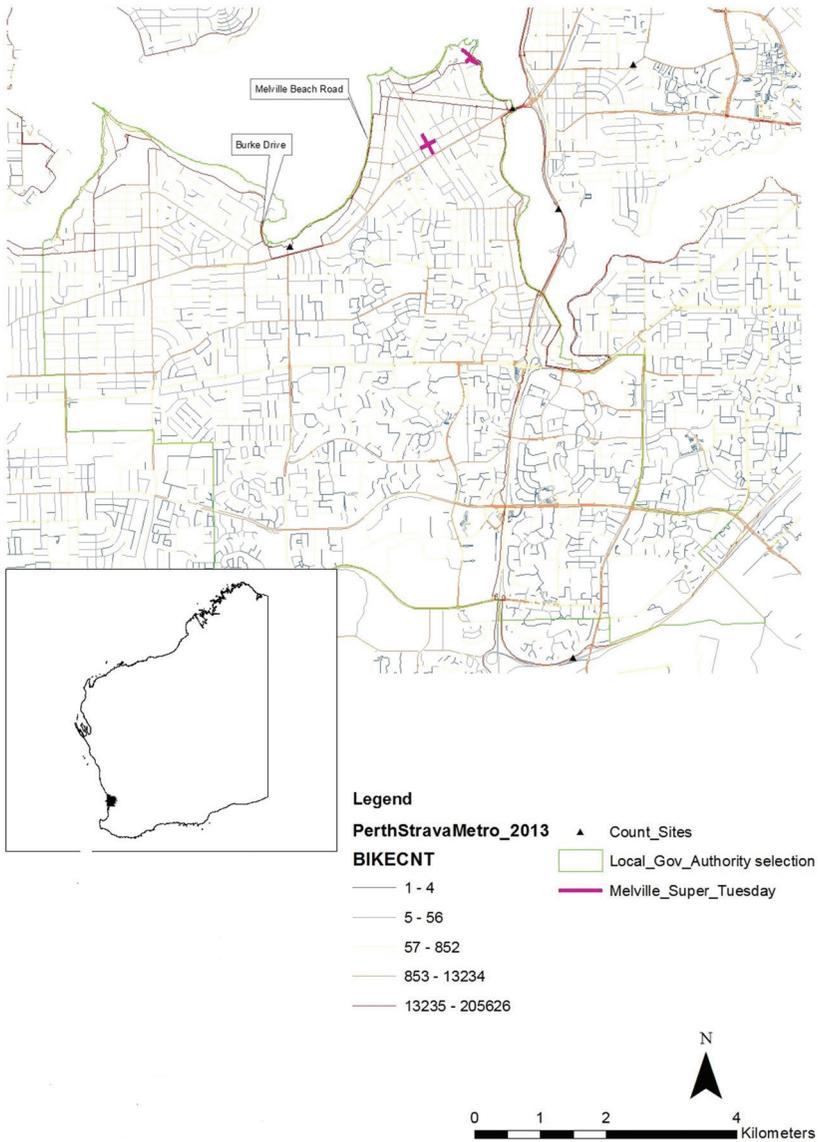
### ***Perth Bicycle Network Monitoring***

The DoT also commissions a private contractor to undertake an annual Perth Bicycle Network (PBN) monitoring event, whereby seventy-one sites across metropolitan Perth are manned for a set period of time to count passing cyclists. Count site locations include both dedicated bike/shared paths and roads that form part of the PBN. The majority of sites are situated around inner-city suburbs as well as the CBD, Fremantle and Rockingham urban centres. Time periods consist of either three hours (6.30am to 9.30am) or, less commonly, twelve hours (6.30am to 6.30pm) on one day of the year. The PBN Monitoring event in 2013 (the most recent with data publicly available) was held on Tuesday 19 March and recorded an overall increase in cyclist numbers of 29 per cent since 2012 (Painted Dog Research, 2013).

### ***Super Tuesday***

A number of local government authorities in WA were also involved in the nationwide annual bike count event called Super Tuesday. This involves volunteers monitoring count sites for three hours (6am to 9am) on the first Tuesday in March each year. This event is organised by The Bicycle Network and provides a nationwide snapshot of commuter cycling on that particular day. As an example, the location and spatial orientation Super Tuesday

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*Figure 2: Map showing location and orientation of Super Tuesday count sites and STRAVA 2013 annual commuting cyclist counts within the City of Melville local government authority regions. STRAVA cycling count data is displayed using geometric interval classification.*

monitoring sites for the City of Melville (one with the highest level of cycling in Perth) are shown in Figure 2.

### *Surveys*

Whilst each of these passive methods has its merits, they undeniably offer a limited overview of cyclist behaviour and movements across metropolitan Perth due to their fixed locations or temporary status. To complement this information, surveys are a rich source of data on cycling behaviour, including motivations and attitudes.

Recent developments in mobile phone application technology have seen a rise in the numbers of personal fitness applications used for tracking an individual's fitness data. The data is useful for population health studies, tracking fitness trends, social network analysis and urban planning (Clarke & Steele, 2011). This paper focusses on a specific mobile phone fitness application (MPFA), STRAVA, to enhance our understanding of the pattern of cycling movements within Perth.

Blake and Perkins (2015a) surveyed 425 cyclists to establish their propensity to utilise smartphone fitness applications. The survey consisted of twelve questions, broken down into three categories that included questions relating to cycling usage (type of cycling, number and length of journey), mobile phone application usage (propensity to use and brand of application) and socio-economic questions (age, gender and household income).

The results of the survey were then used to examine the MPFA data captured in 2013 for Perth and compare it with the Department of Transport figures for the same period to establish if it supported existing data and/or further enhanced an understanding of cycling habits within an urban environment. Then, the survey results were compared against data from the StravaMetro<sup>®</sup> (beta version) application, popular among cyclists as it enables users to map their rides and share personal data via a social networking component.

StravaMetro<sup>®</sup> aggregates and continuously updates all of the cycling data recorded by STRAVA members for a given location and timeframe to a street network. Privacy of members is protected by anonymising and aggregating the data to a linear street map such that the value of the data is conserved. Due to connectivity problems with the geometry of the Main Roads WA road network and PBN bicycle infrastructure, the Open Street Map (OSM; an open source of road network spatial data) was used to aggregate rider information.

Individual rider data was consolidated to present aggregated information at predetermined temporal scales (e.g. monthly, peak riding season, annual cycling activity) as well as minute data on any segment of the path. In addition to the spatio-temporal data on cycling trips, demographic information about cyclists' age, gender, mean cycling activity and mean distance travelled for each local government area, for a specified time period, were provided separately.

## ANALYSIS AND RESULTS

This chapter uses multivariate spatial data analysis and visualisation to describe the cycling patterns in Perth. Fixed counters, survey and StravaMetro<sup>®</sup> samples were compared, both as aggregated statistics and by route.

Getis-Ord cluster analysis (Getis & Ord, 1996) was also undertaken to understand annual recreation cycling behaviour in Perth and its spatial patterns. This analysis aims to identify hot spots by examining cycling spatially in relation to neighbouring zones. Clusters of similar high or low values emerge from the comparison with expected values across space.

### *A Profile of Perth Cyclists*

#### *General Descriptive Statistics*

The results of the cycling survey by Blake and Perkins (2015a)

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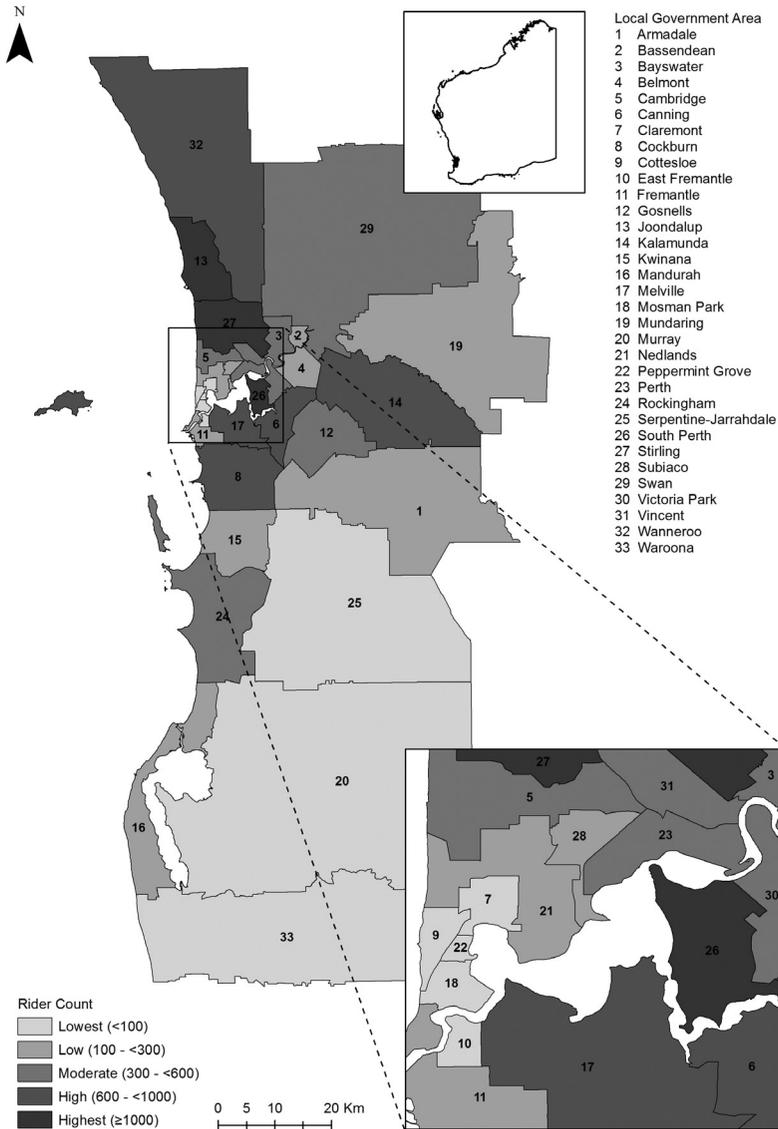


Figure 3: Spatial distribution of STRAVA MFPAs users (cyclists) for 2013 by local government authority areas within the Perth-Peel Metropolitan Region. Data is displayed using geometric intervals. Number of cyclist's ranges from <100 (Low) to in excess of 1000 (Highest).

showed that cyclists identified themselves in a more complex fashion rather than simply as recreational or commuting cyclists – or even as ‘just’ cyclists. Whilst 28 per cent of cyclists surveyed identified themselves as recreational cyclists only, 14 per cent indicated that they only cycled for commuting purposes. The majority of respondents indicated that they cycled both for recreation and commuting purposes (55 per cent). Fewer recreational rides were undertaken per week compared with commuting rides but they tended to be longer in distance. There is a substantial variation in the distance travelled, with 70 per cent of recreation rides between 21 kilometres and 80 kilometres in length, 95 per cent of commuting rides less than 50 kilometres in length, of which 60 per cent were less than 20 kilometres.

A majority of the respondents were male (79 per cent) and 71 per cent were thirty-six years of age or older. A further 27 per cent were aged between twenty-six and thirty-five years, with only 2 per cent of cyclists who participated in this survey less than twenty-five years of age. A majority of survey respondents also had household incomes at the upper end of the scale with approximately 85 per cent of survey respondents having a household income above \$80,000 per year.

A comparison with StravaMetro® demographic data shows that the ratio of male to female cyclists using STRAVA across the Perth metropolitan area is 4:1 (ranging from a ratio of 2.1:1 in Peppermint Grove to 6.1:1 in Serpentine-Jarrahdale). The local government authorities (LGA) with the greatest number of STRAVA users in 2013 were Stirling (1,926 cyclists), South Perth (1,421 cyclists), Joondalup (1,143 cyclists) and Melville (1,046 cyclists) (see Figure 3). These four local government areas have median annual household incomes of \$91,000, \$83,500, \$92,500 and \$84,000 respectively, which is consistent with results from the MPFA user survey. The general trend is indicative of higher MPFA use in LGAs closer to the CBD/Swan River, with a reduction in use with increasing distance from the CBD and corresponding with a decrease in median household income.

STRAVA mobile phone fitness application use was highest in the thirty-five to forty-four age bracket, but also widely used by those aged twenty-five to thirty-four and to a lesser degree in the forty-five to fifty-four age group. Once again this is consistent with the results of the cycling survey.

Perth LGA had the highest number of bike movements but a lower mean distance for each journey at approximately 18.5 kilometres, compared with Stirling and Joondalup LGAs which had high numbers of bike movements but mean distance per trip of approximately 28 kilometres and 27 kilometres respectively. The highest mean distance per trip was approximately 50 kilometres undertaken by riders in Melville and Mosman Park LGAs. This may be a reflection of the spatial distribution of commuting and recreational cyclists, suggesting that a greater proportion of cyclists undertake recreational rides in these LGAs. The demographic data also provides average time and median time in seconds for the cycling activities undertaken within each LGA. This allows the average or median speed of cycling activity for cyclists within each LGA. When considered in conjunction with age, this information could be indicative of the proportion of recreational and commuting cyclists and of the quality and type of surface that cyclists are using (i.e. road or path and volume of vehicular or pedestrian traffic). Consequently, this information could provide valuable information for urban planners.

#### *Recreational Cycling Patterns*

The growth in the number of people cycling in Perth is not just associated with commuting cyclists, but also to a large extent with people who cycle for a number of other reasons such as a leisurely ride by the coast or river with the family, group rides with a cycling club or friends or as an athlete in training. Unfortunately, most of the available bicycle data available from the DoT is representative of a small proportion of cyclists and only those who favour the use of bicycle paths.

The increase in the number of cyclists using road infrastructure in Perth is likely to be associated with a rise in recreational cyclists, particularly those who participate in structured group rides and athletes; and anecdotal evidence suggests they are more likely to use road infrastructure than paths. This inclination to use road infrastructure may be due to a preference to experience alternative routes and because of the connectivity between places provided by roads (Adams, Goodman, Sahlqvist, Bull & Ogilvie, 2013; Titze et al., 2010). Yet, as stated previously, our understanding of the extent to which cyclists use roads, either for commuting or recreational purposes, remains limited.

A subsequent study by Blake and Perkins (2015b) into preferred route selection by recreational cyclists showed that there was a high proportion of recreational cycling activity occurring in the Perth CBD and inner suburbs and extending west to Fremantle (Figure 4). This was determined by subtracting the STRAVA 'commute count' from 'bicycle count' for 2013.

To produce a heat map and identify the roads/regions of high mean, annual recreational bicycle patronage, a Getis-Ord cluster analysis (Getis & Ord, 1996) was undertaken of the 2013 STRAVA mean annual recreational cycle count data for the Perth metropolitan area. Based on this analysis, seven key regions/roads have been identified (Figure 4).

Medium-high recreational cycling occurs in the northern and southern inner-city suburbs. In the north, medium-high levels of recreational cycle numbers extend north along the coast to Joondalup and, to a lesser degree, to Yanchep (Figure 4). Recreational cycling to the south and east of Perth tends to follow corridors that are associated with major road infrastructure. To the east there appears to be two corridors, one from the northern suburbs and one from the southern suburbs. In the case of Rockingham to the south, the majority of recreational bicycle traffic tends to be associated with the Perth Bicycle Network dedicated bicycle infrastructure (Figure 4).

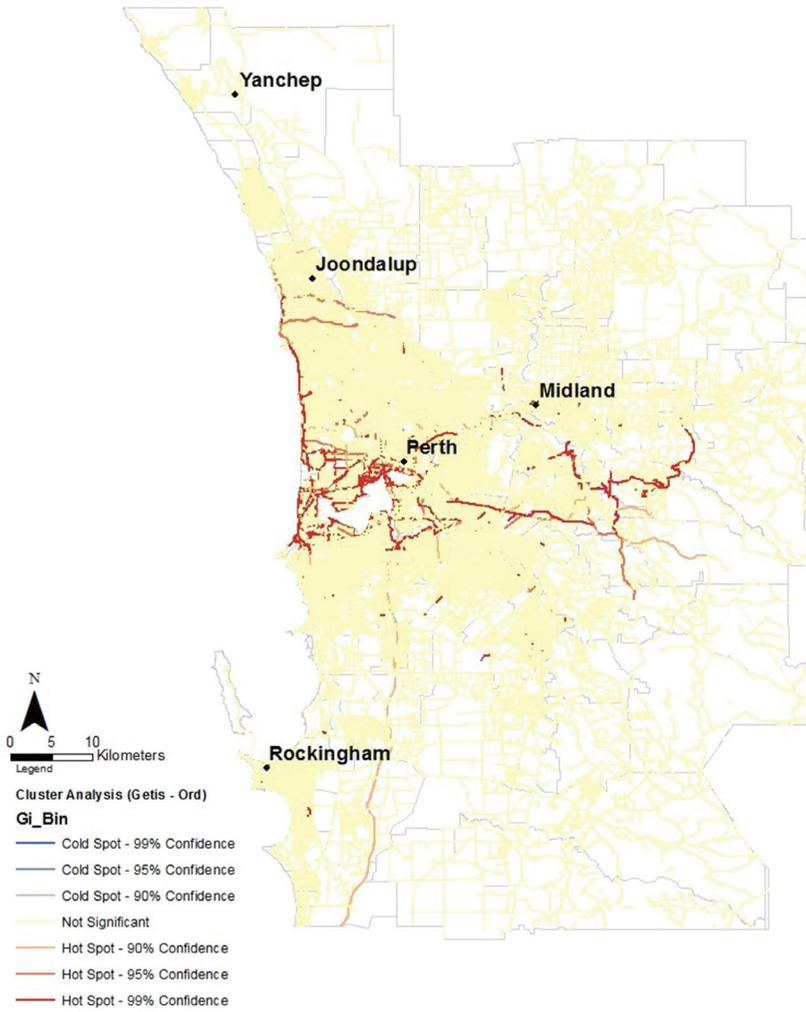


Figure 4: Heat map showing preferred recreational cycling routes across the Perth metropolitan area.

The distribution and types of roads used by recreational cyclists appears to differ quite markedly from those used by cyclists for commuting purposes. Commuting cyclists ride on the north, south and east transport corridors and the largest volume of commuting cycling is to and from the CBD. Analysis of this data also indicates that, where possible, commuting cyclists used dedicated bicycle infrastructure and road infrastructure as opposed to shared paths. The study by Blake and Perkins (2015b) shows that a large proportion of recreational cyclists in Perth favour cycling through the Perth CBD and inner-city suburbs, particularly north of the river. The coastal strip north of the river towards Hillarys Boat Harbour is also a favourite, as is the Fremantle region and the Swan and Canning River foreshores. There is also a reasonable pattern of recreational cycling in the northern suburbs, around Joondalup and east towards Midland, Darling Scarp and Kalamunda. As expected, cyclists avoid roads that are designed to carry high volumes of traffic, including heavy vehicles.

When analysed by road type, there is a tendency for recreational cyclists to favour local, lower volume roads (such as Local Distributor and Primary Distributor), but also use higher volume District Distributor A and B road types. The preference to use a particular road type is likely to vary between different regions of the Perth metropolitan area and is influenced by vehicle intensity, road surface, topography, the presence of vehicle management (slowing) infrastructure, presence and volume of pedestrian traffic, and the presence and connectivity of dedicated bicycle infrastructure.

### ***MPFA and Fixed Counters***

By interrogating the StravaMetro<sup>®</sup> data, the spatial and temporal characteristics of cyclist movements in the Perth metropolitan area and the connectivity of the bicycle network can be identified. For example, the preferred pathways of morning commuters and recreational riders, based upon 2013 StravaMetro<sup>®</sup> user data, shows that the preferred morning commuter routes for the Perth

metropolitan area align strongly with the existing bicycle infrastructure associated with the Perth Bicycle Network, whereas the recreational riders prefer using a greater proportion of the road network. This analysis allows DoT and LGA planners to identify which infrastructure is being utilised by cyclists. This has a number of implications not just for planning.

A comparison of DoT fixed counter and StravaMetro® bike counts for 2013 showed agreement in terms of the spatial distribution of cycling traffic across the Perth metropolitan area. There are similar patterns of high bicycle traffic using the PBN, particularly for commuting purposes. However, due to the nature of the MPFA and the uptake by particular cyclists, STRAVA's representativeness of cycling behaviour appears to be skewed towards recreational cyclists.

The discrepancy in the representativeness of StravaMetro® data and the variability in agreement with DoT data could be due to the number and type of cyclists using STRAVA. As such, it may be indicative of regions across the Perth metropolitan area where cyclists have a preference to use roads rather than bicycle infrastructure, as well as indicating those regions that have a higher proportion of commuting cyclists, recreational cyclists or leisure cyclists.

StravaMetro® aggregated data shows that the PSP on the Narrows Bridge was the busiest section of bicycling infrastructure in the Perth metropolitan area with a total of approximately 250,000 bicycle movements, similar to DoT findings which also identified this as the most utilised piece of cycling infrastructure in the state with approximately 870,000 bicycle movements along this stretch of PSP. StravaMetro® data identified a number of road connections with PSPs and RSPs that have high bicycle counts (in excess of 150,000 for the year). The main stretches of road that showed high levels of bicycle movements were Burke Drive in the City of Melville (Figure 3) with a bicycle count in excess of 120,000 bicycles, Hackett Drive with 120,000 bicycle movements per annum and Melville Beach Road, also in the city

of Melville (see Figure 2), with approximately 117,000 bicycle movements per annum. Interestingly, both of these are situated next to shared paths. As alluded to throughout this chapter, the fact remains that the fixed-point counters provide little information on the movement of cyclists on the road network; at best it provides very limited snapshots for specific road intersections, as the following examples demonstrate.

Mounts Bay Road PSP is a popular cycling route for both recreational cyclists who wish to cycle along the river and commuting cyclists travelling to Perth CBD for work. StravaMetro<sup>®</sup> trips recorded for the month of March on the PSP (7,851) account for only 14 per cent of the total number of bike trips recorded by the DoT counter (56,713), however, StravaMetro<sup>®</sup> trips were also recorded on Mounts Bay Road itself, something that is not captured when analysing fixed-counter data alone. This has important implications for state and local government agencies with regards to how they allocate limited resources for the implementation and upkeep of cycling infrastructure.

A small sample of the data (e.g. Tuesday 25 March 2013) for the Mounts Bay Road counter site (recorded between 6.30am and 9.30am for the annual PBN Monitoring program) draws attention to the limitations of this fixed-location approach: only two cyclists were recorded travelling on the road and almost 700 travelling on the PSP. However, if the StravaMetro<sup>®</sup> data is examined for the month of March 2013, logged in STRAVA as 'AM commute' (defined as work-related travel between 6am and 9am), there appears a substantial discrepancy in the proportions of road and path traffic at the Mounts Bay Road site between the two data collection methods. StravaMetro<sup>®</sup> data suggests that for the month of March, on average, 173 cyclists a day use road infrastructure at this point. StravaMetro<sup>®</sup> data also showed that on average 158 cyclists a day used the path infrastructure during March. This appears indicative of the particular cyclist type that utilises MPFA technology. Whilst difficult to conduct a direct comparison between the two data-collection methods, the results

do highlight the potential for under-representation of cycling movements when relying on current data-collection methods (fixed mechanical counters and bike counts) to assess cycling trends, particularly on road infrastructure.

As StravaMetro<sup>®</sup> data is directional it allows the determination of the flow of cycling traffic in a particular direction. It is interesting to note that StravaMetro<sup>®</sup> bike-count data for the month of March shows that bicycle traffic on Mounts Bay Road is greater heading west (64 per cent) than east (36 per cent), as is the case for the PSP (73 per cent and 27 per cent respectively). The reverse of this is not seen in the PM data, which suggests this data is representative of recreational riders using road infrastructure and heading towards Fremantle/western suburbs, a popular route for group rides, as opposed to the central CBD, which would be expected if they were commuting cyclists. The fixed counter on the PSP shows that there is a similar pattern of movement, but with substantially less discrepancy between east and west, with 56 per cent of cyclists heading west and 43 per cent east.

Whilst DoT fixed counters provide superior information relating to cycling movements on dedicated cycling infrastructure (i.e. PSP and RSP), as well as annual cycling participation rates (temporal changes in cycling participation are based on these estimates), it falls short of being able to elucidate information about cyclists' movement on road infrastructure and minor shared paths. This has important implications for the future of cycling infrastructure funding if cyclist travel patterns and behaviour are incomplete, thus underestimating movements.

## CONCLUSION

The examples included in this chapter show that whilst there are a number of Perth cyclists who use the PSPs and RSPs for either leisure or commuting purposes, there is an equally large number of cyclists who avoid the RSPs in favour of using roads. This case study also reveals that a large proportion of Perth metropolitan roads carry some degree of bicycle traffic throughout the year.

Cycling along the foreshore is likely to be dominated by recreational cyclists and, in particular, leisure cyclists (if on dedicated cycle paths). Recreational cyclists travelling in groups are likely to use roads because of the high level of pedestrians on the paths who limit the speed at which the group of cyclists can travel (Aldred & Jungnickel, 2012). East–west paths away from the foreshore are likely to be dominated by commuting cyclists travelling towards the PSPs that connect bicycle traffic with the CBD.

MFPA data provides an invaluable tool for local government authorities responsible for improving cycling infrastructure. Whilst it cannot replace existing cycle data–collection methods, it provides a means of broadening the depth of knowledge about cyclists' habits in the Perth metropolitan area and allows for more informed planning decisions regarding the implementation of cycling infrastructure within Perth.

This study raised a number of further questions about cycling in Perth. Whilst overall cycling participation rates are increasing, the rates for commuting to work remain stubbornly low at 1.3 per cent of total commuting trips (Australian Bicycle Council, 2015b). These figures are consistent with rates experienced in some other Australian capital cities, but are dwarfed by the participation rates found in many European cities, particularly those recognised as more cycle–friendly such as Copenhagen and Amsterdam. Copenhagen had already achieved a figure of 30 per cent of all work and educational trips undertaken by cyclists in 2010 and aims to reach 50 per cent of all trips by the end of 2015 (City of Copenhagen, 2011). Perth experiences a Mediterranean climate with mild, wet

winters and warm, dry summers; has a relatively flat terrain within the metropolitan region; and an expanding network of bike paths – all factors that could encourage higher participation rates. So why are cycling participation rates so low and how can we promote cycling as an alternative to other travel modes for short-to-moderate distances? Road safety, built environment, peer pressure, habit and past behaviour all play a part in influencing travel mode choice and route selection, but low density and wide geographical spread is at the core of a car-based society (see chapter 7). Recent planning initiatives for urban densification and provision of an extended cycling and walking network, as well as campaigns for smart transport and healthier lifestyles are paving the way for a more sustainable transport system, but it remains uncertain to what extent they will offset habit and reliance on car travel.

This study highlights the further need for research into the cycling route choice, either for recreation or commuting purposes. In addition, the research emphasises the need for combining data sources and shows the benefits of the MFPA data provided by STRAVA, which can be fused with other secondary and primary data sources to understand the spatial and temporal patterns of cycling, and the reasons for cycling in Perth.

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