Integrating the *Who*, *What* and *Where* of American Retail Centre Geographies

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Summary

Retail centres occupy a significant role in determining the economic prosperity, desirability and vibrancy of urban areas. This research is rooted in a pragmatic effort to provide an overview of American retail centre geographies, through development of an empirically grounded framework, using data from SafeGraph, to examine *where* they are located, *what* characteristics they have, and *who* uses them. The resulting geographies are interesting, offering significant potential as a tool for monitoring and protecting the American retail system as is continues to evolve, and in yielding substantive insights about key theoretical debates in retail geography, made possible only through integration of the *who*, *what* and *where*.

KEYWORDS: Retail, Agglomeration, Typology, Catchment.

1. Introduction

Retail centres, the main cores of retail activity in urban areas, occupy a significant role in determining the economic prosperity and desirability of urban areas (McCann and Folta, 2008; Han et al., 2019). Despite this, research on the 'geographies' of retail centres at the national level remains scarce (Sevtsuk, 2014), often considering only singular geographical aspects, instead of capturing critical information about *where* they are located, *what* characteristics they have and *who* uses them. However, increased provision of useful datasets and empirical frameworks (Ballantyne et al., 2021) are enabling such a vision to be realised. In response, this paper aims to provide an overview of American retail centre geographies, through development of an empirically grounded framework that integrates these three geographical aspects of retail centres. Using data from SafeGraph, we explore *where* these retail centres are located, *what* characteristics they have and *who* uses them.

2. The *'Where'* of American Retail Centre Geographies

2.1 Approach

Many approaches to retail centre delineation face notable limitations; computational cost and scalability, interpretability and accuracy (see Pavlis et al., 2018; Ballantyne et al., 2021). The approach used here utilised the H3 spatial indexing system, which holds significant potential for an approach that is both interoperable and computationally inexpensive. The approach, seen below in Figure 1, takes as input 3,746,543 retail places (and their building footprints), and retail land-use polygons from

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OpenStreetMap (1A), and aggregates them to a grid of hexagons (1B). Then to delineate the boundaries, a series of contiguous tracts of hexagons are assembled based on direct adjacencies (1C), before searching within the 'k-ring' of each hexagon (1D) to identify nearby (within 50m) contiguous tracts to merge with (1E). Additional consideration to major rivers was given, by restricting the merging of tracts in areas where this issue is pertinent (e.g. Chicago). Computationally, the approach utilised 'h3jsr', an R package for performing spatial operations within H3, and the code used is available on the authors GitHub repository.

Figure 1. Approach to retail centre delineation.

2.2 *Where* are American Retail Centres?

10,956 major retail centres were delineated, mapped below in Figure 2. The majority were found in heavily populated areas, with the most populated metropolitan areas containing the largest number of centres. They varied greatly in size, with the smallest comprising 50 retail places and the largest 27,907 (Manhattan). The distribution of a variety of retail centres can be seen below in Figure 3, where a broad range of forms were apparent, such as large sprawling, and highly linear ones (3B), related in many ways to existing work on retail/urban agglomeration form. The large sprawling retail centres occurred in many other American cities such as Seattle and Washington, similar to those seen in UK cities (Pavlis et al., 2018), and similarly, the linear centres (4B) were not all that different to high streets. Also interesting was the incorporation of surrounding features (e.g. car parks), as below in 3C, made possible using landuse polygons.

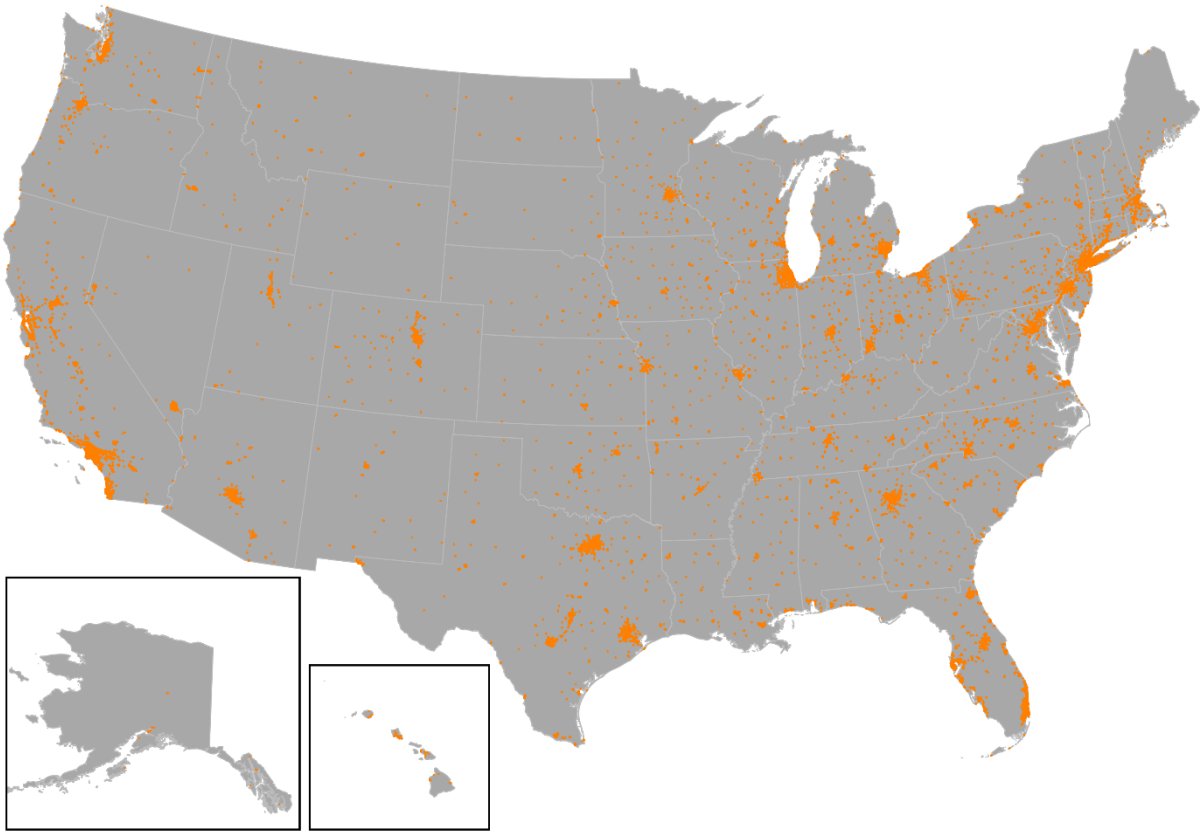

Figure 2. Distribution of American retail centres

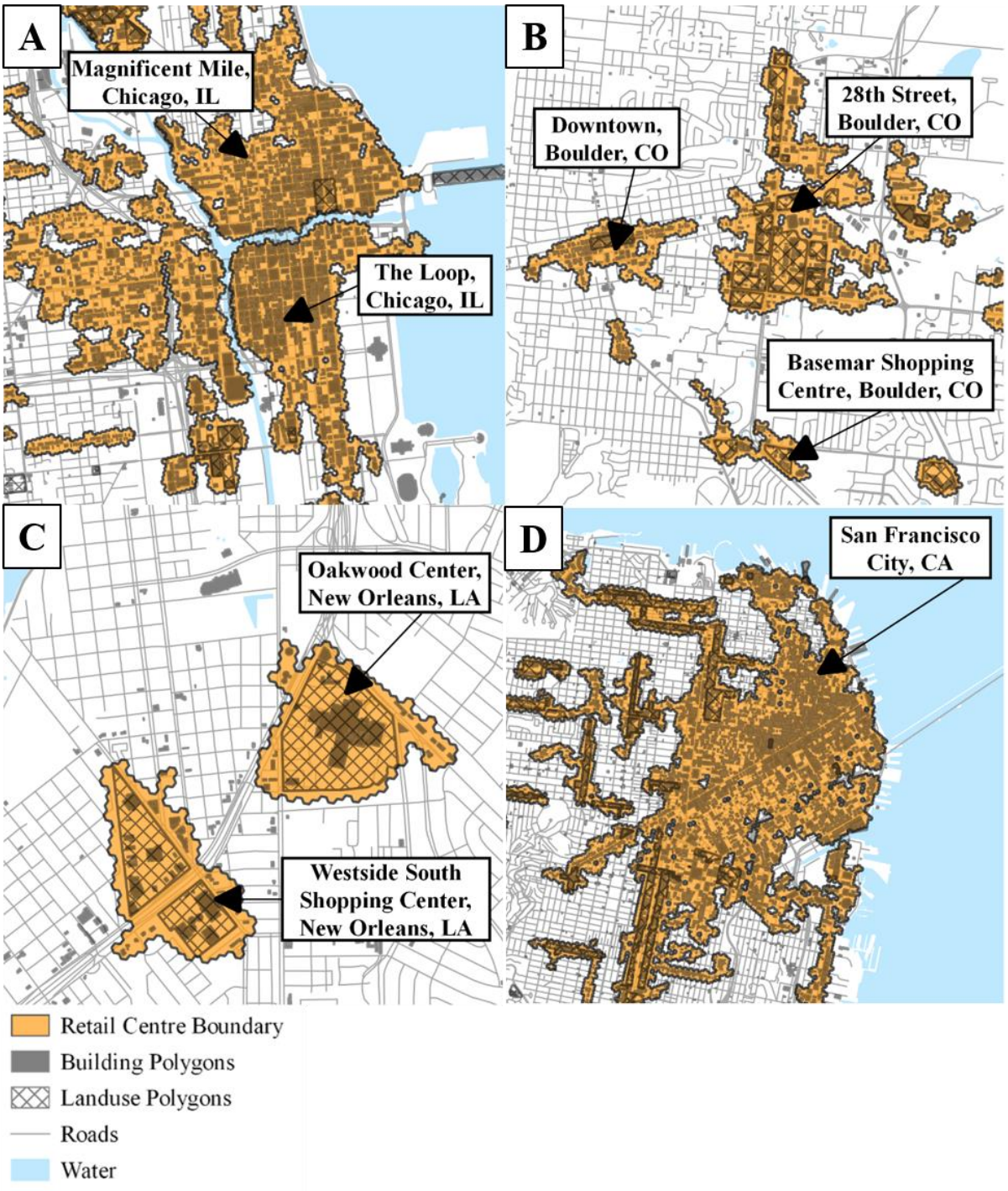

Figure 3. Retail centres in four contrasting urban/retail environments.

3. The '*What*' of American Retail Centre Geographies

3.1 Approach

To account for the functional differences between the centres delineated in section 2, a multidimensional typology was constructed, utilising the framework first proposed by Dolega et al. (2019). A series of variables were extracted to account for each of the four classification domains – composition, diversity, size & function and economic health, mainly derived from the SafeGraph places dataset itself, with additional variables created to ensure greater applicability to the US, in comparison to that used in Ballantyne et al. (2021). The typology was constructed using PAM, an unsupervised

machine learning technique that assigns retail centres to groups based on similarities/differences between them. Sensitivity analysis and dimensionality reduction were performed prior to PAM, and the number of groups (*k*) was determined using elbow plots and silhouette scores. PAM was performed twice to extract a two-tier retail centre typology, consisting of four 'higher-order' groups and ten 'nested' types.

3.2 *What* are the characteristics of American Retail Centres?

The characteristics of the retail centre groups (Figure 4) highlighted interesting differences in the composition and function of the groups. Both the first and second group comprised a similar offering, but were differentiated by size, diversity and urban morphology. Furthermore, despite polarising retail offerings, discount and anchor retailers occupied a key role in both the third and fourth group. The spatial distribution of groups was interesting; with concentrations of group one centres in the major cities, whilst groups two and four were highly abundant and uneven.

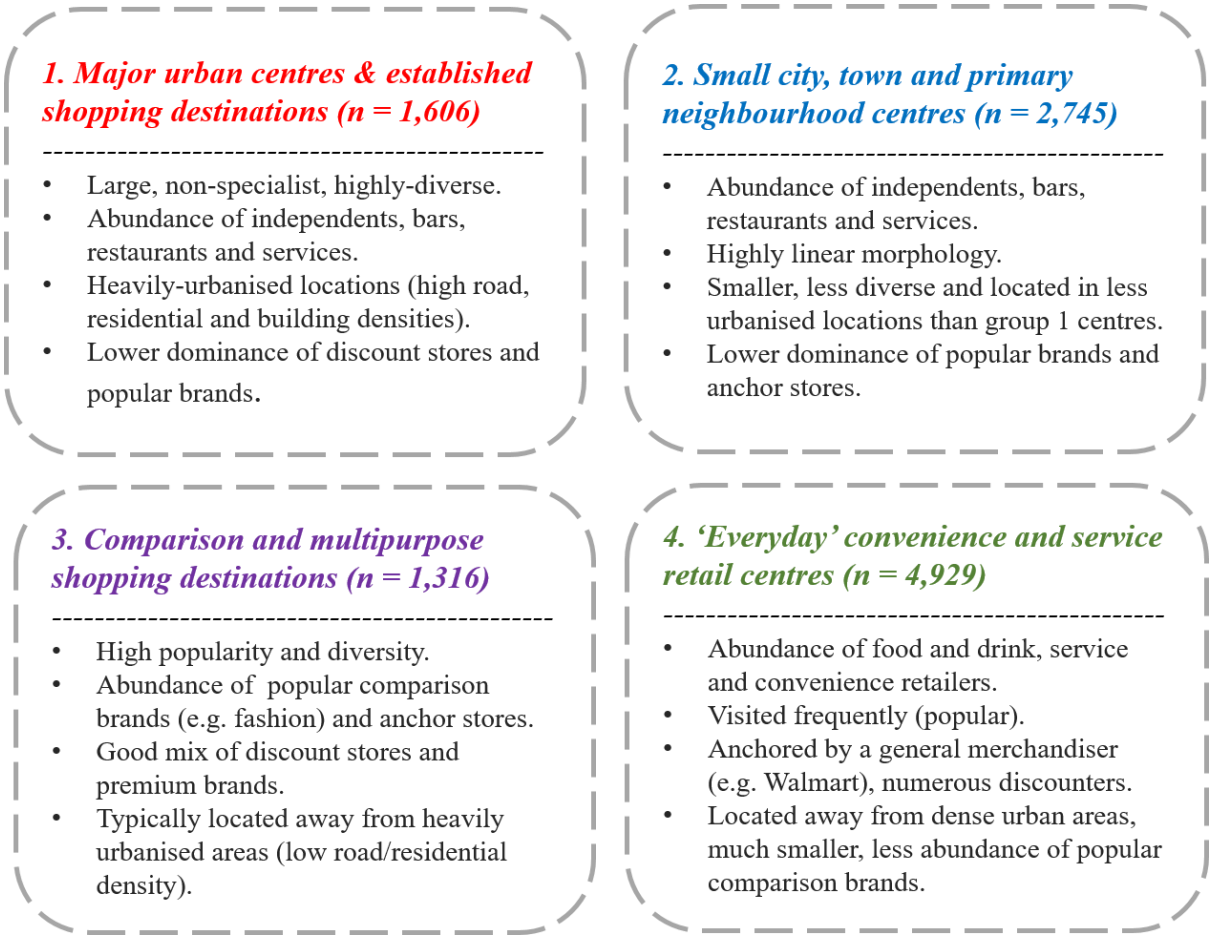

Figure 4. Pen portraits for the retail centre groups.

The relationship between function and scale was intriguing. By dividing the groups into four size categories (Table 1), we are able to see how functions mapped across different scales; for example with the smaller centres having a greater diversity of function, and the larger ones being more homogenous.

Table 1. Retail centre scale and function.

Retail centre group	Retail centre size			
	Small	Medium-sized	Large	Very large
	Percentage			
1	10.49	76.70	100.00	100.00
2	27.67	2.18	0.00	0.00
3	12.43	13.10	0.00	0.00
4	49.41	8.01	0.00	0.00
Total retail centres (=100%)	9865	687	39	5

4. The '*Who*' of American Retail Centre Geographies

4.1 Approach

Retail centre catchments were delineated through modification of the bespoke Huff model used in Dolega et al. (2016). The Huff model posits that consumer patronage can be modelled by considering the attractiveness (A_j) and spatial location of retail locations (D_{ij}), with α and β calibration parameters used to ensure the model accurately represents reality. In this application, we model consumer patronage to retail centres from census tracts, calibrating the model with SafeGraph's weekly patterns dataset, whilst accounting for functional differences between centres. The model parameters (α, β) were calibrated using the patterns dataset to provide an 'observed' degree of patronage which could be compared with the 'predicted' obtained from a series of Huff models. Correlation testing was used to identify the best performing model in each case, as below in Table 2.

Table 2. Example calibration of α and β Huff model parameters.

	β		
	Pearson's R		
α	0.1	0.5	1.0
0.1	0.309*	0.539*	**0.657***
0.5	0.270*	0.537*	0.654*
1.0	0.196*	0.529*	0.649*

4.2 *Who* uses American Retail Centres?

The Huff model parameters were of great interest, offering insights as to the role of attractiveness/distance to different retail functions. The larger β values seen for types in group four were of interest; these centres typically provided an 'everyday' retail offering that is highly sensitive to distance. In contrast, the equal values for type 3.1 was notable, as this type comprised many of the established shopping locations, thus could be more likely to fit the conceptual basis of the Huff model. However in general the α was lower than β, as in the UK (Dolega et al., 2016).

For Seattle (5B), its catchment was very similar to others in this type of centres*;* typically very large, owing to a lack of directly competing centres nearby. However, this effect was reduced in polycentric cities like Los Angeles. Similarly, the Downtown Boulder catchment was large (5A), but it is likely this competes with other nearby centres in the same group, thus some over-estimation is apparent. Interestingly, large variability in average catchment sizes was seen between different types, providing further evidence of the link between function and scale.

5. Conclusions

This research is rooted in a pragmatic effort to better understand the 'geographies' of American retail centres, providing a mechanism through which to identify how and where effective responses are needed to protect the retail sector. Using data from SafeGraph, we explore *where* centres are located, *what* characteristics they have and *who* uses them, demonstrating that the three are better understood when examined together. We provide a comprehensive definition of retail centres for the US and a 'fit for purpose' typology, and calibrate the Huff model using a large mobility dataset. In addition, we highlight apparent connections between function, scale and consumer patronage, suggesting understandings of retail centre geographies should integrate these aspects, rather than considering them in isolation. This research has provided an empirical framework, with code available on GitHub, enabling repeated empirical measurement of retail centre geographies and extension to other international settings.

6. Acknowledgements

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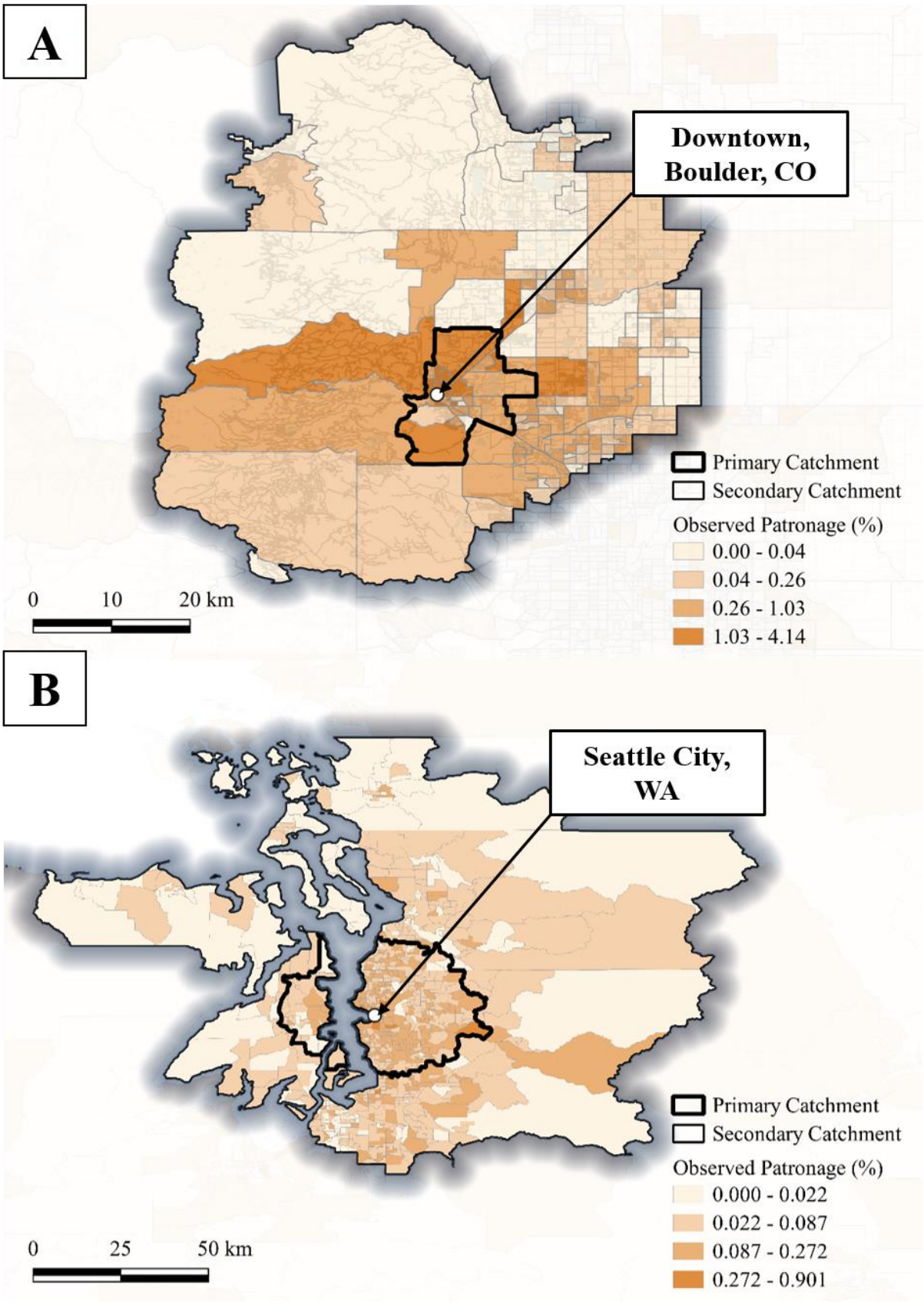

Figure 5. Catchments for Boulder and Seattle.

Biographies

Patrick Ballantyne is a PhD student in the Geographic Data Science Lab. His research involves using quantitative and spatial approaches to understand retail environments, with a particular interest in retail centres, and those outside the UK, demonstrating how such understandings can be used to understand the effects of wider retail sector processes.

Alex Singleton is professor of Geographic Information Science at the University of Liverpool, and Deputy Director of the ESRC CDRC. His research is concerned with how the complexities of individual behaviours manifest spatially and can be represented and understood though a framework of geographic data science.

Les Dolega is a lecturer of Retail Geography and Geographic Information Science at the University of Liverpool. His research interests and expertise are in economic/retail geography and GIS, in particular performance of town centres and their evolutionary trajectories.

Jacob Macdonald is a lecturer in GIS and Spatial Analysis at the University of Sheffield. His research interests involve leveraging big, spatial data for studies of urban environmental and economic processes. He is particularly interested in novel forms of granular data and the interplay of urban amenities, built environment and neighbourhood dynamics.