THE SHRINKING CITY SCHOOL: FOLLOWING TRAJECTORIES OF SHRINKAGE ACROSS THREE DECADES OF AN URBAN SCHOOL DESERT

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by

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The undersigned, appointed by the dean of the Graduate School, have examined the dissertation entitled

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presented by Heather Sweeney

a candidate for the degree of doctor of philosophy,

and hereby certify that, in their opinion, it is worth of acceptance.

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DEDICATION

I would like to thank my partner Alexander Gremp for supporting the pursuit and completion of my doctoral work.

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ABSTRACT

Late on the evening of January 12th, 2021, the Saint Louis Public Schools (SLPS) Board voted to close seven of its schools and transition one of its high schools to a middle school (Clancy, 2021). Sweeping closures are not a new phenomenon for the residents of St. Louis. Just in the last three decades, SLPS has closed 54 buildings, reducing its sites by 67%. What we understand about urban school closure, like those occurring in the city of St. Louis, encompasses official justifications for closure, the history and terms of the policies supporting or driving closure, and the actions taken by school districts as they enact closure. This study joins two spatial concepts, shrinkage and school deserts, through Doreeen Massey's relational politics of the spatial (2008) to explore a) the trajectories of shrinkage (out-migration, economic shifts, and housing) which require negotiation by the Saint Louis Public Schools and b) the resultant uneven distribution of educational access and academic pathways for St. Louis students. Through the creation of a Geographic Information Systems database this study utilizes descriptive statistics as produced from two spatial modeling tools in ARCGIS, each model established a layer which was combined to produce a final GIS database. Two key findings surfaced from this series of analysis. The first is that the variables of shrinkage are not randomly distributed across the St. Louis Metropolitan Area but in fact clustered. The second is a school desert patterning which suggests a) residents of south city, select west and north counties have greater access to a local public school while residents of north city have lost many of their local public schools since the year 2000 and b) a consequential relationship where a block group which shares boundaries with a flourishing school oasis is more likely to be a struggling school desert.

Chapter 1- Introduction

"Our district has the talent and resources it needs to provide every single student with a world-class educational experience. However, that talent and those resources become less effective when they are stretched over 68 buildings, some of which have fewer than 200 students. By consolidating, each school and every student will benefit" Superintendent of Saint Louis Public Schools (SLPS) Dr. Kelvin R. Adams (Clancy, 2021, paras. 8). When SLPS originally announced the closure of eleven schools in early December 2020, an outpouring of community protest paused closures to allow stakeholder participation in a week-long school consolidation plan feedback process before a final vote (Gordon, 2021). Late on the evening of January 12th, 2021, the Saint Louis Public Schools Board voted to close six of its schools (five North City: Clay, Dunbar, Farragut, Ford, Northwest and one South City: Fanning), transition one of its South City high schools (Cleveland ROTC) into a biomedical magnet school and transition one of its North City high schools (Carnahan) to a middle school (Clancy, 2021). Three schools managed to escape the chopping block for this round of closures. Two elementary schools will remain open (one North City: Hickey and one South City: Monroe) (Clancy, 2021). Meanwhile, Sumner High School, which is the first high school founded for African Americans west of the Mississippi (Gordon, 2021), was given a reprieve as Harris Stowe State University (St. Louis based Historically Black College or University) decided to become partners with the school in a revitalization effort to be assessed in the following years.

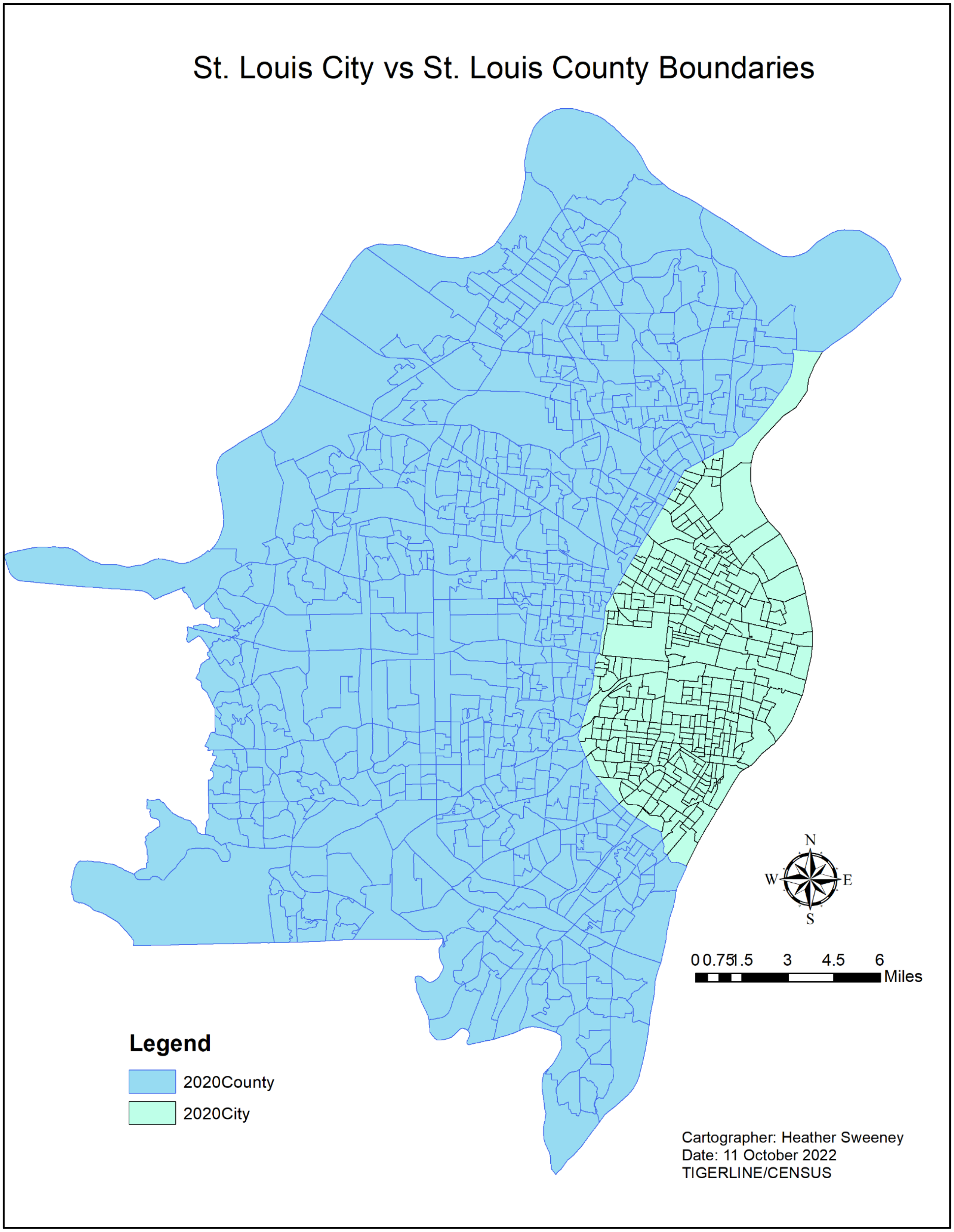
Justification for these school closures is reminiscent of SLPS closures of the past and ones that occur regularly across the country (Gordon, 2021). They are often framed as a necessary response to a city's long-standing loss of population attributed to white flight. From a record population of 856,800 in 1950, making St. Louis the eighth largest city in the nation, the city's population was an estimated 300,576 at this time in 2021 (Census QuickFacts); over time, this was a loss in which 80% of the city's white population evacuated to surrounding suburban counties (Gordon, 2021). However, few studies explore the relationship of school closings and where they are located to the variety of other social conditions in their surrounding area: is it just white flight that impacts the distribution of and access to resources within and between our spaces? This dissertation seeks to explore these issues using geographic information system (GIS) mapping. The following sections of this introduction provide a deeper review of St. Louis City, the purpose and research questions of this project, and a brief overview of the methods.

A Brief History of the St. Louis City Metropolitan Region

In order to understand all of the factors that may impact school closures within St. Louis City, it is important to understand the history of relationships and delineation between the city and the surrounding suburbs, which comprise St. Louis County, as their situation is quite unique in comparison to other major metropolitan areas. To begin, the 1876 Missouri Constitution granted state municipalities' home rule thus beginning the process of political fragmentation and localized power that would soon establish a patchwork metropolitan area across one of its major cities, St. Louis. Home rule is the delegation of state powers to local governments; this granted Missouri cities the option to adopt charters of self-government. Through the use of its new home rule powers St. Louis adopted its present-day boundaries and opted for formal separation from St. Louis County effectively setting the stage for future fragmentation (See Figure 1).

As a result, many inner core neighborhoods lost population as the occupancy status in the old tenements began to vary from block to block and building to building. By 1940 the influx of European immigrants abated and many native-born white families moved out to the western periphery of the city or into the county over. While the city's overall population declined only slightly in aggregate between 1930 and 1940, the drain from the urban core was significant. The result was a gap-toothed settlement pattern, disinvestment from the ancient building stock and deterioration of homes and shops and city streets for the next several decades (Heathcott, 2005).

Figure 1. *St. Louis City vs St. Louis County Boundaries*



Migration patterns across the St. Louis metropolis visually demonstrates what has been a known trend across American cities for decades, suburban sprawl hollowing out city centers. Here is a brief overview of what happened in the 20th century:

1930-1950: Balanced change, equal white exodus and African American entrance into the city center. In-migration during the war was segregated and focused in the north-side of St. Louis city.

by 1958: Property restrictions, deed restrictions and deed agreements allowed only one Black occupant per city block

by 1970: The St. Louis city population was shrinking

1970-2000: The St. Louis city population collapsed by more than 75%, available housing fell by more than 60% and more than 1/3 were abandoned or empty shells.

Specifically, within the St. Louis metropolitan area, mobility or access to the suburban dream of St. Louis County fell across racial lines where private realty codes of conduct, federal regulations enacted through the preference of local politics and neutral court decisions reinforced, supported or drove the establishment of residential restriction and the creation of an ever-tightening ring around the African American population (Gordon, 2008).

County municipalities progressively drained the wealth of the city through the local tax structure, as the city struggled to shelter its residents, the thriving economic development of the western counties called to wealthy white city dwellers as a suburban housing oasis (Heathcott, 2005). “At the core of the local tax structure is the property tax, which in Missouri is leveled against both real property (land and structures) and tangible personal property (cars and boats)” (Gordon, 2008 p. 53). Property tax has accounted for varying portions of local revenues: throughout the 1940’s municipalities counted on property taxes to provide 2/3 of local revenue but it now accounts for between 20 and 30 percent of local revenues and 30 to 50 percent of locally generated revenues. Due to a 1955 state law, rising property values automatically lowered tax rates whenever reassessment inflated revenues by more than 10%. In addition to this, exemptions for personal property tax grew: a new circuit breaker law reimbursed low-income seniors for property taxes that exceeded 4% of income; public and religious properties were extended to include properties in blighted redevelopment areas or enterprise zones; the 1980 Hancock Amendment limited growth in state taxes to the rate of growth in family income and prohibited new or increased local taxes without popular approval. Such provisions stripped the city of St. Louis of assessable property, removing a sizeable chunk from the tax rolls thus deflating property tax revenues (Gordon, 2008).

One of our most vital community structures that is dependent on funding from property taxes is our local school system. PK-12 institutions offer neighborhoods access to capital, they socialize our children, cultivate knowledge, and serve as a vehicle to enter into economic prosperity. That is, of course, if such institutions are accessible, of quality, and cognizant of neighborhood contexts. In the fiscal year 2001-02, assessed property value in St. Louis and St. Louis County ranged from over $270,000 per pupil in West County suburbs to barely $67,500 per pupil in North County suburbs and the city (Johnson, 2012). Those districts in fiscal trouble are both poorer and smaller than their peers, lack the local tax base to provide sufficient public services, welcoming community spaces, and access to viable educational options (Gordon, 2008).

Once serving an enrolled student population of 115,543 students (Crouch, 2015), by 2021 SLPS schools housed a combined enrolled population under 20,000 students (District Demographic Data, 2021). While the school-age African American population of the City of St.

Louis closely tracks that of SLPS (ACS 5-YR, 2020), only 38% of the city's school-age white children attend public schools (District Demographic Data, 2021). And so, it is the belief of school officials that these closures will allow for the reallocation of resources both financial and human, which will provide all students with a more supportive, engaging, and equitable experience (Clancy, 2021). As the latest round of closures took place in the 2021-2022 academic year, six schools joined over forty-five other SLPS schools to close since 1983 (Crouch, 2015), becoming vacant buildings in disinvested communities primarily located north of the infamous Delmar Divide.

A Brief History of Saint Louis Public Schools

Established in 1838, the Saint Louis Public School System (SLPS) opened the first public high school west of the Mississippi. And, like many of its peer urban districts who draw from a long history of serving the community, offering stabilization, structure, and support to families and their children, SLPS continues to face challenges as the educational landscape changes while still working to overcome the old (Comprehensive School Improvement Plan, 2008).

A continued factor influencing the SLPS institutional environment over the last half century is the district's operation of one of the largest and most expensive court-ordered desegregation programs in the country (Comprehensive School Improvement Plan, 2008). The St. Louis Student Transfer Program was born out of a 1983 Settlement Agreement approved by the Federal Court intended to better establish racially integrated schooling within both the City of St. Louis and St. Louis County. Under the Settlement Agreement African American students who live within city boundaries could choose to transfer to one of the participating St. Louis County school districts and non-African American students living in participating suburban school districts could choose to transfer to an SLPS Magnet School (Voluntary Interdistrict

Choice Corporation, VICC, 2017). Throughout its time, and to this day, the primary source of funding for VICC is the State of Missouri and funds were received in a similar fashion to many of our nation's voucher programs. Much like a voucher program, student funds follow the students from their home district to the program. Like a busing program, the funds VICC received are used to provide transportation services but, unlike a busing program, funds are also allocated to pay tuition amounts to participating school districts based upon the differential local districts' costs of education (Voluntary Interdistrict Choice Corporation, 2017).

According to an article in the *St. Louis Post-Dispatch*, by 2016 more than 60,000 of St. Louis city's African- American students have transferred to suburban schools through the program (Crouch, 2016). From its beginnings in the early 1980s to 1995, 55% of the city's African American students were attending desegregated schools and by 1980, that number was reduced to 18% (Crouch, 2016). Prior to the start of the program, most of the 117 suburban schools were racially homogenous. According to the *St. Louis Post-Dispatch*, within four years of the start of the program, all but seven of those 117 suburban schools increased their minority enrollment (Crouch, 2016).

While the program is set to close completely by 2024 (VICC, 2017), the magnet schools will still function within the city as a form of school choice. Within the last half century, SLPS received one of the first federal magnet school grants, which allowed SLPS to create and implement magnet programs across its schools (Comprehensive School Improvement Plan, 2008). Following the approval of charter school legislation in 1998, the State of Missouri has approved the creation, accreditation, and enrollment of 43 charter schools in the City of St. Louis (Rhinesmith, 2019, paras. 5). A decision which has entered the city into the national school choice dialogue and enveloped SLPS into a competitive educational marketplace (Comprehensive School Improvement Plan, 2008).

All of these policy changes have occurred while the district's enrollment declined from over 100,000 students in 1970 to approximately 30,000 students in the 2007-08 academic year (Comprehensive School Improvement Plan, 2008). In addition, the students in the city schools have consistently come from economically disadvantaged backgrounds. Across the early 2000s student population, 85% of SLPS students received free or reduced lunch and over 20% of SLPS students were defined by the state as homeless (Comprehensive School Improvement Plan, 2008). In order to meet the rising needs of SLPS families and students, the district established special education programs, home tutoring programs, and social services programs but these programs drained much of SLPS's funding and resources (Comprehensive School Improvement Plan, 2008). Due to the declining student enrollment and receding financial base, SLPS was forced to close schools or consolidate (Comprehensive School Improvement Plan, 2008).

In June 2007 the Department of Elementary and Secondary Education (DESE) declared SLPS unaccredited, citing challenges linked to school finance, governance and academic instruction and rigor, all which needed to be met by the district within the next ten years (Potter, 2017). Prior to this, SLPS had attempted to address their financial and academic challenges through the installation of rotating superintendents; each bringing their own vision or plan of action (Comprehensive School Improvement Plan, 2008). There were varying approaches to the restructuring of PK-12 curriculum, new ideas about the development of initiatives or schools, unique approaches to the delivery of professional development, the creation of leadership training programs, and a fresh take on the structure of benchmark testing (Comprehensive School

Improvement Plan, 2008). As their loss of accreditation may suggest, however, these efforts made little impact on SLPS student progress.

In turn, a “Special Advisory Board” (SAB) was created through the first iteration of the SLPS School Improvement Plan (Comprehensive School Improvement Plan, 2008). This board, which took power away from the elected school board, was tasked with regaining district accreditation through the design and implementation of a MSIP Accountability Plan. The MSIP Accountability Plan was mandated by DESE and was to be used by the SAB to identify targeted objectives and strategies aligned with those outlined in MSIP (Potter, 2017). DESE presented this request with a tool meant to assess the implementation and effectiveness of the MSIP Accountability Plan, the District’s Scorecard, a measurement document that tracks progress on key areas including MAP test scores, attendance, dropout and graduation rates (Potter, 2017).

The first School Improvement Plan was created for implementation in 2008, this was titled Comprehensive School Improvement Plan and contained a Comprehensive Long-Range Plan addressing MSIP-4 priorities (Comprehensive School Improvement Plan, 2008). The district became provisionally accredited in October 2012 (Potter, 2017). This set the stage for a new SIP, which was titled Transformation Plan 1.0 and set out to align SLPS with the new priorities outlined in MSIP-5 (Transformation Plan 2.0, 2015). Under the Transformation Plan 1.0, the district scored in the fully accredited range for two straight years: showing academic growth in English Language Arts, math, and social studies by exceeding its growth targets as well as increasing student attendance and graduation rates (Potter, 2017). With the creation of the Transformation Plan 2.0 in 2015, SLPS made the shift to a data driven district touting continued academic growth as well as stability in leadership and finances and was able to maintain their accreditation status (Potter, 2017; Transformation Plan 2.0, 2015). The State Board of Education voted unanimously to classify SLPS as fully accredited in January of 2017 (Potter, 2017).

Purpose Statement

The school closure literature highlights three primary justifications given by school officials for closing a school: cost efficiency, academic performance, and equality (Tieken & Auldridge-Reveles, 2019). By any of these measures, most SLPS schools could be forced to shutter their doors. The median assessed property value of St. Louis County school districts far outpaces the valuation of city neighborhood homes (Gordon, 2021), leaving SLPS to depend on state aid and taxation to narrow the expenditure per pupil gap. SLPS students between grades 3-8 habitually score two grade levels below the national average on standardized tests in math and English language arts. And this can be parsed out further to unveil a dramatic racial opportunity gap: the district's white students score about .11 grade levels lower than the national average while their African- American counterparts score 2.46 grade levels lower (Gordon, 2021).

While these measures seem to provide a picture of why SLPS schools are experiencing closures, the district answer to the question of how schools got to the point of closings deflects blame to forces beyond its control: "We operate downstream from political forces that have divested themselves of our neighborhoods and our children," writes the school board in its summary document (Adams, 2020, p. 3). An argument similar to the one made decades before in response to Liddell v Board of Education, the court case which began the longest-running and largest desegregation program in the nation (Strauss, 2017), where officials attributed city public school segregation to unforeseen forces beyond their control (Gordon, 2021).

Despite the lack of ownership espoused in such school board statements, perhaps there is a ring of truth to them or at very least the elucidation of spatial trajectories which should be examined in conversations of school closures. Our current levels of segregation and the durability of neighborhood inequality transform policy interventions intended to equalize education into mechanisms for further neighborhood stratification. If we are to take seriously the static nature of inequality and advantage within particular communities, despite the changing of the populace within, we must acknowledge the social fabric of our cities and neighborhoods (Green, 2015; Sampson, 2012). The social fabric of our cities, like St. Louis, is space. The way in which we think about space has shifted from an emphasis on the physical dimensions of a fixed form such as the cartographic boundaries which house our activities to one of living power influencing the course of our lives. Thinking critically about space asks for one to recognize that localities can have either a positive or negative impact on every facet of our life. To use the term made popular by Soja (2009), this means exploring spatial justice, or the distribution of and access to resources within and between our spaces.

Spatial justice centers the spatial dimensions of justice, critically examining the expressions of (in)justice built into our localities (Soja, 2009). As both an outcome and a process, spatial justice is simultaneously the distributional patterns that are inherently (un)just and the socio-political processes which established these distributional patterns. Distributional patterns are the spatial structures of privilege and advantage created by locational discrimination, which is shaped by oppression such as racism, classism and sexism enacted through socio-political processes like redlining, gerrymandering, and other exclusionary practices.

Towards a critical spatial examination of St. Louis public education, I have constructed a spatial justice framework to guide this study through the joining of the concepts of shrinkage and school deserts under Doreen Massey's relational politics of the spatial (Massey, 2008). The concept of shrinkage highlights the stark economic realities faced by St. Louis residents and St.

Louis County residents, where city residential spaces house a population of majority low-income, minority, low education attainment, and under-employed residents who often lack the social capital, cultural capital, and financial capital to provide a choice of high-quality education to its families and students. The demographics of family structure, income and education levels, and occupation or employment status of residents do not reflect those of predominantly White, middle-class suburban residential neighborhoods (St. Louis County) with an increased presence of liabilities such as teen pregnancy, crime, and drug abuse and the absence of assets such as libraries, social service agencies, community and child-care centers, and religious institutions (Goldring, Cohen-Vogel, & Smrekar, 2006). The concept of school deserts explores the neighborhood context, particularly the presence of assets, level of access and culture which have a deep impact on the education of its residents. The locale and proximity of schooling can provide a supportive community based in the familiar and known but depending on the presence or quality of particular assets and liabilities (Johnson, 2012), can have a generally negative impact on neighborhood educational institutions, neighborhood students' access to quality education, and the academic attainment of the neighborhood (Johnson, 2012). Integral to this framework is the acceptance of space as a collection of relations, as a multiplicity, and always under construction, as well as an understanding that the practices which create our relations collectively produce entities and identities. Massey (2008) argues for a politics that focuses on these practices and their subsequent relations. Spatial trajectories are our practices, their wake traced along both time and place. The practices of interest when discussing St. Louis and SLPS school closures are vacancy rates, the presence of school aged children, and migration.

Place is an event, the clash of a "temporary constellation of trajectories" (Massey, 2008, p. 154), which demands negotiation. It is true that SLPS is not directly responsible for the ingrained racial and socioeconomic divisions of both the city and its school system. Nor should the district be blamed for the development of suburban enclaves which resulted in white flight from both city schools and city homes. Specifically, within the St. Louis metropolitan area, mobility or access to quality housing and education falls across racial lines following historic private realty codes of conduct, federal regulations enacted through the preference of local politics and neutral court decisions all of which reinforced, supported, or drove the establishment of residential restriction and divergent infrastructure investment. This has left more children attending segregated schools in segregated neighborhoods with limited resources both financial and human.

Research Questions

This study will apply Massey's relational politics of space (2008) to an examination of the lead up and fall out of SLPS school closures of the past. First, this study will identify the pathways followed by different trajectories of shrinkage which must be negotiated. Second, the study will locate the negotiations made through school closures by SLPS, which form school deserts across the St. Louis Metropolitan Statistical Area. Examining the practicing of place both driving SLPS school closure and occurring because of closings will offer an urban- suburban case study to add to our understanding of the impacts of closures. To structure this examination, I put forth the following research questions:

RQ1. How has shrinkage occurred over time across the St. Louis Metropolitan Area?

RQ2. How does this shrinkage relate to public school closures?

RQ3. How do school closures shape the type of educational opportunities available to St. Louis Metropolitan Statistical Area students?

Using Geographic Information Systems to Explore Spatial Trajectories

As an introduction to why the policy action of school closure should be approached spatially, I present a basic overlay analysis in Geographic Information Systems. School status data was retrieved from the Urban Institute Education Data Explorer for all open public schools in both the City of St. Louis and St. Louis County. I created a base map using TIGERLINE Census boundary files to give the 2010 and 2020 block group polygons. I also created a school building pin layer utilizing the physical address of each public school to represent open schools. The building pin layer was overlaid with the block group base map to create a set of three maps: Figure 2. City vs County School Closures in 2000, Figure 3. City vs County School Closures in 2010, and Figure 4. City vs County School Closures in 2020.

In 2000 SLPS managed k-12 school buildings with a somewhat even distribution across the metropolitan area (refer to Figure 2 below). By 2010, the number of sites operated by SLPS had sharply decreased with notable loss in North City (refer to Figure 3 below). Now, in 2020 district sites are easily counted on the map with 15 SLPS schools remaining in North City and 17 located in South City (refer to Figure 4 below).

Figure 2. *City vs County School Closures in 2000*

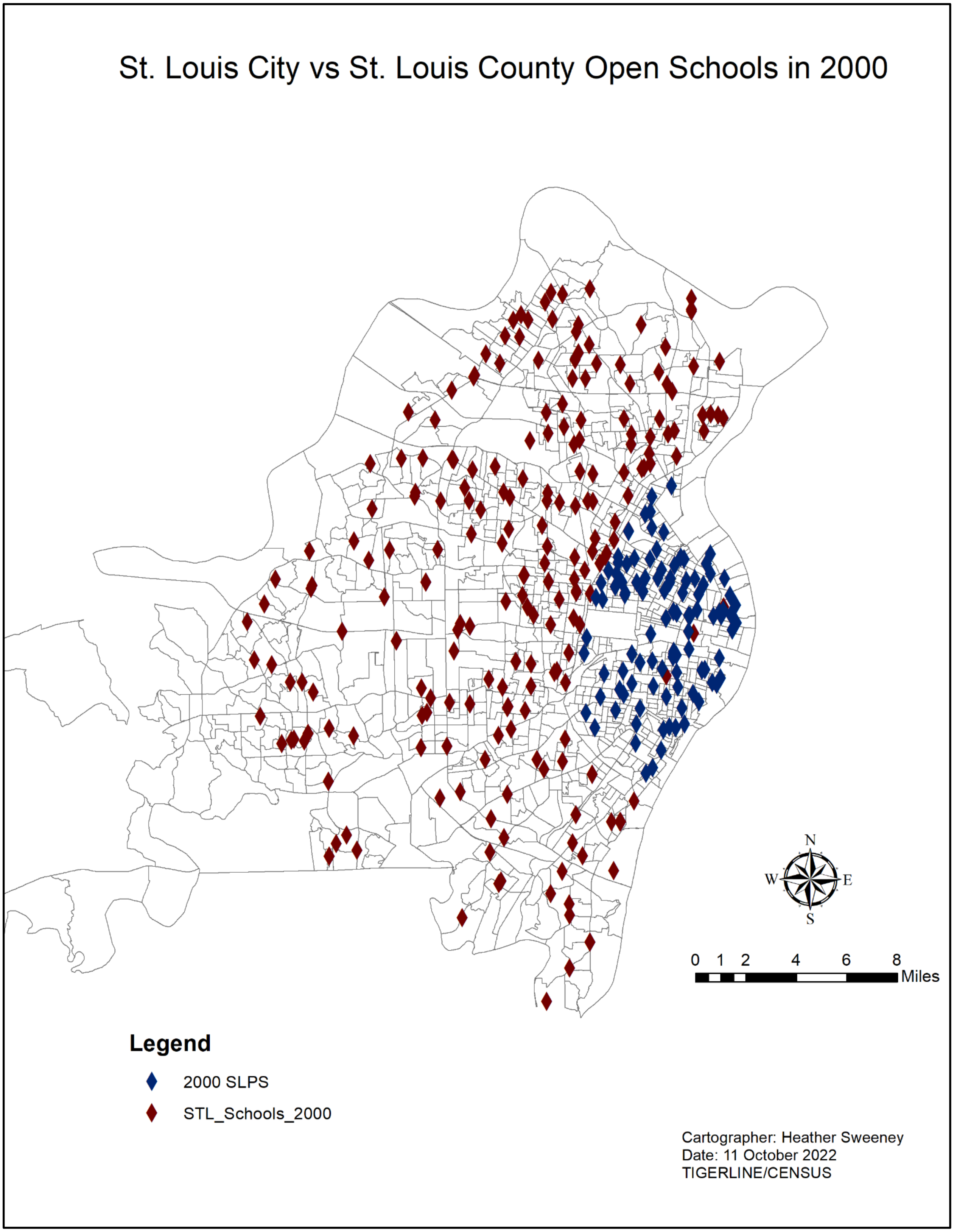


Figure 3. *City vs County School Closures in 2013*

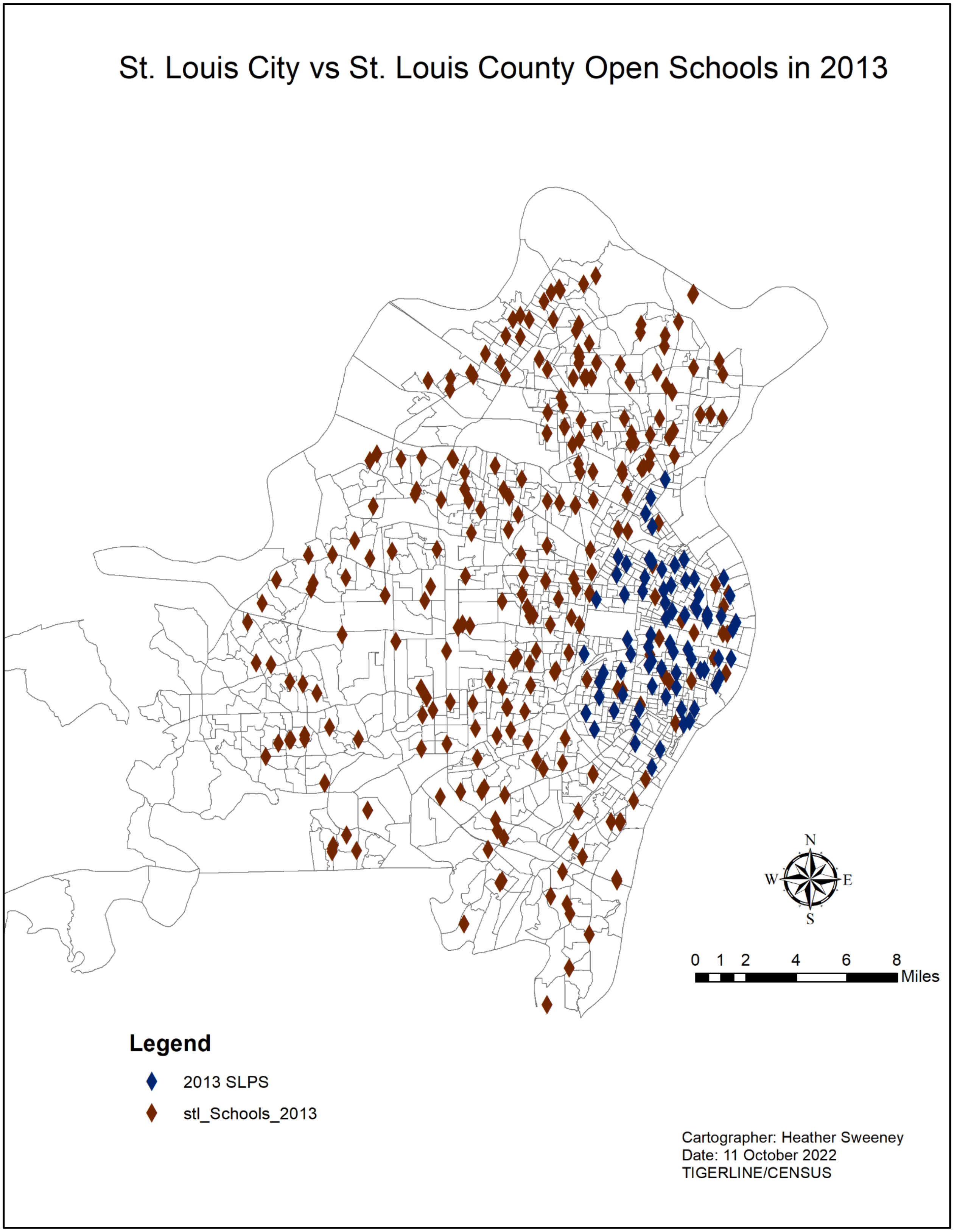
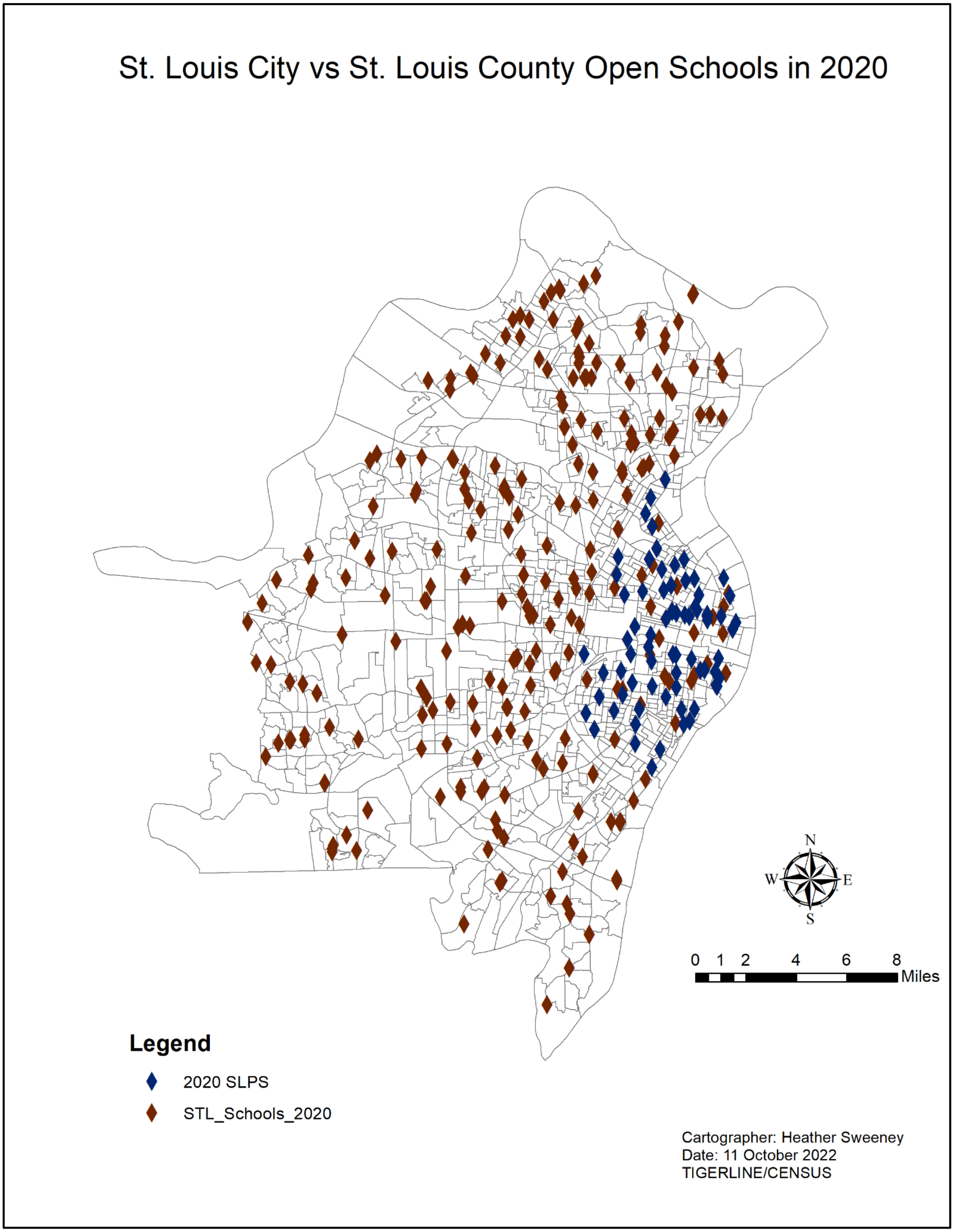


Figure 4. *City vs County School Closures in 2020*



With each decade SLPS sites were shuttered at alarming rates. A system that once operated densely populated public schools evenly distributed across a single metropolitan area has become a shadow of its former self, where the architect William B. Ittner was brought in to build glorious brick monoliths to urban education. The point being the above figures offer but a glimpse into the uneven distribution of k-12 public education in St. Louis. These figures do not dig into the quality hierarchy of SLPS schools. Nor do they provide insight into which subset of the city's school-aged children attend each school. What they do make clear are two important observations: one, the Saint Louis Public School District has struggled against shrinkage for at least the last three decades and two, there is a need to explore which communities have been disparately impacted by Saint Louis Public Schools negotiation of shrinkage (school closures).

To that end, this study intends to explore a) the trajectories of shrinkage (out-migration, economic shifts, and housing) which require negotiation by the Saint Louis Public Schools and b) the resultant uneven distribution of educational access and academic pathways for St. Louis Metropolitan Statistical Area students. To adequately address these examinations Chapter 2 – Guiding Frameworks will begin with an overview of the closure literature framed by spatial injustice, followed by the presentation of my spatial framework incorporating the concepts of shrinkage and school desserts into Massey's relational politics of the spatial and my research questions. Chapter 3- Methods will discuss the spatial analysis tools, supporting mathematics and data to be entered into a Geographic Information System analysis connected to each of my research questions. Chapter 4 - Spatial Analysis will discuss the resultant analysis of shrinkage and school closure executed through Moran's I, Geographically Weighted Regression and Hot Spot Analysis. Chapter 5 - Discussion will offer up a summary of findings, limitations, and implications for future research.

Chapter 2 - Guiding Frameworks

What we understand about urban school closure tracks along the policy implementation process, encompassing school official justifications for closure, the history and terms of the policies supporting or driving closure, and the actions taken by school districts as they enact closure. Existing scholarship has established the relationship between underperforming schools, closures, and the disparate effects on the academic performance of low-income students of color. Just as in recent studies on school choice, geospatial methodology is a critical step outside of traditional quantitative or qualitative methods when addressing the spatial injustices created by educational policies, such as school closure. Following a broad look at what we understand about urban school closure, I turn to the presentation of my conceptual framework. In this, I join two spatial concepts, shrinkage, and school deserts, through Doreen Massey's relational politics of the spatial (2008) to explore a) the trajectories of shrinkage (out-migration, economic shifts, and housing) which require negotiation by the Saint Louis Public Schools and b) the resultant uneven distribution of educational access and academic pathways for St. Louis Metropolitan Statistical Area students.

Literature Review: School Closure

As a policy action, school closure is wielded by policy actors. Those who possess the positional power to first, establish the measuring stick of school performance and then, to determine which buildings fall short of this measurement; therefore, must be closed. Traditionally, key political actors involved in school closure are members of the school board, district administration, and, at times, building level administrators. These individuals and groups are central to school closure. Over the last few decades, the Saint Louis Public School District has operated under a variety of leadership from an external consulting group to a Special Advisory Board to a newly elected school board and superintendent.

Closure is not just a policy to be wielded. Closure is experienced. It is felt by students, by their communities and it is unevenly distributed with ripple effects across our landscapes. Families, students, building level staff (administrators, teachers, counselors, and other support staff) and community members are the secondary actors in the policy action of school closure. The negotiation of place occurs between key political actors and secondary actors in official and unofficial forums. A recent article by Tieken and Auldridge-Reveles (2019) positioned school closure as yet another educational policy which is a source of spatial injustice in education. In their examination of the school closure literature, Tieken and Auldridge-Reveles apply Soja's concept of spatial injustice (2010) to trace this policy's production of unjust geographies within and across rural and urban landscapes. Here they argue the impossibility of politically neutral schooling by discussing how schools perpetuate inequity through five facets of school closure: justifications, politics, implementation, distribution, and impacts. Justifications include the reasons and arguments made by school officials when choosing closure. Politics are the local, national, and regional policies promoting school closure as a tool for educational reform. Implementation refers to the process that follows the decision to close a school or schools. Distribution studies examine the effects of school closure on the localities. Finally, impact studies explore the experiences of students, parents, and communities as they navigate the different stages of closure. As my examination of school closure endeavors to further our understanding of this phenomenon as spatial injustice, beginning with an overview of the literature framed by Tieken and Auldridge-Reveles' five facets seemed most appropriate.

Justifications for Closure

Researchers have identified the three most common reasons given by school officials when justifying school closures: cost efficiency, academic performance, and equality (Tieken & Auldridge, 2019). Schools are closed when districts face limited operational funds whether as a result of a national budget crisis such as the 2008 recession (Jack & Sludden, 2013; Lee & Lubienski, 2016; McMillin, 2010; Tieken & Auldridge-Reveles, 2019; Valencia, 2012; Wyckoff, Adelaja, & Gibson, 2011) or insurmountable district deficits or both (DeebSossa & Moreno, 2016; Deeds & Pattillo, 2015; DeYoung, 1995; Dodson & Garrett, 2004; Dowdall, 2011; Garnett, 2014; Khalifa, Jennings, Briscoe, Oleszweski, & Abdi, 2014; Larsen, 2014; Siegel-Hawley, Bridges, & Shields, 2017; Spader, 2007; Strange, 2013; Teieken & Auldridge-Reveles, 2019). Schools are labeled “inadequate” (Bastress, 2003; Casey, 1998), “deficient” (A. W. Johnson, 2012; Thompson, Wood, & Honeyman, 1990), or “failing” (Buras, 2015; Ewing, 2018; Kirshner, Gaertner, & Pozzoboni, 2010; Pappas, 2016; Steggert & Galletta, 2018; Tieken & Auldridge-Reveles, 2019) then scheduled for closure by school officials as they cite building wide low test scores (Finnigan & Lavner, 2012; A. W. Johnson, 2012; Khalifa et al., 2014; Subramaniam, 2011; Tieken & Auldridge-Reveles, 2019; Weiss & Long, 2013), abysmal attendance, or undesirable graduation rates, or some combination of the three (Briscoe & Khalifa, 2015; Deeds & Pattillo, 2015; Kemple, 2015; Khalifa et al., 2014; Kretchmar, 2014; Tieken & Auldridge-Reveles, 2019; Warner, Brown, & Lindle, 2011; Weiss & Long, 2013). The closure of such “failing” schools means displaced students will be afforded the opportunity to enroll in higher performing or better resourced schools and therefore, be better served by the district overall (de la Torre & Gwynne, 2009; Duke, 2012; Grant, Arcello, Konrad, & Swenson, 2014; Jack & Sludden, 2013; A. W. Johnson, 2012; Sunderman & Payne, 2009; Tieken & Auldridge-Reveles, 2019).

Performance benchmarks employed by not only the districts themselves but the researchers examining school closures ranged in standards meant to identify "low performance" (Luppescu, Allensworth, Moore, de la Torre, & Murphy, 2011; Tieken & Auldridge-Reveles, 2019). These discrepancies within and between the research and practical application of school closure do not allow for a clear picture of the actual performance of schools labeled "failing" or "low performing" as they are identified for closure. Despite such discrepancies, academic performance measures remain a key justification in most school closure conversations (de la Torre & Gwynne, 2009; Han et al., 2017; Steiner, 2009; Stuit, 2012; Tieken & Auldridge-Reveles, 2019), notably, through combination of two justifications: cost efficiency and the equality argument (Tieken & Auldridge-Reveles, 2019). The equality argument suggests that closure offers marginalized communities the opportunity to connect their students with quality education through enrollment at a new school (Dowdall, 2011; England & Hamann, 2013; Grant et al., 2014; Green, 2013; Jack & Sludden, 2013; A. Jackson & Gaudet, 2010; Strange, 2013; Tieken & Auldridge-Reveles, 2019; Williams, 2013). Take for example school closures researched in similar urban contexts to St. Louis, such as Kansas City, Pittsburgh, and Philadelphia, where school officials believed closures and subsequent student reassignment would lead to equal access to student support systems such as counseling and tutoring, up to date technology and updated buildings, as well as a wider array of courses and extracurricular engagement such as arts programs and athletic teams (Dowdall, 2011; Tieken & Auldridge-Reveles, 2019).

Academic accountability is a major focus within the literature, with several studies focusing just on closures due to low performance (Han et al., 2017; A. W. Johnson, 2012; Stuit, 2012; Subramaniam, 2011; Tieken & Auldridge-Reveles, 2019; Weber, Farmer, & Donoghue, 2018); however, as with arguments that school closures further equality, academic performance is typically cited in addition to the cost efficiency justification (Tieken & Auldridge-Reveles, 2019). In studies of urban school closures, cost efficiency surfaced around the early 2000s (one such study is McLean, 2003) with the central issue being the utilization of limited space. Urban school districts have and continue to experience pressure from State Education Agencies and other governing bodies to evaluate the use practices of each building under its jurisdiction given the restrictive nature of our metropolitan localities. (Deeds & Pattillo, 2015; de la Torre & Gwynne, 2009; Dowdall & Warner, 2013; Finnigan & Lavner, 2012; Green, 2017; Meiners, 2016; Ozek, Hansen, & Gonzalez, 2012; Sunderman & Payne, 2009; Tieken & Auldridge-Reveles, 2019; Weber et al., 2018). These evaluations most often lead to the identification and closure of underutilized sites (Finnigan & Lavner, 2012; Tieken & Auldridge-Reveles, 2019; Weber et al., 2018). In justifying closures from a cost efficiency standpoint, officials claim to be "right-sizing" schools by "consolidating" facilities. A redistribution would then offer equal access for all students to expanded academic and extracurricular offerings by taking students out of low performing schools (Aviles & Heybach, 2017; A. W. Johnson, 2012; Lipman, 2007, 2014, 2018; Lipman & Haines, 2007; Slater, 2018; Tieken & Auldridge-Reveles, 2019; Waitoller & Super, 2017).

Policies of Closure

Across the last few decades of national educational policy, school closure has been wielded as a school accountability measure where the parameters range from permissible action to mandate. In attempts to provide academic opportunity and greater educational equality, sweeping federal policies supported, directed, and structured school closures. Such focus on "failing," "underperforming," or "low-achieving" schools is not new to American educational reform. The Bush administration introduced School Improvement Grants (SIG) in *No Child Left Behind* (NCLB), a program which centered on closing "failing," "underperforming," and "low-achieving" schools. The cornerstone of NCLB, the insertion and greater influence of the federal government into the task of quality control of U.S. public schools, brought about a dramatic shift in the operations of public schooling. With this new role came an increase in funding for historically underfunded school districts; a push for higher achievement among low-income and minority students attending public schools; numerous new accountability measures to be tracked by schools and reported to both the government and the public; and the expansion of standardized testing to a requirement of yearly testing for all students beginning in 3rd grade (U.S. Department of Education, 2008).

Concerned by shifting international ranks, NCLB was designed with the goal of re-establishing the U.S. as a strong competitor on the educational world stage. With the move to holding schools accountable to the achievement of their entire student population, the federal government's expanded role emphasized an increase in performance across historically underserved and underperforming student groups: English-language learners, special education students, and low-income and minority students. States and their school districts were now required to assemble report cards for parents detailing the quality of education being provided at each of their public schools. These report cards served as the rubric for classifying school achievement, where a school either ranked as in need of improvement or achieving by their performance in specified student achievement metrics that are now broken down by race, ethnicity, gender, English language proficiency, immigration status, socioeconomic status (SES), and disability (U.S. Department of Education, 2008). Should it be discovered that a school is not making adequate yearly progress, State Education Agencies (SEA) and districts were required to either develop and implement school improvement plans for these “low-performing” schools or close the school (Kemple, 2015; Lipman & Haines, 2007; Sherrod & Dawkins-Law, 2013; Steiner, 2009; Tieken & Auldridge-Reveles, 2019).

Through the Education Finance Incentive Grant, NCLB attempted to encourage school districts to engage in an equitable distribution of Title 1 funding; while districts were not required to meet the policy expectations, choosing not to do so meant a reconfiguration of their grant formula and possible decrease in next year’s funding (New America, 2016). In addition to this emphasis on historically underserved populations, NCLB also required parents be given an opportunity to transfer their student out of a school identified for improvement to one of greater quality. This opportunity was facilitated by the school district through a communication requirement of NCLB, which required schools to share their status with parents, should it change (U.S. Department of Education, 2008).

Under NCLB parents could take advantage of a diverse public-school educational marketplace through transfer to any one of the expanded arrays of choice programs: charter schools, magnet schools, virtual, alternative, specialized, and thematic school programs (U.S. Department of Education, 2008). To support student transfer out of failing public schools, NCLB required a portion of Title 1 funding be set aside for transfer costs such as student transportation. A few years into the implementation of NCLB, 120,000 eligible students had transferred out of underperforming schools (U.S. Department of Education, 2008). NCLB also allocated Department of Education funding to the creation and maintenance of charter schools as well as the development of magnet schools. According to the U.S. Department of Education this funding led to more than 1.2 million American students enrolling in 4,300 charter schools located in 40 states by the year 2008. The 2007-2008 school year also saw the creation of 175 magnet schools across 41 school districts to serve an estimated 128,000 students (U.S. Department of Education, 2008). The establishment of charter schools within metropolitan statistical areas has been linked to school closures (Steggert & Galletta, 2018; Tieken & Auldridge-Reveles, 2019; Waitoller & Super, 2017; Weber et al., 2018). First, via competition for students, as enrollment in traditional public schools can take a hit as the presence of charter schools grows (Dowdall, 2011; Farmer et al., 2013; Garnett, 2014; Lipman, Vaughan, & Gutierrez, 2014; Jack & Sludden, 2013; Journey for Justice Alliance, 2014; Meiners, 2016; Tieken & Auldridge-Reveles, 2019; Weiss & Long, 2013). Second, via competition for state funding, as each new charter school further splits up the available pot of monies (Null, 2001; Steggert & Galletta, 2018; Tieken & Auldridge-Reveles, 2019). The role played by charter schools in the closing of traditional public schools continues to be explored as federal policies, like those discussed above, have expanded opportunities for the establishment of charter schools (Duke, 2012).

Once Barack Obama took office and appointed his first Secretary of the U.S. Department of Education, Arne Duncan, there was a national consensus that *No Child Left Behind* just wasn't making the type of change the previous administration promised. Enter in the *American Recovery and Reinvestment Act of 2009*, which included a $3 billion dollar investment to drive School Improvement Grants (SIG). What was initially presented as funding life blood for struggling schools quickly became a fifty -fifty gamble for school districts. While this investment into Title I SIGs was intended to stimulate the existing program under Section 1003(g) of the *Elementary and Secondary Education Act of 1965* it also came with new program requirements for State Education Agencies wishing to receive funds on the behalf of Local Educational Agencies (LEA) (School Improvement Grants--American Recovery and Reinvestment Act of

2009, 2009) and these new program requirements are the focus of criticism and challenge from educators.

Historically SIGs offered SEAs the ability to provide subgrant funds to LEAs for the purpose of improving persistently “low-achieving” schools; the *American Recovery and Investment Act* of 2009 continued SIGs but instituted a new requirement for fund distribution: LEAs must choose and implement one of four prescribed turnaround intervention models as outlined by the U.S. Department of Education. These four intervention models were: the turnaround model, the restart model, the school closure model, and the transformation model (School Improvement Grants--American Recovery and Reinvestment Act of 2009). Should the LEA choose the turnaround model, this would include replacing the principal and no less than 50% of the staff as well as granting the new principal greater autonomy. Should the LEA choose the restart model underperforming schools would reopen under a charter school operator, charter management organization, or education management organization (School Improvement Grants--American Recovery and Reinvestment Act of 2009). Should the LEA choose the transformation model, again the principal is replaced followed by the implementation of a rigorous staff evaluation and professional development, a comprehensive instructional reform plan which increases learning time and applies community-oriented school strategies, and a greater operational flexibility within the school. Should the LEA choose the school closure model, this closes the underperforming school and enrolls its students in another school within the LEA with a higher achieving student population (School Improvement Grants--American Recovery and Reinvestment Act of 2009).

Either because of national education reform policies which amplified school closure through funding promises like School Improvement Grants, or as part of a greater city vision

(Buras, 2015; Caref et al., 2012; Lipman & Haines, 2007), district strategic plans implemented in cities like Baltimore, Chicago and Philadelphia have recommended closure for under enrolled and low-performing schools (Deeds & Pattillo, 2015; de la Torre & Gwynne, 2009; Jack & Sludden, 2013; Lee & Lubienski, 2016; Lipman & Haines, 2007; Shiller, 2017; Steggert & Galletta, 2018; Tieken & Auldridge-Reveles, 2019). Take for example, the well-studied case of Chicago's Renaissance 2010 plan, which brought about the closure of more than 50 schools across the city district while simultaneously opening new charter schools within its bounds (Caref, Hainds, Hilgendorf, Jankov, & Russell, 2012; Lipman & Haines, 2007). Or, the New Orleans School Facilities Master Plan, which overhauled the entire system, shuttering practically every school building, firing all city teachers, and replacing local schools with a charter-based system of education (Buras, 2015; Lincove, Barrett, & Strunk, 2017). Then there are local school choice policies implemented in places like the City of St. Louis, such as interdistrict, intradistrict, and voucher programs, to which researchers have attributed notable precursors to school closures: lowering city enrollments and deflated district funding (Jimerson, 2002; McMillin, 2010).

Implementation of Closure

Once policy makers decide school closures are necessary the implementation process to follow incorporates all or most of the following progression of identified stages (Tieken & Auldridge-Reveles, 2019): a) academic, financial and equality justifications for closing selected schools are positioned by school officials; b) closure preparation, which centers on the development of a management plan for the flow of students from their current school to their new either through a gradual phasing out, an immediate un-enrollment or a shifting of the grade configurations within receiving school buildings; c) selected schools are closed; d) students are transitioned from closed schools to their respective new buildings; e) the newly vacant buildings, now surplus properties, are sold or leased (Bifulco & Schwegman, 2019; Bross, Harris, & Liu, 2016; Brummet, 2014; Dowdall, 2011; Dowdall & Warner, 2013; Engberg, Gill, Zamarro, & Zimmer, 2012; Finnigan & Lavner, 2012; Jack & Sludden, 2013; Kemple, 2015; Khalifa et al., 2014; Lipman et al., 2014; Patterson et al., 2006; Siegel-Hawley et al., 2017; Steiner, 2009; Subramaniam, 2011; Tieken & Auldridge-Reveles, 2019).

At some point in the progression of the above stages, community input may be encouraged by school officials and/ or policy makers by way of a public vote, an open forum, or through the creation of a committee to oversee implementation (DeYoung, 2000; Ewing, 2018; Good, 2016; Hendrix, 2013; Hyndman et al., 2010; Kirshner, 2015; Kretchmar, 2014; Pappas, 2016; Shiller, 2017; Tieken & Auldridge-Reveles, 2019). Studies have shown that this community input can influence how closures are managed by officials. However, most community members who have been directly impacted by school closures more commonly describe official request for community input as performative; little regard for the immediate needs of their community is shown across the closure process (Buras, 2015; Freelon, 2018; Pappas, 2016; Tieken & Auldridge-Reveles, 2019). Despite engaging in votes, forums and/ or committees, many community members still walk away from the closure process feeling excluded (Alsbury & Shaw, 2005; Bard, Gardner, & Wieland, 2006; Buras, 2015; Chance & Cummins, 1998; Deeb-Sossa & Moreno, 2016; DeYoung, 1995; DeYoung & Howley, 1990; Ewing, 2018; Freelon, 2018; Gaertner & Kirshner, 2017; Kirshner, 2015; Lincove et al., 2017; Lipman et al., 2014; Null, 2001; Patterson et al., 2006; Siegel-Hawley et al., 2017; Shiller, 2017; Tieken & Auldridge-Reveles, 2019; Vaughan & Gutierrez, 2017; Warner et al., 2011). These feelings of exclusion are often the result of existing racial discrimination (Briscoe & Khalifa, 2015; Desimone, 1993; Tieken & Auldridge-Reveles, 2019) such as the disparate allocation of resources to schools serving majority low-income, ELL, special education student populations (Freelon, 2018; Good, 2016; Kretchmar, 2014; Patterson et al., 2006; Tieken & Auldridge-Reveles, 2019).

Despite a neutral framing (Deeds & Pattillo, 2015), the school closure implementation process can be discriminatory and exclusionary. A case study by Finnigan and Layner (2012), examined how a district closed only one of six schools matching outlined closure criteria. Another study exploring California school closures noted one district's decision to close one local school building, citing budget deficits, while beginning construction on a new building in a wealthier neighborhood within its catchment area (Deeb-Sossa & Manzo, 2018; Deeb-Sossa & Moreno, 2016; Tieken & Auldridge-Reveles, 2019). Siegel- Hawley et al. (2017) found Richmond, Virginia officials closed a school that was both more cost efficient and performing better academically than many of its peers, which would remain open. Inconsistencies in not only the implementation of closures but the performance metrics utilized to identify schools for closures call to question the influence of wealth, education, political connection and power in this process (Finnigan & Lavner, 2012; Pappas, 2016; Tieken & Auldridge-Reveles, 2019) and foregrounds claims that school closures simultaneously seek to promote competition while minimizing democratic participation in our educational system (Aggarwal, Mayorga, & Nevel, 2012; Allweis, Grant, & Manning, 2015; Aviles & Heybach, 2017; A. W. Johnson, 2012; Killeen & Sipple, 2000; Lipman, 2007, 2014, 2018; Lipman & Haines, 2007; Slater, 2018; Tieken & Auldridge-Reveles, 2019; Waitoller & Super, 2017).

Distribution of Closure

Place matters a great deal to the students, families, and communities affected by school closure, so it should be no surprise that the locality of closures features prominently across the literature. A central argument made by researchers is that the selection of schools for closure "serves to further marginalize already marginal places" (Tieken & Auldridge-Reveles, 2019, p. 929) due to the relationship between demographics and socio-political boundaries (Casey, 1998; de la Torre et al., 2015; Ewing, 2018; Good, 2016; Grant et al., 2014; A. W. Johnson, 2012; Lee & Lubienski; 2016; Lipman, 2007, 2018; Tieken & Auldridge-Reveles, 2019; Weber et al., 2018).

Several studies have uncovered the classicism of closure, pointing to the disproportionate rate of closings happening to schools serving poor communities (Bastress, 2003; Brummet, 2014; de la Torre et al., 2015; Engberg et al., 2012; Han et al., 2017; Jensen & Ritter, 2010; Sherrod & Dawkins-Law, 2013; Tieken & Auldridge-Reveles, 2019). Take for example the analysis conducted by Engberg et al. (2012) which found that the students displaced by closures across a mid-sized city district were much more likely to receive free or reduced priced lunch than their nondisplaced peers.

Other studies have identified the racial unevenness of closure (Billger, 2010; de la Torre et al., 2015; Engberg et al., 2012; Gallagher & Gold, 2017; Han et al., 2017; Jensen & Ritter, 2010; Journey for Justice Alliance, 2014; Lee & Lubienski, 2016; Lipman & Haines, 2007; Subramaniam, 2011; Tieken & Auldridge-Reveles, 2019; Williams, 2013). A mix of large-scale quantitative studies and single-site examinations have tested for this racial disproportionality finding that when all other factors are held constant (such as academic performance), the Black and Latinx student population is most impacted by school closures (Bifulco & Schwegman, 2019; Brummet, 2014; Caref et al., 2012; de la Torre & Gwynne, 2009; Engberg et al., 2012;

Ewing, 2018; Finnigan & Lavner, 2012; Good, 2016; Journey for Justice Alliance, 2014; Lee & Lubienski; 2016; Lipman & Haines, 2007; Lipman et al., 2014; Luppescu et al., 2011; Meiners, 2016; Subramaniam, 2011; Tieken & Auldridge-Reveles, 2019); however, the percentage of Black students in a school was a better predictor of closures than the percentage of Latinx students (Burdick-Will, Keels, & Schuble, 2013; Tieken & Auldridge-Reveles, 2019; Weber et al., 2018). Meanwhile, schools serving a majority white student population have shown success in resisting closure (Desimone, 1993; Garnett, 2014; Grant et al., 2014; Siegel-Hawley et al., 2017; Tieken & Auldridge-Reveles, 2019; Williams, 2013).

Trends in migration also seem to influence the occurrence of school closures within and between communities (Casey, 1998; de la Torre et al., 2015; DeYoung, 1995; Lipman & Haines, 2007; B. A. Miller, 1990; Salmon, 1990; Tieken & Auldridge-Reveles, 2019; Williams, 2013). Research has found that many urban districts with downward enrollment trends experienced school closures (Billger, 2010; Billger & Beck, 2012; Brummet, 2014; Mills, McGee, & Greene, 2013; Tieken & Auldridge-Reveles, 2019), noting this loss in student population tracked with residential out migration trends. For many cities, a portion of this outmigration can be attributed to gentrification (Aggarwal et al., 2012; Dowdall, 2011; Lipman & Haines, 2007; Tieken & Auldridge-Reveles, 2019). Research conducted in Chicago overviews two neighborhood changes associated with both gentrification and a drop-in public-school enrollment, the first of which is an increase in property values (Good, 2016), and the second, often related change, is a shift in demographics as a once high proportion Black residential population with children is replaced with a whiter, younger, childless population (Burdick-Will et al. 2013). Outmigration can also be the result of impending school closure, with white families relocating to a new school district either by residential move or by enrollment at a private school (Desimone, 1993; Garnett, 2014;

Grant et al., 2014; Siegel-Hawley et al., 2017; Tieken & Auldridge-Reveles, 2019; Williams, 2013).

As state budget allocations to pk-12 districts continue to decline (Dowdall, 2011; Duncombe, Miner, & Ruggiero, 1995; Schwinden, 1993; Tieken & Auldridge-Reveles, 2019), the differential rate of not only assessed property value by neighborhood but also school tax levies (Billger & Beck, 2012; Lawrence, 2001; Lipman & Haines, 2007; Meckley & Hazi, 1998; Tieken & Auldridge-Reveles, 2019) speaks to the importance of locality in school closure. It is clear that school closures happen to particular urban communities, namely low-income communities of color conscribed by an urban landscape which is segregated both racially and economically, losing population and the product of a mis-managed local economy.

Impacts of Closure

Research has produced a limited understanding of the effects of urban school closure with mixed evidence in support of the benefits of closure, considering the academic, student, and community impacts of closure.

Of the impacts identified in the closure literature, academic impacts are the most thoroughly investigated, primarily the shift in student test scores and/or grade point averages from the year preceding closure to the year immediately following (Brummet, 2014; de la Torre & Gwynne, 2009; Gordon et al., 2018; Larsen, 2014; Ozek et al., 2012; Sherrod & Dawkins-Law, 2013; Tieken & Auldridge-Reveles, 2019). In the time between announcement and closure, students' test scores already begin to plummet. While the short-term effects of closure demonstrate a negative correlation between closure and student academic performance, the long-term effects are not so definitive. The long-term effects of closure seem to relate to the overall academic quality of a student's new school, with those sent to an academically stronger school demonstrating academic gains (de la Torre & Gwynne, 2009; Engberg et al., 2012; Han et al., 2017; Tieken & Auldridge-Reveles, 2019) and the performance of the displaced students, with high-performing students benefiting from closure while low-performing students suffered (Bifulco & Schwegman, 2019; Tieken & Auldridge-Reveles, 2019). However, most students affected by closure are not sent to a higher performing school (de la Torre & Gwynne, 2009; Ewing, 2018; Han et al., 2017; Lipman et al., 2014; Sherrod & Dawkins-Law, 2013; Tieken & Auldridge-Reveles, 2019). A recent analysis of Philadelphia school closures found that affected neighborhoods had few high-performing schools within its bounds, leaving displaced students with a mostly paralleled, low-performing schooling option (Jack & Sludden, 2013; Tieken & Auldridge-Reveles, 2019). Students who are relocated from one low-performing school to another low-performing school experienced a significant drop in test score performance following arrival at the new building (Engberg et al., 2012; Han et al., 2017; Tieken & Auldridge-Reveles, 2019). It is not just displaced students affected by closure. Multiple studies have documented the spillover effects of closure, both for the positive and the negative. For the positive, students who would have attended the closed school seem to perform better than they would have, should they have attended their original school (Kemple, 2015; Tieken & Auldridge-Reveles, 2019). For the negative, there is a dip in the test scores of current students following the receipt of displaced students (Brummet, 2014; Carlson & Lavertu, 2016; Gordon et al., 2018; TIeken & Auldridge-Reveles, 2019). In terms of graduation rates, the evidence is again mixed and dependent on the level of examination, with evidence suggesting closure can increase district-wide graduate rates (Luppescu et al., 2011; Tieken & Auldridge-Reveles, 2019) and evidence suggesting closure decreases student-level rates (Kirshner et al., 2010; Tieken & Auldridge-Reveles, 2019).

Studies examining other aspects of the impact of closure on students centers on their connection to school such as mobility, absenteeism, and extracurricular participation. Experiencing the closure of their school can be a confusing experience for students, riddled with uncertainty as they are confronted with complicated emotions (Brummet, 2014; de la Torre & Gwynne, 2009; Deeds & Pattillo, 2015; Kirshner et al., 2010; Ozek et al., 2012; Sherrod & Dawkins-Law, 2013; Steggert & Galletta, 2018; Tieken & Auldridge-Reveles, 2019) at the loss of connection to peers and teachers as well as their student voice (Conner & Cosner, 2014; Deeds & Pattillo, 2015; Gordon et al., 2018; Kirshner et al., 2010; Lipman et al., 2014; Shiller, 2017; Tieken & Auldridge-Reveles, 2019; Toneff-Cotner, 2015) but also a sense of opportunity. Student mobility is defined as continued or subsequent movement between schools. Findings on student mobility is mixed with studies showing both an increase in mobility (de la Torre & Gwynne, 2009; Gordon et al., 2018; Kemple, 2015; Tieken & Auldridge-Reveles, 2019) and no change in mobility (Ozek et al., 2012) following relocation to a new school. Of those students who relocate, many make the move before the official closure date (Han et al., 2017). A handful of longitudinal studies identified an increase in student absenteeism (Engberg et al., 2012; Larsen, 2014; Tieken & Auldrdige-Reveles, 2019), with one conducted by Engberg et al. (2012) noting this increase seems to fade over time. With closure often comes increased travel time to school such as longer bus rides, limited accessibility to the school building and diminished extracurricular engagement; issues which disproportionately affect the schooling experience of low-income students of color (Conner & Cosner, 2014; Deeb-Sossa & Manzo, 2018; de la Torre et al., 2015; Graham et al., 2014; Hyndman et al., 2010; Killeen & Sipple, 2000; Lee & Lubienski, 2016; Lipman et al., 2014; Spence, 1998; Tieken & Auldridge-Reveles, 2019). Also, potentially due to the above, parental engagement in school sees a marketable decrease following closure (Cochran et al., 2011; Deeds & Pattillo, 2015; Lipman et al., 2014; Spence, 1998; Tieken & Auldridge-Reveles, 2019).

The communities affected by closure consist of both the school community and the local community or neighborhood. Cost efficiency ranks pretty high in the closure justification rhetoric, but very little investigation exists to support such widespread use of the bottom-line argument. What research is available posits that closure does not save the district as much money as initially projected (Dority & Thompson, 2013; Dowdall, 2011; Finnigan & Lavner, 2012; Killeen & Sipple, 2000; Tieken & Auldridge-Reveles, 2019), such that the savings amounts to a very small fraction of the district's overall budget (Jack & Sludden, 2013; Tieken & Auldridge-Reveles, 2019). Aside from students, teachers make up a tremendous share of the school community. For many teachers, closure equates to job loss (Ewing, 2018; Hill & Jones, 2018; Lincove et al., 2017; Tieken & Auldridge-Reveles, 2019). While there are those teachers who, like their students, relocate to another school within the district, some chose to take a break from instruction, and others left the profession for good (Hill & Jones, 2018; Tieken & Auldridge-Reveles, 2019). Closure related job loss disproportionately impacts the tenure of experienced, locally educated, and Black female instructors (Lincove et al., 2017; Tieken & Auldridge-Reveles, 2019). The local community surrounding a closed school cannot escape closure related repercussions. The shuttering of school doors means the loss of an important community institution (Alsbury & Shaw, 2005; Chance & Cummins, 1998; Ewing, 2018; Lipman et al., 2014; Surface, 2011; Tieken & Auldridge-Reveles, 2019) where the now vacant building sits unused and for sale (Dowdall, 2011; Spader, 2007; Tieken & Auldridge-Reveles, 2019) or leased out to a charter school (Dowdall & Warner, 2013; Tieken & Auldridge-Reveles, 2019). How the community interacts with not only their local school, but the district is impacted by closure. The political voice of communities is stifled by the top-down nature of the closure process (Alsbury & Shaw, 2005; Lipman & Haines, 2007; Pappas, 2012; Tieken & Auldridge-Reveles, 2019). When closure leads to consolidation, the representation of elected positions is diminished (Alsbury & Shaw, 2005; DeYoung, 2000; J. Johnson, 2006; Tieken & Auldridge-Reveles, 2019), particularly for Black school board members (Johnson, 2005; Tieken & Auldridge-Reveles, 2019).

While studies examining the impact of closures are few and far between, for the moment, those that do exist present mixed or negative effects. With the literature suggesting academic success following school closure hinges on the quality of the new school, students who attend a higher performing school as a result of closure seem to perform better; however, landing at a higher quality school is not typical for most students experiencing closure. Aside from academics, closure also means disconnection for most students, a loss of relationship with peers and teachers as well as lower involvement in extracurriculars due to extended travel times to their new school. Students are not the only ones becoming less involved following school closure, despite spikes in civic engagement in parental protests over a closure decision, once the building becomes vacant, communities lose a central social and political institution.

Conclusion

Vacating a community fixture, such as a school, is disruptive to the well-being and stability of that locality. While attending to the justifications, politics, and implementation of school closure allows insight into policy actions, such examinations are insufficient. As scholars push to uncover the uneven distribution and disparate impacts of closure it is imperative to frame this issue as a spatial one. Just as Tieken and Auldridge-Reveles applied Soja’s concept of spatial justice to refute the political neutrality of school closure, continuing to address this prevalent educational policy from a spatial lens brings in the local narrative of policy actions. As discussed in the next section, thinking of policy through a spatial justice framework removes it from a disconnected policymaker neutrality and situates it within the lived experience of the students, families and communities facing school closure. To create my spatial justice framework, I turn to Doreen Massey's relational politics of the spatial from her 2008 work "For Space" for inspiration. In understanding school closures as spatial injustice, what Soja (2010) describes as both an outcome and a process, Massey offers a frame to capture not only a surfacing of the underlying processes of production but also identify the unjust patterns of distribution. It is with her relational politics of the spatial that I can join the spatial conceptions of shrinkage and school deserts towards answering my research questions.

Theories on Space

In her piece "For Space," Doreen Massey (2008) moves us away from the static conceptualization of space with its bounded utilization and theoretical divide with time towards a dynamic understanding of space as a negotiated multiplicity. Here she presents an approach to spatial analysis called a relational politics of the spatial, which calls for a new geography, one which attends to "negotiations within place, the challenge of linking local struggles, and the possibility of an outwardlooking politics which reaches beyond place" (Massey, 2008, p. 148). To this end, a relational "politics of place, then, involves both the inevitable negotiations presented by throwntogetherness and a politics of the terms of openness and closure" (Massey, 2008, p. 148).

Throwntogetherness

Place is an event, the clash of a "temporary constellation of trajectories" (Massey, 2008, p. 154), which demands negotiation. Negotiation is "the range of means through which accommodation… may be reached or not" (Massey, 2008, p. 154). Therefore, throwntogetherness, refers to the following: a) places are constructed through the practice of negotiation; b) knowing that places vary, we understand the practice of negotiation to possess a diverse array of approaches; c) it is through this practicing of place (the negotiation of intersecting trajectories) that we are continually changed. Throwntogetherness requires place to be understood as the meeting point of trajectories. In terms of the place known as the City of St. Louis, a particular type of trajectory is most influential, the trajectory of shrinkage.

The Trajectory Known as Shrinkage. The term shrinkage encompasses a set of demographic changes and physical dimensions, which signal a shift for a neighborhood, city, or other geographic location. Much like the catalyst of migration, the demographic changes of falling birth and marriage rates as well as increased rates of divorce and diverse household types (Bierbaum, 2020; Wiechmann & Bontje, 2015), result in economic downturns, greater unemployment, population loss, and decreased school enrollment (Beauregard, 2009; Bierbaum, 2020; Fol, 2012; Hollander & Németh, 2011; Schilling & Logan, 2008; Stanley, 2009; Thomas, 1990; Weaver & Holtkamp, 2015; Wiechmann & Bontje, 2015). The physical dimensions of shrinkage are patterns of housing vacancy and/or vacant land, conflicting investment in and a resulting underutilization of infrastructure, and the differential application of land valuation and land use practices such as mass demolition (Accordino & Johnson, 2000; Bierbaum, 2020; Hackworth, 2016; Hollander, 2010; Hollander, Johnson, Drew, & Tu, 2017; Hollander & Németh, 2011; Pallagst, 2010; Ryan, 2008, 2012; Rybczynski & Linneman, 1999; Stanley, 2009; Wiechmann & Bontje, 2015). Shrinkage does not occur in a bubble. This trajectory of change takes place across spatial scales. The shrinkage occurring in one space can always be linked to the growth occurring within a neighboring locale (Audirac, 2009; Bernt, 2016; Bierbaum, 2020;

Haase et al., 2014; Cunningham-Sabot, Audirac, Fol, & Martinez-Fernandez, 2013; Martinez-Fernandez et al., 2012; Pallagst, 2013; Weaver & Holtkamp, 2015). Such co-creation of shrinkage and growth translates to the visibly uneven development indicative of today's suburban, urban metropolitan areas. Shrinking spaces house residents constrained by high poverty rates, low educational attainment, and limited access to employment; therefore, these spaces lack opportunities for economic development while operating with lower tax revenue (Bierbaum, 2020; Giloth & Meier, 2012).

Massey's relationship politics of the spatial provides organization to the joining of two spatial conceptualizations independently applied to school closure. Shrinkage is an often-cited cause for school closure; therefore, this concept must be included in the exploration of school closure enacted in St. Louis. However, on its own it does not offer a comprehensive exploration as it only addresses the lead up to closure without discussion of the repercussions of closure. As shown in the spatial framework visualization included at the end of this chapter (see figure 1 below) the concept of shrinkage connects to my research question one. Shrinkage has informed the data selected and ARCGIS tool identified to address this first question, which will lay the foundation for my second research question. The second question requires the second piece of Massey's throwntogetherness, negotiation of trajectories. Armed with the trajectories of shrinkage identified through research question one, I will move to an exploration of school closure negotiations of shrinkage.

School Closure Negotiations of Shrinkage. As argued by Bierbaum (2020) the utilization of closure by our school districts to negotiate the trajectory of shrinkage can be identified: "(a) in the 'feedback loop' of catalysts and consequences of shrinkage (Haase et al., 2014), (b) in the material reality of the aging physical infrastructure, (c) in the use of austerity logics and “right-sizing” approaches and discourse, and (d) in the disproportionate impacts on lower income communities and communities of color” (p. 453).

As shown in the spatial framework visualization included at the end of this chapter (see figure 1 below) school closure of negotiations informed the choice of ARCGIS tool to address my second research question. Taking the variables of shrinkage as identified for my first research question, I will include contextual variables as well as the change in number of open schools to conduct a Geographically Weighted Regression. This analysis will hopefully move forward the application of Massey’s throwntogetherness towards the final analysis, which aims to question the terms establishing the openness and closure of place (in this case, the accessibility to public schools within and between St. Louis neighborhoods).

Openness and Closure. To really think of space relationally, we must recognize the open and relational construction of place. “The negotiations of place do not create bounded territories but constellations of connections with strands reaching out beyond” (Massey, 2008, p. 187). This means there must be a shift in emphasis from a concern of the degree of openness and closure to one that questions the terms which established such openness and closure. Our organization of time and space can be seen as attempts to regulate the range and nature of allowed adventures and approved chance encounters. A relational politics of space then addresses our embedded, interlocking organization of time and space.

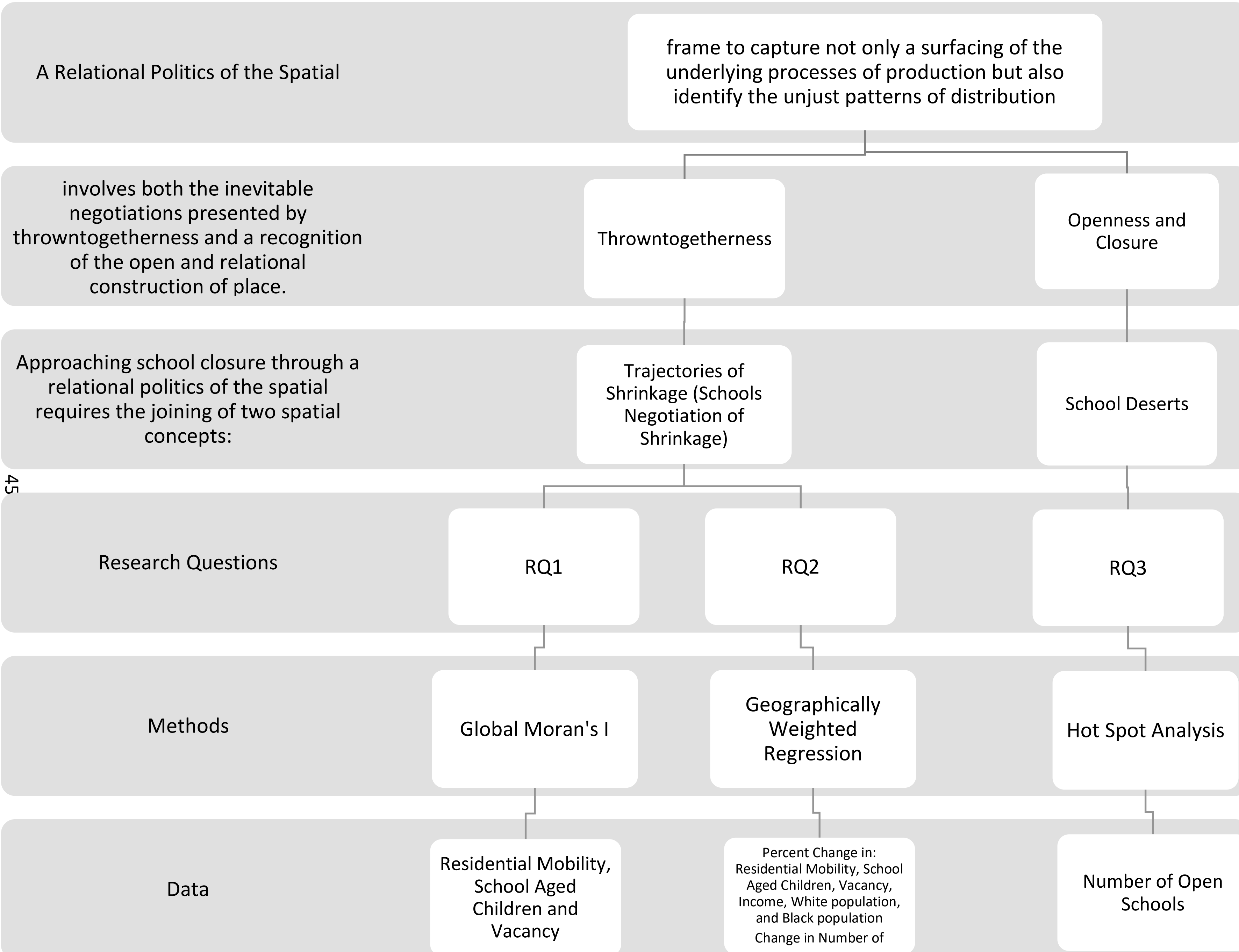
School Deserts. In contemplating the openness and closures contributing to and resultant of the trajectory of shrinkage, another geographic concept provides a fitting opportunity to broaden our understanding of the consequences of school closure. Application of desert nomenclature to the issue of educational access is not new. In 2016, Dache-Gerbino utilized the concept to explore accessibility to higher education. Then in 2020, Bierbaum applied the concept of access deserts to analyze the spatial injustice created by the uneven distribution of school closures across the state of Pittsburgh.

Surfacing first within the food availability discourse, the concept of deserts allows us to assess both the prevalence of the phenomenon and accessibility to the identified resource. In consideration of food deserts, scholars focus on identifying spaces that lack access to affordable, good-quality, fresh food (Bierbaum, 2020; Shaw, 2006). For instance, the United States Department of Agriculture (USDA) uses the following measures to map food deserts: approximately one mile to reach a grocery store in urban areas and 10 miles for rural areas (Bierbaum, 2020; Rhone, 2019).

Food desert scholars have found lack of access to good, quality food to be yet another consequence of the systemic oppression experienced through engagement with our many institutions. There exists tremendous trepidation on the part of grocery store chains to build in urban corridors not only because of a lack of demand for healthy foods but also because of the innate conflict between higher rent and lower residential purchasing (Bierbaum, 2020; Shaw, 2006). In recent years, scholars have expanded the notion of access to incorporate a consideration of food and diet socialization. Bringing a supermarket to an area does not solve the problem of food deserts, while it is a start, there is a need to address the food industry and its role in the unhealthy eating associated with poverty in America through market saturation of cheap and addictive foods.

As the ongoing conversation on food deserts illustrates, the utilization of access deserts in the examination of policy is a powerful visual which can begin to unpack the complexities of uneven distribution (Almadan, 2015; Bierbaum, 2020; Sadler et al., 2016; Ver Ploeg, 2010). As Shaw (2006) observed, multiple resources are needed for both the acquisition and the consumption of food. Resources such as reliable transportation, the accumulation of wealth, and a cultural framework which centers the purchase and preparation of healthy meals. Therefore, the mapping and analysis of school deserts, as applied by Bierbaum (2020) will serve as a starting point from which I will further explore the spatial injustice of school closures. Through the identification of school deserts within and between the urban and suburban spaces of the St. Louis Metropolitan Statistical Area I hope to gain a deeper exploration of the relationship between shrinking cities, their pk-12 enrollment and subsequent concentrations of advantage and disadvantage. In service of this deeper exploration, my methodologies outlined in Chapter 3 are designed to: locate the path of shrinkage trajectories across the City of St. Louis over the last three decades; trace the uneven distribution of school closure, which is the result of such trajectories of shrinkage facilitated by a co-created landscape of disparate policy outcomes; and present the spatial fixity of school deserts interrupting the equitable distribution of and access to a cohesive educational pathway for many St. Louis students.

As shown in the spatial framework visualization included at the end of this chapter (see Figure 5 below) the concept of deserts informed the choice of ARCGIS tool applied to answer my third and final research question. Building from the uncovering of trajectories of shrinkage to the unpacking of how public schools negotiate this shrinkage, there is now an opportunity to identify the unseen structure of access.


A Relational Politics of the Spatial
frame to capture not only a surfacing of the underlying processes of production but also identify the unjust patterns of distribution
involves both the inevitable negotiations presented by throwntogetherness and a recognition of the open and relational construction of place.
Throwntogetherness
Openness and Closure
Approaching school closure through a relational politics of the spatial requires the joining of two spatial concepts:
Trajectories of Shrinkage (Schools Negotiation of Shrinkage)
School Deserts
Research Questions
RQ1
RQ2
RQ3
Methods
Global Moran's I
Geographically Weighted Regression
Hot Spot Analysis
Data
Residential Mobility, School Aged Children and Vacancy
Percent Change in: Residential Mobility, School Aged Children, Vacancy, Income, White population, and Black population
Change in Number of
Number of Open Schools

Chapter 3 - Methodology

In this chapter I elaborate on the construction of a Geographic Information Systems database to conduct spatial analysis in the pursuit of answering my research questions: *How has shrinkage occurred over time across the St. Louis Metropolitan Area? How does this shrinkage relate to public school closures? How do school closures shape the type of educational opportunities available to St. Louis Metropolitan Statistical Area students?* Each research question is discussed in further detail through the presentation of the following: a) an explanation of how the spatial concepts discussed in chapter two will be used, b) an overview of chosen variables, their units of observation, data sources and study significance as supported by the research, and c) a detailing of the spatial analysis chosen to address the question which overviews the technique and supporting mathematics. My research questions are structured to build upon one another. Addressing the first question offers the needed insight to explore the second, which provides the foundational layer for the analysis addressing the final question. This chapter begins with a brief overview of using GIS in education policy research.

GIS in Education Research

The last two decades of educational policy research has witnessed the application of GIS tools to analyze a range of problems and issues across education. GIS provides researchers with the ability to highlight the geospatial dimension of education policy. As both a visual and analytic method which emphasizes patterns and the generation of descriptive visualizations, GIS offers insight into the relationship between geography and education policy in a way unmatched by other statistical approaches. Take for example the earliest application of spatial analysis to educational issues: the examination of school choice policies and patterns of parental choice. Research on school choice has demonstrated the importance of community context in educational opportunity (Brock, 2013; Chumacero, Gómez, & Paredes, 2011; Edmark, Frölich, & Wondratschek, 2014; Gulosino & Lubienski, 2011; Hamnett & Butler, 2013; Harris, Johnston, & Burgess, 2007; Rehm & Filippova, 2008; Seppánen, 2003; Singleton, Longley, Allen, & O'Brien, 2011; Taylor, 2009; Yoshida, Kogure, & Ushijima, 2009). Gauging barriers to accessibility such as disparate housing and income distribution within and between localities (Anyon, 2005; Sharkey, 2013), teacher labor market (Dougherty et al., 2009; Pitts & Reeves, 1999; Schultz, 2014), segregation (Arizona, Cobb & Glass, 1999; Saporito & Sohoni, 2006), school organizational behavior (Lubienski & Doherty, 2009), gerrymandering of school attendance boundaries (Lubienski, Gulosino, & Weitzel, 2009; Lubienski, Lee, & Gordon, 2013) and other contextual differences through locational analysis has offered educational scholars the opportunity to push beyond traditional statistical approaches (Burgess, Greaves, Vignoles, & Wilson, 2011; Marshall et al., 2010).

This earliest wave of spatial analysis leveraged GIS tools for objective measures of socio-educational issues relying almost exclusively on quantitative data (Schuurman & Pratt, 2002) or as an atheoretical descriptive supplement to other empirical methods (Yoon, Gulson & Lubienskit, 2018) such as graphic illustrations of student enrollment patterns, teacher quality distribution, school closures and school choice. Critics argued the traditional, positivistic view of our spatial world has conceived of space in mathematical terms that can be represented on a map, uncomplicated by lived experience or on the ground perspectives. Mapping quantitative data in GIS carries the assumption that space is immutable. The sense of place we ascribe to locations and the power relations inherent in our co-creation of space (Allen, 2011; Lury, Parisi, & Trerranova, 2012; Tate, 2012; Waitoller & Annamma, 2017) must be included in GIS examinations of educational issues to overcome this assumption and its representation limitations.

One-way researchers can attend to our sense of place is through qualitative geographic approaches which center historical geographies (André-Bechely, 2007). Education policy is intrinsically linked with historically shaped geographic “artifacts of past and present” advantages and disadvantages (Pulido, 2000, cited in André-Bechely, 2007, p. 1361) such as urban (re)development, discriminatory housing practices, demographic shifts within and between regions, and subsequent residential segregation by race or income (Butler & Robson, 2003; Reay, 2007; Gulson, 2011; Lipman, 2008; Yoon, 2011). Such qualitative studies uncover the processes underpinning the inequitable outcomes of equality-driven educational policy when it encounters the existing disparities of our segregated landscapes. Moving towards a new wave of geographic exploration of educational policy, researchers have begun to develop mixed methods or participatory projects to incorporate both the empirical validity of quantitative approaches and the critical examinations of hidden processes offered by qualitative methods. While this study utilized a more traditional quantitative GIS approach, critical geographic frame drove data selection, underpinned the research questions, and informed the progression of the analysis. To address research question one, Massey’s concept of throwntogetherness, which centers negotiations within place and understands place to be the clash of trajectories, informed the database design for, choice and application of the Global Moran’s I tool. To address research question two, Bierbaum’s fitting of the concept of shrinkage to school closures informed the database design for, choice and application of a Geographically Weighted Regression. To address research question three, Massey’s conceptualization of openness and closure informed the database design for, choice and application of a Hot Spot Analysis. Unique to this examination is the blending of multiple conceptions of spatial phenomena to build a historical narrative of the locational practices which deeply impact school closure. Beginning with research question one, I present my methodological sequence.

RQ1: How has Shrinkage Occurred Over Time Across the St. Louis Metropolitan Area?

When we approach space as a clash of trajectories, we are examining throwntogetherness; where places are constructed through the practice of negotiation. In terms of the place known as the City of St. Louis, a particular type of trajectory is under negotiation, the trajectory of shrinkage. In the case of the City of St. Louis and its public school system, the trajectories of shrinkage requiring negotiation are a declining city population, competition from charter schools or public county schools, and lack of funding due to depressed home values (Bierbaum, 2020). The negotiation of shrinkage occurs as a feedback loop of catalysts and consequences concerning a particular set of variables. Important to the application of shrinkage is the inclusion of the places seeming to benefit from another's struggles. In this case, the neighboring place benefiting from the city's shrinkage is St. Louis County, the suburban subdivisions surrounding the city to the northwest, west, and southwest. Therefore, the compilation of shrinkage variables caught in this feedback loop contains data for the City of St. Louis and the surrounding St. Louis Counties. The feedback loop Saint Louis Public Schools is caught in can be depicted through an examination of multiple types of data, including residential mobility (declining city population versus growing county population), the measure of school-aged children (competition from other public-school options) and the material reality of an aging infrastructure, as represented through vacancy rates (financial instability for city schools versus financial security for county schools). Table 1 (see below) identifies the variables chosen to locate the shrinkage occurring across the St. Louis Metropolitan Statistical Area. The goal of this

GIS analysis was to visualize the path of shrinkage trajectories across the St. Louis Metropolitan Area (St. Louis City and St. Louis County) over the last two decades from 2000-2020. Therefore, the values identified to represent shrinkage were transformed into percent change attributes then entered into the spatial autocorrelation tool (Global Moran's I) to determine the distribution and clustering of spatial trajectories of shrinkage.

Table 1

RQ1 Variables and Data Sources

Variable	Data Source	Study Significance
Percent Change in Residential Mobility	ACS, 2013-2019 Decennial Census, 2000 & 2010	Feedback loop of catalysts and consequences of shrinkage (Haase et al., 2014)
Percent Change in School Aged Children	ACS, 2013-2019 Decennial Census, 2000 & 2010	Feedback loop of catalysts and consequences of shrinkage (Haase et al., 2014)
Percent Change in Vacancy	ACS, 2013-2019 Decennial Census, 2000 & 2010	Physical dimension of shrinkage (Accordino & Johnson, 2000; Hackworth, 2016; Hollander, 2010; Hollander, Johnson, Drew, & Tu, 2017; Hollander & Németh, 2011; Pallagst, 2010; Ryan, 2008, 2012; Rybczynski & Linneman, 1999; Stanley, 2009; Wiechmann & Bontje, 2015).

Global Moran's I

Global Moran's I measures spatial autocorrelation by evaluating whether the pattern of features and the associated attribute are clustered, dispersed or random. In ARCGIS features are a spatial representation (point, line, or polygon) storing a set of attributes (data variable). First, the spatial autocorrelation tool calculates both an observed index value (Moran's I Index) and an expected index value, which are compared ("How Spatial Autocorrelation Works, n.d.). Then, the tool computes a z-score and p-value, which assesses the significance of the difference

The Moran's I statistic for spatial autocorrelation is given as:

$$I = \frac{n}{S_0} \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} w_{i,j} z_i z_j}{\sum_{i=1}^{n} z_i^2} \qquad (1)$$

where z_i is the deviation of an attribute for feature i from its mean $(x_i - \bar{X})$, $w_{i,j}$ is the spatial weight between feature i and j, n is equal to the total number of features, and S_0 is the aggregate of all the spatial weights:

$$S_0 = \sum_{i=1}^{n} \sum_{j=1}^{n} w_{i,j} \qquad (2)$$

The z_I-score for the statistic is computed as:

$$z_I = \frac{I - \mathrm{E}[I]}{\sqrt{\mathrm{V}[I]}} \qquad (3)$$

where:

$$\mathrm{E}[I] = -1/(n-1) \qquad (4)$$

$$\mathrm{V}[I] = \mathrm{E}[I^2] - \mathrm{E}[I]^2 \qquad (5)$$

between the observed index value and expected index value ("How Spatial Autocorrelation Works, n.d.). ESRI published the above ("How Spatial Autocorrelation Works, n.d., paras. 1) and below calculations for Global Moran's I ("Global Moran's I Additional Math, n.d., paras. 1).

Additional calculations are as follows:

$$\mathrm{E}[I^2] = \frac{A - B}{C} \quad (6)$$

$$A = n\left[(n^2 - 3n + 3)S_1 - nS_2 + 3S_0^2\right] \quad (7)$$

$$B = D\left[(n^2 - n)S_1 - 2nS_2 + 6S_0^2\right] \quad (8)$$

$$C = (n-1)(n-2)(n-3)S_0^2 \quad (9)$$

$$D = \frac{\sum_{i=1}^{n} z_i^4}{\left(\sum_{i=1}^{n} z_i^2\right)^2} \quad (10)$$

$$S_1 = (1/2)\sum_{i=1}^{n}\sum_{j=1}^{n}(w_{i,j} + w_{j,i})^2 \quad (11)$$

$$S_2 = \sum_{i=1}^{n}\left(\sum_{j=1}^{n} w_{i,j} + \sum_{j=1}^{n} w_{j,i}\right)^2 \quad (12)$$

The observed index value (Moran's Index) represents cross-products, a description of neighboring feature attributes, with values falling between -1.0 and +1.0 ("How Spatial Autocorrelation Works, n.d.). The cross product will be positive if the values of neighboring feature attributes are either both larger than the mean or both smaller than the mean (clustering). It will be negative if one value is smaller than the mean and the other is larger than the mean (dispersed) ("How Spatial Autocorrelation Works, n.d.). The greater deviation from the mean, the greater cross-product result. If cross-product values balance each other out, the Index will be zero ("How Spatial Autocorrelation Works, n.d.). As an inferential statistic, Global Moran's I is interpreted within the context of its null hypothesis. The null hypothesis of Global Moran's I states that the attribute being analyzed is randomly distributed among the features of the study areas (a random chance spatial process). If the p-value returned from the spatial autocorrelation tool is statistically significant, the null hypothesis is rejected ("How Spatial Autocorrelation

Works, n.d.) and the alternate hypothesis accepted. Each variable from table 1 carries both a null and alternate hypothesis, they are as follows:

(1) *Null hypothesis: Residential Mobility is randomly distributed across St. Louis City census tracts.*

Alternate hypothesis: Residential Mobility is clustered across St. Louis City census tracts.

(2) *Null hypothesis: The number of school aged children residing within St. Louis City is randomly distributed across census tracts.*

Alternate hypothesis: The number of school aged children residing within St. Louis City is clustered within particular census tracts.

(3) *Null hypothesis: Vacancy rates are randomly distributed across St. Louis City census tracts.*

Alternate hypothesis: Vacancy rates are clustered within particular St. Louis City census tracts.

RQ2: How does this Shrinkage Relate to Public School Closures?

As argued by Bierbaum (2020) the utilization of closure by our school districts to negotiate the trajectory of shrinkage can be identified through the 'feedback loop' of catalysts and consequences of shrinkage. With trajectories of shrinkage identified and their location within and between the neighborhoods which compose the St. Louis Metropolitan Statistical Area determined (analysis conducted with Global Moran's I towards answering research question 1), the next step was to locate the relationship between the trajectories and public-school closures over time. The variables of shrinkage assessed by the Global Moran's I were determined by the shrinkage discourse overviewed in chapter 2, this being the material reality of the aging physical infrastructure, declining population and competition. Because this analysis is examining the relationship between the trajectories of shrinkage and public-school closure across the St. Louis Metropolitan Area, attention must also be paid to the disproportionate impacts on lower income communities and communities of color. As discussed in chapter 1, St. Louis is a deeply divided metropolitan area across both racial and socioeconomic lines, whose residents are still facing the repercussions of historically prejudice and oppressive residential practices. What this means is that the shrinkage variables identified for the founding analysis are insufficient for this next stage. To appropriately position this next analysis within the St. Louis context, I also included median income as well as population counts for white and black residents.

When examining phenomena across both space and time a Geographically Weighted Regression (GWR) modeling is particularly useful. Therefore, this spatial analysis was applied to the dependent variable (school closures) and the independent variables (shrinkage variables) as described in Table 2 below. The following testable statements were used to link the variables of shrinkage and SLPS school closures to RQ2:

Null hypothesis: The presence of shrinkage trajectories does not influence the number of school closures within a given St. Louis City census tract

Alternate hypothesis: The presence of shrinkage trajectories does influence the number of school closures within a given St. Louis City census tract

Table 2
RQ2 Variables and Data Sources

Variable	Data Source	Study Significance
Percent Change of Shrinkage Variable(s) (IV)	ACS, 2013 and 2020 Decennial Census, 2000	As described in Table 1.
Percent Change in Median Income (IV)	ACS, 2013 & 2020 Decennial Census, 2000	
Percent Change in White Population	ACS, 2013 & 2020 Decennial Census, 2000	

Percent Change in Black Population	ACS, 2013 & 2020 Decennial Census, 2000
Change in Open/ Closed Public School (DV)	School status retrieved from Urban Institute Education Data Explorer.

Geographically Weighted Regression

Geographically Weighted Regression (GWR) explores the relationship between a dependent variable (DV), and a single or multiple independent variables (IV), as it varies across the landscape. The dependent variable (DV), in statistical models, is the phenomenon of interest, in this case, the DV is the occurrence of school opening or closure. The independent variable (IV), in statistical models, is the phenomenon believed to explain the DV or model outcome, in this case, the IV(s) are the variables identified to represent our trajectories of shrinkage.

GWR furnishes a local model of the dependent variable by calculating a regression equation for each feature in the data set ("How Geographically Weighted Regression Works, n.d.). Using a "weighted window" over the data, GWR analyzes values and estimates coefficients at specific points by attending to neighboring features; therefore, allowing the model to vary over space.

GWR models run under two parameters that must be set based on the variables and questions asked by the researcher. The first is the local weighting scheme. The local weighting scheme ensures that features farther away from the regression point are given less weight (therefore, have less influence on the results) and features closer to the regression point are given more weight (therefore, have greater influence on the results) ("How Geographically Weighted Regression Works, n.d.). The local weighting scheme has two kernel options, ADAPTIVE and FIXED. Which kernel is chosen largely depends on the spatial configuration of the feature in the Input feature class. If the observations are reasonably regularly positioned in the study area, then a FIXED kernel is appropriate; if the observations are clustered so that the density of observations varies around the study area, then an ADAPTIVE kernel is appropriate. Based on the need to apply GWR across the entire St. Louis Metropolitan Statistical Area evenly, this model parameter was set to an adaptive weighting scheme which allows the influence of surrounding features to remain present even as features become gradually less influential. In choosing an ADAPTIVE kernel the bandwidth is a count of the number of nearest observations to include under the kernel – the spatial extent of the kernel will change to keep the number of observations in the kernel constant.

The second parameter is bandwidth, set as either a distance band or number of neighbors, which is used by each local regression equation to control the degree of smoothing ("How Geographically Weighted Regression Works, n.d.). There are three choices for the Bandwidth method: AICc, CV and BANDWIDTH PARAMETER. The first two choices allow you to use an automatic method for finding the bandwidth which gives the best predictions, the third allows you to specify a bandwidth. The AICc method finds the bandwidth which minimizes the AICc value – AICc is the corrected Akaike Information Criterion (it has a correction for small sample sizes). The CV finds the bandwidth which minimizes a Cross Validation score. In practice there isn't much to choose between the two methods, although the AICc is my preferred method. The AICc is computed from (a) a measure of the divergence between the observed and fitted values and (b) a measure of the complexity of the model. The complexity of a GWR model depends not just on the number of variables in the model, but also on the bandwidth. This interaction between the bandwidth and the complexity of the model is the reason for my preference for the AICc over the CV score.

Ordinary Least Squares. Before fitting a Geographically Weighted Regression model, it is accepted practice to first explore a linear regression model, such as Ordinary Least Squares (OLS), where the estimation coefficient is by Ordinary Least Squares. To perform an OLS regression analysis within ARCGIS a series of databases must be created, joined to an existing shapefile, projected to a suitable coordinate system, then saved as a new layer before being run through the spatial statistic tool. To create the dependent variable for analysis, the status (open or closed) of all public schools (charter, magnet, alternative/ other) serving the City of St. Louis and St. Louis County with block group identifiers was retrieved from Urban School's data explorer for 1990, 2000, 2013 and 2020. From this a new variable titled public-school closure (PSC) was created for each block group by subtracting the number of open schools in the previous decade from the number of open schools in the next. To create each independent variable, I calculated the percent change between subsequent decades 2000- 2013 and 2013- 2020 for each variable using the following equation (((y2 - y1)/ y1)*100). A new layer titled OLS was constructed for each decade (2013, 2020) by joining a .csv file containing the manipulated census data to a TIGERLINE shapefile of St. Louis City and St. Louis County block group polygons. Each new layer was projected to UTM_1983_NAD_ZONE_15 Projected Coordinates to create two Ordinary Least Squares Projected (OSLP) layers. These layers were then run through the OLS spatial statistic tool where the dependent variable was school closures and the independent variables were percent change in residential mobility, percent change in number of school aged children residing within the block group, percent change in vacancy rate, percent change in white population, percent change in black population, and percent change in median income.

RQ3: How do School Closures Shape the Type of Educational Opportunities Available to St. Louis Metropolitan Statistical Area Students?

The negotiations taking place within the spaces of St. Louis does not create boundaries, but rather highlights the flow and movement of resources. Surfacing first within the food availability discourse, the concept of deserts allows us to assess both the prevalence of the phenomenon and accessibility to the identified resource. The utilization of access deserts in the examination of policy is a powerful visual which can begin to unpack the complexities of uneven distribution (Almadan, 2015; Sadler et al., 2016; Ver Ploeg, 2010). Through the identification of school deserts within and between the urban and suburban spaces of the St. Louis Metropolitan Statistical Area I sought to explore a) the uneven distribution of school closure across a co-created landscape of disparate policy outcomes, b) the accompanying lack of access to quality schools for students located within school deserts, and c) how we frame access by extending this conceptualization to include the distribution in educational pathways experienced by students residing within school deserts. The Urban Institute collects data across systems of pk-12 education such as the opening of new schools or the closure of existing schools. For this analysis, I retrieved the status for all public schools, inclusive of magnet and charter schools, across both St. Louis City and St. Louis Count for 1990, 2000, 2013 and 2020. I then calculated the change in open public schools by subtracting the first year from the last year for each decade (1990-2000, 2000-2013, and 2013-2020) to serve as the input variable for the hot spot analysis.

Table 3
RQ3 Variables and Data Sources

Variable	Data Source	Study Significance
Change in Number of Public Schools	Urban Institute Education Data Explorer	Locational points for all open public school buildings between 1990-2020 serve as the centroid for proximity.

Hot Spot Analysis

In ARCGIS, the Hot Spot Analysis (Getis-Ord GI*) tool calculates the Getis-Ord Gi* statistic for each feature. The Getis-Ord Gi statistic returned is a z-score, which is either negative or positive. The Hot Spot Analysis tool considers each feature within the context of neighboring features. A local sum is created for each feature which is then compared proportionally to the sum of all features. Therefore, statistical significance refers to not only the difference between the local sum and expected local sum but also the extent of this difference. The z-score is considered statistically significant when it both has a positive high value and is surrounded by other high values (hot spot) or when it both has a negative low value and is surrounded by other low values (cold spot). ESRI published the below calculations for Getis-Ord ("How Hot Spot Analysis Works, n.d., paras. 2).

The Getis-Ord local statistic is given as:

$$G_i^* = \frac{\sum_{j=1}^{n} w_{i,j} x_j - \bar{X} \sum_{j=1}^{n} w_{i,j}}{S \sqrt{\frac{\left[n \sum_{j=1}^{n} w_{i,j}^2 - \left(\sum_{j=1}^{n} w_{i,j} \right)^2 \right]}{n-1}}} \quad (1)$$

where x_j is the attribute value for feature j, $w_{i,j}$ is the spatial weight between feature i and j, n is equal to the total number of features and:

$$\bar{X} = \frac{\sum_{j=1}^{n} x_j}{n} \quad (2)$$

$$S = \sqrt{\frac{\sum_{j=1}^{n} x_j^2}{n} - \left(\bar{X} \right)^2} \quad (3)$$

The G_i^* statistic is a z-score so no further calculations are required.

Feature Layer. To create the visualization of public-school negotiation of shrinkage, each operating public school building locale (coordinates provided by the Urban Institute) became a pin. I joined the building pins to a TIGERLINE 2010 or 2020 block group shapefile to then run through the hot spot analysis.

Conclusion

This study created a Geographic Information Systems database to examine the lead up and fall out of SLPS school closures across the last few decades. While this study utilized descriptive statistics as produced from two spatial modeling tools in ARCGIS, each model also established a layer that was combined to produce a final GIS database. Undertaking a critical approach to a geographic examination of education policy, this study blends multiple conceptions of spatial phenomena to build a historical narrative of the locational practices which deeply impact school closure. Examining the practicing of place both driving public school closure and occurring because of closings will offer an urban- suburban case study to add to our understanding of the impacts of closures.

Chapter 4 - Spatial Analysis

In this chapter I walk through the spatial statistical tools employed to answer my research questions: *How has shrinkage occurred over time across the St. Louis Metropolitan Area? How does this shrinkage relate to public-school closures? How do school closures shape the type of educational opportunities available to St. Louis Metropolitan Statistical Area students?* As presented in chapter 3, each research question builds upon the other and is explored by a different spatial statistical tool. The first task was to determine the spatial variation of shrinkage across the St. Louis Metropolitan Area; therefore, each shrinkage variable was run through Moran's I (the spatial autocorrelation tool of ARCGIS). The second was to model the spatial relationships of public-school closures and variables of shrinkage by creating ARCGIS databases to run through a Geographically Weighted Regression. The third was to visualize the availability of and access to pk-12 public educational opportunities across the St. Louis Metropolitan Statistical Area with a hot spot analysis of school building pins situated in city and county block groups.

Shrinkage Over Time

By way of an initial data exploration, I mapped each variable of shrinkage at three points in time, 2000, 2013, and 2020. The intention was to provide a visualization of the spatial variation in each variable (figures 1-9, inserted below). I compared a single shrinkage variable across the decades as well as the state of the collection of variables at each point in time. Two key boundaries led my observations: first, the governmental separation of St. Louis City and the county; second, the locally recognized Delmar divide demarcating the hard line between North and South city.

Preliminary Analysis of School-Aged Children Variable

Figures 6 to 8 demonstrate the change over time of school-aged children residing in the St. Louis metropolitan area. As I review in subsequent pages, these visualizations suggest the trajectories of shrinkage flow along paralleled directional paths highlighting the dichotomy of an aging city population and a young family county enclave.

Figure 6. *School Aged Children Residing in St. Louis City and County Block Groups*

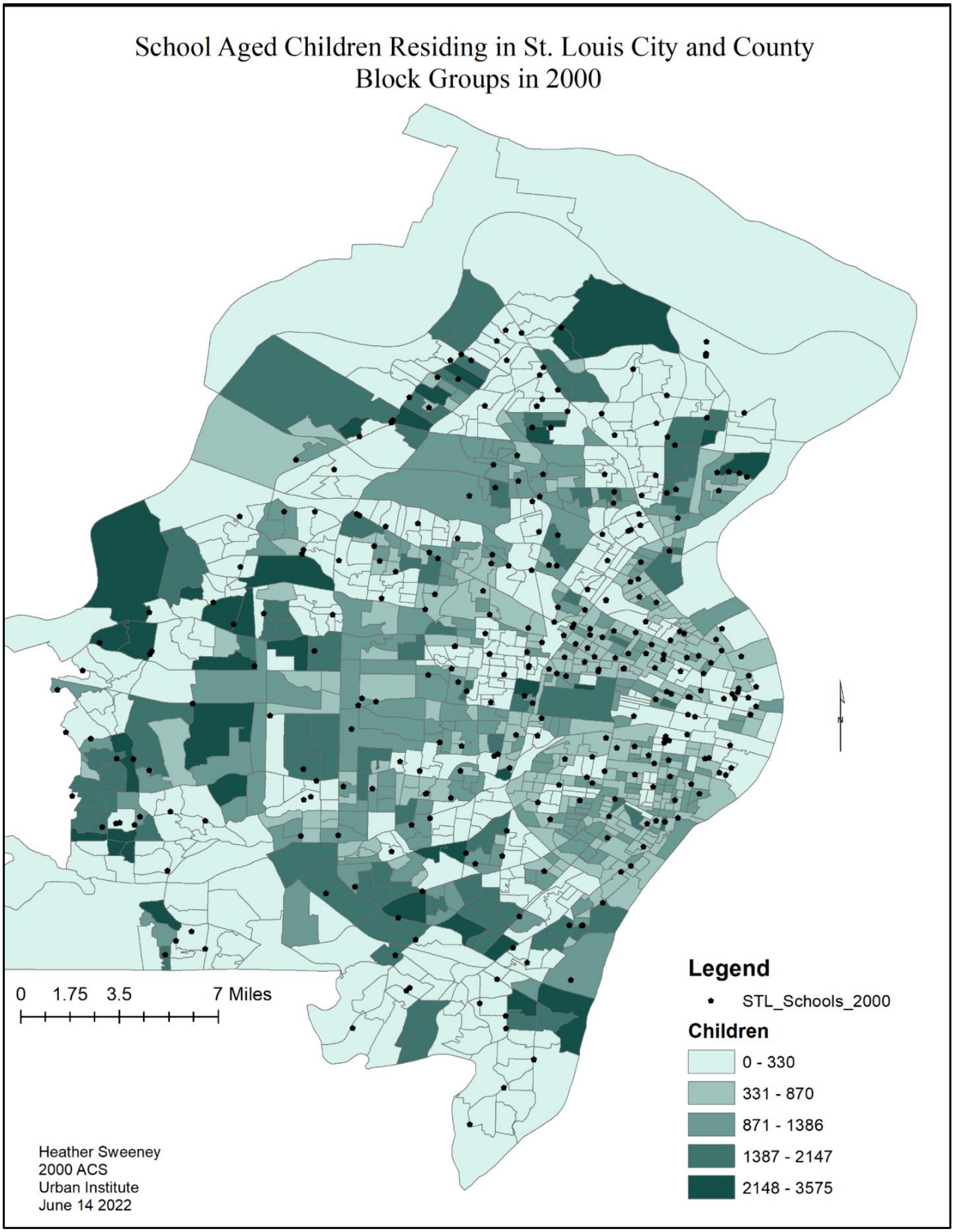


Figure 7. *School Aged Children Residing in St. Louis City and County Block Groups*

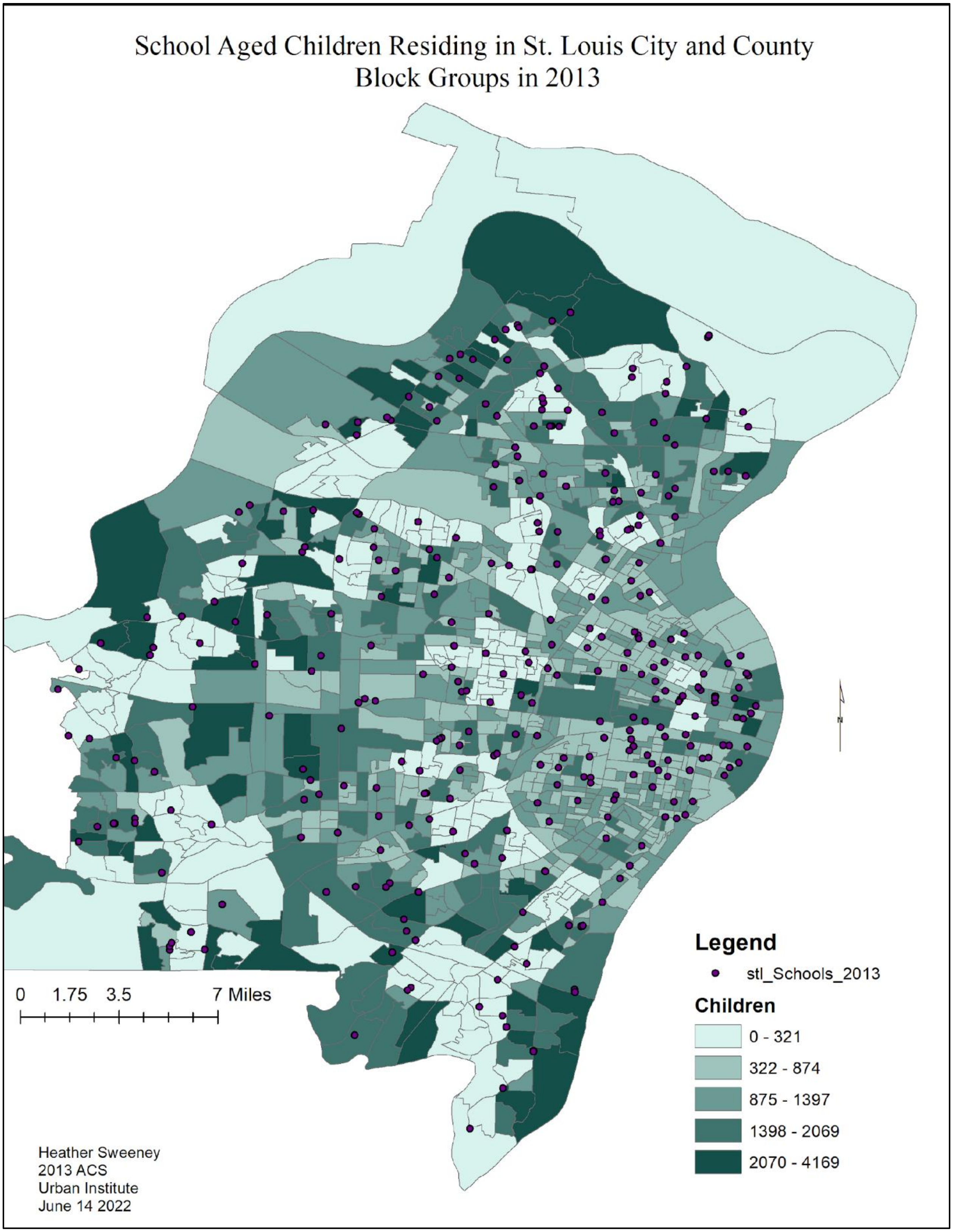


Figure 8. *School Aged Children Residing in St. Louis City and County Block Groups*

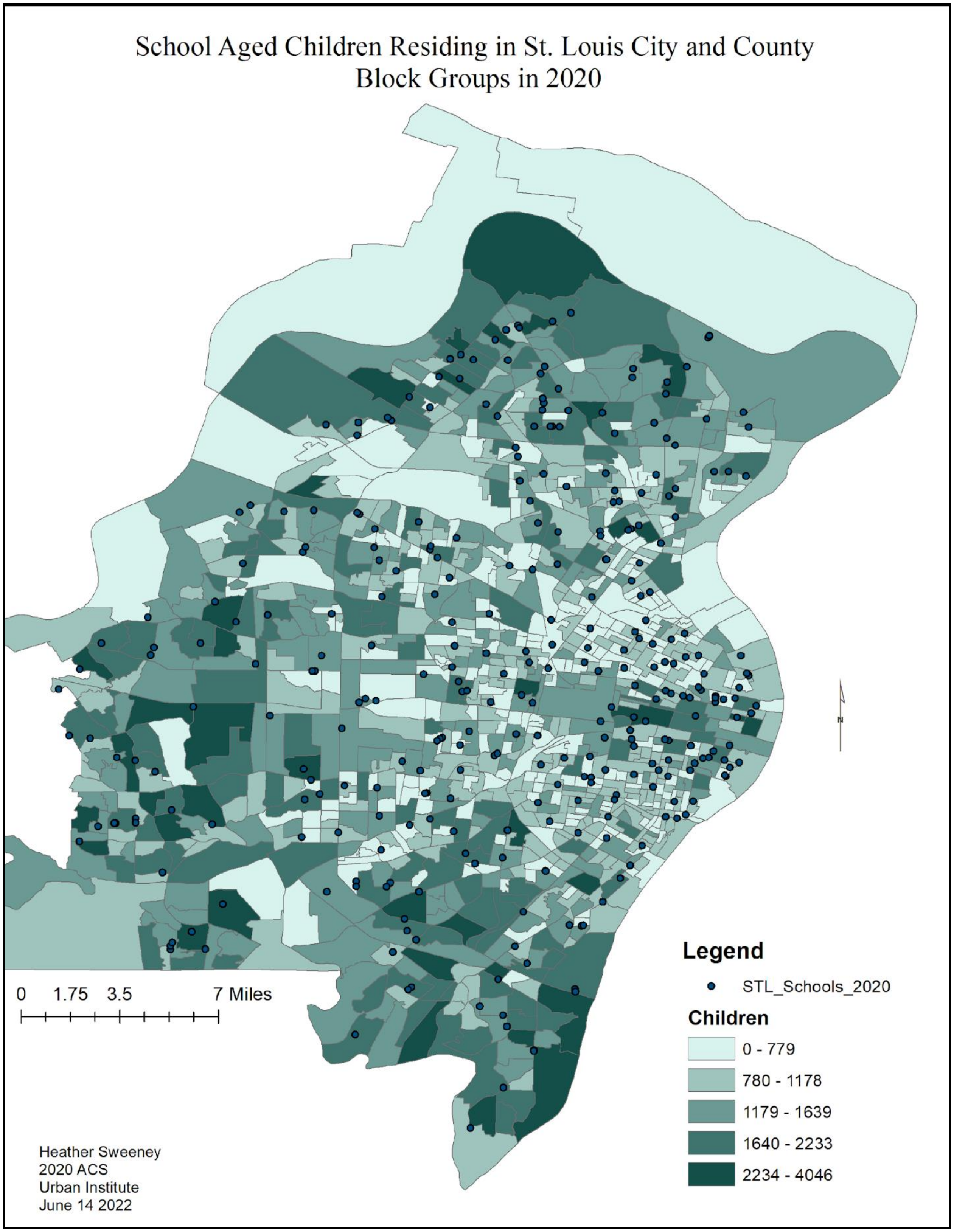


Figure 6, school aged children by block group in 2000, depicts the tremendous loss in population suffered by the City of St. Louis between 1970 and the end of 1990. The depressed number of school aged children (shown in pale green, 0 to 330 children residing within block group) in strips of north city that stretch out to north county and the hollowed out central corridor (again, shown in pale green). Note the continuous, center strip of darker green (representing 2,148 to 3575school children) from the official boundary between the city and the county. The block groups housing the greatest number of school aged children tend to be in the western counties, cutting across both north and south counties. Outside of this dark green path, there are some off shoots of darker green (like rays of sunlight moving from the suns center- the city). A slightly broken ring of pale green encompasses the city and county boundary. The natural breaks built into the color scale show a smaller school aged population than those residing across the St. Louis Metropolitan area in 2013 and 2020 (each topping out at 4,000). The darkest green spaces house a maximum of 3,575 children and the pale green spaces house between no children and just 330. These patterns reflect the dichotomy of an aging city population and a young family county enclave.

Figure 7, school aged children by block group in 2013, shows a return of families to the city (the darkest green spaces house up to 4,169 school aged children), perhaps due to the uptick in overall residential mobility from 2000 (as shown in figures 4 to 6). The city, which was pale green in 2000 has now become a blended greenscape. The central corridor more than doubling the number of school aged children (being the dark green and representing approximately 1,000 to 2,000 school aged children). While both north and south city block groups house at a minimum 332 school aged children to a maximum of 2,069. This happened simultaneously with changes implemented by the Saint Louis Public Schools system as it strove to become accredited again such as the creation of many of its magnet schools, the establishment of a robust charter system within city limits, and the neighborhood revitalizations driven by several community development corporations.

Figure 8, school aged children by block group in 2020, shows a steady number of young families residing within city limits but located at the central corridor and select south city spaces. While the gradients may seem to indicate a second decrease in the number of school aged children in north city and pockets of south city, the natural breaks tell a different story. The pale green pockets could house up to 779 school aged children which is within the range of the slightly less pale green of 2013 in those same spaces. However, this does not mean there isn't any change. Due to the shift in natural breaks, it is likely some of the block groups in north city did lose population, especially given that more north county block groups are darker green than the decade before (signaling that block groups house at least 1,179 school aged children towards a maximum of 4046). The ring of darker green continued to ripple out over the northern, western and southern counties, suggesting further relocation into the county, larger child to parent ratio in the county versus the city, or an influx in new families from outside of the Metropolitan Statistical Area.

Preliminary Analysis of Residential Mobility Variable

Figures 9 to 11, demonstrate the change over time of residential mobility by block group from 2000 to 2020. For this study, residential mobility signals a household relocation from their previous county of residence to a different county, which is located anywhere in the U.S. Across these two decades, residents of south city and the counties relocated in flocks between 1990 and 2000. By 2013 county movement slowed while the city saw an increase in relocation, coming to halt by 2020.

Figure 9. *Residential Mobility Across St. Louis City and County Block Groups*

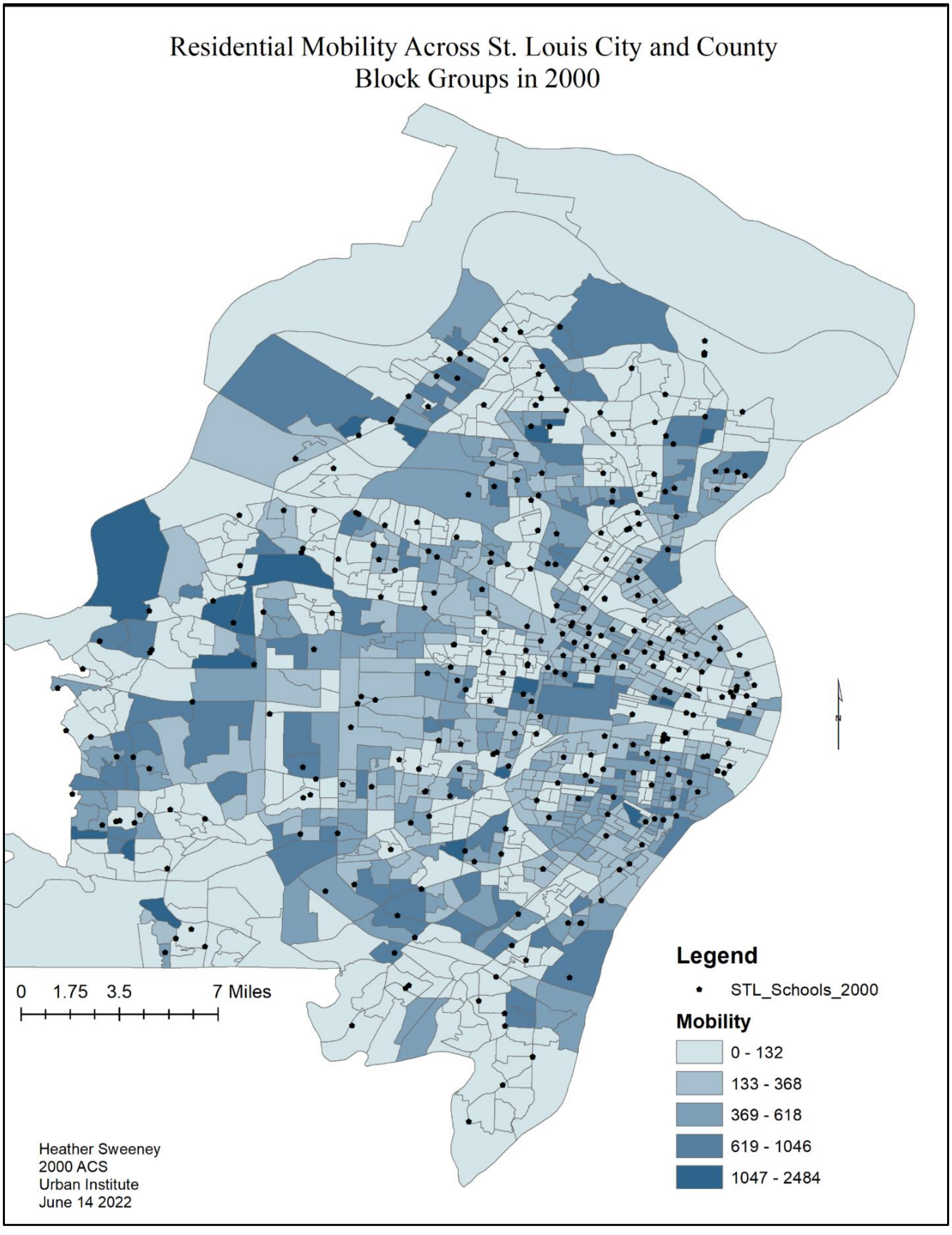


Figure 10. *Residential Mobility Across St. Louis City and County Block Groups*

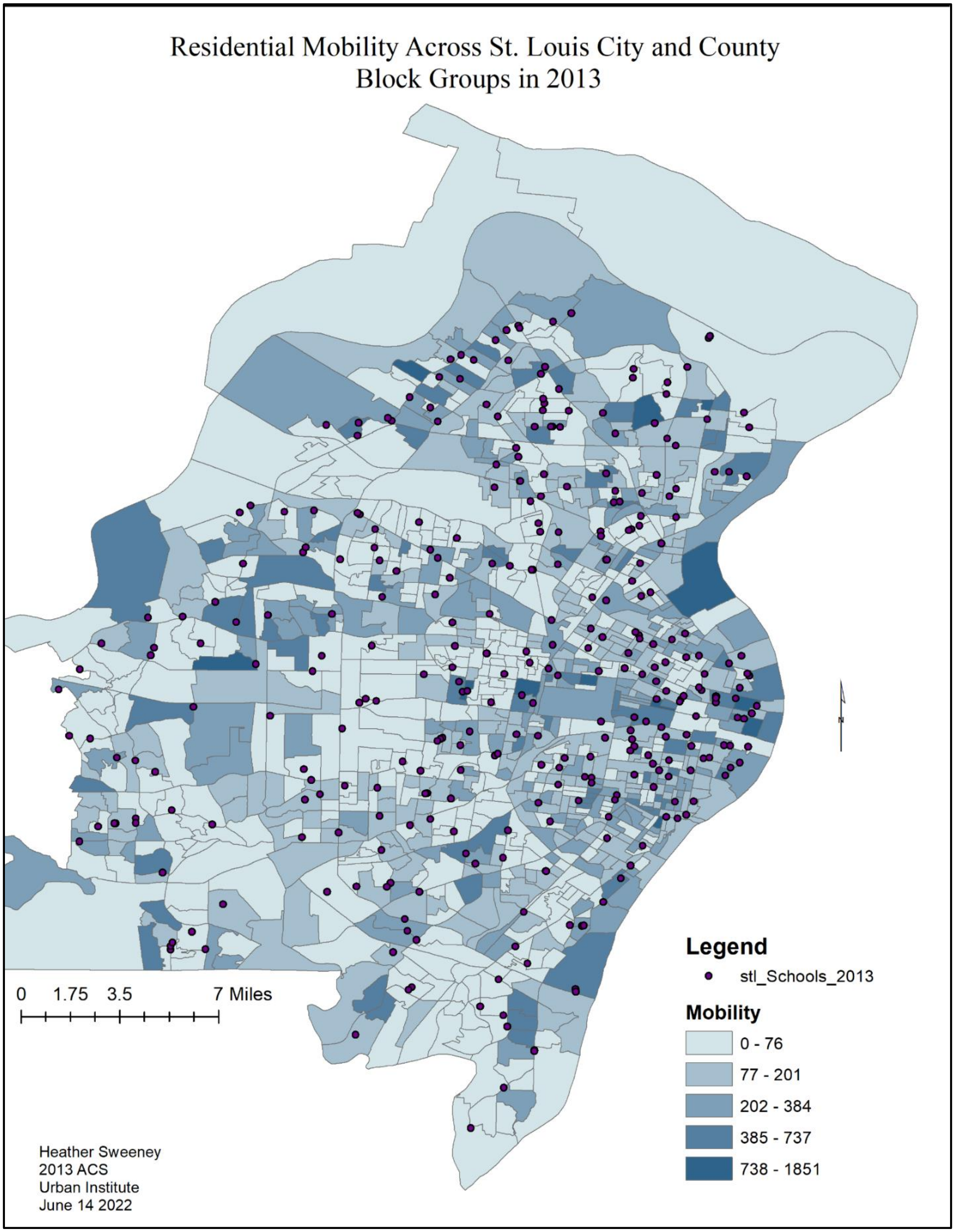
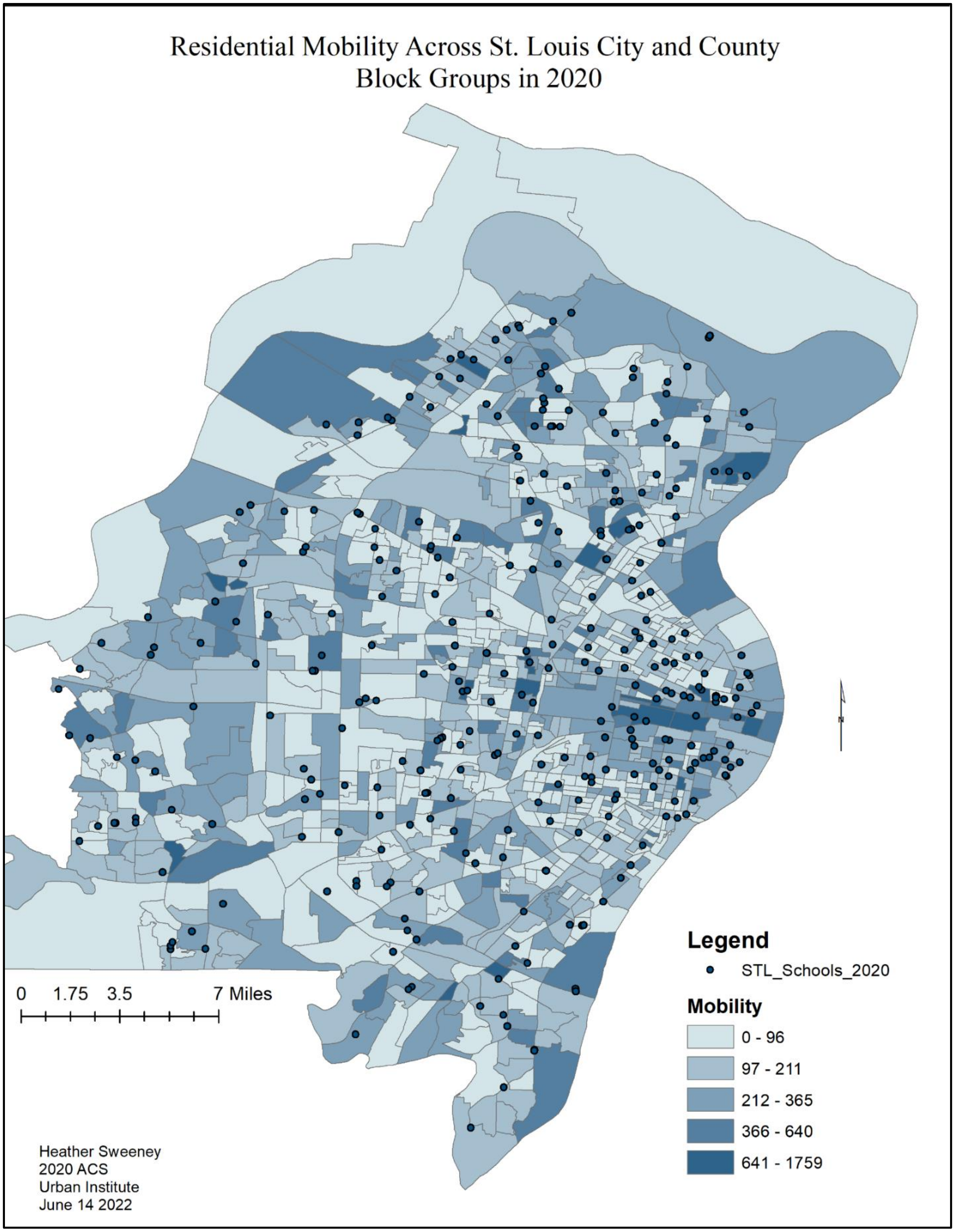


Figure 11. *Residential Mobility Across St. Louis City and County Block Groups*



Figures 9 to 11, residential mobility by block group from 2000 to 2020, depict the three stages of migration across the St. Louis Metropolitan Area. During the first wave, in 2000, residents were relocating from south city, and there was movement taking place in the western, southern and northern counties. In this first wave, there is a greater proportion of residents making moves with the darkest blue representing up to 2,484 households and the palest blue representing up to 132 households. During the second wave, in 2013, there was far less movement in the county and an uptick across the entirety of the city. In this second wave, the proportion of residents relocating has decreased with the darkest blue representing from 738 to 1,851 households and the palest blue representing from 0 to just 76 households. During the third wave, in 2020, residential mobility has no discernable direction, and the number of relocations has dropped again; however, there sits a darkest blue strip matching that of the central city corridor that is of interest, given the city's redevelopment efforts between 2013 and 2020.

Preliminary Analysis of Vacancy Rate Variable

Figures 12 to 14 demonstrate vacancy rates by block group from 2000 to 2020. For this study, vacancy rates encompass all vacant property types (single family, rental, vacation, and other) within a single block group. This map series visualizes the well-known history of (re)development in St. Louis: racially motivated application of blighting and urban renewal.

Figure 12. *Vacancy Rates Across St. Louis City and County Block Groups*

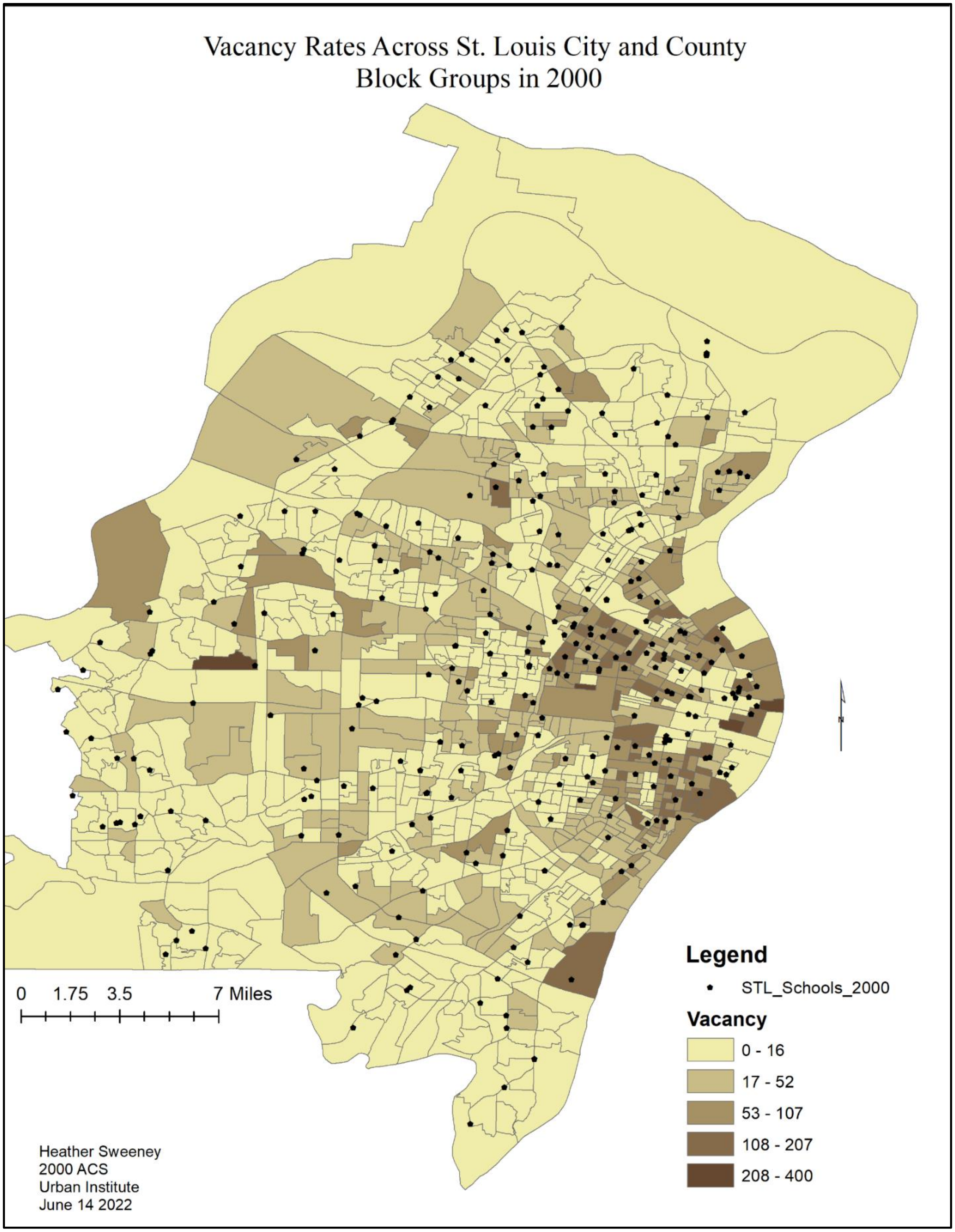


Figure 13. *Vacancy Rates Across St. Louis City and County Block Groups*

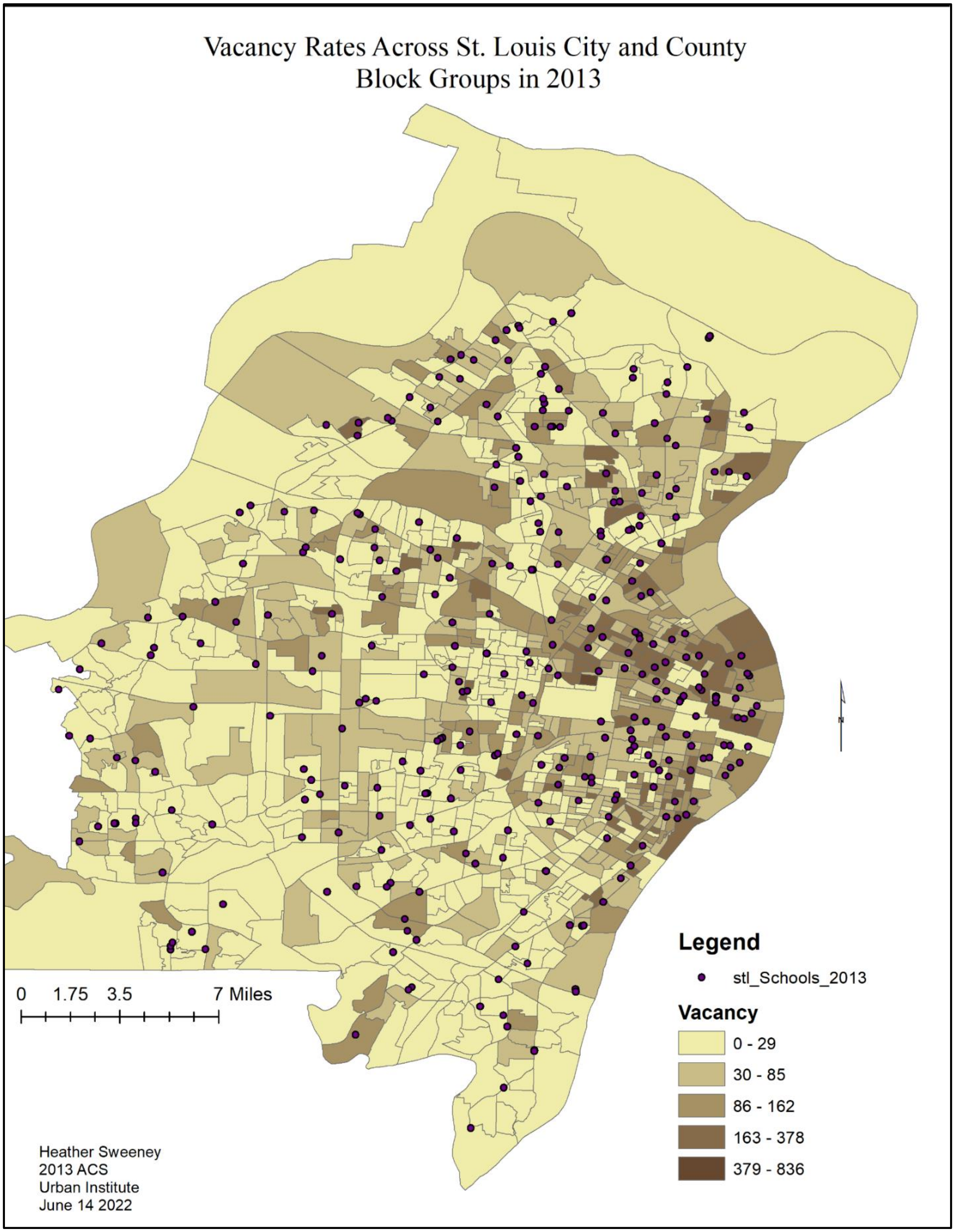
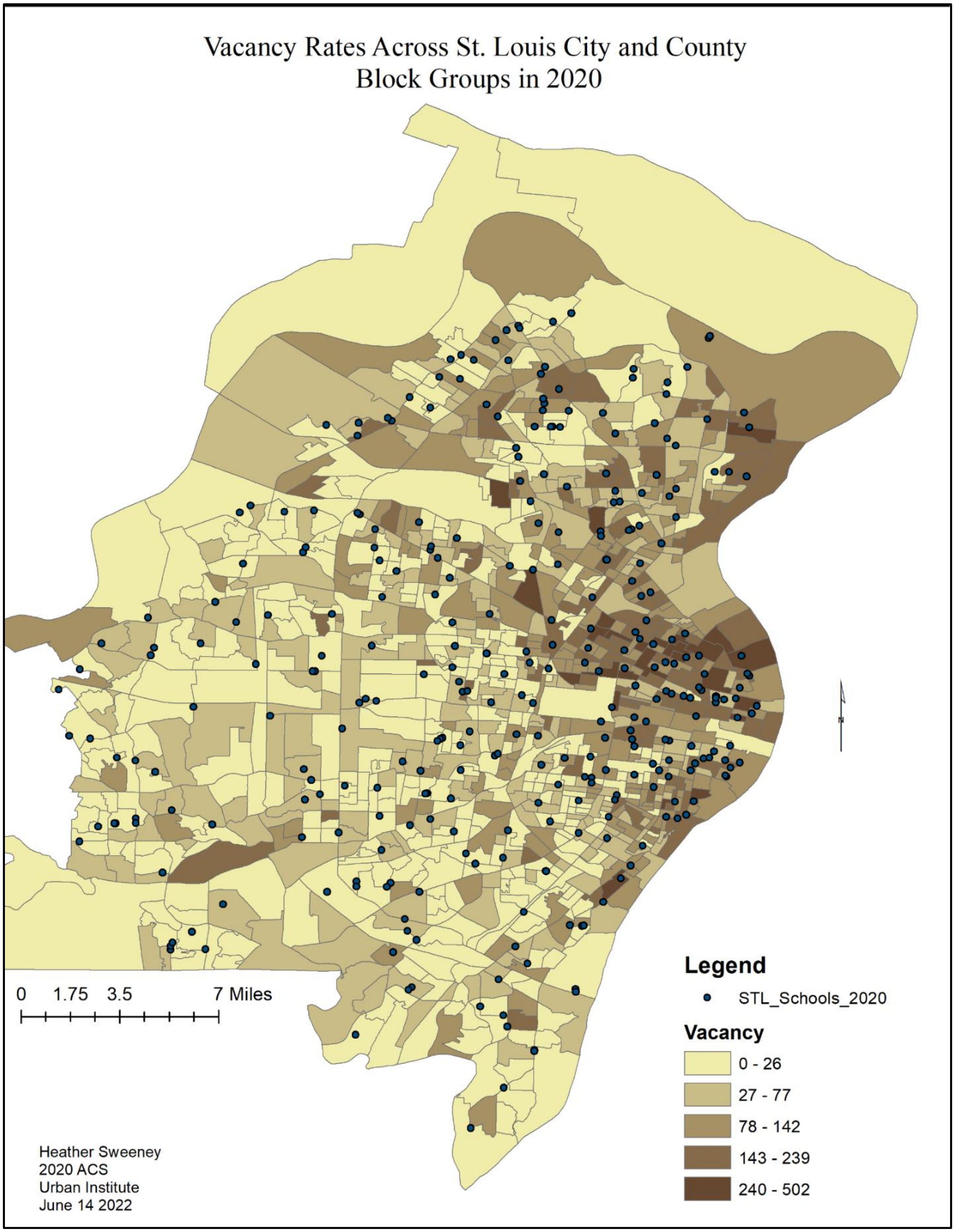


Figure 14. *Vacancy Rates Across St. Louis City and County Block Groups*



Figures 12 to 14, vacancy rates by block group from 2000 to 2020, tell the story of development, blighting and urban renewal. In 2000 (figure 12) pockets of heightened vacancy are easily identified in both north and south city (the darkest brown spaces signifying between 208 to 400 vacancies). In 2013 (figure 13) the number of vacancies double (the darkest brown spaces signifying a vacancy rate between 379-836) and the pockets of 2000 expanded to cover large swaths of the city. By 2020 (figure 14), north city vacancies have become north county vacancies and the city continues to be overwhelmed by abandoned homes (the darkest brown spaces signifying a vacancy rate between 204 – 502). This trend also signifies a rise and fall in overall vacancies across the city; hitting its heigh in 2013 with 836.

Spatial Autocorrelation

To perform Moran's I (Spatial Autocorrelation) within ARCGIS a series of databases were created and then projected to a suitable coordinate system before being run through the spatial analysis tool. A layer titled Spatial Autocorrelation (SA) was constructed for each decade (2000, 2013, 2020) by joining a .csv file containing the retrieved census data to a TIGERLINE shapefile of St. Louis City and St. Louis County block group polygons. The data retrieved from the census includes three variables of interest from the American Community Survey (2013, 2020) and the 2000 decennial census for all block groups across both the City of St Louis and St. Louis County. These three variables are residential mobility, number of school aged children residing within the block group, and vacancy rate. Moran's I requires a projected coordinate system; therefore, the SA layer was projected to UTM_1983_NAD_ZONE_15 Projected Coordinates to create the Spatial Autocorrelation Projected (SAP) layer. The SAP layer was then run through a Moran's I spatial analysis.

How has shrinkage occurred over time across the St. Louis Metropolitan Area?

A positive Moran's Index indicates clustering, meaning similar values cluster (high values cluster near other high values and low values cluster near other low values) while a negative Moran's Index indicates dispersion, meaning like values repel each other (high values tend to cluster near low values). The z-score indicates the statistical significance of the clustering or dispersion. For all shrinkage variables, the Moran's Index is positive, and the z-scores are statistically significant; therefore, this data supports my initial observations by confirming clustering.

Table 4
Shrinkage Variables Moran's I Results

School Aged Children	*2000*	*2013*	*2020*
Moran's Index	0.23	0.19	0.24
Z-Score	12.91*	10.36*	13.52*
P-Score	0.00	0.00	0.00
Residential Mobility	*2000*	*2013*	*2020*
Moran's Index	0.19	0.12	0.12
Z-Score	10.77*	6.72*	6.87*
P-Score	0.00	0.00	0.00
Vacancy Rates	*2000*	*2013*	*2020*
Moran's Index	0.42	0.32	0.43
Z-Score	23.33*	17.94*	24.01*
P-Score	0.00	0.00	0.00

*p < 0.001

This confirmation allows for the acceptance of two understandings important to the subsequent analysis. The first is the understanding that the variables of shrinkage are not randomly distributed across the St. Louis Metropolitan Area. The second is the understanding that their trajectories may be rooted in the spatial ordering of the city and surrounding counties. Therefore, all null hypotheses are rejected, and the alternative hypothesis accepted.

(1) *Null hypothesis: Migration is randomly distributed across St. Louis City and County block groups*

Alternate hypothesis: Migration is clustered across St. Louis City and County block groups.

(2) *Null hypothesis: The number of school aged children residing within St. Louis City and County is randomly distributed across block groups.*

Alternate hypothesis: The number of school aged children residing within St. Louis City and County is clustered within particular block groups.

(3) *Null hypothesis: Vacancy rates are randomly distributed across St. Louis City and County block groups.*

Alternate hypothesis: Vacancy rates are clustered within particular St. Louis City and County block groups.

The next component of my analysis moves these understandings into an exploration of the relationship between shrinkage variables and school closure across the St. Louis Metropolitan Area. This is done through the execution of both a global (Ordinary Least Squares) and local (Geographically Weighted Regression) model. The next section of this chapter overviews the set-up to run both a local and global model as well as their results.

Ordinary Least Squares

As prefaced in chapter 3, before fitting a Geographically Weighted Regression model, I will explore the data with a linear regression model, Ordinary Least Squares (OLS). Just like Geographically Weighted Regression, OLS models the relationship between a dependent variable and one or more independent variables. For this study, the dependent variable is change in number of schools and the independent variables are percent change in residential mobility, percent change in number of school aged children residing within the block group, percent change in vacancy rate, percent change in white population, percent change in black population, and percent change in median income.

OLS Results

The ARCGIS OLS tool produces several goodness-of-fit measurements in the geoprocessing pane, which are presented in the below tables (see Table 4 and Table 5). R2 measures the collective ability of the independent variable(s) to explain variation in the dependent variable, where possible values range from 0 to 1. As this is a proportion, values closer to 1 tend to indicate stronger predictive performance. The 2013 PCT OLS Model has a r2 of .03 suggesting that the model accounts for just 3% of the variance in school closures. The 2020 PCT OLS Model has a r2 of 0.00 suggesting that the model accounts for 0% of the variance in school closure. While the r2 score may be influenced by the number of variables, the adjusted r2 measure takes into account the number of variables; therefore, the adjusted r2 may be a more reliable reference. For both the 2013 and the 2020 PCT OLS Models, the r2 and adjusted r2 measurements are the same. This suggests both models are missing one or many contributing variables or the form of the model is not quite right, as both are failing to account for any significant percentage of variance in school closures. The variance inflation factor (VIF) measures multicollinearity, the correlation between independent variables and the strength of said correlation. With low VIF values, around 1, for both the 2013 and 2020 PCT OLS models, the independent variables are acceptable in moving forward with a Geographically Weighted Regression (GWR) rather than pursuing a different set of explanatory variables.

Table 5
2013 PCT OLS Model Diagnostics

Independent Variables	*Dependent Variable: School Closures*
Residential Mobility	0.00058 (0.00029)
School Aged Children	0.00105 (0.00032)
Vacancy Rate	0.00013 (0.00005)
White Population	-0.00010 (0.00005)
Black Population	0.00001 (0.00003)
Median Income	0.00066 (0.00030)
Number of Observations	1749
AICc	2318.40
R2	0.03
Adjusted R2	0.03
Joint F-Statistic	0.00*
Joint Wald Statistic	0.08
Koekner BP Statistic	0.00*
Jarque-Bera Statistic	0.00*

Standard error in parenthesis, * $p < 0.01$

Table 6
2020 OLS Model

Diagnostics	*Dependent Variable: School Closures*
Residential Mobility	-0.00001 (0.00005)
School Aged Children	0.00023 (0.00031)
Vacancy Rate	-0.00001 (0.00010)
White Population	0.00010 (0.00011)
Black Population	0.00003 (0.00004)
Median Income	0.30
Number of Observations	1062
AICc	1451.78
R2	0.00
Adjusted R2	-0.00
Joint F-Statistic	0.40
Joint Wald Statistic	0.36
Koekner BP Statistic	0.03*
Jarque-Bera Statistic	0.00*

standard errors in parenthesis, * $p < 0.01$

The Akaike Information Criterion (AIC) is an estimator of prediction error. The AIC measures the relative distance between the fitted model and an unknown used to compare different models employing the same independent variable(s). Therefore, the AIC offers a way to compare models. This is useful in the exploration of moving from OLS to GWR in modeling the relationship between variables of shrinkage and school closure. A smaller AIC value is preferable; however, the value itself is not of importance, but rather the difference between the AICs of the comparison models. The 2013 PCT OLS Model AIC is 2318.40. The 2020 PCT OLS Model AIC is 1451.78. It would appear there is room for improvement with a different model.

I have fitted two OLS models to spatial data. There is likely some structure in the residuals which have gone unaccounted for in both models. The significance of the Jarque-Bera Statistic indicates the residuals are not normally distributed (a concern that will be explored by running the residuals through Moran's I). The residuals from each OLS model are assumed to be independent and identically distributed with a mean of zero; therefore, should this test show the residuals are in fact autocorrelated then one of the underlying assumptions of OLS will be violated, making the results of the OLS regression analysis unreliable.

The results of Moran's I are as shown below in table 7 and table 8. Table 7 shows that the residuals of the 2013 OLS model are random. Table 8 shows that the residuals of the 2020 OLS model are clustered, with a less than 1% likelihood that this clustering is due to random chance.

Table 7
2013 OLS Moran's I Results

Moran's Index	0.00
Z-Score	0.02
P-Score	0.98

Table 8
2020 OLS Moran's I Results

Moran's Index	0.03
Z-Score	6.44*
P-Score	0.00
*p < 0 .001	

The significance of the Koenker (BP) Statistic indicates that the independent variables do not have a consistent relationship to the dependent variable within either model. All but one variable (percent change in black population) in the 2020 PCT OLS Model have a statistically significant measure of robust standard error, suggesting heteroscedasticity. All told, these diagnostic checks mean both the 2013 OLS and 2020 OLS models are a poor fit to the data.

Both table 5 and table 6 present the coefficients for each explanatory variable in 2013 and 2020, respectively. If it is negative, this indicates a negative relationship between the explanatory variable and school closure. If it is positive, this indicates a positive relationship. The coefficient is given in the same unit as their explanatory variable and represents the expected change in the dependent variable (school closure) for every 1 unit change in the explanatory variable. Take for example the residential mobility coefficient, in 2013 a 0.00058 increase in open public schools is expected for each household which relocates to the block group and in 2020 a 0.00001 decrease in open public school is expected for each household which relocates out of the block group. Each coefficient could offer some insight into the direction of the relationships between the explanatory variable and the dependent variable; however, they are not showing a strong accounting of any change in the number of open public schools. To confirm this observation, I reviewed the robust probabilities for each coefficient, all of which were statistically insignificant; therefore, neither the 2013 nor the 2020 coefficient set indicate statistical significance.

There is potential for improvement with GWR, particularly in addressing the spatial autocorrelation and heteroscedasticity issues caused by fitting a global model to non-stationary data. Therefore, I decided to run a GWR with the same ARCGIS databases to see if there was any improvement on model fit and the explanatory ability of the independent variables.

Geographically Weighted Regression

The same 2013OSLP and 2020OLSP layers were run through the GWR spatial statistic tool where the dependent variable was change in number of schools and the independent variables were percent change in residential mobility, percent change in number of school aged children residing within the block group, percent change in vacancy rate, percent change in white population, percent change in black population, and percent change in median income.

GWR Results

The ARCGIS GWR tool returns a new table containing model diagnostics. These diagnostics are shown in table 9 and table 10 below. The r2 and adjusted r2 values represent the same measurements as described above when overviewing the OLS models with the inclusion of AICc, which is the corrected AIC value. In addition to these goodness-of-fit measurements, the GWR tool also provides a few more assessment values. The first is the number of nearest neighbors used to calculate the estimation of each set of coefficients. The residuals squares value is the sum of the squared residuals. The effective number is related to the choice of bandwidth, in that it reflects a tradeoff between the variance of the fitted values and the bias in the coefficient estimates. Sigma is the square root of the normalized residual sum of squares where the residual sum of squares is divided by the effective degrees of freedom from the residual.

Table 9
2013 PCT GWR Model

Diagnostics	*Dependent Variable: School Closures*
Neighbors	257
Residual Squares	308.94
Effective Number	152.84
Sigma	0.44
AICc	2179.92
R2	0.22
Adjusted R2	0.14

Table 10
2020 PCT GWR Model

Diagnostics	*Dependent Variable: School Closures*
Neighbors	831
Residual Squares	228.86
Effective Number	21.84
Sigma	0.48
AICc	1399.55
R2	0.03
Adjusted R2	0.01

To determine if the move from an Ordinary Least Squares regression to a Geographically Weighted Regression provides a better model for my selected variables, I will compare the shared goodness-of-fit measures produced by each spatial statistic tool. For quicker reference, I will refer to the OLS model as the global model and the GWR model as the local model, as this is an important delineation between spatial levels explored by the respective approaches.

For the year 2013, the global adjusted r2 is 0.03 and the local adjusted r2 is 0.14. This over 10 percent jump suggests the shift from a global (OLS) to a local (GWR) model offered some improvement (see table 11 below). The AICc value for the global model is 2318.40 while the local model is 2179.92, this is a difference of 138.48. This also presents strong evidence for an improvement in model fit to the data (see table 11 below).

Table 11
2013 OLS and GWR Model Diagnostics

	Dependent Variable: School Closures	
Diagnostics	*2013 OLS*	*2013 PCT GWR*
AICc	2318.40	2179.92
R2	0.03	0.22
Adjusted R2	0.03	0.14

For the year 2020, the global adjusted r2 is 0.00 and the local adjusted r2 is 0.01 (see table 12 below). This shift seems rather insignificant and does not suggest a vast improvement in performance. The AICc value for the global model is 1406.32 while the local model is 1399.55, this is a difference of 6.77 (see table 12 below). Generally, AICc values within about 4 points of each other are viewed as synonymous. This score also suggests there is little improvement with a shift from a global (OLS) to local (GWR) model.

Table 12
2020 OLS and GWR Model Diagnostics

	Dependent Variable: School Closures	
Diagnostics	*2020 OLS*	*2020 PCT GWR*
AICc	1406.32	1399.55
R2	0.00	0.03
Adjusted R2	-0.00	0.01

The final diagnostic check focuses on the residuals. This requires both the mapping of standardized residuals and the use of Moran's I. Two questions of interest drive the analysis of standardized residuals: 1. Are the residuals spatially autocorrelated and 2. Where are the unusually high or unusually low residuals? To answer this first question, I have run both the 2013 GWR and 2020 GWR residuals through Moran's I (results in table 13 and table 14). To address the second question, I have mapped the standardized residuals for both the 2013 GWR model and the 2020 GWR model (see figures 15 to 18, inserted below).

There was little to no change in the spatial autocorrelation of residuals in the shift from the global (OLS) to the local (GWR) model. As shown in table 13 and table 14, both the 2013 local and global models produce randomly distributed residuals while both the 2020 local and global models produce highly clustered residuals. Therefore, the 2013 model residuals are not spatially autocorrelated but the 2020 model residuals are spatially autocorrelated. This is visually laid out in four maps, 2013 OLS Residuals, 2013 GWR Residuals, 2020 OLS Residuals and 2020 GWR Residuals, respectively (see figures 15 to 18, inserted below).

Table 13

2013 OLS and GWR Moran's I Results

Moran's Index	
Local (GWR)	-0.00
Global (OLS)	0.00
Z-Score	
Local (GWR)	-0.04
Global (OLS)	0.02
P-Score	
Local (GWR)	0.97
Global (OLS)	0.98

Table 14

2020 OLS and GWR Moran's I Results

Moran's Index	
Local (GWR)	0.02
Global (OLS)	0.03
Z-Score	
Local (GWR)	4.43*
Global (OLS)	6.44*
P-Score	
Local (GWR)	0.00
Global (OLS)	0.00

*$p < 0.001$

Figure 15. *2013 OLS Residuals*

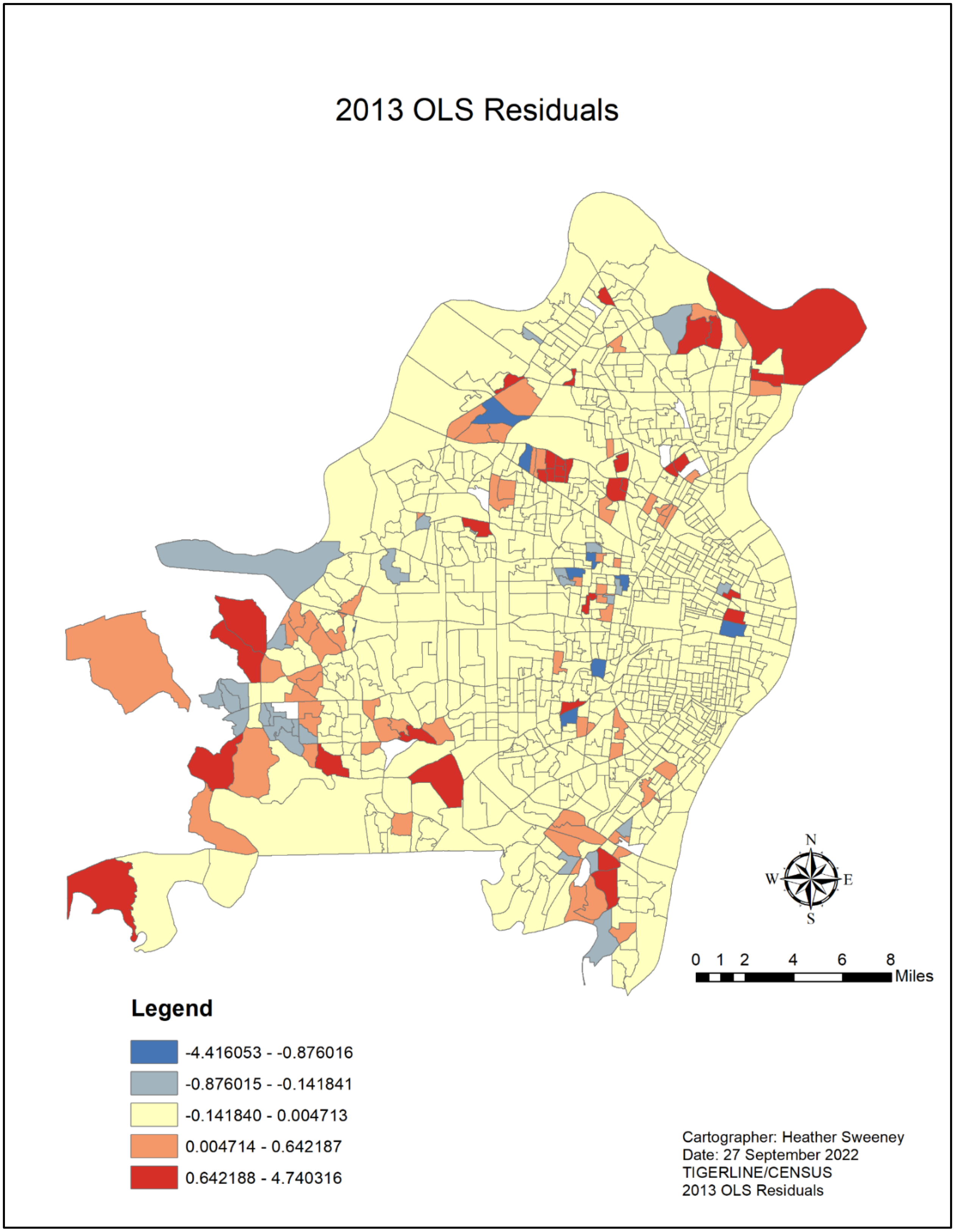


Figure 16. *2013 GWR Residuals*

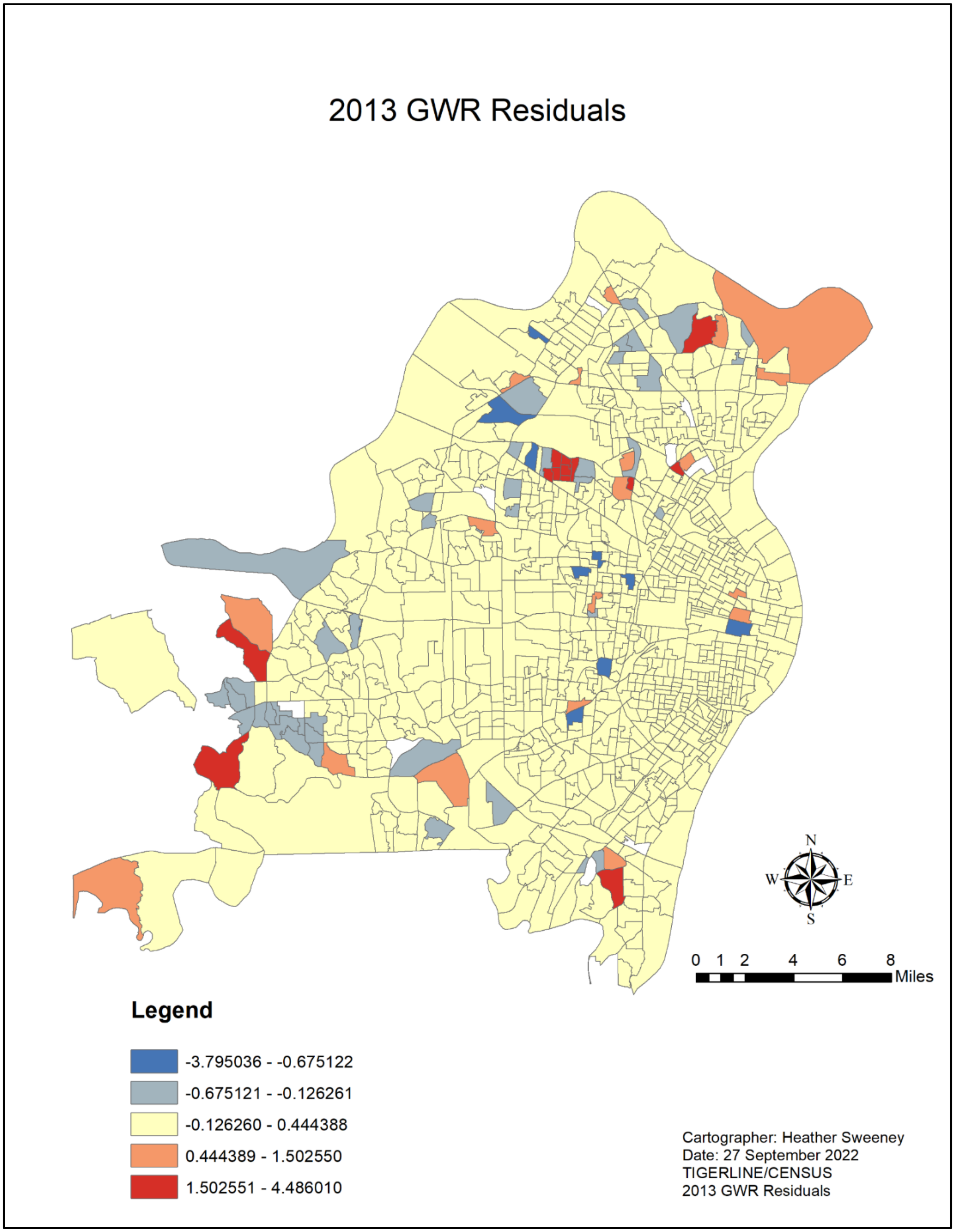


Figure 17. *2020 OLS Residuals*

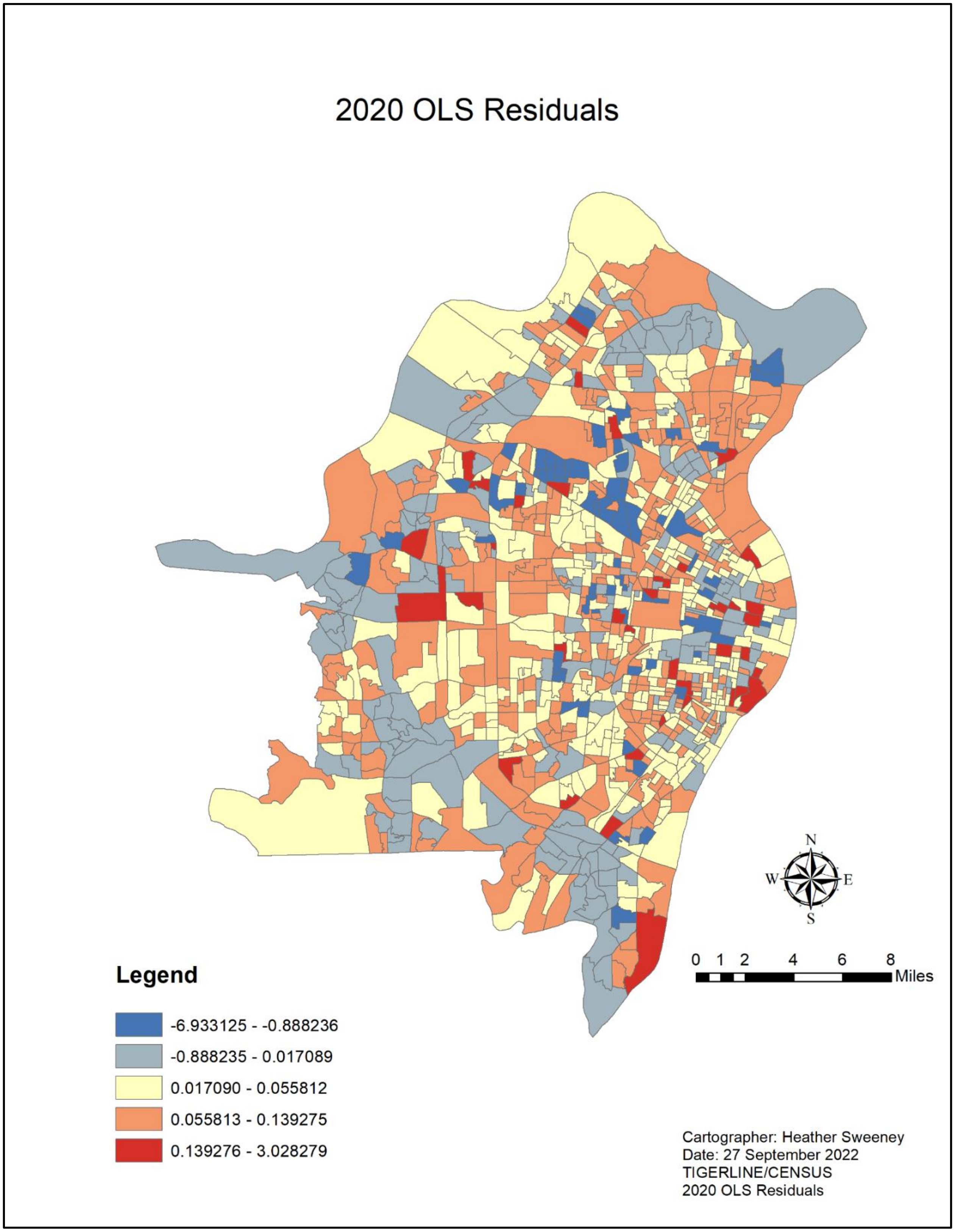
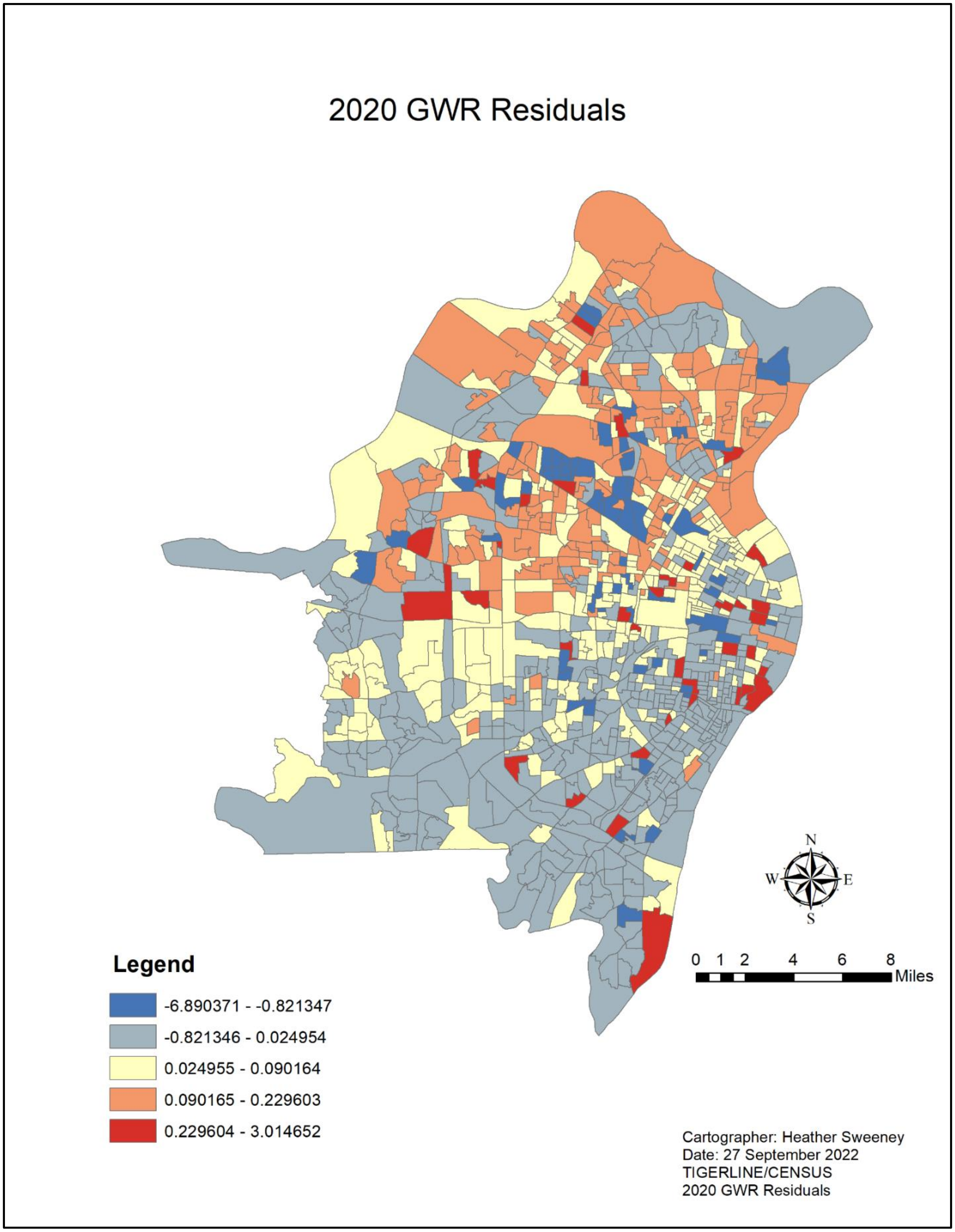


Figure 18. *2020 GWR Residuals*



The mapped residuals offer insight into the distribution of the unusually high and unusually low residuals. As Moran's I indicated, both the local and global 2013 models do not have clusters of unusually high (red, up to 3) or unusually low (blue, down to -7) residuals when mapped. The 2020 local and global model maps tell a different story. There is certainly an increase in the number of unusually high and unusually low residuals; however, the residuals clustering in both the local and global model are each a step in from the far reaches of the high and low spectrum. These are the patches (in the global model) and swaths reaching north and south (in the local model) of high (orange, hovering around zero) and low (gray, hovering around zero). Interestingly, in the global model, the high take up dispersed pockets across the entire metropolitan area while the low form a ring on the very outskirts of the county. While the local model residual clustering flows outward from the city. The high residuals cover both north city and the northern counties. The low residuals cover both south city and the southern counties.

How does this shrinkage relate to Saint Louis Public Schools (SLPS) closures?

The GWR returns a new feature class with an attribute table housing the dependent variable values, the coefficient estimates for all independent variables, the fitted values and the residuals. One column contains the observed dependent variable values, school closures per block group. The next set of columns contain the estimate coefficient values for the independent variables, percent change in residential mobility, percent change in vacancy rate, percent change in school-aged children residing within each block group, percent change in white population of block group, percent change in black population of block group, and percent change in median income. There is a column containing fitted values, these are the predicted y values given the model coefficients. There is a column containing the residuals, which is the difference between the observed values of the dependent variable (school closures) and the fitted values.

It is the estimation coefficients that are the focus in considering a potential relationship between shrinkage and school closing. Estimation coefficients are estimates, have a standard error and are either positive or negative. A positive coefficient is just as it sounds, a positive relationship where an increase in the independent variable is followed by an increase in the dependent variable. A negative coefficient means an increase in the independent variable brings a decrease in the dependent variable. As the values of the coefficients change sign, they will pass through zero. Given this, some coefficients may be so close to zero that any variation in them will not influence the local variation in the model. In reviewing the coefficient estimates, I am assessing the null hypothesis:

Null hypothesis: The presence of shrinkage trajectories does not influence the change in number of public schools within a given St. Louis City or County block group.

Alternate hypothesis: The presence of shrinkage trajectories does influence the change in number of public schools within a given St. Louis City or County block group.

I have mapped each variable coefficient estimate for the percent change between 2000-2013 and that of 2013-2020 (see figures 19 to 30, inserted below) to compare a single coefficient across the decades as well as the state of the collection of coefficients at each point in time. Every coefficient range is insignificant. While there appears to be a spatial patterning to the negative and positive shifts of each coefficient, the value hovers so close to zero that no coefficient seems to bear any level of influence on the open or closed status of public schools. Therefore, the null hypothesis is accepted: *The presence of shrinkage trajectories does not influence the change in number of public schools within a given St. Louis City or County block group.*

Figure 19. 2013 GWR *Percent Change in School Aged Children Coefficient*

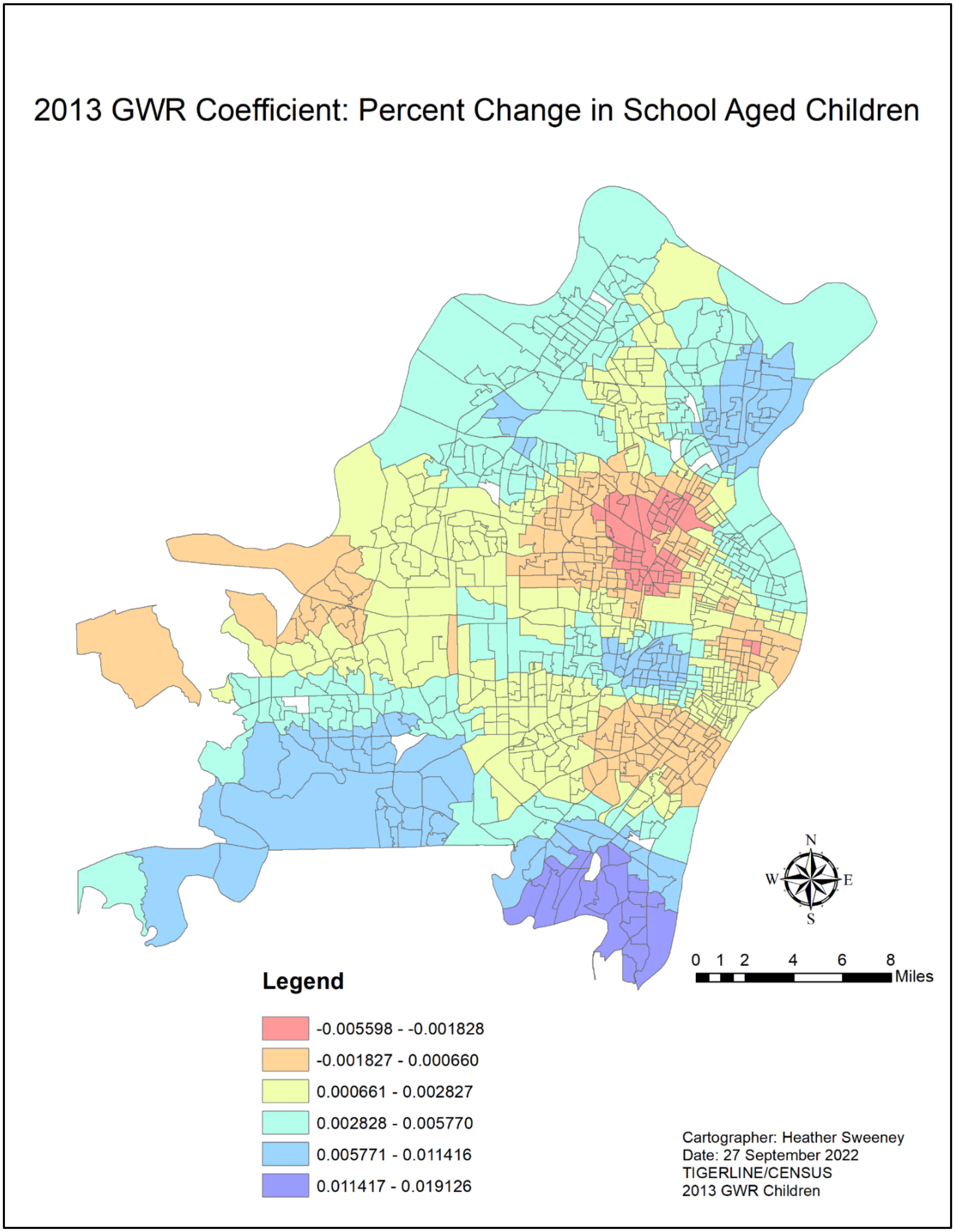


Figure 20. *2013 GWR Percent Change in Residential Mobility Coefficient*

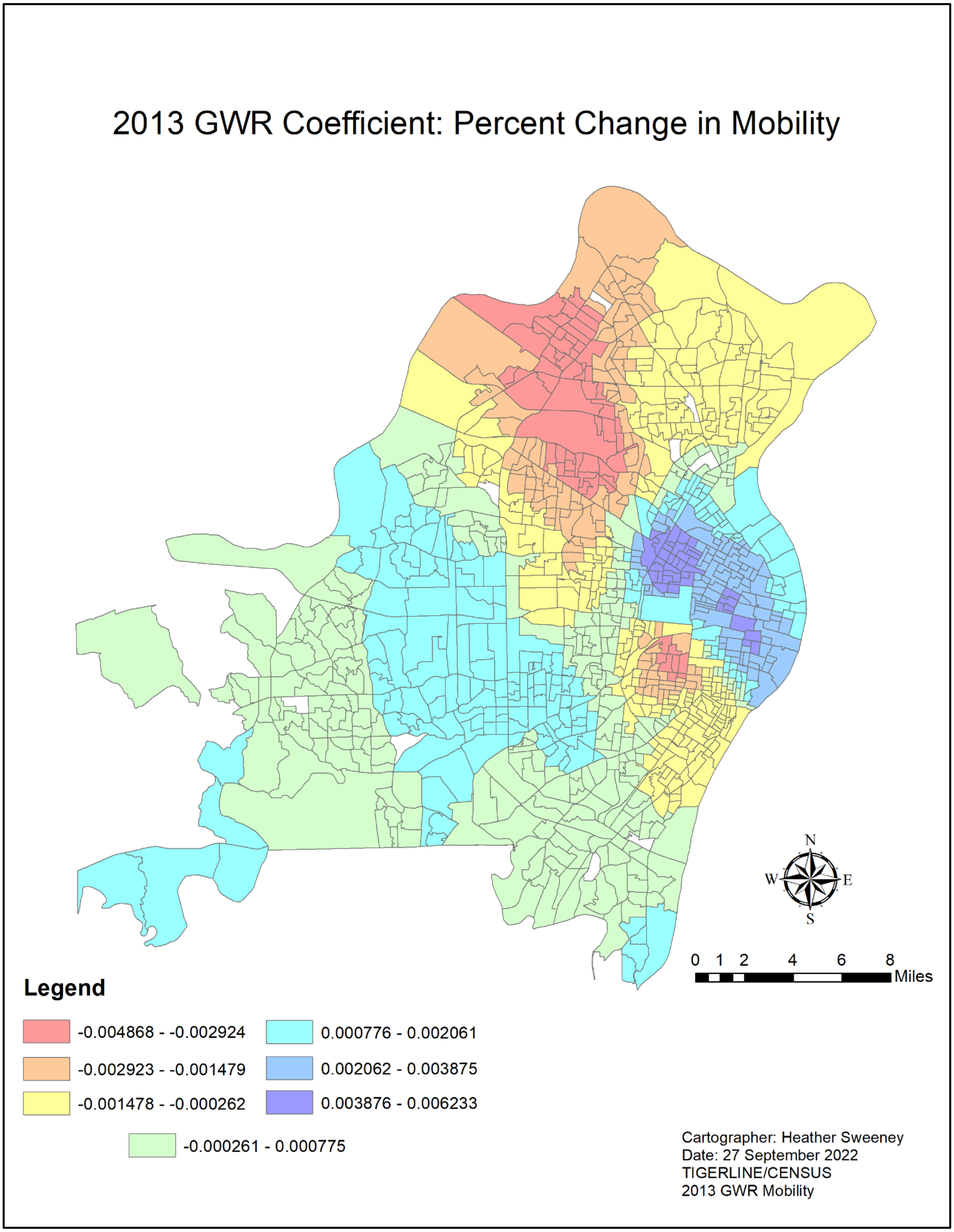


Figure 21. *2013 GWR Percent Change in Vacancy Rate Coefficient*

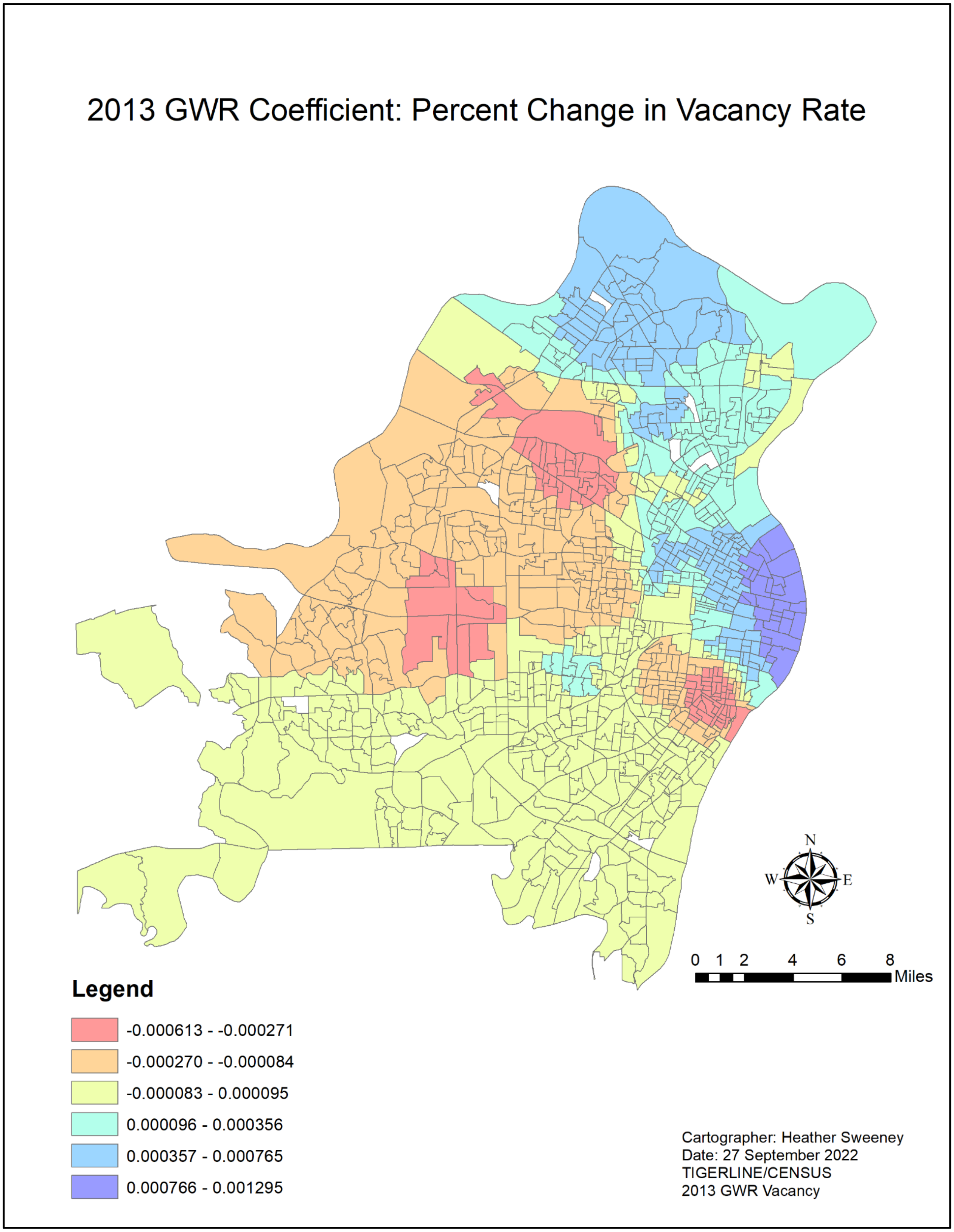


Figure 22. *2013 GWR Percent Change in Median Income Coefficient*

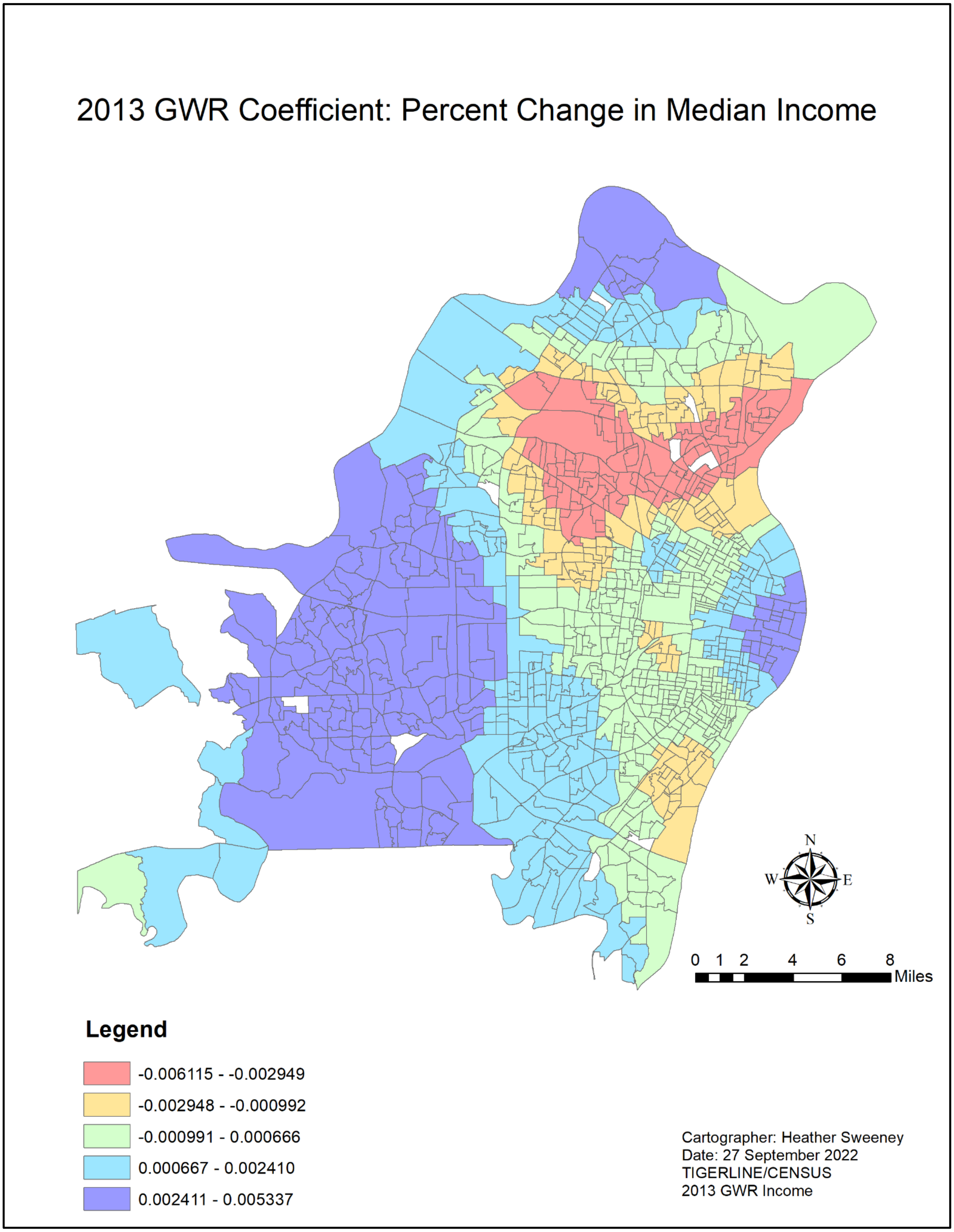


Figure 23. *2013 GWR Percent Change in Black Population Coefficient*

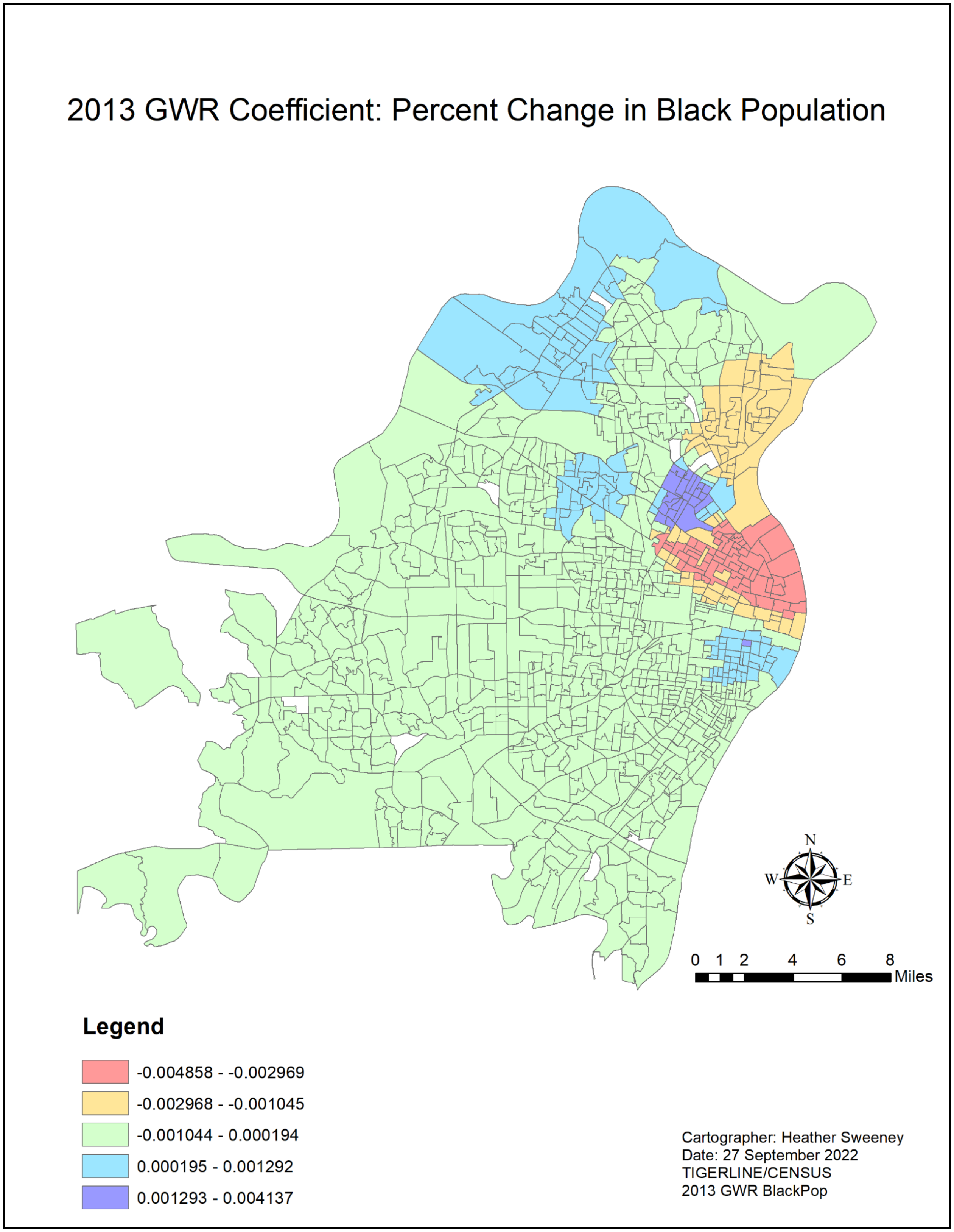


Figure 24. *2013 GWR Percent Change in White Population Coefficient*

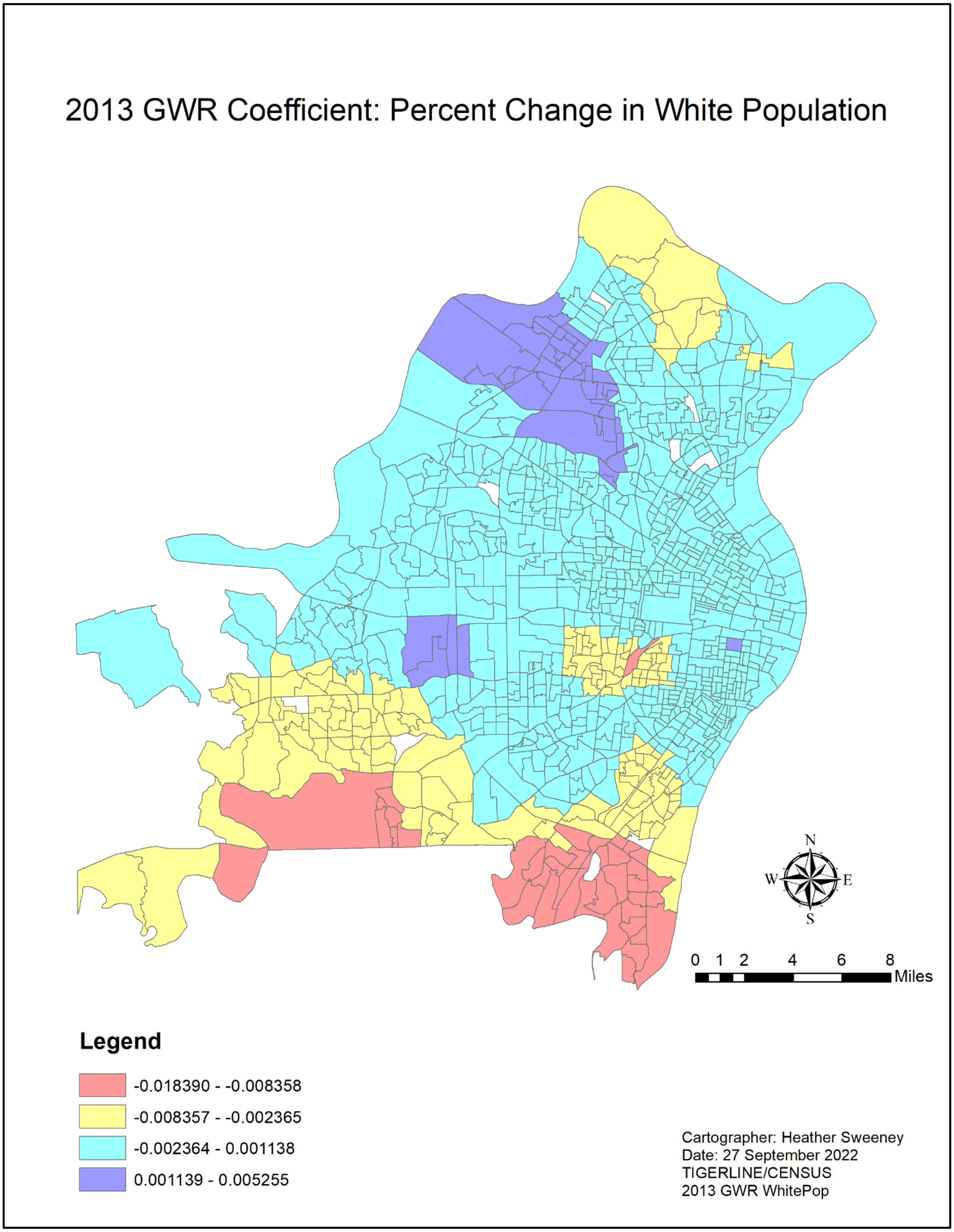


Figure 25. *2020 GWR Percent Change in School Aged Children Coefficient*

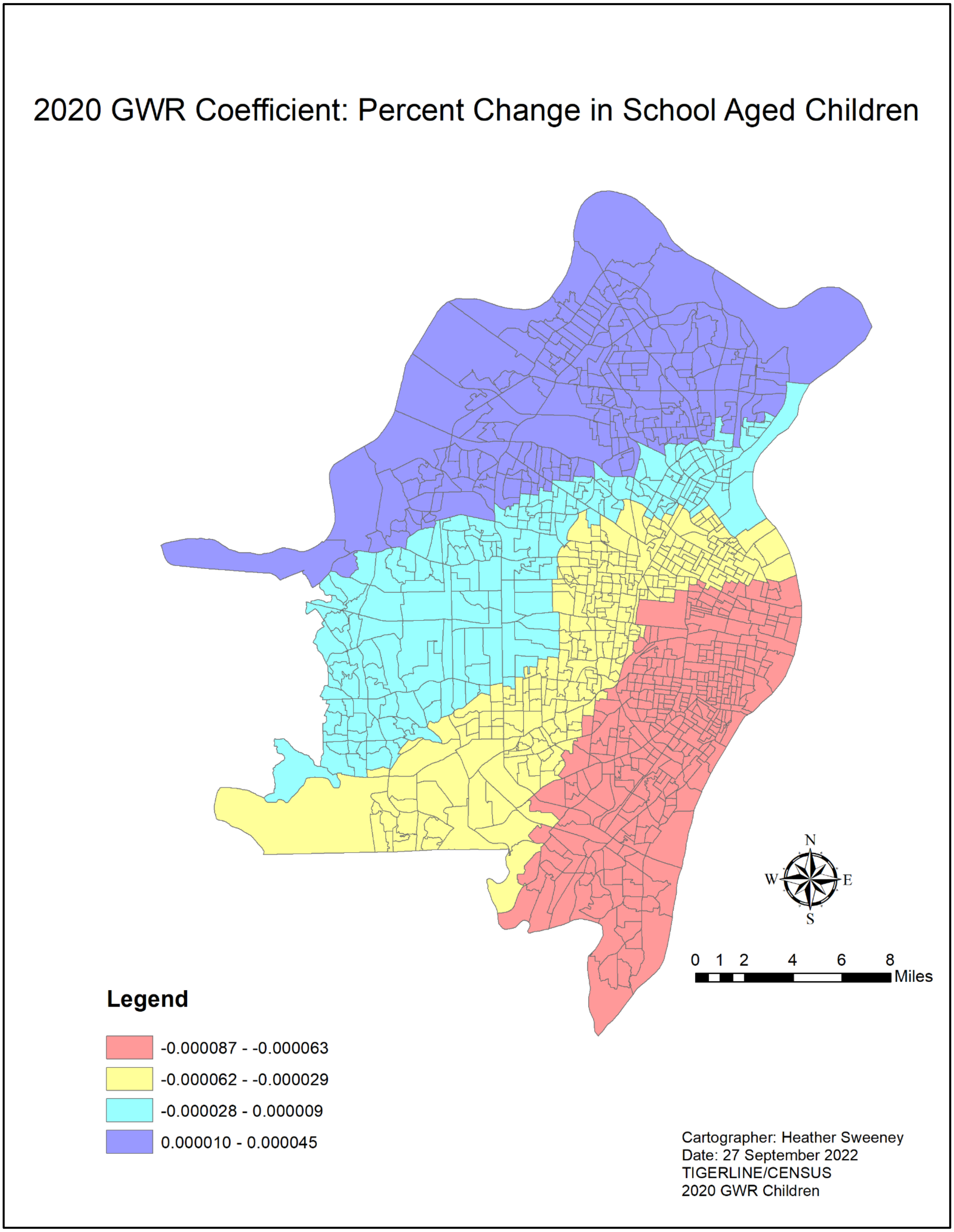


Figure 26. *2020 GWR Percent Change in Residential Mobility Coefficient*

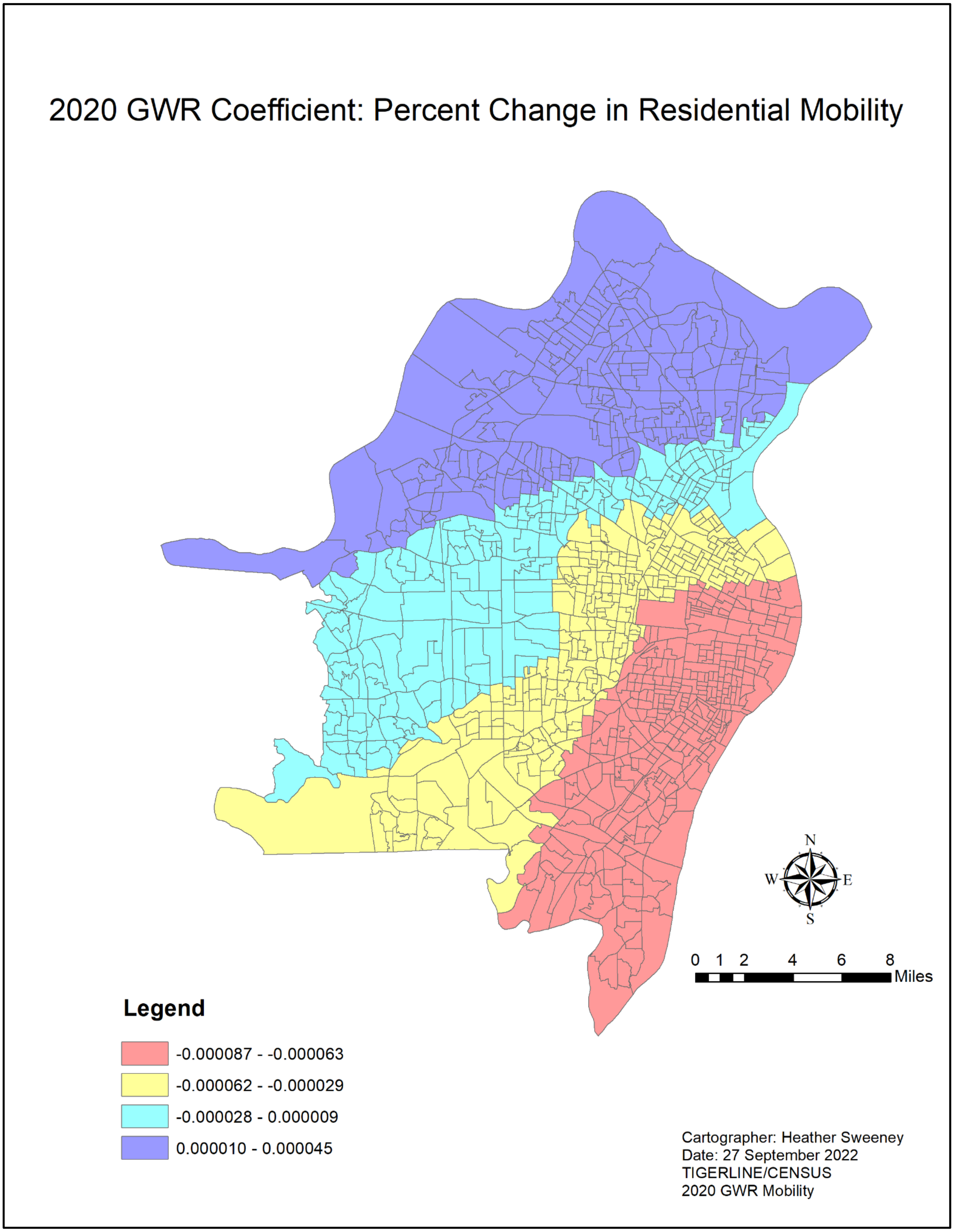


Figure 27. *2020 GWR Percent Change in Vacancy Rate Coefficient*

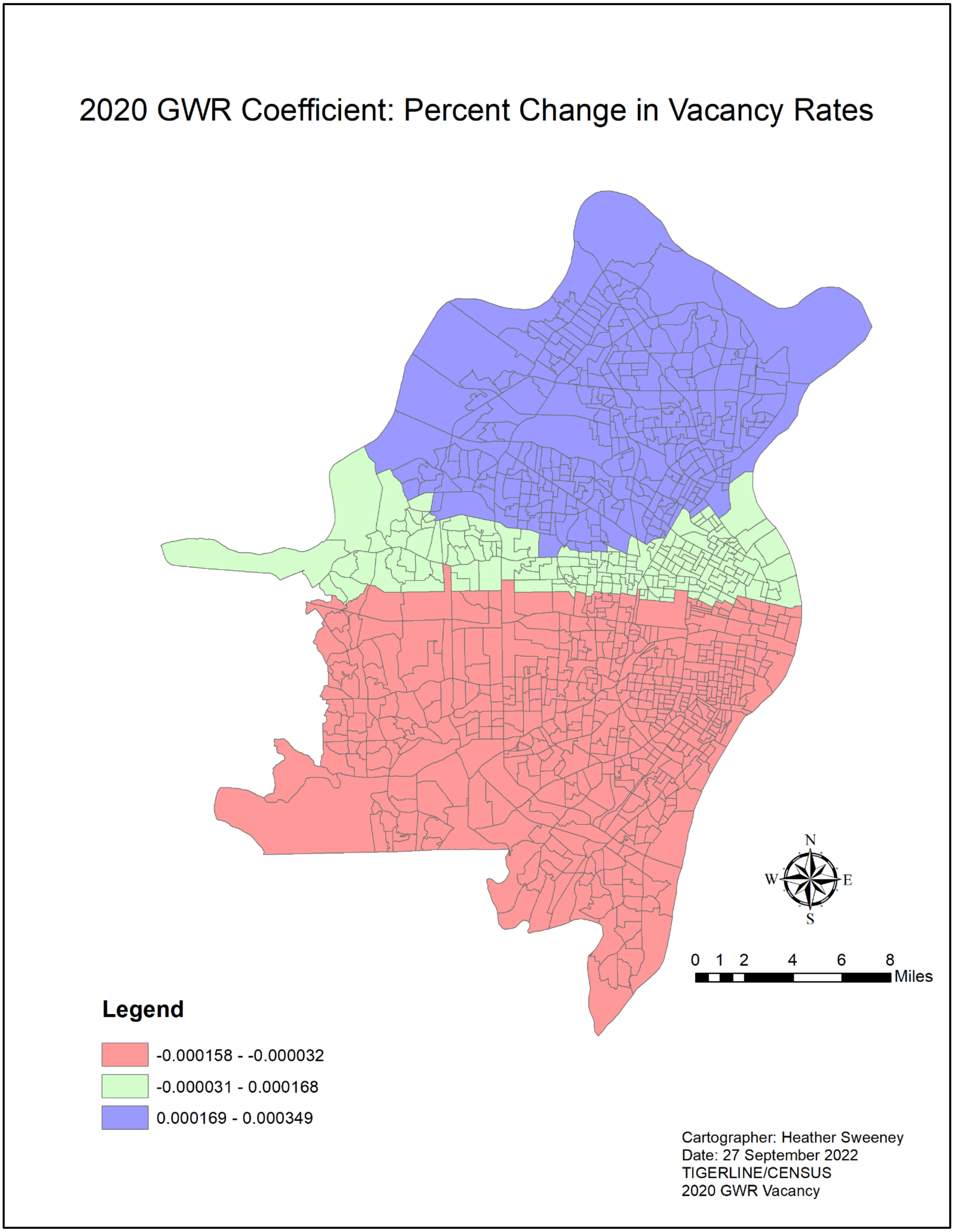


Figure 28. *2020 GWR Percent Change in Median Income Coefficient*

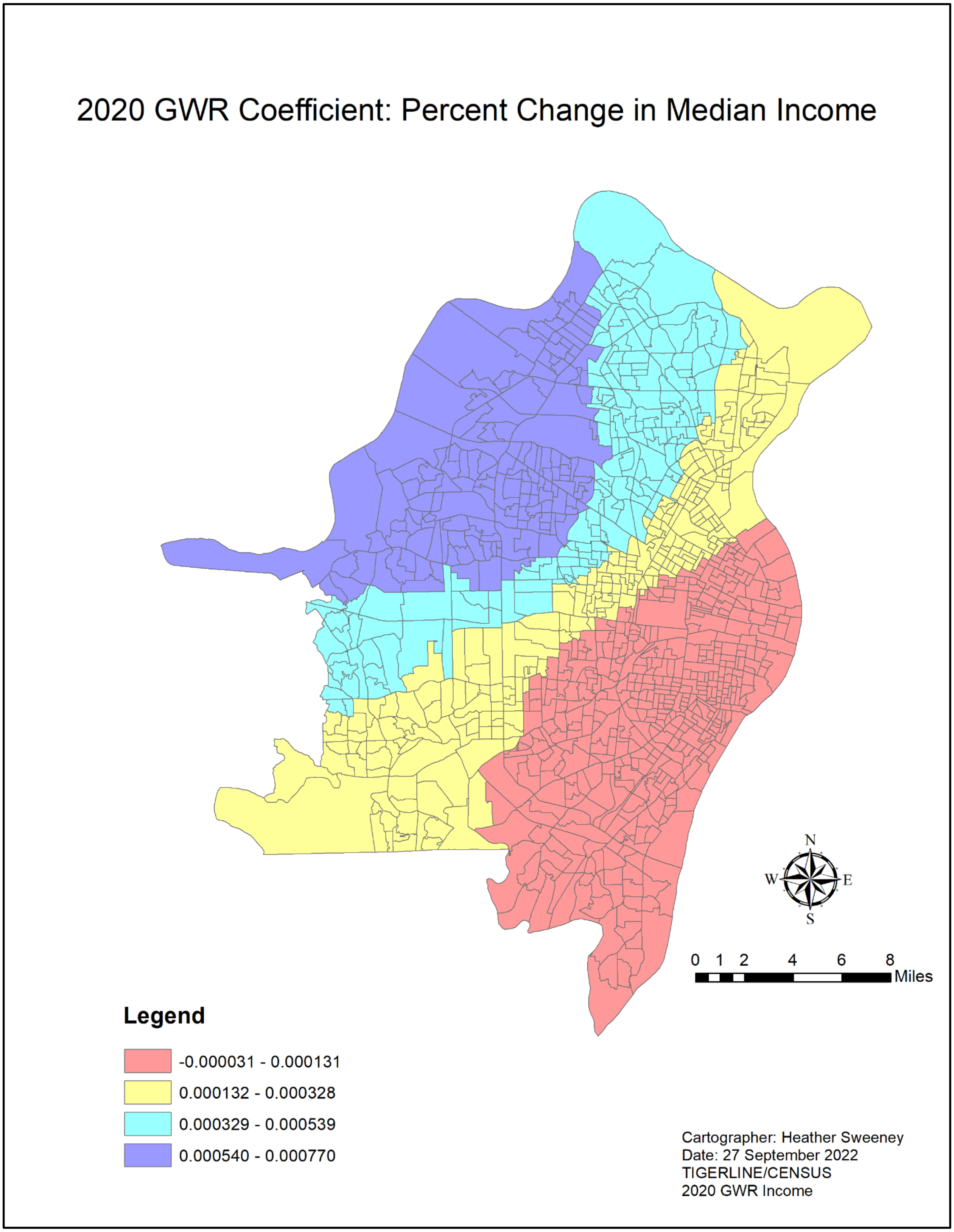


Figure 29. *2020 GWR Percent Change in Black Population Coefficient*

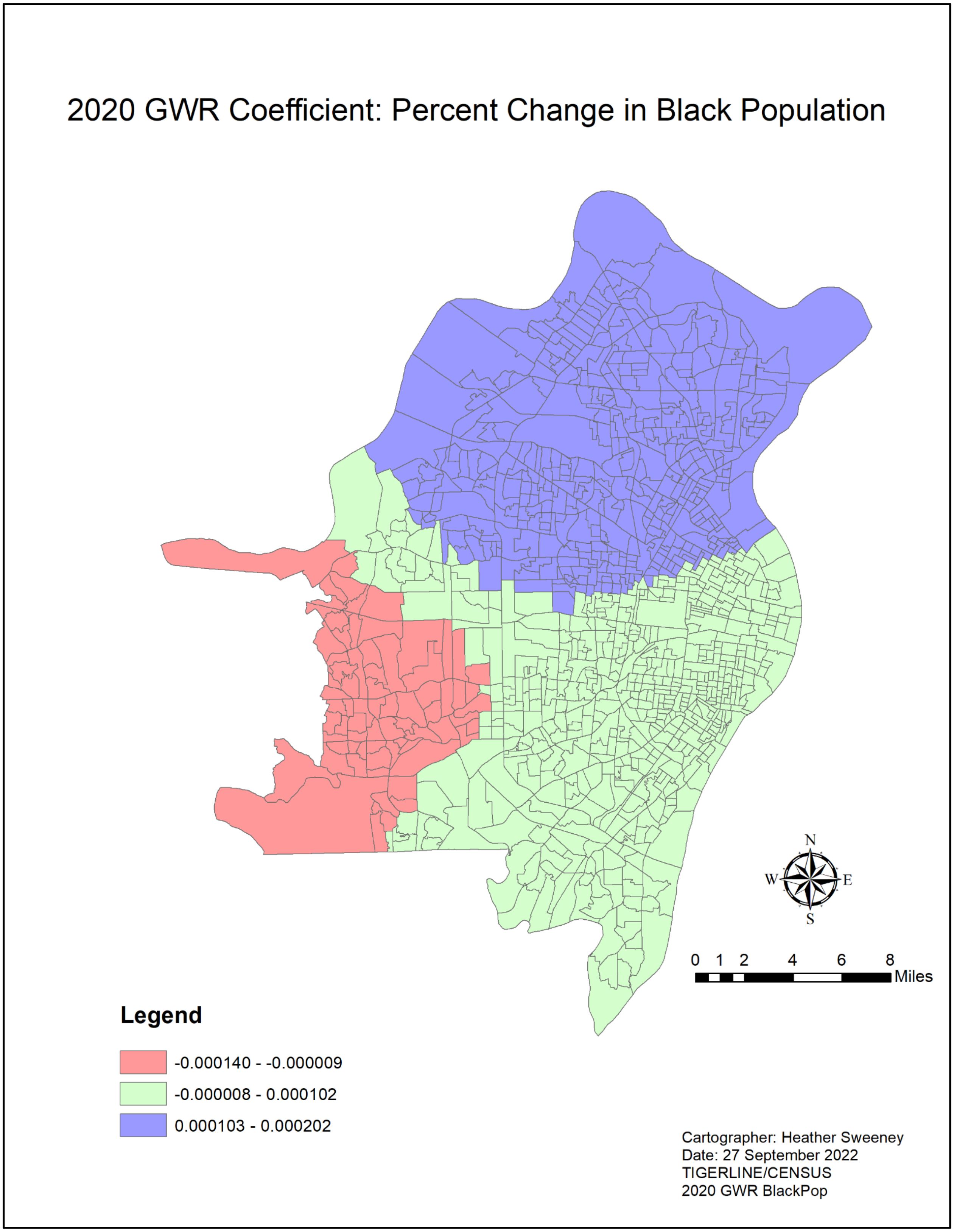
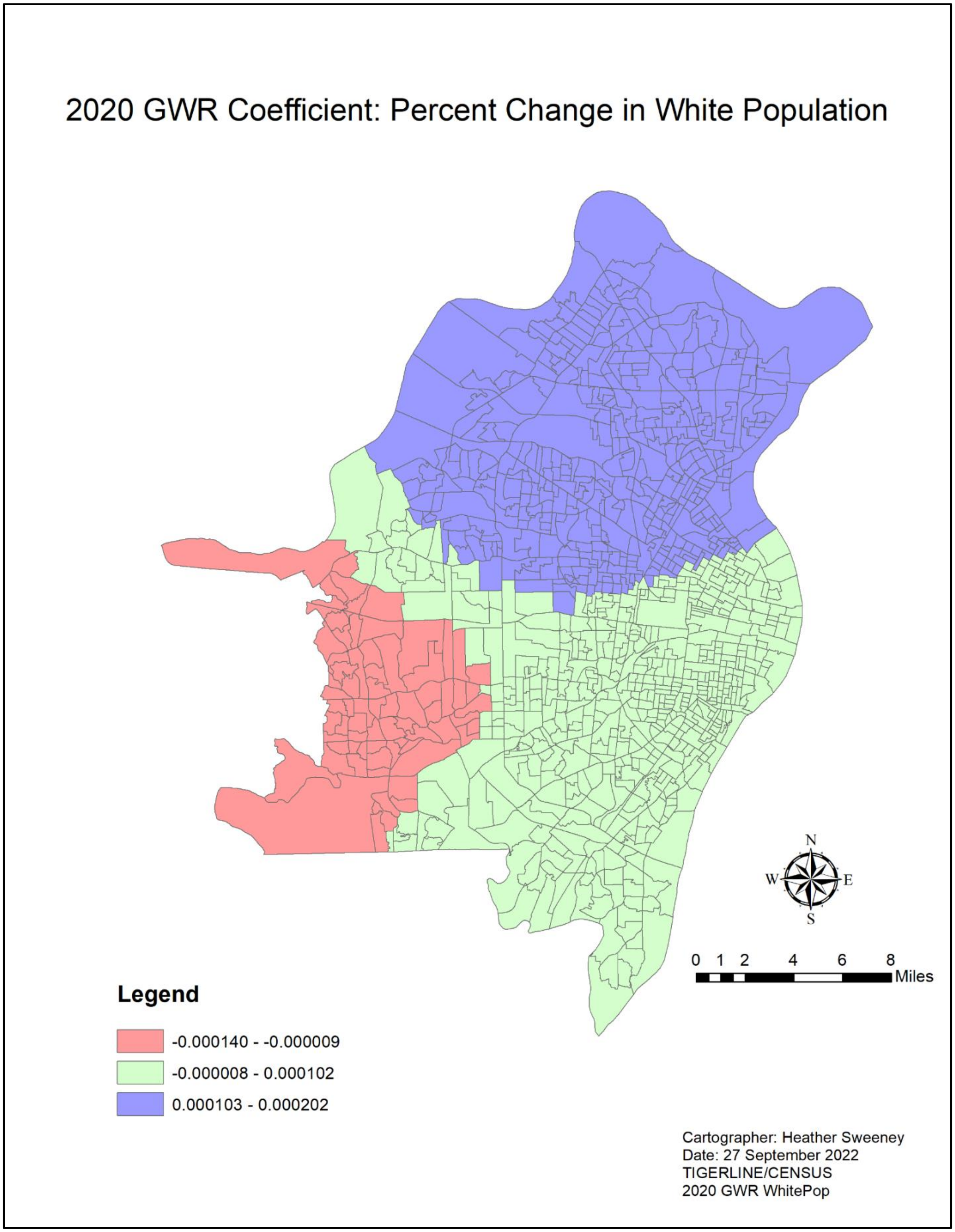


Figure 30. *2020 GWR Percent Change in White Population Coefficient*



The final component of my analysis is to identify and visualize access to a local public school. To accomplish this task, I employed the Hot Spot Analysis (Getis-Ord Gi*) tool in ARCGIS. The final section of this chapter provides the steps to set-up the tool and the results.

Hot Spot Analysis

The respective STL_Schools.lyrs created for the exploratory visualization presented at the beginning of this chapter were joined to the projected 2000_SA.lyr, 201_SA.lyr, and 2020_SA.lyr to create three new hot spot analysis (HSA) layers: 2000HSA.lyr, 2013HSA.lyr, and 2020HSA.lyr. By joining spatial attributes, ARCGIS summed the public-school counts of each block group into a new attribute titled Count. In the Hot Spot Analysis (Getis-Ord Gi*) tool, the newly created attribute Count was entered in as the input field. This is the attribute of interest which will be the focus of the hot spot analysis. Hot spot analysis requires a conceptualization of space, as previously used for Moran's I, I chose the contiguity_edges_corners conceptualization as these best fits the polygon bounding of census block groups. The Getis-Ord Gi* tool was run on each layer to produce a final set of layers (2000GHSA.lyr, 2013GHSA.lyr., and 2020GHSA.lyr), whose attribute tables house the z-score and p-values which indicate the degree and significance of the clustering occurring. The z-score and p-value are measures of statistical significance which indicate whether or not the null hypothesis is to be rejected. In terms of a hot spot analysis, the null hypothesis states that the value of the variable of interest is randomly distributed. The p-value is the probability that the observed spatial pattern is the result of a random process. The z-score is the standard deviation, which moves through a bell-curve signifying the intensity of clustering, at one end a clustering of high values and at the other, a clustering of low values (see figures 31 to 33, inserted below).

Figure 31. *2000 Hot Spot Analysis*

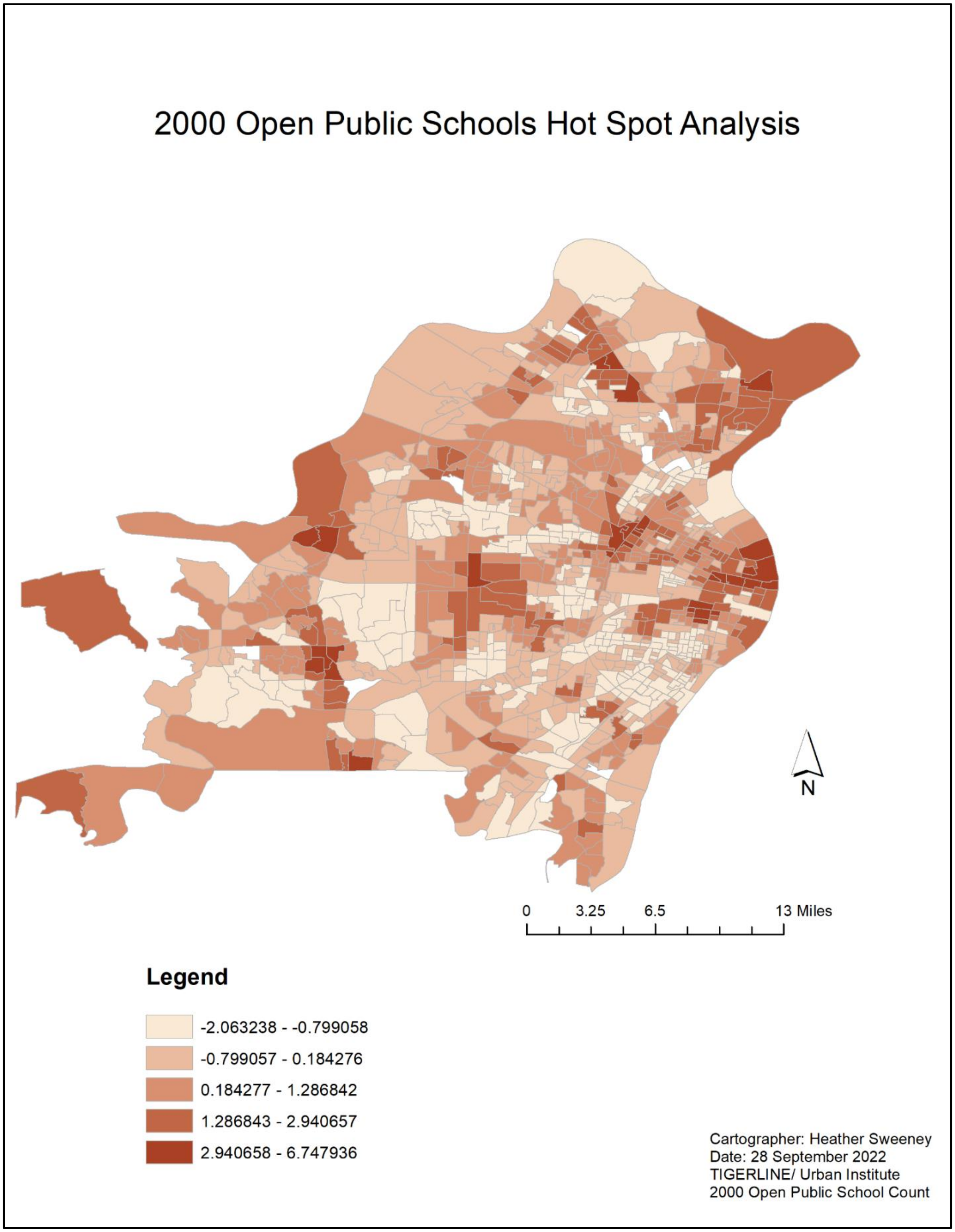


Figure 32. *2013 Hot Spot Analysis*

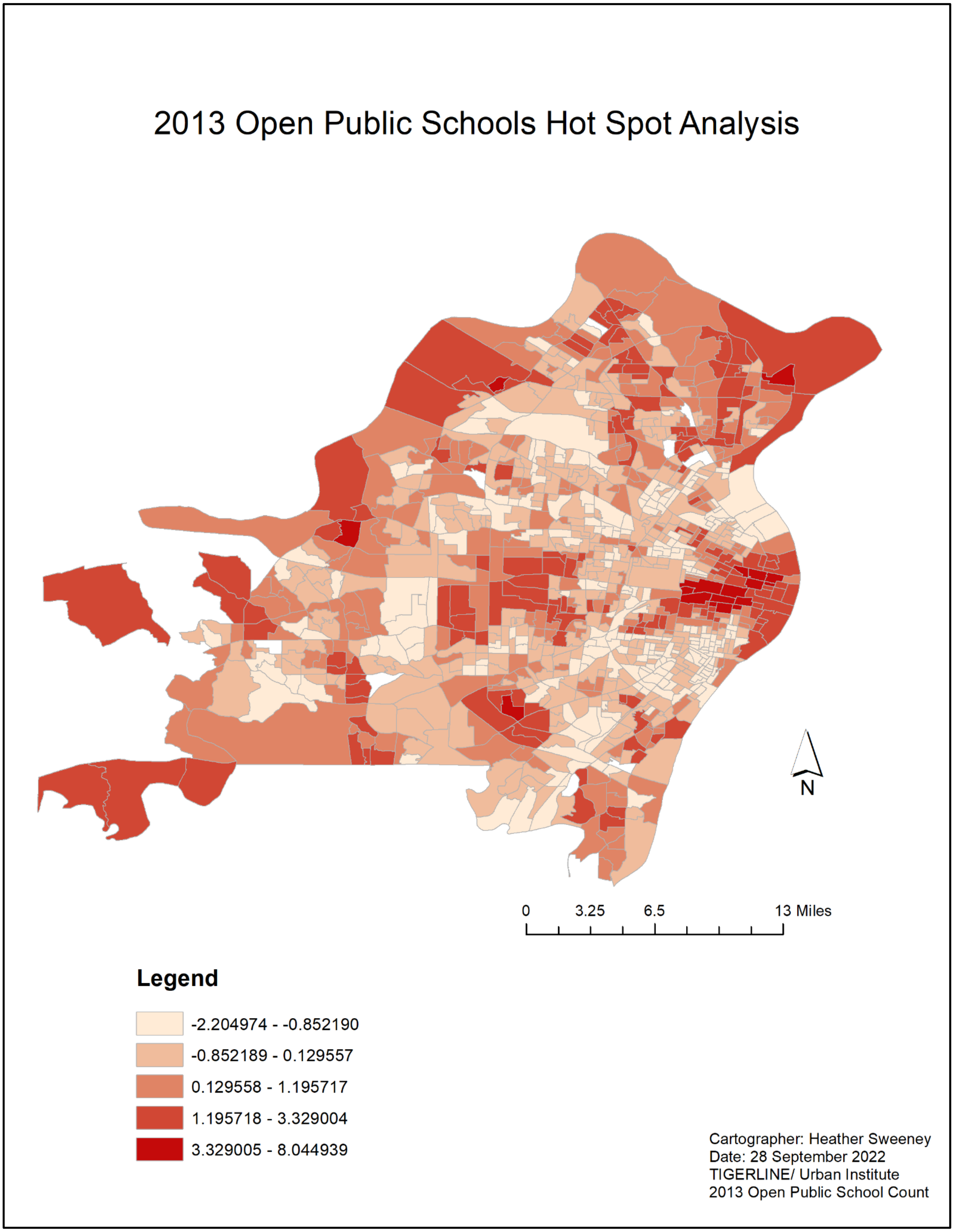
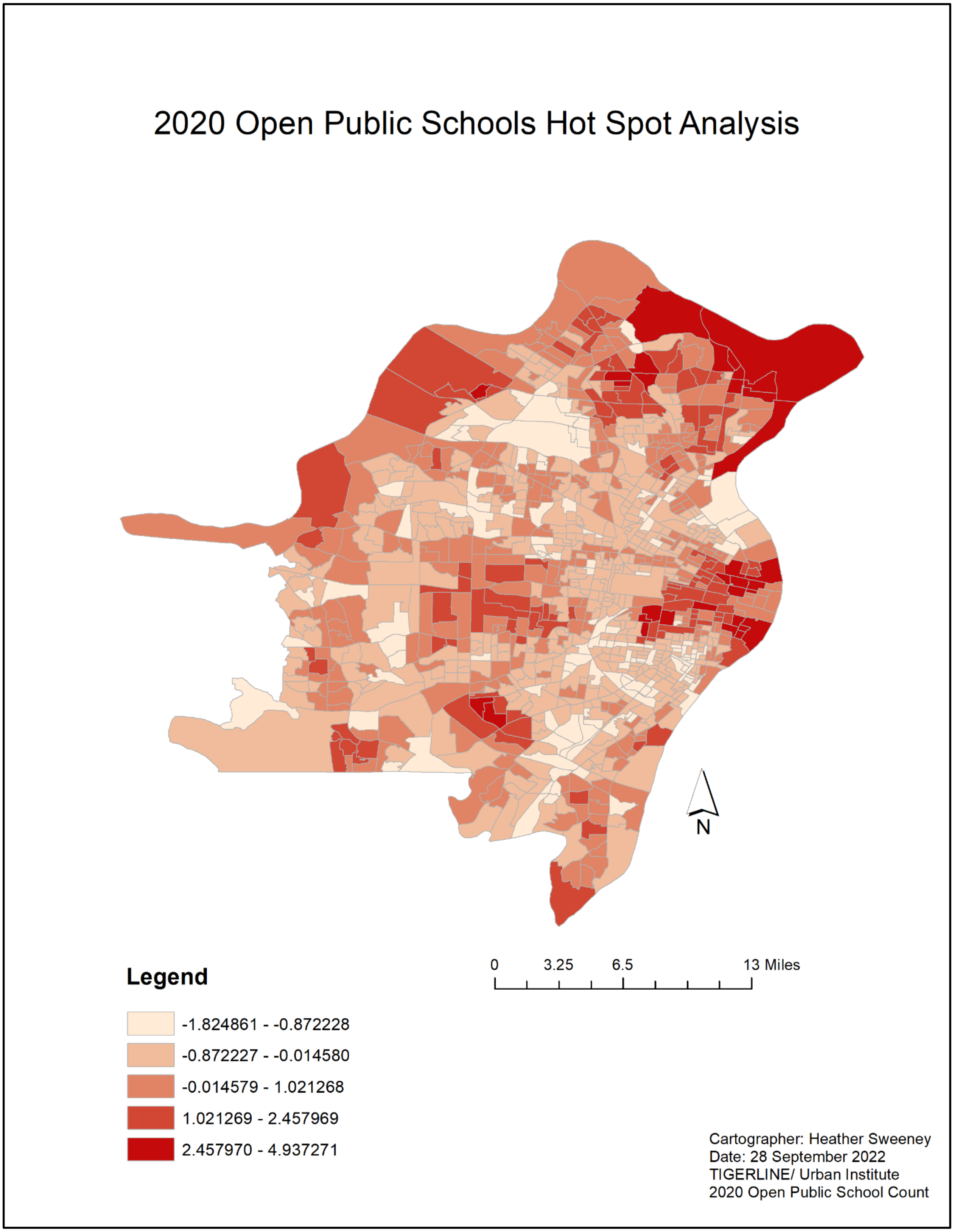


Figure 33. *2020 Hot Spot Analysis*



How do school closures shape the type of educational opportunities available to St. Louis Metropolitan Statistical Area students?

The z-score is considered statistically significant when it both has a positive high value and is surrounded by other high values (hot spot) or when it both has a negative low value and is surrounded by other low values (cold spot).

In 2000, there is a clustering of high values (number of schools) across north city and a strip moving from the east half of the central corridor to the west. These are signaled by the deepest red spaces housing between approximately 3 to 7 public schools. There are also three pockets of high values in the county: one in the northern most counties, one in the west central counties and a third in the farthest counties from the city. By 2013 the once high value cluster of the northern part of the city is now a clustering of low values (signaled by the light cream spaces housing negative buildings and the darkest red spaces housing 3 to 8 school buildings). And the central corridor clustering of high values has not only intensified but expanded south. The western county, periphery county and northern county clustering’s have also intensified. A shift made visually pronounced due to the clustering of low values sharing their borders. In 2020, these same clusters remain; however, the possible values have been cut in half (the darkest red spaces max out at approximately 5 public schools versus 8 in previous decades).

This pattern suggests residents of south city, select west and north counties have greater access to a local public school while residents of north city have lost many of their local public schools since the year 2000. The pronounced nature of these hot spots also suggests a consequential relationship. A block group which shares boundaries with a flourishing school oasis is more likely to be a struggling school desert.

Conclusion

In this chapter I presented the data preparation and build out of an ARCGIS database, the application of Moran's I to understand the spatial distribution of shrinkage variables, a global and local regression model exploring the relationship between shrinkage variables and school choice, and the deployment of a hot spot analysis to identify access to public school across the St. Louis Metropolitan Area. Moran's I confirmed my prediction that the variables of shrinkage are not randomly distributed but clustered. Both sets of global (OLS) and local (GWR) models were not a good fit for the data nor did the models uncover a significant relationship between the variables of shrinkage and school closures. The hotspot analysis offers boundaries for school deserts and school oases across the St. Louis Metropolitan Area. The findings of each analysis will be further explored and unpacked in the next chapter.

Chapter 5 - Discussion

This study applied Massey's relational politics of space (2008) to an examination of the lead up and fall out of school closures across Metropolitan St. Louis from 1990 to 2020. First, this study identified the trajectories of shrinkage – or specifically residential mobility, vacancy rates, and the population of school-aged children – which must be negotiated. Second, the study located the negotiations made through school closures by public school districts, which form school deserts across the St. Louis Metropolitan Statistical Area. Examining the practice of place both driving school closure and occurring because of closings offered an urban-suburban case study to add to our understanding of the impacts of closures. Three research questions were answered through a scaffolding analysis conducted within a Geographic Information System. In this final chapter, I first review the findings from each research question and what they mean for the city of St. Louis. Then I discuss the limitations of this project and conclude with ideas for future educational policy research using GIS.

Review of Findings

RQ1. How has shrinkage occurred over time across the St. Louis Metropolitan Area?

Through a Moran's I Spatial Autocorrelation analysis, two understandings came to light regarding the shrinkage occurring (residential mobility, vacancy rates, and school aged children by block group) over time across the St. Louis Metropolitan Area (St. Louis City and St. Louis County). The first is the understanding that the variables of shrinkage are not randomly distributed across the St. Louis Metropolitan Area but in fact clustered. The second is the understanding that this clustering may be rooted in the spatial ordering of the city and surrounding counties.

RQ2. How does this shrinkage relate to public school closures?

Armed with the above understandings, I progressed to the next spatial analysis. The intention here was to connect the distributional patterns (closure) that are inherently (un)just and the socio-political processes (shrinkage) which established these distributional patterns. Through both an Ordinary Least Squares Regression and a Geographically Weighted Regression I explored the relationship between the independent variables of percent change in variables of shrinkage, locational discrimination (as represented by the variables of median income, black population, white population) and the dependent variable of change in number of open public schools. While there appears to be a spatial patterning to the negative and positive shifts of each coefficient (the influence each independent variable exercises on the dependent variable), the value hovers so close to zero that no coefficient seems to bear a significant level of influence on the open or closed status of public schools. Therefore, the presence of shrinkage trajectories does not appear to influence the number of school closures within a given St. Louis City block group.

RQ3. How do school closures shape the type of educational opportunities available to St. Louis Metropolitan Statistical Area students?

While the regression analysis did not provide a statistically significant relationship between shrinkage and closure, my third and final analysis focused on the clustering and dispersion of open public schools, which did not require a significant finding with regression modeling. Through hot spot analysis of open public schools in 2000, 2013 and 2020 I visualized the distributional patterns of closure built into the space that is St. Louis. This pattern suggests residents of south city, select west and north counties have greater access to a local public school while residents of north city have lost many of their local public schools since the year 2000. The pronounced nature of these hot spots also suggests a consequential relationship. A block group which shares boundaries with a flourishing school oasis is more likely to be a struggling school desert.

This implementation of a Geographic Information System towards a critical spatial analysis of St. Louis public school closure demonstrates the observation made by Soja in his own recounting of spatial justice in the city: "It is relatively easy to discover examples of spatial injustice descriptively, but it is much more difficult to identify and understand the underlying processes producing unjust geographies" (Soja, 2009, p. 3). Visualizing the uneven development of St. Louis City and the surrounding St. Louis County supported what I assumed to be true: dividing socio-political boundaries are entrenched and directly translate to the presence of valued resources such as income, dwellings, and schools within and between residential spaces. However, the spatial analysis intended to move from a descriptive understanding to a deeper understanding of the processes underpinning St. Louis public school closure was unfruitful. Despite similarities in distributional patterns there was no significant relationship either positive or negative between the phenomena of shrinkage and closure in a study that looks across the St. Louis metropolitan region.

Implications for St. Louis City

Based on the results of analysis one and three, the trajectories of shrinkage and school closure follow paralleled paths across the city. Such alignment draws attention back to the negotiation of place occurring between key political actors (St. Louis policymakers such as the School Board and SLPS administration) and secondary actors (communities, families, and students) in official and unofficial forums. As St. Louis policymakers implement the local, national, and regional policies promoting school closure as a tool for educational reform; the unintentional impacts of school closure may be remediated with an understanding of the trajectories of shrinkage and existing school desert boundaries as identified by this analysis. As argued by Tieken and Auldridge-Reveles (2019) the idea of politically neutral schooling is impossible. Rather than attempt to frame closure decisions neutrally, St. Louis policy makers should shift to an equity framework. Educational equity means that every child receives what they need to develop to their full academic and social potential. Operating from this equity framework means foregrounding the needs of each child attending St. Louis Public Schools, which vary based on each child's family background, social identities and other contextual factors when making decisions. Armed with the knowledge of where St. Louis City residents are most impacted by shrinkage and where public-school deserts exist, closure decisions should be made to redistribute opportunity to the neighborhoods with the greatest need rather than the neighborhoods that look the best on paper.

Implications for Theory

Applying Doreen Massey's relational politics of space was a deliberate choice. Approaching the issue of school closure from a messy view of space and our relationship to its construction offered a complexity unachievable with GIS alone. Exploring the lead up to and results of school closure through the undeniable negotiations of contextual features in our day-to-day operationalization of space emphasized how these negotiations are bound by the openness and closures we've created through socio-political boundaries. Therefore, highlighting the inherent geographic nature of closure. Undoubtedly, the messiness of such spatial conceptualization needs to be calibrated with future research. Experimenting with new boundaries, such as those we know for the spaces, we inhabit that are not printed on any map. And extending the application of such messy conceptualizations to other policy explorations.

Implications for Educational Policy Research

GIS offers educational policy researchers a range of tools to produce either objective measures of socio-educational issues by analyzing quantitative data (Schuurman & Pratt, 2002) or atheoretical descriptive supplements to other empirical methods (Yoon, Gulson & Lubienski, 2018) such as graphic illustrations of distributional patterns. Visualizations are powerful. Being able to look at a map of your city, state or country and trace the change of a phenomena of interest resonates on a personal level, bringing the reader into the research in a way unmatched by even the most eloquent of analysis sections. Not only this, but GIS allows for complexity. We can speak to connected spaces, multiple variables, and change with a single visual. However, GIS has limitations, most importantly, this tool can only conceive of our spatial world in mathematical terms that can be represented on a map.

The Limitations of GIS

According to Steinberg and Steinberg (2015), Geographic Information Systems (GIS) came into being as a tool for use in the field of traditional geography; however, over the last few decades it has developed and been applied by a variety of disciplines. Despite having grown in use, GIS is still limited to the map data model, which consists of points, lines, and polygons. The map data model also assumes that all data is and can be linked to specific, discrete locations and that lines can be drawn to delineate the exact boundaries between data categories (Steinberg & Steinberg, 2015). When conducting social science research, all datasets are not so easily defined nor are they quite as geographically specific, either because the researcher must protect the privacy of participants, or they are analyzing conceptual maps.

In creating the datasets for this study, I retrieved social demographic data from the U.S. Census public server. This data has already been manipulated several times through aggregation to different geographic scales from the individual data originally collected. Conducting an analysis on the same data point is complicated by the fact that the U.S. Census changes coding of data from year to year, particularly with the decennial Census, and governmental boundaries are also constantly changing, meaning the block groups of 2000 are not the same in 2013 and 2020. Creating a suitable ARCGIS data set with the 2020 census data was difficult. The block groups of 2020 where not the block groups of 2013; therefore, the development of change over time variables required additional manipulation after discerning which block groups were broken up, absorbed or simply missing. This issue was evident in the final regression maps for 2020. There was no discernable directional flow for the relationship between coefficients and the dependent variable. Given that we entered into a global pandemic in 2019, these data conformity issues likely stemmed from COVID-19 and the fall-out, which we are currently navigating. Aside from these data conformity troubles, simply put, social demographic data is difficult to fit into a Geographic Information System due to its non-stationary nature. Software like ARCGIS operates on points, lines and polygons, that is, it assumes neat, close-ended boxes of data with defined boundaries. Mapping quantitative data in GIS carries the assumption that space is immutable. Addressing the fluidity of social phenomena has always been a challenge for geographers.

Unique to this examination is the blending of multiple conceptions of spatial phenomena to build a historical narrative of the locational practices which deeply impact school closure. Rather than simplifying a complex issue by applying a single spatial conceptualization focused on understanding one piece of the puzzle, I designed a framework meant to address the issue by following its trajectory. Such a framework incorporated space-time compression, viewing the change at the smallest geographical level available, over time, across a metropolitan space, and the change over time across a public school system nestled within this metropolis. Outside of selecting appropriate variables which accurately encapsulate the socio-political phenomena of interest and identifying them at the appropriate geographic level, tackling the fluidity of space within GIS is a difficult task. I relied on mathematical data manipulation before pulling my dataset into GIS. Creating a percent change variable from raw census data. The intention being to incorporate the fluidity of social phenomena. Others have taken up this task by layering the same observations from different geographic levels and across different points in time. What is limiting about each of these, and what likely contributed to my lack of significant findings with either regression model, is the simple fact that the data used is unparticular and nonlinear. Historical datasets, in particular those curated by the Census do not source from the same well year after year, nor do they address the precise set of questions, and they are never packaged in the same fashion. Geographers have had to front load their analysis with data manipulation when using historical datasets, matching the locational data from one point in time to another to ensure the locality is the same from year to year. Therefore some have turned to procuring their own data sets through extensive collection methods, possibly spanning years but certainly producing a granular, more accurate accounting of time and space.

Future Educational Policy Research Application of GIS

How might future research on school closure capture the sense of place we ascribe to locations and the power relations inherent in our co-creation of space (Allen, 2011; Lury, Parisi, & Trerranova, 2012; Tate, 2012; Waitoller & Annamma, 2017) in GIS examinations? Education policy is intrinsically linked with historically shaped geographic “artifacts of past and present” (Pulido, 2000, cited in André-Bechely, 2007, p. 1361) such as urban (re)development, discriminatory housing practices, demographic shifts within and between regions, and subsequent residential segregation by race or income (Butler & Robson, 2003; Reay, 2007;

Gulson, 2011; Lipman, 2008; Yoon, 2011). Publications tracing the artifacts of past and present which created the geographic channels of advantage and disadvantage across St. Louis such as Gordon's *Mapping Decline* (2008) influenced the variables of focus across each stage of my analysis.Within Gordon's work following the history of St. Louis, he discusses the prejudicial practices which built present day St. Louis; these being predatory lending practices, redlining, and blighting and urban renewal (2008). These practices are connected to the uneven distribution of vacancy across the City of St. Louis as well as the demographics of present-day St. Louis Counties, as wealthier white residents moved to escape a declining city center (Gordon, 2008). Despite centering St. Louis's historical geography in this way, this analysis failed to find a statistically significant relationship between this history and the current levels of access to public schools in general across the metropolitan area. Perhaps urban redevelopment, discriminatory housing practices and demographic shifts are entirely unrelated to school closure in St. Louis. Perhaps the variables I chose to represent each of the above practices missed the mark. Take for instance, the choice of dependent variable. I examined the change in number of schools within block groups, meaning there were block groups that gained a single or multiple public schools, block groups that lost a single or multiple schools, and block groups that remained the same over time. Would a focus on just those block groups which lost schools have produced a stronger relationship? While at first glance vacancy and residential mobility appear to offer a tracking mechanism for population loss, would an independent variable set composed of educational attainment, income, and population age have better represented a shrinking population? Perhaps school closure is influenced by a more complex set of factors than what I was able to locate in census data or exists as publicly available data points.

Closure is felt. Vacating a community fixture, such as a school, is disruptive to the well-being and stability of that locality. Which have been shown to be predominately, low-income communities of color conscribed by an urban landscape which is segregated both racially and economically, losing population and the product of a mis-managed local economy. If my datasets had been sourced from and with these communities, perhaps the analysis would have produced a clearer connection between shrinkage and closure because it was devised by lived experience. Future research on school closure could incorporate community research projects where the data is sourced from and with the residents experiencing closure. This would not only provide a deeper connection to the lived experience of school closure, but greater validation of the data employed within a GIS analysis.

Not only would approaching this issue through a community research project potentially prove more fruitful in the design of ARCGIS datasets but the collection of primary data would be ideal. Rather than depending on curated census data aggregated and set to pre-determined political boundaries, if a researcher were to source the same socio-demographic information around residential mobility and school enrollment from a single household, they would be able to set this data at any geographic location. Inclusive of aggregating it to an entirely new type of boundary, such as constructing a patchwork of neighborhoods or school enrollment zones.

As researchers, what we believe to be representative of particular experiences is not always the most important feature to participants. Given that my analysis, which relied entirely on what the research says matters in school closure, did not identify a relationship between research supporter variables, it begs the question of: what variables do matter in school closure and how do we find them?

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VITA

Born January 30th, 1987, in Chicago, Heather Sweeney's pk-12 education included both public and private schools both within the city limits and the Northwest Suburbs. An avid vocalist from a young age, Heather pursued a Bachelor of Music in Voice at Webster University in St. Louis. It was this undergraduate experience which nurtured pre-existing leadership abilities and sent an ambitious twenty-something down the path of becoming an educator, non-profit leader and eventual scholar in educational policy studies.

Following graduation Heather earned her Master of Science in Education in Higher Education Administration from the University of Kansas. From here she pursued inaugural roles which allowed her to cultivate quality educational programs and services that were accessible to a diverse array of students spanning pk-20, local educational systems, and global ones. It was these formative years as a practitioner that lead her to pursue doctoral work where she might engage in critical spatial explorations of the disparate impacts of educational policy spanning pk-20.