



Who is going where in King County?

Exploring novel data sources

2023 Population Health Initiative Applied Research Fellows

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Recent Population Trends in King County

King County's population grew from 1.74 million in 2000 to 2.27 million in 2020- an increase of over half a million people in two decades ([US Census Bureau](#), [US Census Bureau](#)). In that time, the percentage of the population that identified as "White alone" decreased from 75.7% to 63.5%. The "Asian alone," "Hispanic or Latino," and "Native Hawaiian and Other Pacific Islander alone" populations doubled, while the "Black or African American alone" and "American Indian and Alaska Native alone" populations increased by a smaller percent. From 2000 to 2020, the population of King County grew older on average. The percentage of the population under 18 years decreased from 22.5% to 19.2%, and the population 65 years and older increased from 10.5% to 14.2%.

While increasing in-migration has been a boon to the local economy, it has also strained the local housing market. In 2017-2021, King County had the fourth highest level of income inequality among Washington counties, with the top 20% of earners taking home approximately 19 times more than the bottom 20% ([Communities Count](#)). The median household income in King County increased by 86% from 2000 to 2020, rising from \$53,157 to \$99,158 ([King County](#)). In 2021, about one-third of all King County households were rent-burdened, meaning they spent 30% or more of their income on housing ([Federal Reserve Economic Data, 2022](#)). Amongst low-income households, 76% are rent-burdened ([King County, 2021](#)). King County has made considerable progress in increasing housing supply but needs to build even more units to keep up with demand ([State of Washington Office of Financial Management, 2023](#); [Seattle Times, 2023](#)). Without sufficient housing and, in particular, affordable¹ housing, existing households are pressured to move both within and out of King County.

What is driving migration?

Tech and healthcare industries

The region's booming tech and healthcare industries have undoubtedly affected in-migration. Both industries rely on highly educated workers, many of whom are from foreign countries ([American Immigration Council, 2022](#); [Migration Policy Institute, 2023](#)). Though it is unclear just how big of a role these industries have had on population growth and subsequent housing pressures in King County, there is evidence that neighborhoods with more South Lake Union workers (most of whom are ostensibly employed by Amazon or other high-revenue companies in South Lake Union) saw bigger rent increases ([Zillow, 2017](#)). Tech continues to play an outsized role in the region, but recent layoffs suggest that hiring is cooling off ([Seattle Times, 2023](#)). In early 2023, healthcare overtook tech as the industry with the most job postings in Washington state ([Seattle Times, 2023](#)).

¹ We follow [King County's definition](#) and consider affordable housing as housing that costs 30% or less of the household's monthly income.

Increasing domestic out-migration

In the last two years, King County has seen more people moving out to other U.S. counties than people moving in from other U.S. counties ([Census, 2023](#)). Even millennials (now ages 25-39), who used to drive in-migration, are no longer moving in at the same rate. Between 2015 and 2019, Washington was among the top 3 states with highest domestic net migration of millennials – Seattle specifically ranked 1st or 2nd depending on the year ([SmartAsset, 2021](#)). But in 2021, Seattle lost more millennial residents than it gained for the first time. This could be a temporary decline due to the COVID-19 pandemic, or part of a national trend where high-cost coastal regions are seeing declines in all working-age residents ([New York Times, 2023](#)).

Why do people move?

Migration is strongly related to one's age and stage in life ([Dieleman, 2001](#)). Big life milestones such as going to college, changing jobs, getting married, and having kids typically spur migration. Still, there are also macro-level factors that affect one's decision and ability to move. [Black et al. \(2011\)](#) identify five types of macro-level factors that influence migration:

- Economic (e.g., labor market, housing market)
- Political (e.g., zoning policy)
- Environmental (e.g., pollution exposure)
- Social (e.g., family obligations, cultural familiarity)
- Demographic (e.g., population density)

When considering whether to stay or move, households are balancing numerous factors about their specific household's needs as well as the attributes about their current residence and potential future residences. A household's ability to move can also be moderated by systemic barriers. For example, discriminatory local policies and politics may prevent households of color or queer households from moving in. Black and brown households are more likely to be denied loans and face lower credit scores and due to discriminatory lending practices ([Quillian et al.. 2020](#)). Further, those without access to generational wealth are significantly disadvantaged in their ability to move.

According to a 2021 survey conducted by the Puget Sound Regional Council, people who moved within the area in the last five years were most likely to cite reasons such as wanting more space, changes in household size, or wanting an upgrade ([Puget Sound Regional Council, 2022](#)). However, in the same survey, about a quarter of those who moved cited negative, displacement-related reasons (e.g., increased housing costs, loss of community, forced move). Renters, low-income residents, and Black residents were more likely to move due to displacement-related reasons.

Migration frequency and distance also vary by socioeconomic status. Between 2002-2017, King County residents with the highest credit scores were the least likely to move, and those who moved were most likely to stay within the same neighborhood ([Hwang et al., 2023](#)). In contrast, residents with the lowest credit scores moved more often and were the most likely to move outside of the Seattle metro area. Thus, while

affluent households have the privilege of being able to stay in neighborhoods that are already resource-rich, working-class households are moving more frequently and moving further distances.

In this report we will limit our focus to four factors that might affect migration: (1) rental prices, (2) planning policy and land use, (3) environmental risk, and (4) access to amenities. While we cannot say whether these factors caused a household to move in our analysis, we instead make descriptive comparisons between common origin and destination neighborhoods.

Historical & Cultural Context of Housing Inequity in King County

Housing availability, affordability, and access in King County is undoubtedly influenced by programs, practices, and policies at the federal, state, and local levels. Specific examples of these include settler colonialism, exclusionary zoning, racial restrictive covenants, and redlining. This long history of these racist practices is responsible for housing segregation that continues to this day and has resulted in the inequitable distribution of resources and opportunities among persons of different identities, especially with regard to racial and ethnic identities.

Settler colonialism

As a settler-colonial state, the United States has displaced and excluded indigenous peoples in the name of progress, particularly through the process of urbanization ([Porter and Yiftachel, 2017](#), p. 177). When developing urban areas, settlers look toward a futuristic metropolis while enshrining indigeneity as primitive and belonging in the past. Yet, the indigenous people of this region persist and continue to have a relationship with their land. King County is on the land of Coast Salish peoples. In 1855, the Treaty of Point Elliott ceded millions of square miles of land from the Coast Salish peoples to the United States and established a number of reservations in what is now Washington State ([Duwamish Tribe](#)). There are three Native American reservations in and around King County. The Muckleshoot Reservation is located at the southern end of the County, in the city of Auburn. The Snoqualmie Reservation is in East King County, near Snoqualmie, WA. The Puyallup Reservation is in Pierce County, located just south of the county border from Federal Way. Notably, white settlers blocked the establishment of a reservation for the Duwamish near the City of Seattle, despite the treaty's promise. This exclusion and displacement of indigenous peoples continue to affect residential patterns today.

Racial restrictive covenants

Racial restrictive covenants refer to exclusionary language written into housing deeds which explicitly ban the sale of property to specific races of people. The Seattle Civil Rights & Labor History Project has identified more than 30,000 deeds with racially restrictive language in King County ([Racial Restrictive Covenants](#)). For example, the deeds of about 320 properties in a subdivision of Seattle's Beacon Hill neighborhood state that "No person other than one of the Caucasian race shall be permitted to occupy any portion of any lot in said plat or any building thereon except a domestic servant actually employed by a Caucasian occupant of said lot or building." In Sheridan Heights, Lake Forest Park, this language was added to the deeds of about 95

properties in 1941: “No part of said property shall ever be used or occupied by any person of Asiatic, Negro, Hawaiian, or Malay race or any person of extraction or descent of any such race ...” Innis Arden, Shoreline was subdivided by William and Martha Boeing and was marketed as a racially-restricted neighborhood.

People of color were limited to housing without restrictive language in their deeds. Central areas of Seattle had fewer restrictive covenants than more suburban residential areas such as Laurelhurst and Magnolia ([Seattle Civil Rights and Labor History Project, 2006](#)). The Central District became home to Seattle’s Black community. Immigrants, largely from Asia, have been arriving in King County since the 19th century. In Seattle, Asian communities clustered around what is now called the Chinatown-International District (CID).

Redlining

In 1934, the Federal Housing Administration began to categorize tracts of land based on the risk to lenders. They consistently designated Black neighborhoods and other neighborhoods of color as “Hazardous”, coloring them red on the maps. This process of “redlining” made it prohibitive for Black Americans to secure loans that were necessary to purchase homes. Segregation and racism in real estate meant that Black families were only allowed to purchase homes in Black neighborhoods, yet banks were unwilling to offer insured mortgage loans in those neighborhoods due to their Hazardous rating. Seattle’s redlining map labels the Central District, which historically has housed Black residents, as “Hazardous.” The description of one area plainly states, “This is the Negro area of Seattle” ([Nelson et al.](#), accessed July 2023).

Redlining policies and programs, along with other social, political, and economic factors such as white flight and subsidized housing, have entrenched housing segregation. As a result, neighborhoods of color have often suffered from disinvestment and limited access to resources and opportunities ([Urban Institute](#)). Residents of these neighborhoods are hindered from building generational wealth and have poorer health outcomes overall.

Exclusionary zoning

Exclusionary zoning refers to local policies that control where more affordable housing can be built in order to prevent certain segments of the population from moving into privileged spaces. Often, these zoning policies aim to “protect” single-family neighborhoods by distancing them from industrial or commercial uses. In effect, they also distance wealthier neighborhoods from housing such as apartment buildings or mobile homes, which are only allowed in higher-intensity zones ([Whittemore, 2021](#), p. 168). The result is wealth-based segregation, which is closely tied to race-based segregation because of the systemic barriers to building wealth that people of color face in this country.

For example, the City of Seattle’s 1923 zoning map designated the Chinatown-International District as “Area District D,” referring to manufacturing districts ([Seattle Municipal Archives Digital Collections](#)), even though most of the city’s Asian population was residing in this neighborhood. Meanwhile, racial restrictive covenants and other practices excluded Asian communities from residential parts of the city. As a result, the residents of the CID were relegated to this district, even though it was not planned as an area to live in. They were thus

systematically housed apart from wealthier, whiter residents of Seattle who had the means and access to live in neighborhoods zoned for residential use.

In King County, 89% of residential parcels are single family homes. About 75% of the land available for residential use in Seattle is zoned as Neighborhood Residential (NR) ([Seattle Planning Commission, 2018](#)), which primarily allows “single family dwelling units with up to two ADUs [‘accessory dwelling units’]” ([Seattle Department of Construction & Inspections, 2023](#)). This limits the land on which higher-density housing can be developed.

Gentrification and displacement in King County

Due to the region’s housing crisis, many neighborhoods have experienced gentrification in the last two decades ([Hwang, 2020](#)). Today, there is widespread concern about displacement and gentrification spreading to more neighborhoods. While there is no standardized definition, gentrification typically refers to the influx of affluent and/or white residents into an urban low-income neighborhood ([Freeman, 2005; Ding et al., 2016, Rucks-Ahidiana, 2022](#)). Displacement typically refers to existing low-income residents being forced to move out of their neighborhood due to increased living costs. While gentrification is thought to directly lead to displacement, the evidence is mixed and varies considerably by city ([Ellen & O'Regan, 2011, Freeman, 2005](#)). Still, even when existing residents are able to stay in the neighborhood, the transformation of the neighborhood can lead to cultural and political displacement ([Hyra, 2015; Shaw & Hagemans, 2015](#)). Even if there is little to no residential displacement, gentrification still has a felt impact on the community.

Studies of gentrification in King County have focused on Seattle. From 1990 to 2013, low-income neighborhoods with greater shares of Black residents, such as the Central District, Columbia City, and Rainier Valley, were more likely to undergo gentrification than comparable low-income neighborhoods ([Hwang, 2020](#)). In the Central District, a historically Black neighborhood, over 90% of residents were Black in 1970 ([Seattle Civil Rights & Labor History Project](#)). As Seattle’s economy shifted from manufacturing to engineering, more white professionals and highly-educated immigrants flocked to Downtown while many of the area’s longtime Black families were pushed further south. As of 2020, less than 20% of Central District residents are Black ([Seattle Civil Rights & Labor History Project](#)). In Rainier Valley and Rainier Beach, data shows that the proportion of White residents is growing faster than the proportion of residents of color in the neighborhood ([Puget Sound Sage, 2012](#)). Residents are determined to avoid a repeat of what happened to the Central District ([South Seattle Emerald, 2022, The Urbanist, 2022](#)).

Seattle’s Chinatown-International District (CID) is another highly-impacted neighborhood. For generations, the CID has been home to Asian immigrants as one of the few neighborhoods that even allowed residents of Asian descent. Many residents are also elderly and low-income. Over the decades, development of transit infrastructure, two stadiums, and market-rate condominiums have jeopardized CID’s residents’ ability to stay ([KUOW, 2023; Seattle Times, 2018](#)). The expansion of the Link light rail has also raised concerns of transit-induced gentrification in the CID and beyond. After the groundbreaking of the Link’s southern corridor, neighborhoods next to Link stations saw a larger increase in white residents than comparable neighborhoods that were not next to a Link station ([Hess, 2020](#)). Despite these changes in racial composition, eviction rates

stayed the same suggesting that either affected residents were able to stay in the neighborhood or that any resulting displacement was not captured by eviction filings ([Urban Institute, 2020](#)). Community members are worried that without careful planning, the continued expansion of the Link will further exacerbate displacement pressures ([Seattle Times, 2022](#); [Seattle Times, 2023](#)).

Outside of Seattle, neighborhoods are experiencing the ripple effects of gentrification as people move further away from the city center. The Puget Sound Regional Council considers much of South King County and parts of North King County such as Shoreline, Lynwood, and Mukilteo to be at high risk for displacement ([PSRC, 2019](#)). Many households in South King County were actually first displaced from Seattle and are now facing the same pressures of rising housing costs ([Crosscut, 2022](#)).

Current Work to Address the Housing Crisis

In response to the region's fast-growing population, the state of Washington enacted the Growth Management Act in 1990 to address urban sprawl and limit the loss of open space, among other goals. This legislation requires certain counties and cities, including King County, to adopt and update long-range comprehensive plans to manage their population growth. In addition, Seattle's comprehensive plan encourages denser housing development in [Urban Villages and Urban Centers](#) and discourages density elsewhere. This policy further concentrates population and housing growth in 30% of the city's land area ([cite](#)). These limitations on development exert pressure on the housing market.

There are ongoing efforts to address these systemic injustices in housing access and affordability. For example, the King County Housing Authority manages affordable rental housing throughout the county. The Multifamily Tax Exemption (MFTE) program sets aside subsidized affordable rental units for households who fall below an income threshold. Seattle's Office of Housing supports first-time homebuyers who make 80% or less of the Area Median Income (AMI). Various nonprofits and foundations also contribute to this work. In 2019, Seattle removed regulatory barriers to the development of accessory dwelling units (ADUs), which are separate living spaces on the same lot as another house ([Seattle Department of Construction & Inspections](#)). Seattle renamed its "Single Family" zones to "Neighborhood Residential" zones in 2021 in recognition of the growing share of ADUs, townhouses, apartment buildings, row houses, and other housing types present in these zones ([Seattle City Council](#)). Washington State passed HB1110 in 2023, allowing for the development of duplexes and fourplexes in any residential area ([WA 68th Legislature](#)). Yet, large multifamily housing still cannot be built in much of King County.

The ARFP 2023 Project

The 2023 Population Health Initiative (PHI) Applied Research Fellowship Project (ARFP) builds on research conducted by ARFP Fellows in previous years. Previous projects focused on creating small area population projections (2020), disaggregating population growth by household size and tenure (2021), and estimating changes in housing supply (2022). In this year's project we investigate household migration and displacement

within King County. Together, these findings of these projects offer a more complete picture of how in-migration, internal migration, and housing needs in King County have evolved together over time.

There is ample qualitative evidence of migration and displacement in King County ([Office of Planning & Community Development, Department of Neighborhoods, 2015](#); [Crosscut, 2022](#); [Puget Sound Regional Council, 2022](#)), yet quantitative analyses are limited. This project aims to build on community accounts by quantifying the timing (when do people move), volume (how many people move), and location (where do people move to and from) of these migration patterns. We also build on previous quantitative analyses of migration in King County (Hwang et al., 2023) by integrating more recent data including, importantly, the years of the COVID-19 pandemic.

Unlike in previous ARFP projects, this year's project uses non-administrative data, in part due to the challenges of measuring migration. Residents do not always register their address changes when they move. Even with accurate address information, proper measurement of migration requires governmental offices such as the Department of Licensing or the Internal Revenue Service to grant access to highly sensitive residential data from both the place of origin and destination. Thus, we explore the utility of Data Axle's private consumer data which offers the advantage of including longitudinal geolocation data by household and for which the University of Washington has license to use. Notably, the consumer data only comprises households with credit histories or adults interacting with governmental services. As such, low SES households and young adults are likely underrepresented. These data are more timely than estimates from the American Community Survey (ACS), so assessing their accuracy at the sub-county level is of interest. See the Data and Methods section for a more detailed description of these data sources.

Project Objectives

Our primary goals for this project are to (a) understand how Data Axle can be used to measure migration patterns within King County for all residents and for sub-groupings of the population such as socioeconomic status, race/ethnicity, or age, and (b) provide neighborhood context for these migration patterns based on rental data from Craigslist, the American Community Survey (ACS), and publicly available data on land use and neighborhood resources.

- 1) Assessing the utility of the Data Axle database** - How representative is Data Axle of the King County population? How can Data Axle be useful in measuring migration into or within King County?
- 2) Measuring internal migration in King County** - Where are people moving within King County? And in particular, where are people moving within displacement-prone neighborhoods in Seattle and South King County?
- 3) Investigating the neighborhood context** - What are the socioeconomic conditions of common pairs of origin and destination Health Reporting Areas (HRAs)? We consider four facets:
 - a) Economic - rental prices
 - b) Planning policy - residential land use, Urban Growth Area Boundaries, school districts
 - c) Environmental risk - exposure to pollutants, flood risk
 - d) Access to amenities - density of transit stops, open space, and healthcare parcels

Data and Methods

Data Sources

Data Axle Consumer Data: Data Axle is a private marketing analytics firm that sources national consumer data at the household-level. These data are provided in annual snapshots with information about residential address and demographic characteristics (e.g., tenure, age of household head) for each household. We used these data to estimate internal migration measures for King County between 2017-2022.

Data Axle, like many other private consumer panel data, relies on opaque data generating processes. Data Axle uses multiple data sources to identify household locations across time, including those enumerated in Table 1, and then estimates missing household attributes using statistical models. Data Axle does not share their full list of data sources or the models they use to impute household demographics. They also occasionally acquire new data sources, which can add many new households at once. From 2017-2022, Data Axle identifies anywhere from 900 thousand to 1.5 million households within King County.

Sources	Nature
Utility connections and changes	Public
Change-of-address notifications	Private
Real estate tax assessments and deed transfers	Public
Voter registrations (where available for marketing applications)	Public
Credit card billing statements	Private
Public records, such as bankruptcies, pilot licenses, hunting licenses, and boat registrations	Public
Telephone white page directories	Private
Newspaper and magazine subscription lists	Private

Note: Data Axle indicates that it has over 100 contributing sources but does not list them all.

Table 1: Data Axle consumer data sources. This is a non-exhaustive list of the public and private data sources used to generate Data Axle's panel of households. Source: Acolin, Dechter-Frain, and Hall (2022).

Scraped Online Rental Listings (SORL): These data consist of online rental listings in King County posted beginning in January 2017– June 2023. These listings were collected daily from multiple real estate websites using an automated web scraper ([Hess and Chaskins, 2022](#)). We exclusively use listings from Craigslist as it is the most comprehensive source represented in the dataset. In the Seattle metropolitan area, Craigslist is tied with Trulia as the second most popular rental website ([Costa et al., 2021](#)). Combined, this data includes over 800,000 Craigslist listings with information on location, number of bedrooms, monthly rent, and date of availability. We used these data to analyze rental costs of a given area between 2017 to 2022.

American Community Survey: The ACS is an ongoing household survey conducted by the Census Bureau to collect annual demographic and socioeconomic data on individuals and households. While the survey is ongoing, the data is published annually at the county level. Depending on the size of the county, the data may be reported with or without uncertainty. Data is aggregated over 5-year periods to provide estimates of census tract-level totals and means which can have large uncertainty. In comparison to Data Axe, the ACS provides smaller sample sizes, but the sampling of households is designed to be representative of the U.S. population. We use ACS data on household migration flows by household tenure or age of householder at both the county and tract level throughout this report, and access the data using the [tidycensus](#) package in R.

Assessor's Property Information Files: The King County Department of Assessments provides public records of the [Assessor's Property Information Files](#) available for download. We accessed the Parcel dataset in July 2023. The dataset included 600,000+ rows of data, with each row representing a parcel of land in King County. From this dataset, we used data on the land use and area of each parcel.

We aggregated the 128 different parcel categories of land use in the dataset into 22 broader categories. Of these 22 categories we created, 6 referred to residential land uses: single family, middle housing, multifamily, mobile home, group quarters, and miscellaneous. We also considered the percentage land area of open space.

King County Metro and Sound Transit Data: We used the [Consolidated GTFS Schedule File Set](#) dataset available via Sound Transit's website to source information about the county's public transit routes. The dataset includes data from King County Metro, City of Seattle Streetcar, and Sound Transit.

Environmental Health Disparities Map: The [Environmental Health Disparities Map](#) was produced by the Washington State Department of Health (WA DOH) and the University of Washington's Department of Environmental and Occupational Health Sciences (UW DEOHS). It is an interactive tool that shows pollution burden and population characteristics for the entire state of Washington. From this dataset, we use the "environmental exposures" measure ([UW DEOHS & WA DOH, 2022](#)).

Methods

Data Cleaning

Data Axle

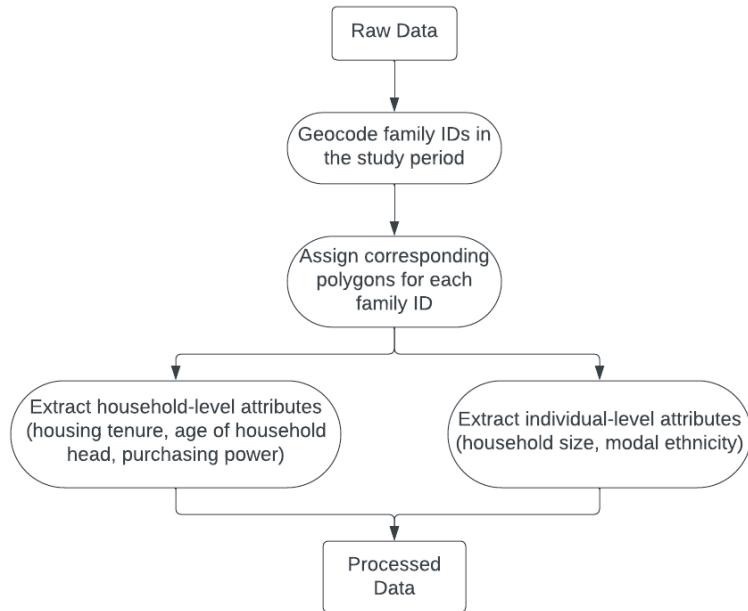


Figure 1. Data Axle Cleaning Flowchart. This flowchart represents our standardized data cleaning process for the Data Axle database.

The complete Data Axle dataset comprises annual snapshots spanning from 2006 to 2022 at the family level. To clean the data, we first extracted all families located in King County from 2017 to 2022, and geocoded each family ID to Census tracts and HRAs based on its respective longitude and latitude coordinates. Then, we constructed two distinct sets of household attributes: one originally at the household level. From the household-level data, we extracted housing tenure and age of the household head. The resulting data output captures longitudinal changes of household addresses across various geographic levels and the corresponding household attributes.

Leveraging the longitudinal data structure, we enhanced the processed data by filling in missing addresses for households based on their trajectory over time. Specifically, whenever we encountered a gap in the address information for a household in a particular year, and observed that the addresses before and after this year remained unchanged, we filled in the missing observation with the same address as the surrounding years. As illustrated in the hypothetical example in Table 2 for Household 1, the address was missing in 2018, but remained unchanged for the rest of the years. For Household 2, the addresses were absent for the first two years and kept the same for the subsequent years. We decided to impute the same address for

Household 1 in 2018 as it is reasonable to assume that its address did not change when the preceding and succeeding records were identical. In contrast, for Household 2, we retained the missingness as it is, as we could not dismiss the possibility that the household was formed or in-migrated in 2019.

Households	2017	2018	2019	2020
Household 1	Tract A	Tract A	Tract A	Tract A
Household 2	x	x	Tract B	Tract B

Table 2. Cases of missing addresses in Data Axle. In this figure we illustrate two common types of missing addresses for a given family ID and year within Data Axle, and the steps we take to address this missingness. Cells with missing addresses are highlighted in red for each hypothetical household. In cases like Household 1, where a family ID is observed at a common address in the year preceding and following the missing year, we assume the household also resided at that address. In cases like Household 2, we do not correct the missingness, as this household may have only relocated to or formed within King County in 2019.

This imputation procedure was further validated by comparing the resulting proportions of households that moved across census tracts per year. Without filling in the missing addresses in cases like Household 1 in Figure 4, the proportions of households that moved across Census tracts per year were too large, ranging from 60% to 70%. However, after modifying these missing addresses, the corresponding proportions ranged from 20% to 30%.

SORL

The complete SORL dataset includes listings posted in King County scraped from multiple websites, including Craigslist, Apartments.com, Trulia, Zillow, and Section 8 Housing. Some sources, such as Trulia and Zillow, have put barriers in place to prevent web scraping and are therefore less represented in our dataset. We chose to only investigate listings scraped from Craigslist because it is the most comprehensive.

To clean the data, we first extracted all Craigslist listings that were posted between January 2017 and December 2022. We then assigned each listing to the appropriate Census tract and HRA based on its respective longitude and latitude coordinates. Next, we filled in missing information about *rent* and *number of bedrooms*. To fill in missing rent information, we searched for text in the listing description that started with a \$ sign, followed by any number of digits. This sometimes yielded multiple values, as it is common for listings to describe other fees in addition to the base rent. We then kept the largest number, assuming this would correspond to the rent. This reduced the proportion of listings with missing rents from 4.57% to 2.23%. To fill in missing bedroom counts, we used a similar process to search for text patterns in the listing description. This reduced the proportion of listings with missing bedroom counts from 1.48% to 0.76%.

Lastly, we removed duplicate listings from the processed data. Listings were considered duplicates if they had the same post id number, number of bedrooms, square footage, and longitude and latitude coordinates (up to

3 decimal places). The resulting data output captures over 800,000 rental listings in King County between January 2017 to December 2022.

Parcel Dataset from the King County Assessor's Property Information Files

The King County Assessor's Property Information Files contains information about the over 620,000 parcels of land in King County. We downloaded this dataset in July 2023 and joined it with a shapefile of [King County Parcels](#) based on common PIN numbers. We aggregated the 128 different parcel categories of land use in the dataset into 22 broader categories, including Retail, Industry, Open Space, and 6 types of residential categories. We also joined this dataset with shapefiles of King County's 2020 HRAs and 2020 Census tracts to identify which geographies within which each parcel lies.

Measures

Migration Measures

We constructed three migration measures on an annual basis: **crude migration probability, area-level migration flows, and area-level migration rates**. Crude migration probability enabled us to derive estimates of the volume of migration activity at the county level, a calculation that was subsequently validated against ACS estimates. To obtain area-level estimates, we calculate annual flows and rates of in-migration and out-migration as well as net migration rates.

Crude Migration Probability

We constructed annual crude migration probability estimates at the household level for 2017-2022. This metric is calculated by dividing the total number of households that moved between two geographic units by the total number of households for a given year. For example, the crude migration probability for King County in 2017 at the tract level was computed as the total number of households that moved across Census tracts, divided by the total number of households in 2017. This measure allows us to capture magnitudes of migration activity at the county level on an annual basis, but it does not differentiate between in- and out-migration.

$$\text{Crude migration probability} = \frac{\# \text{ HHs moved across geographic units}}{\text{Total # HHs}}$$

To calculate the closest ACS equivalent of the crude migration probability, we first subtracted the number of households that live in the same house as they did one year ago (B07001_017) from the total number of households (B07001_001). This provides us with the total number of households who moved in the last year. We then divided this by the total number of households to get a probability. Lastly, we lagged these estimates by one year to match our Data Axle estimates. This is because the ACS asks households whether they moved the year before whereas our Data Axle estimate compares the current year to the year after.

Area-level Migration Flows

Area-level migration flows were examined across ten HRA groupings used by King County in urban planning among other things. This measure allows us to capture the number of households migrating between various origin-destination pairings, but cannot provide insights into the scale of migration - the proportion of households in a given area that migrated.

Area-level Migration Rates

Area-level migration rates can distinguish between in- and out-migration and inform us of the scale of migration. In this project, we examine the in-, out-, and net-migration rates at both the tract and HRA levels. These metrics all share a common denominator: the total number of households in a given geographic area. Their numerators differ, including the total number of households that moved out, the total number of households that moved in, and the difference between these two counts, respectively.

$$\text{Out-migration} = \frac{\# \text{ HHs moved out of given area}}{\text{Total } \# \text{ HHs in given area}}$$
$$\text{In-migration} = \frac{\# \text{ HHs moved into given area}}{\text{Total } \# \text{ HHs in given area}}$$

One limitation of Data Axle is that we cannot distinguish between out-migration and family dissolution, as well as between in-migration and family formation or data acquisition. To address this challenge, we tracked the address changes of each unique family ID. Only family IDs that could be located within King County during the specified focal time frame were treated as migrated families. In other words, the current measure incorporates migration events exclusively within King County, although its scope could potentially be expanded to encompass moves beyond the county borders.

Neighborhood Context Measures

Economic

- **Median rent:** The 50th percentile, or median, of observed asking rents on Craigslist after data cleaning. We break this down by the number of bedrooms.
- **First quartile rent:** The 25th percentile, or first quartile, of observed asking rents on Craigslist after data cleaning. We break this down by the number of bedrooms. We chose to report the first quartile in addition to the median as it is a more relevant benchmark for lower-income households.
- **Percent change in first quartile rent:** The first quartile rent in a given year minus the first quartile rent the previous year, divided by the first quartile rent in the previous year.

Environmental risk

- **Average exposure decile:** We use the measure of Environmental Exposure from the Washington Environmental Health Disparities (EHD) Map ([UW DEOHS & WA DOH, 2022](#)). This measure quantifies pollution burden for each geographical area based on exposure indicators for the following

pollutants: diesel exhaust PM2.5 emissions, ozone, particulate matter 2.5, toxic releases from facilities, and proximity to roadways. The EHD Map categorizes census tracts into deciles scored 1-10, each of which represent 10% of the dataset. The lowest decile is the least impacted by pollutants, while the highest decile is the most impacted.

- **Percent of land in 500-year floodplain:** We use floodplain maps from the Federal Emergency Management Agency (FEMA) to calculate the percentage of land area in each geography that is within the 500-year floodplain. Areas within the 500-year floodplain have a 0.2% or higher annual chance of flooding.

Planning Policy and Land Use

- **Residential land use:** We took into consideration all 27 residential land uses listed in the Parcel data of the Assessor's Property Information Files, and categorized them into: single family, multifamily, middle housing, mobile home, group quarters, and miscellaneous. Then, we calculated the percentage of each category within a Census tract or HRA in terms of (a) the number of lots, and (b) the land area or square footage of land use. In this project, we use:
 - Percent area of multifamily parcels: the total land area of all multifamily parcels divided by the total land area of all residential parcels
 - Percent area of single family parcels: the total land area of all single family parcels divided by the total land area of all residential parcels
 - Percent count of multifamily parcels: the total number of multifamily parcels divided by the total number of residential parcels
 - Percent count of single family parcels: the total number of single family parcels divided by the total number of residential parcels
- **Main school district:** The school district to which most schools within a given Census tract or HRA belong. For example, the Auburn - North HRA includes 19 schools in the Auburn School District and 1 school in the Federal Way School District. We consider Auburn - North's main school district to be Auburn.
- **Percent of land in urban growth area:** The percentage of land area for a given Census tract or HRA that lies inside the urban growth area, within which King County and the region concentrates development.

Amenity access

- **Transit arrivals and stops per square mile:** The density of transit stops and the frequency of transit in a given Census Tract or HRA. Transit stops include those serviced by King County Metro buses and RapidRide buses, the Seattle Streetcar, Sound Transit Express buses, Link light rail, and Sounder heavy rail.
- **Percent area of open space:** The proportion of a Census Tract or HRA that is open space, based on tax parcel data from the Parcel dataset of King County Assessor's Property Information Files.

- **Healthcare parcels per square mile:** The density of medical, dental, and hospital parcels in a given Census Tract or HRA. This is based on tax parcel data from the Parcel dataset of King County Assessor's Property Information Files.

Findings

Data Representativeness

To assess how well the Data Axle data represent the population of King County, we compared the total number of households by tenure in 2021 using ACS and Data Axle².

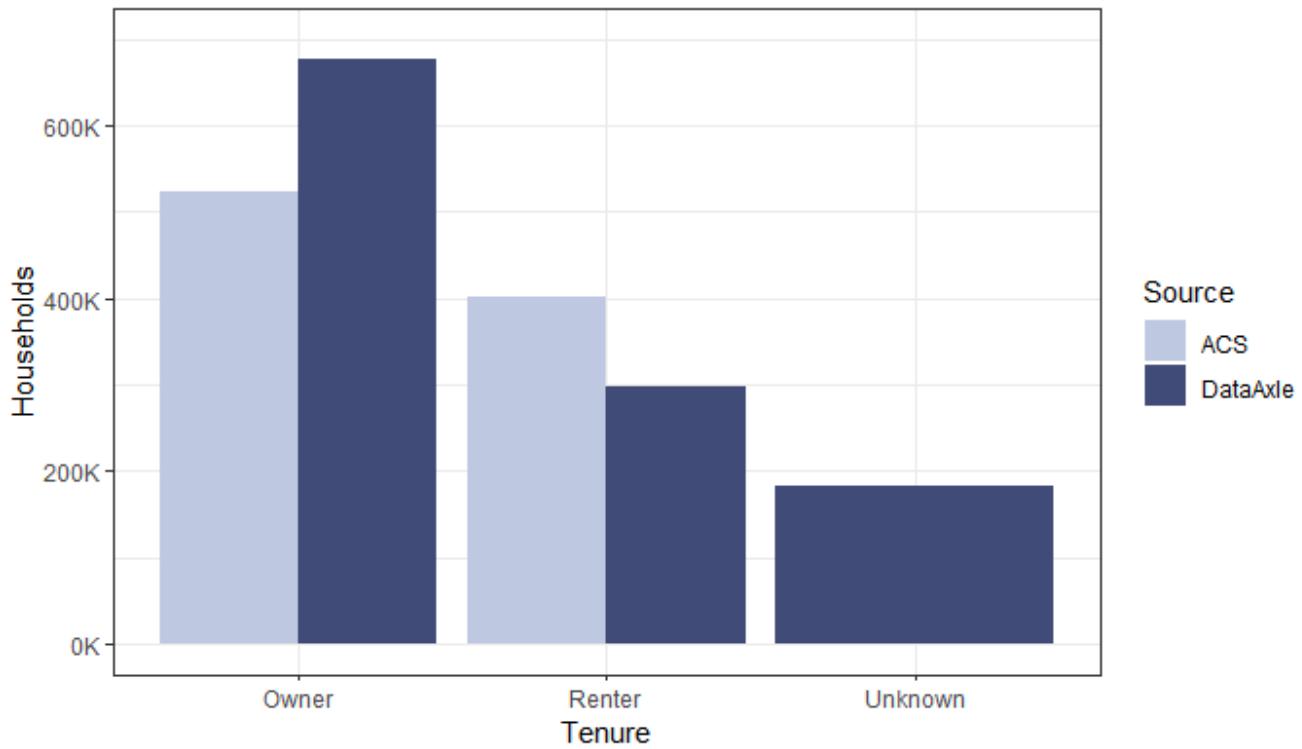


Figure 2. Comparison of unique households or families by housing tenure (2021, Data Axle and ACS).

This figure shows ACS estimates of the number of King County households by tenure (light blue), and the number of unique family IDs in King County observed by Data Axle by housing tenure (dark blue).

This comparison reveals two insights:

1. **Homeowners are over-represented, while renters are under-represented in Data Axle.** This is consistent with what we know about Data Axle - households that are financially stable are more likely to possess consumer profiles and thus are more likely to be included in the database.

² We specifically focused on tenure because this variable is one of the most reliable variables from Data Axle, based on the fact that it is self-reported for many households and our meeting with stakeholders Dr. Arthur Acolin (UW Department of Real Estate) and Ari Decter-Frain (Cornell University) who have extensively used Data Axle and are co-authors of Table 1

2. **The total number of households in Data Axle is much larger than that in ACS.** The tenure variable in Data Axle is either self-reported or imputed, which introduces an additional "Unknown" category not present in ACS. Moreover, households are defined differently between ACS and Data Axle. In ACS, households are defined as those who occupy the same housing unit, whereas in Data Axle, households are more akin to families or relational households, where multiple families can share a single housing unit.

We also consulted with migration researchers Dr. Arthur Acolin (UW Department of Real Estate) and Ari Dechter-Frain (Cornell University) who have extensively used Data Axle, to understand other advantages and drawbacks of using Data Axle. We determined the following:

1. **Data Axle data is more accurate for short distance moves than long distance moves.** Moreover, Data Axle only covers households in the U.S. and cannot be used to measure international immigration.
2. **Most household demographic attributes are unreliable.** Data Axle imputes its measures of race and ethnicity, age of household head, and purchasing power. This means that disaggregated results, such as looking at migration by household race or household socioeconomic status, is not recommended.

County-level Migration

1. **Our estimates of internal migration from Data Axle are much more dynamic than those estimates provided by ACS.** We see a spike in 2018-2019, followed by a sharp drop in 2020 during the COVID-19 pandemic, and signs of increasing movement again in 2021.
2. **Rent trajectories show a small dip in prices in 2020 for smaller units (0-2 bedrooms), but quickly recovered.** Post-2020, prices quickly recovered and have even increased compared to pre-2020.

What proportion of households are moving between areas within King County?

In Figure 3, we show annual estimates of crude migration probability calculated from Data Axle at the HRA (light blue) and Census tract (dark blue) levels. The estimates for HRAs and Census tracts have the same shape, showing a slight decrease in observed migration activity through 2019, followed by a sharp uptick in 2020 that is likely attributable to the COVID-19 pandemic, and then a subsequent decrease in 2021. However, the estimates at the Census tract level are consistently higher than those for HRAs.

We compare crude migration probability estimates from Data Axle to the closest analog that can be calculated from the ACS. As previously mentioned, this variable (from table B07001) estimates the number of households that moved residences in the last calendar year. Theoretically, we would expect the crude migration probability at the residence or housing unit level to be larger in magnitude than estimates at the Census tract level. However, Figure 3 shows that these estimates lie well above the level of the crude migration probability at the HRA level observed in Data Axle. This suggests that our estimates from Data Axle are biased downward, which may be due to the over-representation of homeowners and those who are

not moving. The ACS estimates show similar decreasing trends to estimates from Data Axle up to 2019, but show no changes in rates of movement by King County households since then. Though the ACS is a household survey that is representative of the population, it also suffers from lower response rates for households that are likely to move and suffered serious non-response rates in the 2020 wave. It is unclear whether one should trust the stagnant estimates from the ACS over the changes observed in Data Axle that fall in line with expectations of a decline in migration activity at the height of the COVID-19 pandemic and the imposition of the eviction moratorium ([CDC & HHS, 2020](#)).

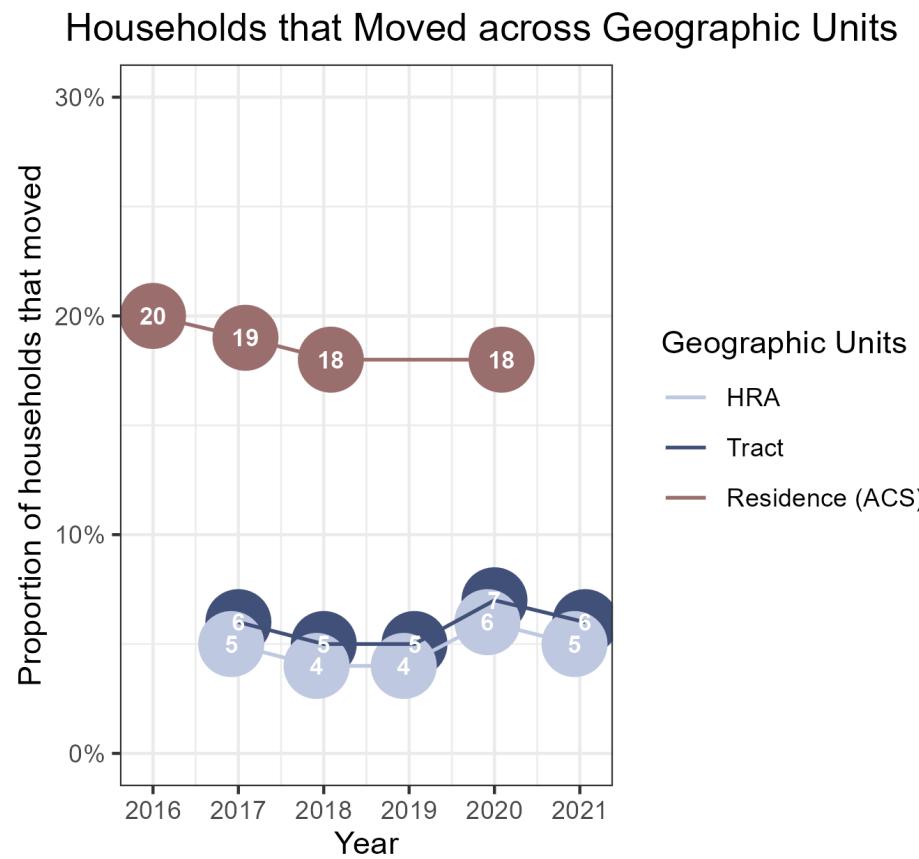


Figure 3. Estimates of King County crude migration probabilities (2016-2021, Data Axle and ACS).

Annual crude migration probabilities at the HRA level observed in Data Axle (light blue). Annual crude migration probabilities at the Census tract level observed in Data Axle (dark blue). Annual crude migration probabilities at the housing unit or residence level estimated from the ACS (red).

In the right panel of Figure 4, we estimate crude migration probabilities at the Census tract level from Data Axle by the age of the head of household. Age group of the head of household is model-based for most households, and the accuracy of this imputation is unknown. However, the data sources that comprise Data Axle would suggest that households with older heads of household are more likely to be well-represented as they are less likely to move or experience big changes in family structure due to children leaving the

household. For these reasons, we expect, *a priori*, that crude migration probabilities estimated from Data Axle for older individuals to be lower than for other age groups and to more closely resemble estimates from the ACS. Focusing only on the right panel of Figure 4, we do, indeed, see that the crude migration probability is lower for households with a head aged 65+ than for those with household heads aged 25-44 or 45-64. It is much larger than for heads of households aged 18-24. However, the values at all ages are much lower than the rates observed in the ACS.

The left panel of Figure 4 shows estimates of the crude migration probabilities from the ACS. The ordering of crude migration probabilities by age groups is the same as that observed in Data Axle. However, estimates for all age groups from the ACS lie far above the corresponding estimate from Data Axle, which is, again, at least partly explained by the fact that households who do not move are most likely to be represented in Data Axle. Additionally, the numerator and denominator differ quite a bit from Data Axle, as these are calculated using the number of individuals in each age group that moved residences in the last year.

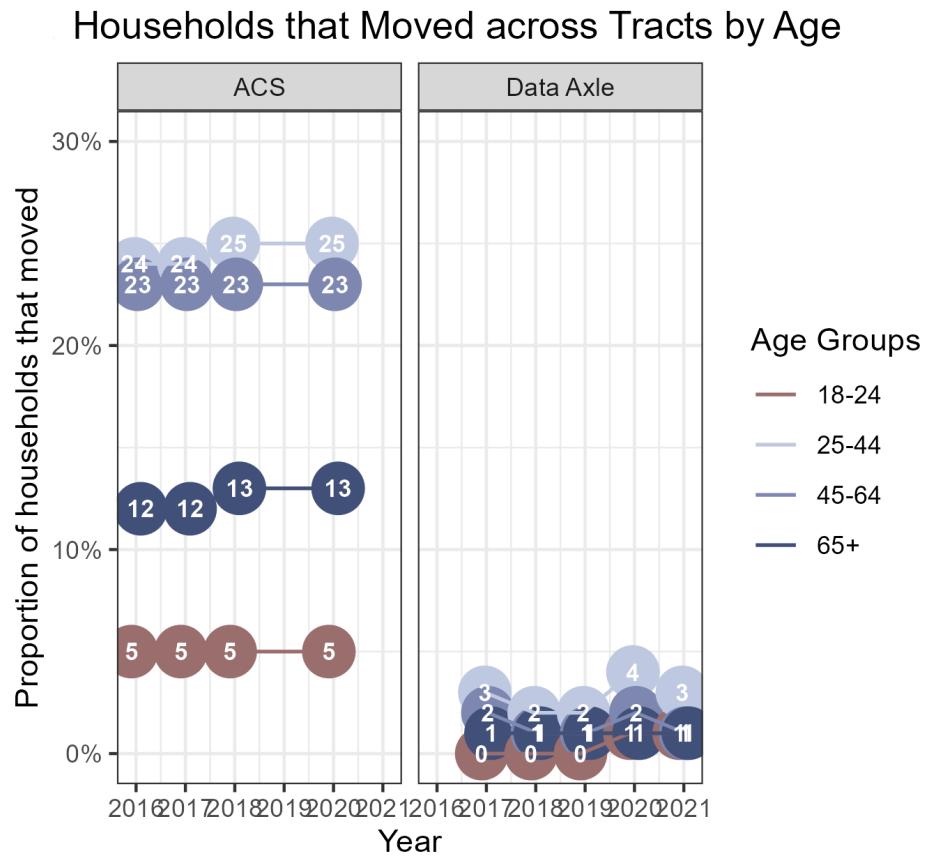


Figure 4. Estimates of King County crude migration probabilities by age group (2016-2021, Data Axle and ACS). Left: Annual crude migration probabilities at the Census tract level for individuals estimated from the ACS. **Right:** Annual crude migration probabilities at the Census tract level for households observed in Data Axle.

Finally, we compare estimates of the crude migration probability by household tenure. Recall, tenure is the one household characteristic that is predominantly self-reported in Data Axle. As such, we expect it to be more reliable than age and may be more aligned with estimates from ACS. On the other hand, we know that the total number of owner-occupied households in Data Axle is larger than in the ACS and the number of renter-occupied households is too small.

Focusing first on the right panel of Figure 5, we see that within Data Axle the crude migration probability for all households is low, with renters slightly higher than homeowners. The crude migration probabilities observed in Data Axle for renters are around one-tenth of those estimated from Data Axle. Taking these results in tandem with Figure 2, we can conclude that not only are renters under-represented in Data Axle, but those renters we do observe must be those who are less likely to move. Focusing on the Data Axle estimates for owner-occupied households, we find again that, though they are over-represented in absolute numbers, Data Axle is still not capturing homeowners who move..

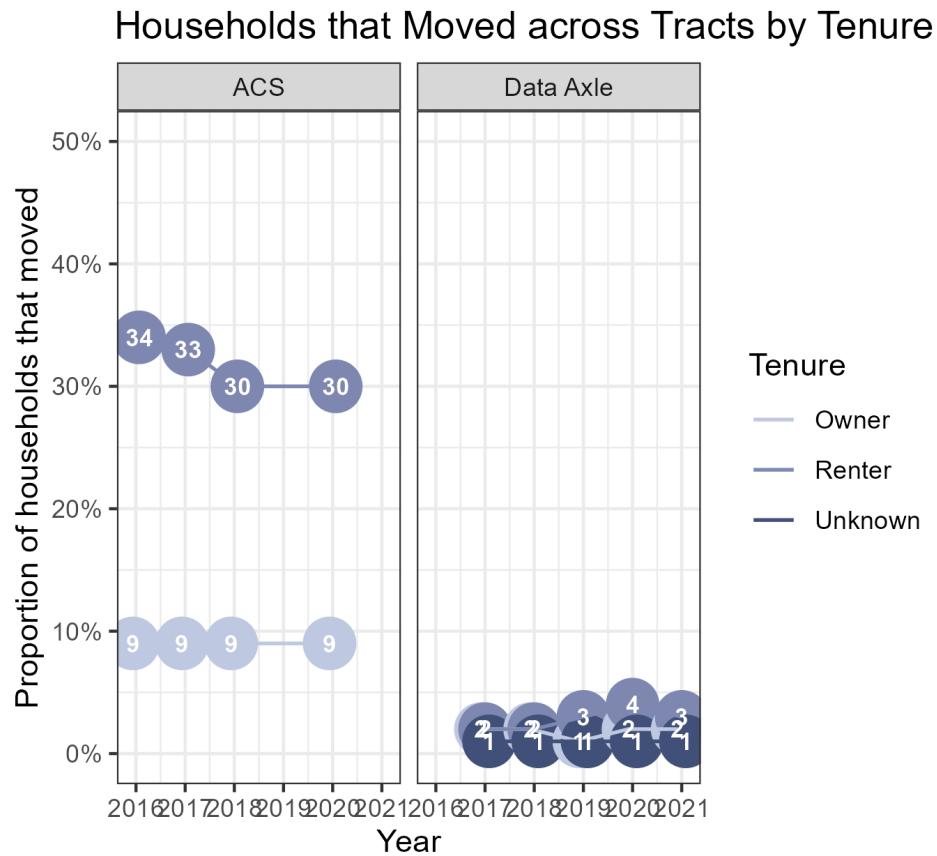


Figure 5. Estimates of King County crude migration probabilities by housing tenure (2016-2021, Data Axle and ACS). **Left:** Annual estimates of crude migration probabilities for households by tenure from the ACS. **Right:** Annual estimates of crude migration probabilities for households by tenure observed in Data Axle.

How have rental prices changed over time?

Rental pricing can both affect household decisions to migrate and be affected by migration activity. In this section, we look at changes in Craigslist rental pricings in King County for 2017-2022.

In Figure 6, we plot the median Craigslist asking rent by number of bedrooms from 2017-2022. We see that asking rents were generally stable or slightly increasing in the years prior to the COVID-19 pandemic. In 2020, rents dipped, but this was only the case for studios, 1-bedroom (1BR) and 2-bedroom (2BR) units. This might be explained by households who moved during the height of COVID-19 pandemic restrictions in search of more space. We suspect that as demand for these smaller units fell, so did rent prices. Accordingly, we see that rents for larger units were seemingly unaffected and continued their pre-2020 trajectory. Post-2020, rents have quickly recovered and in some cases, surpassed their pre-2020 prices.

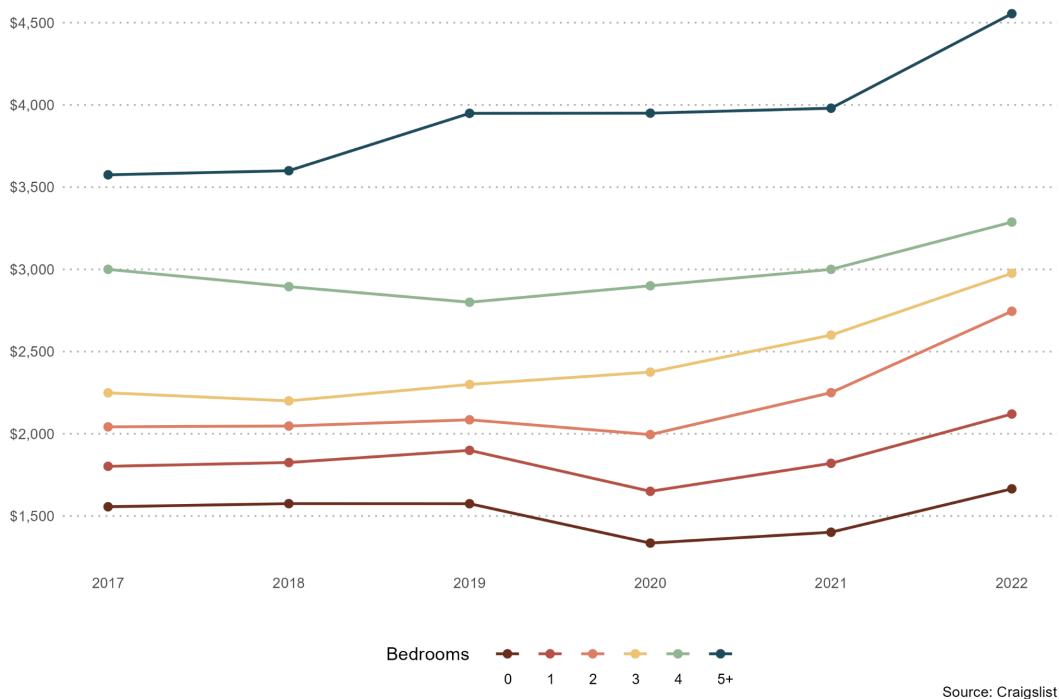


Figure 6. Median asking rent by number of bedrooms (2017-2022, Craigslist).

However, given growing income inequality in King County, we suspect that changes in the median rent price may not reflect changes in rental pricing of units occupied by individuals and households on the lower tail of the King County's income distribution. Thus, in Figure 7, we show changes in the first quartile of Craigslist rents.

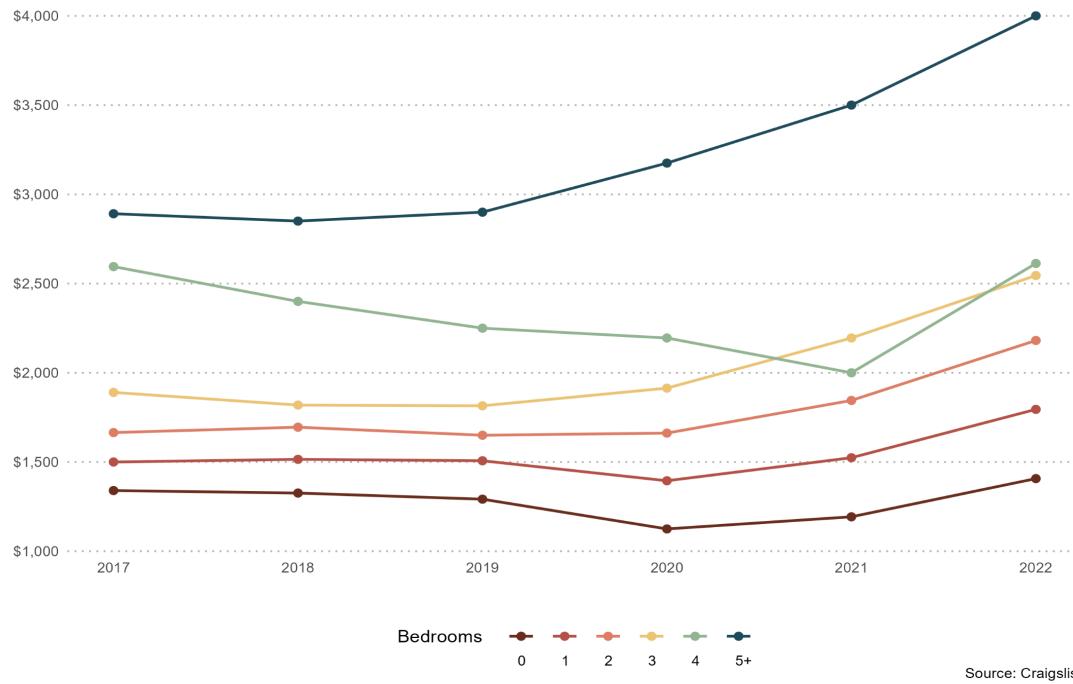


Figure 7. First quartile asking rent by number of bedrooms (2017-2022, Craigslist).

We see that the pattern largely follows the median asking rent trajectory with a small dip in prices in 2020 amongst smaller units, followed by a quick recovery post-2020. Interestingly, 4-bedroom (4BR) units were continually on a downward trajectory from 2017 to 2021. One potential explanation is that 4BR are more likely to be single family homes rather than apartments. The vast majority of newly constructed single family homes in the county are 4+ BRs ([ARFP Report, 2022](#)). It is possible that this increased supply has helped cool down first quartile 4BR rents while larger 5+ BR listings are far more expensive and less affected by the increased supply.

Area-level results

1. **Most internal migration is hyperlocal.** Most internal migration appears to be happening within the same HRA or between neighboring HRAs.
2. **Most internal migration is happening within and between Central Seattle, North Seattle, and Eastside HRAs.** Unsurprisingly these HRAs have the largest populations. They also generally comprise higher income and higher resource neighborhoods.
3. **Changes in rent do not seem to clearly precede out-migration.** Over our study period, we found weak correlations between percent change in rent and out-migration rates at the Census tract-level.

In Figures 8 and 9, we visualize migration flows between the 10 HRA groupings, Pierce County, Snohomish County and all other counties in Washington (denoted WA). We do not show estimates for internal migration within the latter three geographies. Tiles are colored such that darker tiles correspond to higher migration flows. Across the years we can see that the darkest tiles are typically along the diagonal, indicating that the highest volume of migration is actually *within* HRA groupings. Other pairs with high migration volumes appear to be between adjacent HRA groupings, such as between Central Seattle and North Seattle. Finally, we see a strong migrational relationship between Auburn-Federal Way and Pierce County and between North Seattle and Snohomish County.

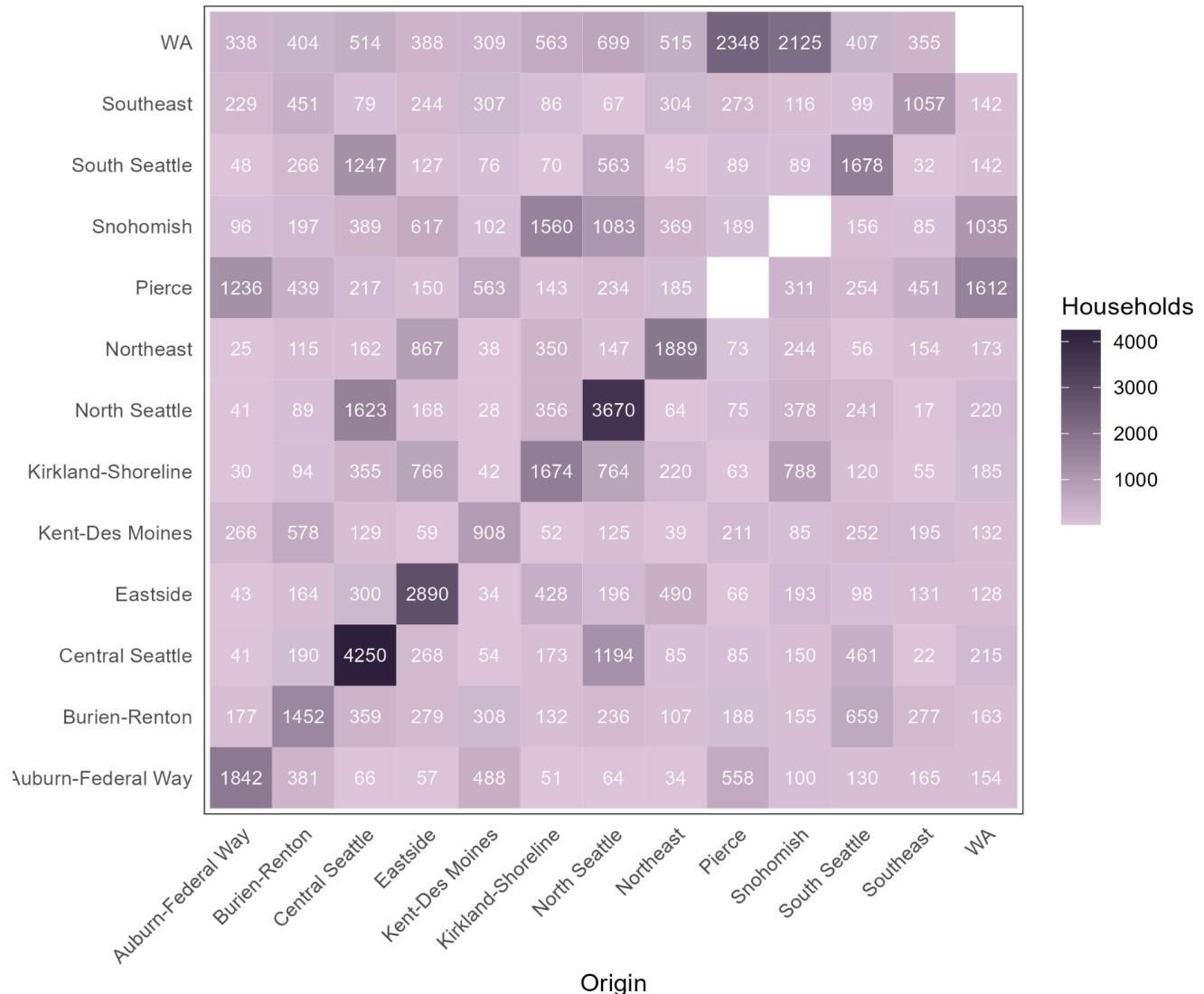


Figure 8. Migration flows between HRA groupings (2017, Data Axle). Numbers depict observed migration flows between pairs of HRA groups with the x-axis representing origins and y-axis representing destinations. Darker tiles correspond to greater migration flows. See Appendix for all years.

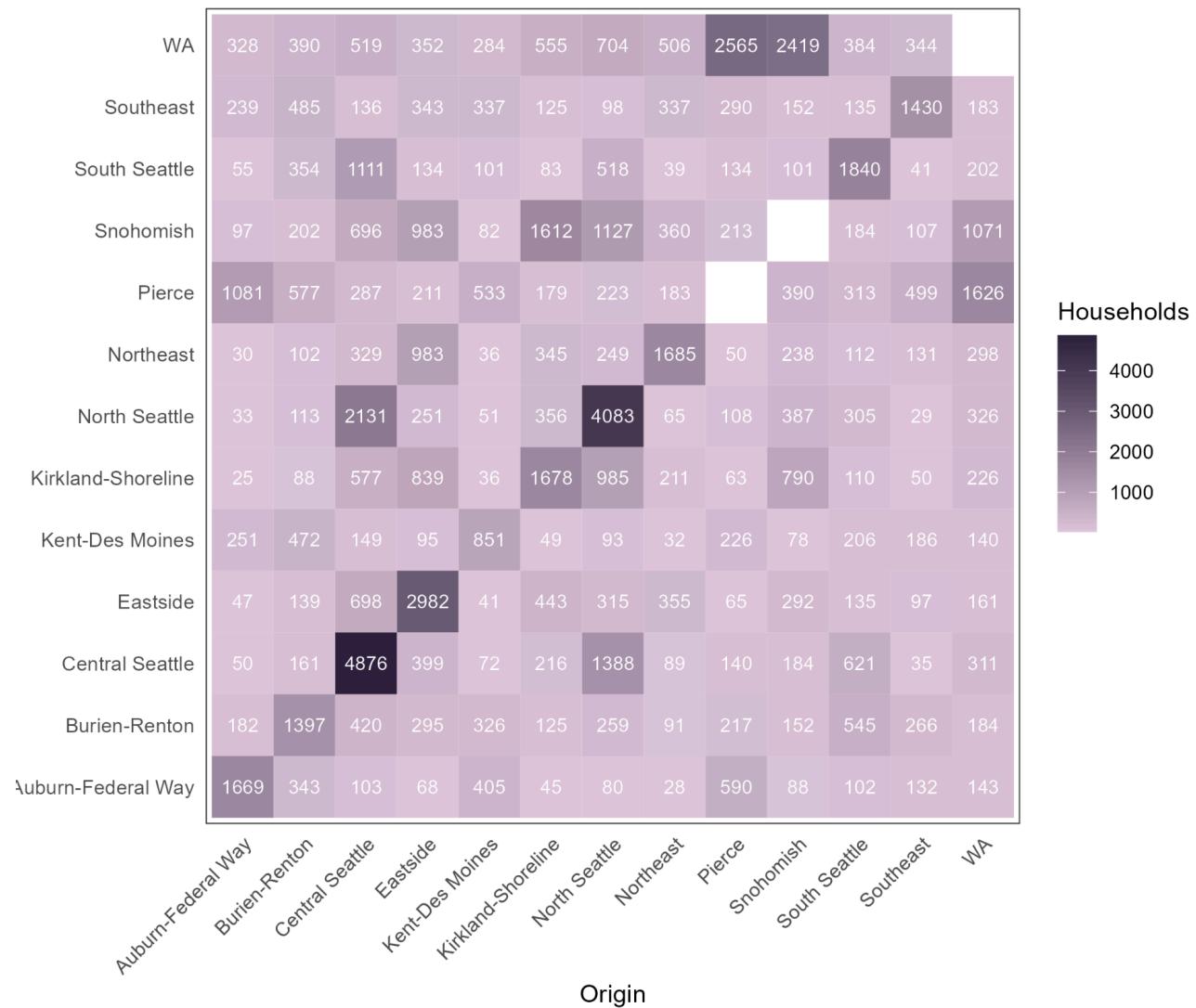


Figure 9. Migration flows between HRA groupings (2021, Data Axle). Blocks depict observed migration flows between pairs of HRA groups with the x axis representing origins and y axis representing destinations. Darker tiles correspond to greater migration flows

Are out-migration rates correlated with changes in rent?

In Figures 10-13, we visualize each tract's percent change in rent against its out-migration rate estimated from Data Axle. We constructed these such that the percent change in rent is in comparison to the year before, expecting that a change in rent would precede out-migration.

Across the years, we do not see a clear relationship between percent change in rent and out-migration rates. This is likely due to Data Axle's under-representation of renter-occupied households.

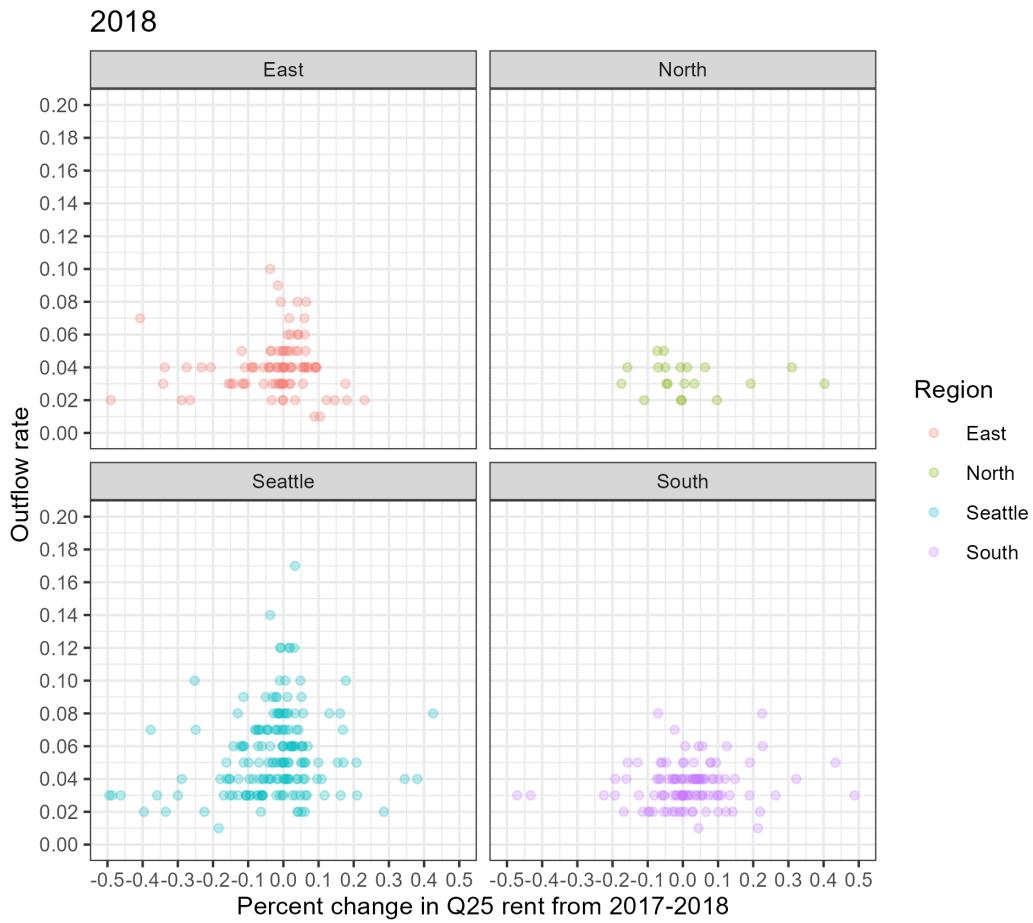


Figure 10. Out-migration rates and percent change in the 25th percentile of asking rent at the Census tract-level (2018, Data Axe and Craigslist). Census tracts are assigned to one of the four King County regions based on the location of their centroids. See Appendix for all years and plots with outliers.

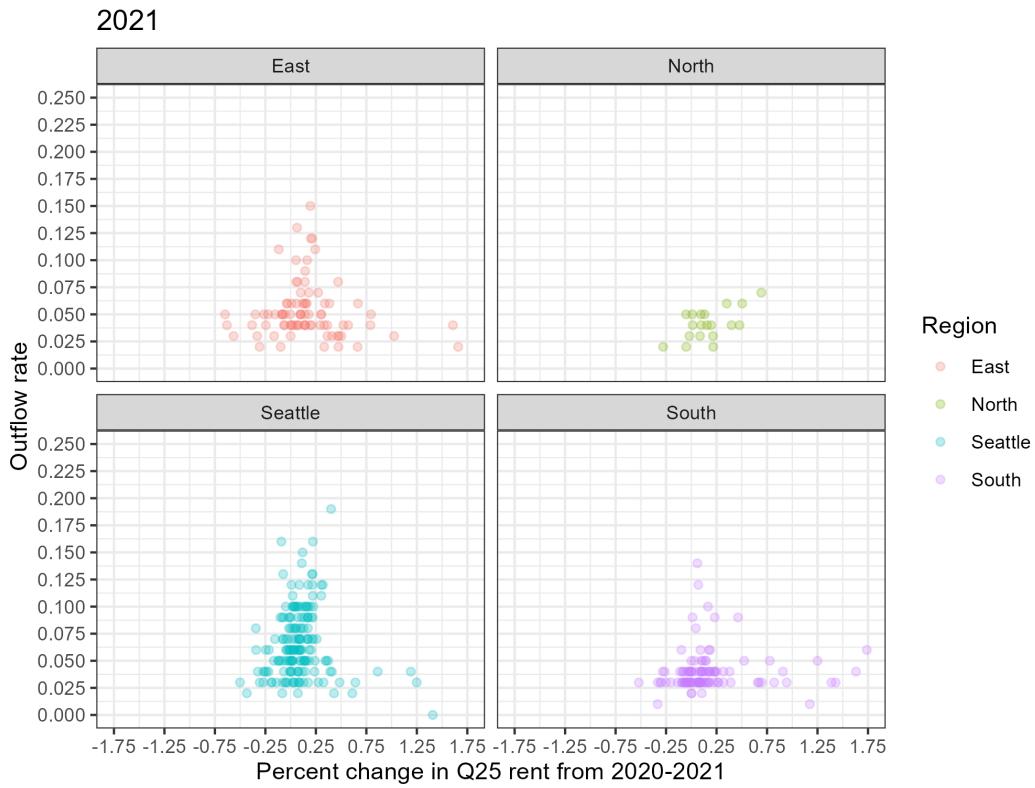


Figure 11. Out-migration rates and percent change in the 25th percentile of asking rent at the Census tract-level (2021, Data Axe and Craigslist). Census tracts are assigned to one of the four King County regions based on the location of their centroids. See Appendix for all years and plots with outliers.

Zooming in on Seattle and South Seattle, Figures 12 and 13 plot the information as in the bottom two panels of Figures 10 and 11, but now colors represent the HRA grouping to which each tract belongs. We can see that most of the variation in out-migration in Seattle is driven by HRA grouping differences with Central Seattle seeing generally higher rates of out-migration and South Seattle seeing lower rates of out-migration. In South King County, out-migration is less stratified by HRA grouping.

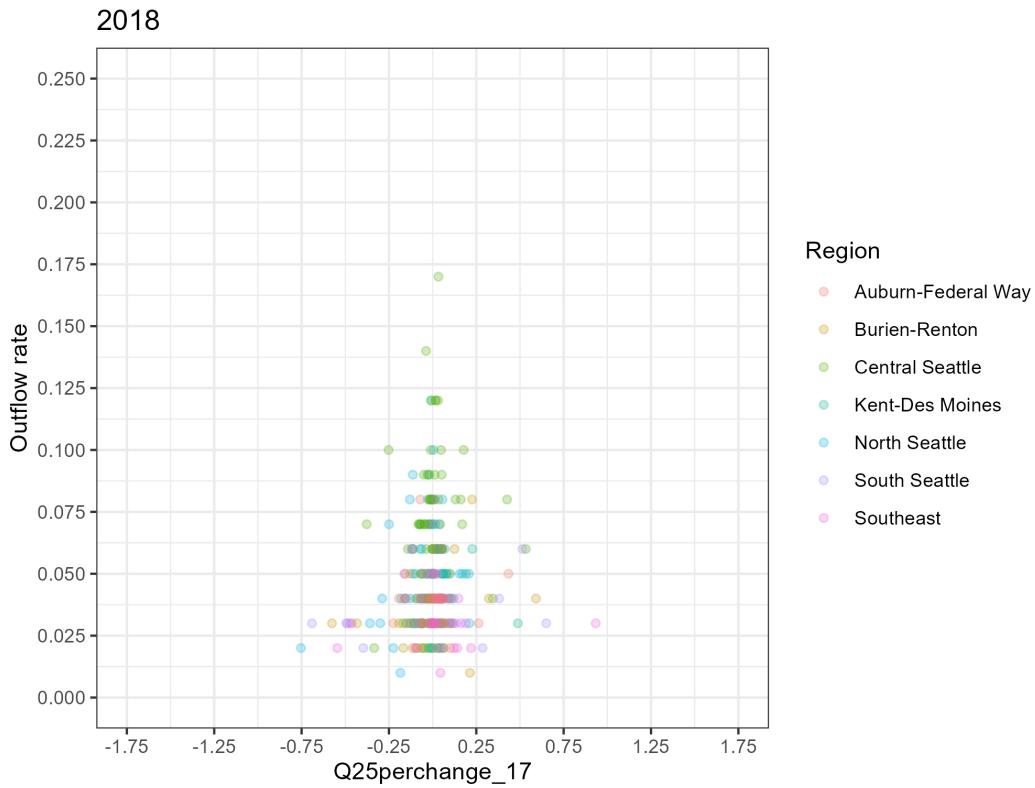


Figure 12. Out-migration rates and percent change in the 25th percentile of asking rent at the Census tract-level by HRA grouping in Seattle and South King County (2018, Data Axe and Craigslist). Census tracts are assigned to HRA groupings based on the location of their centroids. 1 tract outlier is hidden. We consider tracts that saw greater than 150% increase in 1Q rent to be outliers. See Appendix for all years and plots with outliers.

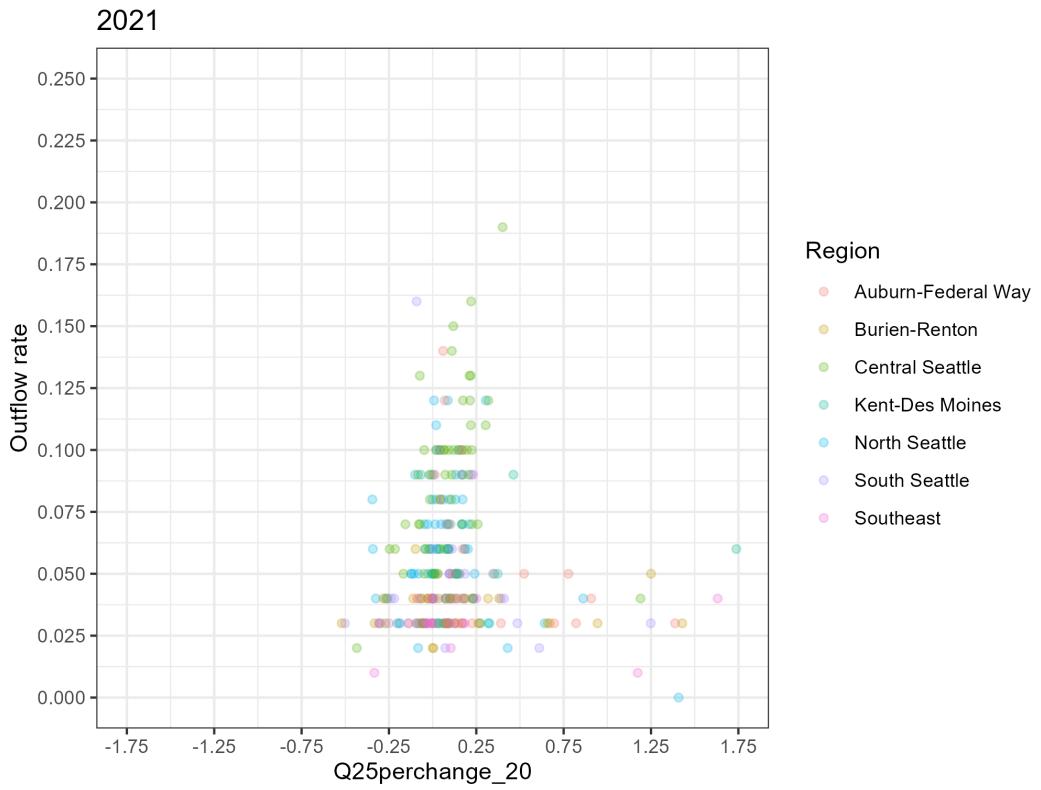


Figure 13. Out-migration rates and percent change in the 25th percentile of asking rent at the Census tract-level by HRA grouping in Seattle and South King County (2021, Data Axle and Craigslist). Census tracts are assigned to HRA groupings based on the location of their centroids. 13 outliers are hidden. We consider tracts that saw greater than 150% increase in 1Q rent to be outliers. See Appendix for all years and plots with outliers.

Case Studies

Next, we present three case studies of specific HRAs. In King County, we often hear the narrative that individuals and households are being displaced southward from the city of Seattle. For our case studies, we chose three HRAs that could have potentially reflected this pattern.

- 1. Seattle - Central District, Chinatown-International District, Judkins, and North Beacon Hill.** This HRA has historically been home to communities of color. In focusing on this HRA, we aim to learn whether residents are tending to move away from the center of the city, particularly southward.
- 2. Seattle - Rainier Valley and Rainier Beach.** Rainier Valley and Rainier Beach (RVRB) is a canonical example of a neighborhood experiencing gentrification. It has one of the highest proportions of Black and low-income residents in Seattle. Do the data show a high level of in-migration from the north and out-migration to the south?
- 3. Auburn - North.** We consider whether Auburn - North receives much migration from the city of Seattle. We also focus on Auburn - North as an example of an HRA outside Seattle city limits and where we observe movement to and from Pierce County and other WA counties.

For each of our case studies, we present a more in-depth comparison between the case study HRA and its most common sending and receiving HRAs. We also consider migration to and from three other geographic areas: Pierce County, Snohomish County, and all other counties in Washington. Our results describe where households are moving from and moving to, however, they cannot speak directly to *why* households are moving. We can only look at associations between migration patterns and the characteristics of those origin and destination areas.

Central District, Chinatown-International District, Judkins, N Beacon Hill

We consider the Seattle - Central District, Chinatown-International District, Judkins, N Beacon Hill HRA. This HRA contains the Central District (CD) and the Chinatown-International District (CID), which have historically been home to Black and Asian American and Pacific Islander communities in Seattle, respectively.

Where are outgoing CD, CID, Judkins, N Beacon Hill households moving to?

In 2017, the top five receiving HRAs from CD, CID, Judkins, N Beacon Hill were: Rainier Valley and Rainier Beach, Capitol Hill, West Seattle, Montlake, Madison Park, and Madrona, and Downtown, Belltown and First Hill. Throughout the study period, this list of top 5 receiving HRAs stayed relatively consistent. The main change over time is that in 2019, 2020, and 2021, other Washington counties were part of the list, replacing West Seattle. Since our study identified moves to and from Pierce and Snohomish Counties, “other Washington counties” refers to all counties in Washington State aside from King, Pierce, and Snohomish counties. As shown in Figure 19, these HRAs were spread throughout the city of Seattle, though the three that received the most households over the study period of 2017-2021 were the close-by HRAs of RVRB, Capitol Hill, and Montlake, Madison Park, and Madrona.

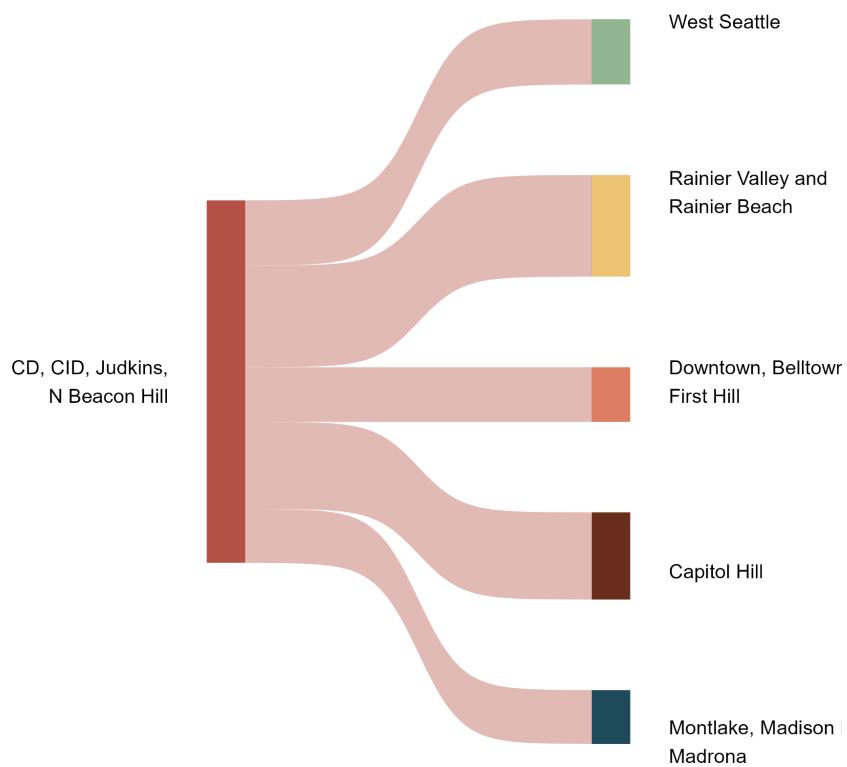


Figure 14. Top receiving HRAs for Seattle - CD, CID, Judkins, N Beacon Hill (2017, Data Axle). Right: Sankey diagram depicting top five receiving HRAs to CD, CID, Judkins, N Beacon Hill. The height of each colored bar corresponds to the relative proportion contributed by each HRA. See Appendix for other years' diagrams.

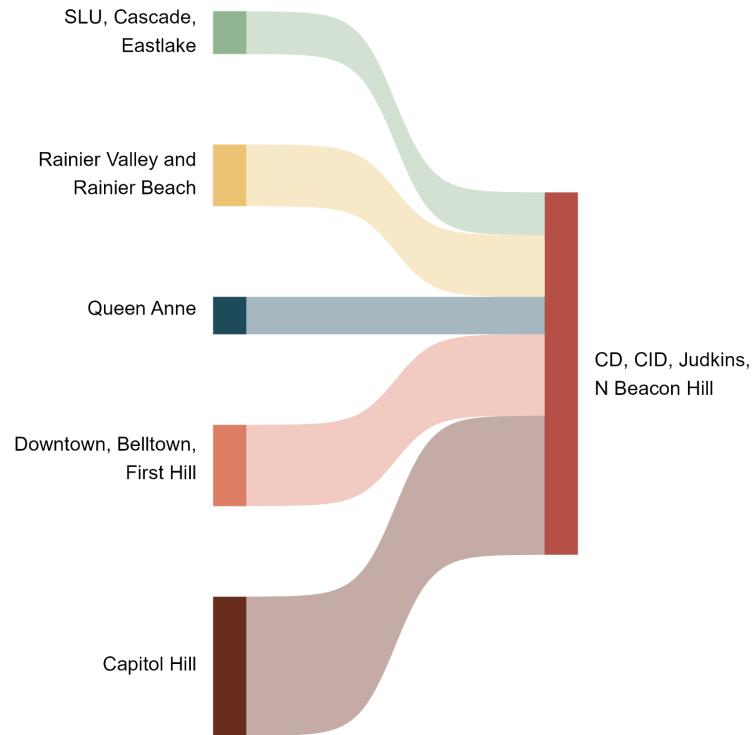


Figure 15. Top Sending HRAs for Seattle - CD, CID, Judkins, N Beacon Hill (2021, Data Axle). Left: Map of Seattle - CD, CID, Judkins, N Beacon Hill (blue) and top five receiving HRAs (yellow). Right: Sankey diagram depicting top five receiving HRAs to CD, CID, Judkins, N Beacon Hill. The height of each colored bar corresponds to the relative proportion contributed by each HRA. See Appendix for other years' diagrams.

Where are arrivals to CD, CID, Judkins, N Beacon Hill households moving from?

As shown in Figure 15, the top five sending HRAs to CD, CID, Judkins, N Beacon Hill in 2021 were: (1) Capitol Hill (2) Downtown, Belltown, First Hill, (3) Rainier Valley and Rainier Beach, (4) South Lake Union, Cascade, Eastlake, and (5) Queen Anne. This pattern holds true for most of the study period, except that the Montlake, Madison Park, and Madrona HRA was part of the top 5 list in 2017 and 2018. As shown in Figure 15, these sending HRAs were mostly in the north part of Seattle, with the exception of Rainier Valley and Rainier Beach.

How have rent prices changed in the CD, CID, Judkins, N Beacon Hill HRA compared to its top sending and receiving HRAs?

In Figure 16, we show the first quartile of observed asking rents of 2BR listings in Central District, Chinatown-International District, Judkins, and North Beacon Hill (dark blue) compared to its top receiving HRAs. We focus on 1BR listings.

From 2017-2020, the CD, CID, Judkins, and N Beacon Hill dropped from the middle of the group in 2017, to next to last in 2020, in 2022 the CD, CID, Judkins, and North Beacon Hill was well below its top receiving or sending areas..

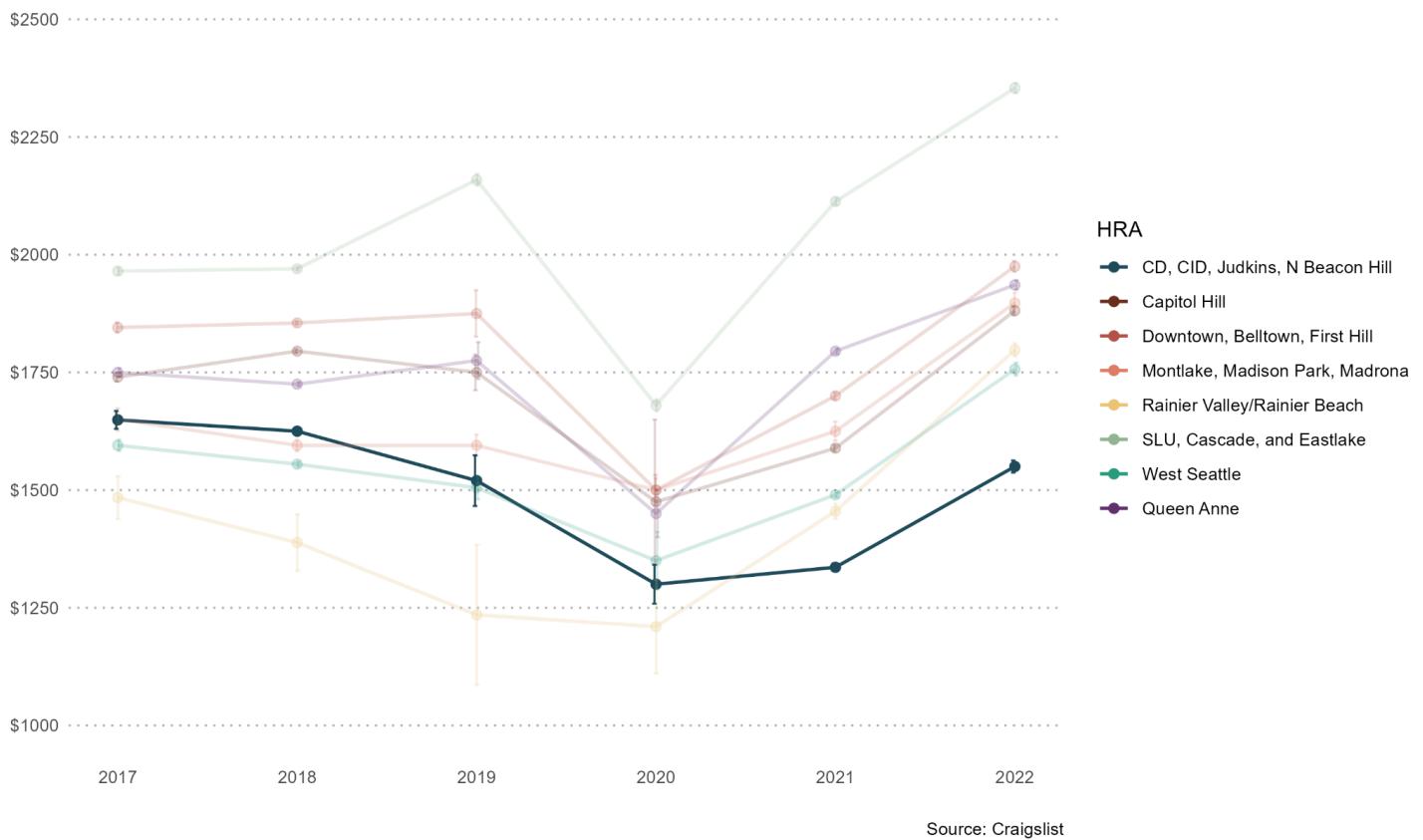


Figure 16. 25th percentile of asking rents for CD, CID, Judkins, N Beacon Hill and its top 2017 receiving HRAs (2017-2022, Craigslist). Error bars represent sample standard deviations.

How does environmental risk in the Seattle - CD, CID, Judkins, N Beacon Hill HRA compare to its sending and receiving HRAs?

Table 2 shows that CD, CID, Judkins, N Beacon Hill and its sending and receiving HRAs all have moderately high decile scores on Washington's Environmental Health Disparities Map, ranging from 6.3 to 8.3 out of 10. Compared to its sending and receiving areas, CD, CID, Judkins, N Beacon Hill has the second-lowest score at

6.4. CD, CID, Judkins, N Beacon Hill and its sending and receiving areas all have little land area within the 500-year floodplain. West Seattle has the highest percentage of land in the floodplain at 0.5%.

How does planning and land use in the Seattle - CD, CID, Judkins, N Beacon Hill HRA compare to its sending and receiving HRAs?

In Table 3, we see that CD, CID, Judkins, N Beacon Hill has a low-to-average concentration of multifamily and single-family housing compared to its sending and receiving areas. CD, CID, Judkins, N Beacon Hill and its sending and receiving areas are all in the Seattle School District and are all within the urban growth area.

How does amenity access in the Seattle - CD, CID, Judkins, N Beacon Hill HRA compare to its sending and receiving HRAs?

In Tables 4 and 5, we see that CD, CID, Judkins, N Beacon Hill has a relatively high concentration of transit stops and the highest percentage of open space compared to its sending and receiving areas. CD, CID, Judkins, N Beacon Hill has an average concentration of healthcare compared to its sending and receiving areas.

HRA	Sending/Receiving	Average Exposure Decile	% of Land in 500-Year Floodplain
Seattle - Central District, Chinatown-International District, Judkins, and North Beacon Hill		6.4	0.0%
Seattle - Capitol Hill	Receiving only	7.5	0.0%
Seattle - Downtown, Belltown, and First Hill	Receiving mostly	8.3	0.1%
Seattle - Rainier Valley and Rainier Beach	Receiving mostly	7.0	0.0%
Montlake, Madison Park, and Madrona	Sending, receiving	6.3	0.0%
Seattle - West Seattle	Sending, receiving	6.7	0.5%
Seattle - Queen Anne	Sending only	7.0	0.0%
Seattle - South Lake Union, Cascade, and Eastlake	Sending only	8.3	0.0%

Table 2. Environmental risk factors: environmental exposure and percentage of land in 500-year floodplain of Seattle - CD, CID, Judkins, N Beacon Hill and its top sending and receiving HRAs (2023, WA Environmental Health Disparities Map, [FEMA 500-Year Floodplain in King County](#)).

HRA	Sending/Receiving	% Area of Multifamily Housing	% Count of Multifamily Housing	% Area of Single Family Housing	% Count of Single Family housing
Seattle - Central District, Chinatown-International District, Judkins, and North Beacon Hill		17.9%	5.9%	62.9%	56.3%
Seattle - Capitol Hill	Receiving only	38.8%	21.1%	50.6%	51.9%
Seattle - Downtown, Belltown, and First Hill	Receiving mostly	75.0%	44.6%	6.9%	14.2%
Seattle - Rainier Valley and Rainier Beach	Receiving mostly	5.8%	1.4%	89.5%	87.1%
Montlake, Madison Park, and Madrona	Sending, receiving	8.4%	3.6%	84.9%	79.6%
Seattle - West Seattle	Sending, receiving	6.2%	3.2%	88.5%	83.8%
Seattle - Queen Anne	Sending only	25.7%	11.0%	61.5%	65.9%
Seattle - South Lake Union, Cascade, and Eastlake	Sending only	68.5%	41.6%	21.3%	21.1%

Table 3. Planning policy and land use factors: residential land use of CD, CID, Judkins, N Beacon Hill and its top sending and receiving HRAs (2023, [Assessor's Property Information Files](#)).

HRA	Sending/Receiving	Main School District	% of Land in Urban Growth Area
Seattle - Central District, Chinatown-International District, Judkins, and North Beacon Hill		Seattle	100%
Seattle - Capitol Hill	Receiving only	Seattle	100%
Seattle - Downtown, Belltown, and First Hill	Receiving mostly	Seattle	99%
Seattle - Rainier Valley and Rainier Beach	Receiving mostly	Seattle	99%
Montlake, Madison Park, and Madrona	Sending, receiving	Seattle	96%
Seattle - West Seattle	Sending, receiving	Seattle	98%

Seattle - Queen Anne	Sending only	Seattle	98%
Seattle - South Lake Union, Cascade, and Eastlake	Sending only	Seattle	97%

Table 4. Planning policy and land use factors: main school district and percentage of land in urban growth area of Seattle - CD, CID, Judkins, N Beacon Hill and its top sending and receiving HRAs (2023, [Assessor's Property Information Files](#), [Urban Growth Area](#)).

HRA	Sending/Receiving	Transit Arrivals per Square Mile	Transit Stops per Square Mile	% Area of Open Space	Healthcare Parcels per Square Mile
Seattle - Central District, Chinatown-International District, Judkins, and North Beacon Hill		17,530	152.7	4.3%	3.8
Seattle - Capitol Hill	Receiving only	15,642	175.2	3.6%	11.8
Seattle - Downtown, Belltown, and First Hill	Receiving mostly	46,456	99.9	0.6%	6.64
Seattle - Rainier Valley and Rainier Beach	Receiving mostly	7,595	55.1	3.6%	1.9
Montlake, Madison Park, and Madrona	Sending, receiving	6,142	51.3	1.2%	0.4
Seattle - West Seattle	Sending, receiving	3,399	25.4	0.4%	0.7
Seattle - Queen Anne	Sending only	13,441	154.1	0.8%	2.2
Seattle - South Lake Union, Cascade, and Eastlake	Sending only	25,965	169.5	1.9%	17.6

Table 5. Amenities: transit arrivals per square mile, transit stops per square mile, percent area of open space, and healthcare parcels per square mile of Seattle - CD, CID, Judkins, N Beacon Hill and its top sending and receiving HRAs (2023, [Assessor's Property Information Files](#)).

Rainier Valley and Rainier Beach

In our final case study, we focus on the Seattle - Rainier Valley and Rainier Beach HRA (RVRB) as a canonical example of a **gentrifying neighborhood**. Rainier Beach has one of the highest proportions of Black and low-income residents in Seattle. It also contains three Light Rail stops within its boundaries (Columbia City, Othello, Rainier Beach), making it a highly attractive place to live. In our analysis, we look at where RVRB households are both moving from and moving to.

Where are incoming RVRB households moving from?

Figure 17 shows the top five sending HRAs for RVRB in 2017 and 2021. While there is some change, generally we see consistency in RV/RB's sending areas between 2017-2021, and the CD, CID, Judkins, and N Beacon Hill and the Capitol Hill HRAs are consistently the largest flows.

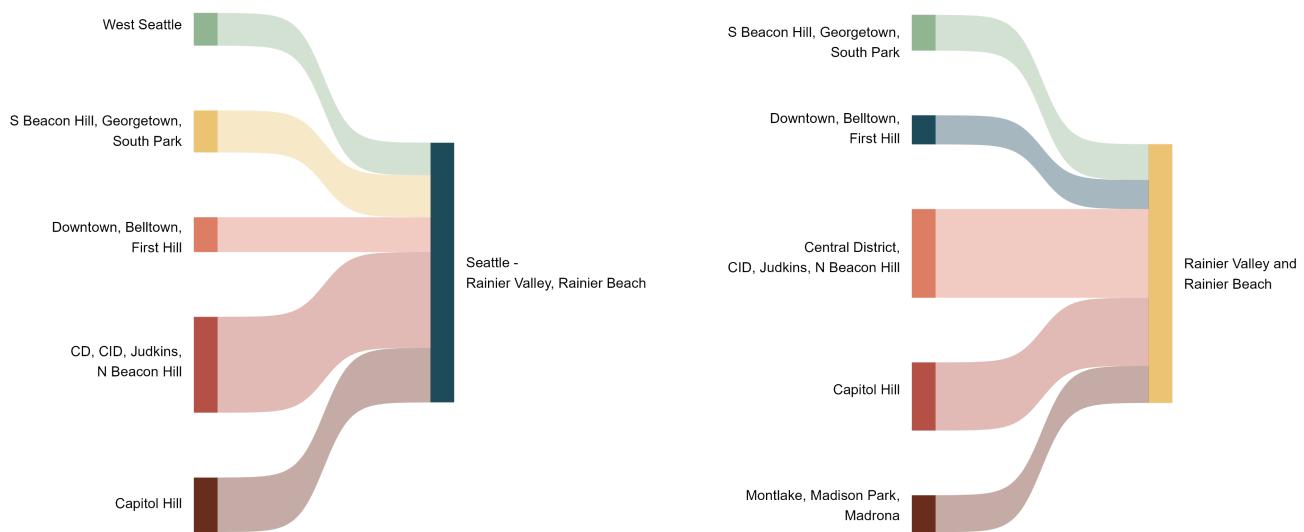


Figure 17. Top receiving areas for Seattle - Rainier Valley and Rainier Beach (Left: 2017, Right: 2021.)
Sankey diagrams depicting top five sending HRAs to RVRB. The height of each colored bar corresponds to the relative proportion contributed by each HRA.

Where are outgoing RVRB households moving to?

Interestingly, many of the top sending HRAs to RVRB are also shown in Figure 18 to be the top receiving HRAs from RVRB. From 2017-2021, the top receiving HRAs were consistently West Seattle; South Beacon Hill, Georgetown, and South Park; Central District, Chinatown-International District, Judkins, North Beacon Hill, Ballard, and Queen Anne. RVRB appears to be contributing roughly equal proportions of households to each of these top receiving HRAs.



Figure 18. Top receiving HRAs for Seattle - Rainier Valley and Rainier Beach (Left: 2017, Right: 2021, Data Axle). Sankey diagram depicting top five receiving HRAs to RVRB. The height of each colored bar corresponds to the relative proportion contributed by each HRA. Sankey diagrams look similar each year. See Appendix for all years.

How have rent prices changed in RVRB compared to its top sending and receiving HRAs?

In Figure 19, we show the first quartile of observing asking rents of 1BR listings in RVRB (dark blue) compared to its top sending and receiving HRAs. We focus on 1BR listings because they are the most common type of listing in these HRAs.

Up until 2020, RVRB had by far the cheapest rent among both its sending and receiving HRAs. In 2017, the asking first quartile rent for a 1BR unit in RVRB was \$1,484. In 2019, rents fell to \$1,235, far below the other HRAs in 2019. For comparison, the next cheapest HRA that year, West Seattle, had an asking first quartile 1BR rent of \$1,505. Yet by 2022, rents in RVRB were in the middle of the group with a first quartile 1BR rent of \$1,798.

High in-migration rates from these more expensive HRAs in Central Seattle might be signs of displacement, however, this bidirectional movement suggests otherwise. Due to limitations in the Data Axle dataset, we do not know the socioeconomic characteristics of these moving households. It is not impossible that the observed in-migration is driven by lower-income households whereas the observed out-migration is driven by higher-income households.

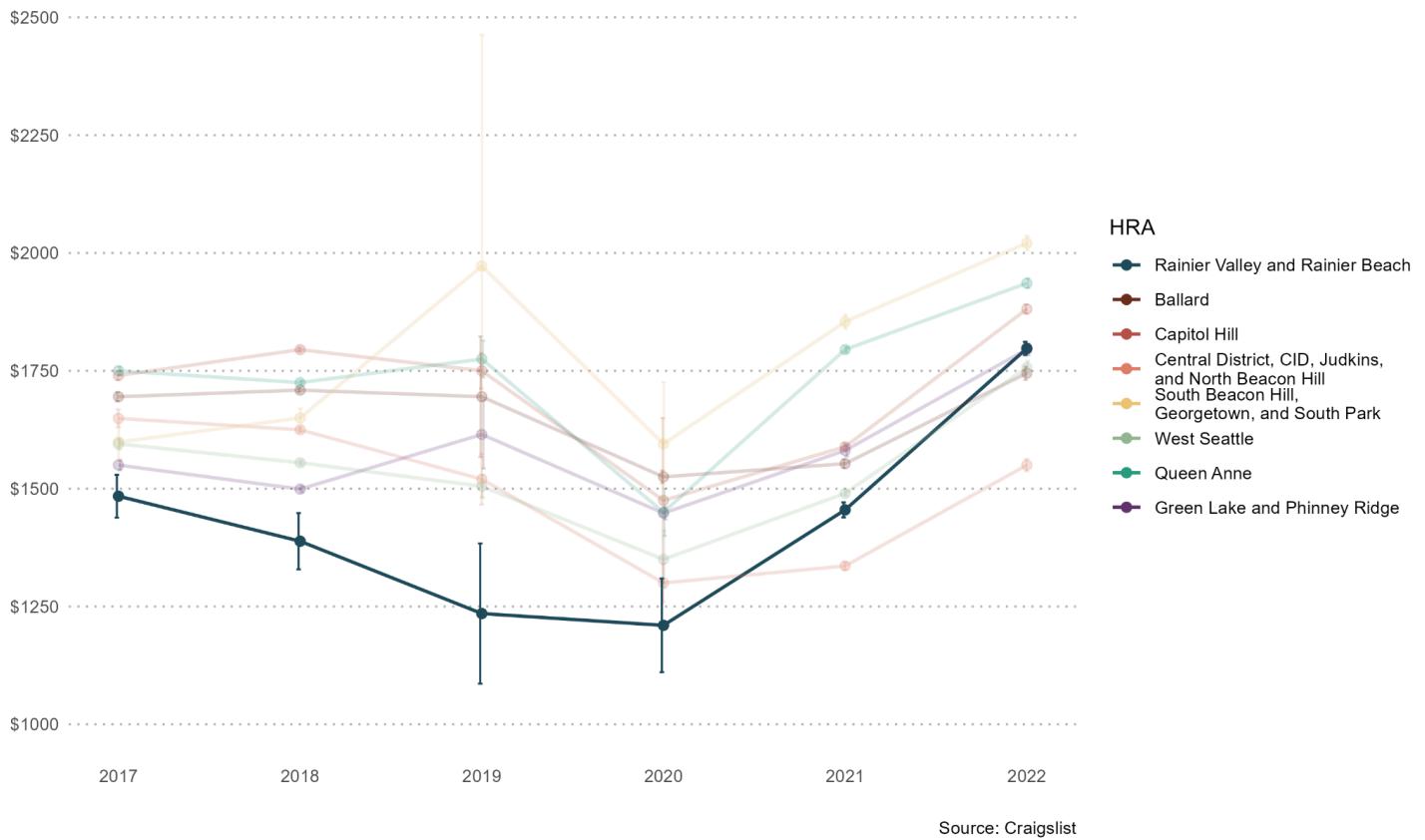


Figure 19. 25th percentile of 1BR rents for Seattle - Rainier Valley and Rainier Beach and top sending and receiving HRAs (2017-2022, Craigslist). Error bars represent sample standard deviations.

How does environmental risk in RVRB compare to its sending and receiving HRAs?

In Table 6, we see that RVRB and its sending and receiving HRAs all have relatively high decile scores on Washington's Environmental Health Disparities Map, indicating high exposure to pollutants. Compared to its sending and receiving areas, RVRB has a relatively high score at 7.0 out of 10. Only two HRAs have higher decile scores than RVRB: the Seattle-Capitol Hill HRA and the Seattle-South Beacon Hill, Georgetown, and South Park HRA. RVRB and all of its sending and receiving HRAs also have relatively little area at risk of flooding. The Seattle-South Beacon Hill, Georgetown, and South Park and Seattle-West Seattle HRAs are the only ones with some land at risk of flooding, at 0.4% and 0.5% respectively.

How does planning and land use in RVRB compare to its sending and receiving HRAs?

Compared to its sending and receiving HRAs, Table 7 shows that RVRB has the highest percentage of residential parcels that are being used for single family housing and the lowest percentage of residential parcels that are being used for multifamily housing, both in terms of land area and number of parcels. Its

sending HRAs have much higher percentages of multifamily housing and much lower percentages of single family housing.

Each of the HRAs are within the urban growth area and are part of the Seattle School District.

How does access to amenities in RVRB compare to its sending and receiving HRAs?

Tables 8 and 9 shows that RVRB has a relatively high amount of green space compared to its sending and receiving areas. RVRB has a low-to-moderate concentration of healthcare compared to its receiving areas, at 1.9 per square mile. Capitol Hill, Downtown, Belltown, and CD/CID all have much higher percentages of healthcare facilities than RVRB. Compared to its sending and receiving areas, RVRB has a low to moderate density of transit stops and frequency of transit arrivals. Its sending-only areas generally have more transit access than RVRB.

HRA	Sending/Receiving	Average Exposure Decile	% of Land in 500-Year Floodplain
Seattle - Rainier Valley and Rainier Beach		7.0	0.0%
Pierce County	Receiving only		
Other WA Counties	Receiving only		
Seattle - Central District, Chinatown-International District, Judkins, and North Beacon Hill	Sending, receiving	6.4	0.0%
Seattle - South Beacon Hill, Georgetown, and South Park	Sending, receiving	7.2	0.4%
Seattle - West Seattle	Sending, receiving	6.7	0.5%
Montlake, Madison Park, and Madrona	Sending only	6.3	0.0%
Seattle - Capitol Hill	Sending only	7.5	0.0%
Seattle - Downtown, Belltown, and First Hill	Sending only	8.3	0.1%
Seattle - Queen Anne	Sending only	7.0	0.0%

Table 6. Environmental risk factors: environmental exposure and percentage of land in 500-year floodplain of Seattle - Rainier Valley and Rainier Beach and its top sending and receiving HRAs (2023, [WA Environmental Health Disparities Map](#), [FEMA 500-Year Floodplain in King County](#)). Note: The Green Lake and Phinney Ridge HRA and the Seattle - Capitol Hill HRA are only sending HRAs and not receiving HRAs to RVRB.

HRA	Sending/Receiving	% Area of Multifamily Housing	% Count of Multifamily Housing	% Area of Single Family Housing	% Count of Single Family housing
Seattle - Rainier Valley and Rainier Beach		5.8%	1.4%	89.5%	87.1%
Pierce County	Receiving only				
Other WA Counties	Receiving only				
Seattle - Central District, Chinatown-International District, Judkins, and North Beacon Hill	Sending, receiving	17.9%	5.9%	62.9%	56.3%
Seattle - South Beacon Hill, Georgetown, and South Park	Sending, receiving	6.8%	1.7%	87.7%	86.0%
Seattle - West Seattle	Sending, receiving	6.2%	3.2%	88.5%	83.8%
Montlake, Madison Park, and Madrona	Sending only	8.4%	3.6%	84.9%	79.6%
Seattle - Capitol Hill	Sending only	38.8%	21.1%	50.6%	51.9%
Seattle - Downtown, Belltown, and First Hill	Sending only	75.0%	44.6%	6.9%	14.2%
Seattle - Queen Anne	Sending only	25.7%	11.0%	61.5%	65.9%

Table 7. Planning policy and land use factors: residential land use of Seattle - Rainier Valley and Rainier Beach and its top sending and receiving HRAs (2023, [Assessor's Property Information Files](#)).

HRA	Sending/Receiving	Main School District	% of Land in Urban Growth Area
Seattle - Rainier Valley and Rainier Beach		Seattle	99%
Pierce County	Receiving only		
Other WA Counties	Receiving only		
Seattle - Central District, Chinatown-International District, Judkins, and North Beacon Hill	Sending, receiving	Seattle	100%

Seattle - South Beacon Hill, Georgetown, and South Park	Sending, receiving	Seattle	100%
Seattle - West Seattle	Sending, receiving	Seattle	98%
Montlake, Madison Park, and Madrona	Sending only	Seattle	96%
Seattle - Capitol Hill	Sending only	Seattle	100%
Seattle - Downtown, Belltown, and First Hill	Sending only	Seattle	99%
Seattle - Queen Anne	Sending only	Seattle	98%

Table 8. Planning policy and land use factors: main school district and percentage of land in urban growth area of Seattle - Rainier Valley and Rainier Beach and its top sending and receiving HRAs (2023, [Assessor's Property Information Files, Urban Growth Area](#)).

HRA	Sending/Receiving	Transit Arrivals per Square Mile	Transit Stops per Square Mile	% Area of Open Space	Healthcare Parcels per Square Mile
Seattle - Rainier Valley and Rainier Beach		7,595	55.1	3.6%	1.9
Pierce County	Receiving only				
Other WA Counties	Receiving only				
Seattle - Central District, Chinatown-International District, Judkins, and North Beacon Hill	Sending, receiving	17,530	152.7	4.3%	3.8
Seattle - South Beacon Hill, Georgetown, and South Park	Sending, receiving	6,066	68.2	0.0%	0.6
Seattle - West Seattle	Sending, receiving	3,399	25.4	0.4%	0.7
Montlake, Madison Park, and Madrona	Sending only	6,142	51.3	1.2%	0.4
Seattle - Capitol Hill	Sending only	15,642	175.2	3.6%	11.8
Seattle - Downtown, Belltown, and First Hill	Sending only	46,456	99.9	0.6%	6.6
Seattle - Queen Anne	Sending only	13,441	154.1	0.8%	2.2

Table 9. Amenities: transit arrivals per square mile, transit stops per square mile, percent area of open space, and healthcare parcels per square mile of Seattle - Rainier Valley and Rainier Beach and its top sending and receiving HRAs (2023, [Assessor's Property Information Files](#)).

Auburn - North

We focus on Auburn - North as an example of an HRA that is outside of Seattle and experiences a significant amount of migratory flow with Pierce County.

Where are incoming Auburn - North households moving from, and where are outgoing Auburn - North households moving to?

Between 2017 and 2020, the sending HRAs to Auburn - North stayed relatively consistent. Pierce County, Auburn - South, and Lakeland, Algona Pacific, and Milton were in the top 5 in all years. The four Kent HRAs (Kent - South, Kent - Central, Kent - West, and Kent - East) and Enumclaw, Black Diamond, and Southeast King County were also present. As shown in Figure 20, these HRAs are all near Auburn - North. In 2021, Other WA Counties appeared in the top 5 sending areas for the first time.

The top five receiving areas for Auburn - North over 2017-2021 did not change. They were Pierce County, other WA Counties, Lakeland, Algona Pacific, and Milton, Enumclaw, Black Diamond, and Southeast King County, and Auburn - South. The sending and receiving areas for Auburn - North are similar over the study period, except that the Kent HRAs were only present as sending areas and not as receiving areas.

With regard to the Enumclaw, Black Diamond, and Southeast King County HRA, we speculate that people are likely moving to and from the cities of Enumclaw and Black Diamond, rather than the more rural parts of Southeast King County. If true, any data points that are measured per square mile are skewed by the large geographical area of this HRA.

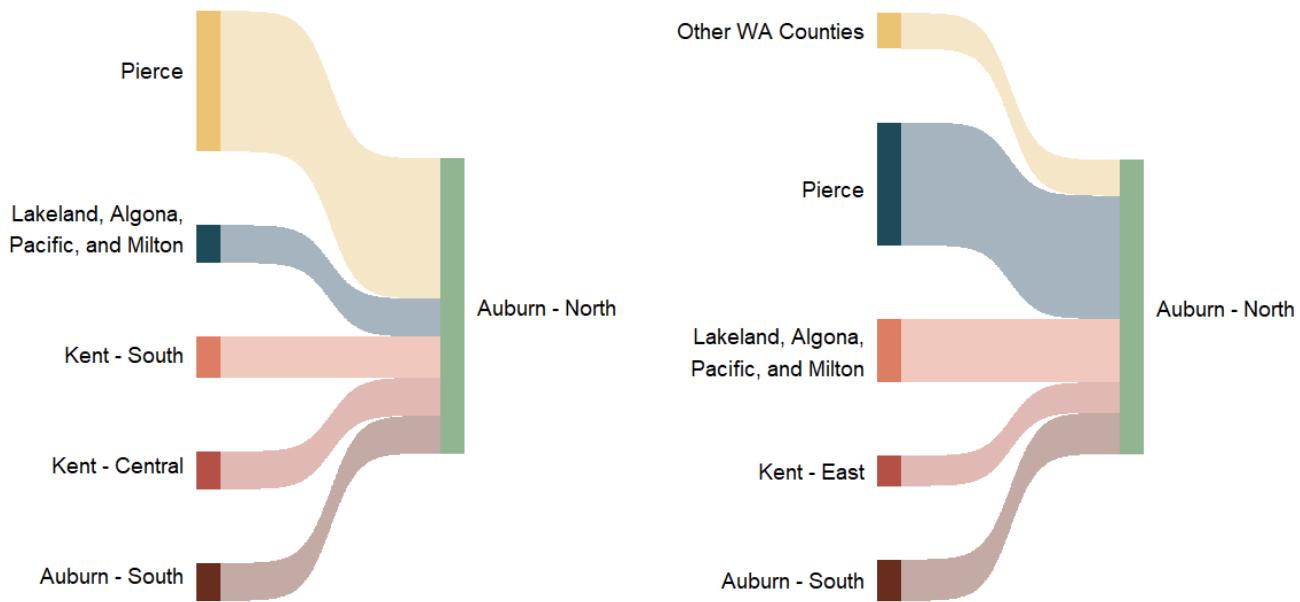


Figure 20. Top sending HRAs for Auburn - North (Left: 2019 and Right: 2010, Data Axle). Left: Map of Auburn - North (blue) and top five sending HRAs (red). **Right:** Sankey diagram depicting top five sending HRAs to Auburn - North. The height of each colored bar corresponds to the relative proportion contributed by each HRA. See Appendix for other years' diagrams.

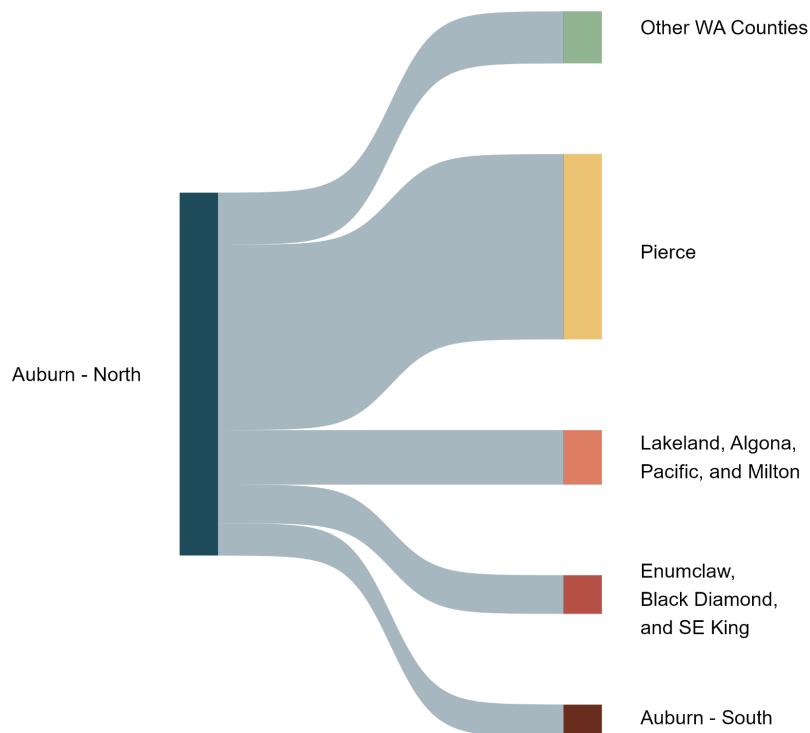


Figure 21. Top receiving HRAs for Auburn - North (2021, Data Axle). Sankey diagram depicting top five receiving HRAs to Auburn - North. The height of each colored bar corresponds to the relative proportion

contributed by each HRA. See Appendix for other years' diagrams.

How have rent prices changed in Auburn - North compared to its top sending HRAs?

In Figure 21, we show the first quartile of observed asking rents of 2BR listings in Auburn - North (dark blue) compared to its top sending HRAs. We chose to focus on 2BR listings because they are the most common type of listing in these HRAs. From 2017-2020, Auburn - North 2BR rents ranked near the bottom of its sending HRAs. However, rent prices quickly increased, and in 2022, Auburn - North was one of the most expensive HRAs for 2BRs among its sending HRAs. In 2017, the first quartile asking rent for a two-bedroom unit was \$1,305. By 2022, this number rose to \$1,875. It seems that most of the in-migration we observed to Auburn - North was from more expensive HRAs. We speculate that Auburn - North rents have increased in response to this increased in-migration. In the coming years, stakeholders should track whether in-migration will subsequently slow down or if the top sending HRAs will shift.

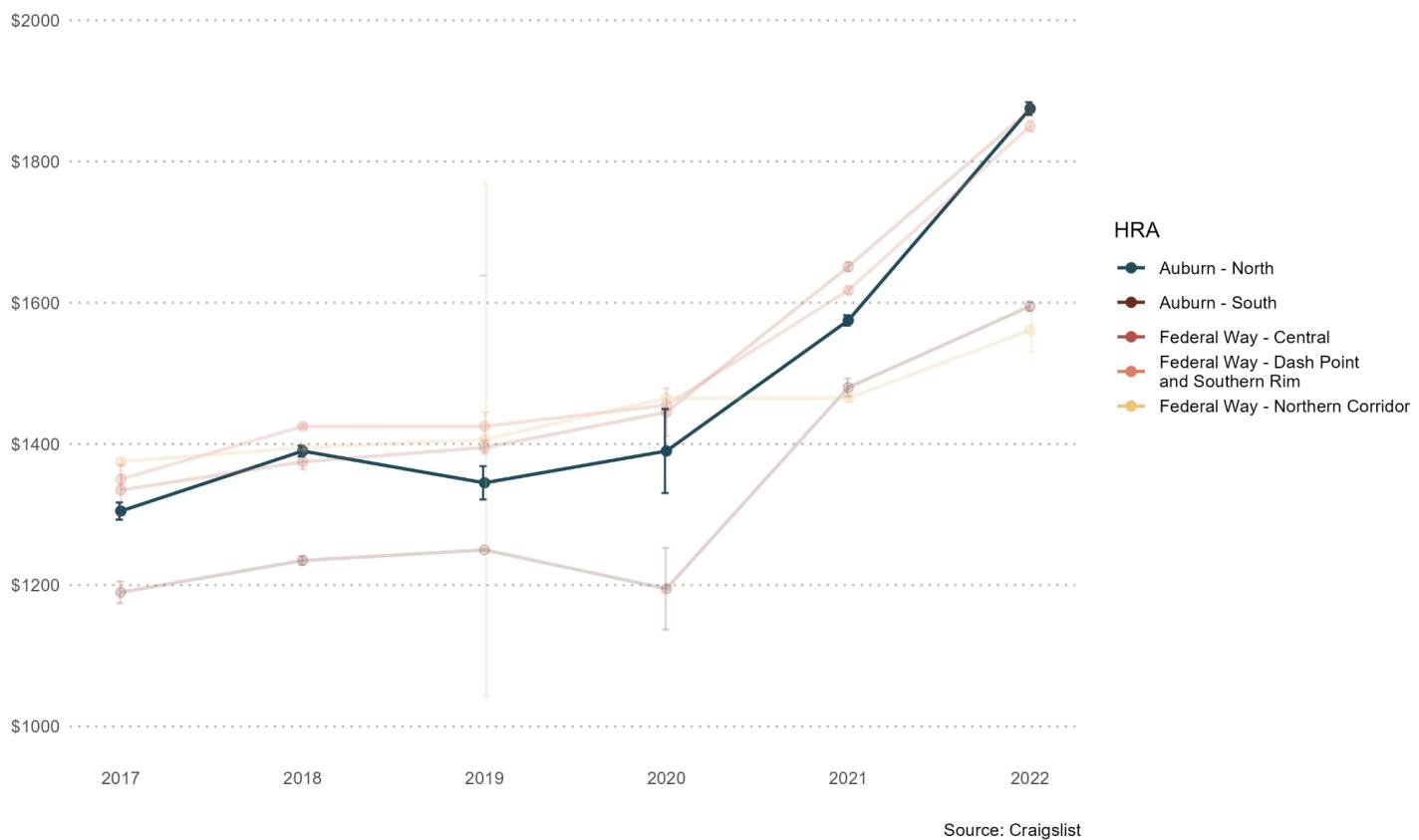


Figure 21. 25th percentile of asking rents for 2BRs in Auburn - North and top sending HRAs (2017-2022, Craigslist). Lakeland, Algona, Pacific, and Milton HRA is not pictured because there are too few rental listings in our dataset. Error bars represent standard errors.

How does environmental risk in Auburn - North compare to its sending and receiving HRAs?

Table 10 shows that compared to its sending-only HRAs in Kent, Auburn - North has a relatively low decile score on Washington's EHDMAP. Among the sending and receiving HRAs, the Auburn - South and Enumclaw, Black Diamond, and Southeast King County HRAs had lower decile scores of 6.3 and 5.0 out of 10, respectively. Scores for other WA Counties and Pierce County were not compiled for this report. Among all sending and receiving HRAs, Auburn - North has the most land within the 500-year floodplain, at 3.3%.

How does planning and land use in Auburn - North compare to its sending and receiving HRAs?

In Table 11 we see that Enumclaw, Black Diamond, and Southeast King County stands out as having very little multifamily housing relative to single-family housing. This is consistent with its rural geography. Two of the Kent HRAs (Kent - Central and Kent - West), which are both only sending HRAs to Auburn - North, have relatively high percentages of multifamily housing and relatively low percentages of single family housing. Auburn - North has similar percentages of multifamily and single family housing compared to its remaining sending and receiving HRAs.

The Enumclaw, Black Diamond, and Southeast King County HRA also stands out as having very little land in the urban growth area, at 4%. Lakeland, Algona, Pacific, and Milton HRA (89%) and Auburn - South (90%) are also partially outside the urban growth area. All other sending and receiving HRAs and Auburn - North are almost or fully within the urban growth area.

While Auburn - North is primarily in the Auburn School District, most of the sending and receiving HRAs (with the exception of Auburn-South), are in other school districts. The Kent School District, which represents the sending Kent HRAs, is consistently sending students to Auburn School District. There is also much movement with the Federal Way and Enumclaw school districts.

How does amenity access in Auburn - North compare to its sending and receiving HRAs?

Tables 12 and 13 show that Auburn - North has the lowest percentage of open space compared to its sending and HRAs. It has comparatively high concentrations of healthcare, at 2.4 facilities per square mile. Most of its sending and receiving HRAs have fewer healthcare facilities per square mile, with the exception of Kent - Central. Auburn - North also has a low density of transit stops and number of arrivals per square mile compared to its sending-only HRAs in Kent. However, it has similar transit coverage to most of its HRAs that are both sending and receiving. Again, the exception is the rural HRA of Enumclaw, Black Diamond, and Southeast King County, which has lower geographical density of amenities.

HRA	Sending/Receiving	Average Exposure Decile	% of Land in 500-Year Floodplain
Auburn - North		7.7	3.3%
Pierce County	Sending, receiving		
Other WA Counties	Sending, receiving		

Auburn - South	Sending, receiving	6.3	0.1%
Enumclaw, Black Diamond, and Southeast King County	Sending, receiving	5.0	0.1%
Lakeland, Algona, Pacific, and Milton	Sending, receiving	8.0	1.1%
Kent - Central	Sending only	8.0	0.0%
Kent - East	Sending only	7.2	0.0%
Kent - South	Sending only	8.3	1.9%
Kent - West	Sending only	8.7	0.8%

Table 10. Environmental risk factors: environmental exposure and percentage of land in 500-year floodplain of Auburn - North and its top sending and receiving HRAs (2023, [WA Environmental Health Disparities Map](#), [FEMA 500-Year Floodplain in King County](#)).

HRA	Sending/Receiving	% Area of Multifamily Housing	% Count of Multifamily Housing	% Area of Single Family Housing	% Count of Single Family housing
Auburn - North		7.4%	1.3%	82.9%	93.3%
Pierce County	Sending, receiving				
Other WA Counties	Sending, receiving				
Auburn - South	Sending, receiving	7.8%	2.0%	74.0%	89.5%
Enumclaw, Black Diamond, and Southeast King County	Sending, receiving	0.3%	0.3%	90.4%	93.0%
Lakeland, Algona, Pacific, and Milton	Sending, receiving	4.2%	0.4%	87.2%	92.3%
Kent - Central	Sending only	40.2%	3.8%	57.1%	92.7%
Kent - East	Sending only	8.6%	0.3%	84.8%	94.1%
Kent - South	Sending only	8.6%	1.0%	85.9%	97.0%
Kent - West	Sending only	36.9%	3.0%	58.8%	93.7%

Table 11. Planning policy and land use factors: residential land use of Auburn - North and its top sending and receiving HRAs (2023, [Assessor's Property Information Files](#)).

HRA	Sending/Receiving	Main School District	% of Land in Urban Growth Area
Auburn - North		Auburn	100%
Pierce County	Sending, receiving		
Other WA Counties	Sending, receiving		
Auburn - South	Sending, receiving	Auburn	100%
Enumclaw, Black Diamond, and Southeast King County	Sending, receiving	Enumclaw	4%
Lakeland, Algona, Pacific, and Milton	Sending, receiving	Federal Way	89%
Kent - Central	Sending only	Kent	100%
Kent - East	Sending only	Kent	100%
Kent - South	Sending only	Kent	90%
Kent - West	Sending only	Kent	100%

Table 12. Planning policy and land use factors: main school district and percentage of land in urban growth area of Auburn - North and its top sending HRAs (2023, [Assessor's Property Information Files, Urban Growth Area](#)).

HRA	Sending/Receiving	Transit Arrivals per Square Mile	Transit Stops per Square Mile	% Area of Open Space	Healthcare Parcels per Square Mile
Auburn - North		659	16.0	0.2%	2.4
Pierce County	Sending, receiving				
Other WA Counties	Sending, receiving				
Auburn - South	Sending, receiving	487	17.5	8.1%	0.7
Enumclaw, Black Diamond, and Southeast King County	Sending, receiving	104	0.5	55.4%	0.1
Lakeland, Algona, Pacific, and Milton	Sending, receiving	255	11.8	3.4%	0.0

Kent - Central	Sending only	2,867	73.4	4.3%	6.5
Kent - East	Sending only	458	10.8	8.0%	0.2
Kent - South	Sending only	1,058	33.5	5.1%	1.3
Kent - West	Sending only	1,282	31.9	5.3%	0.7

Table 13. Amenities: transit arrivals per square mile, transit stops per square mile, percent area of open space, and healthcare parcels per square mile of Auburn - North and its top sending and receiving HRAs (2023, [Assessor's Property Information Files](#)).

Conclusion

Assessing the utility of the Data Axle database:

Our team considered if and how the Data Axle database can be used to measure migration into and/or within King County. We found that this dataset can be useful but does have limitations. Using Data Axle, we are able to draw conclusions about the relative flows and rates of migration across years or geographic units. However, the data inaccurately represents the residents of King County. Younger households and renters are underrepresented, while older households and homeowners are overrepresented. Therefore, this dataset would not be useful for measuring counts of households without calibration or post-stratification of the data to downweight overrepresented households and upweight those that are underrepresented.

Furthermore, most household attributes in the Data Axle dataset are imputed. Because demographic information in this dataset such as race/ethnicity and wealth are based on models that are not documented, we decided not to use these attributes. Per conversations with Dr. Arthur Acolin and Ari Decter-Frain, we learned that many of these model-based measures within Data Axle mimic tract level estimates from the ACS, suggesting these may be modeled based on area-level, rather than individual or household, data. To analyze Data Axle data by race/ethnicity, they recommend applying existing name-based models ([Imai et al., 2022](#)) for predicting race/ethnicity to the provided last names within Data Axle. Though these models have known limitations, this process would improve the quality of race/ethnicity assignment within Data Axle. Furthermore, use of these models would provide the added benefit that one can fully know and understand the imputation model used, unlike those underlying the pre-existing race/ethnicity information within the Data Axle data.

Measuring internal migration in King County

Data Axle greatly under observes migratory activity in King County. Rising rents don't seem to precede observed out-migration in Data Axle over the study period. Data Axle's under-representation of renters and residents who are more at-risk of displacement likely explains why we do not observe strong correlations between rent and out-migration. Further, the relationship between changing rental prices and displacement takes place over many years. Our snapshot of 6 years may be limited. Renters may be bouncing around units within a neighborhood before being forced to move out. Displacement of homeowners through foreclosure can be a long process with different lag times, which may also be harder to capture in data.

We found that a vast majority of HRAs saw net migration gains throughout the study period. Only 1-2 HRAs per year see net losses, such as Tukwila in 2017. We also found that most internal migration in King County was hyperlocal. That is, most internal migration happened within the same HRA or between neighboring HRAs. Additionally, there are pairs of HRAs with high magnitudes of migration between them; these pairs are often consistent across time. Our three case studies of the Auburn - North, Tukwila, and Seattle - Rainier Valley and Rainier Beach HRAs illustrate this pattern.

These findings seem to corroborate the inverted U-shape of migration, which describes how the wealthiest and poorest areas see the lowest rates of migration, while the middle income areas see the highest rates

([Zelinsky, 1971](#)). In King County, the HRAs with the largest magnitudes of moves are in Central Seattle, North Seattle, and the Eastside. Considering that these areas are wealthier on average than the county, these moves are unlikely to be displacement, though we cannot reliably confirm this due to the aforementioned limitations of measuring household socioeconomic status from Data Axe.

Potential uses of this research

Exploring King County: Our Population & Households (Publicly Available Dashboard)

Using these findings, our team was able to update data on the ‘Exploring King County’ online interactive tool created by the 2020 Applied Research Fellows. This tool allows users to view variables like population projections, education level, housing tenure, and median incomes among King County’s Health Reporting Areas and Census Tracts.

In relation to our project, two new variables were added to the online tool. Environmental Health Disparities score, as analyzed in neighborhood context findings, shows the heatmap of percentiles of Environmental Health Disparities within all the Census tracts or HRAs in King County. Median rent allows users to look at median rents in studios to “4+” bedroom apartments as analyzed from the Scrapped Online Rental Listing Data.

This tool can be easily adapted to include future research and provides a user-friendly interface to our findings. (It can be found at the following link: [\(It can be found at the following link: \)](#)

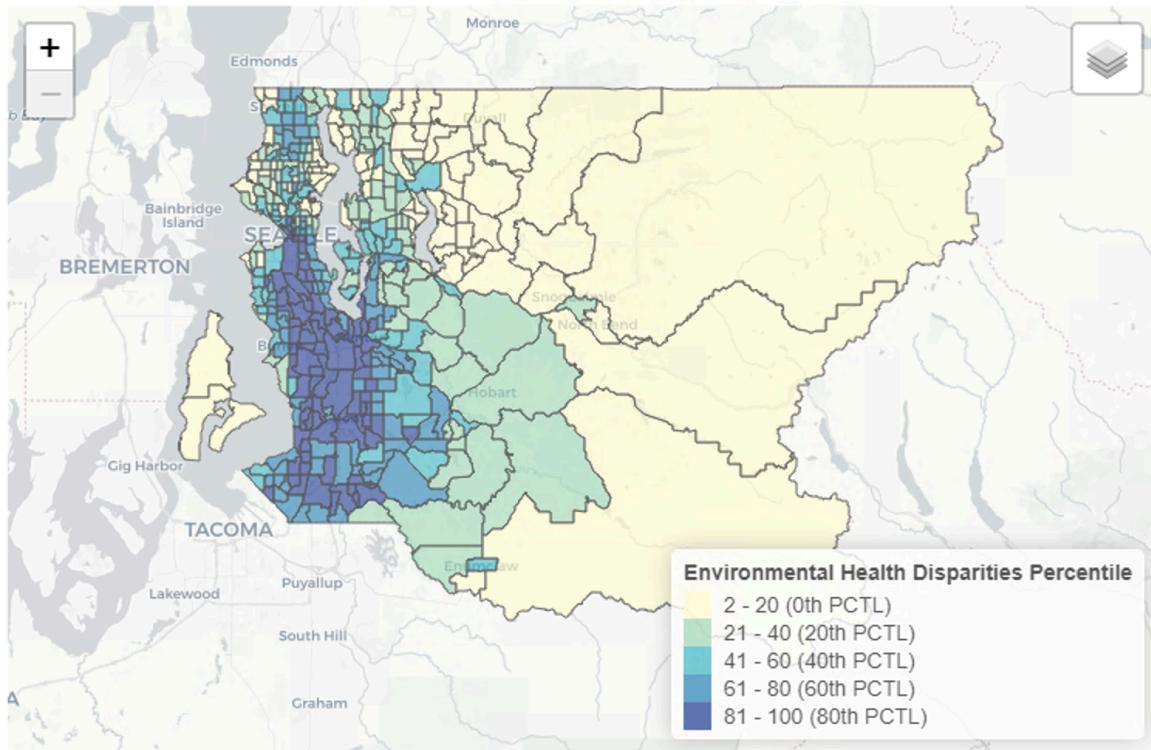


Figure 22. Distribution of Environmental Health Disparities Percentile by Census tracts (2022, WA EHD)

Map).

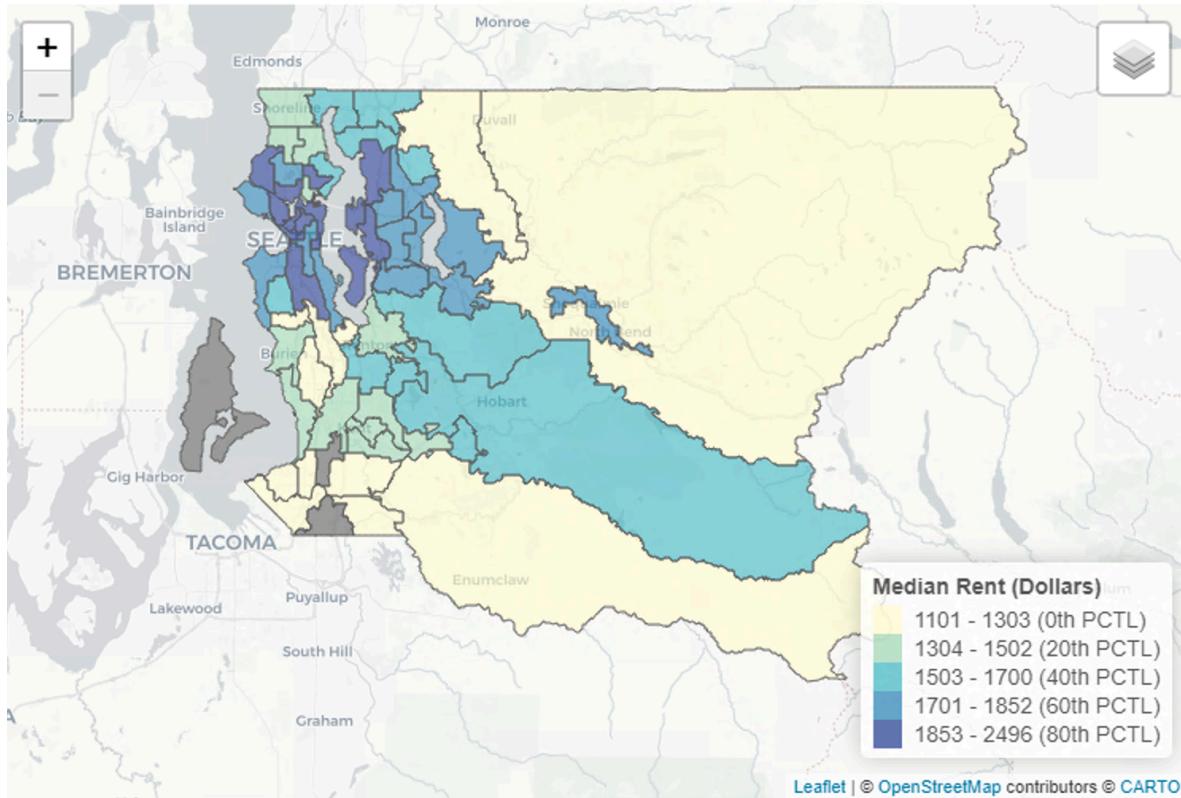


Figure 21. Distribution the median rent of 1BRs at the HRA level in the interactive data visualization tool (20YY, Craigslist).

Measuring Migration with Data Axle

Data Axle tracks unique family IDs across time, which overestimates total households in King County compared to the ACS and Census. Due to the nature of its underlying data source, Data Axle drastically underrepresents renting households and other households that are less likely to stay in place. Further, Data Axle is less likely to observe individuals and families with little credit history and limited consumer behavior and many of its demographic and socioeconomic characteristics of observed households may be inaccurate. Despite these limitations, we have confidence that observed “moves” within Data Axle are real, except where they cannot be distinguished from family dissolution or formation which also often accompany migration events. For this reason, the identification of pairs of sending and receiving HRAs within this report may be useful for King County officials to monitor with regards to housing needs, rising rents, displacement and migration.

In absence of other, more representative data sources on migration, Data Axle can still be used to track migration trends in and around King County, anticipate how migration trends might unfold, and improve understanding of what sustainable housing infrastructure might look like in the near future. While we encourage County officials to refrain from interpreting migration flows as unbiased estimates, our work and discussions with researchers who specialize in using Data Axle have led us to conclude that migration rates and the relative level of migration activity between places can be useful.

We recommend any future use of Data Axle by King County be accompanied by the use of external data sources such as population estimates and projections, ACS estimates of households by size and/or tenure and their migration activity, distributions of housing stock from the Department of Assessments and building permits, and qualitative information on migration and displacement gathered via community engagement. Though we did not get to assess the performance of post-stratification, or reweighting Data Axle to look more like King County's households, we anticipate it will provide more reasonable migration estimates especially if age or household tenure are used as post-stratification variables. Using Data Axle in conjunction with more representative data will allow for the County to draw upon the useful information that is available in a more timely and geographically-specific manner than other data sources while identifying limitations for specific use cases.

Though King County may not want to purchase their own license for accessing Data Axle data, the data used for this report is available to anyone at the University of Washington pending a Data Use Agreement. Should the use of Data Axle for other purposes be of interest to King County officials, CSDE can facilitate access.

Appendix

Household Migration Flows between HRA groupings for all years.

2017										
	Southeast	South Seattle	Northeast	North Seattle	Kirkland-Shoreline	Kent-Des Moines	Eastside	Central Seattle	Burien-Renton	Auburn-Federal Way
Southeast	1154	2295	527	933	1896	591	520	1001	413	2186
South Seattle	475	1901	4084	661	731	1168	3919	530	2344	360
Northeast	542	656	950	3032	549	1764	952	4198	535	973
North Seattle	535	2153	7144	1154	902	2599	8686	983	3915	575
Kirkland-Shoreline	515	1165	1782	2013	589	4892	2859	1686	1119	657
Kent-Des Moines	1174	1622	1008	603	3840	546	870	607	811	1732
Eastside	753	939	1293	8531	496	1876	1182	3021	616	838
Central Seattle	565	2303	7691	1214	982	1853	6763	1022	3961	544
Burien-Renton	874	4044	2131	1003	1465	1131	2160	756	2201	2352
Auburn-Federal Way	8302	931	492	483	1225	579	548	564	478	1174

2018

	Southeast									
Southeast	1339	2850	582	1128	2412	710	644	1194	448	2680
South Seattle	554	2214	5773	830	837	1485	5576	599	3041	433
Northeast	595	834	1120	3871	664	2233	1188	5235	643	1200
North Seattle	724	2466	10380	1509	1010	3082	11035	1154	5342	633
Kirkland-Shoreline	605	1434	2149	2229	722	6525	3295	1982	1345	904
Kent-Des Moines	1340	1932	1268	692	5335	671	1040	733	887	2280
Eastside	973	1057	1709	11527	589	2352	1446	3703	787	1028
Central Seattle	671	2833	11179	1657	1377	2218	10069	1215	5492	637
Burien-Renton	1087	5903	2695	1150	1727	1459	2504	835	2492	2892
Auburn-Federal Way	11589	1173	646	661	1508	736	653	645	501	1408

Auburn-Federal Way
Burien-Renton
Central Seattle
Eastside
Kent-Des Moines
Kirkland-Shoreline
North Seattle
Northeast
South Seattle
Southeast

2019

	Auburn-Federal Way	Burien-Renton	Central Seattle	Eastside	Kent-Des Moines	Kirkland-Shoreline	North Seattle	Northeast	South Seattle	Southeast
Southeast	1552	3252	708	1272	2853	862	675	1411	569	3333
South Seattle	615	2610	6131	928	982	1610	6024	701	3415	571
Northeast	721	983	1245	4461	797	2685	1314	6168	713	1438
North Seattle	767	2871	10901	1638	1161	3648	12550	1405	5966	767
Kirkland-Shoreline	734	1712	2427	2672	826	7430	3750	2505	1672	929
Kent-Des Moines	1617	2258	1400	762	5862	837	1168	877	1113	2627
Eastside	1073	1296	1968	12643	630	2670	1690	4428	893	1221
Central Seattle	826	3135	11761	1853	1570	2567	10878	1344	5930	724
Burien-Renton	1213	6345	2956	1302	2161	1630	2781	936	3007	3348
Auburn-Federal Way	12775	1399	697	734	1643	868	682	836	643	1639

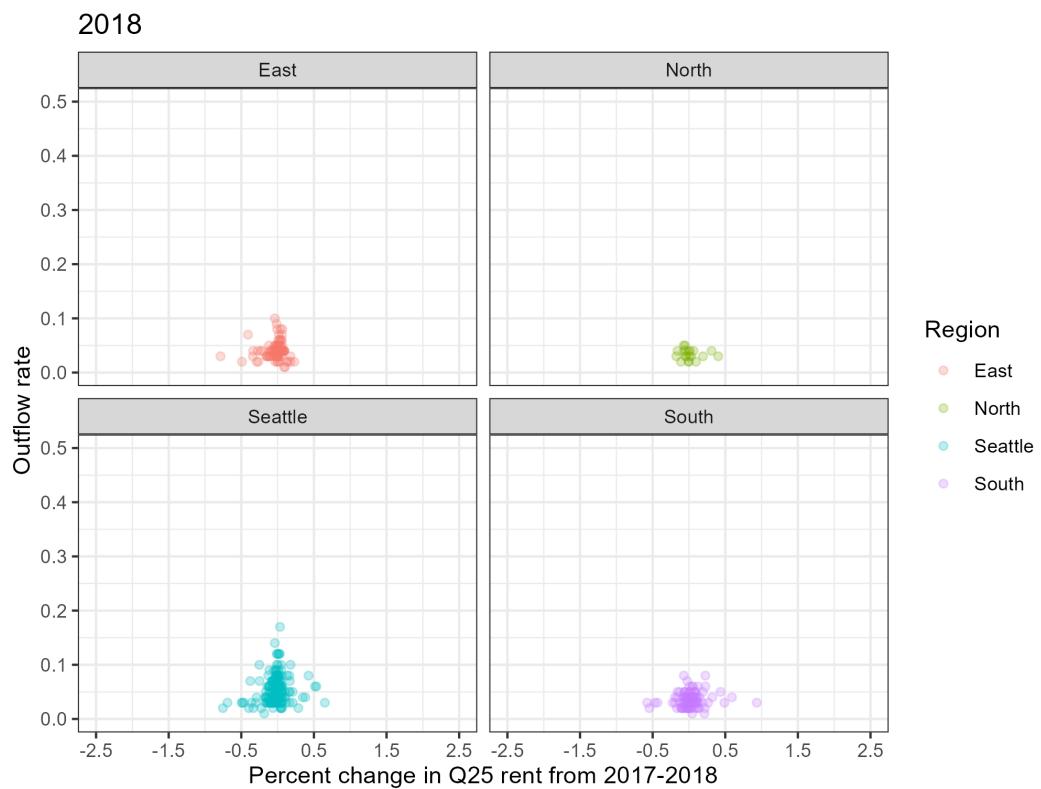
2020

	Auburn-Federal Way	Burien-Renton	Central Seattle	Eastside	Kent-Des Moines	Kirkland-Shoreline	North Seattle	Northeast	South Seattle	Southeast
Southeast	1385	2706	557	1061	2320	718	590	1225	469	2823
South Seattle	515	2195	4919	869	794	1396	4759	598	2827	478
Northeast	638	810	1090	3699	614	2204	1039	5064	653	1230
North Seattle	676	2423	8732	1343	984	3089	10385	1117	4914	601
Kirkland-Shoreline	585	1335	2049	2284	690	5951	3226	2155	1292	821
Kent-Des Moines	1298	1816	1180	684	4705	641	970	691	900	2128
Eastside	888	1104	1539	10222	535	2201	1292	3515	774	1070
Central Seattle	670	2549	9573	1524	1170	2068	8495	1066	4930	696
Burien-Renton	1014	5085	2471	1083	1670	1393	2383	835	2445	2729
Auburn-Federal Way	10266	1150	594	619	1483	722	627	670	506	1337

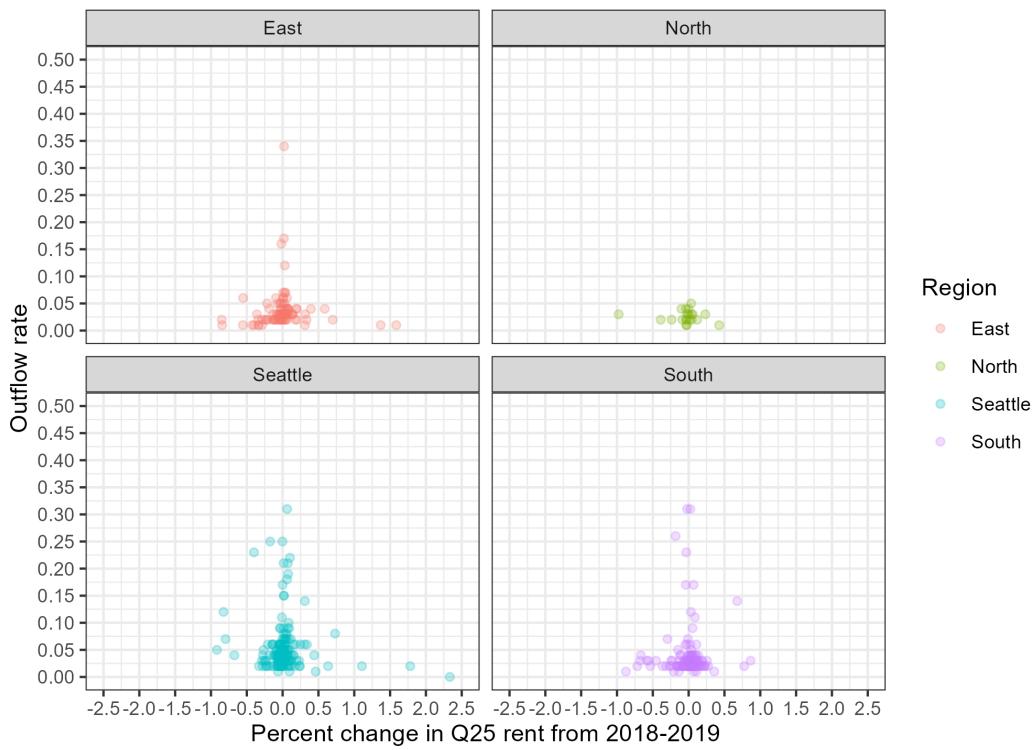
2021

	Auburn-Federal Way	Burien-Renton	Central Seattle	Eastside	Kent-Des Moines	Kirkland-Shoreline	North Seattle	Northeast	South Seattle	Southeast
Southeast	1353	2824	576	994	2292	724	592	1131	465	2643
South Seattle	530	2153	4938	754	816	1430	5073	605	2652	496
Northeast	625	808	1134	3582	651	2157	1065	4959	617	1131
North Seattle	662	2415	8761	1363	1064	2992	10086	1075	4720	630
Kirkland-Shoreline	624	1410	2136	2185	719	6126	3192	1993	1361	788
Kent-Des Moines	1399	1835	1238	709	4928	652	1004	697	865	2000
Eastside	897	1021	1500	10235	559	2191	1323	3555	762	1024
Central Seattle	700	2660	9594	1517	1241	2069	8792	1085	4765	631
Burien-Renton	993	4988	2679	1145	1683	1351	2445	789	2508	2796
Auburn-Federal Way	10101	1079	598	603	1399	708	604	699	553	1353

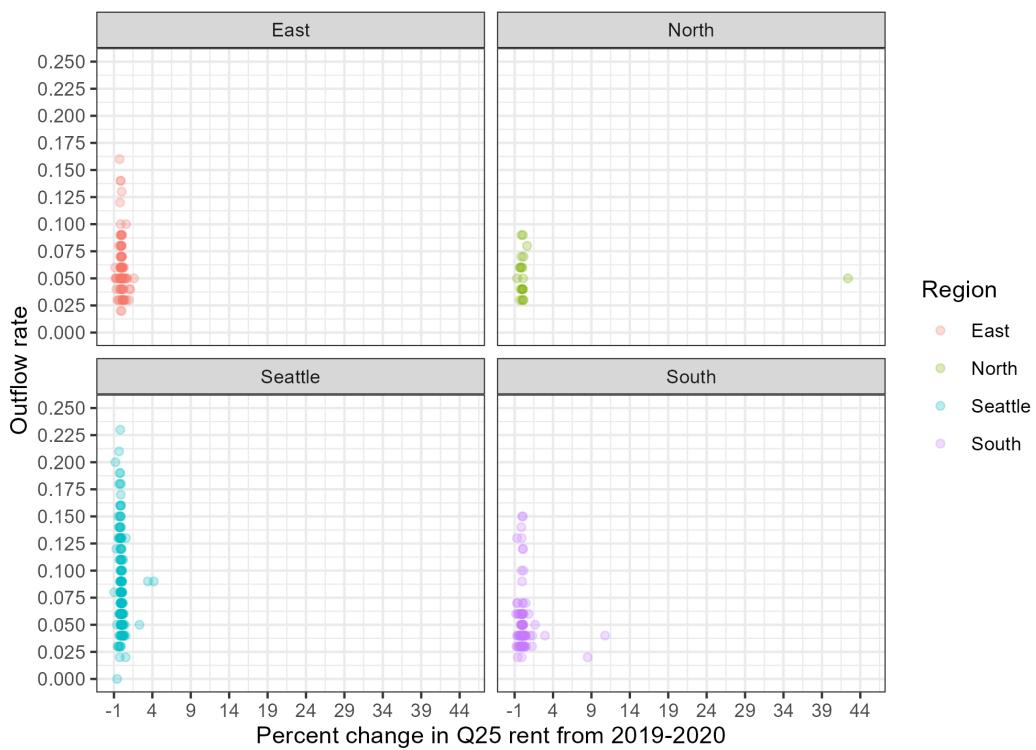
Scatterplots depicting percent change in 1Q rent vs out-migration rates for all years (without outliers)



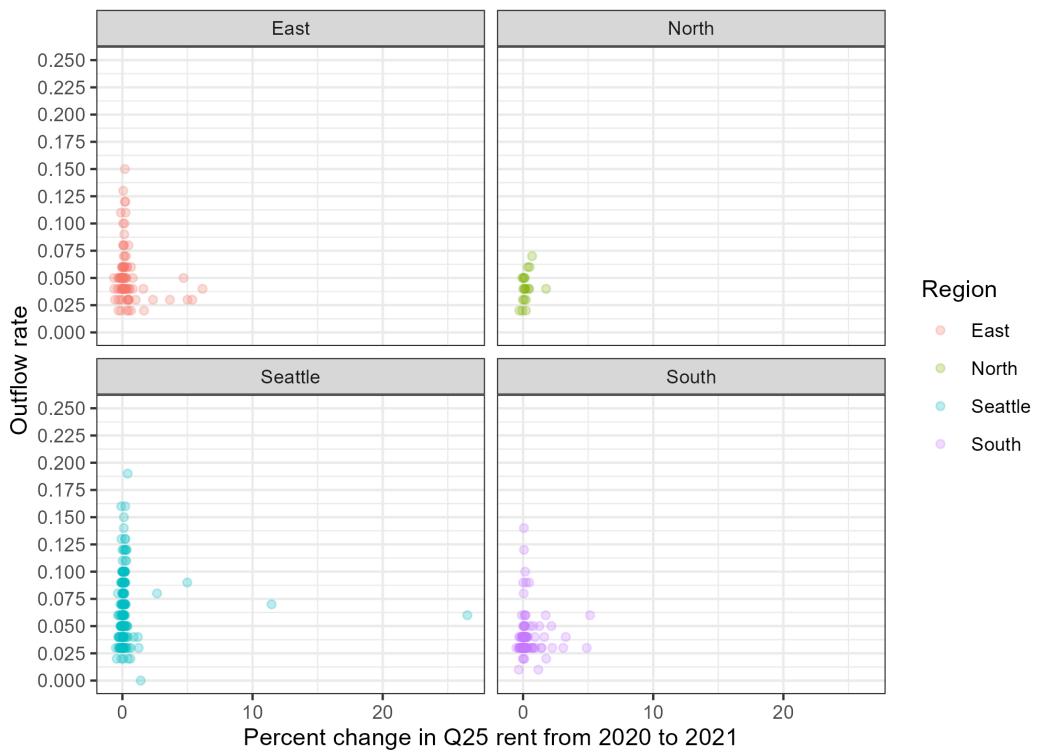
2019



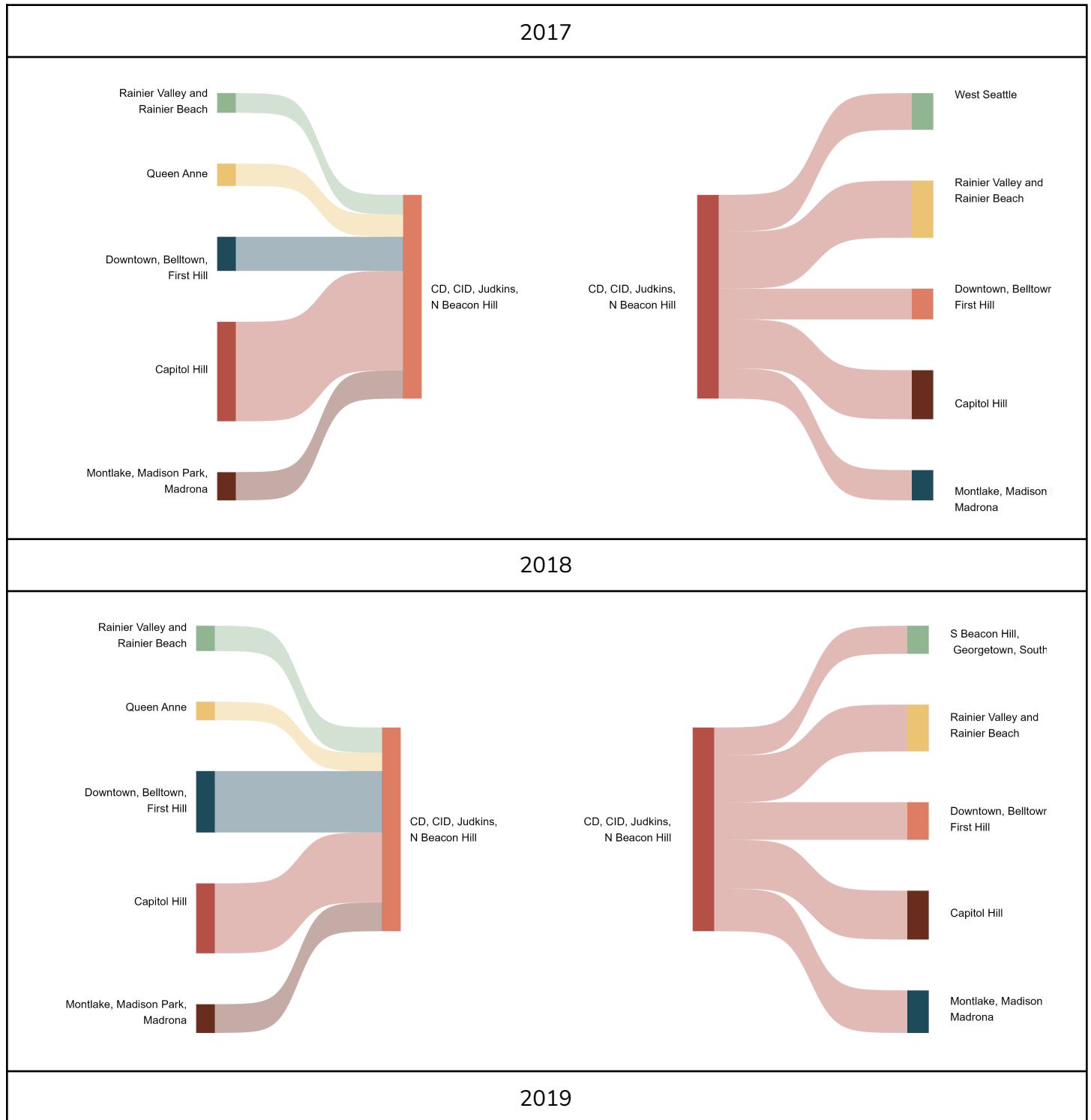
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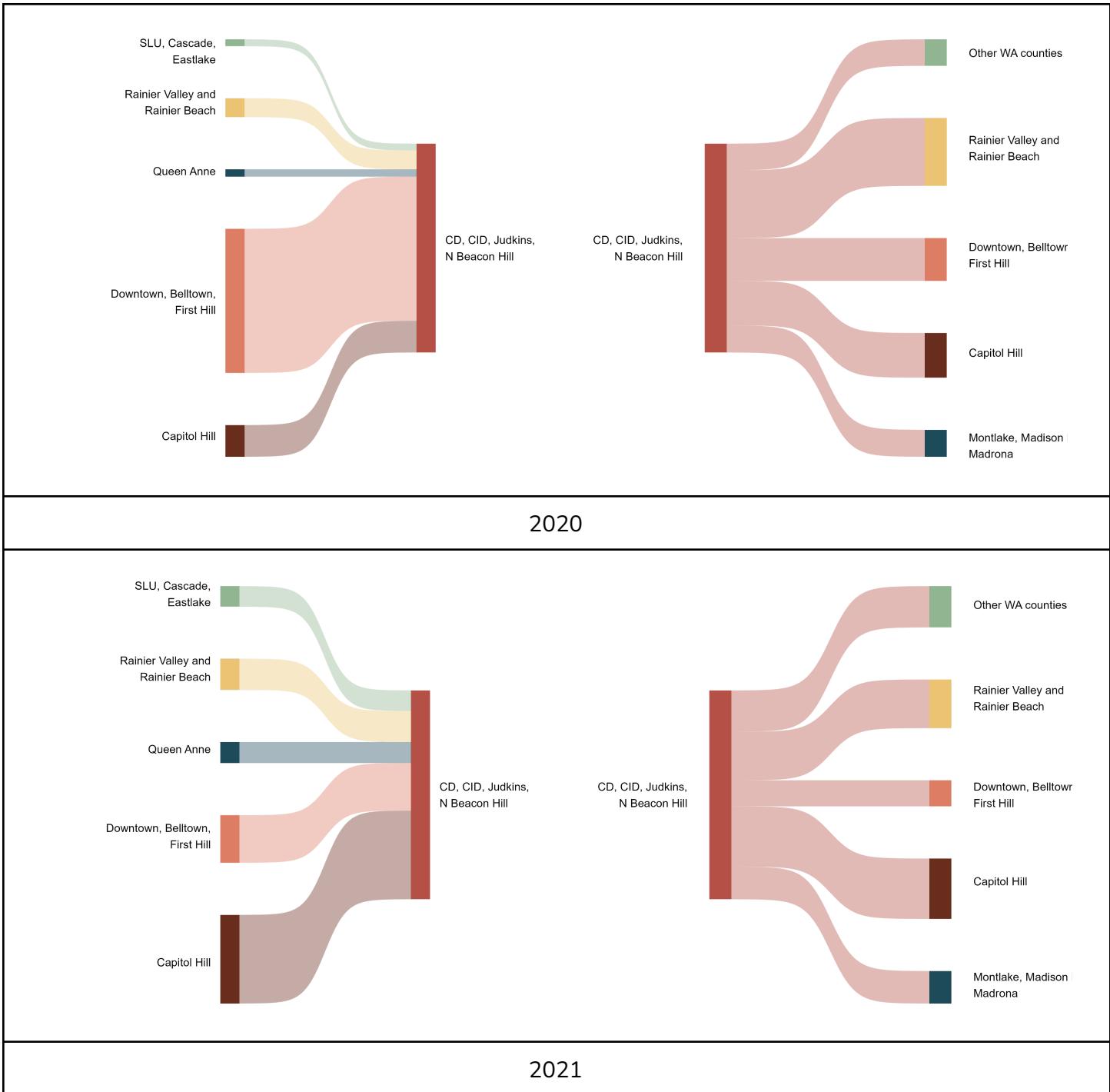


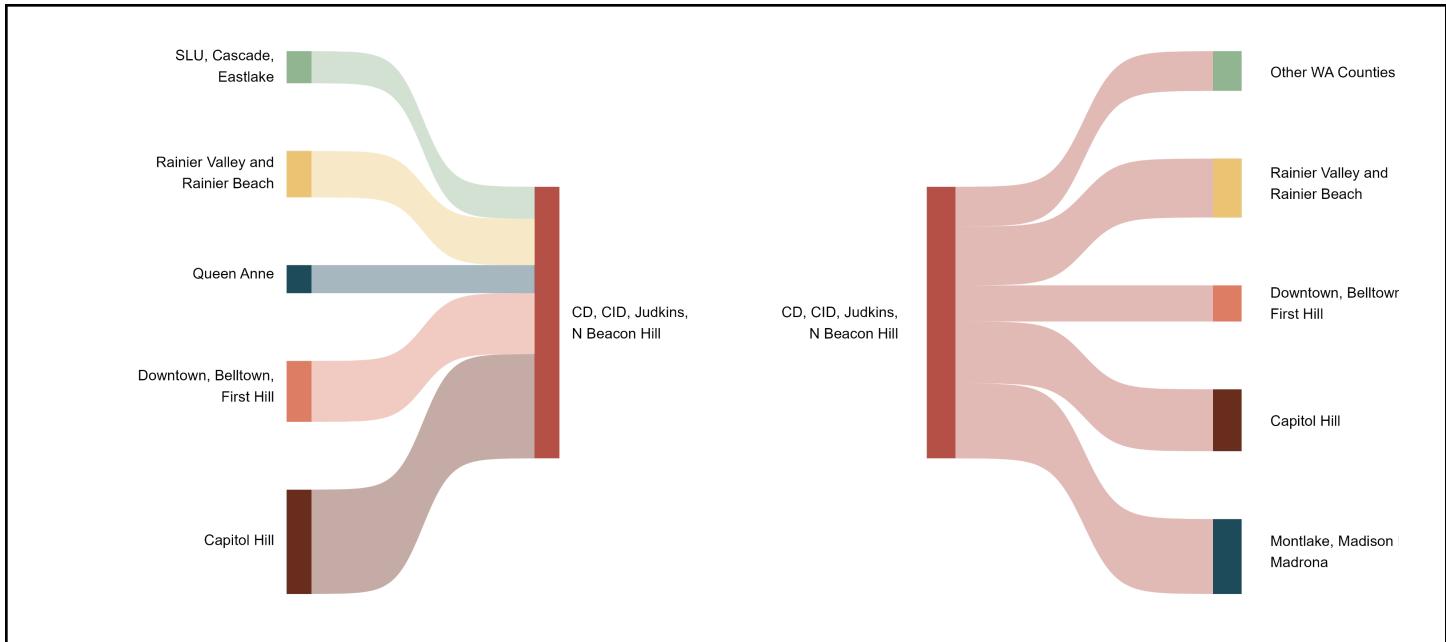
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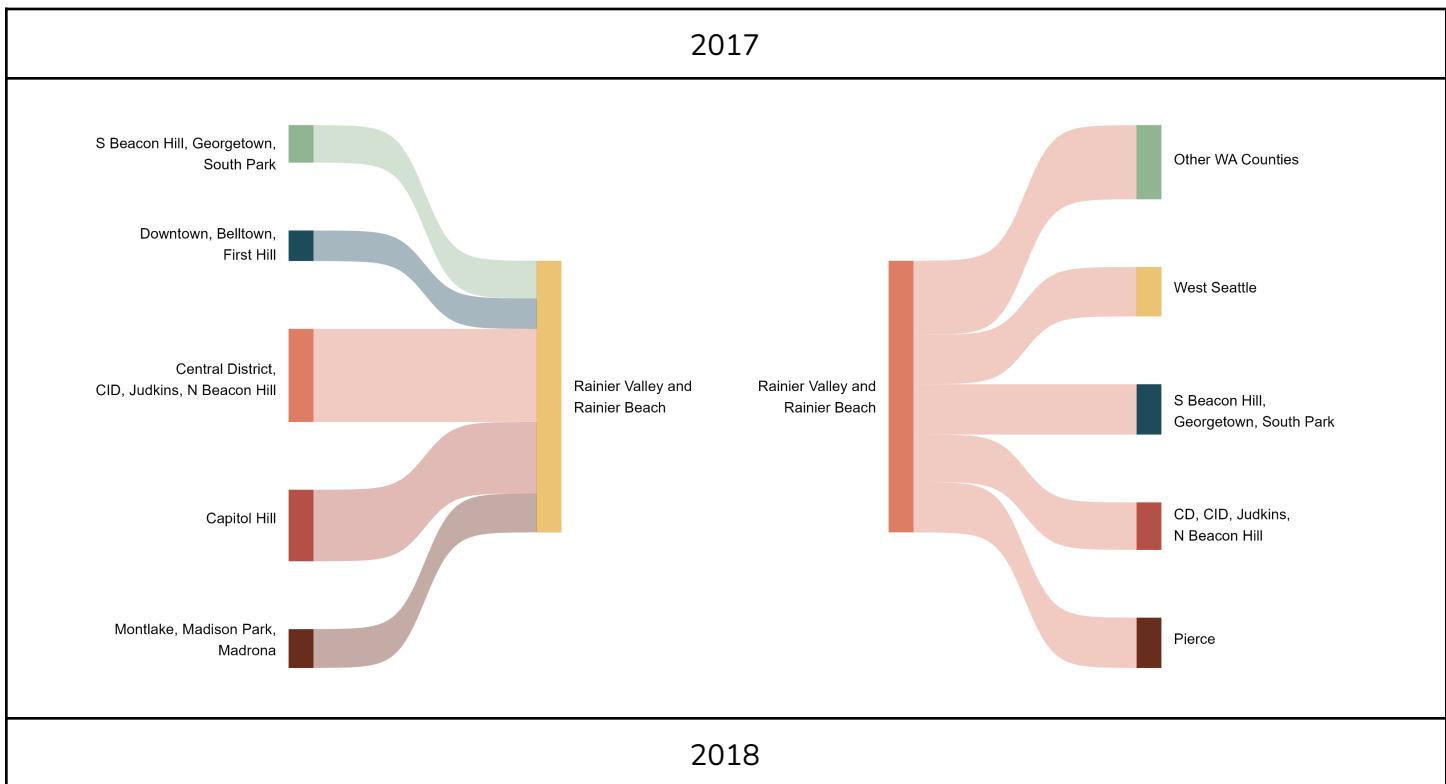
Central District, Chinatown-International District, Judkins, North Beacon Hill Sankey flows all years

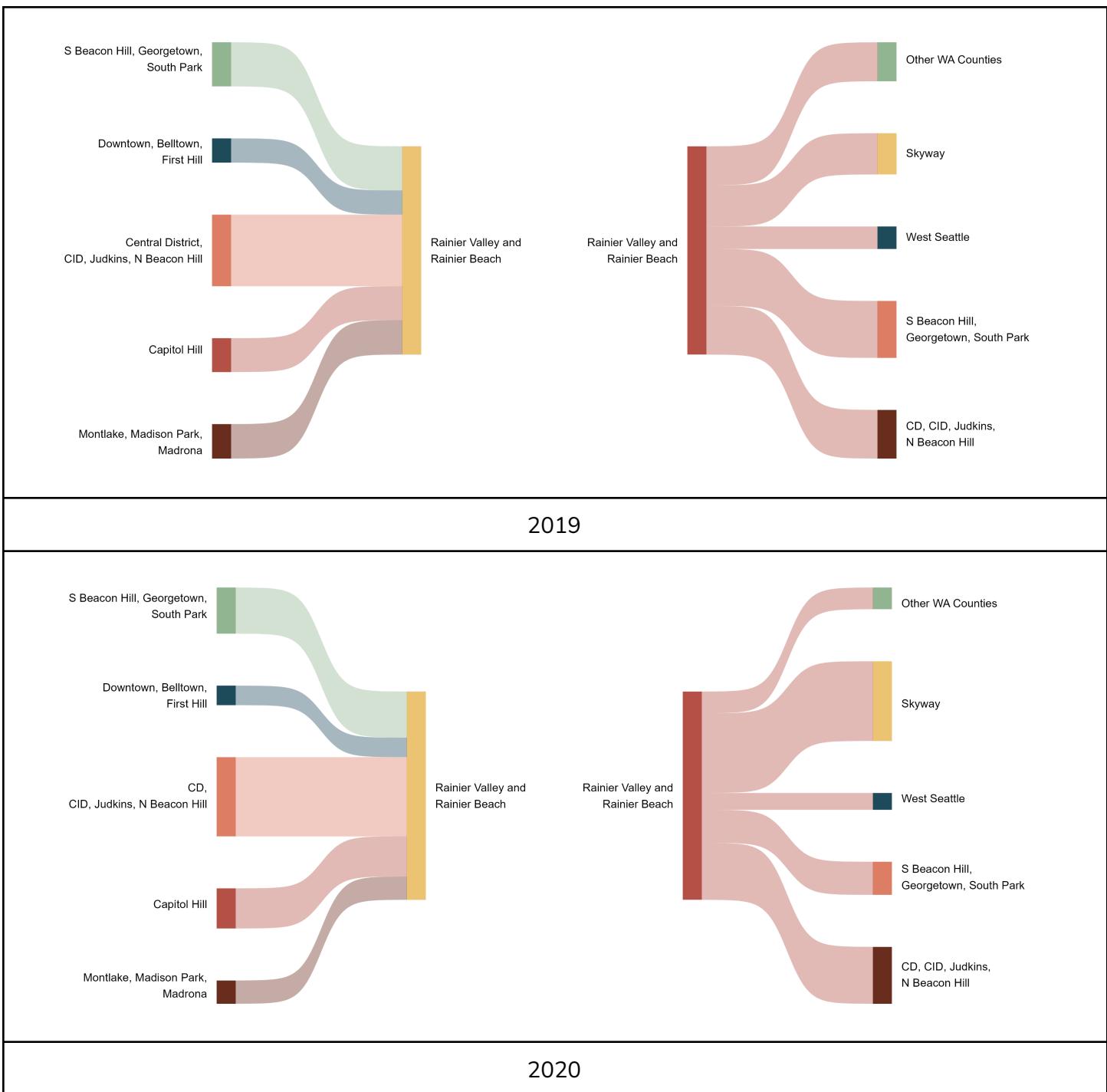


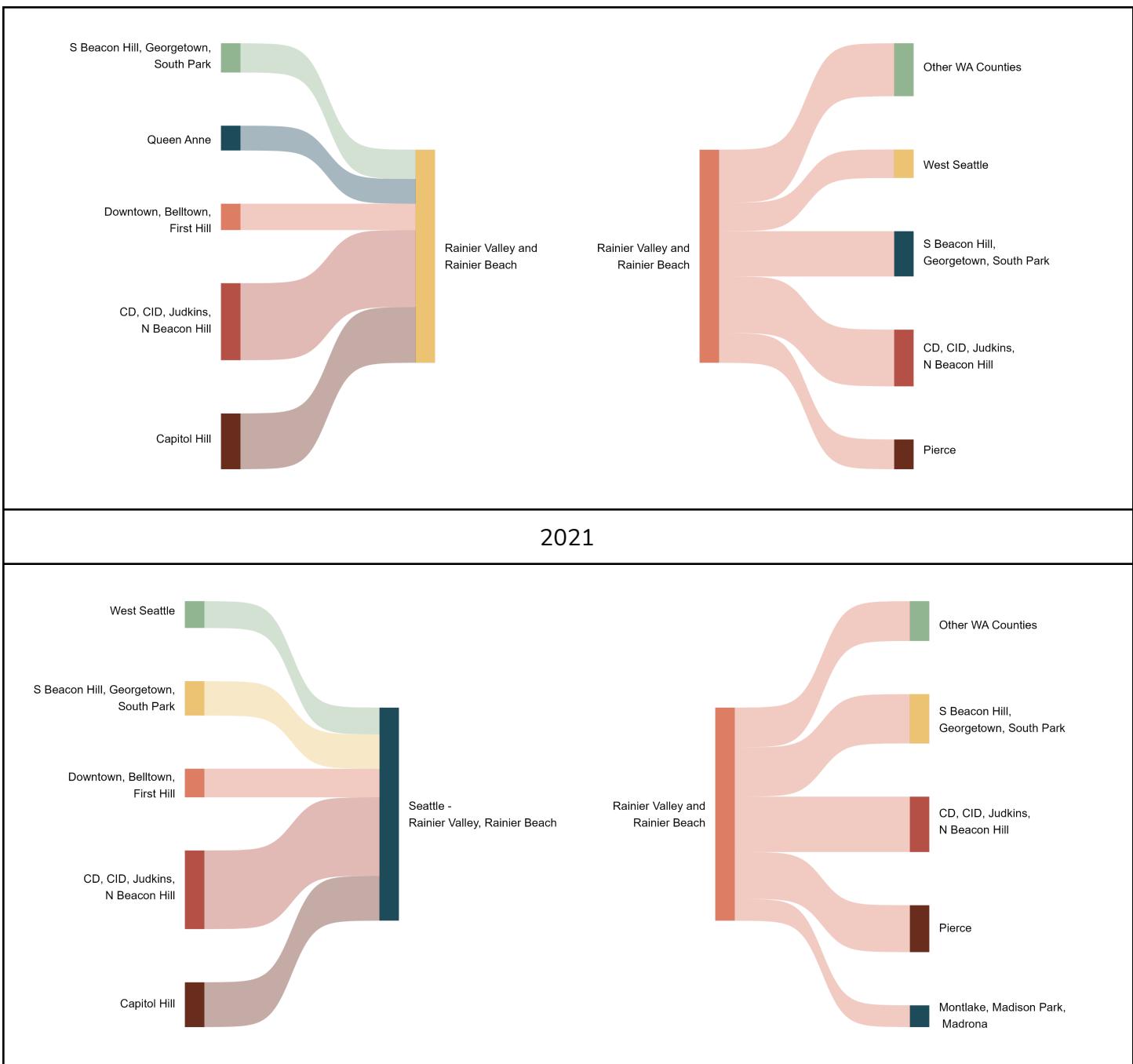




Rainier Valley - Rainier Beach Sankey flows







Auburn-North Sankey flows all years

