Expanding the PeaceHealth Rides Bike-share Network

Spring 2020
LTD

Heather Dawson • Dr. Nicholas Kohler • Lindsey Kurtz

GEOG 482/582 Advanced GIS

UNIVERSITY OF OREGON
LTD
SCI Sustainable Cities Institute
SCYP Sustainable City Year Program

Spring 2020 LTD

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Heather Dawson
Report Author • College of Arts and Science

Dr. Nicholas Kohler
Senior Instructor • Geography

Lindsey Kurtz
Assistant Instructor • Landscape Architecture

COLLEGE OF ARTS AND SCIENCES

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Reed Dunbar, City of Eugene

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About SCI

The Sustainable Cities Institute (SCI) is an applied think tank focusing on sustainability and cities through applied research, teaching, and community partnerships. We work across disciplines that match the complexity of cities to address sustainability challenges, from regional planning to building design and from enhancing engagement of diverse communities to understanding the impacts on municipal budgets from disruptive technologies and many issues in between.

SCI focuses on sustainability-based research and teaching opportunities through two primary efforts:

1. Our Sustainable City Year Program (SCYP), a massively scaled university-community partnership program that matches the resources of the University with one Oregon community each year to help advance that community's sustainability goals; and

2. Our Urbanism Next Center, which focuses on how autonomous vehicles, e-commerce, and the sharing economy will impact the form and function of cities.

In all cases, we share our expertise and experiences with scholars, policymakers, community leaders, and project partners. We further extend our impact via an annual Expert-in-Residence Program, SCI China visiting scholars program, study abroad course on redesigning cities for people on bicycle, and through our co-leadership of the Educational Partnerships for Innovation in Communities Network (EPIC-N), which is transferring SCYP to universities and communities across the globe. Our work connects student passion, faculty experience, and community needs to produce innovative, tangible solutions for the creation of a sustainable society.

About SCYP

The Sustainable City Year Program (SCYP) is a year-long partnership between SCI and a partner in Oregon, in which students and faculty in courses from across the university collaborate with a public entity on sustainability and livability projects. SCYP faculty and students work in collaboration with staff from the partner agency through a variety of studio projects and service-learning courses to provide students with real-world projects to investigate. Students bring energy, enthusiasm, and innovative approaches to difficult, persistent problems. SCYP's primary value derives from collaborations that result in on-the-ground impact and expanded conversations for a community ready to transition to a more sustainable and livable future.

About Lane Transit District

LTD provides more than 10 million trips per year on its buses and EmX Bus Rapid Transit line in Lane County, Oregon. Of Lane County's approximately 4,700 square miles, LTD's service area is about 480 square miles and includes the Eugene-Springfield metropolitan area, and the surrounding cities of Coburg, Cottage Grove, Creswell, Lowell, Junction City and Veneta as well as communities in the McKenzie River valley.

LTD is a special district of the state of Oregon and led by a seven-member board of directors appointed by Oregon's Governor. LTD also operates RideSource, a paratransit service for people with disabilities, and numerous transportation options programs to promote sustainable travel county wide, and Point2Point, an initiative that provides community members with the necessary information and resources to assist them in identifying opportunities to drive less by discovering transportation choices that meet their individual lifestyles. LTD continually explores opportunities to enhance regional mobility through its projects and partnerships with other agencies.

Course Participants

ALLIE QUINN, Biology Undergraduate
ANDREW BUI, Spatial Data Science and Technology Undergraduate
CALVIN BURKE, Environmental Science Undergraduate
CHASE KROGH, Political Science Undergraduate
CLAIRE LEWIS, Biology Undergraduate
DAISY HOOPS, Spatial Data Science and Technology Undergraduate
GABRIEL BRANDOM, Spatial Data Science and Technology Undergraduate
GABRIELLE HENRION, Geography Undergraduate
HEATHER DAWSON, Environmental Science Undergraduate
JACK LEI, Computer and Information Science Undergraduate
KENZIE ROSE, Architecture Undergraduate
LUCY ROBERTS, Undeclared Undergraduate
MASON LEAVITT, Italian Undergraduate
MICHAELA FISHBACK, Environmental Science Undergraduate
MORGAN SCAFIDI, Spatial Data Science and Technology Undergraduate
NOAH TIGNER, Computer and Information Science Undergraduate
SABRINA AYYOUB, Spatial Data Science and Technology Undergraduate
SEAN WILSON, Computer and Information Science Undergraduate
YALIN LI, Environmental Science Undergraduate

Executive Summary

Students in the spring 2020 Advanced GIS course worked together with Lane Transit District to assess how bike-share coverage could be expanded to develop multimodal transit stops and provide greater public transportation opportunities for underserved areas and populations. The students worked independently using spatial datasets that reflected demand for bike-share expansion according to previous reports from the bike-share program and external research. While students based demand on a variety of different factors, the density of residential areas and businesses was a major component in these analyses. Students used map locations of the current LTD bus lines to prioritize the use of the bike-share system in conjunction with the bus system. Additionally, location and route data from bike-share user history was included in many projects in order to reflect actual usage patterns.

The result of each analysis was a suitability map that visualized demand for bike-share station placement based on the specific parameters of each individual project. Demand for station placement was assessed both within and outside of the bike-share program's current operating zone, with some projects putting a focus on specific populations such as low-income and minority residents. The results of these individual analyses show demand for bike-share expansion across a number of different areas, with recommendations including increasing the station density within the current operating zone and adding stations to multiple locations outside of the current operating zone. Areas that were revealed by several different analyses include the student housing areas around Autzen Stadium, the Gateway Mall area, and in west Eugene just beyond the current zone. Student projects covered a wide variety of perspectives within the overall goals, with the inclusion of different datasets demonstrating the scope of geospatial analysis in addressing questions of regional demand.

Introduction

This report is a review of the projects created by students of the spring 2020 Advanced GIS course at the University of Oregon. Each student worked independently on a final project to assess how the PeaceHealth Rides bike-share system could expand coverage and accessibility across the Eugene-Springfield area. The goals for the project included bringing more public transportation opportunities to underserved areas and populations, with a focus on expanding bike-share to increase multimodal transit stops for bus riders and bike-share users.

Student analysts and faculty collaborated with Lane Transit District to identify which approaches would best address these general goals, with individual projects focusing on different perspectives. Conversations with staff and previous suitability analyses for the bike-share program helped inform what data best represented demand for bike-share expansion. Students were encouraged to draw upon the methods used in the Eugene Bike Share Feasibility Study, which used geospatial analysis to explore demand for Bike-Share prior to the implementation of the PeaceHealth Rides program (Toole Design Group, 2014). Students narrowed the overall goal into a few subsets, allowing students to concentrate on a specific aspect of the issue. Each project focused on one or more of the following topics:

- Investigating ideal sites for locating new bike-share stations
- Determining locations that foster multimodal transit opportunities
- Expanding bike-share services to underserved populations and underserved areas

GIS provides a framework to assemble and analyze geospatial data to address any number of topics. For the goals outlined in this report, a GIS analysis compiles different components into a map that visualizes locations that are most suitable according to the parameters provided. A growing repository of geospatial data is becoming widely available, with increasing significance in the investigation of topics with cultural and economic patterns. In preparing students to develop projects for expanding the bike-share network, this class emphasized exploring data sources and relevant themes to address targeted goals.

Analysis Process and Data

The product of these student analyses took the form of suitability maps that identified which regions would be most suitable for expansion of the bike-share program. These analyses were performed in ArcGIS Pro using methods that students mastered over the course of the term. The primary method used was a weighted overlay analysis, which combines multiple spatial data layers to find common areas of high suitability across all layers. In this type of analysis, different data layers are weighted differently according to the relative importance of each topic.

The types of data included in each project depended on the individual focus and what factors each student identified to best represent bike-share demand. Most commonly, demand was at least partially expressed by residential and workplace density, data that was primarily sourced from the U.S. Census Bureau's Longitudinal Employer-Household Dynamics (2017). Certain analyses that put a focus on low-income or minority communities used subsets of this data that were divided by monthly income or race. In order to prioritize the development of multimodal transit opportunities, data provided by LTD on transit routes and stops was also included. This dataset included values showing the average boarding numbers for each stop to allow the selection of locations with high numbers of regular transit users.

Bike-share usage figures provided by the PeaceHealth Rides program served as an additional data source used in these projects. The figures included the starting and stopping locations of each trip as well as the duration, distance, and route taken during each ride. This information can be used to assess a number of different usage patterns, such as exploring demand for expansion by analyzing where bikes are left outside of designated hubs.

Due to the relatively open-ended nature of these individual projects, a wide variety of additional datasets were used depending on the focus of the analysis. Some of these included commuting data, locations of certain amenities (e.g. grocery stores, parks), and streets and paths suitable for bicycles provided by the city of Eugene.

The results of these analyses are divided according to expansion within and outside the current bike-share operating zone, an exploration of how bike-share data on user patterns can inform spatial analyses, and examples of some of the datasets used in these GIS projects.

Increasing Coverage Within the Current Operating Zone

The current operating zone largely serves individuals that either live near or make trips to the downtown area of Eugene, a region defined by the highest overall demand for use of a bike-share system. Successful bike-share networks have been shown to be dependent on a high density of stations, maintaining an easy walking distance between locations. The recommended distance has been stated as no more than 1,000 ft between stations (NACTO, 2015). While producing this density across the entire network may not be feasible for a smaller city like Eugene, it supports the need for increasing coverage within the areas of highest demand. Major factors contributing to areas of local demand include high residential and business density, the university district, and bicycle friendly streets and paths. While certain areas within the current operating zone have a high density of bike-share hubs, other areas could benefit from more accessible hubs. The suitability analyses described in this section provide insight into additional areas of demand within the current operating zone.

EXPANSION ADDRESSING GENERAL DEMAND

Multiple different analyses focused on assessing areas of demand for bike-share based on residence and workplace density as well as availability of bus transit and general amenities. Most analyses that were based on the inclusion of these parameters as well as additional factors described below, with results repeatedly showing that the area currently covered by the bike-share operating zone holds the highest demand for bike-share hub locations. While this is a confirmation that the current operating zone successfully serves high demand areas, there is still room for increasing the density of hubs within this zone. In particular, this region could benefit from greater multimodal connectivity between bike-share and the LTD bus system.

One analysis that assessed placement of multimodal bike-share hubs in this region used data that focused on demand from both high-density residential and workplace areas that prioritized workers who did not commute by car. The analysis included proximity of amenities (e.g. community centers, shopping, etc.) and transit stops that had high ridership. Using geographic analysis to combine these datasets, the resulting map showed multiple areas largely within the current operating that would benefit from multimodal transportation use (Figure 1). Specific recommended locations from this analysis include Valley River Center and the junctions of:

- Mill Street and Hilyard Street
- Charnelton Street and W. 11th Avenue
- 14th Avenue and Hilyard Street
- Kincaid Street and E. 14th Street
- 22nd Avenue and Hilyard Street

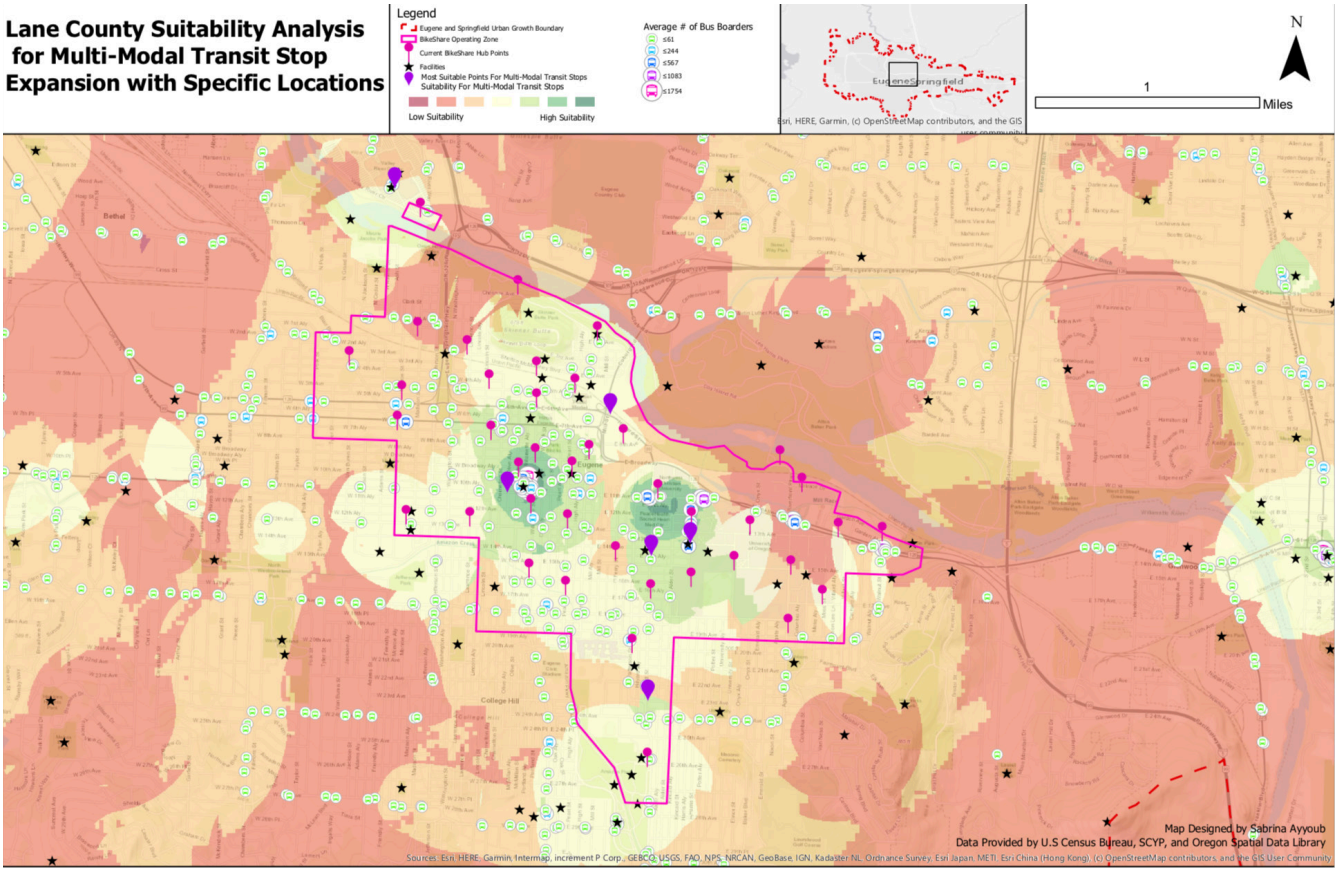


FIG. 1
Suitability map by Sabrina Ayyoub

EXPANSION FOCUSED ON RENTERS AND LOW-INCOME POPULATIONS

Additional geographic analyses that retained a focus on the region of the current operating zone chose to include a focus on specific groups of people. The expansion of the bike-share system to address accessibility for low-income and underserved populations can be assessed with different types of spatial and demographic data.

In an analysis that was aimed at promoting multimodal transport for low-income residents and college students, demographic data was used to calculate housing density for individuals who were renters as opposed to home owners. This suitability analysis prioritized areas close to bus transit stops and existing bike-share hub locations, as well as workplaces with high numbers of employees. The inclusion of user data from previous rides on PeaceHealth bicycles guided the analysis to select for streets with high bicycle use, and locations of most common destinations for bike-share users. The combination of these spatial data layers produced a suitability map showing the highest demand centered near the University of Oregon campus (Figure 2). Specific recommended areas from this analysis include:

- W. 13th Avenue near the UO campus
- Alder Street near the UO campus
- E. 17th Avenue
- E. 14th Avenue and Hilyard Street

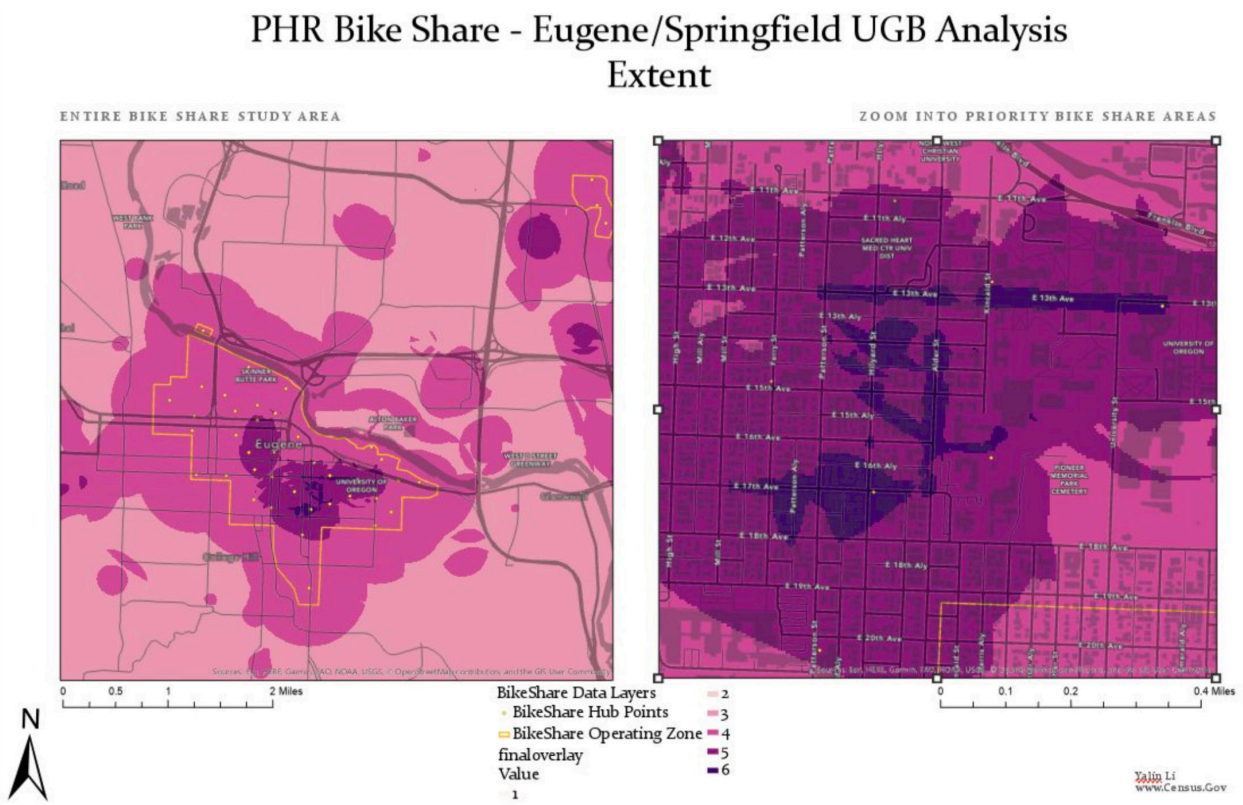


FIG. 2
Suitability map by Yalin Li

A separate analysis assessed increasing multimodal transportation accessibility for low-income populations using LEHD data for individuals earning less than $1,250/mo. To evaluate origin-destination demand for these individuals, density maps of both residence and workplace locations were used to inform the demographic basis for this dataset. For the evaluation of multimodal expansion, this suitability analysis prioritized areas with high transit ridership as well as the most frequented routes taken by bike-share users. The combination of these spatial data layers and an exclusion of current bike-share hub locations produced a suitability map that shows areas in the central region of the current operating zone that would be most suitable for improving multimodal transportation opportunities for low-income populations (Figure 3). Specific recommended locations from this analysis include the junctions of:

- E. 13th Avenue and Hilyard Street
- E. 14th Avenue and Alder Street
- E. 11th Avenue and Ferry Alley
- E. 11th Avenue and Oak Street
- W. Broadway Alley and Charnelton Street
- E. 13th Avenue and Willamette Street
- W. 6th Alley and Lincoln Street
- W. 12th Avenue and Charnelton Street
- W. 5th Avenue and Charnelton Street

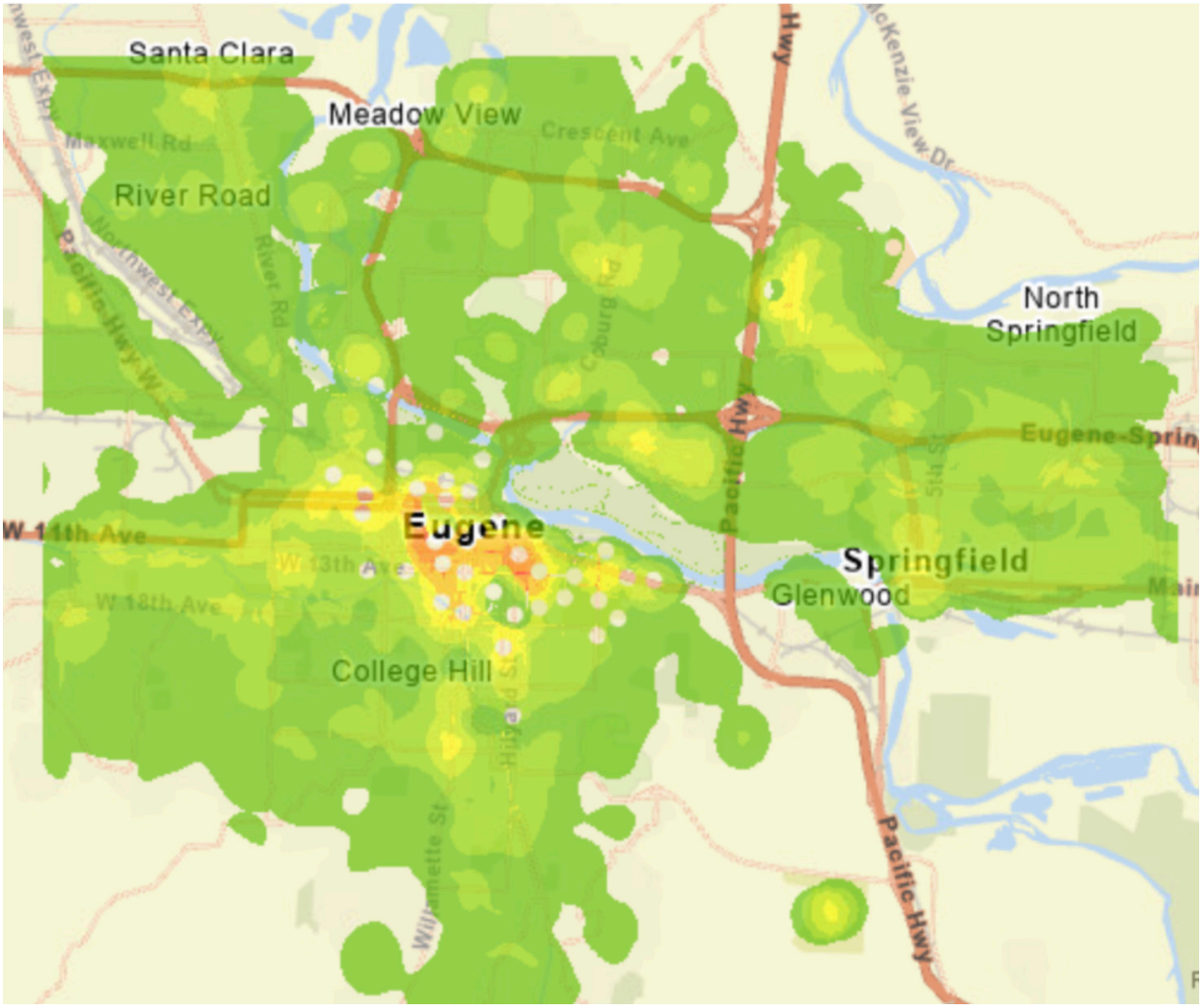


FIG. 3
Suitability map by Kenzie Rose

These analyses demonstrate that there is demand in multiple areas for the placement of additional hubs within the current operating zone. With bike-share being used primarily for short trips, maintaining high station density makes the bike-share system more accessible as many users will not want to walk or travel long distances to reach a hub. A large number of low-income residents live within the area covered by the current operating zone and increasing station density would aid multimodal transportation opportunities for these and other groups.

Expanding Coverage Outside of the Current Operating Zone

The bike-share network serves downtown Eugene and the areas surrounding it, however with the success of the program it is worth considering opportunities for expansion. Network expansion can include a multitude of different factors, explored from different angles in the analyses described below. Some students chose to specifically exclude the current operating zone in their analysis to identify underserved areas and populations.

ADDRESSING EXPANSION FOR LOW-INCOME AND MINORITY POPULATIONS

Improving equitable access of the bike-share system and multimodal transportation opportunities is an important topic that geographic analysis can approach in a variety of ways. These analyses combined demographic data and supporting spatial data that generated suitability maps to serve low-income and minority populations in the Eugene-Springfield area.

With bike-share presenting opportunities for employment, education, community connection and a reduced dependence on cars for personal transportation, providing these benefits to marginalized or isolated groups should be addressed. This goal was kept in mind in an analysis that used demographic data ranked by the number of individuals living below the poverty line, those without higher education, and areas with higher numbers of non-white residents. General demand was assessed using residence and workplace density, as well as proximity to transit stops and prioritization of areas not currently served by bike-share. An additional data layer gave preference to populations with a 10- to 14-minute commute in order to target commuters with the greatest ability to commute via bicycle. A final layer of bike-share user data was included to select areas where users parked bike-share bicycles outside of the current operating zone. This analysis produced a suitability analysis showing a wide variety of areas with high suitability (Figure 4). Specific recommended locations from this analysis include:

- Garfield Park
- Franklin Blvd. and Pacific Hwy
- Irwin Park
- Martin Luther King Jr. Blvd
- Multiple Areas Between Coburg Road., Randy Pape Beltline, Pacific Hwy. and Crescent Avenue
- Willagillespie Rd. and Cal Young Road

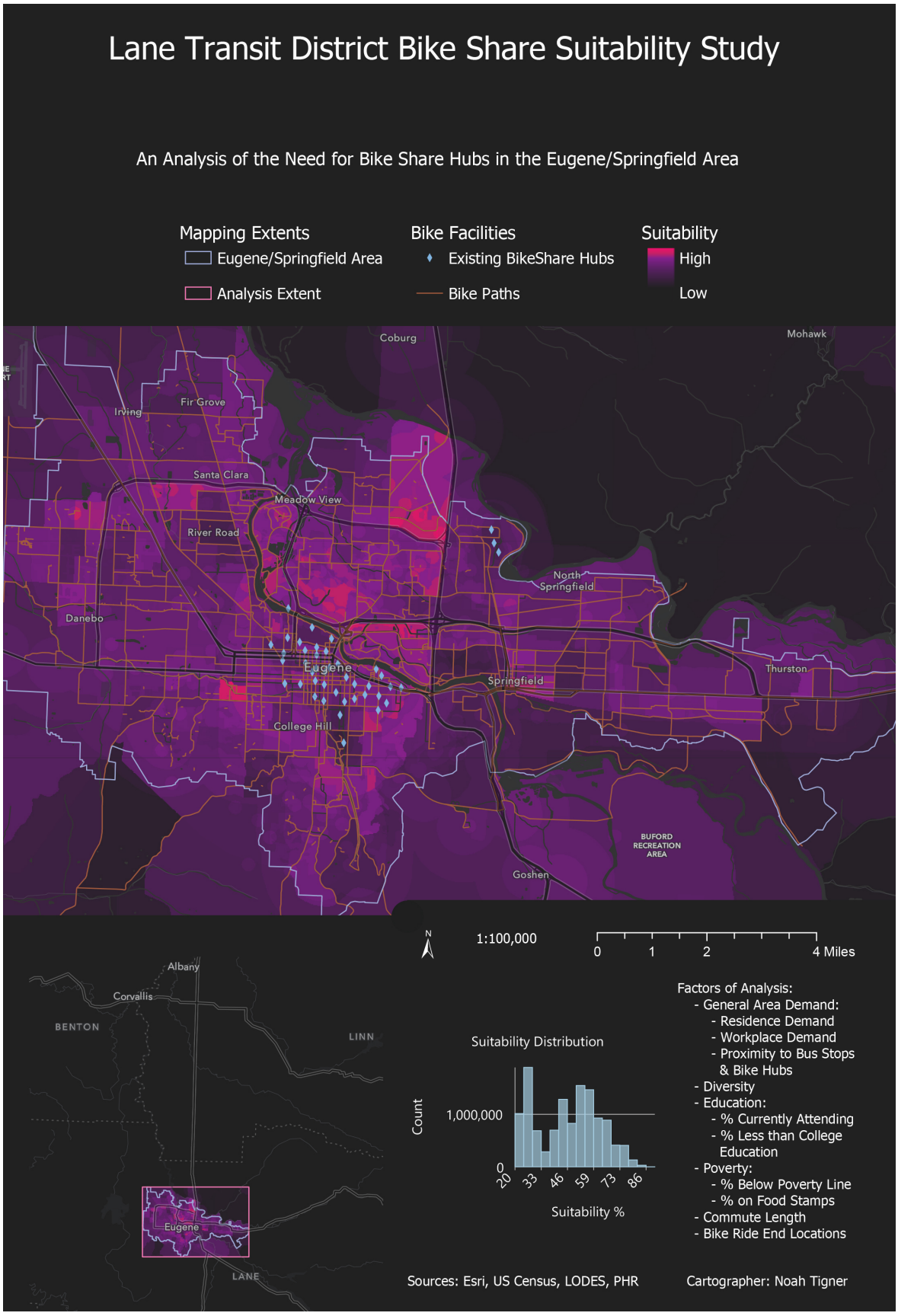


FIG. 4

Suitability map by Noah Tigner

Another student evaluated expansion for low-income groups by assessing how well the current system served these populations, as well as comparing areas where general demand and low-income accessibility demand overlap. This analysis first looked at areas of general demand based on residence and workplace density, amenities, and transit stop locations. A separate map was then created using residence and workplace density for individuals with an income of less than $1,250/mo, along with bike-share user data for beginning and end locations of rides occurring near high density areas. These maps were then combined to find overlapping areas of the highest suitability from each map, with the most suitable locations found near the current operating zone in west Eugene, the Whiteaker neighborhood, south of the University, and near Autzen Stadium. An additional area was found within the current operating zone, near downtown Eugene. These areas represent both high general demand and greater bike-share accessibility for low-income residents (Figure 5).

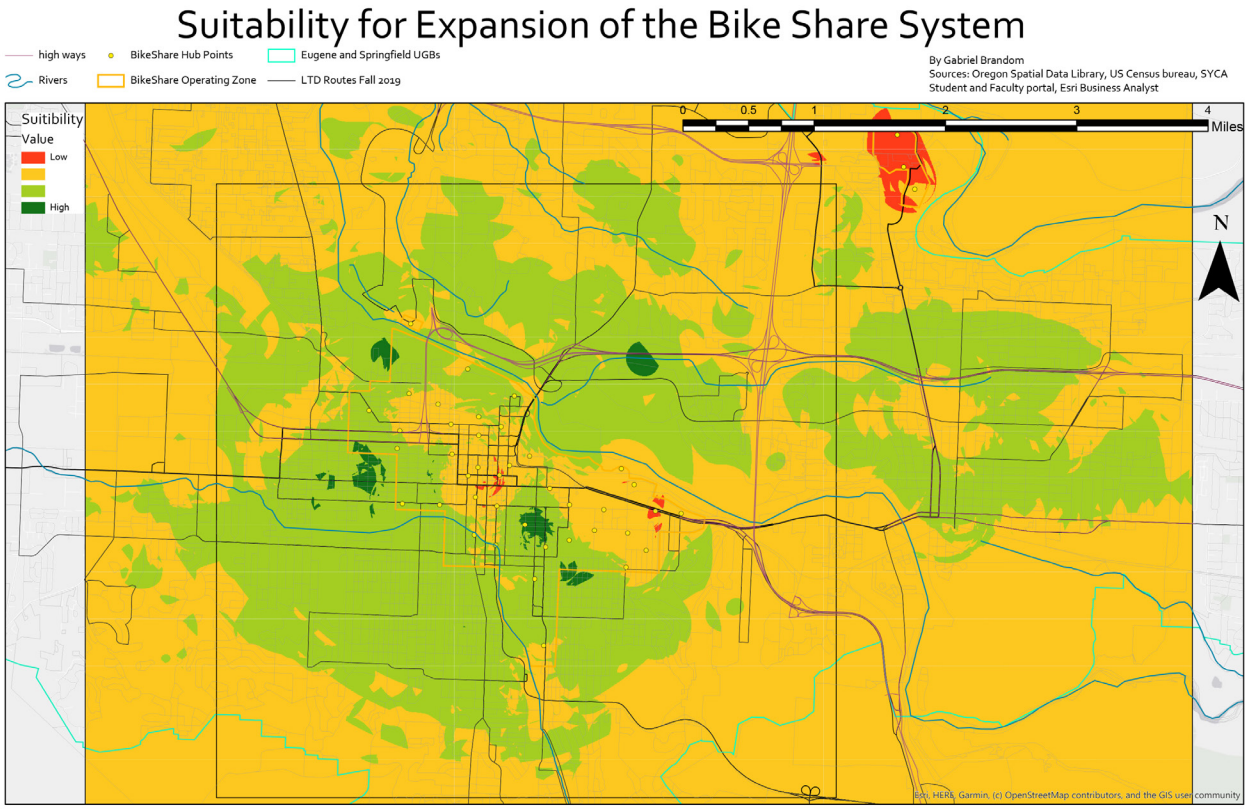
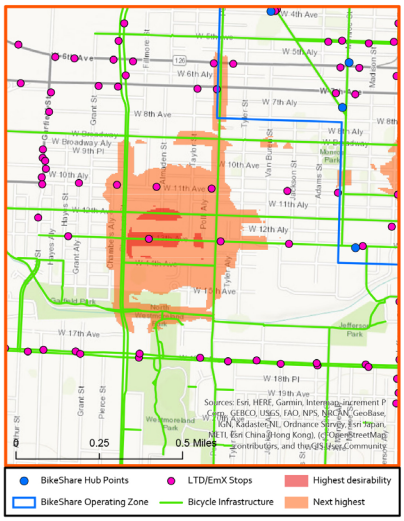


FIG. 5

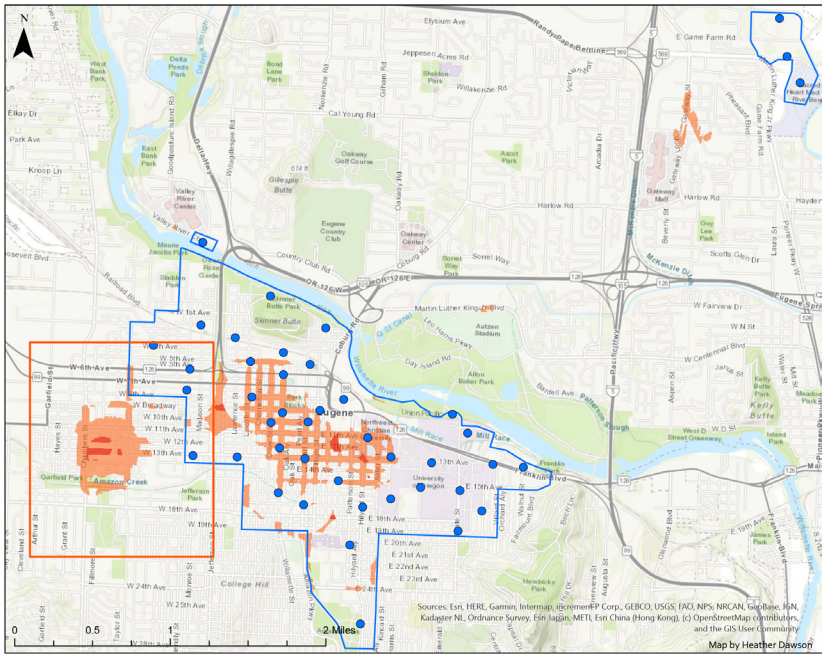
Suitability map by Gabriel Brandom

A similar suitability analysis placed a primary focus on expanding the bike-share system to be more accessible to both low-income and minority groups in Eugene that are not being served by the current bike-share operating zone. In this analysis, safe bicycling opportunities were a primary concern with transit stop accessibility also relevant. The demographic dataset for this project included both residence and workplace location density for low-income (under $1,250/mo) and non-white individuals in the Eugene-

Springfield area. Bicycle safety was taken into account by prioritizing bicycle paths and streets with bike lanes, as well as bike-share user data to highlight routes preferred by bike-share users. Finally, LTD transit stops were included to foster multimodal transit options. While the area surrounding existing hubs was given the lowest priority, the final suitability map showed that demand in these areas was still high indicating that the current operating zone provides bike-share to a number of individuals in low-income and minority groups. However, the suitability map also displayed one region directly west of the current operating zone that could benefit from bike-share expansion (Figure 6).



The areas that scored the highest on the weighted overlay map were selected using the raster calculator function, which revealed one significant region in West Eugene that could be examined to expand bikeshare to low-income and minority populations. When considering which places to locate new stations, specific factors can be taken into account such as proximity to amenities. The map region above encompasses a large stretch of the Fern Ridge bike path, the popular Westmoreland Park, grocery stores, restaurants, unitarian and Christian churches, a food pantry, access to public transit, and bicycle friendly streets.

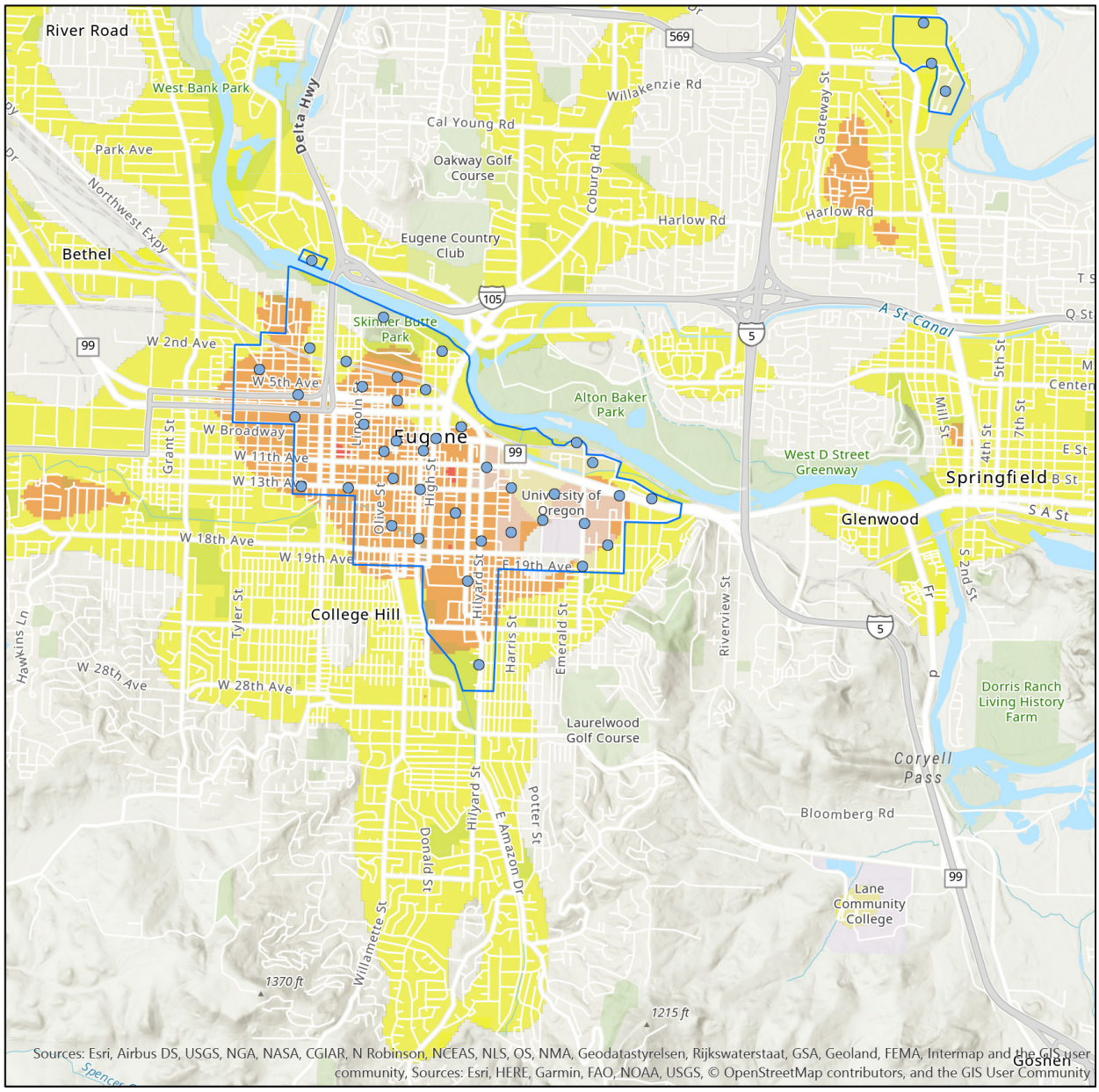


A map showing all areas that scored the highest from the weighted overlay analysis. Areas within the current operating zone will be excluded from consideration, as they are already being served. The main focus will be on the region in West Eugene (the red-bordered area), although future analyses could explore the small highlighted area near the Riverbend bikeshare stations.

FIG. 6

Suitability map by Heather Dawson

A final analysis concentrated solely on expanding multimodal opportunities for minority groups by identifying new bike-share hub locations near transit stops in areas of higher density non-white populations. Demographic data, transit stop data, and existing bike-share hubs were combined to create a suitability map that prioritized minority population density, with a secondary focus on transit stop density. Data on existing bike-share hubs gave greater weight to areas beyond 1,000 feet of any bike-share hubs in order to reach underserved areas. The resulting suitability map shows that the current operating zone serves a number of minority groups in Eugene, showing similar results to some of the previous analyses. However, additional isolated regions in west Eugene and the Gateway Mall area show demand for expansion outside the current operating zone (Figure 7).



Legend

BikeShare Data Layers

- BikeShare Hub Points
- BikeShare Operating Zone

Weighted Overlay

Value

- High
- Intermediate
- Low

0 1 2 Miles

N

FIG. 7

Suitability map by Michaela Fishback

INCREASING ACCESS TO STUDENT HOUSING AREAS AND FOOD SERVICES

The student population in the Eugene-Springfield area makes up a significant portion of bike-share users, and there are a number of high-density student housing areas that lie outside of the current operating zone. As many students rely on public transportation to get to school and for food and groceries, improving access to these destinations through increased bike-share coverage would benefit the student population not currently served by the bike-share operating zone. Several analyses found that there is demand for expansion to the student housing areas near Autzen Stadium. Improving access to food services and grocery stores benefits both the student population and the general population.

Two projects focused on student demand by using residential data for areas with high density student housing and included additional data on transit stops, businesses and amenities, and bicycle friendly streets to factor in overall demand and multimodal accessibility. Locations of current bike-share hubs were also considered in the analysis to focus on areas not currently served by bike-share. Both analyses favored expansion to student housing areas including Duck's Village, Stadium Park, and Chase Village. The projects produced differing results in some regions, with one analysis also noting potential near both W. 11th Avenue and the Gateway Mall area (Figure 8).

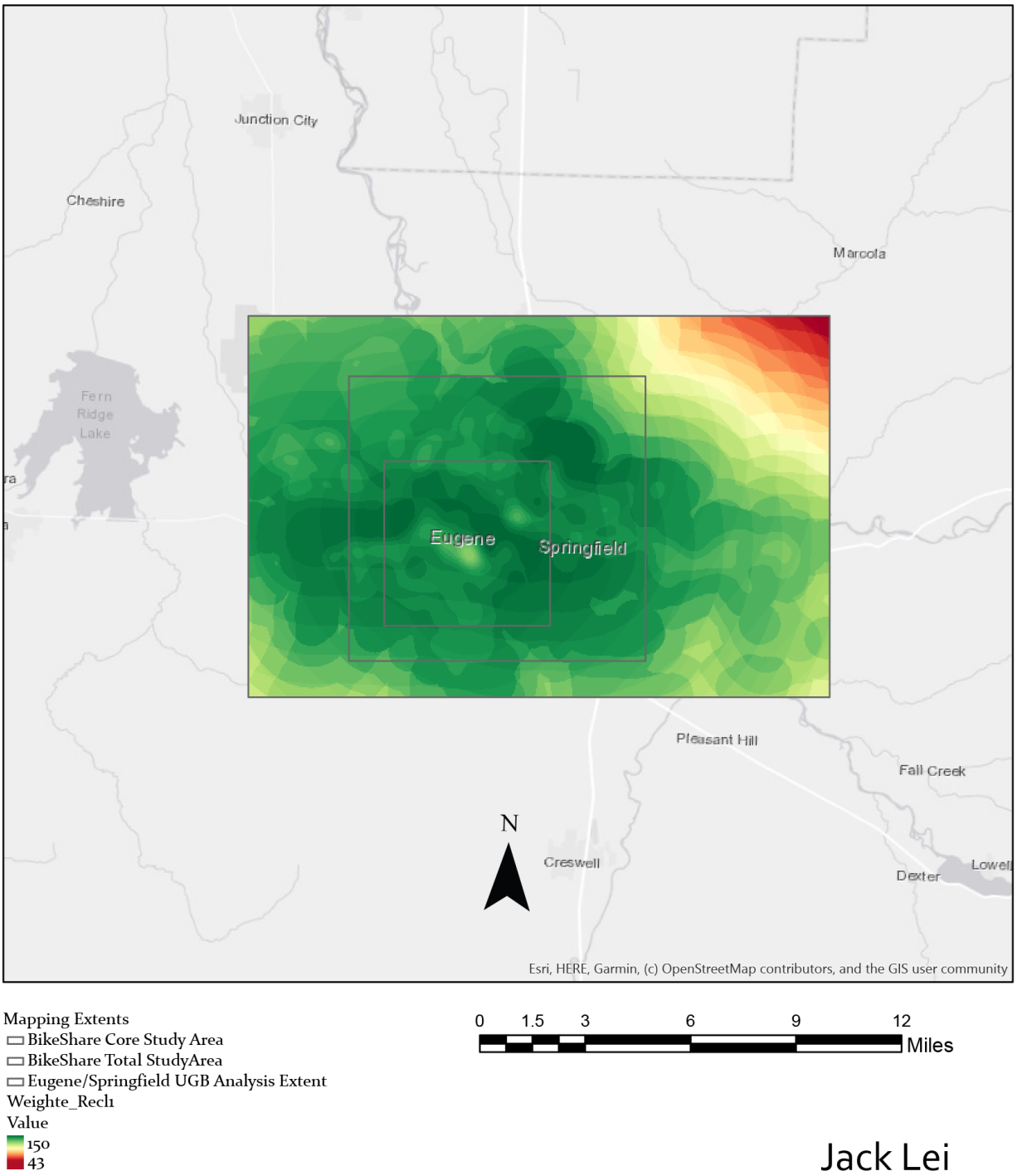


FIG. 8
Suitability map by Jack Lei

The other analysis (by Andrew Bui) showed additional demand within the current operating zone, near the Safeway grocery store on W. 18th Avenue.

A separate analysis was primarily centered around making grocery stores more accessible to individuals relying on public transportation. To assess where bike-share expansion would have the greatest impact in reaching this goal, the analysis gave grocery store location data the highest priority, followed by transit stop locations,

workplace and residential data, and locations of current bike-share hubs to maintain station density. The results of this suitability analysis showed a number of potential areas outside of the current operating zone. These areas include the west side of Amazon Park, Duck's Village and Autzen Stadium, and Oakway Center. The Oakway Center and the area near Amazon Park would improve access to a variety of grocery stores (Figure 9).

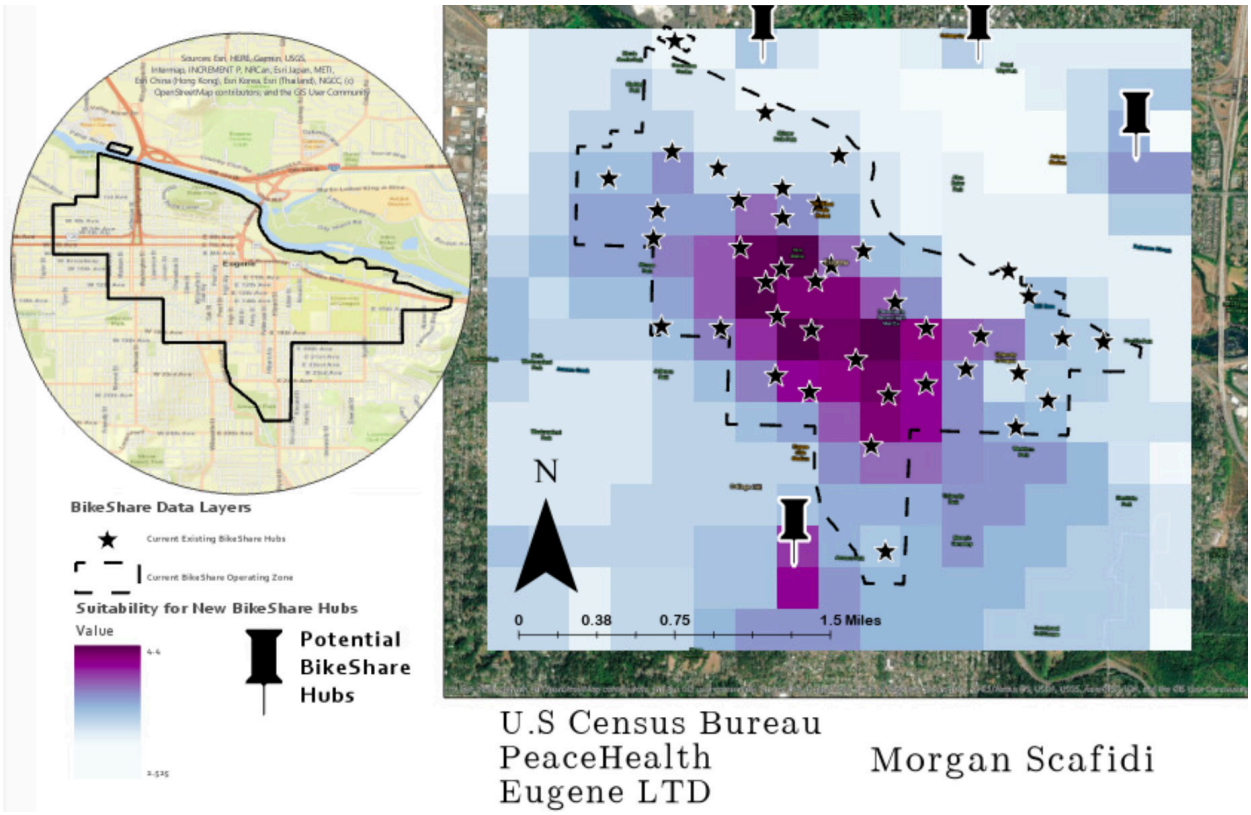


FIG. 9
Suitability map by Morgan Scafidi

EXPANDING THE BIKE-SHARE SYSTEM TO SPRINGFIELD

With the city of Springfield growing in size, the residents and visitors of the City could benefit from inclusion in the bike-share system. The transit system between Eugene and Springfield is well-connected and serves residents in both towns. The presence of established public transportation in Springfield opens up possibilities for increased multimodal transit opportunities by adding bike-share stations near Springfield bus lines.

Demand for expanding the bike-share system to Springfield was demonstrated by a suitability analysis that gave priority mainly to transit accessibility and grocery and dining locations. The analysis gave weight to transit stops with high boarding numbers and prioritized the density of grocery stores, restaurants, and cafes. Entertainment, recreational, and cultural attractions were also included in the analysis in order to focus on areas with diverse destination options. The final suitability map shows high demand

in the current bike-share operating zone, with another area of high demand around downtown Springfield. This suggests that the downtown area has a number of services and attractions that are accessible from the transit system and could benefit from the multimodal opportunities offered by the bike-share system (Figure 10).

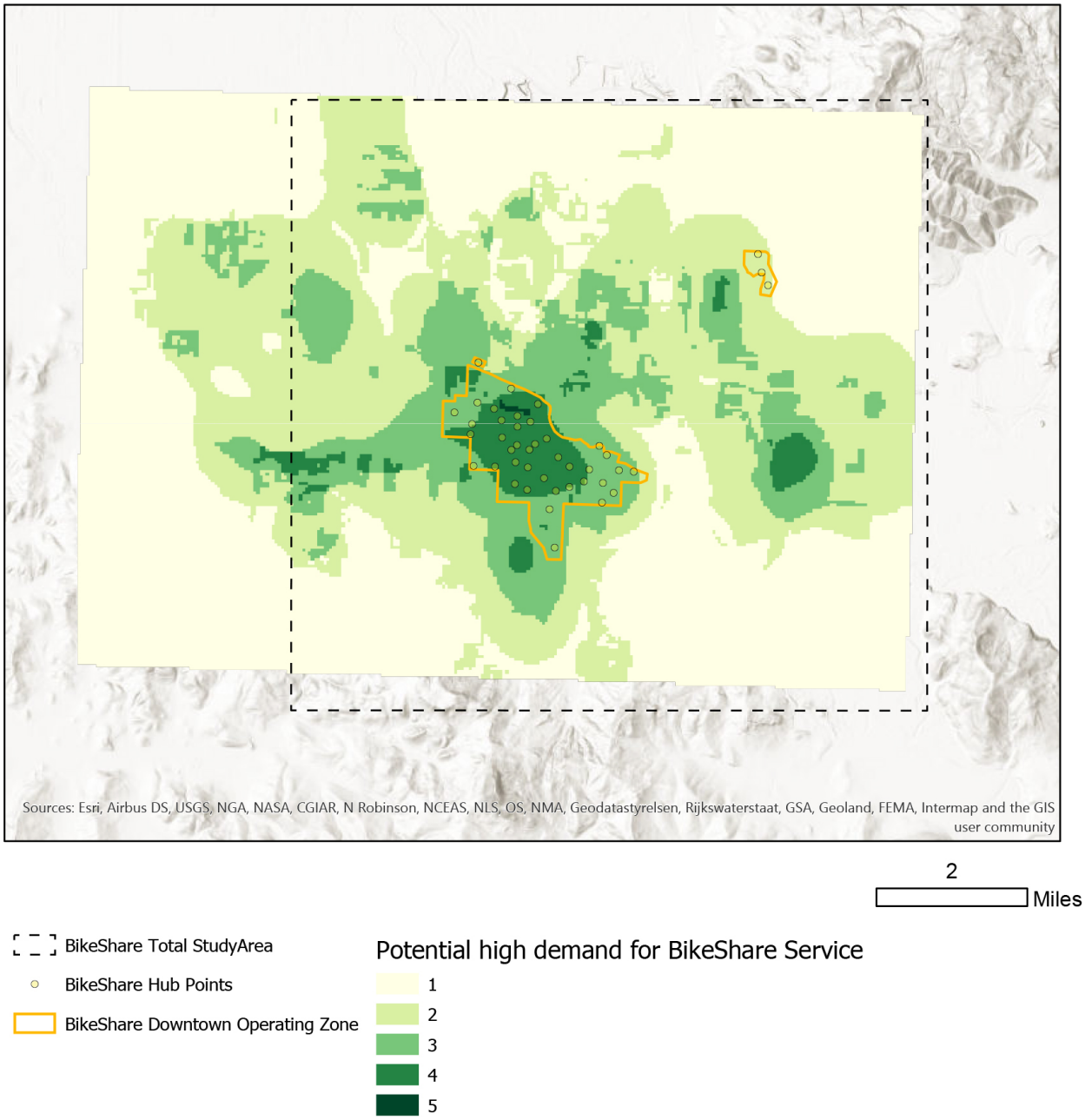
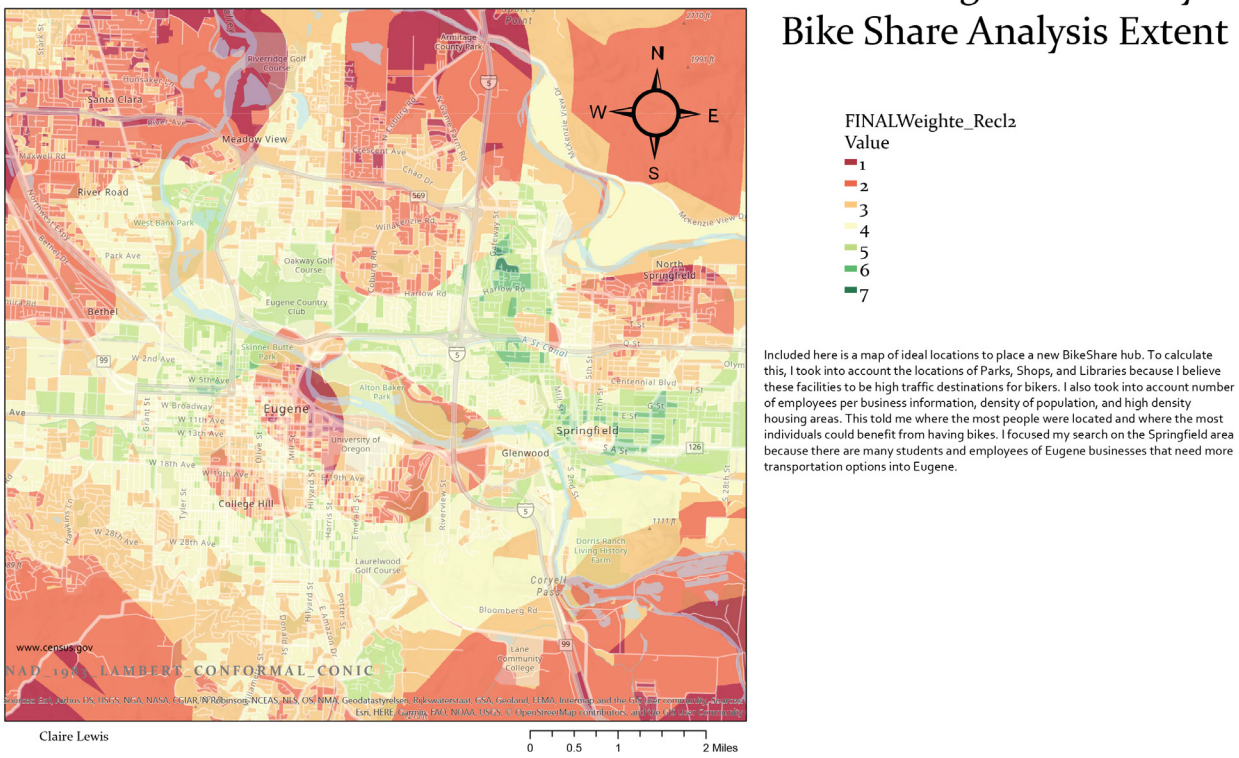


FIG. 10

Suitability map by Gabrielle Henrion

A second project chose to prioritize the Springfield area for bike-share expansion, particularly for connection with the Eugene bike-share system to provide an alternative form of travel for individuals going to and from Eugene on a regular basis. The analysis assessed general demand through residence and workplace density, and the density of amenities such as parks, libraries, and shops. The analysis prioritized areas of high demand within the Springfield city limits. In the final suitability map, the area with the highest demand is centered around the Gateway Mall. Additional demand is scattered around Springfield, including multiple areas near downtown (Figure 11).



Claire Lewis

FIG. 11

Suitability map by Claire Lewis

In summary, these different approaches for assessing bike-share expansion demand outside of the current operating zone show a wide variety of different locations. Several analyses focusing on reaching low-income and minority residents showed demand in west Eugene. Multiple analyses with different focuses identified the Autzen Stadium and Gateway Mall areas as having high suitability for bike-share expansion.

Utilizing Bike-share User Data for Geographic Analysis

The bike-share program collects usage data for all system bicycles, providing opportunities to include actual patterns of use in spatial analyses. This data includes the starting and stopping locations of each ride, the route taken, and ride distance and duration. A number of projects used certain factors from this dataset to reflect how the Eugene bike-share users use the bike-share system. One example of how this data can be used is using route history to create a density analysis, creating a map of the paths that see the most bike-share use. This density map offers insight into user demand and provides on-the-ground data for routes with greater bicycle safety (Figure 12).

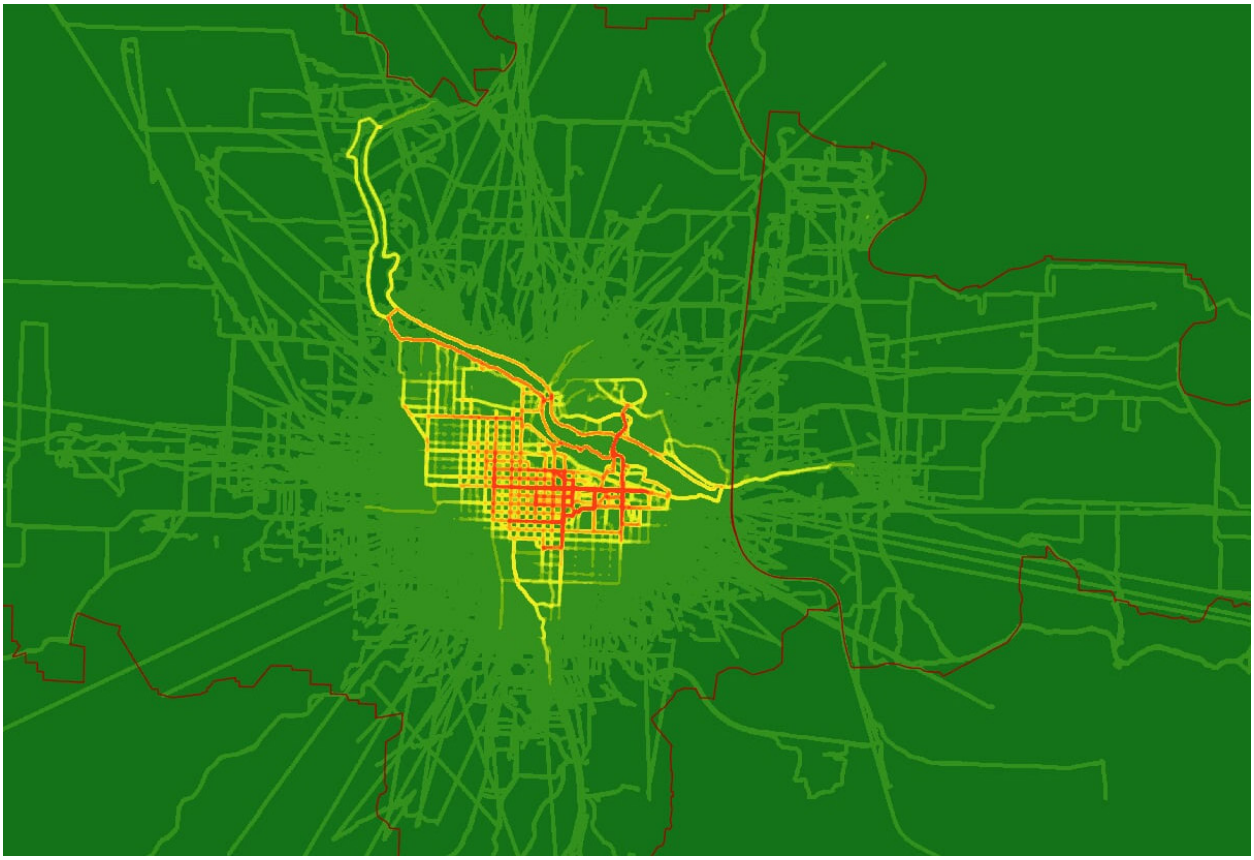


FIG. 12
Density map of routes taken by PeaceHealth Rides users from June 2019 to April 2020

A similar analysis used starting and stopping locations to identify areas with high origin and destination demand. The analyses included below describe how bike-share user data can be used to assess demand and track changes in usage.

USING RIDE BEGINNING- AND END-POINT LOCATIONS TO ASSESS DEMAND

The bike-share user data includes the precise locations of where individual rides ended outside of docking sites, which can be used to look for potential areas of demand that do not currently have bike-share hubs. One project made a density map of ride destinations that fell outside the current operating zone to identify existing bike-share demand in underserved areas. The density map showed distinctly higher demand north of the currently operating zone in the Autzen Stadium and Oakway Center regions (Figure 13).

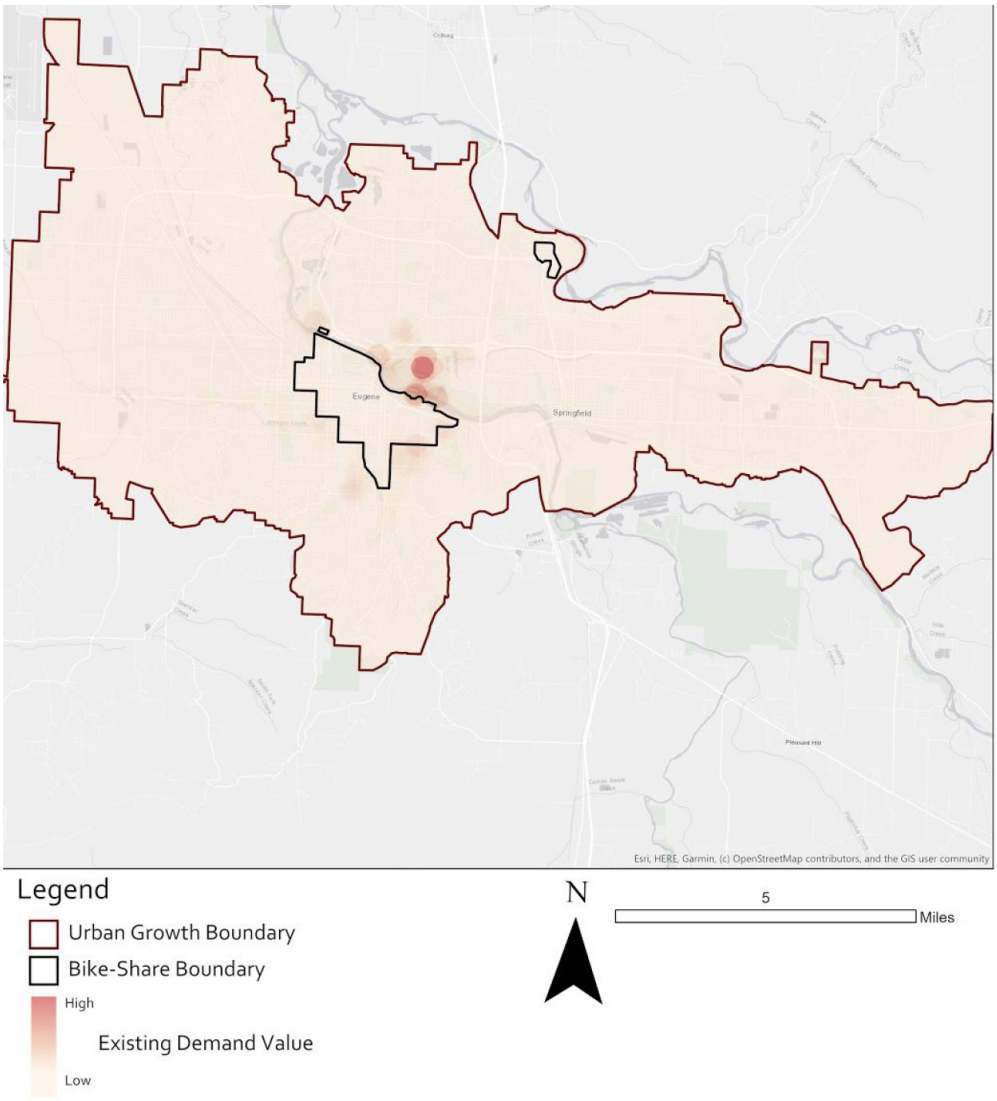


FIG. 13

Density map by Mason Leavitt

In a different analysis by Noah Tigner (described on page 13), end point density was also included as a supporting layer in a weighted overlay analysis to identify underserved areas.

The bike-share user data also allows for interesting analysis opportunities using rides from certain seasons or times. In order to examine user demand from non-students, one analysis looked at ride destinations during the month of August when classes are not in session. The analysis looked at the density of ride destinations outside the current operating zone and found numerous high-density areas (Figure 14). This density map was included as a layer in an overall suitability analysis for multimodal transit expansion, including data on residence and workplace demand as well as transit stop locations. The final analysis identified areas of demand in west Eugene, the Whiteaker neighborhood, near Amazon Park, and east of the University of Oregon (Figure 15).

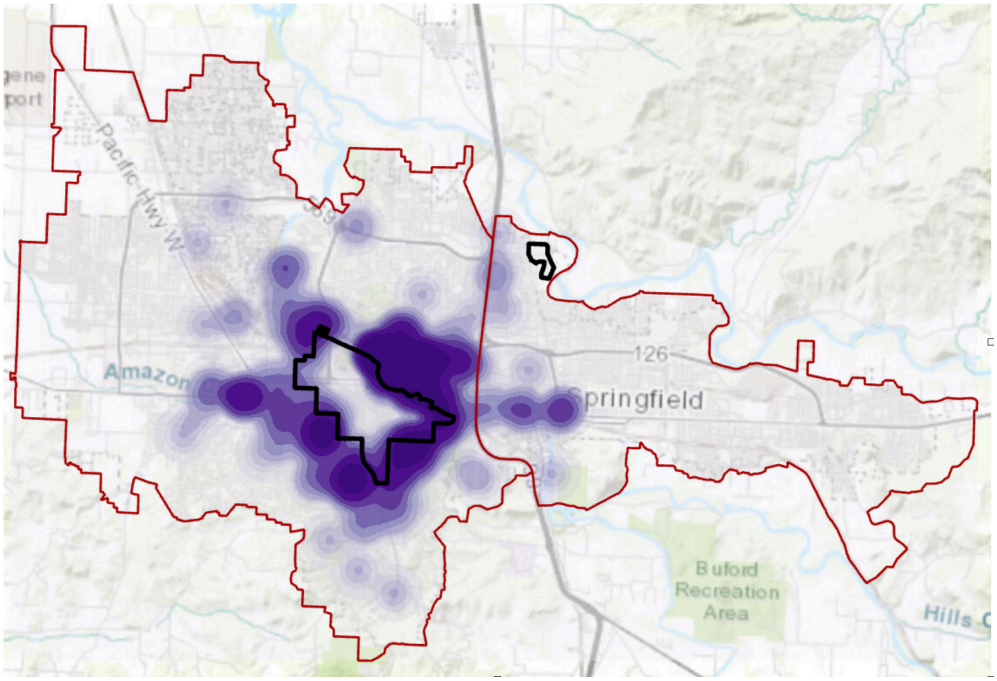


FIG. 14
Density map by Allie Quinn

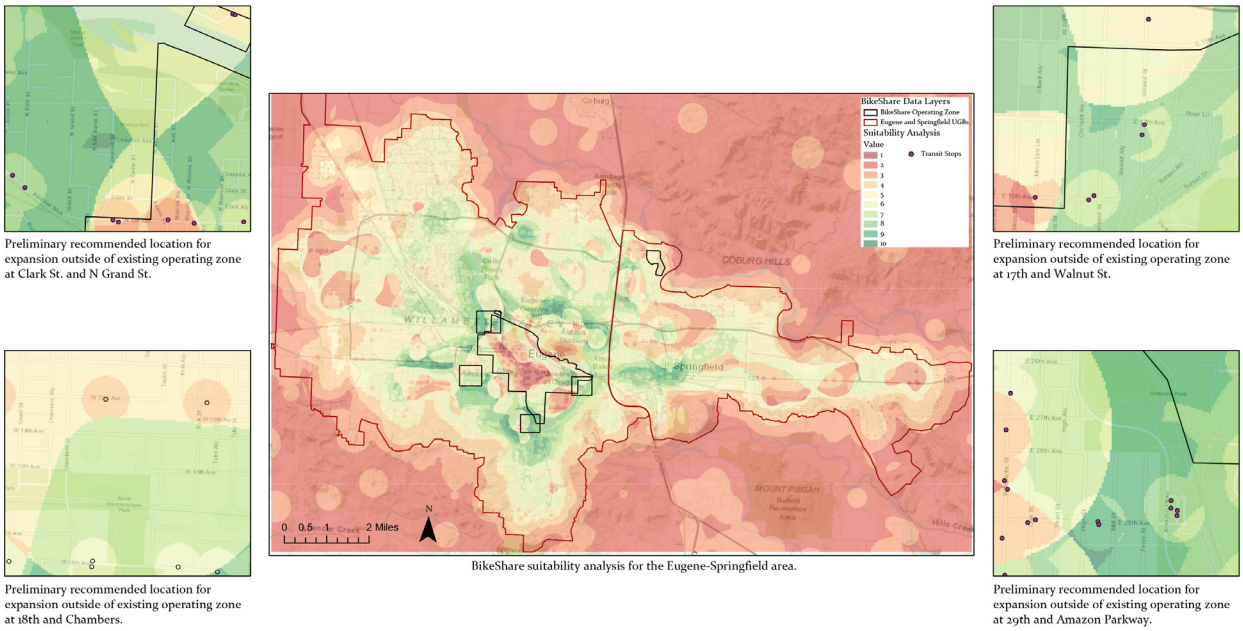
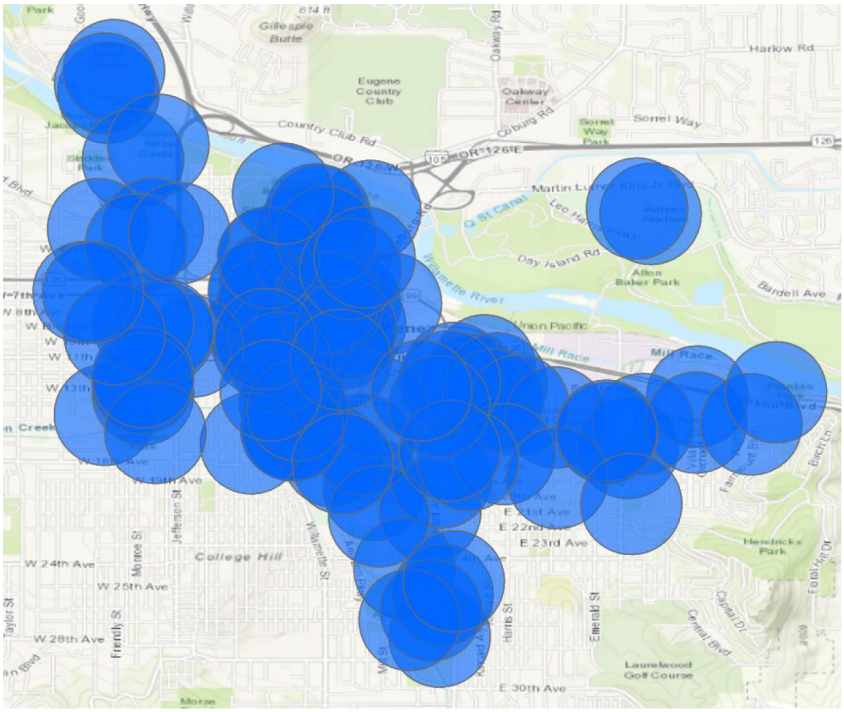


FIG. 15

Suitability map by Allie Quinn

An additional method to assess demand was considered in an analysis that evaluated amenities that are most popular with bike-share users. The analysis used facilities data from the city of Eugene and selected the amenities with the most beginning and end location data points in their general vicinity (defined in this analysis as a 400-meter radius). All amenities that had over 1000 origin and destination data points were selected and ranked by type, producing a list that ranks some of the most frequently used facilities by bike-share users (Figure 16).



Amenities Containing ≥ 1,000 START/END points

i. The Arts
ii. Park
iii. Clinic
iv. Recreation
v. Care Facility
vi. University
vii. Landing Zone
viii. LTD Transit Station
ix. Museum
x. Private School
xi. Retirement Ctr
xii. Community Cntr
xiii. Post Office
xiv. Fire Station
xv. Gov't Office
xvi. Police Station
xvii. Shopping Center
xviii. Transportation
xix. Winery

FIG. 16

Map and ranked list of amenities by Sean Wilson

EMPLOYING USER DATA TO INFORM CHANGES IN USAGE DURING A PANDEMIC

As the bike-share system has been in place since 2018, data on bike-share usage can be compared for a single season across multiple years. As this class was in session during the start of the COVID-19 pandemic shutdown in Lane County, an opportunity presented itself to examine how the bike-share system was used during April 2020 compared to April 2019 when city operations were normal. This analysis used starting and ending location data as well as the distance, duration, and total ride numbers to track changes in bike-share usage during the pandemic. Starting and ending location data between 2019 and 2020 showed that usage shifted away from the University of Oregon campus to student housing areas, indicating that students were still using the bike-share system but not for transportation between classes and other on-campus duties. A comparison of distance and duration showed that while substantially fewer rides were taken during the month of April 2020, the average ride distance increased from 1.1 miles to 2.5 miles and the average duration more than doubled from 13 minutes to 31 minutes. This was largely due to an increase in using the bike-share system for recreation and exercise, demonstrated by the high proportion of rides taken during this time that made a continuous loop rather than stopping at a location other than the point of origin. This shift in usage patterns demonstrates how the bike-share system is utilized when demand for transportation is greatly reduced (Figure 17).

2019	Vs	2020
18,435	*Total Rides in April*	3,565
13 min.	*Average Duration*	31 min.
1.1 mi	*Average Distance (in miles)*	2.5 mi
1,337 (7.2%)	*Number of trips that start and end in the same hub (% of total)*	1,207 (34%)
Thursday	*Most Active Days of Week*	Tuesday & Thursday

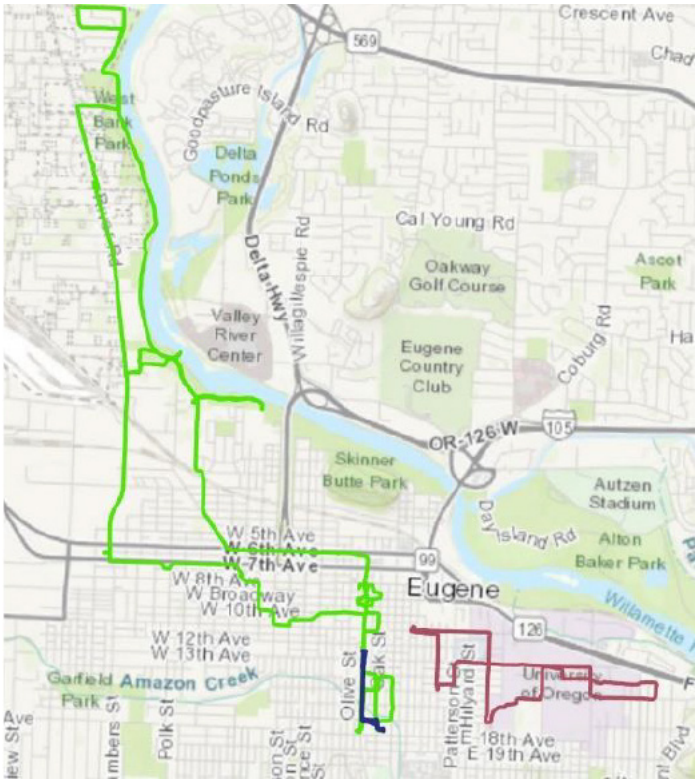


FIG. 17

Data analyzed by Lucy Roberts comparing bike-share usage in April 2019 and April 2020 (left). A map showing different ride patterns demonstrates (in green) a recreational ride path (right)

These projects offer some examples of how the bike-share user data can be incorporated into geospatial analysis. This data provides direct evidence of how people use the bike-share system, making it invaluable for substantiating actual demand in analyses that use additional data to seek out hypothetical users (e.g. using census data for population density). Elements of bike-share user data can be used selectively to answer specific questions or highlight patterns of use.

Examples of Datasets to Expand the Scope of Analysis

Geographic analysis can provide insight for a variety of different topics and make spatial data approachable for any audience. These datasets from student projects exemplify the ways that spatial data can be used to visualize and explore a variety of different topics.

VISUALIZING REGIONS MOST SUITABLE FOR ALTERNATIVE TRANSPORTATION

Many city residents rely on public transportation to get around for a variety of reasons, often due to lack of access to a personal vehicle. These individuals represent a high-need group for expanded multimodal transportation options. Census data on the proportion of residents who own cars can be mapped using spatial analysis to highlight areas where people may be more dependent on public transportation. This analysis visualized car ownership by census tract, showing how fewer residents own cars in the core downtown area and in the southeast neighborhoods. This map was recommended as a supporting map for separate demand analyses (Figure 18).

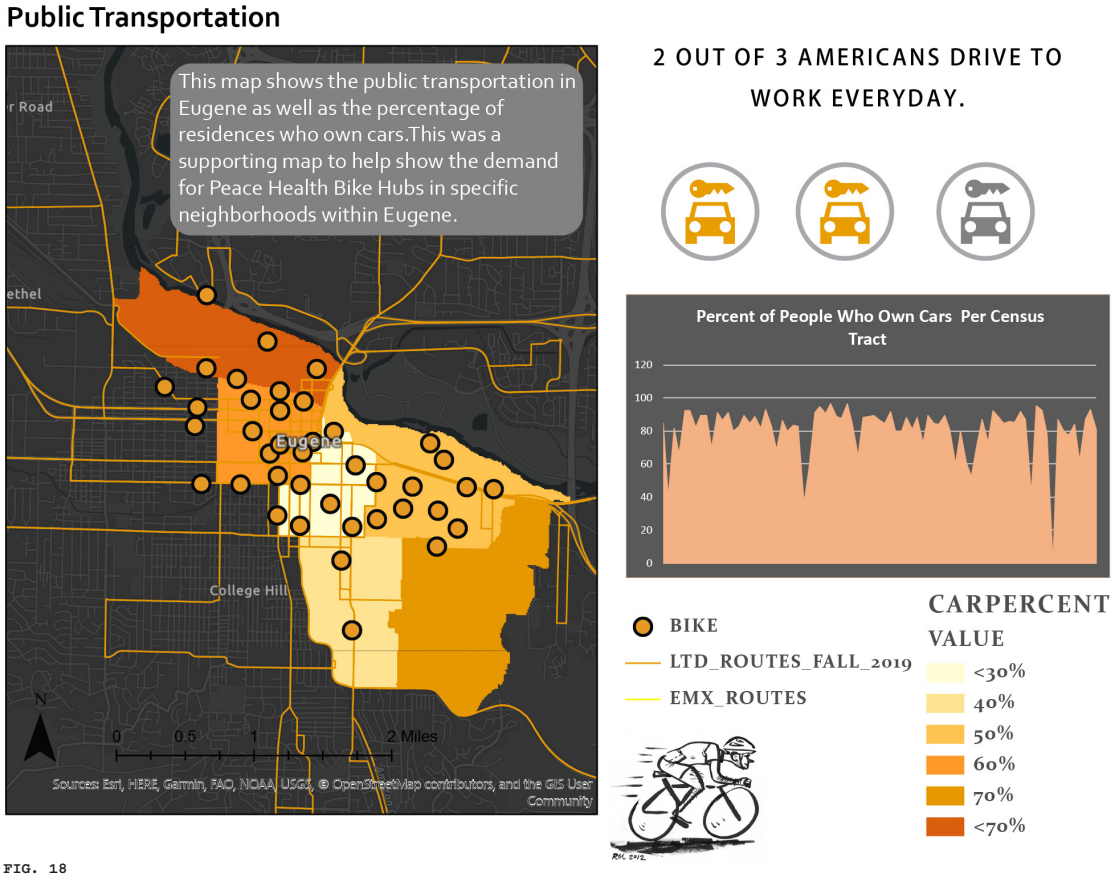


FIG. 18

Map of car ownership by Daisy Hoops

REACHING OUT TO SPECIFIC GROUPS

A number of the analyses described above used census data to prioritize areas with higher percentages of non-white residents. However, this method only takes into account the situational aspects of making bike-share more accessible to minority groups. There may be additional factors to consider such as social barriers. As surveying local minority populations to research social barriers was not feasible for these projects, one analysis chose to map locations of BIPOC-owned businesses (Black, Indigenous, and People of Color) to foster bike-share usage through word-of-mouth. The inclusion of BIPOC business data addresses expanding bike-share to minority communities from a social perspective that census data by race does not provide, demonstrating the different ways geospatial analysis can address issues of equality. This data can be combined with a general demand map to find specific locations that would be suitable for bike-share expansion (Figure 19).

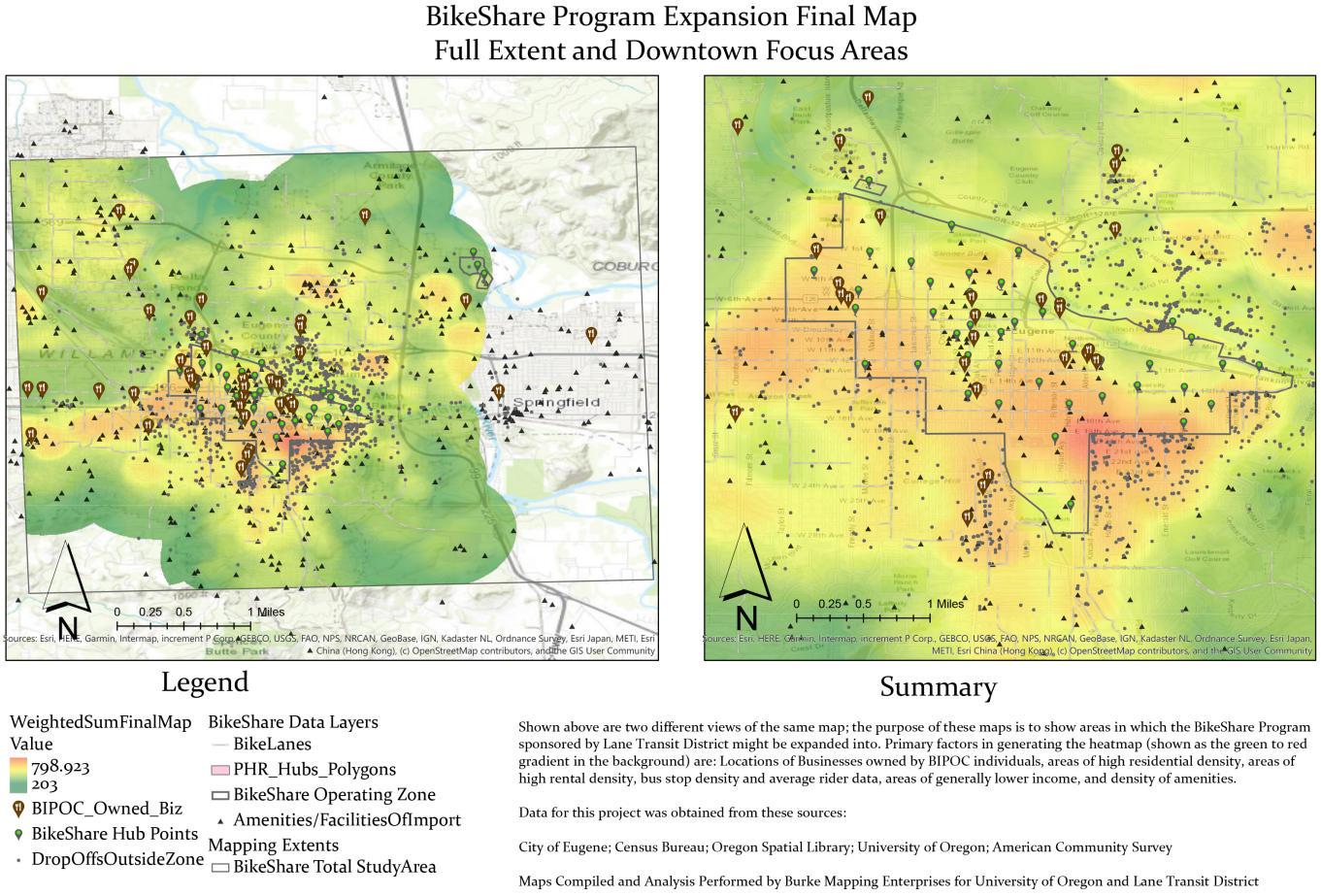


FIG. 19

Suitability map by Calvin Burke

USING ZONING INFORMATION TO RANK AREA SUITABILITY

Because bike-share depends on a large number of users, zoning data provides an alternative to assessing demand through census population density. Geospatial analysis makes it possible to rank certain areas over others and zoning data allows for the selection and prioritization of the most promising areas for bike-share. Selecting developed areas such as high-density residential zones can be used to demonstrate origin demand (Figure 20). This dataset also allows for the investigation of other features, such as recreational opportunities or historic areas.

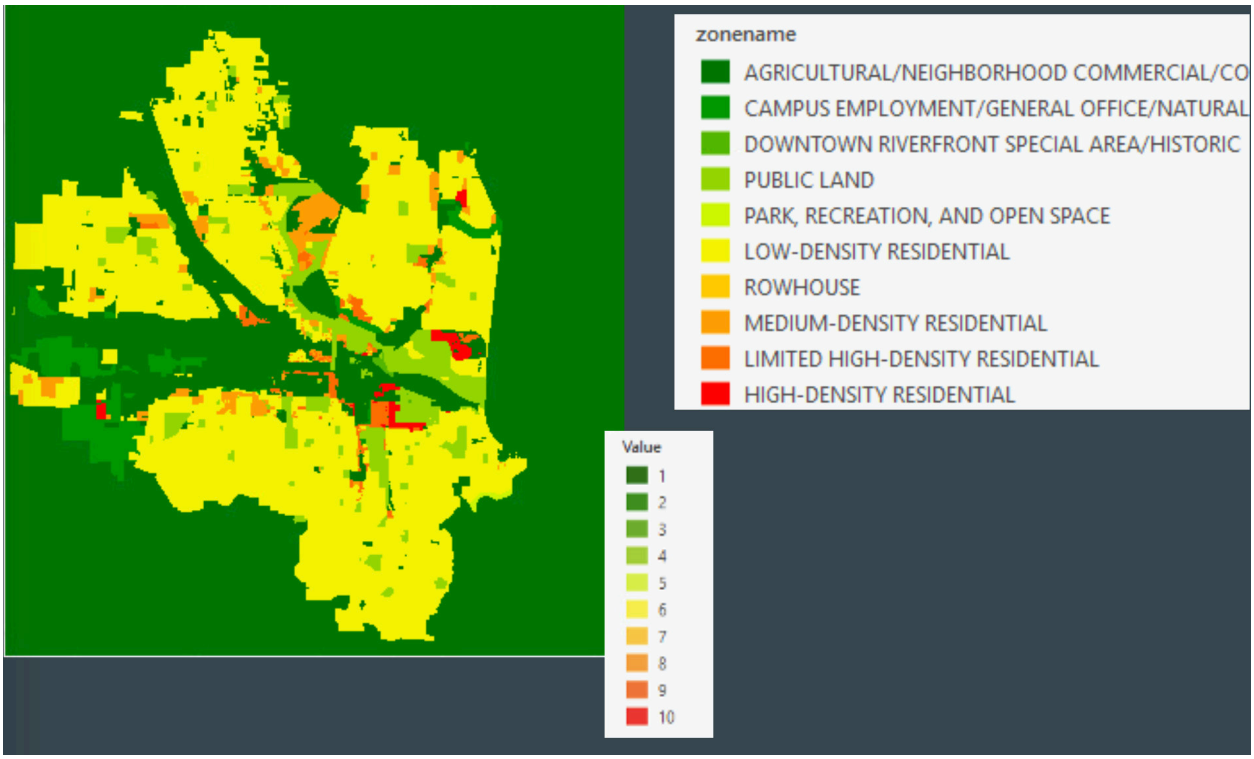


FIG. 20

Map of ranked zoning boundaries by Chase Krogh.

These few examples demonstrate the creativity and breadth that geospatial analysis offers in identifying the placement of bike-share stations.

Conclusion

Student projects used geospatial analysis methods to assess how the bike-share program could increase multimodal transportation opportunities and reach underserved areas and populations. The results of these different projects provide a number of different perspectives and indicate demand for bike-share expansion in a variety of areas.

Increasing the density of bike-share stations in the current operating zone could improve multimodal accessibility for many groups, including low-income residents and students. A high proportion of low-income residents reside in the downtown area and surrounding neighborhoods. Several analyses found that the extent of the current operating zone serves a large audience including a number of low-income and minority groups. The analyses that focused on this area described multiple high-suitability locations. Therefore, students recommend further analysis to determine specific sites for increased coverage in this area.

Many student projects indicated demand to expand the bike-share network outside the current operating zone. Projects focused on a wide range of topics with several analyses tackling issues of equitability in bike-share access. Low-income and minority groups are historically under-represented in bike-share usage (TREC, 2017), therefore ensuring that these populations are prioritized in bike-share expansion is essential. In these analyses, students repeatedly indicated multiple common areas suitable for bike-share expansion including west Eugene, the Autzen Stadium area, and the Gateway Mall area. Students recommend additional analysis in these areas to assess bike-share suitability.

The diversity of project topics and datasets is an example of how GIS can answer different questions and act as a compelling tool for data visualization. This summary of student projects demonstrates the wide variety of topics that can be covered in assessing an expansion of the bike-share system.

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Appendix A

Winter 2020 Report

Adv. GIS Report
SCYP LTD-PHR
Winter 2020

MARCH 2020

University of Oregon – College of Design
Prepared by: Geoffrey Johnson

UNIVERSITY OF OREGON

College of Design

Project Summary

All analysts contributing to this work are members of the Winter 2020 Advanced GIS course in the University of Oregon's Department of Geography. The class analyzed existing data on public transit and bike share usage, demographic patterns, and travel demands. The goal of the project is to assess station placement for expanded bike share coverage and the development of ‘multi-modal’ transit stops to better integrate the various public transit options in Lane County, and expand public transit services for underserved areas and populations.

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2 Downtown Eugene Bike Share Extent

Summary

To emphasize the goal of expanding within and directly adjacent to the existing PHR infrastructure, several student projects focused on the dynamics of rides data and certain characteristics of the PHR Operating Zone service area that might explain activity hotspots. PHR rides data used in these analyses was recorded April 2018-December 2019. The analyses in this section suggest that there are opportunities to expand service both by increasing the density of hubs within the Operating Zone (Maps 1, 2, 6, 7, 8, 9, 10) and adjacent to the Northeast (Maps 3, 4, 5, 7), Southeast (Maps 3, 4), and Southwest (Maps 3, 12). Direct comparison of hub use (Map 5) and non-Hub end points does suggest that merely adding capacity around South and West Campus may not solve the non-Hub lock-ups issue.

2.1 Non-Hub Trip End Point Analyses

Four student analysts focused entirely on the PHR rides that did not end at a PHR Hub. These analyses fall into two categories: 1. Analysis focused on identifying areas for improving the coverage of the Operating Zone, and 2. Analysis focused on expanding to nearby areas that are already used by the ridership without PHR Hubs to support that use.

2.1.1 Analyses Focused Inside the PHR Operating Zone

Comparison of Maps 1, 8 and 9 suggests that the buffer distance is an important parameter and may deserve additional scrutiny. Maps 1 and 9 excluded 200 ft and 300 ft buffers around PHR Hubs, and Map 8 excluded an 800 ft buffer. So, while the hot spot near the DeFazio/Ferry Street Bridge is present on maps 1, 2, and 9, it is not on Map 8. Thus most out of network end points near the Downtown side of the bridge are between 300 and 800 feet of the Hub on 3rd Ave.

Other important areas are at the UO Campus at 14th/Kincaid St, 13th/Agate St, along Patterson St between 12th and Franklin Blvd, on 18th between Oak St and Pearl St, and on 19th between Alder St and Onyx St.

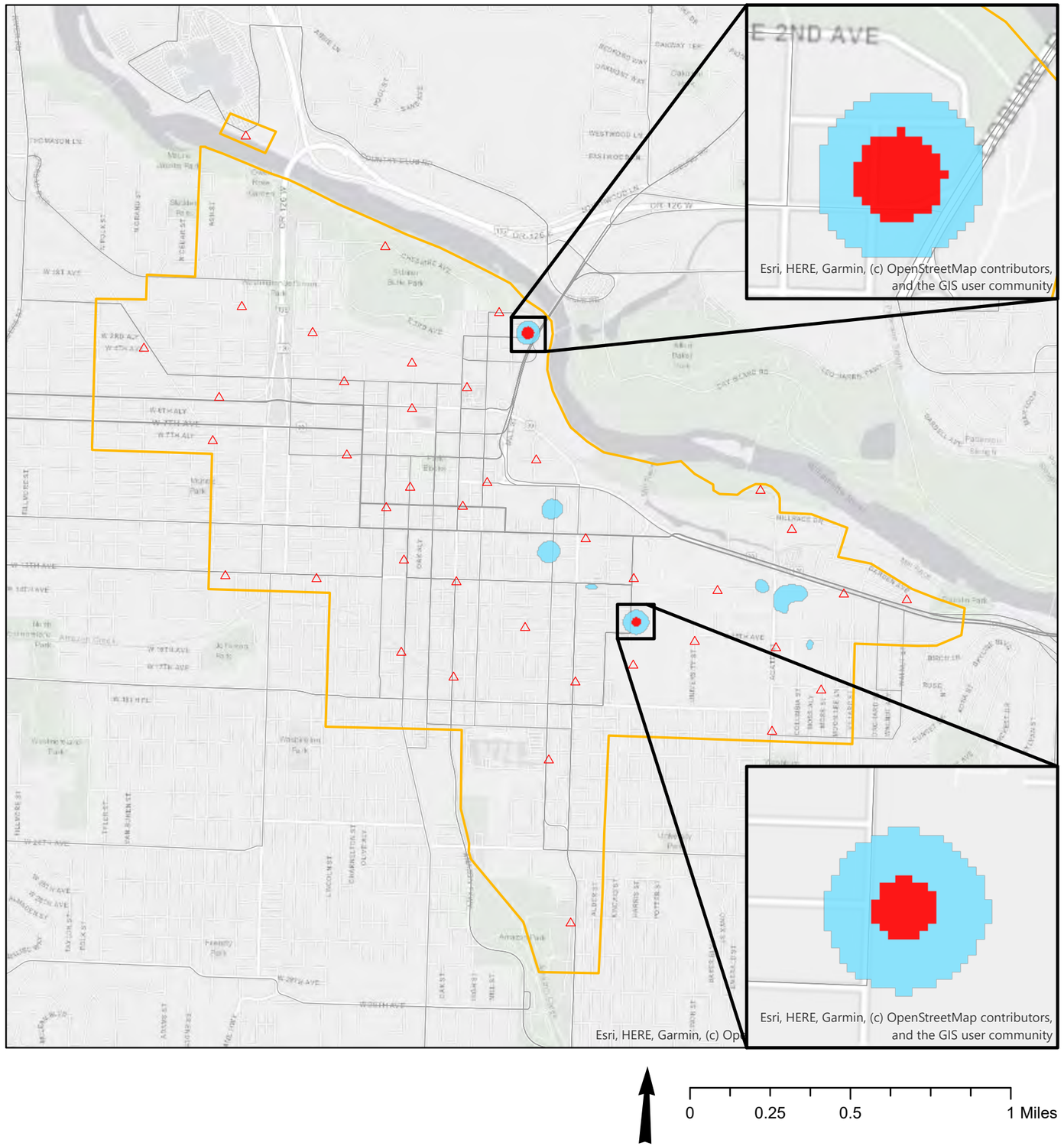
Map 1 – PHR Bike Share – Downtown Area Analysis Extent

Cartographer: Charlotte Klein

Data: All PHR trip end points; PHR Hub locations; Operating Zone Boundary

Analysis: Selected trip end points inside the Operating Zone. Excluded trip end points within 200 feet of a PHR Hub. Kernel density of included trip end points. Reclassification of density into three categories (two symbolized as red and blue cells representing only the upper 30% of all values on the map).

Summary: Using only trip end points within the Operating Zone, this analyst highlights 8 points of the highest non-hub end points. DeFazio/Ferry Street Bridge and the UO's Knight Library are the densest, while 13th/Agate and 11th/Hilyard UO Residence halls are also notable areas.



PHR Bike Share -Downtown Area Analysis Extent

Legend

Trip Endpoints

- Least
- Many
- Most

BikeShare Operating Zone

BikeShare Hub Points

Bus and EMX Routes

- EMX Routes
- LTD Routes Fall 2019

This map displays optimal locations for new bikeshare hub placement based off the density of bikeshare trips that end outside of an existing bikeshare hub. Specifically, a new bikeshare hub is recommended on Mill St between 3rd Ave and 4th Ave and on 14th Ave at Kincaid St.

Charlotte Klein
Oregon Spatial Data Library,
US Census Bureau, LTD.

NAD 1983 Oregon - South Zone Coordinate System

Map 2 – PeaceHealth Bikes New Hub Analysis

Cartographer: Brett Daily

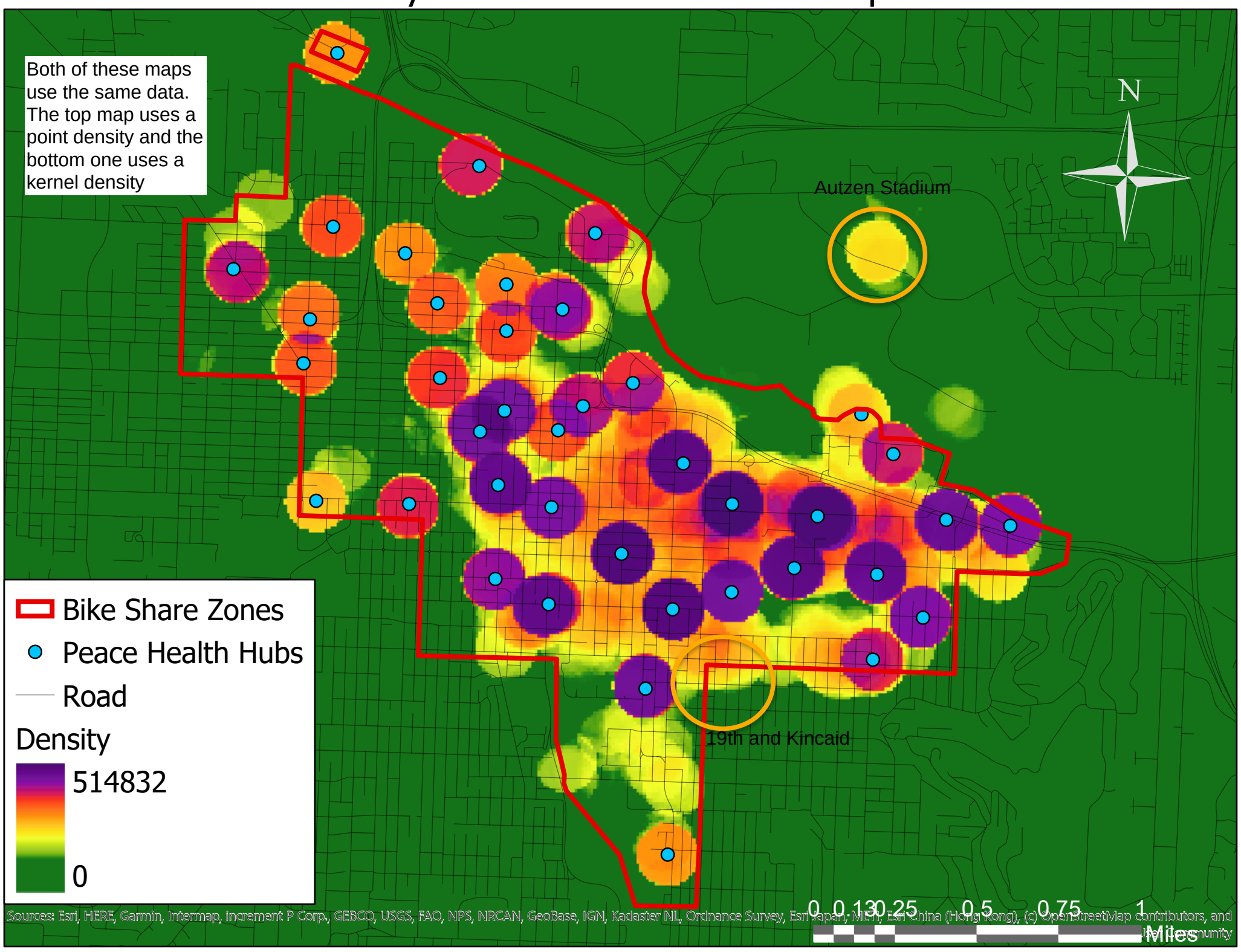
Data: All PHR trip end points

Analysis: Point and kernel density; PHR Hub locations

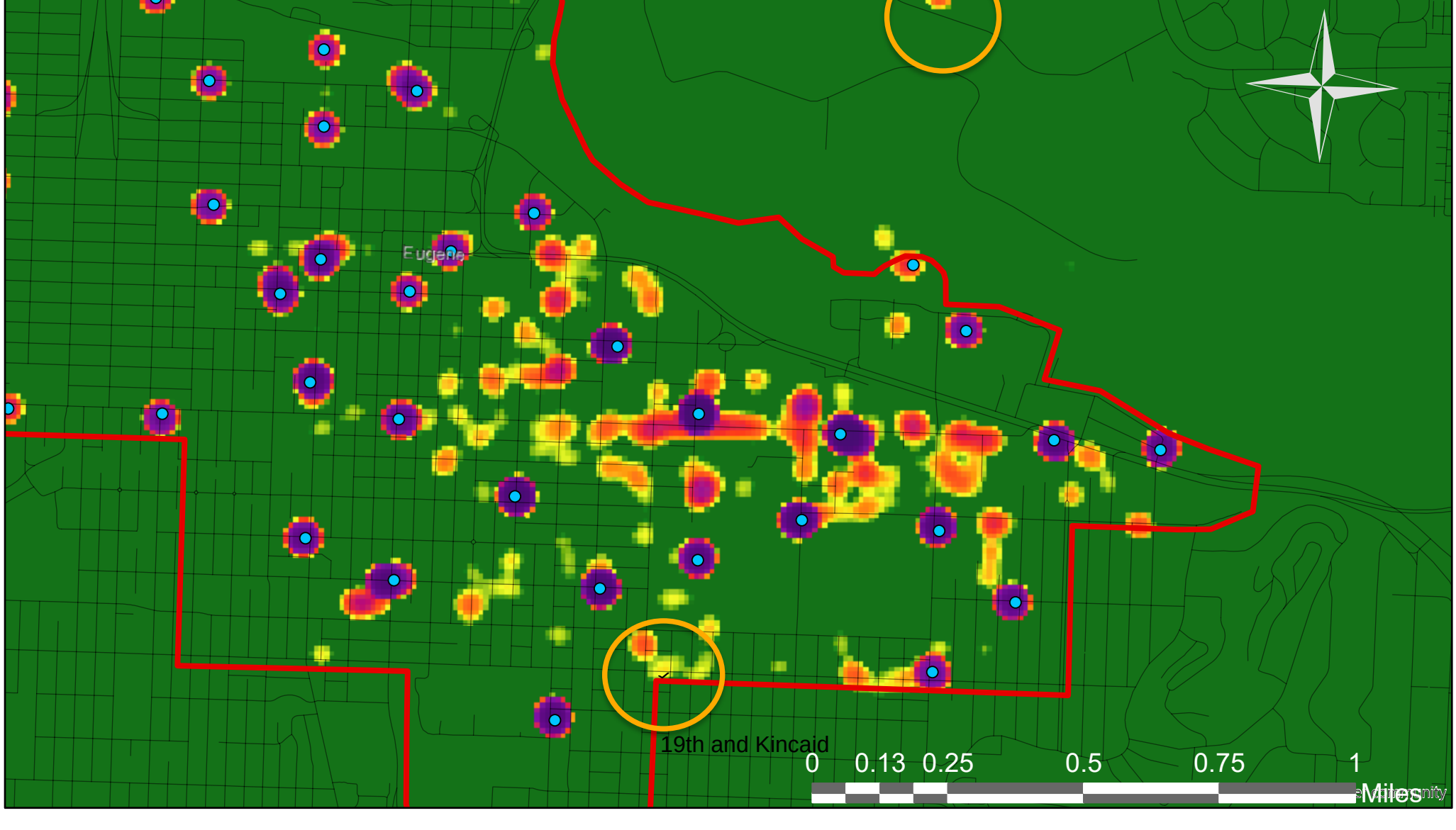
Summary: This analyst includes all trip end points. Densities in both maps are visualized as continuous scale that has not been reclassified into categories, although the two maps show the same data analyzed differently. The point density map allows both visualization of hub-use as the color of areas around the hubs, and the non-hub end points; while the kernel density map emphasizes non-hub end point differences. The kernel density map emphasizes the locations of drops, while the point density map emphasizes regions of greater non-hub end point density.

Peace Health Bikes New Hub Analysis

Point Density of Peace Health ride end point data



Kernel Density of Peace Health ride end point data



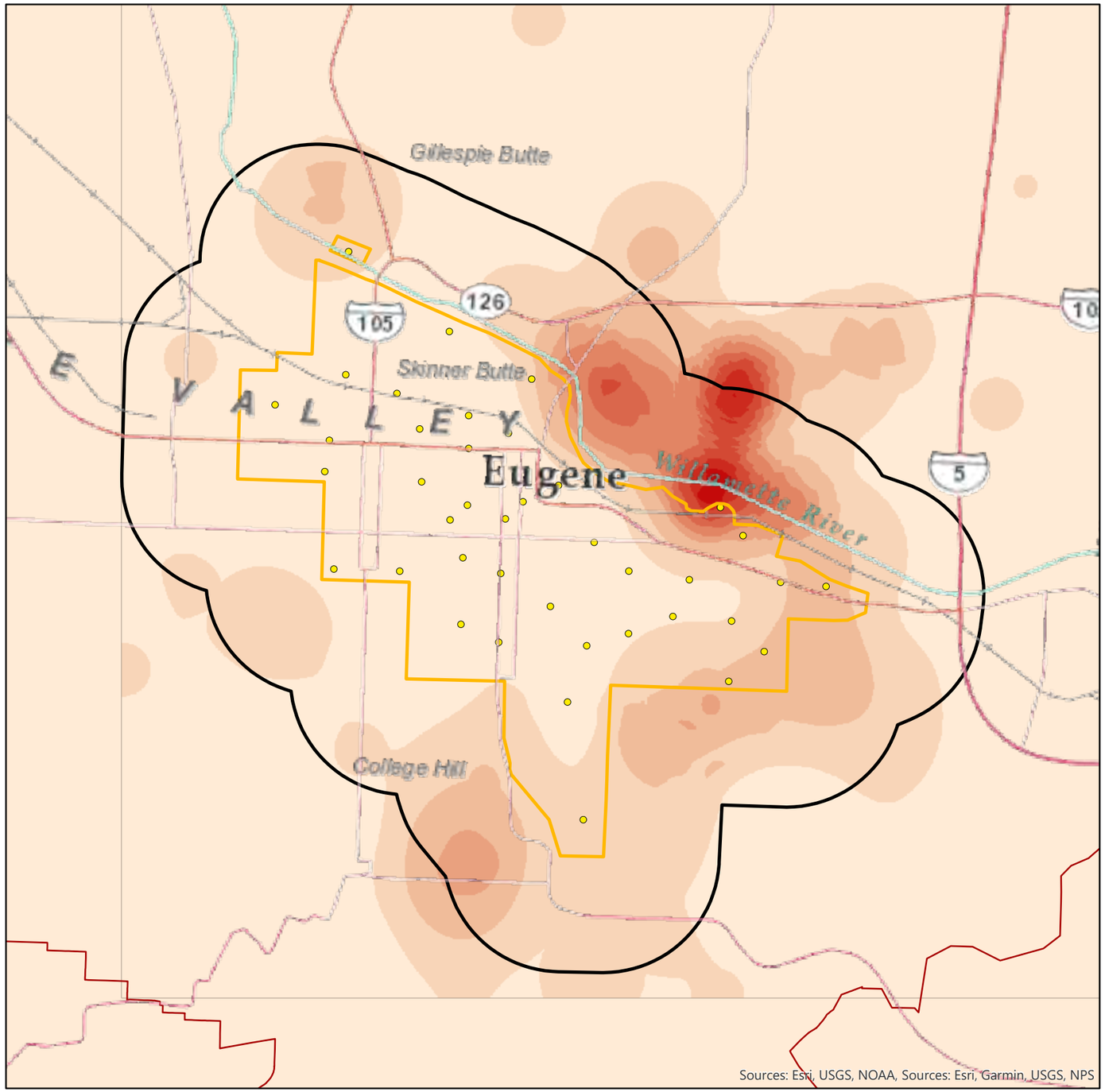
2.1.2 Analyses Focused Outside the PHR Operating Zone

There is strong seasonal signal in the out of Zone end points. An analysis not done here would exclude the football season to eliminate the effect of temporary hubs at Autzen for football game days which are not excluded in the following analyses.

Alton Baker Park stands out which may be attributed partly to seasonal activities (Map 4). The absence of the Summer-time hot spot at 24th/Amazon Pkwy (Map 4) in the annual-sample analysis (Map 3), might deserve more attention.

Map 3 – Eugene Bike Share Expansion Suitability Based on Ride End Points
Cartographer: Ian Freeman
Data: Only Jan, May, Aug and Oct 2019 PHR trip end points; PHR Hub locations; Operating Zone Boundary
Analysis: Selected trip end points outside the Operating Zone. Densities calculated separately for each month of data. Densities reclassified to a common scale and then overlaid with equal weights.
Summary: To visualize the PHR end points outside the Operating Zone, only end points outside the boundary are included. This analyst used only trip end-point data from 4 months – 1 month from each season – and then assigns each represented season an equal weight thus removing seasonal differences. A 0.5 mile buffer is a visual aid to understand the spatial distribution of end point hot spots. The Alton Baker and Autzen areas stand out and likely reflect UO football game activity. 29th/Willamette and SE Eugene are also notable areas of end point activity.

Eugene Bike Share Expansion Suitability Based on Ride End Points



PHR Bike Share -Downtown Area Analysis Extent

- BikeShare Operating Zone
- .5 Mile Operating Zone Buffer
- BikeShare Hub Points

Bike Share Suitability

- Low
- High

The new bike share suitability is calculated using the density of ride end points outside of the current bike share operating zone. This data shows areas of possible operating zone expansion based on real destination demand data.

0 0.25 0.5 1 Miles

Author: Ian Freeman

Map 4 – PHR Ride Data – Bike Share Analysis Extent – New Hub Proposal – Summer ONLY End Points

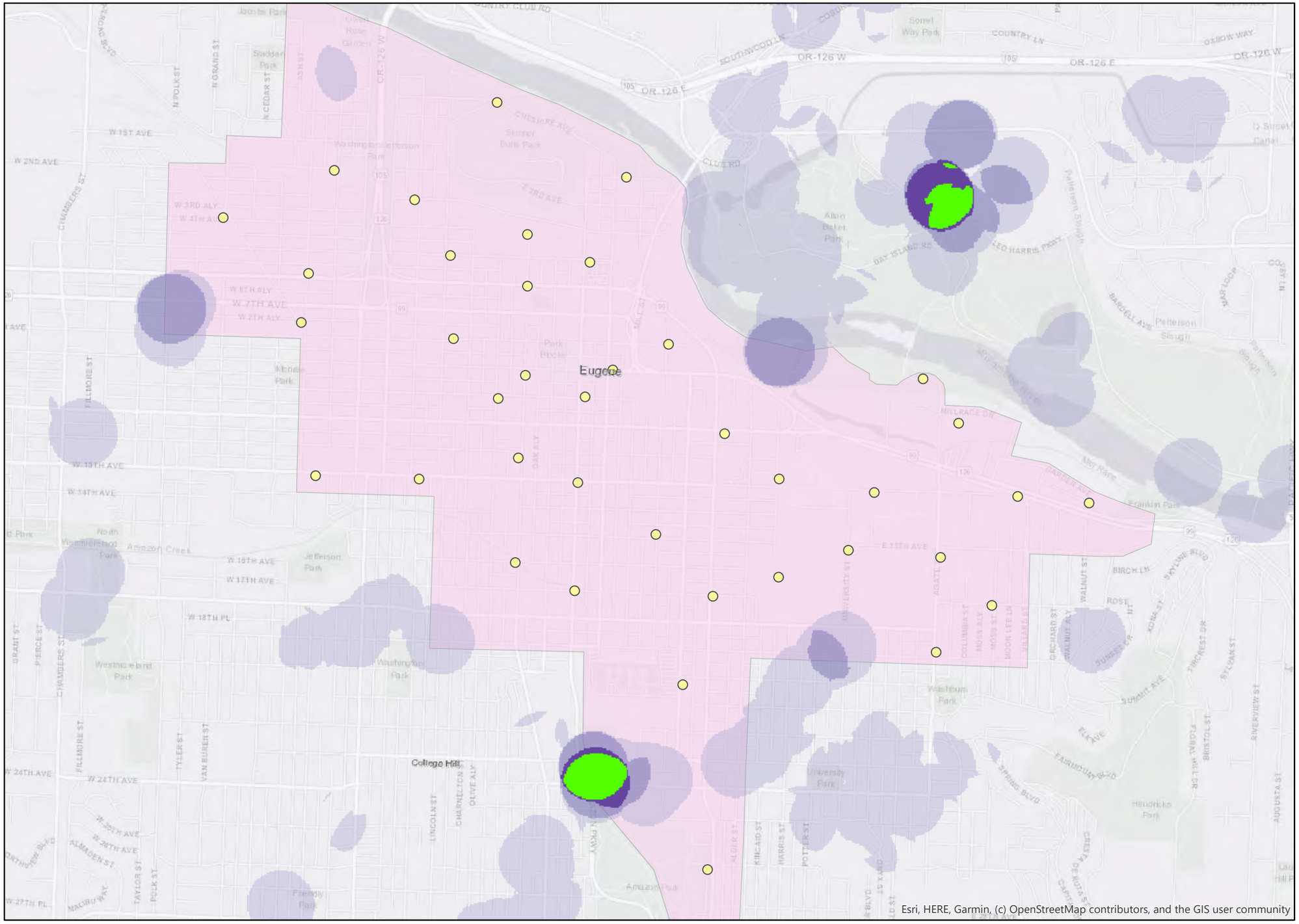
Cartographer: Grace Montague

Data: Jun, Jul, Aug and Sept 2019 PHR trip end points; PHR Hub locations; Operating Zone Boundary

Analysis: Selected trip end points at least 0.25 miles away from existing hubs. Point density of all remaining end points, followed by reclassification of end points into 5 categories (default Jenks natural breaks function for assigning classes).

Summary: Due to the classification method, even the lightest categories represent substantial numbers of end points. During the summer months of 2019 clear hot spots of end point activity are at Autzen Stadium and 24th/Amazon Pkwy. Additional scattered pockets of activity are primarily along the boundary of the Operating Zone at 19th/Harris, 7th/Polk and along the Willamette River.

PHR Ride Data - Bike Share Analysis Extent - New Hub Proposal - Summer ONLY End Points



Legend

Point Density of SUMMER End Points

Summer End Point Density

- ≤138.364334
- ≤988.316674
- ≤2510.324353
- ≤3775.369696
- ≤5040.415039
- PHR_Hub_Points
- BikeShare_Zones

* The areas in green have the highest density of ride end points. That means they are the most frequent places bikes are left outside of existing hubs. These areas would be an ideal places for a new hub as the PHR bike zone grows.

N

0 0.15 0.3 0.6 Miles

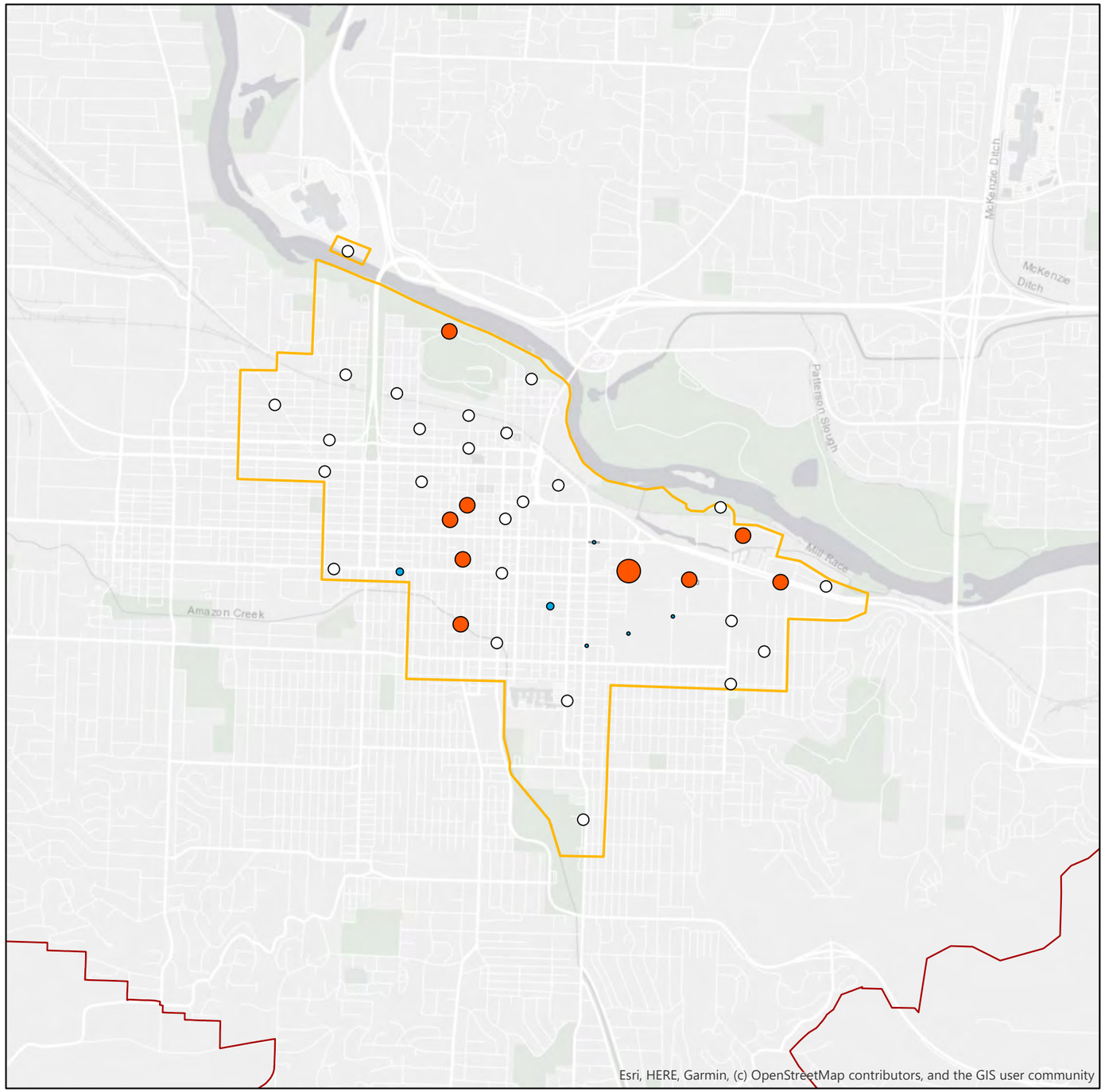
Grace Montague
Sources: LTD, PHR
GEOG 482

2.2 Hub/System-Use Analyses

These analyses examine the use of existing PHR and bike route infrastructure. On an example Wednesday in April (Map 6) rides are predominantly in and directly around the UO Campus. Annually, rides are more likely to end along 13th and along Willamette in the Operating Zone (Map 5).

Map 5 – Bike Share Station Bike Flow per Day
Cartographer: Aaron Reynolds
Data: All PHR trips; PHR Hub locations; Operating Zone Boundary
Analysis: Excluded all rides without a hub assigned to start or end (n ~= 26,000). Flow for each station calculated as [Flow = (# of racks – start) + end] and values are rounded to the nearest integer. This value is an average for the whole study period.
Summary: Flow of bikes at each station visualized to emphasize where more bike end than start. More bikes start than end at locations with smaller/blue symbols.

BikeShare Station Bike Flow per Day



BikeShare data curtesy of PeaceHealth Medical Group

Cartographer: Aaron Reynolds

0 0.25 0.5 1 Miles

Using the "Merged_BikeStarts20182019" and "PHR_Hubs_Polygons" point feature classes, an average flow per day of bikes in and out of each BikeShare station was determined in order to evaluate the current capacities at each BikeShare Station. The number in the 'Flux' field in the table to the right represents the net number of bikes going either in or out of each station. A positive number indicates that on a day to day basis, there are more people ending their trips at that station than there are starting, meaning that station on average has a surplus of bikes. Conversely, a negative number indicates that there are more people beginning their trips at that station than people ending trips, resulting in an average loss of bikes over time. Values of zero mean that a station has a balanced flow of bikes in and out of the station; supply equaling demand at that station. Based on these numbers we can infer a response for each of the bike stations. Stations with a positive 'flow' require a number of empty racks equal to the flow number in order to accommodate the greater than expected amount of bikes at those stations. Stations with a negative 'flow' require a number of racks plus bikes equal to the flow number in order accommodate higher than expected rider demand at those stations.

Bike flow per day

- ≤-2
- ≤-1
- ≤0
- ≤2
+ ≤5

Name	Rack Amount	Flux
E 15th Ave & University St	14	-2
E 8th Ave & Ferry St	15	0
Skinner Butte Park	19	1
W 2nd Ave & Madison St	22	0
Monroe St & Blair Blvd	17	0
W 3rd Ave & Lawrence St	18	0
Eugene Train Station	7	0
E 5th Ave & Pearl St	20	0
E 10th Ave & Pearl St	20	0
E 6th Ave & & Willamette St	11	0
E Broadway & High St	14	0
E Broadway & Willamette St	10	2
W 8th Ave & Lincoln St	16	0
W 10th Ave & Olive St	23	1
E 13th Ave & Pearl St	14	0
E 13th Ave & Kincaid St	20	5
E 15th Ave & Ferry St	19	-1
1600 Millrace Drive	11	1
E 16th Ave & Willamette St	18	1
Knight Law Center	18	0
Matthew Knight Arena	20	1
E 17th Ave & Moss Street	14	0
Franklin Blvd & Walnut St	15	0
W 5th Ave & Lincoln St	16	0
W 4th Ave & Blair Blvd	15	0
Lane Events Center	9	0
W 13th Ave & Lawrence	14	-1
E 2nd Avenue & High St	20	0
Amazon Pool	10	0
Erb Memorial Union	26	1
E 17th Ave & Pearl St	22	0
E 19th Ave and Agate St	8	0
E 17th Ave & Hilyard St	16	-2
W 12th Ave & Willamette St	18	1
Autzen Footbridge	20	0
W 6th Ave & Monroe St	16	0
Valley River	9	0
PeaceHealth RiverBend	7	0
RiverBend Annex	4	0
Heartfelt House	8	0
Eugene Family YMCA	17	0
PeaceHealth University District	15	-2
HEDCO Education Building	9	-2

Map 6 – Future PeaceHealth Bike Share Station Placement

Cartographer: Rachel Hess

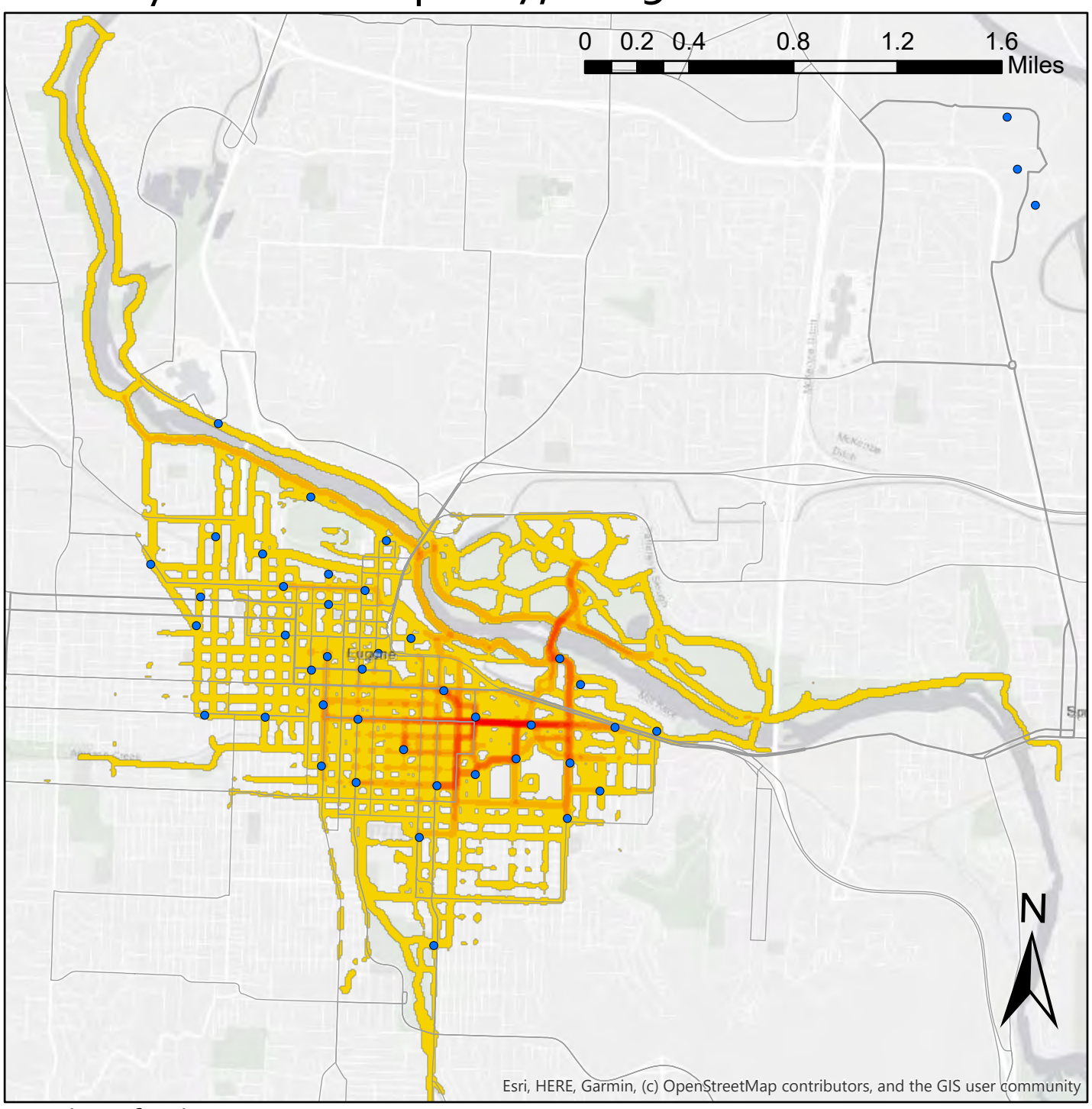
Data: Wednesday April 17, 2019 PHR trip route lines; PHR Hub locations; Operating Zone Boundary

Analysis, Top: Line density of all included trips. Note: values do not represent rides, but line segment density. **Bottom:** Distance from the Operating zone added to trips outside the Operating Zone.

Summary: The UO Campus, West Campus and the Autzen Footbridge are the most used areas. The South Bank River Path, E. 17th, E. 12th, and Willamette between 8th and 17th are interesting middle-use routes.

Future Peace Health Bikeshare Station Placement

Density of Rides: April 17, 2019

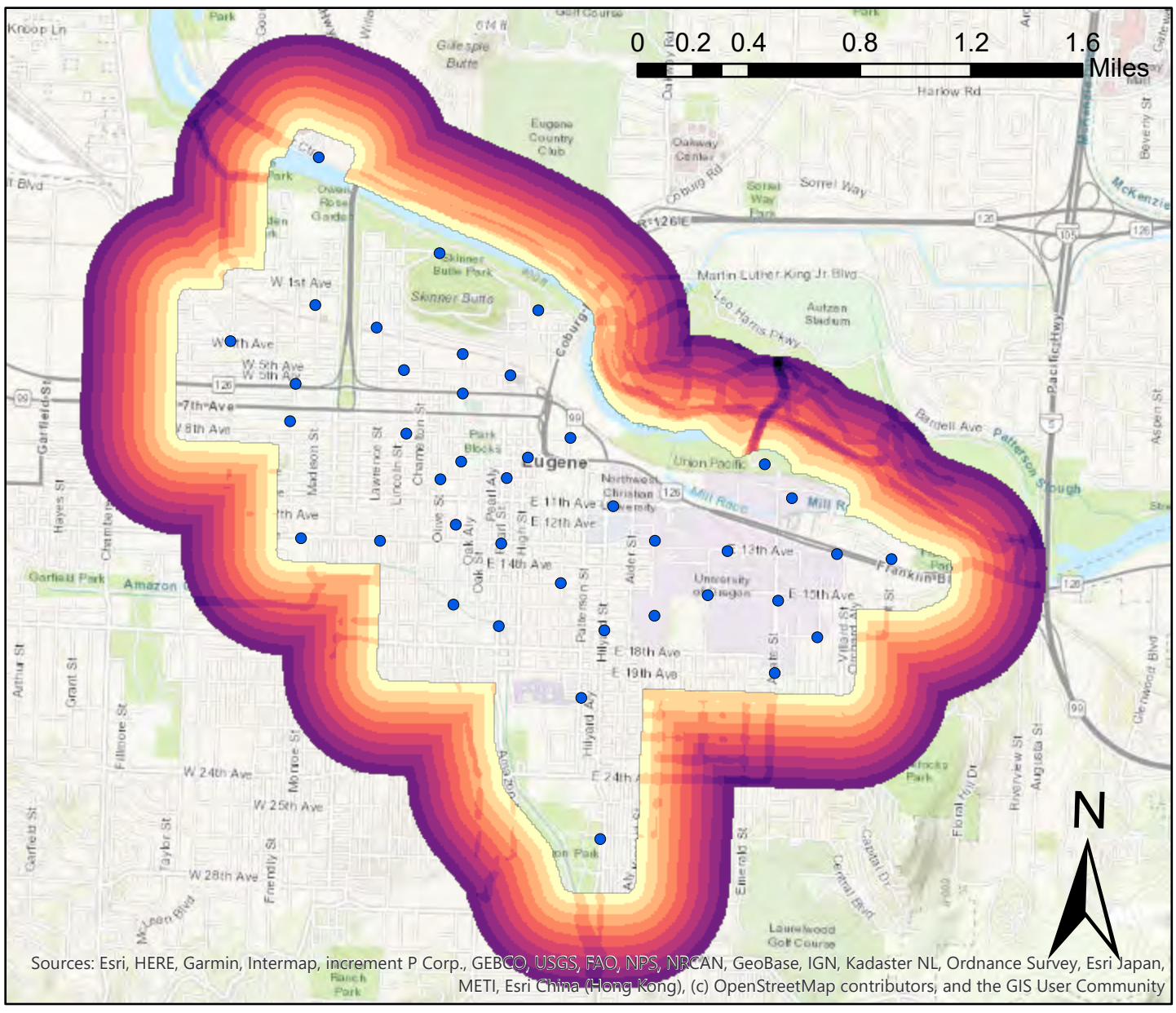


Number of Rides

- ≤ 200
- ≤2989.206434
- ≤6476.61394
- ≤10960.423591
- ≤16938.836458
- ≤26155.556296
- ≤39856.085784
- ≤63520.636719
- Existing Bikeshare Stations

This graphic displays the number of rides in a single day during spring term at the University of Oregon. While most of the rides are concentrated in downtown Eugene, the extent of the rides includes routes far outside the existing service area. If the goal of Peace Health bikeshare is to expand ridership, then the main priority should be to expand service stations to destination's where riders travel. To visualize where riders travel most, data from a sunny day in April was analyzed by a line density function. The map displays the need for expanded bikeshare stations and service area.

Popular Routes Outside of the Existing Service Area



Locations for Future Stations Based on Popular Routes

- Existing Bikeshare Stations

Most Ideal — Least Ideal

This graphic displays the Euclidean distance starting from the Peace Health bikeshare service area extending 2,000 feet outside of the boundary. This Euclidean distance raster layer was added to the ridership density raster layer in order to show the most ideal routes that could benefit from a bikeshare station while within a reasonable distance from the existing stations. The darker lines overlaying the Euclidean distance layer represent the most popular routes that would be ideal locations for future bikeshare stations.

Author: Rachel Hess
Sources: Peace Health Bike Share Rides Data, LTD, City of Eugene

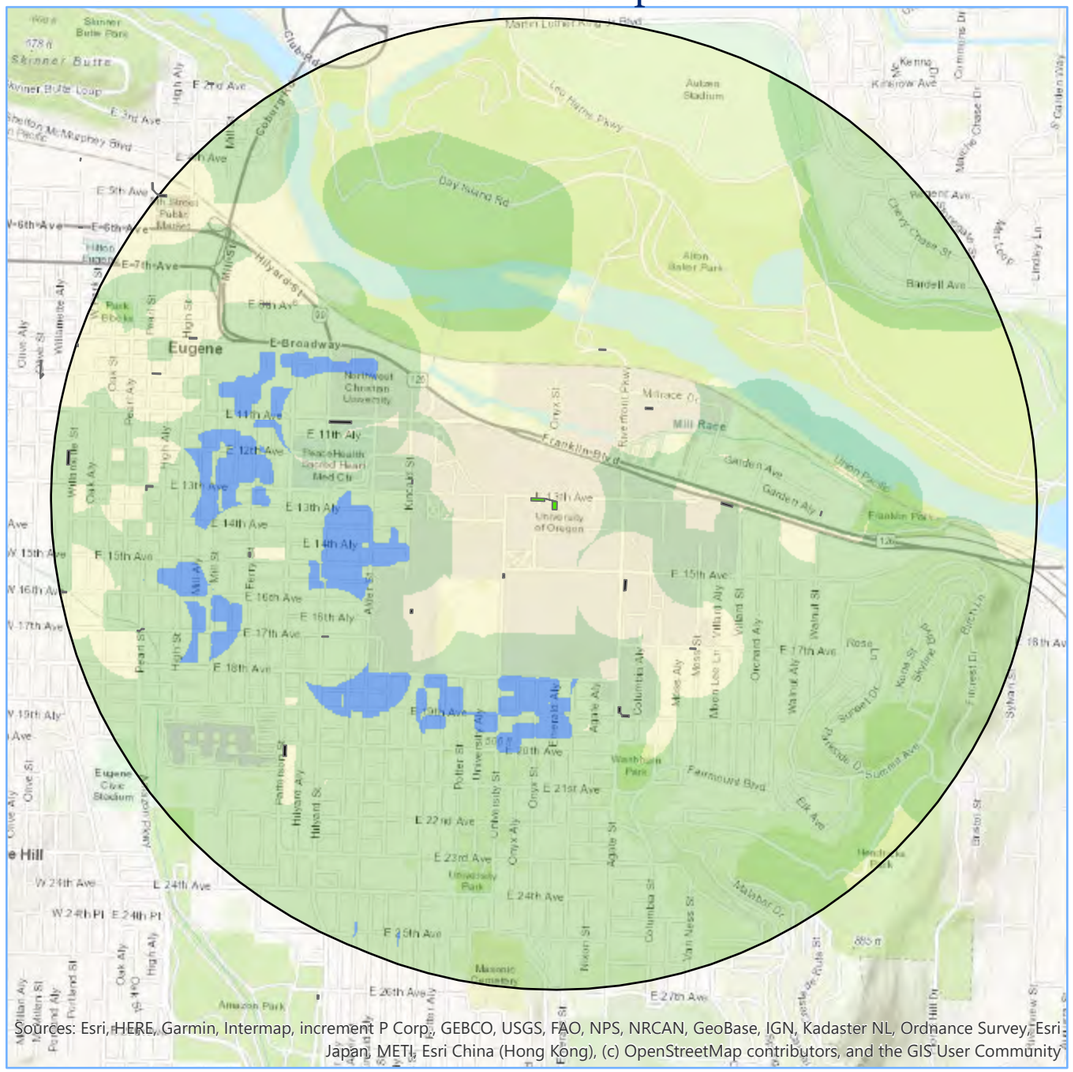
2.3 Analyses Including Additional Suitability Criteria

Seven additional students completed analyses primarily in the Operating Zone but using additional sources of information about demographics, bike traffic, LTD bus access, housing, and other amenities. These analyses underscore the importance of the UO Campus (Maps 7, 8, 9, 11), but also suggest that other areas of the Operating Zone in the Southern portion (Map 9 and 11) and to the North (Maps 9, 10, 11) may benefit from development based on actual use. In general, the overlay suitability analyses that include factors other than non-Hub end points (Maps 7, 8, 12, 13) emphasize the importance of the areas to the South and West of the UO Campus.

Map 7 – Integrating PeaceHeath Bike Share with the University of Oregon
Cartographer: Patrick Pierson
Data: Tax lots; PHR Hubs
Analysis: Selected Apartment Buildings, Rental Houses, and Fraternity/Sorority Houses from Tax lots. Included 0.01 Mile Buffer around selected Tax lots. Excluded 0.1 Mile Buffer around PHR Hubs. Weighted Overlay of Buffers.
Summary: This analyst emphasizes the University ridership. High suitability denoted by Blue cells on the map indicate places within 0.01 miles of privately-owned student housing and at least 0.1 miles from a PHR Hub.

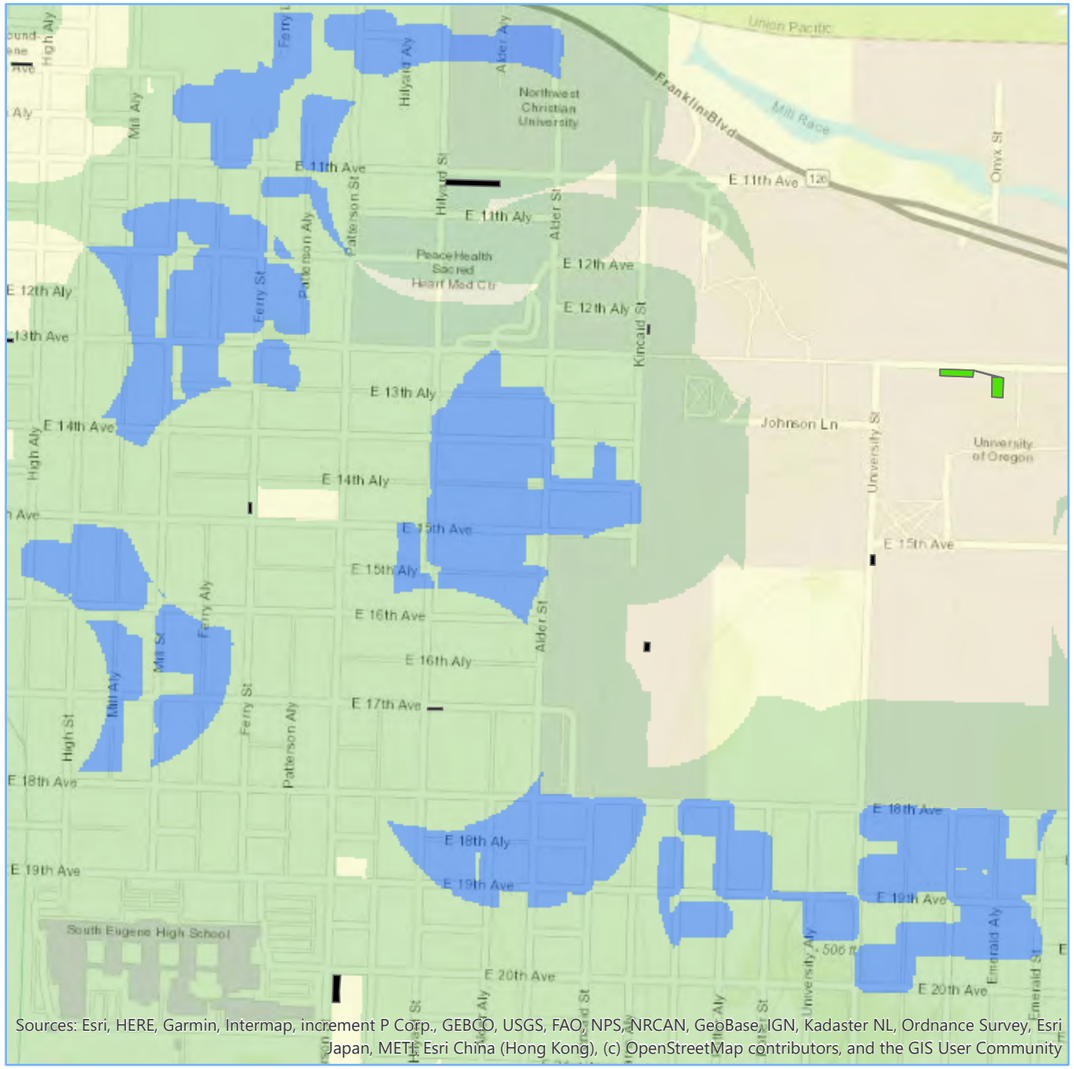
Integrating PeaceHealth Bike Share with the University of Oregon

1 Mile Buffer From the Center of Campus



0 0.25 0.5 Miles

Zoomed Area of Suitable Station Locations



0 175 350 Yards

N

EMU Station
Existing Stations
Suitability Ranking for New Station
1
2
3
1 Mile from EMU Station

Considerations:
To locate the areas with the highest amount of U of O students, the inputs were areas...
Near rental homes
Near apartment buildings
Near fraternities & sororities
Away from current stations.

Objective: Determine the best locations for a new PeaceHealth Rides bike station to help integrate U of O commuters with the bike share transit system.

Next Step: Consider the areas with the highest suitability, and choose the point where a bike station would be useful based on available space, safety precautions, and basic inquiry.

Coordinate System: NAD 1983 HARN StatePlane Oregon South FIPS 3602 Feet Intl.
Patrick Pierson 3-12-2020

Map 8 – PHR Bike Share – Downtown Area Analysis Extent

Cartographer: Andrew Wise

Data: All PHR trip end points; US Census block group total population and median age

Analysis: Point density of PHR trip end points. Raster weighted overlay of age and population (weights and reclassification unknown). Excluded all cells within 800 ft of a PHR Hub.

Summary: The dark red areas shown on the map represent areas with relatively high density of non-hub end points and higher block group-level population.

0 0.25 0.5 1 Miles

PHR Bike Share -Downtown Area Analysis Extent

- CURRENT BIKESHARE HUBS
- OPTIMAL LOCATIONS
- EUGENE AND SPRINGFIELD UGBS
- BIKESHARE OPERATING ZONE

BUS AND EMX ROUTES

- EMX ROUTES
- LTD ROUTES FALL 2019

The analysis over Eugene-Springfield was conducted by monitoring the past rider data. The first weight was attained by by running a density analysis over the final stops of each bike ride, with a minimum distance of 800 feet away from any currently existing bike hub.

After calculating the rider data, I calculated the demographic information surrounding each block group in Eugene. The demographic information consisted of several factors: median age of people in each block group; the proximity to a workplace, as well as the population density per block group.

I then weighed these two layers against one another to create the final map. This creates 4 levels of priority, ranging from yellow, areas that meet our minimum requirement, to dark red, the best regions for new bike hubs. These highest value areas are around Safeway on 18th Ave & Pearl St.; the apartment cluster on 16th Ave & Mill St.; the Jaqua Center on Franklin Blvd & Agate St.; and a final zone near Matthew Knight Arena.

ANALYSIS AND CARTOGRAPHY BY: ANDREW WISE

CREDITS: BASED ON PROVIDED LTD & PEACEHEALTH DATA, AND U.S. CENSUS DATA

Map 9 – Bike Share Suitability by Destination Demand

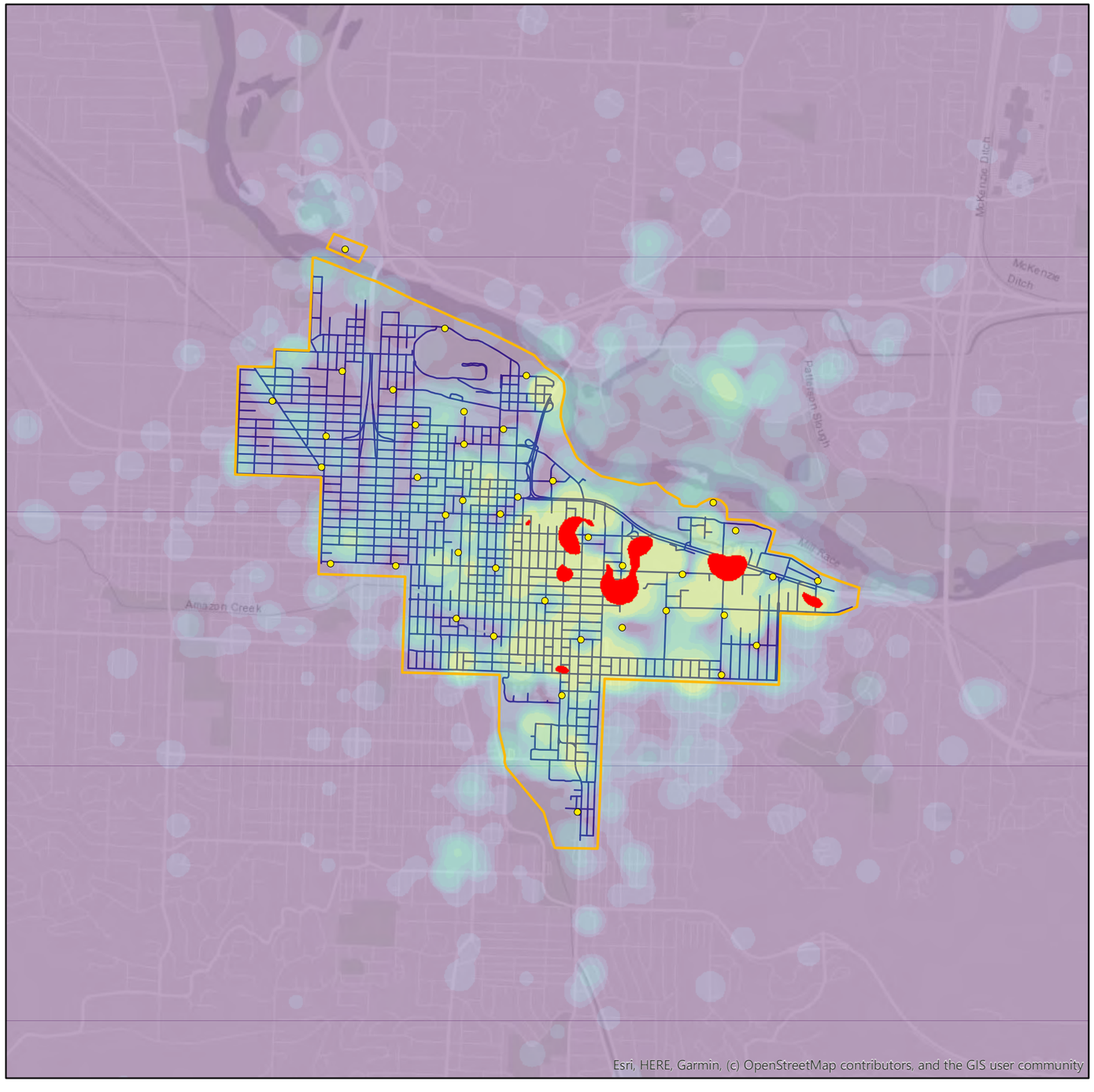
Cartographer: Michael Harry

Data: Random sample of PHR trip end points from the central part of each season (specific sample unknown); PHR Hubs; LTD bus stops with average passenger boarding.

Analysis: 1-minute-walk network service area of each PHR Hub. Trip end points excluded 500 foot kernel density of all trip end points. 500 foot kernel density of bus stops within the Operating Zone weighted by average boarding. Weighted overlay of these two density layers giving equal weight to bus stop passenger boarding density and trip end points.

Summary: This analyst shows where there are many non-hub trip end points and also high density of bus boarding. EMX Stations are apparently significant as is 14th/Kincaid and Patterson at 13th and 19th.

Bike Share suitability by Destination Demand - Downtown Area Extent



BikeShare Downtown Operating Zone
BikeShare Hub Points
Weighte_LTDB1
Value
<= 6
<= 9
<= 12
<= 17
<= 22
<= 27
<= 32
<= 37
<= 42
<= 49
Roads In Service Area

N

This map used a one-minute service area analysis to perform a kernel density analysis on all bikeshare trip endpoints outside of a one-minute walk of existing bikeshare hubs to demonstrate demand in the area. The kernel density was performed using a five hundred square foot search radius. four samples were chosen from different seasons throughout the year.

For further inputs another kernel density was performed on all existing LTD bus stops using the average number of passenger boarding. within the current bikeshare service area. Bus stops outside of the current bikeshare service area were removed before the kernel density analysis. The kernel density analysis was also performed with a five hundred square foot search radius

The final suitability shows a weighted sum of the kernel density from four sample periods throughout the year of bikeshare trip ends combined with the kernel density of existing LTD bus stops. Not shown is the existing service area near the Riverbend Hospital. Because four sample periods were chosen seasonal weather anomalies which may have made unfavorable conditions for bike travel occur should be taken into consideration.

0 0.25 0.5 1 Miles

Creator: Michael Harry, Sources: LTD, Bikeshare, U of O, ESRI

Map 10 – PHR Bike Share Expansion to High Residential Areas

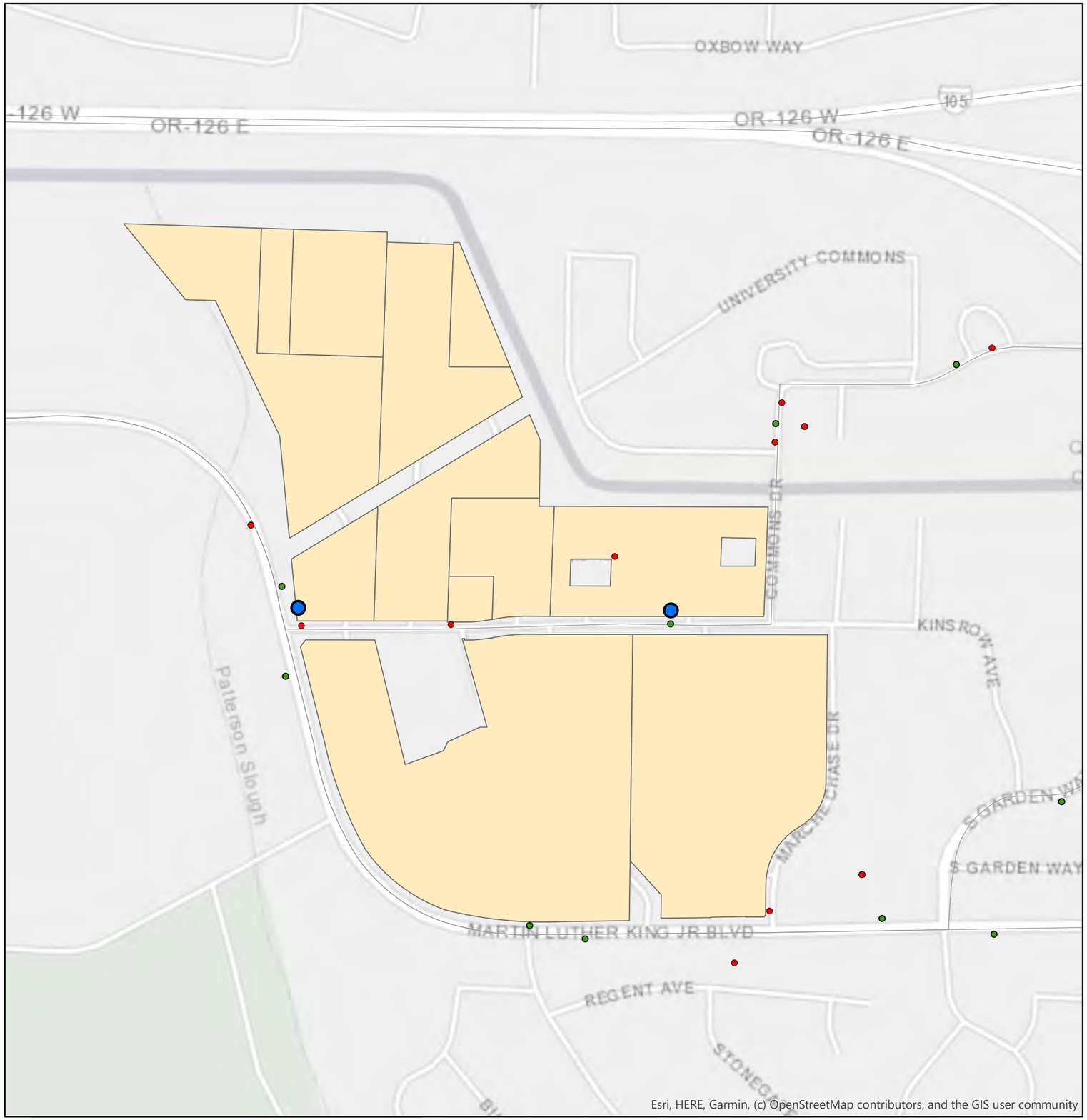
Cartographer: Alicia Nichols

Data: All PHR trip end points; LTD bus stops; Residential tax lots; Eugene/Springfield Businesses (LTD).

Analysis: Kernel density of bus stops and point density of businesses and PHR end points. Feature-to-raster residential tax lots. Reclassified all layers. Weighted overlay of four inputs. Reclassified overlay, raster-to-feature for highest overlay values, and feature-to-point (centroids) to convert those polygons to points. Selected high-density residential tax lots.

Summary: This analyst chooses to highlight small scale application of the overlay techniques. Potential points represent two specific locations identified by overlaying bus stops, businesses, PHR ride end points, and high-density residential tax lots in the Kinsrow area. This area has been separately identified as one key location of high non-hub PHR ride end points.

PHR Bike Share Expansion to High Residential Areas
Cartographer: Alicia Nichols



Legend

- BikeShare Operating Zone
- BikeShare Hub Points
- Bus and EMX Routes
- EMX Routes
- LTD Routes Fall 2019
- Eugene and Springfield UGBs
- Businesses
- High_DensityTaxlots
- Potential Bike Hubs
- Bus Stops

Description:
This map is a representation of Potential Bikeshare hubs in a higher residential area further from campus. Each of the potential locations are found directly within residence tax lots that have a zoning description of higher density. They are also located near frequently used bus stops. This expansion of Peace Health Bikeshare to areas further from campus will allow for multiple options of transportation for students communing to campus or just trying to get around town.

Map 11 – Annual Bike traffic Density in Comparison to Annual Crash Density Involving Bikes in the PHR Operating Zone

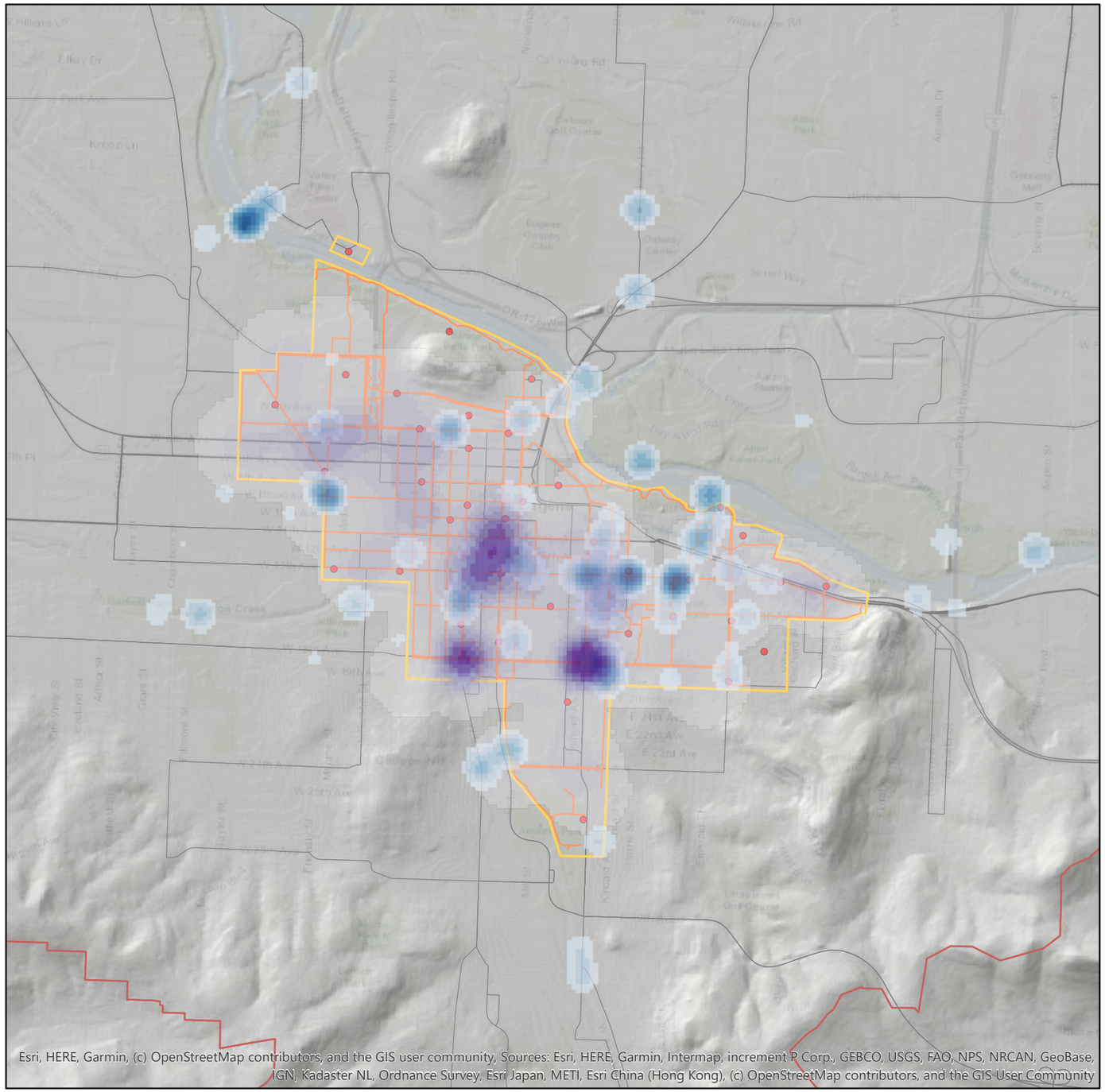
Cartographer: Emma Jensen

Data: Bike traffic (LCOG); Bike crashes involving cars (ODOT); PHR Hubs.

Analysis: Kernel density of bike traffic. Kernel density of bike crashes.

Summary: Hot spots of bike traffic and bike crashes are symbolized separately by this analyst. Identifies places where there are either many bike crashes involving cars (purple hues) or many bike riders regularly (blue hues). Purple hues are drawn on top of blues, thus making it difficult to know precisely where there are both many rides and many crashes.

Annual Bike Traffic Density in Comparison to Annual Crash Density involving Bikes in the PHR Operating Zone



0 0.25 0.5 1 Miles

BikeShare Hub Points
Bikeroutes_PHRregion
Eugene and Springfield UGBs
BikeShare Downtown Operating Zone

Bus and EMX Routes
LTD Routes Fall 2019

lane_shaded
Value
254
0

KernelDensity_Crashes
VALUE
≤48.448648
≤96.897296
≤145.345944

KernelDensity_DailyAnnualride
VALUE
≤193.794592
≤242.24324
≤290.691888
≤339.140536
≤387.589185
≤436.037833
≤484.486481

KernelDensity_DailyAnnualride
VALUE
≤19064.0125
≤38128.025
≤57192.0375
≤76256.05
≤95320.0625
≤114384.075
≤133448.0875
≤152512.1
≤171576.1125
≤190640.125

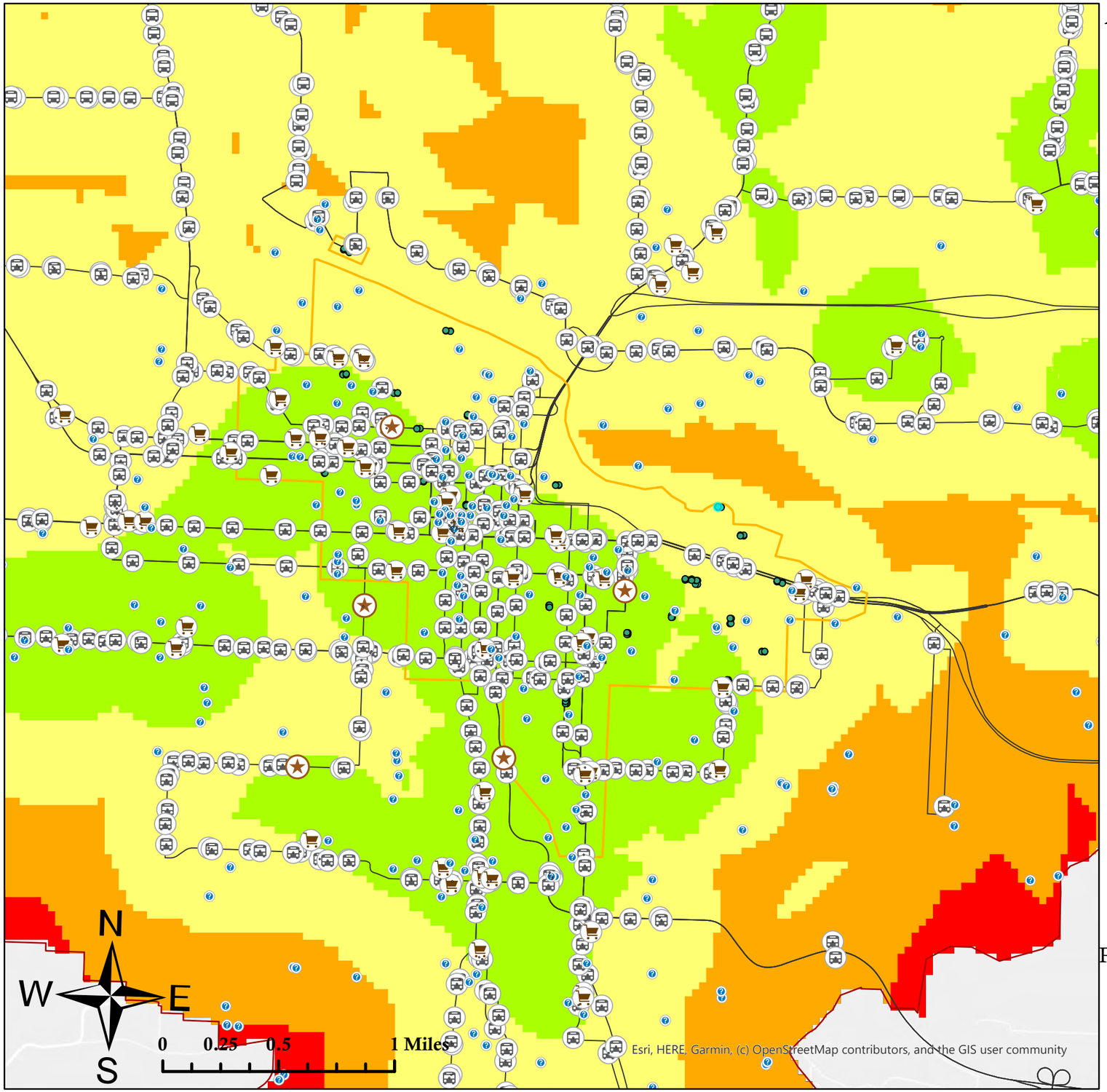
The map to the left represents the Bike Share region with a focus on the placement of bike hubs in relation to average bike traffic on an annual daily bases and crashes with bikes. This information is important because it can help us determine safer regions to place new bike share hubs and allows us to consider the region and how safe it is to be in that area. The background used is a hills shade layout because it shows the terrain in Eugene well and helps determine how the area of the bike share operating zone is affected by this factor.

The use of kernel data is helpful because it shows the regions that have the largest impact of both crashes and bike traffic and allows for careful consideration of that affect on travel time. The region with the largest amount of bike crashes is downtown Eugene which correlates with the amount of bike rides annually in the given region. Another region of significance is near University of Oregon, this shows a large amount of bike traffic with a smaller amount of crashes which could imply there are more bike routes and more enforcement of safety in the regions.

Cartographer: Emma Jensen
Sources: Lane Council of Governments, Lane County DEM,SSIL,SCYP,LTD

Map 12 – Area Suitability Analysis for Placement of New PHR Hubs
Cartographer: Adam Cuellar
Data: US Census block total population; Grocery stores; LTD bus stops
Analysis: Kernel density of block centroids weighted by total population. Euclidean distance from bus stops and grocery stores. Weighted overlay of distance and density rasters. Location-allocation selection of bus stops close to grocery stores and dense population.
Summary: The suitability layer shows the weighted overlay emphasizing areas with high population near to grocery stores and bus stops. Starred bus stops have been identified by Location-Allocation to most equally serve the grocery stores and dense population blocks.

Area Suitability Analysis For Placement of New PHR Hubs



Map Legend

Location-Allocation 2
- Chosen
- Required
- Competitor
- Candidate

Chosen
Required
Competitor
Candidate

- GroceryStores_Clip
- Bus_Stops_Clip
- PHR_Hubs
- Eugene and Springfield UGBs
- BikeShare Hub Points
- BikeShare Operating Zone

Bus and EMX Routes
- EMX Routes
- LTD Routes Fall 2019

Value
- 5
- 6
- 7
- 8
- 9
- 10
- BikeShare Downtown Operating Zone

This map is displaying the results of an overlay analysis, generated using input points such as population density, proximity to facilities, and proximity to other necessities such as grocery stores. The more green a hue becomes, the more suitable it is for the placement of a peace health ride bike. The points that are brown stars are suitable bus stops found using location allocation tool, in which we can integrate the new bike stations which to reduce the number of households that live within food deserts.

Data Source: Oregon Spatial Data Library, Lane Transportation Department, USDA, and the US Census Bureau

Projection: Oregon Lambert Conformal

Created by: Adam Cuellar
3/19/20 Geog 482

Map 13 – Bike Share Suitability to Serve 16-Year-Old Workers

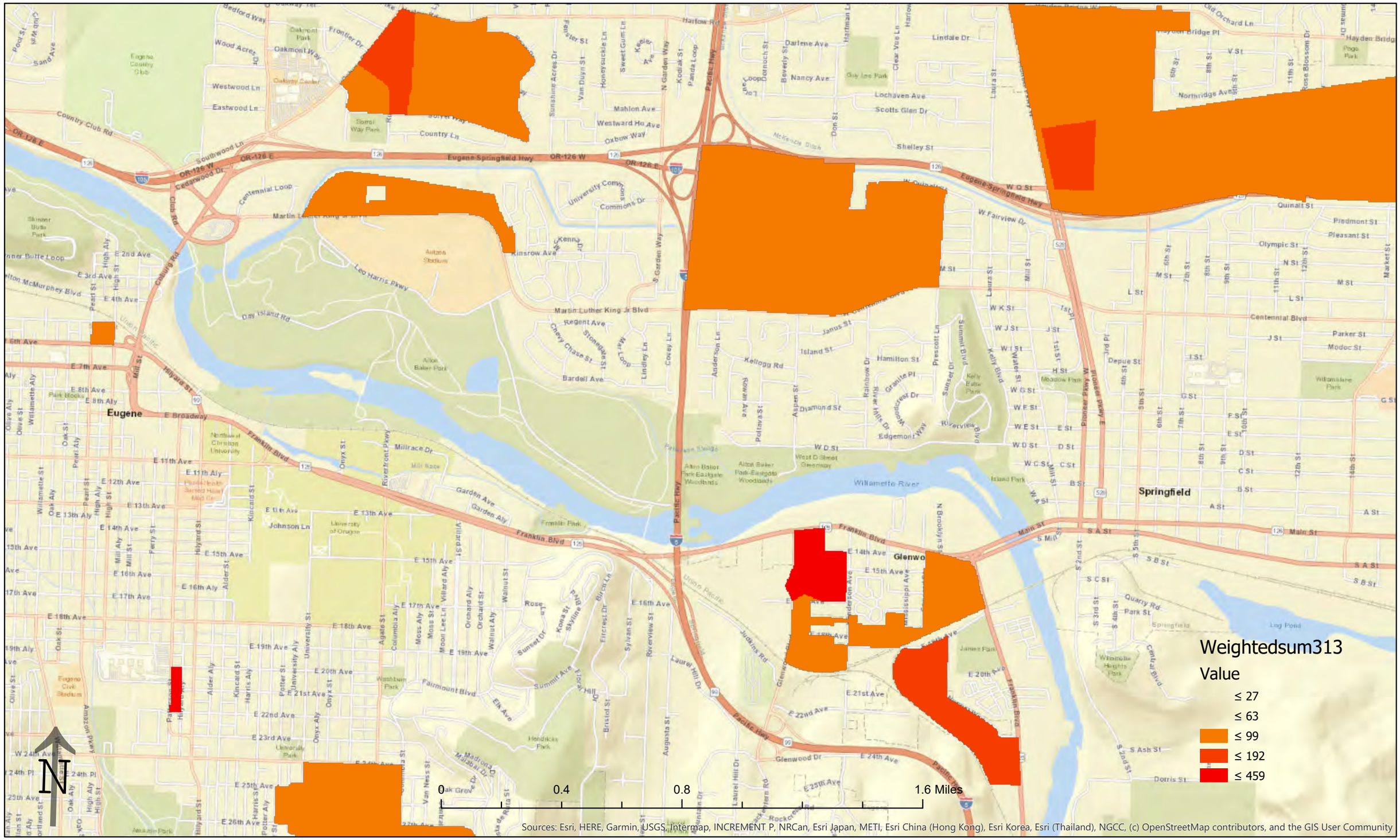
Cartographer: Madison Fung

Data: US Census block group total population 15-17 years of age; LODES Workplace Area Characteristics census block level by jobs sector.

Analysis: 15-17-year-old population block groups and LODES data for retail and food service jobs converted to raster. Weighted sum overlay: 2x weight given to population of 15-17-year-olds.

Summary: This analyst emphasizes census blocks and block groups with higher populations of 15-17-year-olds and more jobs in retail and food service. This can be understood to emphasize areas with family households and more low-skill jobs.

Bikeshare Suitability to Serve 16 Year Old Workers



3 Eugene-Springfield Urban Growth Boundary Extent

Summary

The analyses using the Urban Growth Boundaries of Eugene and Springfield are qualitatively different that the smaller scale analyses of the previous section. These student analysts were more interested in thinking about the expanding access of the PHR system broadly, emphasizing underserved places and populations, and integrating with other public transportation options. Seven of these are suitability projects utilizing primarily overlay tools, and two are network analyses which use a road network provided by ESRI as a component of ArcGIS Pro 2.x.

3.1 Suitability Analyses

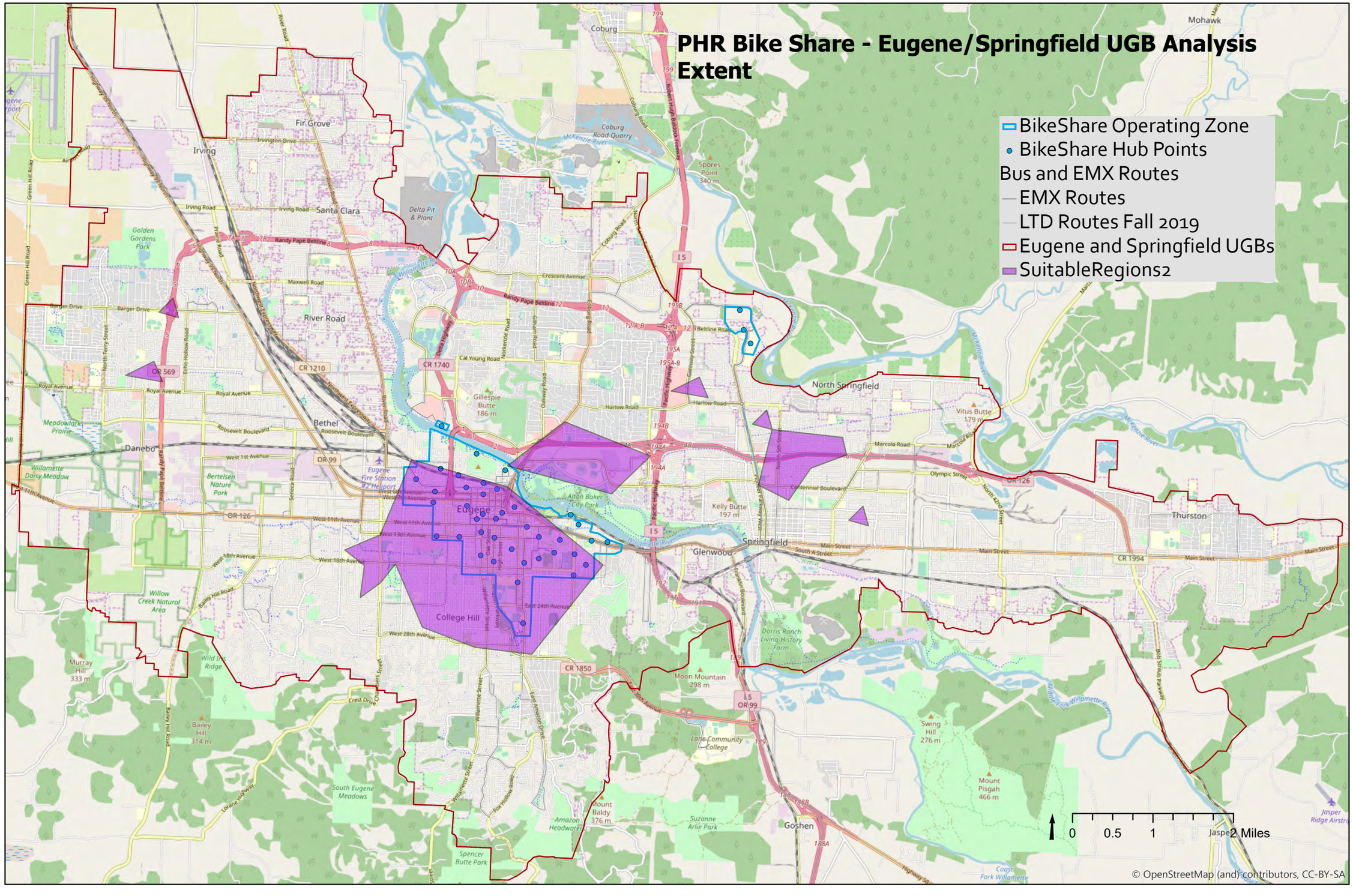
Several student projects focused on expanding the network of bikeshare stations outside of the boundaries of the current service area in Downtown Eugene and the Riverbend Campus by overlaying raster data. In many cases this involved converting point, line or polygon data into raster format data. These can be categorized as those emphasizing lack of LTD access (Maps 15, 16, 17) not (Map 14).

3.1.1 Expanding the PHR Operating Zone

These analysts reach very different conclusions primarily by how they approach proximity: On Map 14, suitability is a function of proximity to housing and jobs, while Map 15 emphasizes areas more than 1 mile from facilities.

Map 14 – PHR Bike Share – Eugene/Springfield UGB Analysis Extent
Cartographer: Joseph Staton
Data: US Census block group median age; US Census block housing units; Employment facilities
Analysis: US Census block group median age feature-to-raster. Point density of US Census block centroids weighted by housing units. Point density of employment facility locations. All three input data sets reclassified on a scale of 1-100. Weighted overlay of three inputs; 25% weight to median age, 35% weight to housing and 40% weight to employment facilities. Cells with an overlay value greater than 70 converted to polygons.
Summary: This analyst shows area that have lower median age, and higher density of housing units and employment opportunities. Northwest of DeFazio/Ferry Street Bridge, immediately Southwest of the PHR Operating Zone, and North of Centennial Blvd between Pioneer Pkwy and Mohawk Blvd are areas indicated by this analysis.

Cartographer: Joseph Staton, Projection: Oregon Lambert, Data Sources: US Census Bureau, LEHD Origin-Destination Employment Statistics



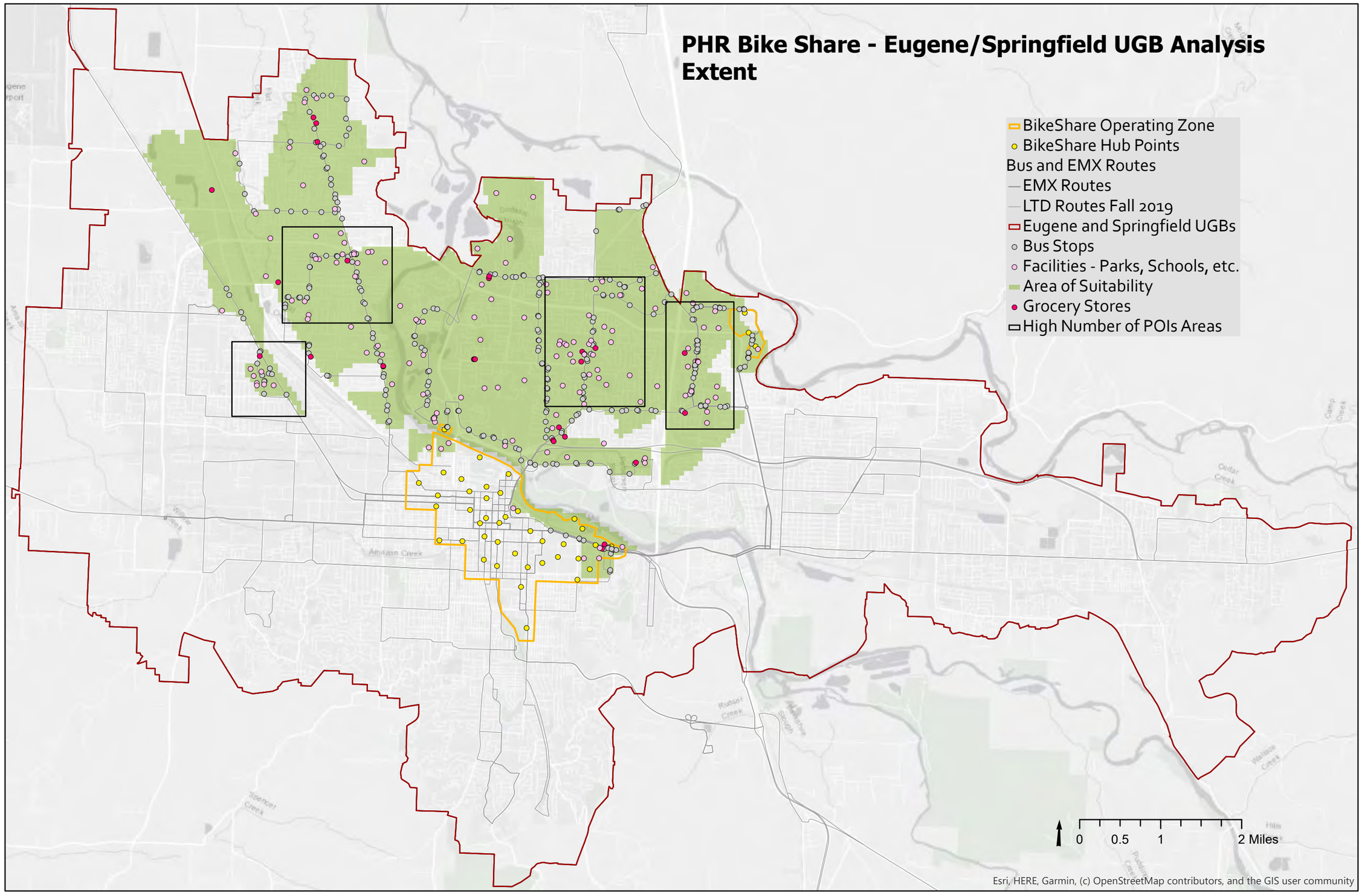
This map shows the suitable regions for bus stops in purple, based on a weighted overlay of median age data, housing density, and density of employment facilities.

3.1.2 Integrating LTD and PHR for Underserved Populations

These analysts suggest the North Eugene and Springfield are areas most in need of additional transportation options, although demographically the pockets identified in Map 14 may be the most likely to use bike share facilities currently.

Map 15 – PHR Bike Share – Eugene/Springfield UGB Analysis Extent
Cartographer: Jonathan Meusch
Data: US Census block group total population; US Census block group LODES Workplace Area Characteristics; Grocery stores; LTD bus stops; Various points of interest (POI; parks, schools, etc.).
Analysis: Euclidean distance to bus stops, grocery stores and POIs. Feature-to-raster US Census block group total population and US Census block LODES total jobs. Each of five layers reclassed. Distance rasters give extra weight to >1 mile distance. Weighted overlay of five input layers (weights unknown, presumed equal). Locate Regions tool (ArcGIS Pro), describing a single region.
Summary: This analyst highlights the broad region where there is likely the most unmet origin demand for alternative work commuting. These are likely to be areas that have substantial problems with the 'last mile' for public transportation because longer distances to buses, higher population and greater numbers of jobs are all included. The size of Census block groups in that area may be playing a role in emphasizing that region. The size of the region is a tool parameter that can be changed.

PHR Bike Share - Eugene/Springfield UGB Analysis Extent



Map 16 – PHR Bike Share Suitability Analysis

Cartographer: Noah Heise

Data: US Census block group household income by income categories; LTD bus stops.

Analysis: Euclidean distance to bus stops. Feature-to-raster US Census block group number of households with income $10,000-$14,999. Reclassified to with higher values for more low-income households and greater distance to bus stops. Weighted overlay of two inputs.

Summary: This analyst emphasizes parts of Eugene/Springfield with greater distances to bus stops and more low-income households.

PHR BikeShare Suitability Analysis - Noah Heise

BikeShare Operating Zone
Eugene and Springfield UGBs
Darker purple represents best suitablility for new BikeShare hubs
Value
≤5.011765
≤6.015686
≤7.019608
≤9.027451
≤10
LTD Bus Stops

0 0.5 1 2 Miles

Map 17 – Bus Stop Locational Suitability Eugene/Springfield UGB Analysis Extent
Cartographer: Cody Jacobson

Data: US Census block group total population; LTD bus stops.

Analysis: Euclidean distance to bus stops to a maximum of 0.25 miles. Feature-to-raster US Census block group total population. Reclassified to with higher values for more total population and greater distance to bus stops. Weighted overlay of two inputs.

Summary: This analysis emphasizes parts of Eugene/Springfield with varying distances to bus stops and high population. By limiting the distance to 0.25 miles from bus stops, this analyst focuses more on places where many people would consider the walk to their closest bus stop feasible. The influence of block group size may be playing a large role in the degree of suitability.

Bus Stop Locational Suitability
Eugene/Springfield UGB Analysis Extent

Bus and EMX Routes
- EMX Routes
- LTD Routes Fall 2019
- Eugene and Springfield UGBs

Population / Bus Stop Overlay Value
- Low Suitability
- Low Moderate Suitability
- Moderate Suitability
- High Moderate Suitability
- High Suitability

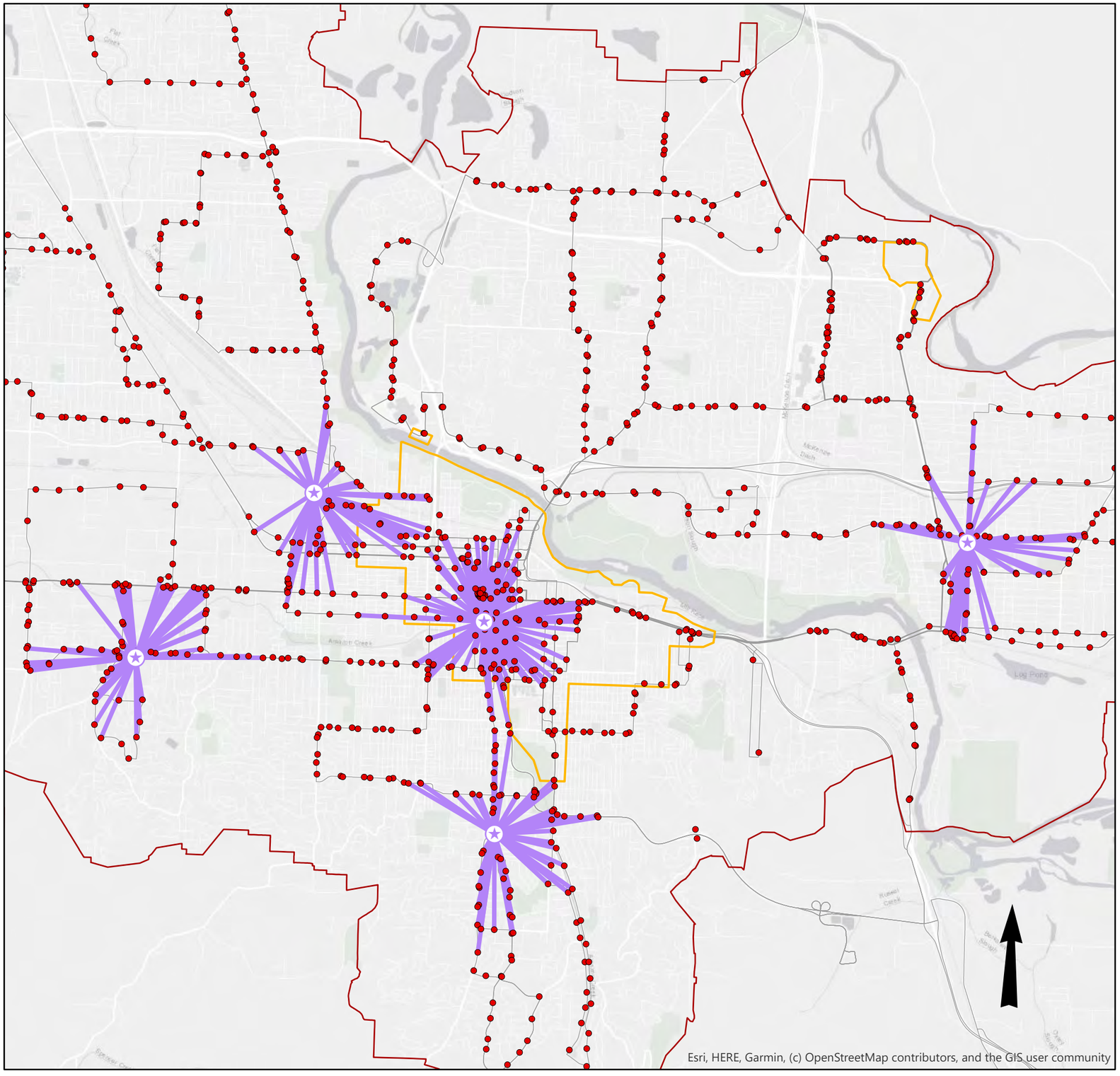
0 0.5 1 2 Miles

3.2 Network Analyses for Integrating PHR Operating Zone Expansion with LTD Service

These network analyses are both implementations of Location-Allocation tools. These tools use road network distance to allocate a specified number of facilities from a set of potential points to best serve a set of demand points. These analyses differ in two important respects: 1. Which locations are facilities and demand points, and 2. How many potential facilities are selected by the tool.

Map 18 – PHR Bike Share – Downtown Area Analysis Extent
Cartographer: Benjamin Switzman
Data: LTD bus stops; Various points of interest (POI; recreational centers, schools, commercial stores, park & rides, and government buildings).
Analysis: Location-Allocation network analysis with demand points are the bus stops, and potential facilities are the POIs.
Summary: Shown on this map are the 5 POIs in the Eugene/Spring field which are central to areas most accessible by bus. These are locations that might serve as centers of future bike share hub nodes.

PHR Bike Share -Downtown Area Analysis Extent



Legend:

- BikeShare Operating Zone

Bus and EMX Routes

- EMX Routes
- LTD Routes Fall 2019
- Eugene and Springfield UGBs
- New Locations Chosen
- Lines
- Facilities
- Bus Stops

Here are five possible locations for new Bike Share Hubs marked by the Stars.
I used location-allocation by using the bus stops as demand points where people will be coming from. The stars are locations within a mile of the most amount of facilities that are accessible from bus stops that are also within a mile range. This is because I am trying to integrate the Bike Hubs to other forms of public transportation to accommodate the majority of citizens to get them through their final mile
towards their destination. The facilities which are recreation, commercial, emergency, and educational locations where people normally bike toward.

Benjamin Switzman
Oregon Spatial Data Library
US Census Bureau

Mercator Auxiliary Sphere

Map 19 – PHR Bike Share – Eugene/Springfield UGB Location-Allocation Analysis
Cartographer: Brandon Larson
Data: LTD bus stops; Various points of interest (POI; winery, culture & arts, shopping centers, recreation, museum, library, LTD transit stations, grocery store, and parks).
Analysis: Location-Allocation network analysis, with POIs as the demand points and bus stops as the potential facilities. 1-mile service area for existing PHR bike hubs.
Summary: Map shows 45 bus stops that would most equally serve the POIs of Eugene/Springfield. The blue service area shows the area that is within 1 mile of existing PHR bike hubs. Potential bus stops within this service area offer opportunities to expand near the Operating Zone.

PHR Bike Share - Eugene/Springfield UGB Location-Allocation Analysis

BikeShare Operating Zone
BikeShare Hub Points
Bus and EMX Routes
— EMX Routes
— Bike Facility
Bus and EMX Routes
— LTD Routes Fall 2019
Eugene and Springfield UGBs
Service Area
Parks
Potential Locations
Water

0 0.5 1 2 Miles

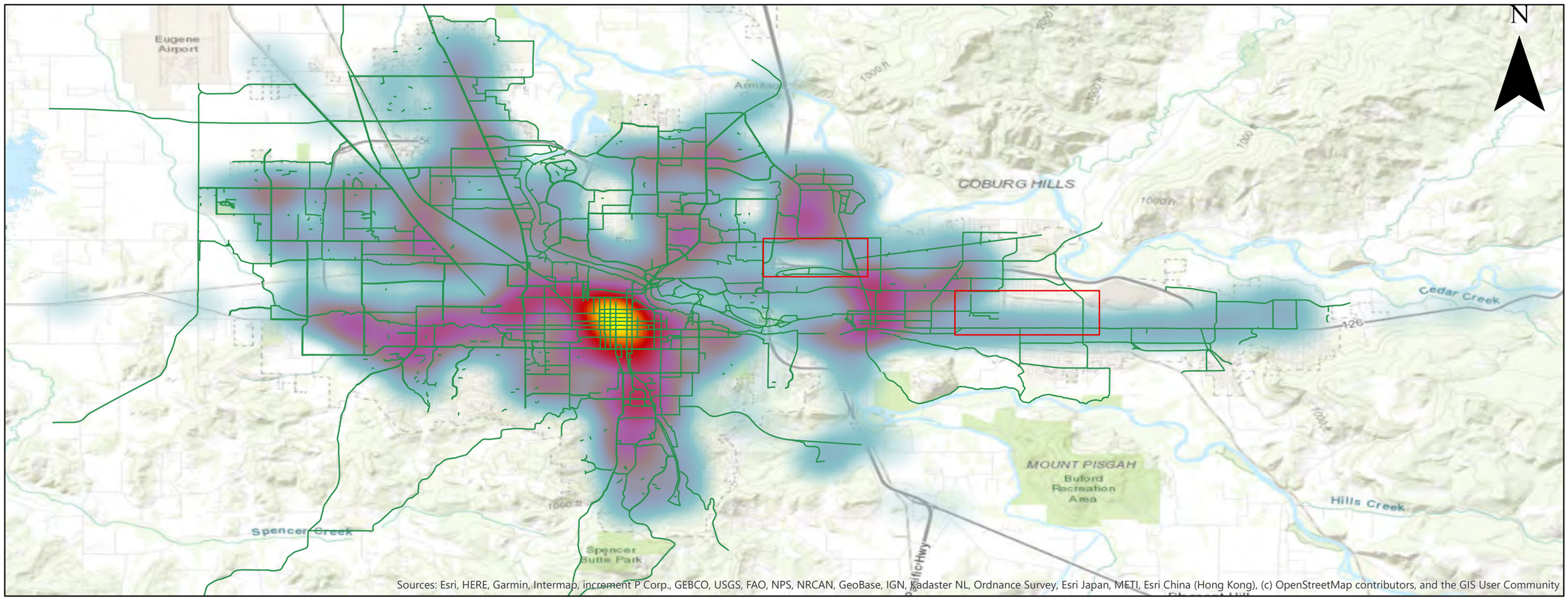
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

3.3 Additional Analyses

Three additional analyses provide context for the preceding sections.

Map 20 – Heat Map of LTD Bus Stop Traffic
Cartographer: Zachary Sumey
Data: LTD bus stops; Bike routes.
Analysis: Point density of bus stops. Euclidean distance from bike routes.
Summary: The analyst shows density of bus stops with bike routes over it. Highlighted are two areas where there are some locations with no bike routes within 350 meters.

Heat Map of LTD Bus Stop Traffic



Bikepaths

Sparse

Dense

The areas highlighted with a red box indicate the areas where there are no official bike paths within 350 meters of an LTD bus stop. On this map we can compare bus stop density with areas that lack suitable bike paths for riders.

0 1 2 4 6 8 Miles

The map above shows the density of bus stops within the the Eugene and Springfield Urban Growth Boundary. This data is relevant when looking at areas where residents have less access to public transportation because there are stressors that prevent bike riders from traveling through specific areas.

Source: City of Eugene, 2020, ESRI,2020
Cartographer: Zachary Sumey,2020

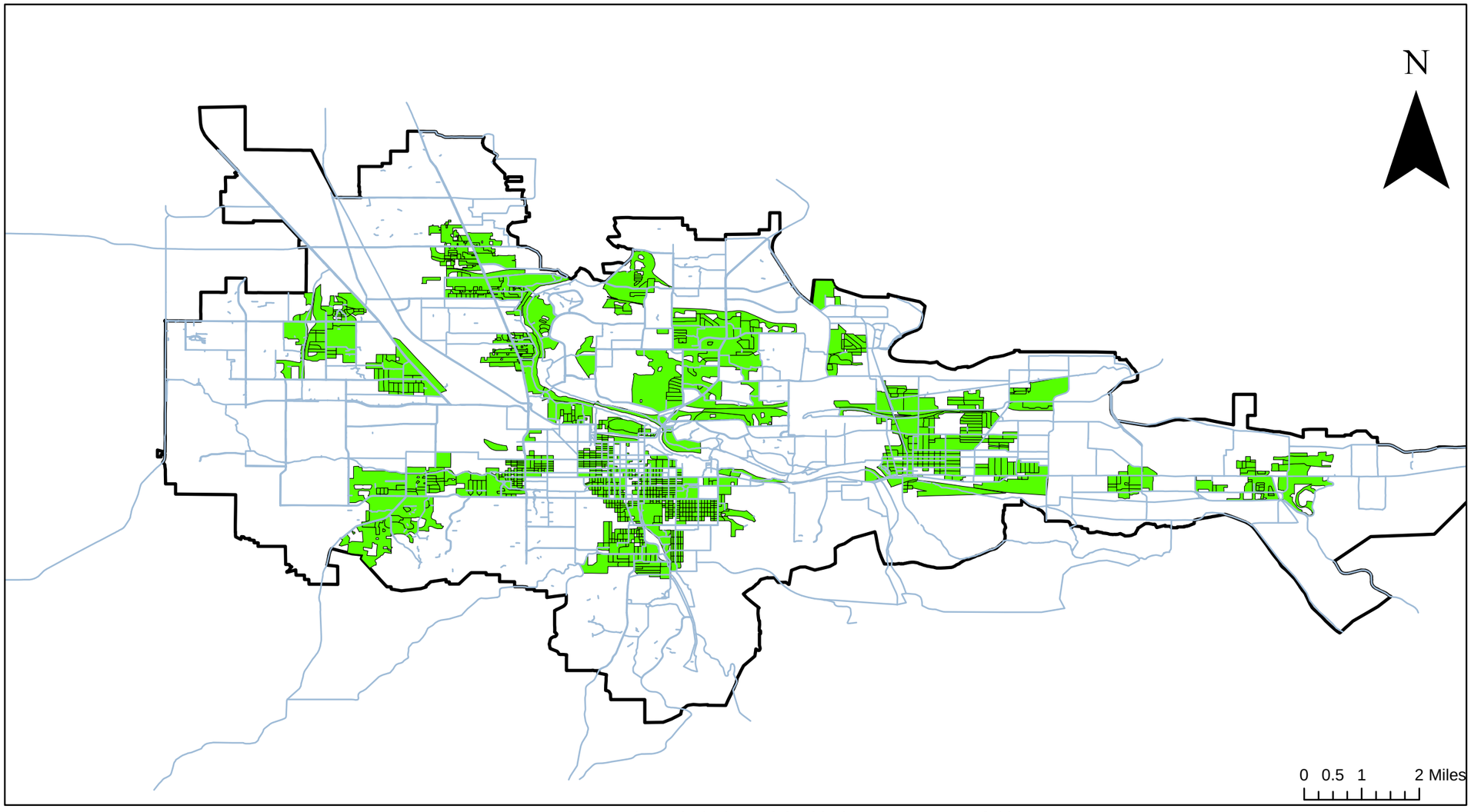
Map 21 – Eugene-Springfield Bike Share High Suitability Census Blocks
Cartographer: Wenhao Zheng

Data: Points of interest (POI) separated into major POI (School, shopping center, bus station, transportation station) and minor (other); LTD bus stops; Bike routes; US Census block total population, race, age and housing options.

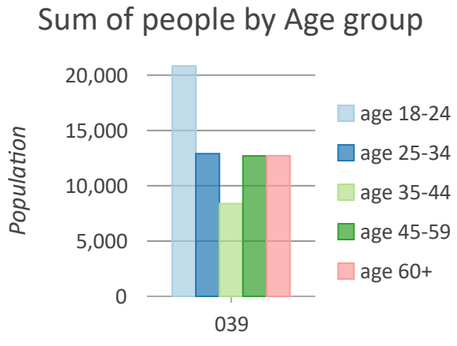
Analysis: Euclidean distance to bus stops and POIs. Line density of bike routes. Kernel density of US Census block centroid weighted by population. Reclassified all five layers to common scale. Weighted overlay of five layers. Reclassified overlay and converted overlay to polygon with feature-to-raster. Selected highest value polygons, and selected US Census blocks by intersection with those high suitability polygons. Selected US Census blocks summarized by age, race and housing.

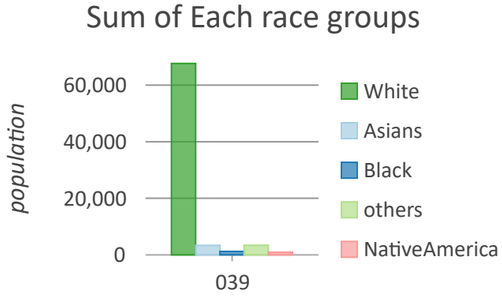
Summary: The analyst wanted to see what the demographic composition of an area considered 'suitable' for new PHR hubs might look like. They used a suitability analysis to select US Census blocks that overlapped with areas near many bus stops, POIs, and bike routes; and where there are also many people and housing units. These US Census blocks were then summarized by age, race and housing options. These areas were high proportion white, mostly under 44-years-old and >60% owner-occupied.

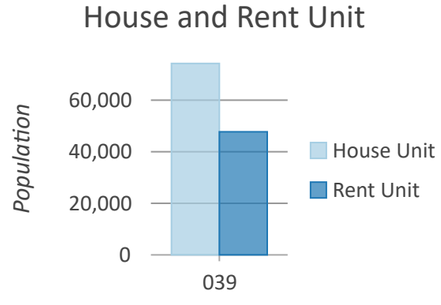
Eugene-Springfield Bikeshare High suitability census blocks



This map shows the high suitability blocks in Eugene Springfield Area





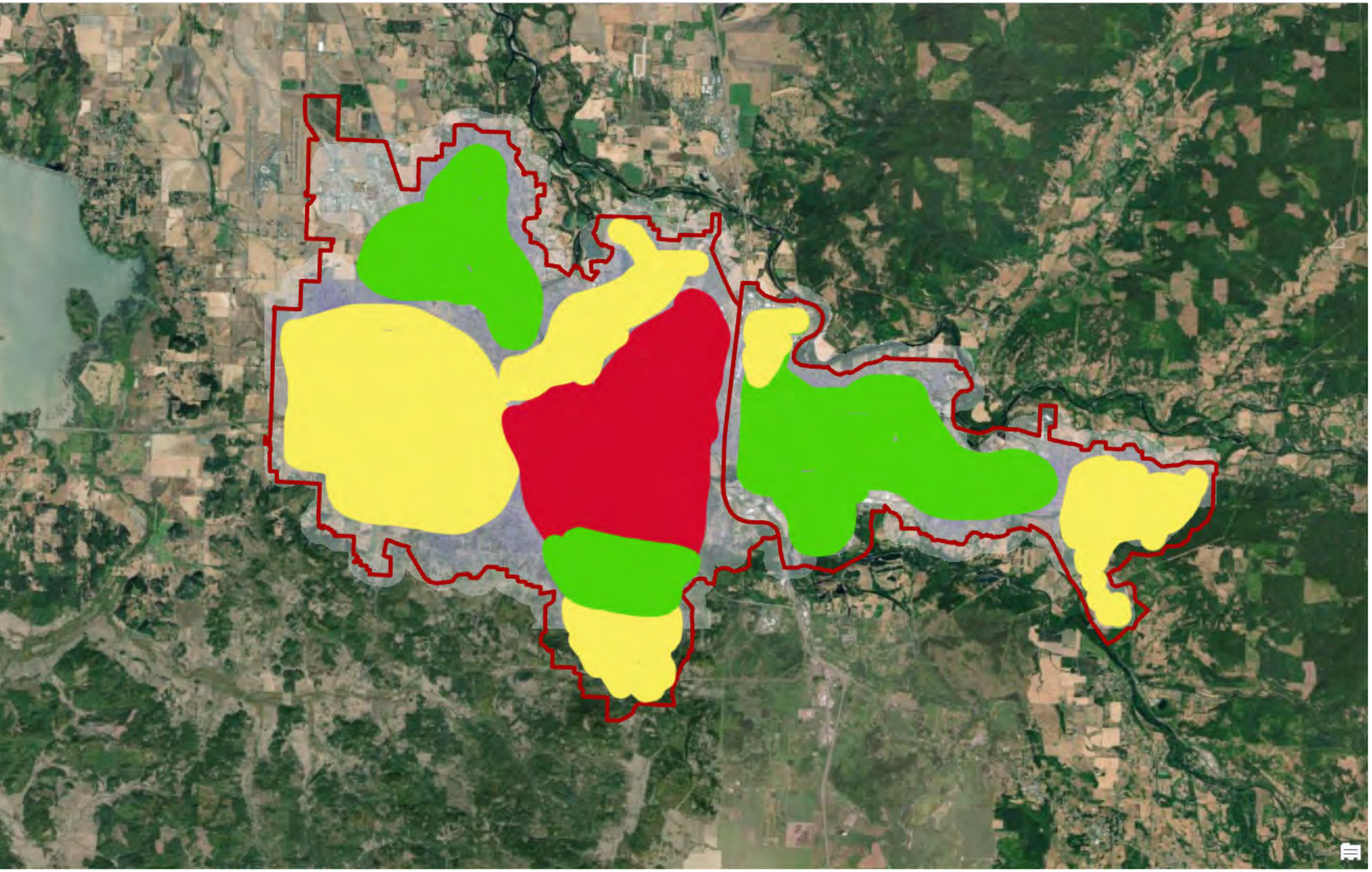


BikeFacility
SelectBlockFinal
EugeneSpringfieldUGA

Author: Zheng
Sources: US Census block, UO Library,
Date: 3/17/2020

Map 22 – PHR Bike Share – Eugene/Springfield UGB Analysis Extent
Cartographer: Jaclyn Fields
Data: Points of interest (POI; schools, libraries, grocery stores); US Census block commuter characteristics; US Census block occupied housing units.
Analysis: Point density of commuters using public transportation, schools, libraries and grocery stores. Feature to raster of occupied housing units in US Census blocks. Weighted overlay: 30% housing units, 10% schools, 10% libraries, 20% grocery stores, 30% public transport commuters. Reclassified values into large categories.
Summary: With a coarse reclassification this analyst makes broad generalizations about suitability which emphasize numbers of public transport commuters and housing density. This analysis suggests that North of Downtown Eugene off Coburg Rd is a key area in terms of existing people who already seek public transportation and where new services would reach the most people

PHR Bike Share - Eugene/Springfield UGB Analysis Extent



Eugene and Springfield UGBs

Weighted_Overlay

Value

10

1

In this analysis a weighted overlay was used to help classify areas that would be in ***high demand*** of an expanded bikeshare network; The weighted layers included occupied housing/rental units, Number of commuters who use public transportation, and areas with a high number of popular facilities which includes grocery stores, schools and libraries.

Weighted the heaviest was commuters using public transportation, then housing density, and then facilities.

Spatial Reference
Name: NAD83 HARN Oregon South ft
PCS: NAD83 HARN Oregon South ft
GCS: GCS NAD83(HARN)
Datum: North American 1983 HARN
Projection: Lambert Conformal Conic
Central Meridian: -120.5000

N

0 1 2 4 Miles

4 Discussion and Recommendations

The work of these students suggests that it is difficult to balance Operating Zone expansion to underserved populations while also expanding services for the existing ridership. Inside the Operating Zone, 14th/Kincaid and 13th/Agate, as well as the Southern and Western margins of the UO Campus super-block are the most obvious areas in need of attention. The Downtown side of the Defazio/Ferry Street Bridge is another anomalous location. Additionally, the area immediately to the South of the Operating Zone appears to both address a large number of non-hub ride end points inside and outside of the Operating Zone as well as access to points of interest in the South Willamette corridor. Demographically this area may be more likely to use bike share without additional measures. The Kinsrow area and associated student housing is also an interesting potential point of expansion.

At the scale of the Urban Growth Boundaries, there is a less coherent message from these analysts. Maps 14 and 18 indicate that expanding South would meet a lot of need that is likely to be realized. Greater potential need to the North, would likely be more difficult to realize without additional measures which might include incentives or education.

SCI Directors and Staff

Marc Schlossberg	SCI Co-Director, and Professor of Planning, Public Policy and Management, University of Oregon
Nico Larco	SCI Co-Director, and Professor of Architecture, University of Oregon
Megan Banks	SCYP Director, University of Oregon
Sean Vermilya	Report Coordinator
Katie Fields	SCYP Graduate Employee
Danielle Lewis	Graphic Designer