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Boise Bike Share Location Analysis

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Executive Summary

In consultation with the Central District Health Department, the Community and Regional Planning program conducted a bike share analysis that locates and optimizes the number of bikes and bike share stations for a 2.25-mile radius in the Downtown Boise area. After examining several bike share projects in other cities and studies of their methodologies two analyses from Seattle, Washington and Los Angeles County, California proved helpful in developing the Boise Bike Share Location Analysis. Using GIS optimization analysis to determine the optimal number of bikes and bike stations resulted in 140 bikes and 14 stations as the optimal finding.

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Acknowledgement

Our thanks goes to the Central District Health Department for inviting our program to help them with their research needs. We would like to express our thanks to Sheila Weaver for her editing feedback on this report.

Introduction

Bike share programs are one mode of transportation giving users travel and connection options for short and medium distances, or for commuting purposes. Bike share programs enable the usages of bicycles on a rental and short-term base. A bike share program provides a system of terminals where customers can unlock bikes via a membership card or via credit card. Users of a bike share programs make trips in short intervals, normally less than 30 minutes and averaging 2.5 miles.

A bike share program for Boise has the potential to increase bike riding, which promotes active living and gives residents and tourists an alternative transportation option. Bike share programs not only have the potential of developing a healthier community but also can promote positive environmental and economic outcomes by providing improved accessibility to local businesses without emissions. Recognizing the potential benefits of a bike share program, Central District Health Department (CDHD), requested assistance from the Community and Regional Planning programs in the form of a location analysis. The analysis will assist CDHD in maximizing the outcomes from a potential capital grant for a Boise Bike Share project.

The following report provides highlights of the research examined on bike share programs both nationally and internationally, and a description of two cases that provide sufficient methodological detail to draw from for our Boise bike share location analysis. A description of the analysis and findings from the Boise bike share is part of this report.

Background

Planning, and personal and public health literature report positive impacts of bike share programs on active living, tourism, and economic development. There is also a positive effect on the environment when there is a shift from automobile transit to zero-emission biking. Tables 1 and 2 provide a national and international comparison of some existing bike share systems. Specifically the tables compare factors such as size of metropolitan populations, number of stations and bikes in the system, size of the serviced area, and the company used to purchase the bike share equipment.

The bike share programs located in Arlington, VA, Minneapolis, MN, and Montreal Canada were of particular interest for the bike share research for the City of Boise. These programs focused on local residents as customers. Other cities primarily target tourists first and then residents in designing their bike share programs. Boise, the capital of the State of Idaho with approximately 205,000 residents, is the largest city in the Boise-Nampa metropolitan statistical region, which has an estimated population 619,694 (U.S. Census Bureau 2010).

Boise's greenbelt path system offers a network of over 20 miles of relatively safe biking without interference of cars or trucks. Boise has a series of bike routes making it ranked one of the top twenty cities for bicycle commuters (per capita) to work (League of American Bicyclists 2011a). In 2011, Boise State University was named one of the bike-friendliest campuses by the League of American Bicyclists (2011b).

Clearly, the cities included in the bike share matrix varied in several ways including by the quantity of bikes and bike stations.

Table 1: Overview of Existing Bike Share Programs Demographics

City	Program	Link	City Size	Metro Size	Target Audience	Ridership (2010)	Service Area	# of Bikes	# of Stations	Station Sizes	Year Started
Montreal	Bixi	https://montreal.bixi.com/	1.6 million	3.6 million	Local Residents	3,000,000	a 5.5 mile by 7.5 mile stretch of the downtown core of the city of Montreal	5000	405	10-40 spaces per station, varied by area.	2009
Twin Cities, MN	Nice Ride	https://www.niceridemn.org/	670 thousand	3.3 million	Local Residents	100,817	Downtown Twin Cities, covering an area 10 miles by 5.5 miles.	1200	116	15-20 spaces per station, varied.	2010
DC Metro Area	Capital Bikeshare	http://www.capitalbikeshare.com	600 thousand	5.6 million	Locals & tourists	NA	Most of DC plus Arlington, VA, covering an area 9 by 7 miles	3700	420	Average of 15 spaces per station, with larger stations accommodating up to 40 bikes	2010
Boston	Hubway	http://thehubway.com/	600 thousand	4.5 million	Locals & tourists	NA	Downtown Boston, covering an area 5 by 1.5 miles	600	61	10-25 parking spaces per station (varied)	2011
Denver	BCycle	http://denver.bcycle.com/	600 thousand	2.5 million	Locals & tourists	100 thousand rides in 2011	Downtown, covering an area 5 miles by 2.5 miles	510	51	Space available for 5-25 bikes, depending on the station	
Miami	DecoBike	http://www.decobike.com/	400 thousand	5.5 million	Locals & tourists		7.5 mile stretch of Miami Beach	1000	66	16 docking bays per station	2011

Table 2: Overview of existing Bike share Programs, Funding, and Implementation Models

City	Rental Cost	Implementation Method	Revenue Model	Major Funders
Montreal	Subscriptions for 24 hours ($5) / 30 days ($28) / annual ($78). Trips <45 mins:free, 60 mins:$1.50, 90 mins:$3, thereafter $12 for each additional hour	Began as part of the city's transportation plan.	Privately held company run by Montreal's municipal parking authority	City of Montreal. Telus Communications, Rio Tinto Alcan & Desjardin banks sponsor bixi stations
Twin Cities, MN	Subscriptions for 24 hours ($5) / 30 days ($30) / annual ($40). Trips <45 mins:free, 60 mins:$1.50, 90 mins:$4.50, thereafter $12 for each additional hour	City of Minneapolis + local non-profits set up Nice Ride and solicited public-private funds.	Nice Ride is a non-profit agency	Transit for Livable Communities (Federal Highway Administration), Blue Cross and Blue Shield of Minnesota (cause: tobacco litigation settlement),
DC Metro Area	Subscriptions for 24 hours ($5) / 5 days ($15) / 30 days ($25) / annual ($75). Trips <30 mins:free, 60 mins:$1.50, 90 mins:$3, thereafter $12 for each additional hour	Arlington County Commuter Services and DC Transit worked to implement the program together with funding from federal and state governments	Unclear, but the system is run by Alta Bicycle Share (http://www.altabicycleshare.com), a division of Alta Planning + Design (http://www.altaplanning.com/).	Federal Highway Administration & Virginia Dept. of Rail & Public Transport. Many local corporate partners.
Boston	Subscriptions for 24 hours ($5) / 3 days ($12) / annual ($85). Based on casual membership: trips <30 mins:free, 60 mins:$2, 90 mins:$6, thereafter $16 for each additional hour	City of Boston signed an agreement with Alta Bicycle Share in 2011 to develop a regional bike share system. Boston is working with MassDOT, the Metro Planning Council, and the Federal Transit Administration to expand the system into surrounding communities.	Unclear, the system is run by Alta Bicycle Share.	$4.5 million in grants from the Federal Government and local organizations. New Balance is a major sponsor as well.
Denver	Subscriptions for 24 hours ($6) / 7 days ($20) / 30 days ($30) / annual ($65). Trips <30 mins:free, 60 mins:$1, thereafter $8 for each additional hour	Denver Bike Sharing was formed as a not for profit by the City of Denver and local non- profits.	Denver Bike Share is a non- profit agency	Local business promote themselves through advertisements on bikes and at bike stations
Miami	Monthly subscriptions for $15 (unltd 30 min rides) and $25 (unltd 60 min rides). Trips 30 mins: $4, 60 mins:$5, 4 hours:$18, 8 hour:$24, thereafter $4 for additional 30 mins	City of Miami partnered with DecoBike LLC, to implement the program	The City of Miami Beach and DecoBikeshare revenues generated by the program.	Local organizations

Case Study Examples

The research identified the programs situated in Seattle, WA and Los Angeles County, CA as the most transparent in terms of the methodologies and categories applied in their demand and supply analyses. Borrowing from these methodologies enabled the development of demand analyses criteria for the City of Boise's bike share project.

Seattle, Washington

Seattle's bike share analysis focused on layers such as population and employment density, retail locations, transit locations, and the presence of bike lanes and paths (Gregerson et al. 2010). The method used in the Seattle case entailed weighting each indicator on its importance for trip generation potential. For instance, population density, an indicator of potential high demand and trip generation, has a weight of one (equal to 100%). Alternatively, parks have a lower value of 0.5 to represent a lesser weight in terms of demand or trip generation potential. Seattle uses 13 factors that all receive equal value with the exception of university housing, parks, and recreational areas, which only receive a weight of 0.5. University housing is considered important to the Seattle bike share analysis due to the average age range of students, its proximity to major mixed-use developments, and the fact that university students' transit mode share is higher than average. However, university housing has half the value due to its population density. In Seattle's bike share analysis, density and proximity were important measurement indicators. For example, the study considered the density of potential factors such as tourist attractions, commute trip reduction (CRT) companies that organize car-pooling or other transit incentives for their employees, and local transit stops. The study also considered a proximity of 1000 meters as measure for regional transit stations, bike lanes and bicycle friendly streets. Additionally, units per acre determined population and retail densities in the Seattle bike share analysis. Seattle also considered slope due to the dominating hilly topography of the Seattle area.

Los Angeles County, California

Los Angeles County's bike share analysis stressed the importance of dividing the data into trip generators, attractors, and facilitators (Kim et al. 2011). The attraction group consists of employment density, schools, parks and retail. The attraction factors received 50 percent of the overall weight. The trip generator factors are built from residential density and populations in poverty, on population characteristics such as number of vehicles in households, age demographics, and mode choice for commuting to work. The generator group receives an importance weight of 30 percent of the overall total. The connector factors included rail stops and rapid bus stops; this group receives 20 percent of overall total weight. The individual factors received a percentage based on its importance within each primary group: attractor, generator, or connector. Subsequently each category has a subtotal weight as well as an overall weight. For example, employee density received a subtotal weight of 35 percent for trip attraction that equates to an overall weight of 18 percent. This distribution of weighted value enables a detailed analysis of the Los Angeles bike share project.

Methodology

The Boise bike share analysis used elements from both Seattle's and Los Angeles County's analysis. Seattle's method of combining proximity and a differentiating weight for each factor appears to be a valuable approach. Additionally, by borrowing from the Los Angeles study's methodology, the factors each vary in their values on how compelling they are as attractors, generators, or connectors for trip generation. In the end, the Boise bike share analysis used two methods of evaluation: Seattle's weighted overlay approach; and Los Angeles county's weighted sum approach.

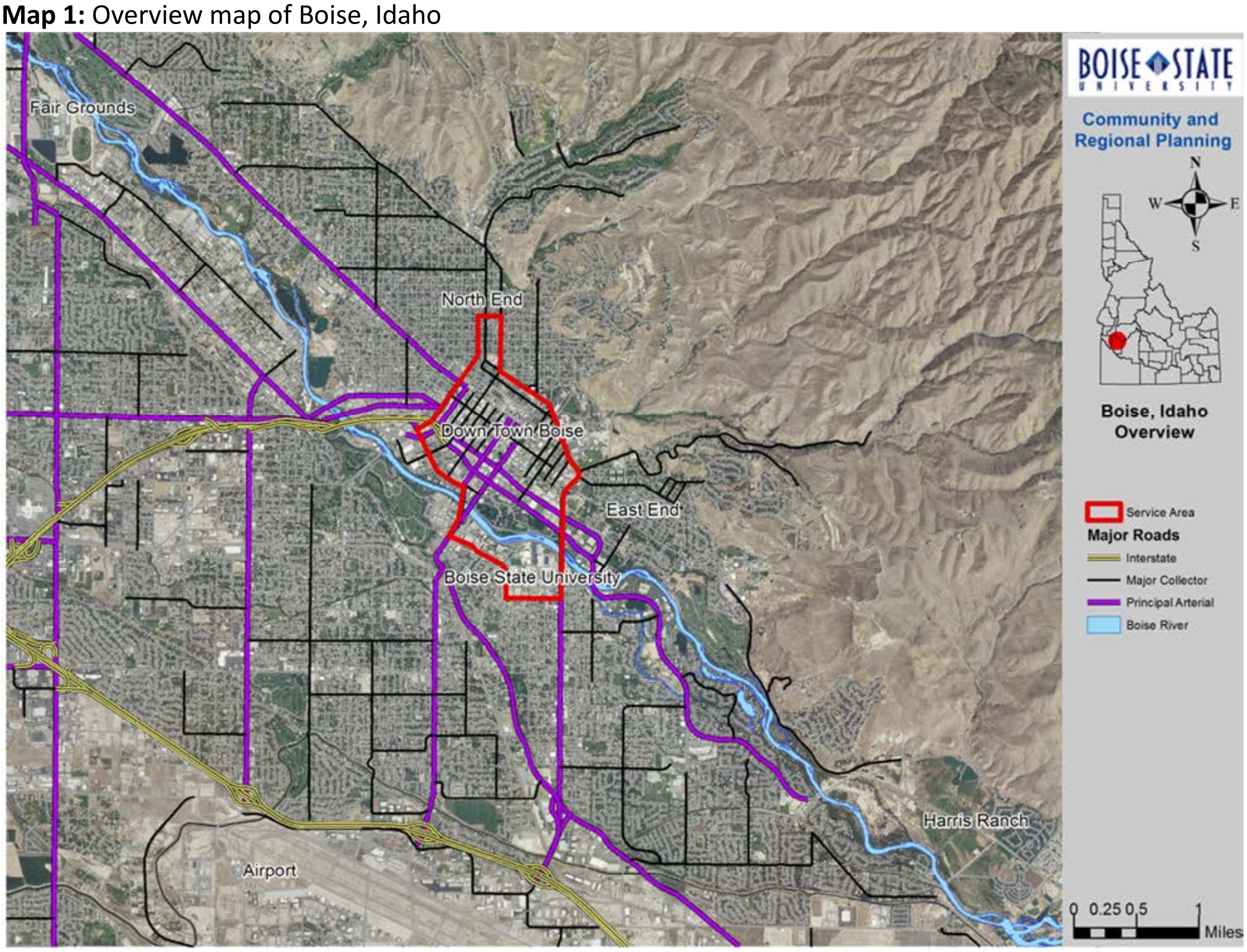
Data acquisition

The study uses data from Ada County Highway District (ACHD), Community Planning Association of Southwest Idaho, the metropolitan planning organization, and the City of Boise in the Boise bike share analysis. Specifically, the data include traffic analysis zones (TAZs) for population and employment information, regional streets, bus stops, bike lanes and paths, aerial photos, and school locations. Additional data obtained includes retail businesses, restaurants, and ATM locations, from the North American Industry Classification System (NAICS) provided within our GIS.

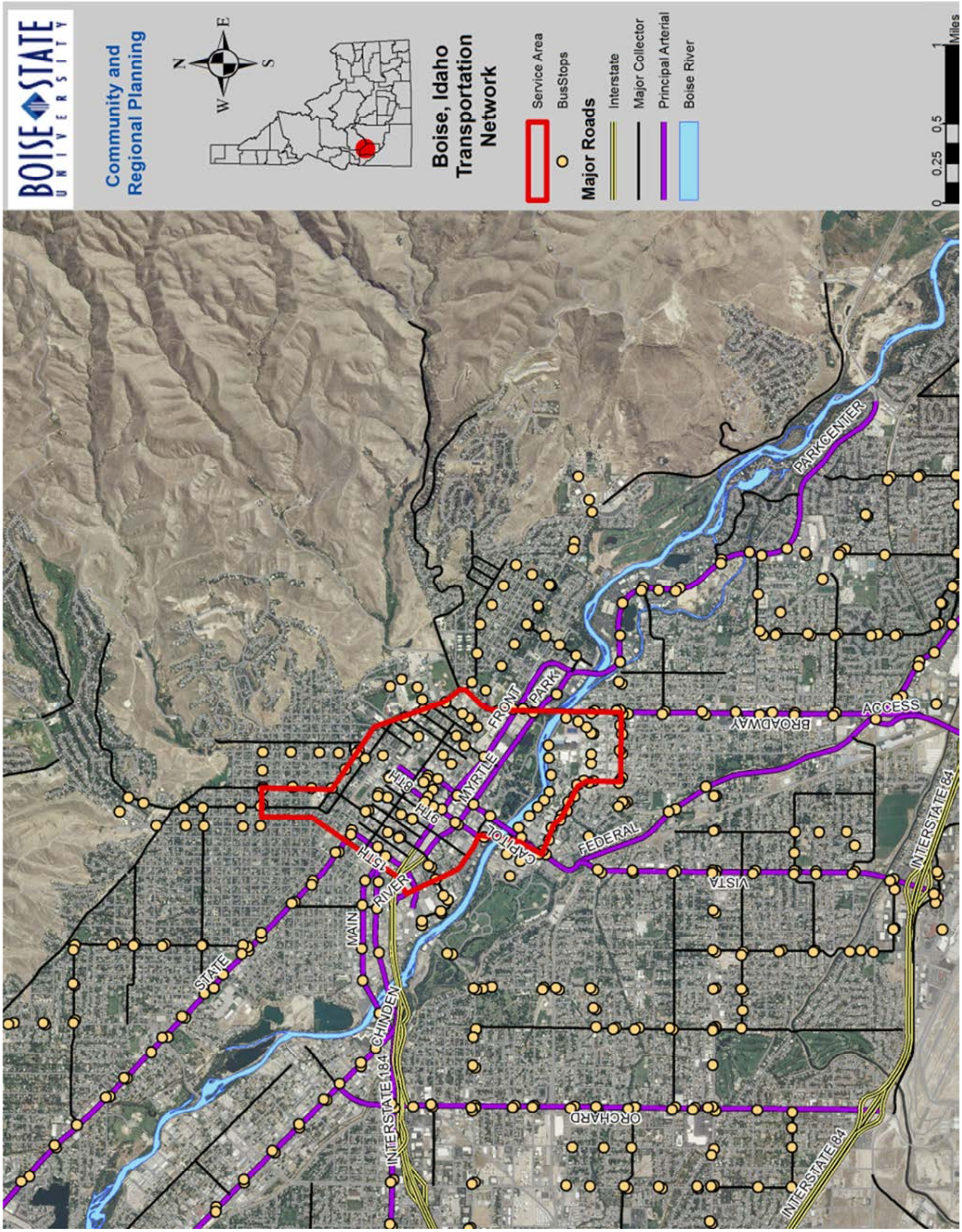
Determination of Service Area and Study Area

The CDHD initiated the request for the study indicating downtown Boise as the main focal point for analysis. The streets of Broadway Ave., Fort St., 16th, River St., 9thSt., and University Dr. are the informal boundary for the service area. This is an area of approximately 2.25 miles in diameter, which fits within the distance for the majority of bike share trips of 2.5 miles. However, in order to make a potential expansion of the service area possible, without additional analysis, the overall study encompasses the majority of Boise and extending into Garden City from the Fairgrounds in the northwest to the Harris Ranch subdivision in the southeast (Map 1) ranging a distance of approximately 11 miles. This includes the greenbelt bike path that runs along the Boise River. The greenbelt is a natural corridor providing access to downtown for the majority of the bicyclist (see also Map 2).

Map 1: Overview map of Boise, Idaho



Map 2: Transportation Network of Boise, Idaho



GIS Layer

While building a GIS model, we identified the following layers are identified as critical for the Boise bike share analysis. The table below presents indicator, scale, the metric and buffer distances used, and the weight assigned for the attractors, generators, and connectors as well as information on the data source.

San Antonio Bike Share Station on a Sidewalk

Table 3: Bike share Analysis Indicators

Indicator	Scale	Metric	Buffer Distances	Weight	Source
Population Density	Transportation Analysis Zone (TAZ)	Populating per acre	n/a	1	COMPASS
Employment Density	TAZ	Jobs per acre	n/a	1	COMPASS
Higher Education	33 ft. cell size	Proximity	820 ft. & 1640 ft.	1	COMPASS
Bus Stops	33 ft. cell size	Proximity	820 ft. & 1640 ft.	1	COMPASS
Bike Paths and Lanes	33 ft. cell size	Proximity	820 ft. & 1640 ft.	1	ACHD
Parking Garages	33 ft. cell size	Proximity	820 ft. & 1640 ft.	1	ACHD
Retail	33 ft. cell size	Proximity	820 ft. & 1640 ft.	0.5	NAICS
Restaurants	33 ft. cell size	Proximity	820 ft. & 1640 ft.	0.5	NAICS
ATMs	33 ft. cell size	Proximity	820 ft. & 1640 ft.	0.5	NAICS
Parks	33 ft. cell size	Proximity	820 ft. & 1640 ft.	0.5	COMPASS

Indicator Representation:

Population Density: Amount of people living in residential area provides potential bicycle users to travel to where they work, play, shop, and for return trips.

Employment Density: Employment centers support high numbers of employees a measure of potential bike use for transportation for short commutes such as for lunch, business meetings, exercise, and work breaks.

Higher Education: Student populations are a measure of potential bike use for transportation to commute between classes as well as to and from school.

Bus and Transit Stops: Bus Stops and other transit stations support biking by potentially providing transportation for portions of the commute.

Bike Paths and Lanes: Provide a measure of safe and effective routes for successful transportation options.

Parking Garages: Provide a measure of potential use such as commuters who choose to drive or carpool to the city center house their vehicles in parking garage and then use the bike share program for transportation for short trips around town.

Retail: Serves as a source of trip attraction.

Restaurants/Entertainment: Serves as a source of trip attraction

ATMs: Serves as a source of trip attraction.

Parks: Serves as a potential destination.

GIS model approach

The Boise analysis used density indicators and buffer factors. Traffic Analysis Zones (TAZs) and census data supplied for the creation of population and employment density indicators. The data for population and employment units per acre provided a density measure to evaluate the value of each TAZ. A higher density of units per acre the more value a TAZ received and therefore a higher value as a trip generator.

The highest and most concentrated values for employment are located in the downtown area. The highest and most concentrated values for residential population are located in older, established, neighborhoods such as the North-End and North East, as well as south of Boise State University's campus.

Table 4: Overview on weights applied

Layer	Weighted Sum	Weighted Overlay
Population	1	18 %
Employment	1	18 %
Bike Path	1	12 %
Schools	1	10 %
Bus Stops	1	12 %
Restaurants	0.5	5 %
ATMs	0.5	5 %
Parks	0.5	5 %
Garages	1	10 %
Retail	0.5	5 %
Total %	-	100 %

Additional data used included bus stops, bike paths, etc. to assist with the development of proximity measures. Two proximity measurements were created for each indicator. For instance, the first proximity buffer produced from the bus stop feature used the distances of 820 feet and second buffer used 1,640 feet. The distance of 1,640 feet equates to a quarter mile, which is an accepted distance and considered walkable for transit locations to be successful.

Any location within 820 feet received a value of 10, locations between 820 feet and 1,640 feet received a value of five, and anything outside the buffer zones received a value of zero.

After calculating population and employment density using TAZ data and combining all the developed attractors, generators, and connectors into a single format for analysis it was possible to create a color schemed map that highlights areas for potential bike share stations. The potential effect of accounting a daily university population was also a consideration. Topography considerations, as applied in the Seattle study, seemed less important as a feature for Boise due to the flatter terrain of the downtown Boise area.

Map 3 highlights areas of high concentrations of values in red. These areas incorporate values from several layers contrasting with blue and green areas, which may only contain data from one or two sources/formats. In addition to providing areas for bike stations, the analysis highlights potential transit corridors for future expansion of the Boise bike share program (also Map 2).

Los Angeles' weighted sum process is a second method used to calculate potential bike share terminal locations. This weighted processing technique requires that each input in the model will receive a percentage out of 100 percent. This method called for giving population and employment densities the highest percentage of weight and restaurants, ATMs, parks, and retail businesses the lowest.

Preliminary Results

In comparison of the analysis results, the weighted sum of each factor provided a more sophisticated results in the Boise bike share analysis because the outcome produced was easier in its interpretation as well as in transparency of methodology.

Hot spots are present around the proposed service area highlighting St. Luke's hospital, the University of Idaho Water Center, areas surrounding BSU's campus, and in downtown locations along the streets of 8th and Main. The map features connector and arterial streets as potential corridors for bike share use. These corridors provide information for future expansion of the Boise bike share program.

Risk Assessment (bike crashes)

In addition to layers reflecting the built environment, we added an overlay layer on top of the analysis-layer: bike accidents. The Idaho Transportation Department provided data on bike accident locations that show a high occurrence of bike accidents in the downtown area. A high rate of bicycle accidents shows that there is potentially a high volume of bicycle traffic in the downtown area already in existence. The bike crash data allowed the analysis to be further refined for recommendations for potential bike share terminal stations.

Optimization Model Approach

One concern raised by Central District Health Department, was what are the optimal number of stations and bikes for Boise population of potential users? The Bike share analysis uses an optimization model approach to address this question.

The GIS driven analysis shown above results in an embedded "topography of feasible locations" for an unlimited system of bike terminal stations without financial constraints. The optimization model uses information gleaned from the GIS analysis along with costs data for purchasing stations, bikes, etc. Considering the potential resources available for the project provided by the Central District Health Department the model was based on maximum of $650,000 for capital expenditures.

The optimization analysis allows for a series of solutions reflecting various available budgets in the amount of $400k, $450k, $500k, $600, and the assumed ceiling of $650k. The model incorporates various vacancies in the bike share stations, for bike returns to locations other than the station where the bike originated. Specifically, the vacancies modeled ranged from a zero to 20 and 35 percent vacancy rates. A 20 percent vacancy translates as four docks occupied at a station of five and for a station of 11 bikes, nine docks would be occupied.

Table 5 presents the computed solutions and amounts of stations/bikes including a 10 percent bicycle reserve. Utilizing all given budget, the optimization approach recommended a solution with six small (5 docks) and 14 large (11 docks) stations and a total (includes 10% reserve) of 203 bikes. To accommodate this outcome with a result in zero percent vacancies at the stations requires a warehouse or depot to keep and maintain the 10 percent reserve of bikes. Regardless of this analysis, a bike depot may already be warranted for storing bikes during periods of less ridership, such as the winter season.

Final Analysis

In consultation with the Central District Health Department and more detailed costs including i.e. engineering fees, etc., 14 stations with 140 bikes the optimal finding. Map 4 includes five secondary locations for better coverage and future extension of the system. As illustrated, this results in two regular stations at BSU (i.e. close to the library and west side of campus, and a station close to Bronco Stadium) but also a secondary station at the Student Union Building.

Map 3: Location Ranking

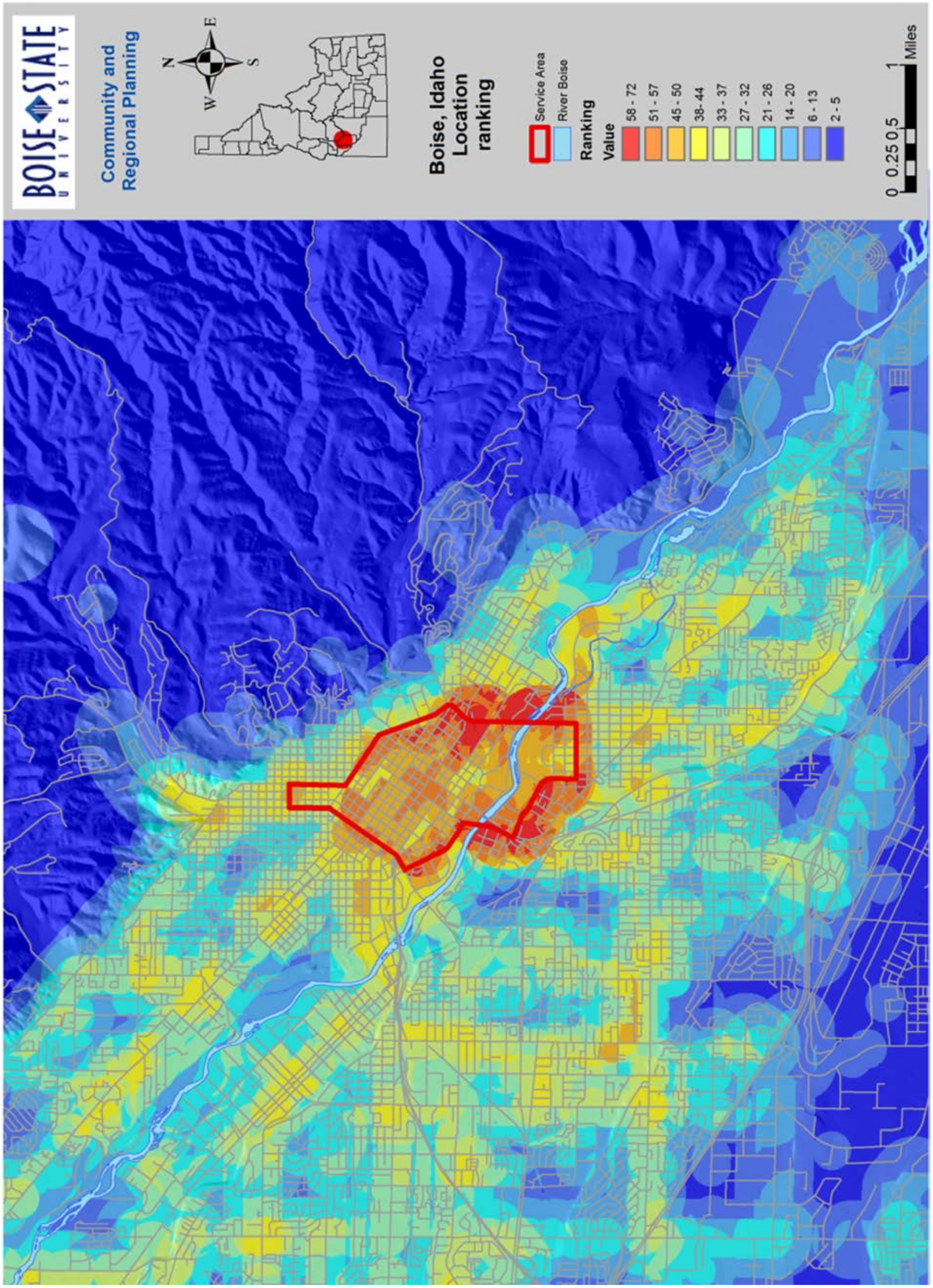


Table 5: Overview of Computed Solutions

Vacancy	Budget	400	450	500	550	600	650
0%	Stations						
All bikes	Size 5	3	2	1	8	7	6
All bikes	Size 11	9	11	13	10	12	14
	Total	12	13	14	18	19	20
	Bikes						
	Stations	114	131	148	150	167	184
	Reserve	12	14	15	15	17	19
	Total	126	145	163	165	184	203
	Cost Total	$ 396,744.00	$ 447,003.00	$ 496,115.00	$ 546,735.00	$ 596,994.00	$ 647,253.00

Vacancy	Budget	400	450	500	550	600	650
20%	Stations						
4 bikes	Size 5	3	4	8	1	2	4
8 bikes	Size 11	10	11	10	16	17	17
	Total	13	15	18	17	19	21
	Bikes						
	Stations	92	104	112	132	144	152
	Reserve	10	11	12	14	15	16
	Total	102	115	124	146	159	168
	Cost Total	$ 391,724.00	$ 445,693.00	$ 499,708.00	$ 544,140.00	$ 598,109.00	$ 641,532.00

Vacancy	Budget	400	450	500	550	600	650
35%	Stations						
3 bikes	Size 5	1	2	6	10	0	1
7 bikes	Size 11	12	13	12	11	19	20
	Total	13	15	18	21	19	21
	Bikes						
	Stations	87	97	102	107	133	143
	Reserve	9	10	11	11	14	15
	Total	96	107	113	118	147	158
	Cost Total	$ 396,758.00	$ 448,433.00	$ 499,007.00	$ 548,434.00	$ 596,261.00	$ 647,936.00

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Photo credits:

- “Bicycle Parking, Salt Lake City”, Thomas Wuerzer
- “View on Boise”, Thomas Wuerzer
- “Bike Station, San Antonio”, Susan Mason

Map 4: Location Ranking – Proposed Service Area