Access to Recreation in San Francisco, CA

Robert Graham

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Access to Recreation in San Francisco, CA

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Capstone Project
University of Denver
June 7, 2012
Abstract

This research presents an assessment of the equity of access to public recreation facilities among communities of San Francisco, California using Geographic Information Systems (GIS), database programming, and open sources of data. Urban parks and the recreation facilities contained therein are valuable public resources that contribute to healthy and well-adjusted citizenry and have significant positive impacts on the shared urban experience. This project utilizes the network analysis and spatial processing capacities of GIS alongside web technologies and open data sources to delineate pedestrian and transit service areas around each of over 300 documented recreation facilities and community centers in the City. These service areas serve as the basis for extended analysis of the distribution of resident recreation access in relation to local population densities among neighborhoods. The research delivers enhanced understanding of San Francisco public recreation opportunities and communicates project findings through several cartographic outputs.
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Project Definition

Urban parks and recreation facilities are valuable natural resources that provide communities with spaces for public expression and create opportunities for active and engaged lifestyles. These important enclaves encourage good health and facilitate community interaction, and their existence and preservation can improve overall quality of life as well as raise property values in their communities (Moore and Kestens, 2011). The distribution of park space contributes significantly to a healthy urban experience, and research suggests that there are great benefits to ensuring broad access to the services and opportunities that parks and related facilities provide.

This research investigates the distribution of San Francisco recreation facilities in order to assess the equity of access to these public services among neighborhoods throughout the City. The study engages the network analysis and spatial processing capabilities of Geographic Information Systems (GIS) and related technologies to develop walkable and transit accessible service areas to represent estimated recreation access. Through visualization and spatial analysis of these service areas alongside population data, the research discerns if some neighborhoods exhibit significantly more or less access to recreation services for walkers or riders in the City, and it visualizes the extent to which the public transit system in the City expands access for residents.
The primary goals of this research are to establish reliable datasets and repeatable methods for pedestrian and transit service area generation around a facilities dataset and apply these resources to spatial analysis of recreation access variation within the City. Through cartographic visualization and statistical methods, the study aspires to achieve enhanced understanding of recreation facility distributions among neighborhoods and identify regions that may benefit most from additional public investments. The research outlines effective and efficient strategies for deriving information and knowledge from multiple dynamic data sources using desktop and web based GIS tools. These strategies provide a framework to optimize the value of data collection efforts and related investments by public and private organizations involved in environmental justice, public health, and social equity in the City.
Foundations

Discussions of the economic and health benefits of public parks and recreation are prevalent in the critical discourses of urbanism, natural resource management, and public health, and there is a strong body of evidence to suggest that parks and open spaces provide significant economic and health benefits to communities in which they exist. Access to parks and recreation can represent a major enabler for socio-economic mobility among disadvantaged and at-risk populations, while exclusion from them is often detrimental to community stability and childhood development. Sports facilities and physical activity can instill confidence in youth and provide a healthy outlet for aggression, and community centers can offer safe spaces and foster congregation among urban residents (Roemmich et al, 2006). These important resources provide benefits across income and demographic groups, and they contribute to healthy and engaged populations for areas that enjoy broad access.

There is inherent economic value to public recreation and related natural resources, as physically and psychologically healthier communities are more productive, and hospitable public spaces can provide powerful incentives for businesses to locate operations in a particular area (O’Connell, 1999). Indeed, there have been a number of studies that attempt to attach economic value to non-market natural capital such as parks, recreational
facilities, forests, and ecosystems. Estimates of ecosystem value range from over $35 million dollars globally, a figure that includes value derived from such environmental services as climate regulation, erosion control, and recreation opportunities that exist outside traditional local and international economic accounting systems (Costanza et al, 1997). The recreation, aesthetic, and educational value of parks, protected areas, and related amenities are important components to such calculations and estimations. For example, the San Jacinto Wilderness of Southern California accounts for nearly $6 million dollars of recreation value to its visitors (Baerenklau et al, 2009). Broad pedestrian and public transit access to public recreation facilities is especially important in densely populated urban environments where walking and transit are common modes of travel and community space is heavily utilized among diverse socio-economic groups.

There are over 300 total public recreational facilities and community centers in San Francisco (GreenInfo Network, 2012), a city with over 17,000 inhabitants per square mile (US Census, 2010). The high density of population in the City leads to heavy demand for public space and recreation opportunities among residents, as private opportunities are limited for many socio-economic groups. Access to parks and recreation becomes increasingly important in this scenario because of the contributions of these resources to public health and social adjustment when other social and
recreational outlets are scarce (Weiss et al, 2011). Similarly, private transportation can be prohibitive in densely populated urban environments, so these important services must exist within a walkable or transit reachable distance in order to be effective.

This study utilizes GIS and related technologies to develop pedestrian and transit service areas in order to enable analysis of recreation facility access distributions among City neighborhoods. GIS is applied widely in the discourse of urban access to parks and related facilities, particularly in the generation of service areas, and a number of case studies exist that utilize GIS to assess park equity and the distribution of related facilities in urban areas. The majority of such studies apply simple buffering techniques to determine park service areas at specified uniform distances, usually between 0.5 and 1 mile for pedestrians. These and related studies also identify and critique several urban park service indices and describe strategies to examine distributional equity within urban park systems (Cutts et al, 2009). Such research suggests that population based approaches to assessing the equity of public resource distribution can provide effective indicators to measure and compare neighborhood conditions.

While simple buffers can provide important information about access to locations or facilities, the discourse of urban amenities access suggests that routing analysis is a far more effective method for creating and
understanding facility access zones, and that service areas delimited using such methods provide a more reliable basis for subsequent spatial inquiries (Oh and Jeong, 2007). Beyond the inherent benefit that network methods more accurately reflect actual travel distance, network techniques are superior to simple buffers because they afford the capacity to include additional costs in the calculations and algorithms leading to service area generation. The ability to include these costs is important because it allows for customization of the estimation results. For example, the network can be limited to paths accessible to only certain classes of users or types of vehicles, or the analysis can include information about barriers or handicap accessible infrastructure (Matthews 2003). This capacity for customization enables targeted analysis and realistic modeling of networks and surrounding areas and yields more reliable service areas that contribute to enhanced validity of the research results.

This research estimates travel time along the walkable and public transit networks of San Francisco and incorporates road type, slope, and transit schedules as key parameters in the analysis. Previous applied research in this field suggests that distances of 0.5 to 1 mile from residence to recreation facility are likely predictors for self-reported exercise and healthy, active urban communities (Cohen et al, 2007). This study enhances the utility of this estimation by incorporating additional factors of the urban
experience into calculations of the facility access zones for pedestrians, and extends this analysis to also include walkable areas around transit stops within a ten minute riding distance. Building on documented strategies for network optimization and incorporation of transit information into service area definitions, the project develops a methodology to incorporate topology and the built environment into determinations of pedestrian network distance as well as to consume online data sources to estimate the extent that public transit services extend the pedestrian access zone boundaries (Lei, 2010). Visualizations of the resulting recreation service areas enable exploration of their spatial characteristics alongside planning neighborhood boundaries and offer insights into trends that may exist in the distribution of access to these facilities.

The applied research and analysis of this project contribute to the critical discourse of urban resource equity through its introduction of innovative spatial methods to describe and analyze the distribution of access to recreation facilities in an urban environment. In addition to producing reliable estimates of pedestrian and transit service areas for San Francisco recreation facilities, the research produces multiple analytic and cartographic outputs that contribute to enhanced understanding of access to recreation within the City as well as a better comprehension of the relative burden and expected efficiency of City recreation resources. The analysis identifies
underserved communities and recreation privilege in the City and presents
effective and repeatable strategies for delimiting pedestrian and transit
service areas for amenities in other urban areas where similar data and
infrastructure are available.

The conclusions and methods developed in this research have the
potential to assist urban planners making resource allocation decisions,
school officials determining need for after-school programs, and
neighborhood associations lobbying for City funding. In addition, community
health and service organizations can use the acquired information to guide
outreach and volunteer activities, and public agencies, politicians, and
officials can apply the research to inform public policy and target
investments. The availability of public equity assessments is important to
conscientious decision makers because these assessments contribute to a
more robust knowledge base that more accurately reflects current social,
environmental, and economic conditions.

**Approach**

The approach to this investigation of recreation access in San
Francisco consists of applied research that employs proprietary and open-
source software platforms as well as innovative analysis that draws upon
documented spatial techniques. Data describing the facility types and
locations are made available through a data inventory project completed by
GreenInfo Network (http://www.greeninfo.org) in collaboration with the California Department of Parks and Recreation. This project, which took place in 2011-12, catalogued playgrounds, ball fields and courts, skateboard parks, barbeques, and community centers as identified through online research, agency contacts, and high-resolution aerial and roadside imagery from Google and Bing Maps. GreenInfo Network additionally curates a Protected Areas Database (PAD) that serves as the basis for public park boundaries and ownership throughout the City. To evaluate the urban topography, the United States Geological Survey (USGS) disseminates the National Elevation Dataset (NED) nationwide, including data at 1/3 arc second resolution for San Francisco. Utilizing the data processing and network analysis capacities of GIS, the research develops pedestrian and transit rider access zones for the recreation facility locations, to be analyzed alongside population counts published by the US Census Bureau in the 2010 Decennial Census at the city block level.

The initial stage of access zone definitions involves creation of an appropriate network dataset that reflects the natural and built topography of the City. Network creation, elevation analysis, service area generation, and map production utilize ArcMap by Esri with the Network and Spatial Analyst extensions. The foundation for the pedestrian network dataset is the collaboratively generated OpenStreetMap (OSM) road network, filtered to
include only walkable segments and joined with slope categories derived from the NED. Decisions regarding initial selection of walkable pathways were guided by the classification hierarchy as detailed in the OSM online Wiki documentation (http://wiki.openstreetmap.org/wiki/Map_Features, 2012). Each selected street segment earns an OSM walkability class based on its feature type to serve as an input in the estimation of overall walkability for the passageway. The classification scheme ranges from 1 to 5, where class 1 features are the most walkable and class 5 the least.

<table>
<thead>
<tr>
<th>OpenStreetMap Feature Types</th>
<th>Walkability Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian, Footway, Steps, Path</td>
<td>1</td>
</tr>
<tr>
<td>Residential, Cycleway</td>
<td>2</td>
</tr>
<tr>
<td>Tertiary</td>
<td>3</td>
</tr>
<tr>
<td>Secondary, Tertiary Link</td>
<td>4</td>
</tr>
<tr>
<td>Primary, Secondary Link</td>
<td>5</td>
</tr>
</tbody>
</table>

*Table 1 - OSM Feature Classification*

In addition to type of road feature, the slope of street segments is an important factor in reliable estimates of walkability. To attribute slope to the selected OSM segments, the project classified cells of the NED floating point raster by percent-rise using spatial analysis tools provided as part of the ArcMap toolset, then converted the elevation raster to polygon features with attached slope attributes and processed a spatial join of the slope values to
OSM segments split by intersections. Slope was classified in ranges from 1 to 9, where class 1 represents less than ten percent rise per grid cell and class 9 is a gradient of over four hundred percent.

Attribution of slope categories and walkability class to the selected OSM segments enables the creation of a deterrence index for use as an
impedance, or cost, in pedestrian service area calculations. This index serves to scale the network distance that can be reached in specified time intervals according to the formula: $3 \text{ miles/hour} \times (1 - \frac{(\text{slope class})}{10}) + \frac{(\text{road class})}{100}$). The formula returns a distance value in miles that reflects an expected maximum walking speed of 2.97 miles/hour along a fully flat and pedestrian-friendly segment, and an expected minimum speed of 0.15 miles/hour when traversing extremely steep-sloped segment designed in favor of motorized vehicular travel.

The study relies upon the ArcMap Network Analyst extension to define and execute the algorithms necessary to develop the facility service areas for pedestrian travelers along the walkable street network. The program generates aggregated service area boundaries representing five, ten, and fifteen minutes of pedestrian travel at the designated speed for each street segment, and enables visualization of the results as cartographic outputs. These visualizations provide preliminary insights into which areas of the City have the greatest and least pedestrian access to recreation facilities.
Following creation of service areas to represent access zones for pedestrian travelers, the research implements open source web technologies
to estimate the additional distance City travelers can reach by public transit. Spatial processing and data management for this phase of the project take place in a web accessible PostGIS (PostgreSQL for GIS) object-relational database management system. This system enables traditional database tables to relate to spatial objects like points or polygons, and it supports analysis that combines spatial queries and functions, such as intersect or contains, with attribute table queries to perform complex data evaluations. As an online data management service, PostGIS stores spatial and attribute data on the web and interfaces with other components of server architecture to provide broad access and functionality to users and programmers of diverse applications. In this study, the online database connects to web services through an internet browser and processes data transactions through a command line or virtual interface using the computing languages of JavaScript and PHP: Hypertext Preprocessor (PHP) in addition to native PostGIS and Structured Query Language (SQL) methods.

<table>
<thead>
<tr>
<th>PostGIS Table</th>
<th>Description</th>
<th>Source</th>
<th>Feature Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian Service Areas</td>
<td>Walkable service areas around recreation facilities</td>
<td>GreenInfo Network, USGS, OpenStreetMap</td>
<td>Polygon</td>
</tr>
<tr>
<td>All Transit Stops</td>
<td>Every public transit stop in the MUNI service network</td>
<td>Nextbus Public XML Service</td>
<td>Point</td>
</tr>
<tr>
<td>Saturday, Sunday, and Weekday</td>
<td>Datasets representing transit stops reachable in ten minutes from recreation centers during each class of MUNI service</td>
<td>GreenInfo Network, Nextbus Public XML Service</td>
<td>Point</td>
</tr>
<tr>
<td>Reachable Transit Stops</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transit Service Areas</td>
<td>Datasets representing network distance reachable by transit on Saturday, Sunday, and Weekday classes of MUNI service</td>
<td>GreenInfo Network, Nextbus Public XML Service</td>
<td>Polygon</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>Planning Neighborhoods</td>
<td>City neighborhoods</td>
<td>San Francisco Planning Department</td>
<td>Polygon</td>
</tr>
<tr>
<td>Census Blocks</td>
<td>San Francisco City blocks attributed with population counts</td>
<td>US Census Bureau</td>
<td>Polygon</td>
</tr>
</tbody>
</table>

**Table 2 - PostGIS Database Structure**

The primary source of data for transit service area creation around recreation facilities is the NextBus public web service (http://webservices.nextbus.com/service/publicXMLFeed, accessed May/June 2012) which provides geographically referenced stops, routes, and schedules for the San Francisco Municipal Transit Agency (MUNI) as an Extensible Markup Language (XML) data feed. The data collection procedure requests XML from this service a number of times throughout the research, the first as a loop to gather all the transit stops in the City and load them as geometry objects to the PostGIS database. The stops inside the boundaries of ten minute pedestrian service areas form the starting point for analysis of transit distance.

Using these walkable public transit stops, the research creates access zones corresponding to scheduled MUNI operations during weekday, Saturday, and Sunday classes of service. Beginning with the walkable stops, the access zones comprise an approximate ten minute ride on public transit from the active facility plus an additional ten minute walk from the arrival
station. The collection effort executes as a JavaScript/PHP program that retrieves Nextbus schedule information via an internet browser for each service class and sends reformatted data to the PostGIS server for storage and analysis. The program parses the XML feed to identify the closest scheduled stop in both directions of each pedestrian accessible stop, and then measures the elapsed time from that stop to each subsequent stop along the route to find the last station accessible within a ten minute ride. The collection of all stops between each start station and its ten minute endpoint on the active route forms an array of the reachable stops for that route, and repetition of this cycle for each route generates a collection of all stations reachable in the timeframe for every MUNI stop contained within the service areas. These collected stations are loaded to the ArcMap network dataset to serve as updated parameters for the creation of multiple service areas that reflect combined walking and transit distances accessible from the recreation facilities during each class of scheduled MUNI service.
Transit Access to Recreation Facilities
San Francisco, CA

Estimated Transit Area - Weekdays

- Public Parks
- OSM Streets
- Recreation Facilities
- Reachable MUNI Stops

Data: GreenInfo Network, 2012
OpenStreetMap (OSM), 2011; USGS, 2012
NextBus, 2012; SFMTA, 2012
Processed in PostGIS and ArcMap Network Analyst
Map by Robert Graham, University of Denver, 2012
Transit Access to Recreation Facilities
San Francisco, CA

Estimated Transit Area - Saturdays
< 20 minutes
< 30 minutes
Neighborhood Boundaries

Public Parks
OSM Streets
Recreation Facilities
Reachable MUNI Stops

Data: GreenInfo Network, 2012
OpenStreetMap (OSM), 2011; USGS, 2012
NextBus, 2012; SFMTA, 2012
Processed in PostGIS and ArcMap Network Analyst
Map by Robert Graham, University of Denver, 2012
Following cartographic visualization of recreation access coverage for public transit users in the City, the generated service areas are imported.
back to the PostGIS database for interactions with planning neighborhoods and Census population counts. A PHP program loops through each neighborhood to sum the population of all Census blocks whose centroid lies inside that neighborhood boundary, then collects population figures from those neighborhood blocks that are also within the recreation service area for that class of service and method of travel. Dividing the number of inhabitants that reside within each service area by the total neighborhood population yields a series of access ratios that serve as the base for objective comparisons among the neighborhoods and between each neighborhood and the City overall. For transit riders, these access scores are calculated using the twenty minute transit access zones for each class of MUNI service and averaged to form a single indicator for public recreation access via transit in each district. Calculations of pedestrian recreation access scores per neighborhood utilize the fifteen minute walkable areas around recreation facilities.

**Solution**

The research discovers that nearly 69% of City residents live within an estimated fifteen minute walk from a public recreation facility (0.6873 recreation access score), and that almost 80% (0.7950 recreation score) reside within an estimated twenty minutes of combined walking and transit travel time. The mean recreation access indicator among all neighborhoods
is 0.7985 for pedestrians and 0.7577 for transit riders, while the median recreation index is 0.8493 for pedestrians and 0.8470 for riders. The southwest neighborhood of Lakeshore exhibits the least pedestrian access to public recreation, with only 28% of residents within a walkable distance of a facility, while the Presidio exhibits the least transit access with only 3% within an acceptable transit time. Ten neighborhoods of the City exhibit complete walkable access to recreation for residents with 100% of the population within the pedestrian access zones, while seven neighborhoods exhibit complete access to the recreation facilities via public transit.

<table>
<thead>
<tr>
<th>Neighborhood</th>
<th>Pedestrian Recreation Access Score</th>
<th>Transit Recreation Access Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bayview</td>
<td>0.8882</td>
<td>0.9149</td>
</tr>
<tr>
<td>Bernal Heights</td>
<td>1.0000</td>
<td>0.8986</td>
</tr>
<tr>
<td>Castro/Upper Market</td>
<td>0.9378</td>
<td>0.9934</td>
</tr>
<tr>
<td>Chinatown</td>
<td>1.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Crocker Amazon</td>
<td>0.5849</td>
<td>0.4633</td>
</tr>
<tr>
<td>Diamond Heights</td>
<td>1.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Downtown/Civic Center</td>
<td>0.9860</td>
<td>1.0000</td>
</tr>
<tr>
<td>Excelsior</td>
<td>0.8261</td>
<td>0.9275</td>
</tr>
<tr>
<td>Financial District</td>
<td>0.6696</td>
<td>0.6017</td>
</tr>
<tr>
<td>Glen Park</td>
<td>1.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Golden Gate Park</td>
<td>0.6011</td>
<td>0.5920</td>
</tr>
<tr>
<td>Haight Ashbury</td>
<td>1.0000</td>
<td>0.9897</td>
</tr>
<tr>
<td>Inner Richmond</td>
<td>0.7332</td>
<td>0.7702</td>
</tr>
<tr>
<td>Inner Sunset</td>
<td>0.6365</td>
<td>0.7638</td>
</tr>
<tr>
<td>Neighborhood</td>
<td>Mean</td>
<td>Median</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-------</td>
<td>--------</td>
</tr>
<tr>
<td>Lakeshore</td>
<td>0.2766</td>
<td>0.2208</td>
</tr>
<tr>
<td>Marina</td>
<td>0.9892</td>
<td>0.4891</td>
</tr>
<tr>
<td>Mission</td>
<td>0.9013</td>
<td>0.9740</td>
</tr>
<tr>
<td>Nob Hill</td>
<td>1.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Noe Valley</td>
<td>1.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>North Beach</td>
<td>0.9302</td>
<td>0.6993</td>
</tr>
<tr>
<td>Ocean View</td>
<td>0.7313</td>
<td>0.6432</td>
</tr>
<tr>
<td>Outer Mission</td>
<td>0.7301</td>
<td>0.5783</td>
</tr>
<tr>
<td>Outer Richmond</td>
<td>0.6611</td>
<td>0.7018</td>
</tr>
<tr>
<td>Outer Sunset</td>
<td>0.4162</td>
<td>0.5099</td>
</tr>
<tr>
<td>Pacific Heights</td>
<td>1.0000</td>
<td>0.9611</td>
</tr>
<tr>
<td>Parkside</td>
<td>0.7054</td>
<td>0.5075</td>
</tr>
<tr>
<td>Potrero Hill</td>
<td>0.9246</td>
<td>0.9229</td>
</tr>
<tr>
<td>Presidio</td>
<td>0.3368</td>
<td>0.0300</td>
</tr>
<tr>
<td>Presidio Heights</td>
<td>0.7505</td>
<td>0.6194</td>
</tr>
<tr>
<td>Russian Hill</td>
<td>1.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Seacliff</td>
<td>0.6388</td>
<td>0.2931</td>
</tr>
<tr>
<td>South of Market</td>
<td>0.4704</td>
<td>0.6501</td>
</tr>
<tr>
<td>Twin Peaks</td>
<td>0.8709</td>
<td>0.8440</td>
</tr>
<tr>
<td>Visitacion Valley</td>
<td>0.8277</td>
<td>0.8820</td>
</tr>
<tr>
<td>West of Twin Peaks</td>
<td>0.7203</td>
<td>0.8500</td>
</tr>
<tr>
<td>Western Addition</td>
<td>1.0000</td>
<td>0.9849</td>
</tr>
<tr>
<td>Mean of all Neighborhoods</td>
<td>0.7985</td>
<td>0.7577</td>
</tr>
<tr>
<td>Median of all Neighborhoods</td>
<td>0.8493</td>
<td>0.8470</td>
</tr>
</tbody>
</table>

Table 3 - Recreation Scores per Neighborhood
Pedestrian Access to Recreation Facilities
San Francisco, CA Neighborhoods

Percent of Residents within Pedestrian Service Area
- under 50%
- 50% - 70%
- 70% - 90%
- 90% - 100%

Recreation Facilities
- includes aquatic centers, ball fields and courts, skateboarding parks, barbecues, and community centers

Public Park

OSM Streets

Data: GreenInfo Network, 2012
OpenStreetMap (OSM), 2011; USGS, 2012
NextBus, 2012; SFMTA, 2012
Processed in PostGIS and ArcMap Network Analyst
Map by Robert Graham, University of Denver, 2012
Transit Access to Recreation Facilities
San Francisco, CA Neighborhoods

Percent of Residents within Transit Service Area

- Recreation Facilities
  includes aquatic centers, ball fields and courts, skateboard parks, barbeques, and community centers
- Public Park
- OSM Streets

Data: GreenInfo Network, 2012
OpenStreetMap (OSM), 2011; USGS, 2012
NextBus, 2012; SFMTA, 2012
Processed in PostGIS and ArcMap Network Analyst
Map by Robert Graham, University of Denver, 2012


**Discussion and Recommendations**

This analysis of recreation access in San Francisco provides several important insights about the distribution of recreation opportunities throughout the City. The maps of neighborhood recreation scores reveal greater access to facilities in the eastern half of the City, and this trend becomes more pronounced in the visualization of transit access zones. This research enables inspection and comparison of neighborhoods in terms of resident access to important public services. It discovers that while San Francisco generally exhibits a majority access to recreation facilities, these amenities are not evenly distributed among all the neighborhoods. The transit service area visualizations suggest an access benefit Citywide from public transportation investments, and this expansion of service coverage for transit riders is most apparent in the central east neighborhoods of Noe Valley up to Western Addition.

In addition to providing reliable estimates of access equity among neighborhood residents to public recreation opportunities in the City, this research elaborates on several effective techniques to engage proprietary and open source technologies toward data collection, spatial processing, and resource analysis efforts. The study demonstrates a successful model for consumption of public data over the web, and it presents an innovative approach for extending traditional service areas surrounding a facility to
reflect scheduled transit route information in addition to walkable network distance. Analysis of population distributions alongside these service areas yields knowledge about relative recreation access among neighborhoods in the City. The derived datasets and scripts from this project provide a robust foundation for further demographic and spatial research based on observed urban access trends.

Next steps for this research could include additional demographic or socio-economic investigations based on the service area polygons or neighborhood indicators, enhancements to the network dataset to incorporate more measures of walkability into the pedestrian service area algorithms, and extension of the Nextbus retrieval scripts to track real-time vehicle locations in addition to scheduled route information. The public transit data collection and processing methods utilized in this study are repeatable in other urban environments where georeferenced transit information is publicly available, so similar research utilizing these methods could be applied to produce additional datasets for comparisons and analysis at multiple geographic scales. Locally, this research suggests that there is relatively broad access to recreation in San Francisco, but there is also much room for improvement, and the study reveals a need for increased investment in recreation equity for the western neighborhoods of the City. Community organizations, local governments, and social advocates can
apply the methods and results of this research to support targeted resource allocation decisions and suggest effective and equitable public policy.
References


