Harvard Kennedy School
San Francisco Planning Department

Policy Analysis Exercise

San Francisco: Change on the Streets

Using Data to Understand the Intersection of Urban Design, Public Policy, and Neighborhood Transformation

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March 25, 2014

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Executive Summary

As a result of the recent push for open and digitalized data, city governments like San Francisco have more data available to them and their citizens than ever before. But in the realm of urban planning, specifically impact evaluation of streetscape interventions, that data is rarely put to best use. Instead, traditional intercept-survey-based methods and in-person people-counting still dominate the area of impact evaluation despite being time-consuming, expensive, and often methodologically statistically poor. This PAE presents an alternative framework for impact evaluation that: (1) Relies on existing datasets; (2) Attempts to distill the impacts of an intervention using sound statistical methodology; and (3) Takes into account citywide and neighborhood-wide trends that may be interacting with the effects of the intervention.

While the overall approach presented here is the crux of this PAE in and of itself, it was applied to two test-cases – bikelanes and parklets – to test for how these interventions might affect specific crime rates nearby. The test cases were used to yield a proof-of-concept as well as meaningful results to inform the Planning Department of these interventions' specific impacts on public safety. Streetscape interventions like bikelanes and parklets were hypothesized to have potential effects on crime rates in the street nearby based on the theory of "casual surveillance": that interventions that attract more non-car activity in the street would put "eyes on the street" which would in turn deter crime.

It was found that despite persistently steady rates of crimes like robberies, assault, and vandalism along the neighborhood commercial districts (NCDs) that most parklets are built along, the construction of a parklet allowed the immediate area around it to experience the same dropping crime rates as found in the rest of San Francisco. In fact, crime incidence dropped slightly more than citywide rates for specific crimes of concern, particularly assault and robbery. Clustering analysis found that most likely this crime is being deterred rather than simply being dispersed from the area right around parklets, only to occur outside the border of an effective zone of surveillance. The effects of bikelanes are less clear-cut, but appear to still have potential effects on reducing some crime along the corridors they're built within, including theft, prostitution, and disorderly conduct. For both test-cases, general (day and night) and exclusively nighttime crime were evaluated and variation between the two is reported. Especially when compared with NCD crime rates, parklets see even greater effects in reducing crimes occurring at night.

Taking into account these empirical findings, recommendations were developed concerning the Better Market Street Plan, a $250 million effort to redesign San Francisco's central corridor. Specifically, a major set of urban design decisions within this revitalization plan involves where to locate bike infrastructure, what kind to build, and the balance to strike between street and sidewalk space within the corridor's right-of-way. Considering the result of the test-cases, this PAE

recommends building a segregated bikelane one block over on Mission Street rather than on Market Street, so that more space can be preserved on sidewalks as “streetlife zones”. Preserving and developing active space for pedestrians will hopefully attract more activity and thereby lower crime in the area, considering crime remains a major barrier to the revitalization of Market Street. The studies undertaken within this PAE have indicated that activity space like parklets or streetlife zones are likely to contribute to reducing the incidence of key crimes in targeted areas along Market Street. While there are numerous other factors that must and will go into this decision, empirical data like this PAE’s findings should play a role in informing those decisions.

Lastly, a catalogue of recommendations is included to improve the city’s open data infrastructure to make analyses like these more possible, more frequent, and more meaningful. While conducting this research a number of challenges were faced surrounding data availability and quality. Specific recommendations are made concerning how to further develop the open data portal into a platform for an open data community, and to facilitate data sharing and improvement. To better take advantage of civic-minded, data-savvy analysts, developers, and programmers, the City should work to further develop data ownership for dataset creators as well as improved communication with and accountability to those outside of government engaging with the data. Third-party data sources are recommended for use in future analytical processes. Lastly, recommendations are made concerning the best way cross-departmental analytical capacity should be incorporated into San Francisco City Government, specifically falling within the administrative control of the newly created role of Chief Data Officer. The City as a whole has made great strides in the realm of opening up and improving data and this PAE intends to reveal one of the possible uses of that data, as well as identifying key needs that remain along the path to making open data more useful and more impactful.

Introduction

A popular discussion in all realms - both in government as well as the private sector - is how we can use the ballooning stores of data rapidly becoming available to work smarter. And a related and inevitable discussion is how complex that process actually is, how difficult it is to weed out useful data from the onslaught as well as knowing the right questions to ask of that data. Concurrently, for years city planning departments like that of San Francisco have been working to codify and understand the interventions they implement within their cities' built environments, and more importantly break down those interventions' impacts on cities' economies, environment, and social matters.

However, generally planning departments have been underutilizing these increasing data resources within the key area of impact evaluation. As this PAE will discuss, when cities undertake impact evaluations of streetscape interventions – such as bike-lanes, pocket parks, and pedestrian plazas – these studies continue to be largely conducted through intercept surveys and pedestrian counts. These methods may help inform departments of the general effects of their work but they have a number of crucial shortcomings:

1. They require a large amount of time and many man-hours on the street;
2. As a result they are expensive or complicated to undertake and can only be conducted at long periodic intervals rather than continuously;
3. The data generated is largely site-specific and may not be easily applied to other parts of the same city, others cities, or future studies down the line; and
4. A number of statistical biases originating from sampling methods as well as a lack of controlling for other factors may introduce questions of reliability into any analysis produced from this data.

With these questions in mind - and in consultation with the San Francisco Planning Department as well as officials from the Department of Budget, the Office of Economic and Workforce Development, and the SFMTA – this PAE proposes a new framework for data-driven impact evaluation for streetscape interventions, as well as being generalizable to other activities that may be conducted on a hyper-local basis by the Planning Department and other departments.

It is imagined that this analytical approach would best run in parallel with existing survey-centric methodologies, so as to utilize existing data resources and run impact evaluations in a consistent and ongoing manner, without necessarily doing away with more infrequent surveys that can still yield valuable insights. While the results of the test case evaluations conducted as a proof-of-concept within this PAE should be of interest, the overall methodology and frameworks presented here are the true focus of the PAE, and what is believed to be of the most value to the Planning Department. The framework to be described in the coming pages represents a new way of thinking about how data can be utilized to inform the use of small-scale interventions or large-scale revitalization efforts on the street-level. This PAE looks backwards as well as forwards, using test-cases concerning features already built by the city to understand what impact they have had, while exploring how the insights gleaned from these analyses can be utilized to shape decision-making as the city embarks on future projects and planning.

Additionally, it is understood that these interventions are not occurring within a vacuum but rather taking place within a larger dynamic of city gentrification along with localized neighborhood transformation. San Francisco's rents have ballooned much faster than the rest of the country's and a recent history of protest and debate is testament to the concern over displacement and issues of affordability that have come to the surface. These issues have been taken into account in a number of crucial ways within this PAE's analyses by:

1. Incorporating city fixed effects to register city-wide changes
2. Seeking to understand how these dynamics may vary from neighborhood to neighborhood.
3. Seeking to understand the implications those variations may have on the interventions being analyzed.

Outside of the purview of this PAE, it should be noted that issues of equity and allocation should and often are part of the conversation of city planning. Using data at a finer granularity as in this PAE's methodology is imagined to make it possible to discuss how the benefits of these interventions may be accruing to different populations or geographies with increased specificity than before.

For this project, analyses have utilized two main features as test cases: bikelanes and parklets. The city has been steadily expanding its network of bikelanes and biking continues to grow as an important transportation option in the city. However, the past several years have seen a sizable amount of disagreement over bikelane construction. This includes the landmark 4-year moratorium on new bikelane construction brought about through a 2005 legal suit on grounds of lacking an environmental review[1], but really caused by straight-forward opposition to bikelanes. In addition, new bike lane construction – such as the proposed bike lane on Polk Street – continues to meet opposition. Such opposition is in part due to the lack of sound data on the actual effects of bikelanes on businesses and the surrounding neighborhood, and it is understood that political dynamics might still devalue that information even after the question has been more closely studied[2]. This PAE

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[1] The City Attorney was responsible for defending against litigation surrounding the San Francisco Bicycle Plan and has also archived relevant documents at www.sfcityattorney.org/index.aspx?page=18.

[2] Numerous articles have reported on this conflict, but one example can be viewed at sanfrancisco.cbslocal.com/2013/04/09/sf-shop-owners-bike-advocates-battle-over-polk-street-bike-lane-proposal.

imagines that impact analyses of existing bike lanes (including the analysis contained within this PAE as well as in a complimentary PAE being produced simultaneously on economic impacts) may help assuage some concerns, allow the city to anticipate and mitigate other concerns, and better carry out its bikelane plan and future additions in an informed manner.

In addition to its comprehensive bikelane network construction, San Francisco has also led the way in recent years in the construction of parklets throughout the city - an innovative and novel program that converts a couple parking spaces at a time into a miniature park, an extension of the sidewalk, and a new space within the pedestrian realm to sit and linger. Parklets are located and built by private business and organizational sponsors rather than at cost to the public, with the city taking a guidance and oversight role. And while the success of the program – both in its own gradual expansion within San Francisco as well as its adoption in other cities – speaks for itself, the overall impact of these parklets in terms of a data-driven analysis remains lacking. This PAE contains the first analysis of parklets' effects on crime and public safety (and the corresponding PAE will delve into any potential economic impact) so that parklets may be evaluated quantitatively and perhaps also used more strategically in the improvement of San Francisco's public realm.

For the reasons described above – timeliness and need – bikelanes and parklets serve as the primary focuses of this PAE and its companion, and economic and public safety impact analyses were conducted for each. We looked at what the effects of bikelanes and parklets were on surrounding businesses, and if they had effects on increasing or decreasing overall sales as compared to the rest of the city, and if perhaps these effects were more profound for certain kinds of businesses. We also looked at how these features may have affected the safety of an area as indicated by police reports of criminal activity, using this as a proxy for certain key quality-of-life issues that physical planning of the streetscape can have an effect upon. We focused on criminal reports concerning incidents such as assault, robberies and vandalism, events that occur on the street and could be influenced by changes to its physical realm and the potential human activity those modifications may attract.

While the bulk of this paper deals with examining the impacts of these small-scale interventions, it is implied that the City could apply this methodology as well as our results to informing large-scale changes undertaken to reinvent key corridors. Cities including San Francisco have been reinvesting in their public realms, tackling issues like pedestrian walkability, multi-modal transportation, and street-level place-making. And all those issues have demonstrated themselves as important for creating a vibrant downtown and the economic development that runs hand-in-hand with it. San Francisco is no exception, set to invest up to $250 million over the next few years within the structure of the Better Market Street initiative. Construction on the Market Street Corridor is set to begin in 2017 and key questions remain surrounding the physical planning and urban design of the corridor's new streetscape, particular concerning biking and pedestrian infrastructure. The primary questions are two-fold:

1. Whether the city should install a separated bike lane the entire length of Market Street from Octavia to Embarcadero, build that infrastructure one block over on Mission, or leave this infrastructure as-is, consisting largely of sharrows[3].
2. Whether the city should widen key sidewalk areas and leave existing wide sidewalks as-is to develop streetlife zones – areas of intended use and vibrancy with physical and cultural programming, simply leave sidewalks as-is, or narrow sidewalks to increase space on the street for multimodal transportation, like biking and public transportation.

These decisions are intertwined, since increasing bike infrastructure on Market Street would necessitate less space for sidewalk and street life zones, and visa-versa. One of the intended outcomes of the following analyses of bikelanes and parklets (intended as a proxy for streetlife zones, with a similar imagined impact on an area) is to help inform this decision process. From these tests, it the intention of this PAE and its companion PAE to make some predictions as to what effects the Market Street area would be likely to experience under these different scenarios, and present empirical reasoning to support those predictions based on past outcomes.

[3] A comprehensive listing and descriptions of different types of biking infrastructure, including sharrows can be found at streetswiki.wikispaces.com/Bikeway+Design+Solutions.

Literature Review: Existing Frameworks

Perhaps surprisingly, there has not been a large amount of statistically rigorous research performed on the impact of streetscape interventions like bike-lanes or pocket parks on surrounding areas in terms of the economics, viability, or safety. In the past few years a small handful of cities have partnered with consultants or academics to examine impacts on a variety of scales. While these studies still mark definite steps forward in imbuing streetscape design with empirical research, they remain exclusively focused on economic impacts. A literature review prior to writing this PAE was unable to find impact evaluations in terms of economic impacts as well as other factors or of small-scale parks or plazas like parklets. This PAE's intention is to contribute to this area of research by working to correct for a variety of shortcomings and missing pieces that have been observed in the existing studies detailed below by:

1. Analyzing factors beyond economic impacts,
2. Incorporating a larger collection of impact study areas in place of the smaller number of selected study areas used by most studies
3. Using sound statistical tests for observed changes and including documentation on the statistical significance of results.

Additionally, and perhaps more importantly, there is little discussion as to how cities can create the capacity for ongoing, consistent impact evaluation of its activities in the physical realm of the street, which is an important aspect addressed in later sections of this PAE.

Below are included summaries of relevant studies performed thus far, their results, as well as a discussion of their statistical methodologies and potential shortcomings.

Measuring the Streets: New Metrics for 21st Century Streets
New York City Department of Transportation, New York City (2012)

In 2012 New York City commissioned an impact evaluation of its bike lanes to understand how they were achieving its goals to "Design for safety, Design for all users of the street, and Design for great public spaces". To do so they tracked the following metrics:

1. Crashes and injuries for motorists, pedestrians, and cyclists
2. Volume of vehicles, bus passengers, bicycle riders, and users of public space
3. Traffic speed, aiming to move traffic not too slowly, but also not too fast
4. Economic vitality, including growth in retail activity
5. User satisfaction

6. Environmental and public health benefits

NYCDOT released this report, highlighting the improvements created by a number of key projects. Particularly interesting was their measurement of economic vitality, as measured by sales tax receipts, commercial vacancies, and number of visitors. However, the report had a number of crucial shortcomings, in that less than a handful of bike lane projects were included, and there was no information provided as to whether these changes were statistically significant or controlled for citywide trends in economic activity.

Street Improvement Analysis: New York City Department of Transportation
Bennet Midland LLC, New York City (2012)

The source for the statistics used in "Measuring the Streets", the complete Bennett Midland report has only recently been made available after a curiously long time had elapsed. However, a small number of presentations have been made surrounding the report (including this one), which are still of interest as they show an earlier iteration of the study. The goal of the Bennet Midland research was to move away from survey-based studies and instead meet the following criteria for its methodology:

1. Use impartial data that is a direct measure of economic activity
2. Account for before-and-after changes, which occur in a short span of time
3. Measure impact in a small geographic area

To achieve these goals, Bennett Midland utilized three data sources, including: (1) New York City Sales Tax Data; (2) Commercial Leases and Rents (CoStar); and (3) City-Assessed Market Values. The study was able to make use of quarterly sales tax data, giving them a granularity of data analysis that is more apt to identify changes occurring on a smaller time frame.

The firm identified comparison sites for each site within which there had been an intervention of study, and then obtained aggregated sales tax info for each site disaggregated into retail and accommodation/food services. In addition, borough-wide trends were used as a control for changes observed within the intervention areas. The firm observed sales data at baseline as well as 1, 2 and 3 years after the intervention. The reported findings are not highly detailed nor conclusive, only reporting that "street improvement projects do not detract from commercial activity at the site of implementation. They may contribute positively". This may be interpreted that they had found non-significant change in the 'right' direction – increased economic activity – but without enough statistical significance to reject the null hypothesis.

It is difficult to accurately interpret this study's findings and while graphs are included that indicate changes in sales taxes, p-scores or other indications of statistical significance are not given. Further, the study does not clearly indicate the effects of bike-lanes or pocket park/plaza construction in general, since only a handful of 'improvement sites' were studied, including bike lanes, pedestrian plazas, express bus service, etc. There are no results presented that indicate the effect of one particular feature type, nor an attempt to gather a large sample of all examples of this type of intervention constructed within the City. Additionally, because the study utilized aggregated sales tax data for pre-identified areas around the intervention sites, it is unclear what the effects at varying differences may be, and what the drop-off rate may be. Additionally, it should be noted that any analysis of commercial lease and rent data or assessed market values was not included in the presentation, though this data had been mentioned before.

The Economic Benefits of Sustainable Streets

New York City Department of Transportation, New York City (2013)

After some time the last and final installment of NYCDOT's report was released, While the report took steps to clarify the exact methodologies employed as well as the results reported in the previous reports, a number of the shortcomings that had been observed in previous iterations remain. The study has taken major steps forward in presenting a truly data-based analysis of streetscape intervention impacts, however the limited number of test-case sites (7) distributed among a variety of interventions (from bikelanes to plaza improvements) makes it difficult to generalize the impact of a particular intervention such as bike lanes. Additionally, the study self-reports a lack of sound methodology for the selection of comparison sites as a way to control for general trends. There was not an attempt to used fixed effects or time effects to control for changes caused by factors besides the intervention. Most importantly, there remains no information reported concerning the statistical significance of any of the results found in the study. Readers cannot know what results, if any, can be correlated with the creation of a streetscape intervention, and which may be simply the result of natural variation over time.

Bikenomics:
Measuring the Economic Impact of Bicycle Facilities on Neighborhood Business Districts (NBDs)

Kyle Rowe, Seattle (2013)

Similar to the preceding observations, this study focused on the subjectivity of survey-based impact evaluations, and strived to build a more objective framework using data sources such as sales tax data. Because of data privacy issues as encountered in other studies, Rowe was forced to predefine NBDs surrounding each bike lane and make data requests for aggregated sets of sales tax information. As in other studies, this requirement limits the study to a hypothesized impact area, and does not allow for the examination of different impact areas, or an understanding of gradually reducing impacts or a cut-off point of impact. Additionally, data availability limitations constrained the author to only two sites for impact evaluation despite a large number of bike lanes within the city.

Like the Bennett Midland study, Rowe reported a non-negative effect on businesses but suffers from two similar shortcomings: (1) No information on statistical significance of any changes reported is included, nor is there an indication of these tests having been performed; and (2) The selection of comparison sites used as controls has an inherent degree of subjectivity which may introduce significant biases.

Economic Effects of Traffic Calming on Urban Small Businesses
Emily Drennen, San Francisco (2003)

This older study was included because it focused on San Francisco, particularly the bike lane built on Valencia Street in 1999 (and revamped in 2010). However, this study was also included to serve as an example of the methodologies this PAE is trying to replace, or at least complement. Wisely taking into account the large role public support and opinion have in the design and approval processes of streetscape interventions such as bike-lanes, the researcher created a set of surveys for small business owners whose establishments lay along the Valencia bikelane built 4.5 years prior. These surveys asked qualitative questions soliciting merchants' opinions and expectations concerning the installation of the bike lane on Valencia, and what they believe the results were of its construction and physical details. Hypothesizing positive feedback, the researcher imagined the results could be used to generate outreach materials targeted at business owners in areas in which other bike infrastructure have been proposed.

While the goals and reasoning behind the study are quite sensible, ultimately the results are both statistically weak and nontransferable to other projects. Namely, the use of surveys generated biased results, and the lack of any control group also does not allow for the study to isolate the sentiment of shop owners and attribute it to the bike lane's construction. The qualitative nature of the study generated valuable but inherently subjective information, with a high degree of sampling bias from eligible businesses choosing to be interviewed or not. These kinds of studies need not be entirely abandoned, but should not be used to generate any kind of quantitative or predictive conclusions. Rather, their role may be more political or sociological in nature.

Methodology

Crime Analysis

The primary data source used to perform public safety impact evaluation was the last 10 years of crime data from the SFPD Crime Incident Reporting system as made available through the SF Open Data Portal. Each reported incident is geocoded, with information on each crime's category, description, time, state of resolution, etc. While all crimes are reported in a large number of categories, crime rates of interest to this study are those crimes one can imagine being influence by "casual surveillance", the theory that streetscape interventions can bring increased numbers of users to an area who would then provide casual surveillance as they go about their lives.[4] Traffic on foot and by bike is thought to potentially provide a greater degree of casual surveillance than car traffic because those individuals move more slowly, are more likely to stop, and are more likely to be a visual deterrent against crime. Pedestrians who stop to sit, talk, or otherwise use the public realm for an activity are thought to have even more potential as a source of casual surveillance, as they are largely stationary –able to see more, more caring of the environment they are in, and more of a visual deterrent to potential crime.

The following crime categories are employed by the SFPD reporting system, but only those categories which are bolded in the list below were used for these analyses, as they are more likely to occur within the public realm and be affected by casual surveillance:

Arson
Assault
Bad Checks
Bribery
Burglary
Disorderly Conduct
DUI
Drug/Narcotic
Drunkenness
Embezzlement
Extortion
Family Offenses
Forgery/Counterfeiting
Fraud
Gambling
Kidnapping
Larceny/Theft
Liquor Laws
Loitering
Missing Person
Non-Criminal
Other Offenses
Pornography/Obscene
Prostitution
Recovered Vehicle
Robbery
Runaway
Sex Offenses, Forcible
Sex Offenses, Non Forcible
Stolen Property
Suicide
Suspicious Occ
Trespass
Vandalism
Vehicle Theft
Warrants
Weapon Laws

[4] Many would rightly attribute the theory of casual surveillance to Jane Jacobs, discussed at length in her book "Death and Life of Great American Cities", though now an idea which has now become enmeshed in planning theory One good example of a detailed description of casual surveillance and its application to contemporary planning can be found in Brisbane's "Crime Prevention through Environmental Design" report: www.hpw.qld.gov.au/SiteCollectionDocuments/CPTEDPartA.pdf.

A quick description of the differences between burglary, larceny/theft, and robbery is included to explain the disambiguation:

Larceny/Theft	Stealing with the intent to keep what is taken, without force
Burglary	Stealing after breaking and entering, gaining unlawful entry
Robbery	Forcible stealing from a person

Each category of crime was analyzed separately, as well as included in one or two aggregation categories: (1) Low likelihood of impact ("low aggregate"); and (2) High likelihood of impact ("high aggregate"). The low likelihood of impact aggregation includes all bolded crime categories of interest, while the high likelihood of impact aggregation includes only those categories by which the causal link between street activation and changes in crime rates is imagined to be strongest due to the effect of casual surveillance, with fewer complicating or intermediary factors. High likelihood crime types are underlined, and are restricted to assault, robbery, and vandalism.

Because this study used SFPD's reported criminal incidents as a proxy for actual criminal incidence, there may be some introduced bias from reporting that is not being controlled for. However, for the sake of this analysis it is assumed there is not a strong variation across the city in reported crime rates relative to actual crime rates. Furthermore, because these analyses are examining changes in crime rate incidence over time between different geographic areas, for this bias to impact the validity of the results the differences between crime reporting and crime incidence would have to significantly vary both over time as well as geographically, which is unlikely.

Crime Clustering Analysis

Because this analysis is dependent on the assumption that we can affect crime rates through interventions of the streetscape, for the sake of completeness it was fitting to include a preliminary clustering analysis (in the form of a nearest neighbor analysis as well as a Ripley's K analysis) of crime overall as well as each crime type. One of the implications of the clustering of crime is that crime incidence is in fact tied to place, that aspects of a place – be they physical, social, or otherwise – have implications for the crime rates those areas would experience.

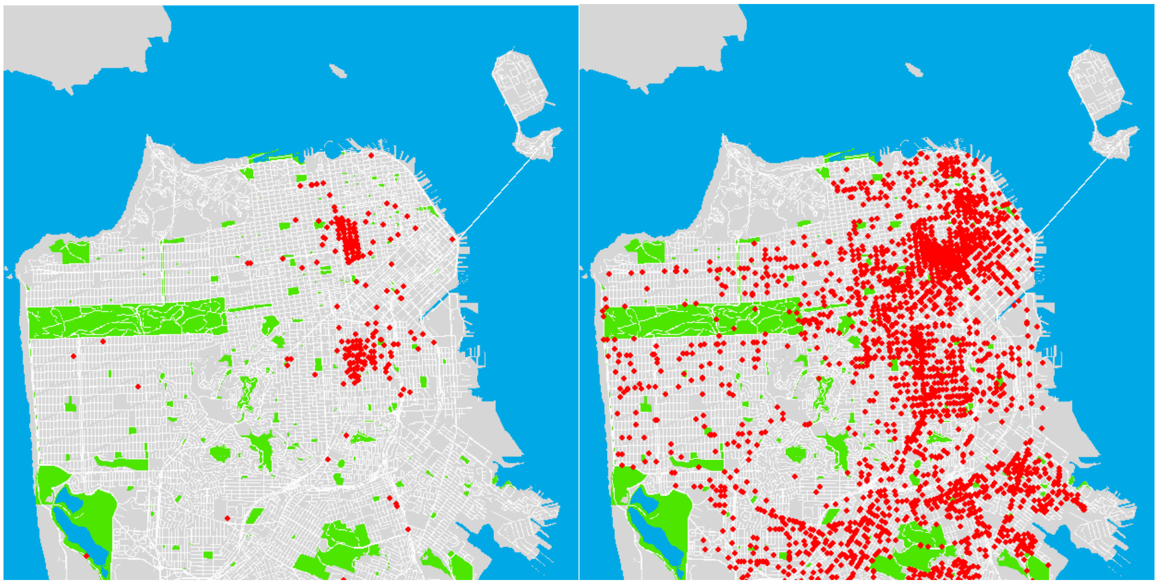


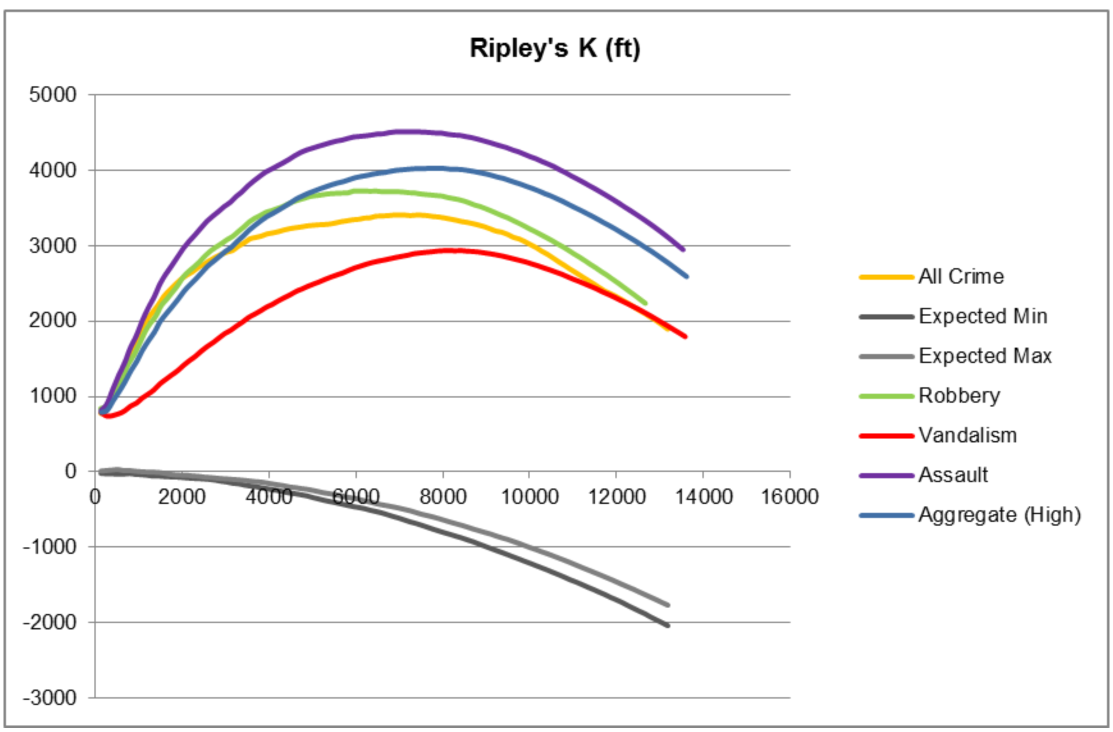
Figure 1: Patterns of prostitution (left) and robbery (right) exhibit varying degrees of clustering

This is of course an almost obvious conclusion: that crime would not be scattered randomly throughout a city but rather be clustered in certain areas. And the following findings of a next neighbor analysis support this trivial conclusion as every kind of crime except for extortion is clustered considerably at high or often very high levels of significance. Because of this it is worthwhile to instead compare various types of crimes' degree of clustering (as signified by their NN ratio, wherein a lower ratio implies increased clustering, by comparing the observed distribution to a Monte Carlo generated 'expected NN', a random distribution of those same points):

Crime Type	Observed NN	Expected NN	NN Ratio	Z-score
Prostitution	40	379	0.11	-73.76
Drug/Narcotic	37	195	0.19	-157.64
Missing Person	90	314	0.29	-86.51
Warrants	69	239	0.29	-114.71
Larceny	39	126	0.31	-211.21
Assault	58	180	0.32	-145.35
Loitering	241	750	0.32	-26.9
Trespass	251	569	0.44	-37.05
Drunkenness	344	757	0.46	-26.99
Liquor Laws	381	837	0.46	-20.87
Robbery	135	289	0.47	-64.49
Vandalism	114	231	0.49	-84.73
All Crime	267	544	0.49	-35.3
Burglary	136	270	0.50	-70.42
Forgery	196	391	0.50	-48.5
Fraud	204	412	0.50	-46.65
Disorderly Conduct	379	749	0.51	-22.74
Gambling	1166	2270	0.51	-5.66
Suspicious Occ	148	292	0.51	-65.28
Sexual Assault	418	791	0.52	-22.53

Vehicle Theft	133	252	0.53	-72.47
Kidnapping	621	1051	0.59	-14.53
Stolen Property	491	773	0.63	-16.04
Embezzlement	728	1093	0.67	-10.31
Arson	871	1266	0.68	-9.36
DUI	711	995	0.71	-9.66
Family Offenses	1407	1845	0.76	-4.04
Bad Checks	1567	1879	0.83	-2.62
Bribery	1937	2159	0.89	-1.47
Extortion	2893	2549	1.13	1.63

A Ripley's K test was also performed for all crime, the high aggregate, as well as the component crimes of the aggregate. This statistical test examines the degree of clustering (the y-axis) at various distances (the x-axis), with each curve peaking at the cluster diameter where the highest degree of clustering is observed before the points begin to become dispersed again. We can see that the high crime aggregate, assault and robbery are more clustered than crime in general but follow largely similar patterns across distance. Vandalism is somewhat less clustered. The high levels of clustering don't differentiate between first-order clustering (meaning incidents are clustering because of an influencing aspect or aspects that vary across the geography of the city) and second-order clustering (meaning incidents are clustering because they are likely to occur near to other incidents). However, either explanation – or the likely mix of the two – still supports the idea that these crimes are occurring in pockets throughout the city, pockets that a may be broken up by changing the physicality, use, and activity of the street. Finding evidence of clustering makes it more likely that environmental modifications may have their intended effects.



Test Case: Parklets

Beginning in 2010 San Francisco began permitting and overseeing parklets as an element of the Pavement to Parks program, converting parking spaces on a semi-permanent basis into parks and seating areas, adding new space for pedestrians to linger: sit, talk, work, watch the world go by, or any number of other activities. Such activities feed into long-standing theories that eyes-on-the-street can make those safer and begin a self-perpetuating virtuous cycle that draws more visitors, creates more pedestrian activity, and makes the street safer still. Thus, proving a local effect on crimes may show that parklets are potentially a powerful tool that can be initiated by store-owners, local business groups, or other types of community associations as a way to make their streets more active and thereby safer.

The Pavement to Parks program supplied a .kml map of all 42 currently existing parklets in San Francisco with other information including dates of installation. This allowed for spatial analysis to figure out which whether crime incidence changed nearby after their installation. As the first city to pilot parklets, San Francisco is also the first city to have enough substantial quantitative data on parklets to run an impact evaluation.

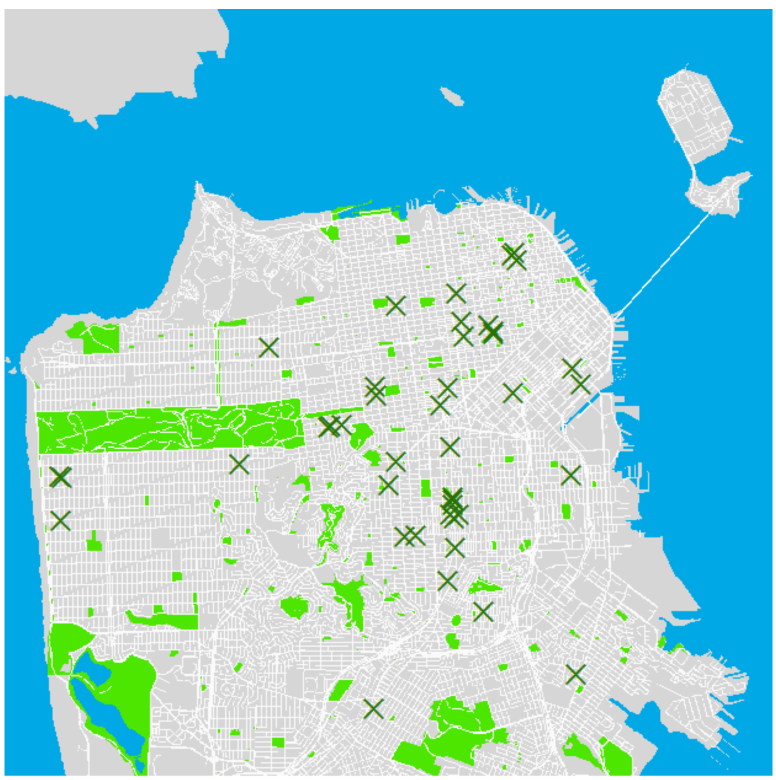


Figure 2: Map showing the locations of all 42 currently installed parklets in SF.

Parklet Crime Analysis

Impact study areas were drawn as circular buffers around each parklet, one with a radius of 50ft and the other at a radius of 100ft, to test for an effect at both scales. These radiuses were picked intentionally: the 50ft radius would capture all immediate crime, spanning the right-of-way near the parklet, while the 100ft radius is the maximum radius before circular test areas might begin capturing portions of the street around the corner, where the eyes of parklet users couldn't actually reach. A corridor analysis was not undertaken at this point because a more thorough study of neighborhood commercial districts (NCDs), in which most of the parklets are located, is to follow. The graphic below shows the two radiuses of analysis, as well as an example crime data set from 2013 to show how geocoded crime incidents are distributed relative to blocks, buildings and the units of analysis:

Figure 3: Map showing a typical geographic distribution of 1 year of criminal incidents (2007) relative to 50ft and 100ft radius study areas drawn around parklets.

The statistical method used to test for a change in crime incidence was a difference-in-proportions test. This means that the proportion of crime types or aggregations occurring within a study area over the whole city's area over the course of the year before or of the intervention (p_1) is compared with that same proportion over the year following the intervention (p_2). This change in proportions is put over the calculated standard error to find the test's z-score, a convention to see if an observed change is statistically significant: that the change observed is meaningful since it is likely not produced by chance alone. By convention, a z-score of 1.96 or above or -1.96 or below is considered statistically significant, corresponding with a 5% or less chance of a type I error.

A type I error is the act of incorrectly rejecting the hypothesis that there was no change in proportions from one year to the next, based on an observed change in too-small sample sizes (the number of criminal incidents being observed). If the number of incidents that are being used as the basis of the statistical test is too low as compared to the change observed, one may observe a change from one year to the next that is due to random variation rather than any real change. If one were to reject the null hypothesis of 'no change' based on an observed change actually attributable to random variation, one would be committing a type I error. By performing a z-test and seeking a z-score of absolute value of 1.96 or more, we ensure that the chance of us making a type I error is less than 5%, a conventionally acceptable degree of error. The formulas used to conduct these tests are as follows:

$$\Delta p = p_2 - p_1$$

$$z = \frac{p_2 - p_1}{standard\ error}$$

$$standard\ error\ (unpooled) = \sqrt{\hat{p} * (1 - \hat{p}) * \left(\frac{1}{n_1} + \frac{1}{n_2}\right)}$$

$$where\ \hat{p} = weighted\ aveage\ of\ p_1\ and\ \ p_2$$

In addition to being aggregated by crime type, proportions of incidents are aggregated temporally. That is, rather than looking at - for example - the change in the number of incidents in 2011, 2012, and 2013 for parklets built in 2012 alone, incidents were aggregated so as to look at changes occurring for all parklets 1 year before, during, and 1 year after their construction, regardless of their actual year of construction. This was performed using a two-stage counting process. First, the number of incidents within study areas and within the city as a whole was calculated by year. These numbers were used to create variables for incidents occurring in these generalized years before and after parklet construction as follows, broken down by crime type or in aggregate, which were then tested for statistically significant changes:

$$count(X, Y) \equiv count(crime\ in\ year\ X\ within\ study\ areas\ of\ \ parklets\ constructed\ in\ \ year\ Y)$$

$$total(X) \equiv count(crime\ in\ year\ X\ within\ SF)$$

$$p_{year\ before\ (-1)} = \frac{count(2009{,}2010) + count(2010{,}2011) + count(2011{,}2012)}{total(2009) + total(2010) + total(2011)}$$

$$p_{year\ constructed\ (0)} = \frac{count(2010{,}2010) + count(2011{,}2011) + count(2012{,}2012)}{total(2010) + total(2011) + total(2012)}$$

$$p_{year\ after\ (1)} = \frac{count(2011{,}2010) + count(2012{,}2011) + count(2013{,}2012)}{total(2011) + total(2012) + total(2013)}$$

NCD Control Analysis

While the preceding analysis effectively controls for city-wide changes in crime incidence, it does not control for localized effects of neighborhood transformation on crime change. Incidentally, the vast majority of parklets have been constructed within or very near to Neighborhood Commercial Districts (NCDs), commercial corridors designated by the planning department to manage gentrification and development within the city[5]. Primarily a spatial designation, NCDs mark corridors and clustering of commercial institutions within the city, and indicate areas more likely to be managed and develop as one area economically. The sample map section below shows two example NCDS in red and blue, the sample areas created as buffers within their streets, and the 50ft and 100ft radius areas around the parklets (for visual comparison):

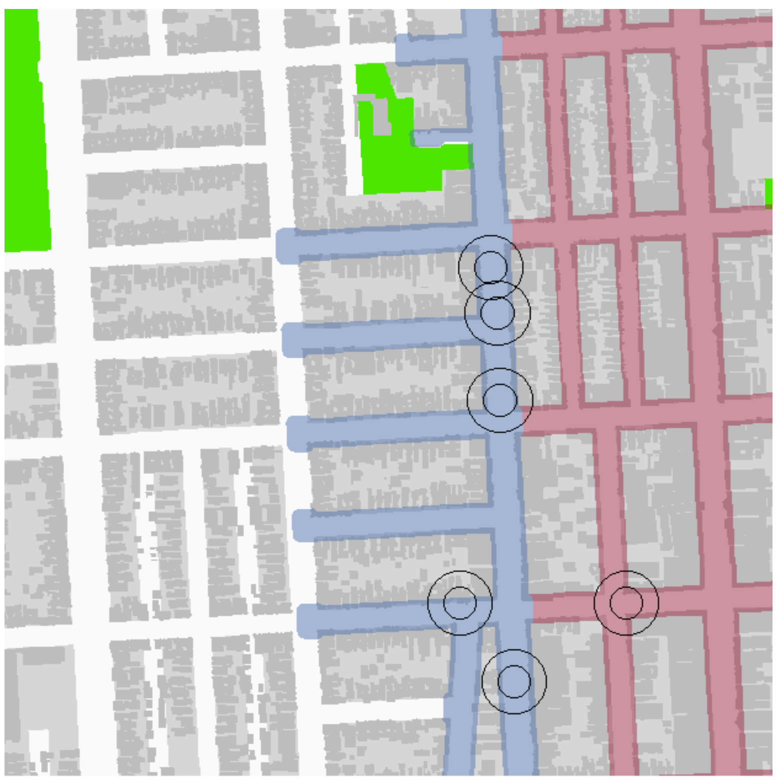


Figure 4: Map showing NCD street buffers (in red and blue) relative to 50ft and 100ft radius study areas drawn around parklets.

[5] The best documentation on the creation of San Francisco's NCDs can be found in Mark Cohen's 1983 article, "San Francisco's Neighborhood Commercial Special Use District Ordinance".

One may suppose a situation wherein demographic or commercial changes along an NCD may be producing the crime incidence changes that tests observe within parklet study areas: that the changes identified as occurring around parklets are really changes happening within the corridors in which parklets happen to be built. Relatedly, economic development within a corridor might provide the means as well as the desire and impetus for business owners to establish parklets, while also being the sources for the crime rate changes observed within those areas.

To test whether this is the case, an identical difference-in-proportions analysis was performed for NCDs in which a parklet was built anytime between 2010 and 2012, with the denominator again being crime incidence within the city as a whole. The same year-before, year-constructed, and year-after proportion tests were used to mimic the timing of the tests used for the parklets so results could be compared, but these had to be adjusted. Because an NCD may have a variety of parklets built in different years, the three proportions used simply resampled the entire NCD study areas every year, regardless of when the parklets within them were built. This approximation was made under the assumption that the larger trends of gentrification or neighborhood change that may be creating the changes of crime rates observed within the parklet sample areas would be occurring generally over the sampled crime of 2009-2013, and not instantaneous and tied to the exact years of parklet construction. The formulas for determining the three key proportions are shown below:

$$count(X) \equiv count(crime\ in\ year\ X\ within\ NCDs)$$
$$total(X) \equiv count(crime\ in\ year\ X\ within\ SF)$$

$$p_{year\ before\ (-1)} = \frac{count(2009) + count(2010) + count(2011)}{total(2009) + total(2010) + total(2011)}$$

$$p_{year\ constructed\ (0)} = \frac{count(2010) + count(2011) + count(2012)}{total(2010) + total(2011) + total(2012)}$$

$$p_{year\ after\ (1)} = \frac{count(2011) + count(2012) + count(2013)}{total(2011) + total(2012) + total(2013)}$$

Lastly, for the sake of completeness the proportion test was repeated with crime counts for the parklet study areas in the numerator and counts for NCDs that have parklets in the denominator, for both 50ft and 100ft radius study areas.

Localized Neighborhood Transformation Analysis

Considering the previous analysis involved an assumption that crime was changing along NCDs in part due to localized neighborhood transformation, it was necessary to check if data corroborated this assumption. Specifically, it may be that the rapid changes affecting San Francisco as may have an impact crimes of inequality as well as convenience. Increased populations of tech-industry workers with disposable income, bringing about increased rent prices, new kinds of commercial establishments opening, and changing demographics, might in fact be centralized along NCDs. The causal theory is as follows: increased inequality and social discord, along with increased wealth brought about by the demographic changes within the city have made crimes of convenience like robbery more common and can explain possible changes in crime observed along NCDs.

One difficulty to be considered is the small size of the NCD corridors relative to census block groups, the smallest resolution demographic information that is available via the American Community Survey, the primary source for the kinds of demographic information that gentrification and demographic changes are usually measured by.

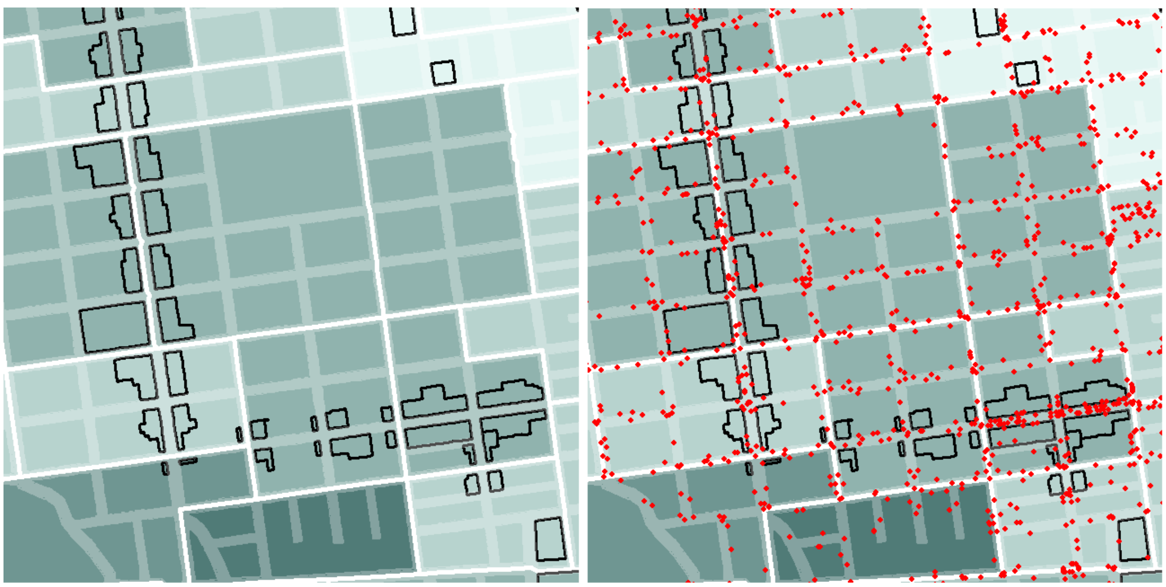


Figure 5: Maps showing the size of American Community Survey block groups, differentiated with different shade of blue and strong white borders, versus NCDs in black and the street grid in faded white (left) and with the addition of crime to show its geographic distribution (right).

Additionally, the kind of neighborhood transformation that may be responsible for changing crime rates may not be explicitly tied to changes in the types of individuals living there as captured by demographic analysis, but rather what populations are passing through and using the corridor. With this in mind it was decided to avoid testing for transformation along NCDs using ACS demographic data, and instead use some set of point data that could indicate neighborhood transformation. Rates of new restaurant openings (as compared to existing restaurants) were studied within NCDs as compared to the city at large, looking for statistically significant differences between in-NCD and general opening rates over the years 2006-2012. Considering how neighborhood transformations occur along commercial corridors in San Francisco, restaurant opening rates may make a good proxy for the economic development patterns tied to the city's gentrification. In the following map NCD study areas were converted into convex hulls marked in black outlines. Existing restaurants are yellow, while new restaurants are increasingly red.

Figure 6: Map of restaurants, with existing businesses in yellow and newer openings becoming orange and then red from 2006-2013. Convex hull study areas around NCDs are marked with black lines.

Test Case: Bikelanes

Because of data availability issues a subsample of bikelanes in San Francisco was used, restricted to those installed in 2010 and 2011. This restriction was put in place because of unreliability in the GIS data on bikelanes made available through the open data portal and as maintained by the SFMTA. It appears that for some segments the year_installed field instead may contain the year a section was last maintained or updated, including simple restriping or patching. As a result, many bikelanes that were built as single projects appear to be broken into construction across many years. This phenomenon was significantly less for the years of 2010 and 2011 because of their recent construction.

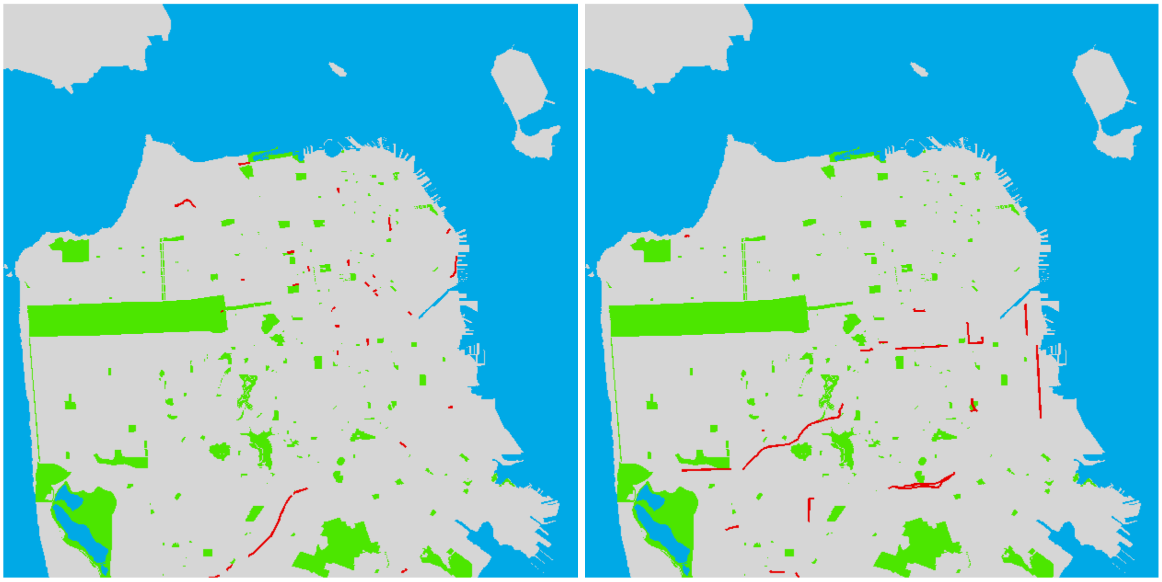


Figure 7: Maps showing evidence of suspicious data-logging. Year 2006 (left) shows more evidence than year 2011 (right) of maintenance and repair projects being logged as newly installed lanes.

Additionally, for the four years preceding November 2009 the injunction against bike lane construction eliminated substantial construction of new lanes, so no projects are available for those years for inclusion in the study sample[6]. However, this injunction created a glut of planned projects, resulting in a number of projects constructed in the years following, allowing for a substantial collection of projects to be included in the study samples from those years. The map below shows all bikelanes in existence within SF's network, highlighting those constructed in 2010 in purple and those constructed in 2011 in red:

[6] In addition to the City Attorney's resources surrounding the injunction referenced earlier, the San Francisco Bike Coalition maintains a relevant page at www.sfbike.org/?bikeplan_lawsuit.

Figure 8: Map showing bikelanes reported installed in 2010 (purple) and 2011 (red) within the context of the entire bikelane network (dark grey).

Data for 2010 and 2011 remained imperfect; there were a handful of lane stubs in both years. In consultation with members of Livable Streets at the SFMTA it was possible to confirm whether these stubs were actually constructed in isolation to connect existing pieces of the bikelane network, or if their year of installation has been mislabeled in the ways discussed above.[7]

Bike Lane Crime Analysis

An identical methodology was used to test for changes in crime incidence following the installation of bike lanes as used for the construction of parklets. The only substantial difference is the nature of the buffering used. Instead of circular sample areas drawn at varying radii around the parklets, sample areas were created so as to catch all crime incidents reported on a street that had a bikelane installed. The following map shows crime incidents in red and a sample area for a bike lane installed in 2010 in purple:

[7] These were determined through email correspondence over January and February of 2014 with Andy Thornley, a Senior Analyst at SFMTA.

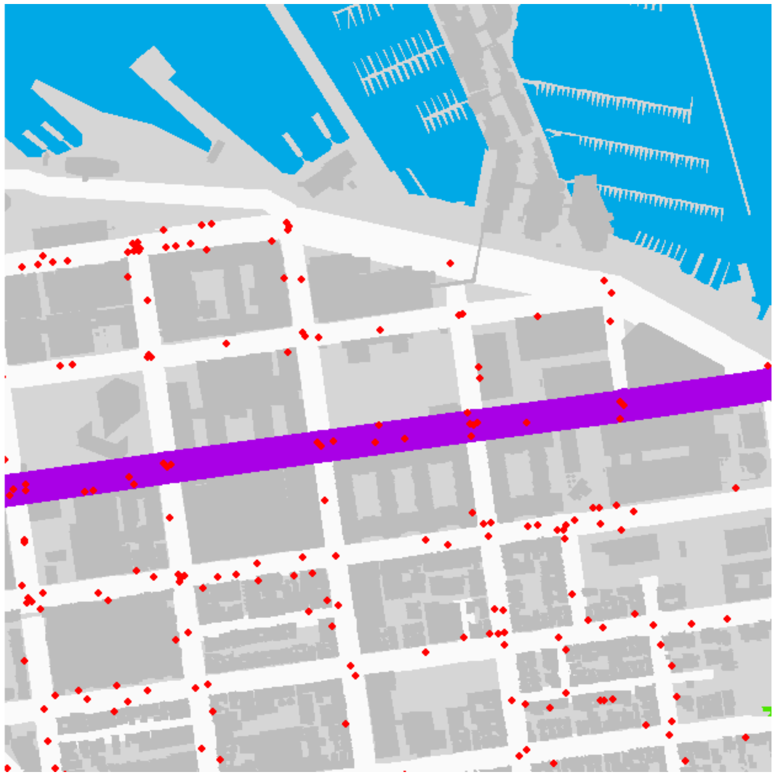


Figure 9: Map showing buffered study area (purple) around a lane constructed in 2010 relative to geocoded criminal incident reports (red).

Again, this study employs a change in proportions test wherein the numerator is the crime counts within the study areas defined by bike lane installation and the denominator is total crime within the city. However, because sampling restricts this study to change due to bikelanes constructed in years 2010 and 2011 the calculation of the proportions is as follows:

$$count(X,Y) \equiv count(crime\ in\ year\ X\ within\ study\ areas\ of\ \ bikelanes\ constructed\ in\ \ year\ Y)$$

$$total(X) \equiv count(crime\ in\ year\ X\ within\ SF)$$

$$p_{year\ before\ (-1)} = \frac{count(2009{,}2010) + count(2010{,}2011)}{total(2009) + total(2010)}$$

$$p_{year\ constructed\ (0)} = \frac{count(2010{,}2010) + count(2011{,}2011)}{total(2010) + total(2011)}$$

$$p_{year\ after\ (1)} = \frac{count(2011{,}2010) + count(2012{,}2011)}{total(2011) + total(2012)}$$

Similar to the parklet analysis, this proportion test checks for changes within the study areas along corridors that saw construction of bikelanes in 2011 and 2012 relative to overall changes in the city.

However, one can imagine that bikelanes were constructed along a particular kind of corridor that may be trending differently than the city at large. To test for this possibility, another difference in proportions test was conducted with the 2011 and 2012 test areas as the numerator over the denominator of all streets with bikelanes in the city.

Findings and Discussion

Parklet Crime Analysis

> *Finding 1:* Areas around parklets see reduced levels of many of the discussed crimes of interest relative to citywide trends, and reduced levels of both the low-likelihood-of-effect and high-likelihood-of-effect aggregate crime counts. In some cases these reductions were statistically significant or near-significant, but not always.
>
> *Finding 2:* NCDs in which parklets were constructed saw large and statistically significant increases of these crime types and aggregates relative to the rest of the city. When crime incident changes within parklet study areas are tested relative to trends within NCDs there are highly significant relative reductions in crime for the parklet study areas.

This study's results contribute more evidence to the theory that parklets can help reduce particular crime types from occurring within nearby areas by increasing eyes-on-the-street and the safety that public security can provide. However, these benefits may not extend far beyond the boundary of sight to entire neighborhoods, and the fact that NCDs that built parklets saw statistically significant increases of relative crime incidence may be of concern.

Parklets often appear in gentrifying or gentrified neighborhoods, where economic development has allowed businesses the extra resources necessary to apply for and build a parklet (which cost $10-15k per space on average[8]). This heightened speed of neighborhood transformation may be one of the contributing factors to the relative increase of criminal incidence along NCDs. Inequality, the social discord that has accompanied it in San Francisco, and new wealth translated into disposable incomes and easily stolen items like smartphones all may have brought about the observed increases in crime.

This study rests on that theory of change, but alternatively gentrification may have brought about an increased police presence as well to serve an increasing population with more wealth and political sway moving into and using these commercial corridors. Increased police presence may increase the apparent crime rates simply because we are observing crime incidence by proxy of police reporting. However, the city as a whole is experiencing dropping crime rates while crime rates within NCDs are holding steady, so this explanation seems unlikely since police beats extend far beyond the edges of an NCD. In either case, however, the immediate areas around parklets have highly statistically significant reductions in crime incidence relative to the commercial corridors they lie within, which remains the key finding.

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[8] Figure pulled from a NACTO report: nacto.org/docs/usdg/pavement_to_parks_sanfran.pdf.

Statistical Tables and Interpretation

Looking at 50ft radius study areas around parklets, assaults saw the most marked relative decreases, though the high aggregate also saw appreciable decreases. In this table like all others to follow, results statistically significant at the previously discussed 95% confidence level (<5% chance of type I error) are marked in yellow, while those that are not strictly significant at this confidence level but still of interest are marked in light yellow:

50ft Parklet Study Areas / City

	Percentgae of crime in study area in year relative to parklet construction			Analysis #1: Year before vs. year after		Analysis #2: Year of vs. year after	
Crime Type	**-1**	**0**	**1**	**change**	**z-score**	**change**	**z-score**
Assault	0.11%	0.10%	0.06%	-0.05%	-2.19	-0.04%	-1.87
Burglary	0.05%	0.05%	0.06%	0.00%	0.09	0.01%	0.44
Disorderly Conduct	0.04%	0.17%	0.11%	0.07%	0.84	-0.07%	-0.59
Larceny/Theft	0.08%	0.09%	0.08%	0.00%	0.35	-0.01%	-0.69
Loitering	0.00%	0.00%	0.00%	0.00%		0.00%	
Prostitution	0.00%	0.07%	0.00%	0.00%		-0.07%	-0.84
Robbery	0.10%	0.10%	0.08%	-0.02%	-0.42	-0.02%	-0.57
Sex Offenses, Forcible	0.11%	0.00%	0.06%	-0.05%	-0.51	0.06%	1.02
Vandalism	0.05%	0.08%	0.05%	0.00%	0.18	-0.03%	-1.10
Vehicle Theft	0.01%	0.07%	0.04%	0.02%	1.21	-0.04%	-1.38
Aggregate Low	0.07%	0.09%	0.07%	-0.00%	-0.48	-0.02%	-2.06
Aggregate High	0.09%	0.09%	0.06%	-0.03%	-1.73	-0.03%	-2.15

Looking at 100ft radius study areas around the parklets, the observed changes overall were less dramatic but there were still noticeable and significant decreases in the high aggregate:

100ft Study Areas / City

	Percentage of crime in study area in year relative to parklet construction			Analysis #1: Year before vs. year after		Analysis #2: Year of vs. year after	
Crime Type	**-1**	**0**	**1**	**change**	**z-score**	**change**	**z-score**
Assault	0.31%	0.29%	0.26%	-0.06%	-1.57	-0.03%	-0.80
Burglary	0.15%	0.15%	0.15%	-0.00%	-0.12	-0.00%	-0.11
Disorderly Conduct	0.28%	0.44%	0.26%	-0.01%	-0.09	-0.17%	-0.94
Larceny/Theft	0.23%	0.23%	0.25%	0.02%	0.97	0.01%	0.53
Loitering	0.00%	0.23%	0.34%	0.34%		0.11%	0.27
Prostitution	0.04%	0.07%	0.00%	-0.04%	-0.62	-0.07%	-0.84
Robbery	0.18%	0.21%	0.17%	-0.01%	-0.12	-0.04%	-0.64
Sex Offenses, Forcible	0.38%	0.40%	0.18%	-0.21%	-1.27	-0.22%	-1.20
Vandalism	0.16%	0.18%	0.11%	-0.05%	-1.44	-0.06%	-1.74
Vehicle Theft	0.13%	0.16%	0.11%	-0.02%	-0.54	-0.05%	-1.19
Aggregate Low	0.22%	0.23%	0.21%	-0.01%	-0.80	-0.02%	-1.18
Aggregate High	0.24%	0.24%	0.19%	-0.05%	-2.11	-0.04%	-1.70

Results from the NCD analysis show that like all NCDs, those which host parklets actually experienced increased crime rates relative to the rest of the city. These marked increases are for NCD areas which are much larger than parklets – it would be hard to believe that these increases were actually caused by parklet construction. Further, the same kind of increases are found within all NCDs, including those that did not gain parklets, meaning another aspect of NCDs – potentially faster gentrification and neighborhood transformation – is the cause of these relative increases.

NCDs with Parklets / City

	Percentage of crime in study area in year relative to parklet construction			Analysis #1: Year before vs. year after		Analysis #2: Year of vs. year after	
Crime Type	**-1**	**0**	**1**	**change**	**z-score**	**change**	**z-score**
Assault	8.85%	8.99%	9.10%	0.26%	1.13	0.12%	0.51
Burglary	5.85%	6.03%	6.70%	0.85%	3.19	0.67%	2.42
Disorderly Conduct	14.17%	14.16%	12.28%	-1.90%	-1.88	-1.89%	-1.87
Larceny/Theft	7.46%	7.82%	8.98%	1.53%	11.40	1.16%	8.37
Loitering	9.28%	5.09%	1.09%	-8.19%	-5.01	-4.00%	-3.18
Prostitution	33.24%	48.74%	39.67%	6.43%	3.13	-9.07%	-4.56
Robbery	9.53%	9.11%	10.19%	0.66%	1.54	1.08%	2.67
Sex Offenses, Forcible	7.97%	9.22%	8.74%	0.76%	0.82	-0.48%	-0.50
Vandalism	6.72%	6.74%	6.83%	0.11%	0.47	0.10%	0.40
Vehicle Theft	5.90%	5.90%	5.98%	0.08%	0.30	0.08%	0.30
Aggregate Low	7.96%	8.04%	8.58%	0.62%	6.71	0.54%	5.83
Aggregate High	8.24%	8.23%	8.51%	0.27%	1.69	0.28%	1.82

Because of observed relative increases of crime within NCDs as compared to the city, it is safe to assume the lower relative crime incidence occurring within parklet study areas is not simply a product of changes occurring within the larger NCDs they are located within, but rather in spite of those changes. Predictably, when we take the proportion test that places crime incidence within parklet study areas over crime incidence within NCDs that gained parklets we find highly statistically significant results of reduced relative crime incidence, particularly of the high aggregate and its component crimes, but also for other crimes as well within both the 50ft and 100ft study areas:

50ft Parklet Study Areas / NCDs with Parklets

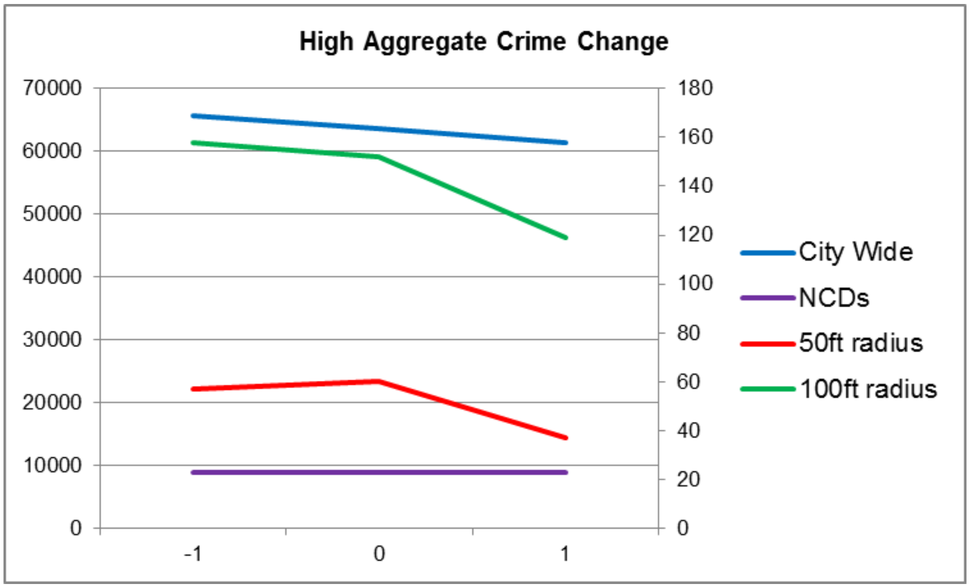
	Percentage of crime in study area in year relative to parklet construction			Analysis #1: Year before vs. year after		Analysis #2: Year of vs. year after	
Crime Type	**-1**	**0**	**1**	**change**	**z-score**	**change**	**z-score**
Assault	1.22%	1.11%	0.36%	-0.86%	-3.63	-0.75%	-3.27
Burglary	0.92%	0.75%	0.67%	-0.24%	-0.60	-0.07%	-0.20
Disorderly Conduct	0.28%	1.23%	0.37%	0.09%	0.20	-0.87%	-1.16
Larceny/Theft	1.01%	1.15%	0.80%	-0.20%	-1.22	-0.34%	-2.04
Loitering	0.00%	0.00%	0.00%	0.00%		0.00%	
Prostitution	0.00%	0.15%	0.00%	0.00%		-0.15%	-0.84

Robbery	1.03%	1.14%	0.37%	-0.66%	-1.81	-0.77%	-2.04
Sex Offenses, Forcible	1.38%	0.00%	0.65%	-0.73%	-0.63	0.65%	1.02
Vandalism	0.74%	1.21%	0.48%	-0.26%	-0.91	-0.73%	-2.17
Vehicle Theft	0.24%	1.23%	0.43%	0.19%	0.69	-0.80%	-1.89
Aggregate Low	0.89%	1.07%	0.60%	-0.30%	-2.98	-0.47%	-4.49
Aggregate High	1.05%	1.15%	0.40%	-0.66%	-4.01	-0.75%	-4.42

100ft Parklet Study Areas / NCDs with Parklets

	Percentage of crime in study area in year relative to parklet construction			Analysis #1: Year before vs. year after		Analysis #2: Year of vs. year after	
Crime Type	**-1**	**0**	**1**	**change**	**z-score**	**change**	**z-score**
Assault	3.56%	3.27%	1.30%	-2.26%	-5.50	-1.97%	-4.90
Burglary	2.63%	2.56%	1.73%	-0.90%	-1.36	-0.83%	-1.28
Disorderly Conduct	1.94%	3.09%	0.73%	-1.21%	-1.28	-2.35%	-2.04
Larceny/Theft	3.06%	2.99%	2.16%	-0.90%	-3.19	-0.83%	-3.04
Loitering	0.00%	4.55%	25.00%	25.00%	3.20	20.45%	1.41
Prostitution	0.12%	0.15%	0.00%	-0.12%	-0.74	-0.15%	-0.84
Robbery	1.85%	2.28%	1.02%	-0.83%	-1.59	-1.27%	-2.27
Sex Offenses, Forcible	4.83%	4.35%	1.30%	-3.53%	-1.78	-3.05%	-1.62
Vandalism	2.35%	2.62%	1.16%	-1.19%	-2.45	-1.46%	-2.90
Vehicle Theft	2.14%	2.68%	1.50%	-0.64%	-1.01	-1.18%	-1.76
Aggregate Low	2.73%	2.80%	1.67%	-1.06%	-6.22	-1.13%	-6.64
Aggregate High	2.92%	2.90%	1.21%	-1.71%	-6.23	-1.70%	-6.16

Because it may be difficult to visualize the meaning of relative changes in crime incidence rates as indicated by the statistical test tables above, below is a summary graph for the high-propensity crime aggregate for the four geographic levels used: Citywide, NCD, and 50ft and 100ft study areas. Like in the tables, data from across the years 2009-2013 is collapsed into three data points: year before parklet construction, year of construction, and year after construction. Importantly, the graph uses two different scales. Citywide and NCD data use the left-hand axis scale while the 50ft and 100ft parklet buffers use the right-hand axis scale because of the large differences in land area of each geography. Even after taking account the different scales used, we can see clear overall trends: while the aggregated crime incidence rates dropped from 2009 to 2013 citywide, those changes were somewhat more pronounced near parklets. Rates within NCDs held stable despite citywide downward trends. When we take into account the fact that most parklets lie within or near NCDs which are experiencing no change in crime incidence, the results observed near parklets are of even more interest.



Nighttime Analysis

> *Finding 3*: Findings become less clear and significant when nighttime crime incidence is compared between parklet study areas and the city, largely because of a loss of statistical power. However, parklet study areas see significant reductions in relevant crime rates as compared to NCDs.

Because the theory of casual surveillance as a crime deterrent may be dependent on time of day, it was important to see if the results found for crime reduction were more or less strong if restricted to crimes occurring at night, or more specifically between the hours of 8pm and 5am. This analysis would see greater levels of crime reduction at night if parklets are effectively drawing activity to areas that are more vacant at night. However, results were more inconclusive: negligible reductions were observed but were of little to no statistical significance. This loss of significance may be caused largely by two factors:

1. The smaller observational sample of only crimes occurring during nighttime hours reduces the power of the statistical tests, so it would require very large relative changes to a small sample to produce results of any significance.
2. The role parklets play in nighttime crime is more complex and does not result in reductions with the same mechanism as observed with general crime. Without observational data on nighttime use and activity of parklets, one cannot definitively say parklets are attracting activity during nighttime hours that might deter crime. Possibly parklets simply do not attract nighttime activity and thus no effect is seen, or they attract a little activity which may deter some crime, or may also attract crime by supplying targets for potential offenses.

This study remains inconclusive about the effects of parklets on nighttime crime incidence. Further research with data on actual activity and use of parklets particularly during nighttime hours would be required to fully understand what is occurring. Statistical tables are included below, despite inconclusive results:

50ft Parklet Study Areas / City (Night)

	Percentage of crime in study area in year relative to parklet construction			Analysis #1: Year before vs. year after		Analysis #2: Year of vs. year after	
Crime Type	**-1**	**0**	**1**	**change**	**z-score**	**Change**	**z-score**
Assault	0.16%	0.11%	0.10%	-0.07%	-1.43	-0.01%	-0.30
Burglary	0.07%	0.00%	0.06%	-0.01%	-0.23	0.06%	1.66
Disorderly Conduct	0.16%	0.50%	0.19%	0.03%	0.14	-0.31%	-0.86
Larceny/Theft	0.13%	0.14%	0.15%	0.02%	0.49	0.00%	0.13
Loitering	0.00%	0.00%	0.00%	0.00%		0.00%	
Prostitution	0.00%	0.10%	0.00%	0.00%		-0.10%	-0.87
Robbery	0.12%	0.11%	0.11%	-0.01%	-0.16	-0.01%	-0.11
Sex Offenses, Forcible	0.12%	0.00%	0.00%	-0.12%	-0.95	0.00%	
Vandalism	0.04%	0.07%	0.08%	0.04%	1.08	0.01%	
Vehicle Theft	0.02%	0.08%	0.00%	-0.02%	-1.07	-0.08%	-2.32
Aggregate Low	0.10%	0.11%	0.10%	0.00%	-0.16	-0.01%	-0.35
Aggregate High	0.11%	0.09%	0.09%	-0.02%	-0.67	0.00%	-0.13

100ft Parklet Study Areas / City (Night)

	Percentage of crime in study area in year relative to parklet construction			Analysis #1: Year before vs. year after		Analysis #2: Year of vs. year after	
Crime Type	**-1**	**0**	**1**	**change**	**z-score**	**Change**	**z-score**
Assault	0.38%	0.27%	0.34%	-0.05%	-0.73	0.06%	0.90
Burglary	0.29%	0.17%	0.18%	-0.11%	-1.28	0.01%	0.06
Disorderly Conduct	0.31%	0.66%	0.38%	0.07%	0.23	-0.28%	-0.65
Larceny/Theft	0.31%	0.35%	0.38%	0.07%	1.70	0.03%	0.59
Loitering	0.00%	0.00%	0.00%	0.00%		0.00%	
Prostitution	0.00%	0.10%	0.00%	0.00%		-0.10%	-0.87
Robbery	0.23%	0.23%	0.23%	0.00%	-0.04	0.00%	0.04
Sex Offenses, Forcible	0.47%	0.75%	0.13%	-0.34%	-1.38	-0.62%	-1.85
Vandalism	0.20%	0.16%	0.11%	-0.09%	-1.62	-0.05%	-0.92
Vehicle Theft	0.17%	0.15%	0.09%	-0.08%	-1.62	-0.06%	-0.92
Aggregate Low	0.28%	0.27%	0.27%	-0.01%	-0.31	0.01%	0.18
Aggregate High	0.29%	0.22%	0.24%	-0.05%	-1.44	0.01%	0.33

While proportion tests for nighttime crime relative to the city as a whole are less dramatic than for crimes occurring at all times, these results become of note once again when the rates within NCDs are taken into account. Nighttime crime incidence within NCDs as compared to the rest of the city increases relative to the rest of the city from 2009 to 2013:

NCDs with Parklets / City (Night)

	Percentage of crime in study area in year relative to parklet construction			Analysis #1: Year before vs. year after		Analysis #2: Year of vs. year after	
Crime Type	**-1**	**0**	**1**	**change**	**z-score**	**change**	**z-score**
Assault	19.35%	20.17%	28.29%	8.94%	13.99	8.11%	13.51
Burglary	12.49%	12.23%	18.24%	5.75%	8.06	6.00%	7.55
Disorderly Conduct	31.40%	32.67%	41.90%	10.50%	3.12	9.23%	3.04
Larceny/Theft	15.08%	16.47%	24.96%	9.88%	29.31	8.49%	22.38
Loitering	33.33%	33.93%	25.93%	-7.41%	-0.65	-8.00%	-0.74
Prostitution	46.23%	59.31%	73.17%	26.94%	8.32	13.86%	5.70
Robbery	16.83%	16.86%	25.04%	8.21%	8.75	8.18%	9.59
Sex Offenses, Forcible	15.93%	17.91%	23.62%	7.70%	3.52	5.71%	2.59
Vandalism	12.10%	12.55%	16.99%	4.88%	8.89	4.43%	8.13
Vehicle Theft	9.86%	9.29%	13.05%	3.18%	5.54	3.76%	6.18
Aggregate Low	15.93%	16.47%	23.54%	7.61%	32.36	7.07%	29.97
Aggregate High	16.30%	16.74%	23.54%	7.25%	17.70	6.81%	18.28

If the earlier analyses for the proportion of crime occurring within the parklet study areas compared to crime occurring within NCDs that gained parklets are repeated – but this time for nighttime crime – once again there are significant relative reductions in crime rates:

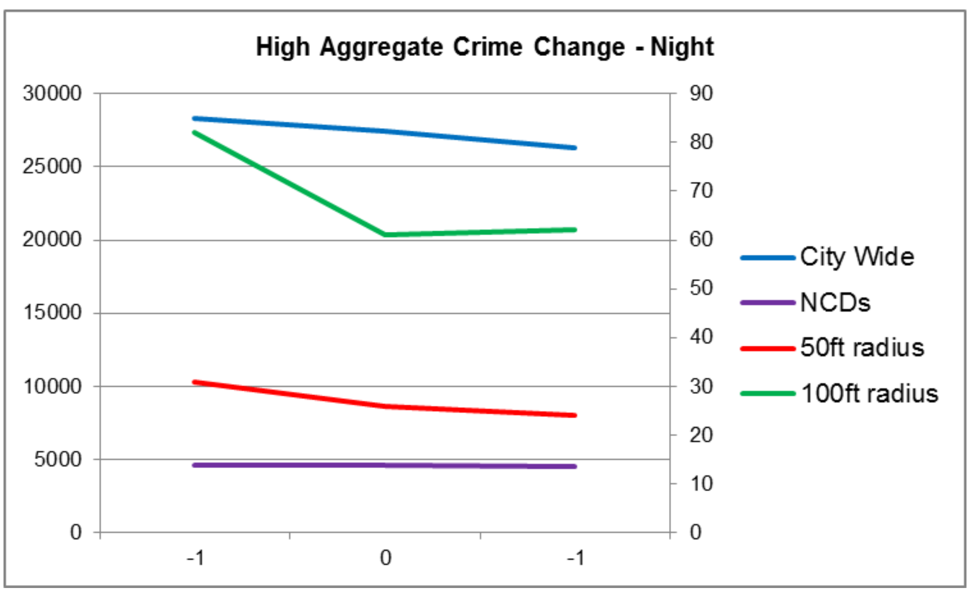
50ft Parklet Study Areas / NCDs with Parklets (Night)

	Percentage of crime in study area in year relative to parklet construction			Analysis #1: Year before vs. year after		Analysis #2: Year of vs. year after	
Crime Type	**-1**	**0**	**1**	**change**	**z-score**	**change**	**z-score**
Assault	1.45%	0.93%	0.37%	-1.09%	-3.01	-0.57%	-1.86
Burglary	0.99%	0.00%	0.48%	-0.51%	-0.82	0.48%	1.28
Disorderly Conduct	0.64%	1.84%	0.00%	-0.64%	-0.99	-1.84%	-1.68
Larceny/Theft	1.31%	1.32%	1.12%	-0.19%	-0.65	-0.20%	-0.70
Loitering	0.00%	0.00%	0.00%	0.00%		0.00%	
Prostitution	0.00%	0.17%	0.00%	0.00%		-0.17%	-0.85
Robbery	1.10%	1.08%	0.16%	-0.94%	-2.10	-0.92%	-2.07
Sex Offenses, Forcible	1.35%	0.00%	0.00%	-1.35%	-1.02	0.00%	
Vandalism	0.52%	0.89%	0.68%	0.16%	0.41	-0.21%	-0.46
Vehicle Theft	0.28%	1.31%	0.00%	-0.28%	-1.06	-1.31%	-2.29
Aggregate Low	1.01%	1.01%	0.66%	-0.35%	-2.30	-0.35%	-2.33
Aggregate High	1.12%	0.95%	0.40%	-0.72%	-3.06	-0.55%	-2.48

100ft Parklet Study Areas / NCDs with Parklets (Night)

	Percentage of crime in study area in year relative to parklet construction			Analysis #1: Year before vs. year after		Analysis #2: Year of vs. year after	
Crime Type	**-1**	**0**	**1**	**change**	**z-score**	**change**	**z-score**
Assault	3.46%	2.37%	1.31%	-2.14%	-3.70	-1.06%	-2.06
Burglary	3.96%	2.32%	1.91%	-2.05%	-1.66	-0.41%	-0.39
Disorderly Conduct	1.28%	2.45%	0.00%	-1.28%	-1.40	-2.45%	-1.94
Larceny/Theft	3.12%	3.25%	2.53%	-0.59%	-1.34	-0.73%	-1.68
Loitering	0.00%	0.00%	0.00%	0.00%		0.00%	
Prostitution	0.00%	0.17%	0.00%	0.00%		-0.17%	-0.85
Robbery	2.21%	2.17%	0.79%	-1.41%	-2.02	-1.37%	-1.98
Sex Offenses, Forcible	5.41%	7.79%	0.00%	-5.41%	-2.07	-7.79%	-2.50
Vandalism	2.59%	2.03%	1.09%	-1.50%	-2.15	-0.94%	-1.47
Vehicle Theft	2.79%	2.35%	1.25%	-1.54%	-1.52	-1.10%	-1.16
Aggregate Low	2.72%	2.53%	1.68%	-1.03%	-4.23	-0.85%	-3.56
Aggregate High	2.97%	2.23%	1.13%	-1.83%	-4.79	-1.10%	-3.16

Similar to the earlier analysis of crime changes regardless of time, parklets are in fact seeing small decreases of crime relative to the decreasing trends across the city from 2009 to 2013. However, this small drop becomes much more meaningful when understood to be within the context of NCDs that have seen stubbornly stable numbers of crime incidents despite citywide downward trends. Below a graph shows the overall trends of nighttime incidents of the high aggregate at the four different geographies:



Clustering Analysis: Are Parklets Displacing Crime?

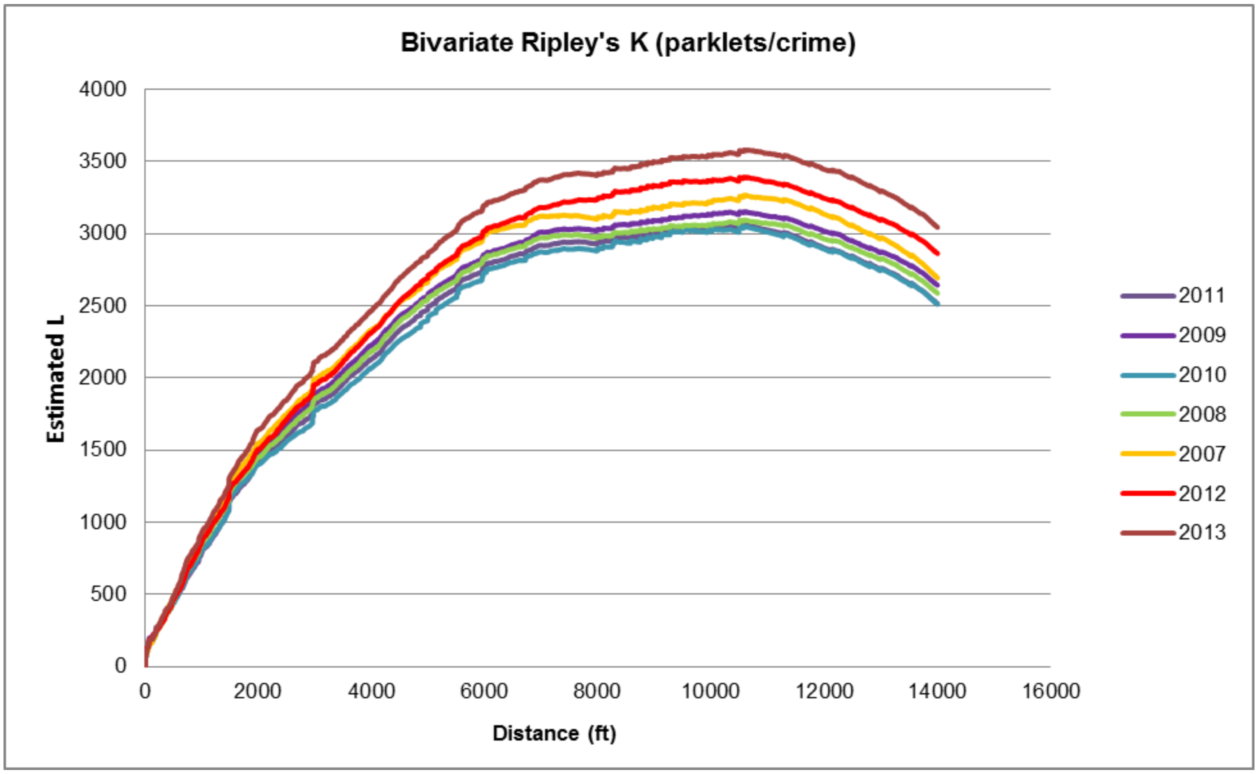
> *Finding 4:* Clustering analysis indicates that most likely the observed decreases in relative crime incidence within parklet study areas is not because that crime is simply being dispersed locally while clustering at the edges of a region or border surrounding parklets, but may be actually eliminated.

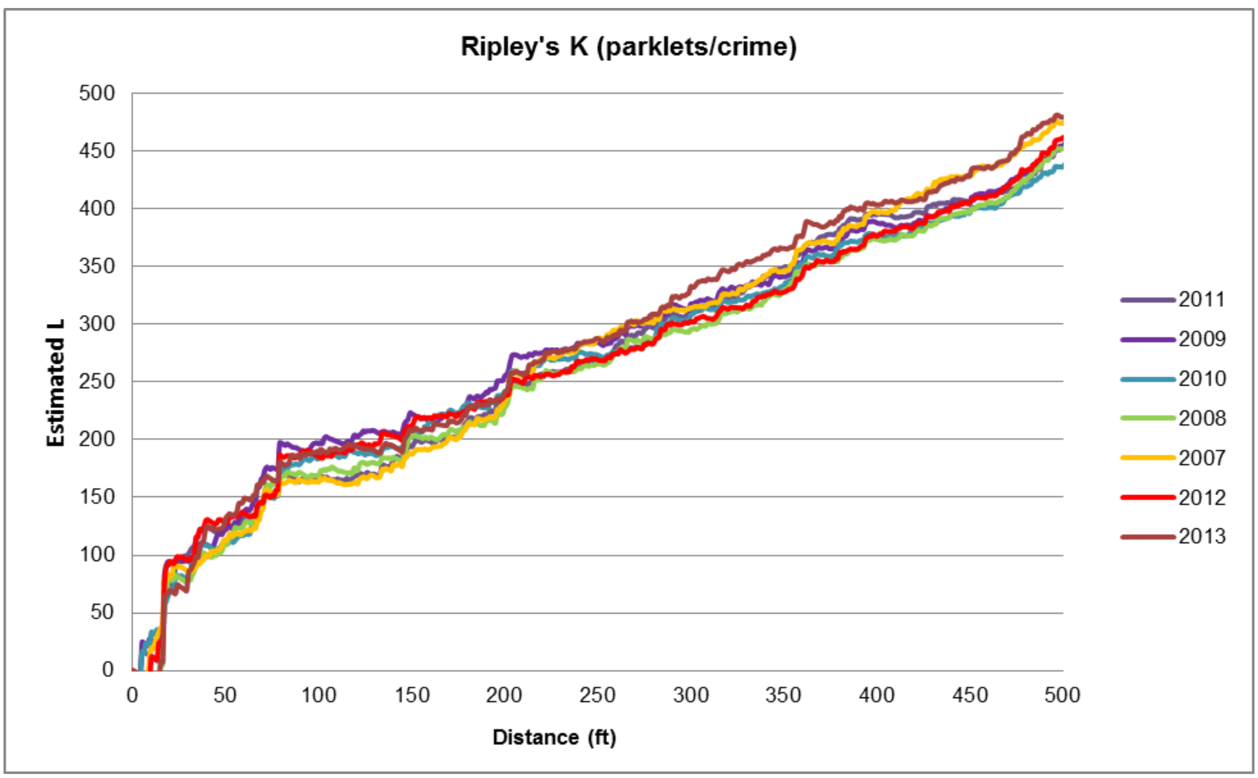
The preceding analysis was both encouraging as well as worrying: Parklets appeared to be associated with significantly lower crime rates within their immediate vicinities as compared to citywide trends, and these relative reductions became even more significant when compared to trends within NCD corridors. Thus, it was considered that perhaps parklets were not reducing or dissuading potential crime, but rather displacing it somewhat farther away and this displacement was shown by the fact that crime remained steady within NCDs over the years of 2009-2013 despite changes seen elsewhere.

In order to investigate this possibility, clustering analysis was conducted using a bivariate Ripley's K test. Like the Ripley's K test conducted earlier, this test examines patterns or trends in the clustering of crime incidents, but rather than looking at how crime incidents cluster with other crime incidents, the bivariate model examines how crime incidents cluster in relation to parklet locations.

For simplicity, the clustering patterns of the high-aggregate (assault, robbery, and vandalism) were tested for each year relative to all parklet sites regardless of year installed. If the concern that parklets were dispersing crime from their immediate vicinities, yet this was resulting in higher concentrations at a distance, we would observe a shallower curve at close proximities for later years followed by a steeper upswing as compared to earlier years. (For further visual explanation see the Ripley's K appendix).However, this phenomenon was not observed, giving reason to believe parklets are not simply seeing reduced incidents of crime nearby by displacing that crime beyond a certain boundary, but rather may in fact be eliminating that crime independent of citywide or neighborhood trends.

Additional Bivariate Ripley's K graphs broken out by year including max and minimum bounds of the expected null hypothesis, as well as zoomed in to the 0-500ft range can be found in the appendix.


Bivariate Ripley's K (parklets/crime)
Estimated L
4000
3500
3000
2500
2000
1500
1000
500
0
0
2000
4000
6000
8000
10000
12000
14000
16000
Distance (ft)
2011
2009
2010
2008
2007
2012
2013


Ripley's K (parklets/crime)
Estimated L
500
450
400
350
300
250
200
150
100
50
0
0
50
100
150
200
250
300
350
400
450
500
Distance (ft)
2011
2009
2010
2008
2007
2012
2013

Neighborhood Transformation in NCDs

Finding 5: While inconclusive and in need of further study, rates of new restaurant openings are increasing more along NCDs than in the rest of the city, and this finding could be used as a proxy for observing faster neighborhood transformation in those areas as well.

Though not entirely conclusive, the study of variation in the rates of new restaurant openings as indictors of gentrification did find potential evidence for localized neighborhood transformation along NCDs that might help explain the trends found in the previous analyses. When the rate of new business registrations for restaurants in NCDs is compared with the rest of the city it was found that from 2006-2012 a changing trend wherein NCDs went from having a lower rate relative to the rest of the city to having a higher rate. In every year the difference in rates of new openings was never significant, however it became increasingly more significant over time as the rate of new openings within NCDs became higher than outside of NCDs. While the results of this particular analysis remain inconclusive, the trending is of interest and points to the possibility that NCDs have been experiencing localized transformation as compared to the rest of the city in a quantifiable way to lend support to the general perception reported in media.

Year		New	Existing	Total	Change	Difference	Z-Score
2006	Non-NCD	171	1005	1176	+14.5%	-2.4%	-1.29
	In NCD	60	434	494	+12.1%		
2007	Non-NCD	129	1176	1305	+9.9%	-1%	-0.68
	In NCD	48	494	542	+8.9%		
2008	Non-NCD	144	1305	1449	+9.9%	-0.1%	-0.08
	In NCD	59	542	601	+9.8%		
2009	Non-NCD	168	1449	1617	+10.3%	-.3%	-0.26
	In NCD	67	601	668	+10%		
2010	Non-NCD	170	1617	1787	+9.5%	+1%	0.73
	In NCD	78	668	746	+10.5%		
2011	Non-NCD	252	1787	2039	+12.4%	+1.5%	1.11
	In NCD	120	746	866	+13.9%		
2012	Non-NCD	297	2039	2336	+12.7%	+2.1%	1.67
	In NCD	151	866	1017	+14.8%		

Bikelane Crime Analysis

Finding 6: Bikelanes' effects on crime are smaller and do not follow the same pattern or logic of parklets' effects. Other crimes appear to be significantly affected by bikelane construction, particularly evidenced by relative decreases in prostitution and sex offenses, but conclusive understanding will require further research.

Tests found rather irregular results for changes in crime in the corridors running along new bikelanes constructed in 2010 and 2011 relative to the rest of the city: Those crimes thought to be most affected by parklet construction are not those influenced by bikelane construction, meaning the presence of bikelanes may affect crimes through a somewhat different mechanism. Disorderly conduct, larceny/theft, and prostitution all saw significant relative decreases along new bikelane corridors as compared to the city as a whole, but the high aggregate and its component crimes that parklet construction influenced are no longer affected similarly.

2010/2011 Bikelane Buffers / City

	Percentage of crime in study area in year relative to bikelane construction			Analysis #1: Year before vs. year after		Analysis #2: Year of vs. year after	
Crime Type	**-1**	**0**	**1**	**change**	**z-score**	**change**	**z-score**
Assault	0.84%	0.81%	0.90%	0.07%	0.76	0.09%	1.03
Burglary	0.91%	0.83%	0.84%	-0.07%	-0.54	0.02%	0.15
Disorderly Conduct	3.93%	1.96%	0.75%	-3.18%	-5.78	-1.21%	-2.85
Larceny/Theft	1.56%	1.45%	1.28%	-0.28%	-3.84	-0.17%	-2.40
Loitering	1.29%	0.33%	1.21%	-0.07%	-0.08	0.89%	1.22
Prostitution	5.58%	2.13%	0.56%	-5.02%	-5.72	-1.57%	-2.68
Robbery	1.08%	0.89%	0.98%	-0.10%	-0.58	0.09%	0.55
Sex Offenses, Forcible	1.05%	0.69%	0.68%	-0.37%	-0.99	-0.01%	-0.04
Vandalism	1.25%	1.02%	1.12%	-0.13%	-1.02	0.10%	0.84
Vehicle Theft	1.37%	1.08%	1.10%	-0.27%	-1.74	0.03%	0.19
Aggregate Low	1.38%	1.16%	1.11%	-0.27%	-6.04	-0.05%	-1.25
Aggregate High	1.01%	0.89%	0.99%	-0.02%	-0.29	0.10%	1.46

Similarly, these patterns of change held relatively constant when tests sampled only those crimes occurring at night, with the addition of forcible sex offenses seeing a relative decrease:

2010/2011 Bikelane Buffers/City (Night)

	Percentage of crime in study area in year relative to bikelane construction			Analysis #1: Year before vs. year after		Analysis #2: Year of vs. year after	
Crime Type	**-1**	**0**	**1**	**change**	**z-score**	**change**	**z-score**
Assault	0.55%	0.59%	0.74%	0.19%	1.54	0.14%	1.13
Burglary	0.71%	0.70%	0.80%	0.09%	0.39	0.10%	0.44
Disorderly Conduct	3.76%	1.36%	1.07%	-2.70%	-2.44	-0.30%	-0.38
Larceny/Theft	1.07%	0.97%	0.76%	-0.31%	-3.06	-0.21%	-2.15
Loitering	0.00%	2.17%	0.00%	0.00%		-2.17%	-0.66
Prostitution	4.39%	1.65%	0.68%	-3.71%	-4.21	-0.97%	-1.62
Robbery	0.81%	0.94%	0.96%	0.15%	0.66	0.02%	0.10
Sex Offenses, Forcible	0.85%	0.57%	0.00%	-0.85%	-2.15	-0.57%	-1.77
Vandalism	1.13%	0.75%	0.98%	-0.15%	-0.87	0.23%	1.44
Vehicle Theft	1.03%	0.69%	0.92%	-0.11%	-0.51	0.22%	1.11

Aggregate Low	1.04%	0.83%	0.81%	-0.23%	-3.55	-0.02%	-0.34
Aggregate High	0.80%	0.71%	0.87%	0.06%	0.68	0.16%	1.70

Corridors that receive bikelanes usually fit a certain type: roads that are wide enough to accommodate the loss of car-space for conversion into a bike-lane, generally not winding or strictly residential along their entire length, etc. The locating of bikelanes has actually varied over time in terms of its methodology and rubric:

> "Historically, San Francisco bicycle facilities were placed only on streets where potential conflicts with other competing demands were minimal. As improvements recommended in the 1997 Bicycle Plan were implemented, bicycle facilities were increasingly installed on higher-volume, complex streets that provided greater access to the destinations that bicyclists wished to reach."[9]

Because streets with bikelanes constructed at any time might crucially differ from city streets in general, it may be apt to observe changes in crime in corridors with newly constructed bikelanes as compared to all streets with bikelanes, regardless of construction date. This tests reports back encouraging results, showing significant relative reductions in crime for many of the key crimes. However, this study still deems this test inconclusive because of occasional strong differences in significance (or even direction of change) for crimes when the year before vs. year after test is used as compared to when the year of vs. year after test is used:

2010/2011 Bikelane Buffers / All Bikelane Buffers

	Percentage of crime in study area in year relative to bikelane construction			Analysis #1: Year before vs. year after		Analysis #2: Year of vs. year after	
Crime Type	**-1**	**0**	**1**	**change**	**z-score**	**change**	**z-score**
Assault	5.94%	5.68%	6.26%	0.32%	1.35	0.58%	6.37
Burglary	8.93%	8.45%	8.60%	-0.33%	-0.82	0.15%	1.19
Disorderly Conduct	17.72%	9.17%	3.65%	-14.07%	-11.78	-5.52%	-13.05
Larceny/Theft	8.04%	7.40%	6.75%	-1.29%	-7.74	-0.66%	-9.14
Loitering	11.11%	1.82%	4.62%	-6.50%	-2.81	2.80%	3.85
Prostitution	22.37%	12.43%	8.16%	-14.21%	-4.69	-4.27%	-7.29
Robbery	6.89%	5.77%	6.55%	-0.34%	-0.78	0.78%	4.76
Sex Offenses, Forcible	7.30%	4.91%	4.73%	-2.57%	-2.57	-0.17%	-0.51
Vandalism	8.49%	6.96%	7.66%	-0.83%	-2.53	0.70%	5.77
Vehicle Theft	10.22%	8.46%	8.43%	-1.79%	-4.22	-0.04%	-0.24
Aggregate Low	8.45%	7.15%	6.92%	-1.53%	-13.67	-0.23%	-5.30
Aggregate High	6.96%	6.14%	6.79%	-0.17%	-0.95	0.66%	9.86

[9] Statement taken from the San Francisco 2009 Bike Plan, available in full at: www.sfmta.com/sites/default/files/projects/San_Francisco_Bicycle_Plan_June_26_2009_002.pdf.

Recommendations

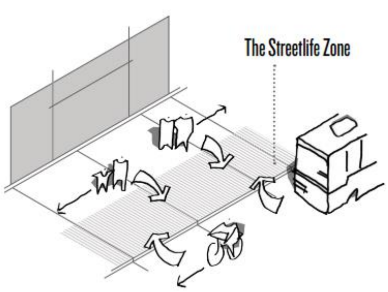
Street Interventions as Multipurpose Tools

The city should continue investigating the effects of streetscape interventions on quality-of-life issues included within the missions of various city departments, in addition to those falling directly under the purview of the planning department. Urban design choices made by the city should be thought of as multipurpose investments, considering their permanency and the effects those choices might have on the costs of providing a range of different services for many years following. Thus, these choices should be made with a more complete understanding of how they might affect a range of urban policy issues. These include, but are not limited to:

1. Public safety – Violent crimes as well as nuisance crimes
2. City finances – Increases in the tax base via improved property values.
3. Public health – Small modifications that may not require Environmental Impact Reviews may still have implications for the mental and physical health of nearby residents and visitors.

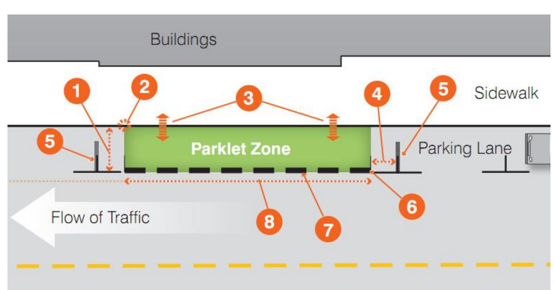
Informing the Better Market Street Initiative

The city is weighing three primary urban design options for the redesign of Market Street, hinging on the placement and type of bike infrastructure, sidewalk widths, and inclusion of "streetlife zones" within sidewalks if made wide enough. The similarity between parklets and streetlife zones as areas in the pedestrian throughway intended for seating, use, and activity, make the results found through this research concerning parklets particularly relevant to the city's decisions surrounding the inclusion and placement of streetlife zones along Market Street. This is despite their slight infrastructural differences: Parklets extend out from the sidewalk into parking spaces while streetlife zones are included within wide sidewalks near the curb.



[10]

vs.



[11]

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[10] Image source: bettermarketstreetsf.org/docs/FINAL_BMS_OUTREACH_BOARDS_8-10_Streetlife.pdf.

The three options being considered for Market Street are detailed below:

<u>Option 1:</u> Improves Market Street's curbside lane using striping, sharrows and other enhancements. Bicycles, transit and vehicles share the outside lanes, with transit only center lanes. The majority of the curb remains in the existing location.

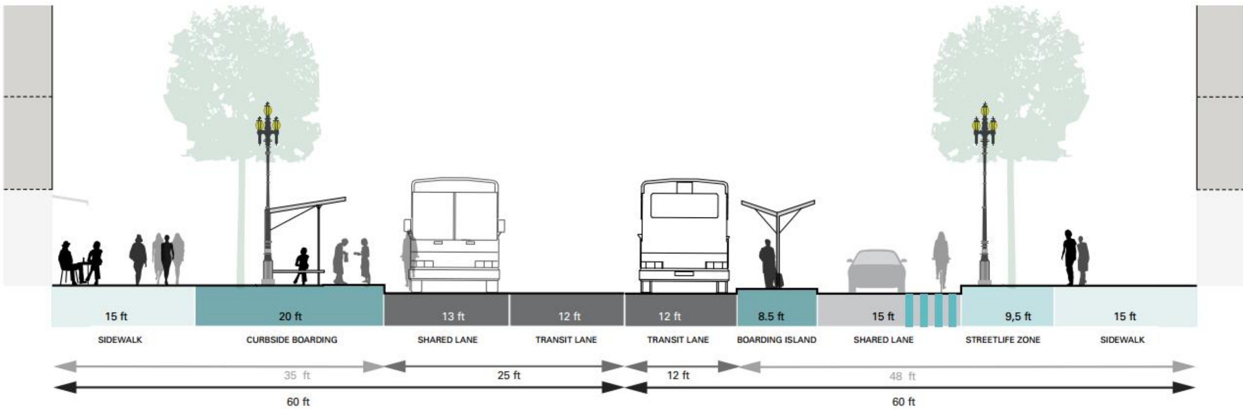

Figure Source: Better Market Street Initiative[12]

<u>Option 2:</u> A one-way cycletrack on Market Street in each direction from Steuart Street to Grant Street and 5th Street to Octavia Boulevard. Four lanes for transit and vehicles remain with transit only center lanes. The curb moves to accommodate the cycletrack, reducing the Streelife Zone area.

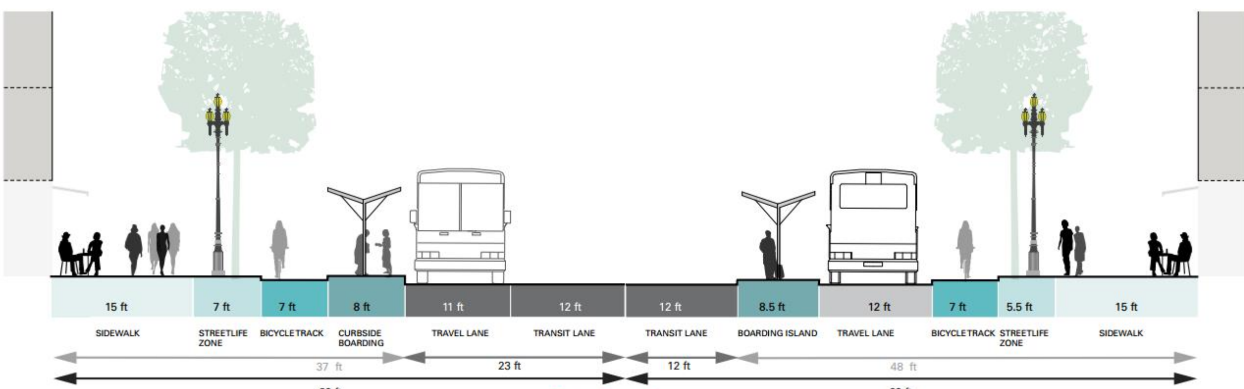

Figure Source: Better Market Street Initiative[13]

Option 3: A one-way, buffered cycletrack on Mission Street in each direction. All transit moves from Mission Street to Market Street and two lanes of vehicular traffic remain

[11] Image Source: greatergreaterwashington.org/image.cgi?src=201305/231002.png.
[12] www.bettermarketstreetsf.org/docs/2013-07-22_Option1.pdf
[13] www.bettermarketstreetsf.org/docs/2013-07-22_Option2.pdf

on Mission Street. Pedestrians benefit from street life improvements on both Market and Mission Streets.

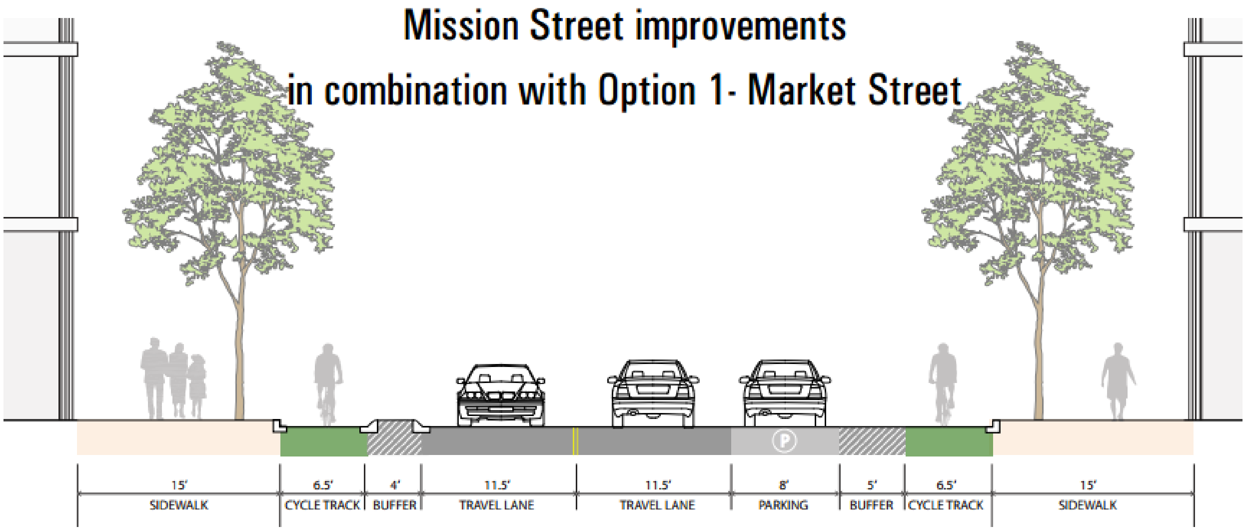

Figure Source: Source: Better Market Street Initiative[14]

Considering the results of the preceding crime incidence analysis, along with the companion analysis on the economic impact of bikelanes being completing simultaneously alongside this PAE, option 3 is likely to be the best urban design scenario for the revitalization of Market Street. One of the key barriers to redeveloping and enticing investment has been the lingering unseemliness of the area, particularly at night where there is little activity beyond a few people passing through, and those who are hanging around are largely homeless and/or intimidating to others. However, Market Street has seen a great amount of construction of new housing units in recent years and is expecting more. One of the goals of Market Street's new urban design should be to get those who will be living along the street out more, to use what could be a rather pleasant urban boulevard as an extension of their homes, a community living room. Activity could help draw out perhaps even more wary hotel guests and pull others to the area as well.

To bring activity to Market Street, sidewalk widths and thereby space for street life zones need to be maximized (as well as potentially programmed and better lit for safety). Considering parklets as a proxy for streetlife zones for the similar roles both can play within the streetscape, we can expect streetlife zones to potentially help reduce crimes of concern, particularly robbery and assault. Despite the stubborn propensity of crimes like these to continue along commercial corridors like Market Street, the right distribution of streetlife zones may be able to help the area match the city's declining rates of these key crime types.

At the same time, bikers need a safe corridor that runs from Embarcadero to Gough Street, meaning a

[14] http://www.bettermarketstreetsf.org/docs/2013-07-22_Option3.pdf

cycle track divided from traffic with bollards. Considering the forthcoming expansion of the Bay Area Bike Share, particularly in the areas surround the Market Street which is likely to attract more inexperienced riders and tourists unaccustomed to traffic patterns (not to mention trolley-car tracks), the need for safer infrastructure will only grow.

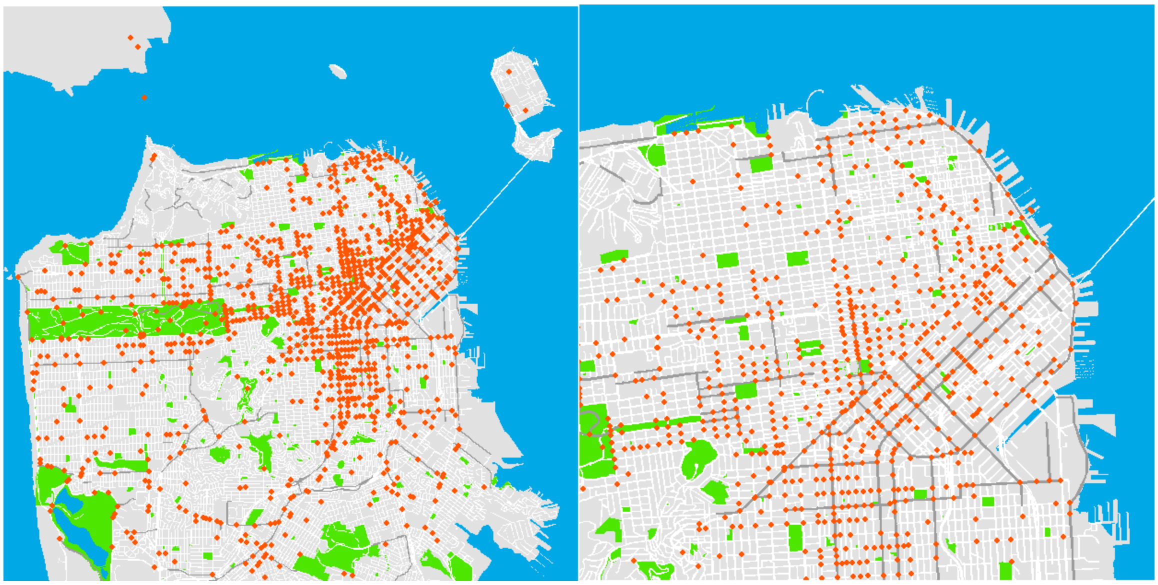

Figure 10: Bike accident locations in San Francisco 2007-2011 (at two scales) according to data maintained by California Highway Patrol, showing a propensity for accidents along corridors that would be well served by improved, safer bike infrastructure along Mission Street from Embarcadero to Gough.[15]

Yet increasing bike infrastructure and safety won't be possible on Market Street without reducing sidewalk widths and streetlife zones, which in turn might harm the area by providing inadequate space and attraction for activity to counter criminal incidents. Moving the cycle track to Mission Street so as to retain maximum pedestrian and activity areas on Market Street, as well as further shifting the focus of public transportation into Market Street, would be the right urban design choice for revitalizing Market Street – as well as SOMA – and can help keep investment into the area growing.

Improving Data Resources and Utilization

While this PAE did intend to use demonstrated test cases to yield meaningful results for the Planning Department, the act of running through this process was meant to uncover key problems and shortcomings that may be standing in the way of full utilization of the city's data for the purpose of data-driven impact evaluation. As various barriers or difficulties were encountered they were intentionally recorded, and have been fleshed out to inform the following recommendations to improve the city's data infrastructure and use. The broad categories of issues to be discussed are:

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[15] Incident data taken from abclocal.go.com/kgo/feature?section=resources/traffic&id=8418458.

1. Data Quality and Ownership
2. Transforming the Open Data Portal into a Data Community
3. Data Availability
4. Cross-Agency Data Utilization
5. Third-Party Data Utilization

Data Quality and Ownership

San Francisco's open data efforts and legislation have been pivotal in moving data out of unusable data formats and departmental silos and into machine-readable and transferable formats, and made available to the public as well as more easily accessible by other departments. However, there is no clear specific ownership or channel for feedback or clarification regarding those datasets. Data quality may be questionable and hard to use, yet it remains difficult to track down its source or creators to get answers to questions or make corrections. For example, in the writing of this PAE it was found that the SFMTA bikeway network GIS data available through the city's open data portal, seemingly the best and most authoritative resource of this information, was in fact not a well-formed data set. After finding potential irregularities in the dataset, it was determined that the year_installed field – a crucial piece of information – may not be correct for all segments. That field may have been used incorrectly, at times indicating when a block of bikelane had been repainted or maintained rather than installed, yet there was no clear process to confirm or correct this information.

Because this study was conducted in cooperation with the Planning Department, contact was possible with employees at the SFMTA who worked in areas closely related to the subject of this dataset. Even then it was difficult to find an authoritative source or responsible author who could ensure that the data was correct or know conclusively where or why errors or modifications to data inclusion were made.

For the general public, the open data platform is highly opaque. A general contact is available for a dataset (Ie. SFMTA Livable Streets) and a form is available that purports to send a message to a responsible party. Yet, the process doesn't provide confidence that messages will reach the correct party, or allow users tie those messages to specific elements of the dataset. There is no record of past queries or resolutions to questions raised.

Of course a government does not have unlimited time to devote to tending their open data sets, but if the goal of open data is data usability rather than mere data availability, a number of steps still need to be taken to guarantee this. If a city and its public are to best gain from the producing open datasets, there must be a better process to ensure a high level of data quality to be made available to developers or others trying to utilize this data. The reasons are twofold, both to make more utilization possible but also to ensure the quality and relevance of those resulting products – that the products created are not based on incorrect data that renders them inaccurate or worse, useless.

Transforming the Open Data Portal into an Open Data Community

The open data portal has the potential of not just acting as a platform to host, render, and distribute data sets produced by government departments and then uploaded, but also as a resource on the history and authorship of datasets and specific data within them. One could imagine tweaking the platform to be something more akin to GitHub - a platform for code and data sharing - that allows for constant open updating accompanied by information on the author as well as annotations and discussion. Currently datasets have a 'discuss' option but it is general and unused, without the capability to tie comments to particular pieces of the datasets or suggest amendments. This makes the discuss feature much less functional, and its disuse by the public likely is due to its lack of real relevance. Discussion and querying the author of a dataset should be collapsed into a single function.

If the platform allowed for the public to not just utilize data but also provided a streamlined way data could be appended, improved upon, or discussed by the public, the platform could crowdsource the maintenance of the data as well. Others may have run into similar data questions as those which have affected this PAE's research, and they may have found answers, or dead ends. As the platform exists now there is no way for disparate members of the public to build off of the work of others and construct a store of knowledge to complement and enhance datasets as made available by the government. Such a system would save those accessing the datasets time and improve the quality of their projects, while also saving government officials the time of having to field repeated inquiries concerning questions they may have addressed for others, as well as queries that might be best answered by civically inclined citizens rather than government officials themselves.

A redesign of the portal must take into account potential audiences for their data and how they would likely want to use the data, what data they would be interested in accessing, how they would likely want to communicate with the city and each other. Going into depth on the preferences of these groups lies beyond the scope of this PAE, but surveys, focus groups, and other traditional qualitative research methods should be used to gather this information before any major overhaul of the City's open data platform is commenced. Potential audiences include:

1. Civic analysts
2. Civic programmers
3. Academics
4. Government workers
5. For-profit – likely technology based – companies
6. Members of the press

Other cities have improved upon the basic open data portal in a number of ways that might serve as best practices to rebuild San Francisco's portal to make it more useful, dynamic, and active. Over 40 states and 45 cities and counties now have open data portals, but many have the same limited 'datadump' functionality that SF should now be improving.[16] Yet, there are some city portals that have gone beyond this first stage of open data portal evolution either in small details or in overall design. These include:

Chicago data.cityofchicago.org

Using the Socrata platform, Chicago's portal remains quite similar to SF's. However, the developer section is slightly more developed. Still immature, the developer section needs to be added to as well, but it provides an example of what kind of additional resources a portal should offer at an absolute minimum. Chicago does run a github page (https://github.com/Chicago) which is mildly active but not terribly so. Interestingly, Chicago is one of the few Socrata-based portals to have pushed the R-Socrata package to more easily import city data into R, the most commonly used open source statistical analysis program.

New York City nycopendata.socrata.com

New York City makes its open data portal appear dynamic and active, key features for attracting more use. The portal shares data visualizations and utilizations of city data by third parties – developers, the media, etc. – on the main page. Also features an active twitter account. The twitter feed serves both to create a more active portal even when no new data sets are being uploaded, as well as highlighting ways the data can and is being used. Publicizing these examples likely has the power of inspiring other analyses and uses of the data, while also providing the suppliers/uploaders of the data the feeling that their work to contribute datasets isn't wasted time and that the data is in fact being utilized. Hosting links and descriptions of others' work appears to be a vital element of creating the virtuous cycle of open data supply and utilization. NYC has a thorough developer portal that includes the standard Socrata API offerings as well hosting NYC-specifically developed APIs. (https://developer.cityofnewyork.us/api).

The city has a github, which is perhaps surprisingly not active. One possible reason for this may be the fact that the city has so many points of connection and interaction for developers that their attention has been thinned and directed through a different channel. As SF moves forward in further developing its own portal, conversation with NYCDoITT might be very useful in identifying which way to best interact with developers so the city can concentrate their attention and activity through one channel that is easier to maintain than across many different ones.

[16] A full list of government entities with open data portals can be found at www.data.gov/open-gov.

San Mateo data.smcgov.org

Like some other cities, while San Mateo uses the same Socrata platform, their website emphasizes data categories (Ie. Health, Business, Public Safety) over data types (Dataset Chart, Map) in presentation and navigation, which may present a more intuitive way for users to browse rather than searching or browsing by data type. San Mateo's open data site also includes other features like an open checkbook which tracks all city expenditures over $5,000 (a feature which is available through a small number of other cities like Las Vegas and Denver), and a performance dashboard for the city's Shared Vision 2025. San Mateo's open data site felt comprehensive, offering different kinds of data and presentations that would likely serve a number of different user-types with varying needs and capacities.

Boston data.cityofboston.gov

Includes the most comprehensive enterprise GIS system of any US city to present as a component of its larger open data portal (though some cities like Palo Alto also have open GIS platforms). Should SF choose to enable layering of multiple GIS layers at once rather than the one-at-a-time visualization possible through the current Socrata platform, Boston's site may be a good model by which to further develop the GIS side of SF's data offerings.

Kansas City, MO data.kcmo.org

The platform's 'data ideas' page allows users to vote on which data sets they'd most want to utilize (http://www.allourideas.org/kcmo/) . In its current form it has garnered a few thousand votes, but the resulting statistics might not be particularly useful. However, it could be a model for incorporating an interactive voting mechanism into the SF portal to either prioritize where departments should be spending their time to release new datasets, or concentrate their efforts in updating, improving, or expanding on existing ones.

Asheville, NC opendatacatalog.ashevillenc.gov

Hierarchically prioritizes submission of datasets from visitors to the site or third parties, placing a button for submission at the center of the front page. Could serve as a model for design should the SF portal choose to try and elicit more data contributors from outside government departments and try to develop the portal as more of a data and analysis exchange, rather than a one-way government data upload.

Austin data.austintexas.gov

Simply in terms of visual presentation, Austin's portal features a more visible app showcase than other portals, and can serve as an example to revise SF's app showcase (which currently is largely hidden, has an appearance of being 'off-site' in terms of a design change, and is repetitious within categories which actually gives an impression of having too few apps).

Houston data.ohouston.org

Houston's portal presents datasets primarily in terms of the organization (Ie. level of government) as well as group (Ie. subject area) rather than in terms of their data type (which is still displayed but secondary). Such an organization is logical, and presents an easier way to browse datasets in addition to search. Searching tends to be helpful if the user knows the exact dataset they need, but otherwise can often be difficult to use in terms of balancing keyword specificity vs. broadness. Additionally, hierarchizing by organization or group is likely to allow for a better browsing experience that allows users to find datasets they didn't know exist (and thus wouldn't think to search for) but are likely to be useful to them (since they're looking at datasets produced by the same department already).

Las Vegas opendata.lasvegasnevada.gov

While the city still uses the basic Socrata interface, it has built a graphical initial front page that highlights various filtered views of the data sets (like maps or charts only) as well as apps and the city's open checkbook. While such an approach doesn't add any significant new functionality to the portal, it does present a more user-friendly interface that is a little simpler and may be less overwhelming for a first-time user. Experienced users can still get to the data in a click through the 'raw data sets' link, but a graphical front page might have the capacity of bringing in and retaining a larger and more diverse audience.

Data Availability

Within the original scope of this PAE there was the desire and plan to perform a hedonistic analysis of property value changes to test for the possibility of value added by the construction of bike lanes. There are a number of existing studies that have hypothesized that either for reasons of direct use-value (intent to use bikelanes for commuting or pleasure) or for the impression of value-added to the neighborhood (that bikelanes may attract desirable neighbors or visitors, or simply add to a positive image of the neighborhood), property values may experience a small bump from the construction of bikelanes nearby. Yet these studies have mostly focused on bike paths rather than bike lanes, or are more general studies rather than thorough econometric analyses.

The hypothesis mentioned above was to be tested by analyzing assessor's data using one of two methods:

1. *Regression Method:* Find change in price, from a past sale in year X in addition to a more recent sale in year Y. Find the distance between a parcel and the closest point of a bikelane in year X and that distance in year Y. Only include those parcels which have experienced a price, recording whether or not there was also a change in distance to bikelane from year X to year Y, and the magnitude of that change. Regress change in value on change in distance, including demographic information or changes as controlling variables and fixed effects.
2. *Clustering Method:* Find change in price, from a past sale in year X in addition to a more recent sale in year Y. Divide these parcels into 5 quintiles, ranked by the change in price. Run clustering analysis to see if properties in the top quintile of value change fall within buffers of newly constructed bikelanes more often than would be expected by a random distribution generated using a Monte Carlo method.

However, both the database as provided by the planning department as well as the assessor rolls available on the open data portal don't include any previous price information – a needed piece of data to study value change. While that field exists in the planning department records, it only has a null value. It is thought that this information is available in some server, or on someone's computer, but this was not obvious or attainable in time for this research.

Assessors rolls from 2008-2013 can be found on the open data portal, but these also contain no information on prior prices. Considering services such as Zillow allow users to search for prices of properties from past sales, it would be plausible to consider that this data could be included on the open data portal. Even if one were to attempt analysis based on assessed value in lieu of information on previous price sold, the open data records only go back to 2008, meaning that without the inclusion of previous assessment value, analysis can only be performed for change in value for properties that were assessed twice between 2008 and 2013. This is highly limiting.

If the city choses to keep data on prior prices off of the open data platform (though it is the recommendation of this author that better records be made available) it should be more easily shared between departments. Likely, this data is held by a number of departments not to mention the assessors' office but the lack of access in the planning department is indicative of the fact that currently data cannot flow easily nor passively from department to department. One of the properties of the new Chief Data Officer should be helping data move not only from within government out to the public, but also within government from department to department.

Cross-Agency Data Utilization

While this framework was developed in partnership with the planning department, in both its construction and presentation it is intended to be easily portable to other departments, and ideally creates a reason for increased cross-agency collaboration and data sharing – elements the previous recommendation touched upon. Most departments maintain data sets that through analysis would be highly relevant to other departments to work more efficiently and empirically. By building this framework this study intends to contribute a store of institutional knowledge to inform departments of its analytical approach as well as the difficulties encountered along the way and how they were resolved, or not. The aim is to lower the initial learning curve to building this methodology to across-the-board, small-scale policy evaluation and make the understandings that may result achievable and attainable.

After conversations with officials in the Office of Economic and Workforce Development (OEWD), the Invest in Neighborhoods Program (IIN), an assistance program to revitalize 25 neighborhood commercial districts, was considered a perfect candidate for evaluation under this PAE's framework. Elements of the program are highly localized along corridors and the city runs a large number of different interventions simultaneously. The framework presented here could provide an empirical basis to tease out the effects of these interventions across a number of dimensions and give a better idea of what's working, where it's working, and how to attain the best societal returns on the investments the city is making. Due to both time restraints as well as agreement from the OEWD it was decided not to pursue any analysis of the IIN Program here, but rather lay out thoughts as guidance should the department choose to execute an impact analysis following this model.

A number of interventions used within the IIN Program could be tested easily within this impact evaluation methodology. Particularly, this framework can help identify interventions that affect not only the immediate partner (Ie. a business receiving a loan) as is often monitored, but also may have larger effects on the larger NCD or neighborhood area. Interventions well suited for study via this framework include:

1. SF Shines - Facade Improvement Grant Program
2. Business Loan Programs
3. Biz Fit SF
4. Plaza Program
5. Jobs Squad

In order to utilize our framework each of these interventions need to be recorded as they are occurring in a machine-readable format and geocoded. This can be achieved either by plotting each point in a geodatabse or building an excel table with an address field that can then be geocoded via ArcMAP. The former approach is preferable and more immediately usable, though the latter may be faster and easier to do with less technical capacity. Maintaining these datasets as independent variables to then test for economic, public safety, and other effects is vital to understanding if these programs have statistically significant impacts on the larger commercial districts that these small-scale interventions are intended to improve as a whole.

Third Party Data Utilization

The analysis of parklets and bikelanes has been by no means exhaustive and has primarily utilized existing open data resources for the purpose of proof-testing existing city data infrastructure for analysis. However while doing this work, various instances have emerged wherein third party data may be of high usefulness to the city, and suggest that these resources are pursued in the future:

Skyhook Wireless

Providing 'geospatial insights', the company provides data on the activity level of smartphones and wi-fi devices on an hourly basis, corresponding to 100m by 100m tiles or 25m by 25m tiles where available. Following is an example of this data for San Francisco, showing relative activity levels for February 23:

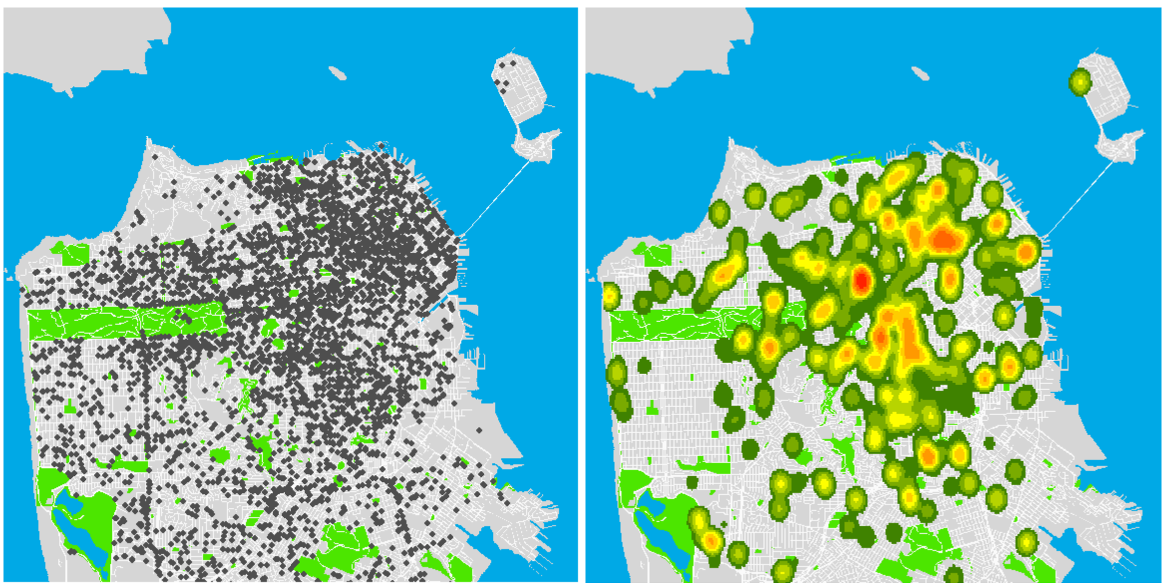


Figure 11: Maps showing example data from Skyhook GI. The map on the left shows the centroid points of tiles simply to show the distribution of that data, with no information included on actual activity levels. The map on the right shows a heat map of actual activity levels as derived from data related to those points.

This data could be used to track changes in use and activity in streets and neighborhoods within SF by comparing data from one time period to another. Such a data source could either be regressed against, to understand what impact city policies or urban design programs may have had in the human use and occupation of an area, or used as a variable to be controlled for when regressing against another dependent variable to indicate behavior change, in order to capture underlying changes occurring within a neighborhood.

There remain a number of caveats with using this data. While these cautions present a need for careful analysis, they do not preclude the use of skyhook data for the types of analyses discussed above. Firstly, the tile size, even at the more granular level of 25m is still large enough that it would be impossible to differentiate activity in the street versus activity occurring in buildings. Depending on whether the neighborhood of interest is primarily residential or commercial in nature, ACS population data or a data source on employment levels could be used to normalize the data to adjust for occupancy of buildings rather than activity on the streets.

Additionally, because the data is derived from signals from smartphones and other wi-fi devices serving as a proxy for human occupation, there may be a bias towards catching the activity of younger people more likely to carry and use those devices and not registering older individuals as well. Since there are few areas of SF with hugely different age breakdowns as compared to other areas of the City, this bias should not constitute a great worry but should still be kept in mind. Lastly, there may be some issues of data reliability in areas with a large number of tall buildings like in the finance district, since this may affect the geographic registration of activity. An exact correcting method may be quite difficult, but may not prove needed since much of the usefulness of this data source may be in the majority of the city where buildings are not particularly tall.

Bay Area Bike Share

The Bay Area Bike Share is in its infancy and still remains geographically limited, oriented primarily towards tourists and last- or first- mile trips of technology workers commuting between SF, Redwood City, Mountain View, Palo Alto, and San Jose.

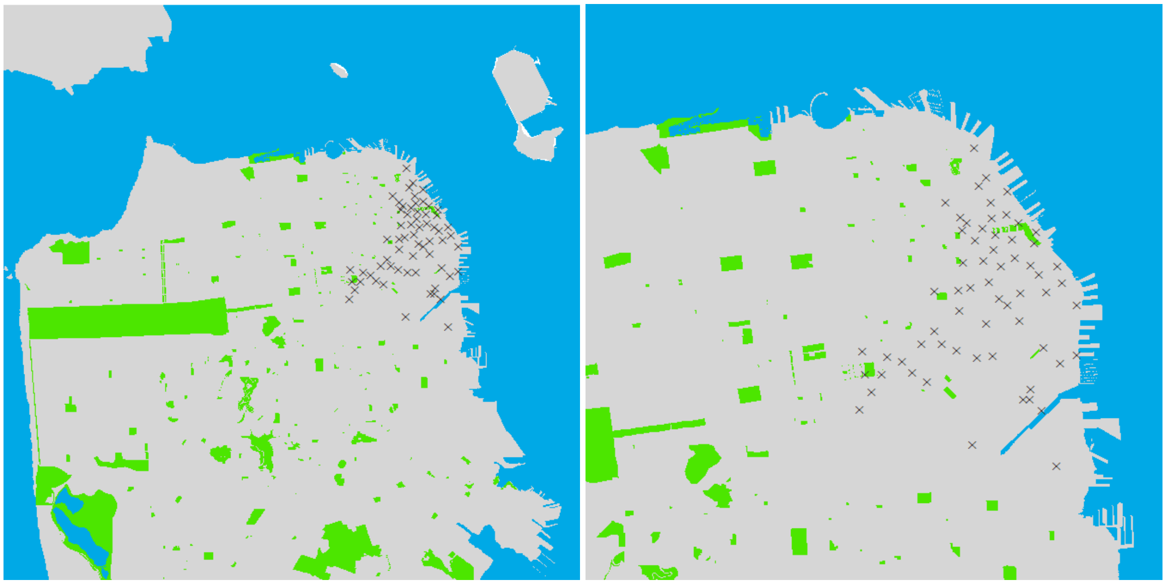


Figure 12: Maps showing limited coverage area of the Bay Area Bike Share as it currently exists as of spring 2014 (at 2 scales).

However, if the program expands its range and ridership, point-to-point data on commonly taken trips could inform which bikelanes are being utilized, how and when they are being used, as well as corridors that may be more needing of bike infrastructure due to high levels of use, yet have not been targeted for bike infrastructure improvements.[17] Currently, point-to-point data is available and could be used to infer the range of routes likely to be taken often through shortest-path network analysis. While GPS tracking of the bikes is not yet operational, the function has been built into the system and once operational could provide exact information on commonly taken routes and other cross-departmentally useful statistics.[18]

A number of cities already release their bikeshare ride history data in some open data format. Those cases are included here to serve as examples of what kind of data might be made available by BABS in the future, or otherwise might be requested from them if this was not already their intention:

Washington DC http://www.capitalbikeshare.com/trip-history-data
Data Available: Duration of trip, start date and time, end date and time, starting station name and number, ending station name and number, ID number of bike used for the trip, whether user was a Registered (annual or monthly) or Casual (1 to 5 day) member.

[17] This idea has been developed from a presentation given by Emily Stapleton of Hubway, Boston's bike share system on March 4, 2014. To clarify, Hubway has not yet implemented this kind of analysis of bikelanes, but the idea was mentioned in this presentation.
[18] Information on potential GPS tracking is available at bayareabikeshare.com/faq.

Chicago https://divvybikes.com/datachallenge

Data Available: Trip start day and time. trip end day and time, trip start station, trip end station, rider type (member or 24-hour pass user), if a member trip it will also include member's gender and year of birth.

Boston http://hubwaydatachallenge.org/trip-history-data

Data Available: duration of trip, start date and time, end date and time, starting station name and number, ending station name and number, ID number of bike used for the trip, whether user was an annual or casual (1 or 3 day) member, zip code (for annual members only), year in which annual members were born, and gender (for annual members only). Also offers a number of other related datasets to support analytical efforts.

Office of Analytics and Research

Ideally, the city would create the position of an Officer of Analytics and Research to work with the Chief Data Officer. The Officer of A&R could head an office staffed through of a system of year-long or summer fellowships so as to not add a funding requirement to the city. The primary purpose of this office would be to provide analytical power to departments citywide, while coordinating data utilization so as to create a united point of interaction with the CDO. The departmental data coordinators called for by the city's amended open data legislation could also be departmental point people for the Officer of A&R, formulating requests as well as improving and creating data resources to be utilized by a particular analysis as well as for general use.

It is important to create a resource and focus for analysis that sits external to any particular department, to allow the opportunity for analysis to serve one or more departmental mandates simultaneously, as well as generate awareness of and access to data resources held by one department but useful and sharable to another. New York City and Chicago are two examples of cities which have developed two different models of such an office, and both could serve as potential examples for San Francisco:

New York City www.nyc.gov/html/analytics/html/home/home.shtml

The City's Mayor's Office of Data Analytics (MODA) follows a more 'traditional' approach to incorporating cross-departmental data analytics capacity into City government. Established via an executive order and working with small staff of six, the office is responsible both for solving service-delivery issues for various departments using data-driven methods, as well as facilitating data sharing both within and outside of government by building a citywide data platform as well as implementing the City's Open Data Law. Should SF consider building an analytical capacity, MODA would serve as a very appropriate model, particularly if this would be similarly cast as an extension of the CDO role.

Chicago dssg.io

While not strictly falling under city leadership, the Data Science for Social Good summer fellowship is run out of the University of Chicago and fellows work on a large number of data science projects with city departments, as well as federal agencies and non-profits. The program accepts 36 undergraduate and graduate students each year from 'quantitative and computational fields' who apply themselves to solving data-centric problems. Such a program brings in a large amount of talent and applies it to a variety of problems, a resource of innovative thought and energy for the city. San Francisco could consider working with a City or Bay Area university to set up a similar program to recruit talent, with the CDO acting as a liaison between the City and this external body.

The recommendations presented thus far would likely be best achieved through the creation of an officer and/or office of analysis and research by centralizing activities and knowledge concerning data utilization across departments. However even without the explicit creation of this office, the preceding recommendations can still be implemented and serve as general suggestions towards analytical activities.

Appendices

Public Safety Impact Analysis

Technical Workflow for producing study area crime counts for analysis

1. SFPD Reported Incidents downloaded from http://apps.sfgov.org/datafiles/index.php?dir=Police&by=name&order=asc in .csv format
2. In ArcMap, create new document using Projected Coordinate System "NAD_1983_StatePlane_California_III_FIPS_0403_Feet"
3. File>Add Data>Add XY Data for each year
4. Under Coordinate System of Input Coordinates go to Edit > Geographic Coordinate Systems > North America > "NAD_1983"
5. For each layer, select layer, then Arc Toolbox > Data Management Tools > Projections and Transformation > Feature > Project, making sure to set Output Coordinate System to "NAD_1983_StatePlane_California_III_FIPS_0403_Feet"
6. Optionally, create new fields Xpr and Ypr within the attribute tables and recalculate their values as "NAD_1983_StatePlane_California_III_FIPS_0403_Feet" so that data does not need to be reprojected if incident data is reused elsewhere.
7. Add a layer of parklets, either imported from the KML file currently available on the SF pavement to parks program website, or using the refined shapefile currently under development. If using the public KML file, a new columns should be added and populated with the year installed.
8. Buffer the parklets layer at 50ft and 100ft radiuses (distance), renaming the year installed column in one or both so that both sets of buffers can be spatially joined to the crime data tables without one set of install years erasing the other. Remove extraneous columns from buffer layers (only preserving undeletable columns and install-date columns).
9. Spatially join each year of crime data (as the target layer) with each buffer layer and export as csv files.
10. Import each csv as sheets in a single workbook.
11. Add count and analysis sheets to count the number of incidents in each year of the crime types of interest that occur within the buffered study areas and the city as a whole.

Parklet and Crime Incidence Ripley's K R-script and Plots

By Year. K(i,j) where i=parket, j=crimes [robbery,assault,vandalism]
Normal (14,000ft) range maps on the left are complimented by short-range maps (500ft) to show detail

Example R-script

Note: requires installation of packages maptools, spatstat, sp, and rgeos
Adapted from the Vegetation and Landscape Ecology Lab's bivariate Ripley's K with Spatstat script available at http://www.bio.sdsu.edu/Pub/franklin/landscape/index.php. Important to note the inclusion of the cut() function to convert ppp into a multi-type point pattern ppp2.

```
library(maptools)
library(spatstat)
library(sp)

sdata =
readShapePoints("C:/Users/Benj/Documents/PAE/bivariate_ripleys_k/agg2012_merge.shp")
range = 0:14000
nsim = 10
points = coordinates(sdata)
win = ripras(points)
ppp = as.ppp(points, win)
ppp = setmarks(ppp, sdata$SymbolID == "0")
ppp2<-cut(ppp, breaks=2)

kmult = envelope(ppp2, Kcross, i=TRUE, j=FALSE, r=range,
simulate=expression(rlabel(ppp2)))
lmult = sqrt(kmult / pi) - range
ylim = c(min(lmult$obs, lmult$hi, lmult$lo, na.rm=TRUE), max(lmult$obs, lmult$hi,
lmult$lo, na.rm=TRUE))

plot(range, lmult$obs, type="l", xlab="Distance (ft)", main="Ripley's K (Parklets/Crime)
2012", ylab="Estimated L", xlim=c(0,14000), ylim=ylim)
lines (range, lmult$hi, lty=2)
lines (range, lmult$lo, lty=2)
```

Graphical Explanation of Clustering vs. Dispersion in a Ripley's K Graph

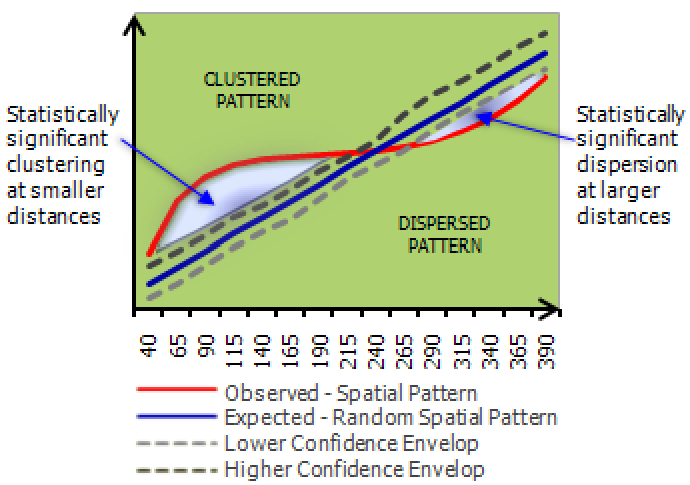
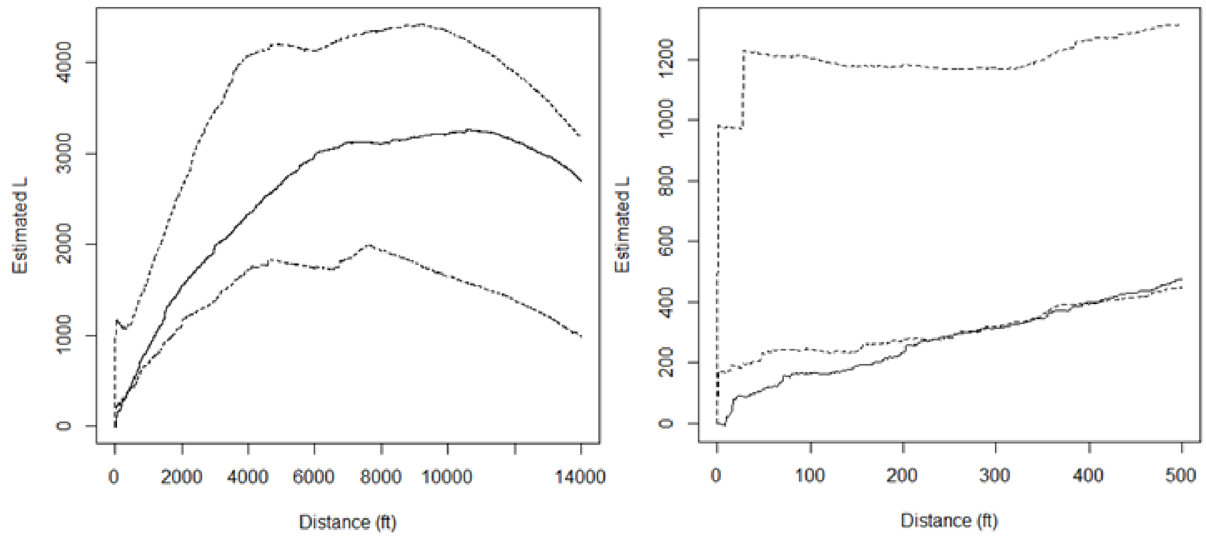


Figure source which also includes additional explanation:
http://resources.esri.com/help/9.3/arcgisdesktop/com/gp_toolref/spatial_statistics_tools/how_multi_distance_spatial_cluster_analysis_colon_ripley_s_k_function_spatial_statistics_works.htm

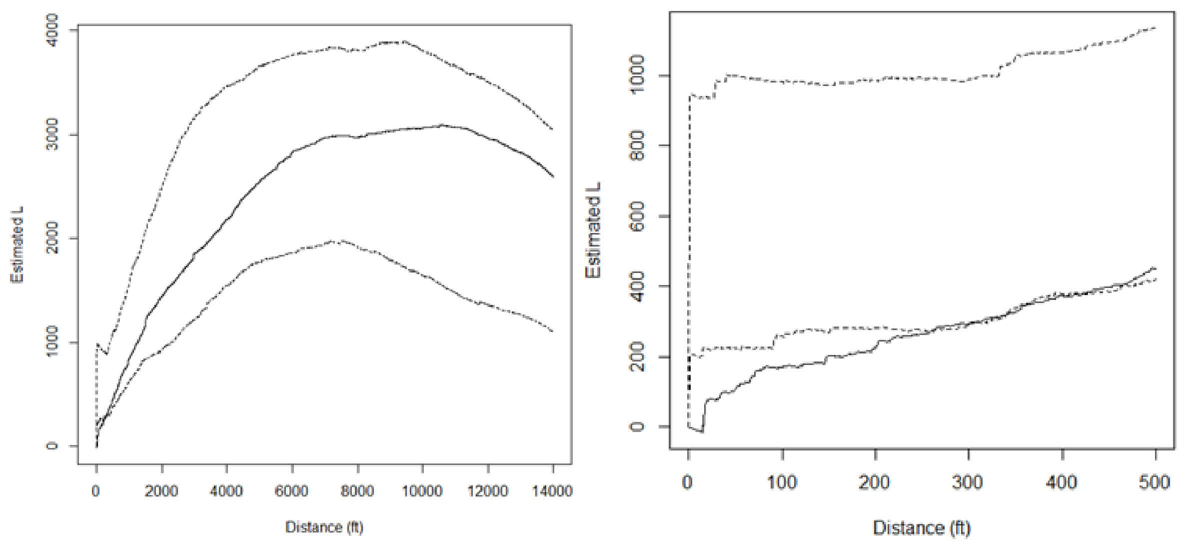
Individual Bivariate Ripley's K Graphs

For high crime aggregate, by year shown at full 14,000ft extent and in detail up to 500ft. Dotted lines indicate expected minimum and maximum bounds.

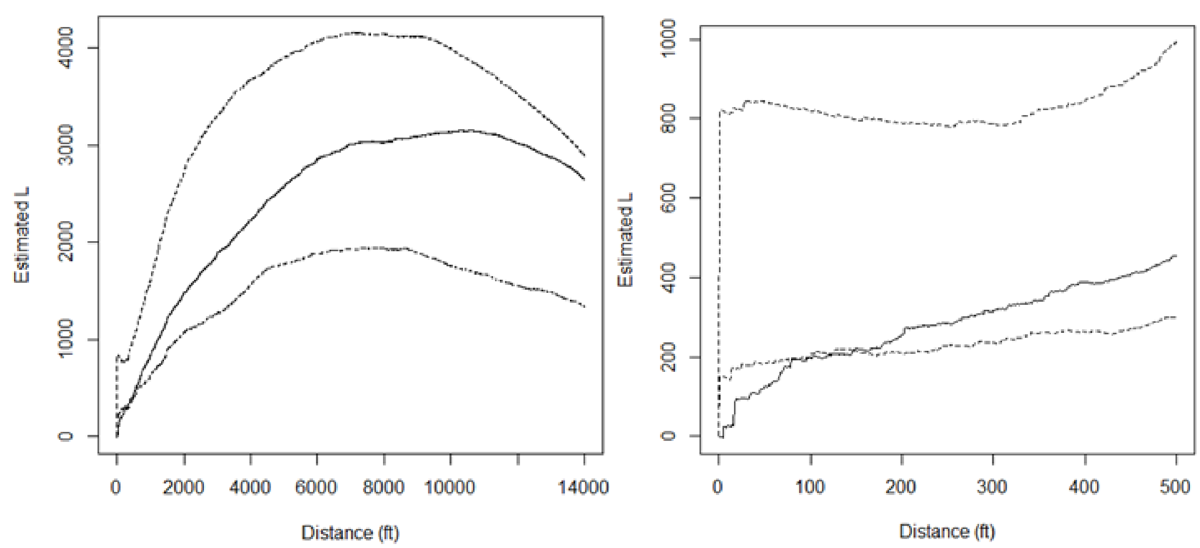
2007



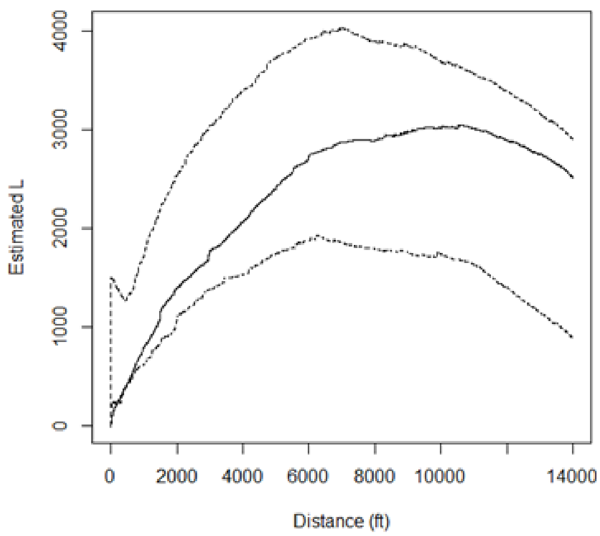
2008

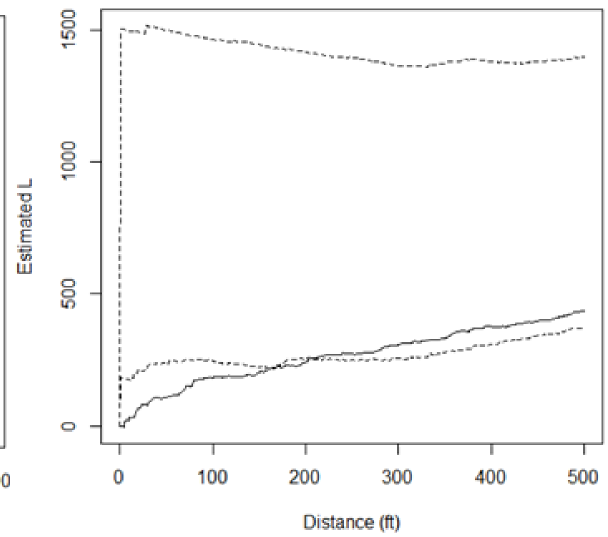


2009

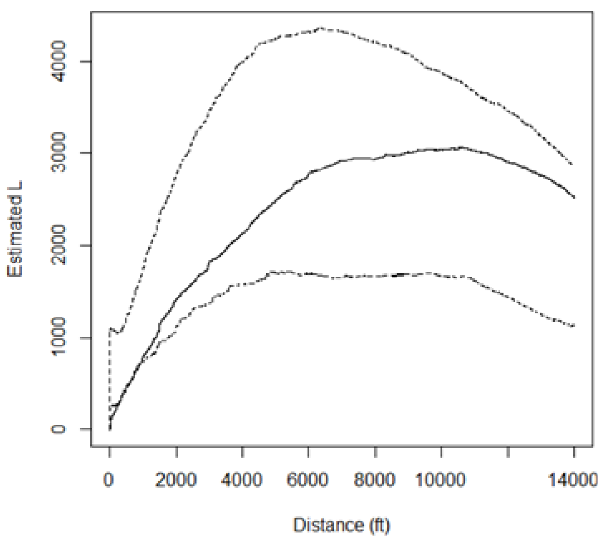


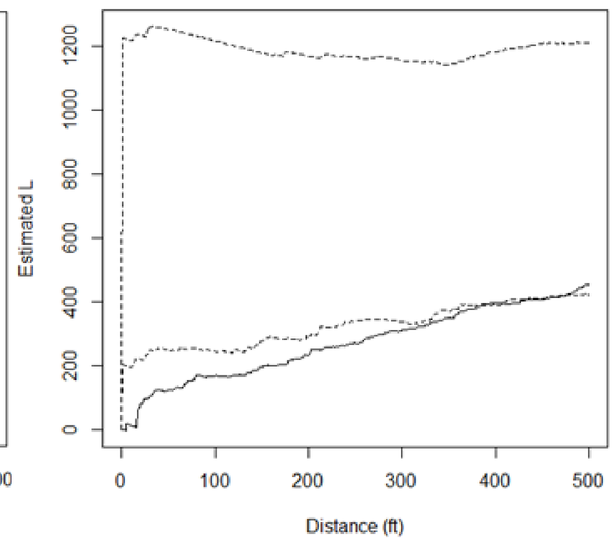
2010



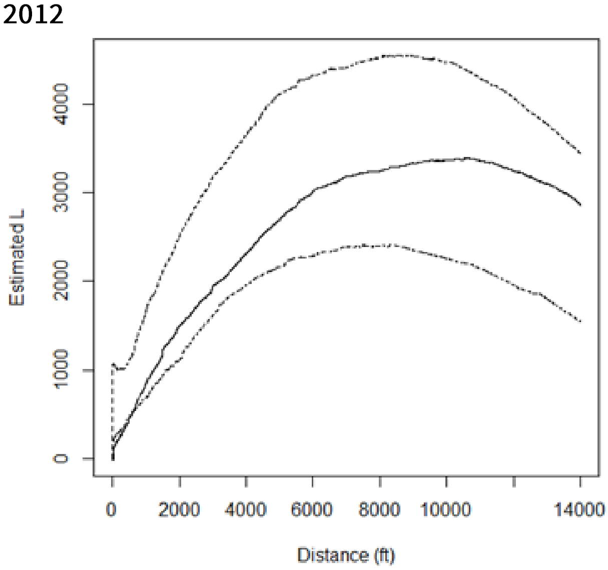


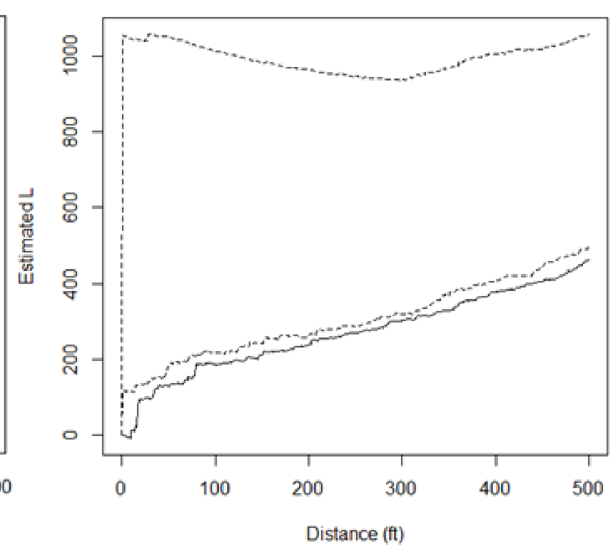
2011



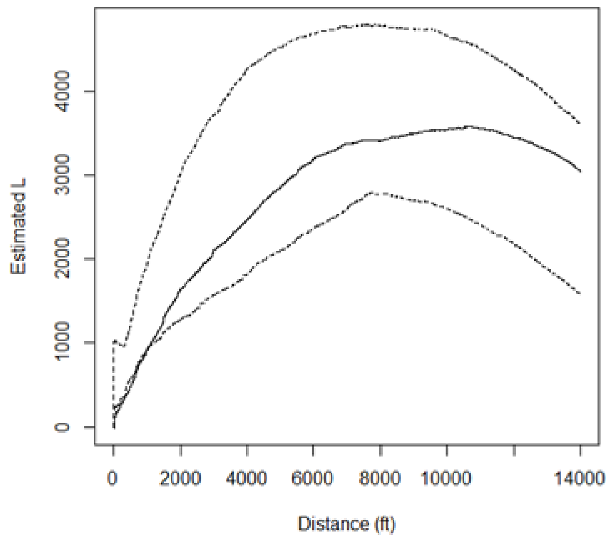


2012

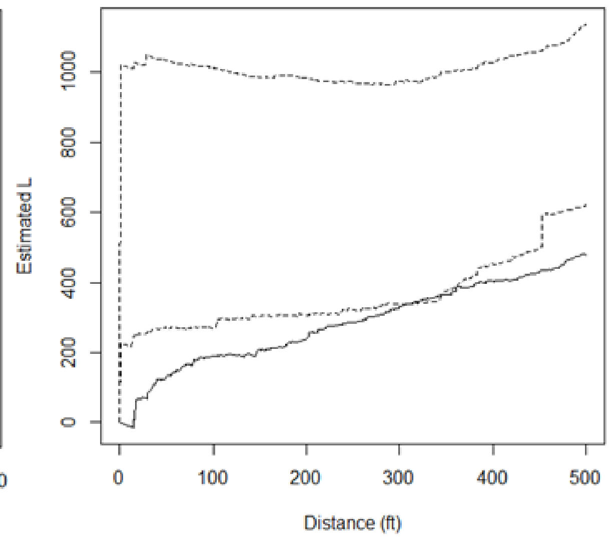




2013



Estimated L
0
1000
2000
3000
4000
0
2000
4000
6000
8000
10000
14000
Distance (ft)



Estimated L
0
200
400
600
800
1000
0
100
200
300
400
500
Distance (ft)

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Acknowledgements

The writing of this PAE was greatly aided by the help, time and effort of a number of individuals from the government of the City and County of San Francisco, Harvard University, and others. I would like to extend a thanks particularly to Neil Hrushowy and Julie Wilson, in addition to Sumeeta Srinivasan, Andy Thornley, Rodney Fung, Gail Stein, and Farshid Alizadeh for their time, ideas, and assistance at various points of completion of this PAE.