Spatial Methods for Quantifying Crime Displacement after a Hot-Spot Intervention

Timothy A. Thomas

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Committee:

Kyle Crowder

Stewart Tolnay

Robert Crutchfield

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Abstract

Spatial Methods for Quantifying Crime Displacement after a Hot-Spot Intervention

Timothy A. Thomas

Chair of the Supervisory Committee:
Dr. Kyle Crowder, PhD
Department of Sociology

Research shows that urban crime concentrates in specific areas, leading scholars and practitioners to combine criminological theory and spatial methods to help inform policies and strategies on how to address this phenomenon. Outside of measuring the success of an intervention in a focal area, there is concern that the operation will simply move crime to nearby areas. Alternatively, some scholars argue that the positive benefits of the operation spread into nearby areas, reducing crime and improving the neighborhood. This study attempts to address previous methodological concerns by measuring the geographic extent to which crime might displace as well as the lasting impact of an operation. Results suggest that crime may move further from a focal area than previously expected, the positive effects of an operation may not last, and there may be unintended effects leading to neighborhood change.

Introduction

Research has shown that urban crime concentrates in specific places across the city landscape (P. L. Brantingham and P. J. Brantingham 1981; Eck, Clarke, and Guerette 2007; Pease and Group 1998; Sherman, Gartin, and Buerger 1989; Weisburd et al. 2010). In Seattle, WA, from 1989 to 2002, Weisburd et al. (2010) found that 50% of crime was committed in 4.5% of the city's street segments.[1] In Minneapolis, MN, Sherman et al. (1989) conducted a similar analysis on calls for service and found that all robberies occurred at 2.2% of the city's street addresses and intersections over a 1-year period. Similarly, all gun assaults in Boston over a 29-year period, between 1980 and 2008, occurred in just 11.5% of the city's street segments, and about three-quarters occurred in only 4.8% of street segments (Braga, Papachristos, and Hureau 2010). Based on the evidence that crime concentrates, researchers suggest that police can maximize resources and effectiveness by utilizing strategies that focus on crime hot-spots.

While there is good evidence that focused policing can reduce crime in a target area (B. Taylor, Koper, and Woods 2010; Weisburd et al. 2010), there is some debate about the broader impact that this approach may have on surrounding areas. Eck (1993) claims that, after a place-specific intervention, crime might be displaced to nearby areas as offenders try to avoid the crime prevention focal area. A counter to the displacement argument is the idea of "diffusion of benefit", where the beneficial influence of an intervention spreads beyond the target area and reduces crime in surrounding areas (Bowers and Johnson 2003; Clarke and Weisburd 1994; Ratcliffe and Breen 2011; Weisburd et al. 2006).

To date, research on the topic of crime displacement and the diffusion of benefit has been sparse and somewhat inconclusive, mostly because of the dearth of good data (Guerette and Bowers 2009) and limitations to available spatial analytic methods (Bowers and Johnson 2003; Clarke and Eck 2005). Many studies on location-specific interventions have centered solely on the success of the intervention at the target area while ignoring displacement of crime or diffusion of benefit (Guerette and Bowers 2009). Past studies examining crime displacement sometimes use inadequate methods to determine the extent to which displacement occurs because their analysis precedes the development of reliable measures of displacement (Guerette and Bowers 2009).

The purpose of this paper is to test whether or not crime displaces to nearby areas or whether the diffusion of crime control benefits occur after a 2010 problem-oriented policing (POP) intervention in Seattle, WA. Using a detailed crime report dataset from the Seattle Police Department (SPD), this study analyzes varying buffer sizes to help understand how far crime may move after an intervention as well as determine the enduring effects of the operation. I conclude with a brief discussion of future research and possible latent, unintended effects of these operations on neighborhoods.

Crime Concentration and New Strategies

[1] To maintain anonymity, crime report locations were stripped of the last two digits of their addresses and geocoded either in the middle of a street or at an intersection of two roads near where the event occurred (e.g., 14XX Main Street).

Because crime is concentrated in a limited number of locations, research recommends focusing police resources in those areas, rather than distributing them throughout the city, to have the largest impact on crime (Bowers and Johnson 2003; Braga 2005). Several strategies exist to address this issue, each with varying results. The Koper Curve, which calls for highly visible police patrols in high-crime areas for random 15-minute intervals throughout the day, has shown to reduce criminal activity (Koper 1995). A more involved approach, typically deployed in higher-crime areas, called the Problem Oriented Policing (POP) strategy. In more difficult areas, POP strategies identify underlying social and physical problems as well as specific types of crime that might be the root cause for an area's troubles. POP approaches not only include arresting criminal offenders, but also cleaning up physical disorder or altering parts of the built environment that might promote criminal activity (Bowers et al. 2011). These efforts typically employ a coalition of actors to address crime issues, such as local police, residents and businesses in the area as well as local and sometimes federal government departments (Braga and Weisburd 2011).

Analysis of interventions in hot-spot crime areas shows definite benefits within their focused areas. A review of 13 studies, with 19 observations of hot-spot crime interventions, showed that 13 (84%) of the 19 interventions saw a reduction in crime within the focal area (Guerette and Bowers 2009). One study on a POP intervention in Lowell, MA, saw a 20% reduction in calls for service, around 30% reduction in serious crimes and over 40% reduction in robberies within the area of focus, relative to changes in a control group of hot spots in nearby neighborhoods (Braga and Bond 2008). After a POP intervention in Jersey City, NJ, drug crimes fell from an average of 1.3 events per month to .14, with lower levels in following months. Prostitution also fell by 70%, staying consistently low in following months (Weisburd et al. 2006).

Displacement of Crime and Diffusion of Crime Control Benefit

The success of an intervention hinges not only on the reduction of crime in the focal area, but also preventing crime from spreading to nearby areas, a great threat to place-based interventions and a common concern of most police forces (Ratcliffe and Breen 2011). On the one hand, crime displacement may occur after an intervention disrupts criminal behavior in a hot-spot (Weisburd 2006). Previous literature suggests that displacement is theoretically "inevitable" if interventions do not address the root cause of criminal activities, or the availability of offender targets (Gabor 1990; Bar and Pease 1990; Eck 1993; Clarke and Weisburd 1994). This is based on the assumption that situational crime prevention methods do not affect an offender's motivation to commit crime elsewhere (Hamilton-Smith and Tilley 2002).

On the other hand, some researchers argue that the reduction in crime in the focal area has a positive ripple effect to nearby areas (Ratcliffe 2002; Bowers and Johnson 2003; Weisburd et al. 2006; Weisburd et al. 2010; Ratcliffe and Breen 2011). Potential crime reduction in nearby areas makes place-based interventions attractive (Weisburd et al. 2006). One explanation for how this operates is that while the focal area receives an increase in police patrols, the reach of the intervention is unknown to offenders, causing them to reconsider criminal activity in nearby areas due to the fear of apprehension. This potentially enduring "free bonus" of police crackdowns in which the deterrence carries over into nearby areas (Clarke and Weisburd 1994; Weisburd et al. 2006) is known as a diffusion of crime control benefit (Clarke and Weisburd 1994; Eck and Weisburd 1995; Weisburd et al. 2004; Braga and Bond 2008; Braga and Weisburd 2011). Both the lack of knowledge about an operation's timeline and spatial reach could deter offenders from committing crime both within and outside the area of focus (Weisburd et al. 2006).

Three main theoretical frameworks work together to help us understand why the diffusion of crime control benefits would extend beyond the area of focus (Bowers et al. 2011; Guerette and Bowers 2009; Ratcliffe and Breen 2011). The first, *routine activities theory*, posits that crime occurs when there is a convergence of suitable targets, motivated offenders, and the absence of guardians (Cohen and Felson 1979). Removing one of these elements would reduce crime in the focal area (Guerette et al. 2009). Weisburd (2006) suggests that POP interventions specifically targets and removes motivated offenders and increases guardianship as well as reducing the chances of displacement of crime through *Incapacitation* and *Deterrence.* Incapacitation is the arrest of numerous offenders in the target area, reducing repeat offenses in nearby areas, while deterrence increases the fear of apprehension for the remaining capable offenders (Weisburd et al. 2006). The Bowers et al. (2003) suggests that after an operation, crime will not move a large distance due to *familiarity decay.* A hot-spot is a locus of criminal activity where the key elements for success requires a comfortable knowledge about the surroundings (Bowers and Johnson 2003; Canter and Larkin 1993; Eck 1993). Moving outside of the comfort zone increases perceived risk of apprehension and requires the offender to secure his or her new environment before continuing operation (e.g. knowing good escape routes, establishing good clientele or victims, and avoiding conflict with rival factions) (Weisburd et al. 2006).

The last theoretical framework is *rational choice theory* where an offender weighs the cost and benefits of associated with a given crime (Cornish and Clarke 1987; Clarke and Weisburd 1994; Weisburd et al. 2006; Guerette and Bowers 2009). A higher perceived risk of apprehension not only operates within the focal area, but also as a deterrent to move to nearby areas because of the high cost of securing a new area (Braga and Weisburd 2010) as well as a lack of knowledge of surrounding areas and the extent of an operation's spatial reach (da Matta and Andrade 2011; Weisburd et al. 2006).

When crime displacement has been observed, research suggests that crime displacement is, usually, not as significant as the positive benefits of crime reduction achieved in the focal area after an intervention (Braga 2005; Guerette and Bowers 2009). One review of 33 studies found that 91 percent of interventions had either no displacement or some displacement that was inconsequential to the positive impact on the treatment areas. The other 9 percent saw considerable displacement (Eck 1993). Another review of 44 analyses found no displacement in 40% of the studies, with six reporting a diffusion of benefit. The rest of the interventions saw displacement, but it was negligible as compared to the benefits of the operation (Hesseling 1994).

The counterfactual of the diffusion of benefit argument can be found within the same theoretical frameworks that explain its existence (Braga 2001). If the costs of committing a crime are lower and there is an absence of guardians nearby, then offenders may continue to operate within another area (da Matta and Andrade 2011; Eck 1993; Guerette and Bowers 2009; Hesseling 1994; Gabor 1990). One of the problems with the research on crime displacement and diffusion of benefit is that there is little account for potential social networks underlying criminal activity, the extent of familiarity of a criminal, and the possible temporal decay of an operation's effect on an area and its surroundings. These are difficult variables to measure but could be accounted for in longer longitudinal analyses and incorporating updated spatial analysis methods.

In summary, an intervention in a hot-spot area increases guardianship while disrupting the familiar area in which offenders operate, increasing the cost of criminal activity. Lack of knowledge of the reach of the operation reduces criminal activity in nearby areas in tandem with offenders' lack of familiarity with areas outside the targeted zone. Most of the current literature on this topic points to the diffusion of benefit as the more prevalent outcome after these focused interventions (Braga and Weisburd 2011; Ratcliffe and Breen 2011).

The Conflicts Between Diffusion and Displacement

Despite the mostly consistent findings that displacement of crime is not occurring during these operations (Braga 2005; Weisburd et al. 2006), extant studies are limited in several ways. First, few actually examine whether crime displacement or the diffusion of benefit occurs. Most studies that analyze situational crime interventions only measure operational success in the area of interest, not whether there was spatial displacement of crime in nearby areas (Bowers et al. 2011; Guerette and Bowers 2009). Second, previous studies have been strictly descriptive in their analysis, which is due, in part, to the lack of adequate data. Most early studies on place-based crime interventions did not use methodologically sound research designs and only examined the success of the operation in the target area. This makes it difficult to reassess those studies and determine if crime displacement was occurring earlier due to the lack of crime counts in surrounding buffer and control catchment areas (Weisburd et al. 2006). Third, sufficient methods in spatial analysis have only recently been developed, which would improve empirical determination of whether crime did move to surrounding areas (Bowers and Johnson 2003; Bowers et al. 2011; Clarke and Eck 2005).

Finally, for those studies that did examine the spatial displacement of crime or the diffusion of benefit, the geographic buffer zones used to observe displacement may not have been sufficiently large to detect displacement due to the intervention. In most cases, buffers were limited to 1 to 2 blocks away from the operation. The argument for the short-distance buffer is that familiarity decay contributes to the amount of spatial displacement of crime that will occur (Weisburd et al. 2006). Most researchers have considered a one-block buffer a sufficient distance (Lawton, R. B. Taylor, and Luongo 2005; B. Taylor et al. 2010).

In contrast, creators of the most widely used model in detecting crime displacement versus the diffusion of benefit observe a diffusion of benefit within the first block buffer from the focal area, but then observe displacement of crime in subsequent blocks, with the effect decaying over greater distance (Bowers and Johnson 2003; Eck 1993)[2]. Analyzing a situational crime prevention program targeted towards burglary, Bowers and Johnson hypothesize that burglars avoid the intervention area while moving farther out (2003). On the one hand, higher levels of crime observed in subsequent areas might relate

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[2] Bowers and Johnson (2003) used 400m buffer rings (roughly the size of one urban block per ring) to measure displacement.

to contamination from exogenous hot-spots, not from the intervention pushing offenders into nearby areas. On the other hand, there is evidence that the displacement observed by Bowers and Johnson was somewhat related to the intervention because of the relative decay in crime.

> "...[T]he confidence with which changes in the buffer zone can be attributed to scheme activity is likely to be inversely related to the distance between two areas. Thus, the fact that the level of displacement appears to have decayed over greater distances suggests that the effect was at least partly attributable to activity within the target area" (Bowers and Johnson 2003).

It is important to consider the buffer size when assessing displacement and diffusion. For some studies, the 1-2 block buffer was a compromise based on the necessity to avoid observing contamination of crime from nearby hot-spots as well as provide adequate distance to observe potential displacement from the focal area (Braga and Bond 2008; Weisburd and Green 1995). Other concerns about buffer size include consideration of natural boundaries, such as rivers and landmarks, and offenders' physical accessibility to different areas (Bowers and Johnson 2003).

Measuring displacement only within two blocks may not capture how different crime types move or the distance that an offender may be willing to move outside the target area. For example, drug crime is more mobile than other crimes and tends to be more prone to displacement because of its market nature (Eck and Weisburd 1995; Gabor 1990; Lawton et al. 2005). Drug offenders prefer to work in areas close to where they live, establishing a network within their cohort to make sure that the market operates productively (P. J. Brantingham 1984; Rossmo 1999). They carefully position their open-air markets for their customers close by (Eck and Weisburd 1995) allowing them to displace a few blocks away if need be without incurring the cost of reestablishing the market. If one market is shut down, it is important for dealers to find close, alternative clientele or safe, known areas where they can continue operation. Since dealing drugs is an income-based offense, the cost of not continuing the trade is high and finding new areas to operate becomes more salient to the dealer. Violent crime, on the other hand, is usually less planned than drug crime and generally less location-specific. Violent offenders are less concerned about their surroundings and would not seek out a "substitution" of targets in surrounding areas (Lawton et al. 2005). Potentially, violent crime could arise where competing drug markets intersect due to friction between drug offenders that are encroaching on new turf.

There is limited research on the distance criminals are willing to travel outside of a focal area after a place-based operation. For the most part, the literature on this topic revolves around understanding criminal routines and an offender's choice structure in choosing victims. Based on the available literature, we can assume that an offender's willingness to travel to commit a crime is dependent on the characteristics of the offender as well as the neighborhood in which they reside and are familiar (P. J. Brantingham and P. L. Brantingham 2003). Environmental criminologists Brantingham and Brantingham (2003) suggest that depending on available methods of travel, offenders tend to move within their neighborhood, or even the next adjacent neighborhood, to commit crimes.

This raises concern about limiting displacement analysis to within two blocks of an intervention (Lawton et al. 2005; B. Taylor et al. 2010). In addition, the social and criminal networks to which an offender may be connected could reach beyond the focal area and even into nearby hot-spots, providing opportunities to continue offenses in those nearby areas even after an intervention is over (P. J. Brantingham and P. L. Brantingham 2003; Ratcliffe and Breen 2011).

To conclude, a review of the literature and theory shows somewhat conflicting views on whether crime displaces or benefits diffuse after hot-spot operations. For the most part, researchers assume that benefits supersede the displacement of crime. However, the lack of good data and the use of inadequate methods may lead to inappropriate conclusions. It is important to analyze the effects of focused interventions by testing the extent to which crime may displace. Using a unique geocoded dataset, this study examines whether or not extending the buffer zones beyond the traditional two-block radius provides alternative conclusions. In addition, by examining data several months after the intervention, we can assess some of the long-term effects of operations.

Operation History and Data

The main source of data for this analysis is a City of Seattle database of crime reports collected by the Seattle Police Department, geocoded down to the street intersection and mid-point of the street segment between intersections. Crime reports were collected from the City of Seattle's public web database site, data.seattle.gov (2010).[3] The analysis takes advantage of data on crimes occurring after July 2010, when reliable event-level data became publically available from the City of Seattle Police Department. These reports include crime descriptions and their time of occurrence. This level of detail allows the researcher not only to measure micro-level changes in crime by location, but also to examine how the spatial distribution of crime changes over time. Most publically available crime data is aggregated to the police precinct, beat, or some other larger geographic level. Using this street-level dataset will provide a unique opportunity for hot-spot research.

To determine if crime moves after an intervention, I consider a 2010 Problem Oriented Policing (POP) operation that took place in Seattle's Central District at 23rd Avenue and East Union Street (see Figure 1), that attempted to address problems related to a 30-year drug market and related physical disorder (Braga and Weisburd 2011). The Central District is one of the oldest and most diverse residential neighborhoods in Seattle. Through the twentieth century, this area has seen its population transition from largely European to Japanese, Jewish, and then African American. After World War II, the Central District became home to most of Seattle's black population partly due to housing discrimination and restrictive covenants in the rest of the city of Seattle (Henry 2001). After World War II, high levels of poverty, crime, and socio-economic disadvantage have characterized the neighborhood (Taylor 1994).

[3] These incidents are based on initial police reports taken by officers when responding to incidents around the city. The information enters the SPD Records Management System (RMS) and is then transmitted out to data.seattle.gov. This information is published within 6 to 12 hours after the report is filed into the system.

In April 2010, the Seattle Police Department (SPD) responded to increased complaints from local businesses and residents about excessive narcotics crimes at the intersection of 23rd Avenue and E Union Street (see Figure 1). The SPD teamed with several departments in the city of Seattle, residents, and business owners and initiated a two-stage operation to address narcotic-related activity in the East Union corridor of 20th and 25th Avenues. The first stage, “Safe Union”, was an undercover operation targeting and later arresting 17 high-level drug dealers. Uniformed police presence was increased in the area to help reduce overall crime as well (Relations 2010a). In October 2010, operation “Safer Union” began with a focus on eliminating “blight and diffuse crime at this well travelled intersection” (Relations 2010b).

This study focuses on the second operation, “Safer Union”, and compares crime counts in four three-month periods prior to the operation (July-September) and post-operation (October-June) to assess not only the success of the operation in the focal area, but the extent to which crime may move to surrounding areas. Limitations in the data raise concerns about comparing three-month periods. First, there may be some seasonal effects on crime between pre- (July to September 2010) and post- (October and on) intervention crime counts. Crime rates fluctuate over the year, with summer months tending to have the highest rates of crime (SPD 2013). It would help to have data ranging further back to compare trends in crime rates based on previous years. Second, the prior operation, “Safe Union”, may have affected overall crime rates through the arrest of 17 high-level drug dealers, disrupting comparison to previous summers. To address these issues, this analysis identifies a control area, which is similar in characteristics to the intervention area, to compare for variations in crime in an area that is not affected by a hot-spot intervention. Figure 2 displays the demographic similarities of the focal, control, and larger Seattle area. The selected control area is the most demographically similar location to the target area, relative to the rest of the city of Seattle. The control area provides the best estimate of crime rates surrounding 23rd and Union had the targeted area not experienced an intervention.

Method

This study uses two popular methods to measure the displacement of crime and diffusion of benefit. The first method is the weighted displacement quotient (WDQ), developed by Bowers and Johnson (2003), which provides a measure of whether there was displacement of crime or diffusion of benefit in nearby areas. If sufficient displacement of crime is detected in the buffer zones, then the operation is a failure because it simply relocates crime rather than preventing it.

The second method is the total net effect (TNE) of the operation developed by Guerette (2009). The TNE provides an overall impact of the intervention, showing how many crimes in the buffer area were possibly caused or prevented by the intervention relative buffer and focal area. The WDQ and TNE compare three geographic units over two time periods to determine the effects of a focused operation on surrounding areas. The three zones consist of 1) a focal area where the intervention took place, 2) the buffer zone around or near the focal area, and 3) a control area that is relatively near the focal area and, ideally, has similar characteristics and qualities. A comparison of crime counts between two time periods, t_0 and t_1, shows the relative shifts in crime patterns.

The time periods used in this analysis consist of three-month intervals starting in July 2010: three months prior to the intervention (July-September, 2010), three months during the intervention (October-December, 2010), three-months post-intervention (January-March, 2011), and six months after the intervention (April-June, 2011). The three months prior period was held constant at t_0 while comparing different iterations of t_1, which was either the "during," "post," or "six months" post-operation period (i.e. pre vs. during, pre vs. post, and pre vs. six-months post)[4]. One of the useful characteristics of these two methods is that researchers can compare relatively short periods pre- and post-operation to find the intervention's effect on surrounding areas (Guerette and Bowers 2009). The rationale for holding the pre-operation period constant in this analysis and comparing it to varying periods after the intervention is to determine the operation's long-term effect.

The WDQ determines if the changes in crime counts in the focal and buffer area are unique as compared to the control area (Guerette and Bowers 2009) and consists of the following formula:

$$WDQ = \frac{\left(\frac{Bt_1}{Ct_1} - \frac{Bt_0}{Ct_0}\right)}{\left(\frac{At_1}{Ct_1} - \frac{At_0}{Ct_0}\right)}$$

where *A* is the focal area, *B* is the selected buffer zone, *C* is the control area nearby, and t_0 and t_1 are the before and after time periods. The numerator holds the Buffer Displacement Measure, which reflects changes in the number of crimes in the buffer zone, normalized by the number of crimes in the control area, in t_1 minus the prior buffer and control in t_0. This compares crime trends in the area of interest, due to the intervention, to crime trends in the control area that did not experience an intervention. A positive buffer displacement coefficient would suggest possible displacement, while a negative coefficient would suggest possible diffusion of benefit because the buffer zone experienced less crime than the control area.

The denominator holds the Success Measure of the operation in the focal area as compared to the control area. Here the crime counts in the focal area, normalized by the crime counts of the control area, in t_1 is subtracted from the ratio of the number of crimes in the focal area to those in the control area in the prior period of t_0. This provides a score that suggests whether the operation reduced crime as intended. A negative score in the denominator would signify a decrease in crime while a positive score would signify an increase in crime. If the denominator is positive, then continuing with the WDQ is not necessary because the operation was a failure (Bowers and Johnson 2003).

Table 1 displays the interpretation of the weighted displacement quotient taken directly out of Bowers and Johnson's (2003) research. WDQ scores lower than -1 suggest net displacement of crime, with relative crime counts increasing more in the buffer area than in the intervention area. Values between 0 and -1 show either no displacement or some

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[4] Traditionally, the WDQ has been used to compare two consecutive time periods (e.g., crime rates in January through March versus crime rates in April through June), but this analysis will take some liberty by comparing the crime count prior to the operation to three separate periods after the intervention began: during-operation, post-operation, and six-months post-operation. Ratcliffe and Breen (2009) also observed multiple time periods in their analysis of Camden, NJ.

low level of displacement that is smaller than the direct effects of the operation. Any value above one (1) suggests there is a diffusion of benefit from the operation, where overall crime decreased in the buffer area.

Since the data are crime counts, the chi-square test and the phi coefficient are good methods for determining statistical significance. The 2x2 chi-square test indicates whether or not the differences between the focal and buffer areas in the first time period versus the second time period are the result of a random variation in crime frequencies (Bowers and Johnson 2003; Ratcliffe and Breen 2011). Ratcliffe and Breen (2011) suggest that the phi statistic is an even better measure. With a range between -1 and 1, the phi coefficient measures the strength of association between two binary variables: in this case, time periods between the focal and relative buffer area. Association weakens as the phi approaches zero (no association), which is an optimal outcome in the practice of measuring crime displacement. When comparing spatial associations, it is necessary that a change in one area (e.g., the focal area) is independent of its comparison area (e.g., the relative buffer). A phi over 0.3 would suggest a strong association, meaning that an increase in the focal area would lead to an automatic increase in the buffer, or vice versa. A weak, or no, association would give the researcher confidence that any changes in the buffer are unique (Ratcliffe and Breen 2011).

The Total Net Effect (TNE) helps evaluate the overall impact of the intervention by determining the count of crimes that displaced into the chosen buffer area (Guerette and Bowers 2009). The following equation defines the relationship of the TNE:

$$TNE = \left[At_1\left(\frac{Ct_0}{Ct_0}\right) - At_0\right] + \left[Bt_1\left(\frac{Ct_0}{Ct_1}\right) - Bt_0\right]$$

where the components are the same as those in the WDQ: *A* is the number of crimes in the focal area, *B* is the number of crimes in the selected buffer zone, *C* is the number of crimes in the control area nearby, and t_0 and t_1 are the before and after time periods.

Guerette et al. (2009) point out three advantages to using the WDQ and the TNE together in analyzing intervention effectiveness. First, the WDQ calculates the amount of displacement or diffusion of benefits while providing a significance test to the observations through chi-square tests and phi measures for association between the focal and buffer zones. Second, the TNE accounts for the overall effect that the intervention had on the area with intuitive scores - the number of crimes increased or prevented in the buffer area due to the intervention. Third, both the WDQ and TNE can be used for short post-evaluation periods (Guerette and Bowers 2009), which is a common data constraint in most Problem Oriented Policing operation evaluations.

This analysis compares WDQ and TNE scores using several different definitions of buffer areas to see if extending the buffer zone beyond the traditional two-block area might provide different assessments of success for the intervention. The buffer zone selection process in this study stays within Bowers and Johnson's (2003) methodology to analyze displacement and diffusion. Using the geographic morphology of the intervention focal area, a buffer of one-block starts at the border of the targeted area and extends one block out. The second buffer starts at the outer border of the first buffer and extends one block out, and so on, until reaching the fifth, one-block-wide buffer (see Figure 3). The buffers do not overlap as to test whether displacement or diffusion decayed across successive buffer zones as predicted by the familiarity decay model (Eck 1993). This model proposes that offenders will avoid committing crimes outside of areas that are more familiar to them (i.e. they will stay inside focal area). But, it is reasonable to assume that if offenders were deterred by the intervention, they could commit offenses in the nearby vicinity (Bowers and Johnson 2003).

The control area chosen for comparison to the focal and buffer zones, as suggested by Bowers and Jonson (2003), is an eight-by-eight block area at the intersection of Martin Luther King Jr. Way and South Jackson Street. Exploratory spatial and demographic analysis reveals that this location is the most similar in residential and business characteristics, and relatively similar in crime count, to the focal area of 23rd and Union (see Figure 2). The purpose of using a control area is to compare a similar area to the focal and buffer zones that has no intervention influencing the temporal patterns of crime counts. This provides a quantitative baseline to compare changes in crime between areas. The borders of the control, focal, and buffer zones are held constant across time and geographic size.

The crime reports and buffers were organized in ESRI's ArcGIS, while database management and statistical analyses were performed in the statistical program R. The crime reports were aggregated into four three-month intervals starting with July to September 2010 and ending with April to June of 2011. Then, they were aggregated into seven zones: the focal area where the intervention occurred, the control area, and five different buffer zones.

Results

Figure 4 shows the raw crime counts for the focal, control, and buffer areas in each period. In the focal area, there is evidence that the intervention helped decrease crime well below pre-operation counts. Buffer one shows a small increase three months after the operation, which then drops, while buffer two shows a dramatic increase. Buffer three shows little change in crime counts while buffer four increases six months after the operation. Finally, buffer five shows quite an increase of crime from pre-opeartion to three months post operation.

Using only buffer crime counts to measure operational success is problematic due to the geographic area within each buffer. Buffer areas (i.e. square footage) increases in size the further they area from the target area, such as buffers four and five blocks away. This leads to higher crime counts by virtue of containing more possible perpetrators and victims. As a result, the crime counts are not directly comparable between the different buffers and the focal area. Fortunately, the WDQ and TNE focus on temporal changes in crime counts within each area rather than crime ratios. Thus, we turn to these two measures to quantify the displacement of crime or the diffusion of benefit based on the spatial relationship of the surrounding areas.

Table 3 displays pre-intervention crime numbers as compared to the three-month intervals "during," "post," and "six-months" post-intervention crime in each of the five buffer areas. The "Success Measures" show that crime decreased in the focal area for each of the periods after the operation. The chi-squared tests are mostly significant and the phi coefficients are below .3 except for three observations. One observation to note is that all of the phi coefficients are positive because the crime counts fell mostly on the diagonal of the phi's 2x2 table. This is due to higher crime counts in the pre-focal period. A negative phi coefficient would occur if most of the crime counts in a scenario fell on the off-diagonal.

Figure 5 provides a more accessible interpretation of the WDQ scores for the buffer areas using a rope-ladder graph. Small squares represent the WDQ of pre-intervention versus during-operation, circles represent pre- versus post-, and diamonds represent pre-versus six-months post-operation. Each of the grey stripes show variation in the WDQ coefficients using different time-lags, allowing the reader to see the fluctuation in WDQ scores between periods. Any value less than negative one (-1) signals significant displacement of crime. Any value greater than negative one (-1) signals negligible displacement or significant diffusion of benefit.

According to the interpretation of the WDQ in Bowers and Johnson (2003) (see Table 1), the 15 periods within the five buffers of operation Safer Union saw no significant diffusion of benefit greater than the direct effects of the intervention (i.e., no WDQ scores are above +1). This is counter to some of the results from previously discussed POP interventions. Six of the fifteen periods, 40%, scored between 0 and 1, meaning they achieved some diffusion of benefit. Five of the fifteen, about 33%, experienced displacement of crime, but less than the direct effects of the operation. Four of the fifteen periods, about 27%, saw displacement of crime greater than the direct effects of the operation, meaning that the program increased crime in several buffer zones. Three of the periods had values relatively close to negative one, resulting in displacement about equal to the direct effects of the operation.

The TNE (Figure 6) shows a similar pattern to the WDQ with a more tangible interpretation – possible increases or decreases in crime.[5] About 73% of the fifteen periods saw potential prevention of crime, ranging from 1.5 to 52.7 crimes. The other 27% of the periods saw potential increases in crime ranging from 2.5 to 32.3 crimes. Of the five buffer zones, blocks two, four, and five see the greatest increase, largely in the six-months post-operation period. Blocks one and three see an overall reduction in crime in all three periods while block 2 sees a decrease in post-operation and an increase in the periods during and six-months post-operation. In both the WDQ and TNE, as distance from the target area and time from the intervention increases, the potential for displacement increases.

Interpretation

The periods during and post-operation see the least amount of displacement in the buffer areas. This could mean that while the intervention was having a positive impact on the focal area offenders were more cautious in committing crimes in nearby areas due to unfamiliarity of the operation's timeline and geographic extent, possibly even adjusting to the increased guardianship in the area. Post-operation crime numbers show that the operation had some lasting effect in the surrounding areas. But, in the six-months post-operation period, we see the most crime displacement, especially in blocks two, four, and

[5] Multiplying the original values of the TNE by a negative one inverts the values for easier interpretation (i.e., values to the right of the red line in Figure 5 signify an increase in crime, where previously those numbers would have been negative before the transformation). Now, any positive score means an increase in crime while a negative score signifies a decrease in crime.

five. This could mean that the operation's effects wore off slightly over time where offenders increased activity after sufficient time had passed. There is a mix of WDQ results, with diffusion less than the direct effects of the operation in two buffers and displacement greater than the direct effects in three. Nevertheless, we might be seeing increases in crime through contamination from exogenous hot-spots in buffers four and five, not from the intervention. But, an interesting outcome from these results is that buffer two saw two periods of displacement after the intervention starts, which is within the traditional 2-block buffer catchments used by many of the previous studies. This signals good evidence for displacement as a result of the operation and not from exogenous buffer zones.

Several explanations may clarify these findings. One possible explanation is that the fluctuation in crime from the pre-operation period to six-months-post-operation period is a seasonal effect of pre-summer crime rates on the rise. In regards to the increases in crime in the outer buffers, it is possible that these buffers are observing contamination by nearby hot-spots (Guerette and Bowers 2009). Another explanation could be that displacement may be a slow process that simply takes time to transpire.

The familiarity decay model suggests that crime spreading from the focal area will decline as distance increases. But in this analysis, the largest indication of crime displacement occurs in buffers farthest away from the operation. It is difficult to determine if crime in those buffers was a consequence of the operation at 23rd and Union or contamination, but there is evidence that the operation had a disruptive effect on the landscape, especially since there was a decrease in crime in the during- and post-operation period in the outer two buffers.

The results from the WDQ and TNE support two major conclusions about the use of multiple buffer zones and about analyzing additional periods to determine temporal changes. First, there is evidence that using only one- or two-block buffers may be inadequate in determining whether or not crime displacement occurred after an operation. The first buffer saw positive effects, as seen in other studies that look at short buffers. In the results, the WDQ and TNE both reveal that buffers two, four, and five saw potential displacement of crime at different periods, providing evidence that criminals may skip blocks to conduct criminal activity while their main focal area is under increased surveillance. One could argue that criminals move farther than two blocks away, explaining the increase of crime in the three- to five-block buffer zones. Bowers and Johnson (2003) found that displacement of crime occurs in the three- to five-block range, but warn that this may be due to contamination from other hot-spots nearby, leaking into the buffer zones and confounding results as to whether the operation in the focal area was the cause of the crime increase in those buffer zones. So far, there are no known methods of eliminating such contamination from the results. Yet the fact that buffers 4 and 5 saw displacement of crime six months after the operation, and not before, provides evidence that these areas may not have been experiencing contamination, but are indeed experiencing an intervention effect. Other confounding factors could include external events that might increase crime in an area. This is where the control area comes into play. One solution that Bowers and Johnson (2003) provide is averaging crime in multiple control areas to provide a more rigorous value to compare with the buffer and focal areas. Doing this in Seattle is particularly difficult because of geographic and demographic constraints of the city – there are two bodies of water to the east and west side of the city as well as diverse ethnic groups to the north and south of the focal area, making it difficult to find appropriate control areas that are not too far away.

Second, including multiple time periods is important in determining the effects of the operation over the long term in the area. The results demonstrate that the intervention's effects may weaken over time. Without the six-months post-operation observation, one would conclude that crime decreased overall. Most studies do not analyze more than a few months post-operation, which may lead to inappropriate conclusions about operational success. Other researchers examine longer, aggregated periods such as one-year prior versus one-year post-operation, which may conceal some of the fluctuation in the frequency of crime. Again, these analyses are mostly dependent on the availability of adequate data. There is evidence that using varying, subsequent periods after the operation demonstrates interesting results in crime fluctuation. The success of an operation in an area hinges on the result of diffusion of benefit proceeding from the focal area. With the apparent evidence of displacement in different buffers and periods, it seems that extended research on the topic of crime displacement is necessary.

Conclusion

This study assesses the effect of a Problem Oriented Policing (POP) operation on a 30-year-old drug market in Seattle's Central District. Using unique geocoded data at the street level, this study analyzes the effects of the operation on the target area and surrounding areas using the weighted displacement quotient (WDQ) and the total net effect (TNE) of the operation. The goal of this research is to assess whether extending observation buffers from the focal area beyond the traditional one- to two-block buffer area provides more useful results than those produced by previous research on crime displacement into nearby areas. Comparing different temporal frames illustrates that the operation was an overall success in the focal area, with mixed results in the buffer zones. Of the fifteen time periods and areas in the analysis, there was no significant diffusion of benefit greater than the direct effects of the operation. Six of the 15 buffer periods, 40%, experienced some diffusion that was about equal to the effects of the intervention (i.e., there was not an overall positive diffusion of crime control benefits from the operation to surrounding areas). Five of the 15 buffer periods, a third, saw some displacement after the operation, but less than direct effects of the intervention. The final four buffer periods, 27%, saw a significant amount of displacement that was greater than the direct effects of the intervention. Previous research cites successful operations with a diffusion of benefit in buffers located one to two blocks away (Weisburd et al. 2006), as does this study in the first block, and to some extent in the second block. However, in buffers that were two, four, and five blocks away, there was evidence of significant displacement of crime in different periods, similar to the finding by Bowers and Johnson (2003). Buffers four and five blocks away may have been experiencing some crime from surrounding hot-spots, but this does not rule out the possibility that the intervention displaced crime to these outer areas.

Discussion

Throughout this research, several concerns arise from the literature and the analysis. One concern is the internal validity of this study. The observation periods in the focal area used to measure changes in crime before the intervention may be capturing contamination by the previous undercover operation ("Safe Union") that identified and arrested 17 key drug dealers in the area before the operation "Safer Union" under study. This raises questions about the internal validity of the results since there was not enough data to measure crime counts before the first operation. Higher crime prior to operation "Safe Union" may change the outcome of WDQ and TNE, possibly resulting in either greater diffusion or displacement in the buffer zones post-operation. The control area did not experience an intervention before the available data, making the two areas somewhat dissimilar to each other concerning treatments between each area. Ideally, neither the focal nor the control area would have a prior intervention before the beginning of the available data. This does not nullify the findings, but rather highlights the need for longitudinal data to assess these types of operations in future research. Without access to better data, it is difficult to determine not only the outcome of the operation, but also how long the effects lasted after the operation ended.

One peculiar outcome in this study is the overall positive phi coefficients in Table 3. These values are correct because the diagonal of the 2x2 table holds most of the crime in each of the scenarios. If crime counts were mostly on the off-diagonal, then the phi would have been a negative coefficient. This raises a more important methodological concern: crime counts should be standardized to some geographic unit, such as crimes per square mile. As buffer distance increases, so do the buffers' geographic size. This leads to capturing more crime events simply due to the nature of observing a larger spatial footprint. A geographically standardized crime count could very well result in different coefficients in all the WDQ, TNE, and significance tests.

Whether crime observations in the outer buffer rings were the result of seasonal effects or contamination from exogenous hot-spots, they highlight the need to continue developing methods for identifying crime displacement. One possible approach is to more closely examine interactions between hot-spots in relation to the theoretical framework of concentrated crime. Researchers have consistently found that crime concentrates in the urban landscape (Bowers and Johnson 2003; Eck and Weisburd 1995; Guerette and Bowers 2009; Weisburd et al. 2006). But there is little research on understanding how these hot-spots may be connected. There may be some connection or social network functioning between hot-spots allowing offenders to be resilient to interventions, where by offenders cease activity in one hot-spot and resume in the next with little. Most likely, not all offenders move from place to place and deterrence occurs with some offenders, preventing future crimes (Weisburd et al. 2006). Nonetheless, it would be helpful to see how other non-treated hot-spots are reacting to interventions nearby, potentially providing insight to networks between locations. One option is rethinking how researchers design buffer catchment areas. In addition to, or even rather than relying on, concentric buffers around one hot-spot, we could create a catchment zone around nearby hot-spots to observe temporal changes during the intervention. This could provide insight into how interventions nearby affect those areas by monitoring increases or decreases in crime in nearby hot-spots.

Another issue that may arise in the method of aggregating crime into buffers is the inability to identify specific areas within buffers that might be seeing an abnormal increase in crime. In general, the WDQ measures the aggregated crime of a buffer. A WDQ result could signal that the diffusion of benefit is occurring, with lower crime from period one to period two, relative to the focal and control area. Nevertheless, it is possible that crime observed in the aggregated buffer is occurring in one small sub-area. For example, say a buffer decreases from 50 crimes to 25 crimes in some period after an intervention. Imagine that 23 of those 25 crimes in the post-intervention period occur on one street block. The WDQ and TNE would ignore this concentration and describe it as diffusion of benefit. However, at the street level, the intervention creates a micro hot-spot. In addition, a micro hot-spot or spike in crime may be encroaching over a subsequent buffer boundary, dividing a micro cluster of crime between two buffers, masking the problem of increases in crime.

One solution to this problem would involve creating raster maps in the GIS to identify concentrations of crime, like a weather map, in each period and then overlaying the buffer areas to see if there are spikes or other anomalies encroaching on the buffer boundaries. Because a raster consists of grid cells with some value, in this case crime, researchers could subtract the prior period raster map from the during or post raster map of crime and create a third map that would show high-low values of crime (whether crime increases or decreases from the prior period).

Finally, a salient question emanating from this research concerns neighborhoods and their residents. What are the characteristics that might attract these concentrations of crime? What are the lasting effects of an operation on the neighborhood? Does the population change after such an event?

While this paper is a criminological story, it is also a demographic story about how policies shape and change neighborhoods. Police have only a limited effect on crime in hot-spot areas – changing the landscape to reduce criminal opportunities has a more lasting effect (Braga and Weisburd 2010). Since the operation at 23rd and Union, several businesses that participated in the cleanup in "Safer Union" have closed and been replaced by other businesses that are attracting a different clientele (Boruch et al. 2011; Fucoloro 2011; 2012a; 2012b). These closures are not directly related to the intervention per se but could be evidence of a much larger phenomenon in the area, a demographic shift in neighborhoods within Seattle's Central District.

The area around 23rd and Union has seen a demographic change over the past 30 years, with a decline in the African-American population and a rise in non-minority groups, which some characterize as gentrification of the neighborhood (Henry W McGee 2007). Unpublished research by the author has shown improvement in socio-economic status (SES) of the area, such as increasing education levels, higher income, and lower poverty. What is unique about this finding is that there is reason to believe that SES improvements are not the result of the improvement of the population but its replacement. Informal interviews of black residents in the area suggest that higher property taxes and a change in the cultural and commercial structure of the area has led to more African-Americans leaving the area for less expensive and more culturally attractive locales. The improvement of SES along with evidence of a decrease in the black population raises the question about who benefits from specific enforcement policies and neighborhood change.

Operations Safe and Safer Union are characterized by police as a response to ongoing calls from residents about a 30-year open-air drug market. One must ask the question, why would this operation take place now rather than earlier? Were police strategies that were capable of addressing the problems at 23rd and Union just recently developed? Or, did the socio-demographic changes in the neighborhood motivate such an operation?

Addressing the root of these changes in socio-demographic characteristics might shed light on the mechanisms not only of crime, but also of neighborhood change. A longitudinal demographic analysis of this area, along with a more complete crime dataset reaching further back in time to see what types of neighborhood changes are occurring, might reveal how local government policies may affect neighborhood change. Did the intervention facilitate a change in the market features of the area through business closures? And, whom did this change benefit: the existing population or a new, incoming population?

We know that many crime hot-spots are located in disadvantaged neighborhoods (Sampson et al. 2002) and that disadvantage in a neighborhood decreases the ability of residents to defend against social troubles such as crime, lack of economic mobility, and lack of opportunities (Peterson and Krivo 2010). In this context, could changes to the landscape through policies enacted to "clean up" areas become a social problem against which disadvantaged neighborhoods are unable to defend, leading to the migration of a minority group or community? Future research should analyze demographic changes in localized geographic areas, along with crime rates for specific years, to help unravel the mechanisms of how policing measures may have latent effects on specific types of neighborhoods and how these policies may help facilitate other neighborhood changes.

Figure 1: Map of Seattle and the intersection of 23rd and Union

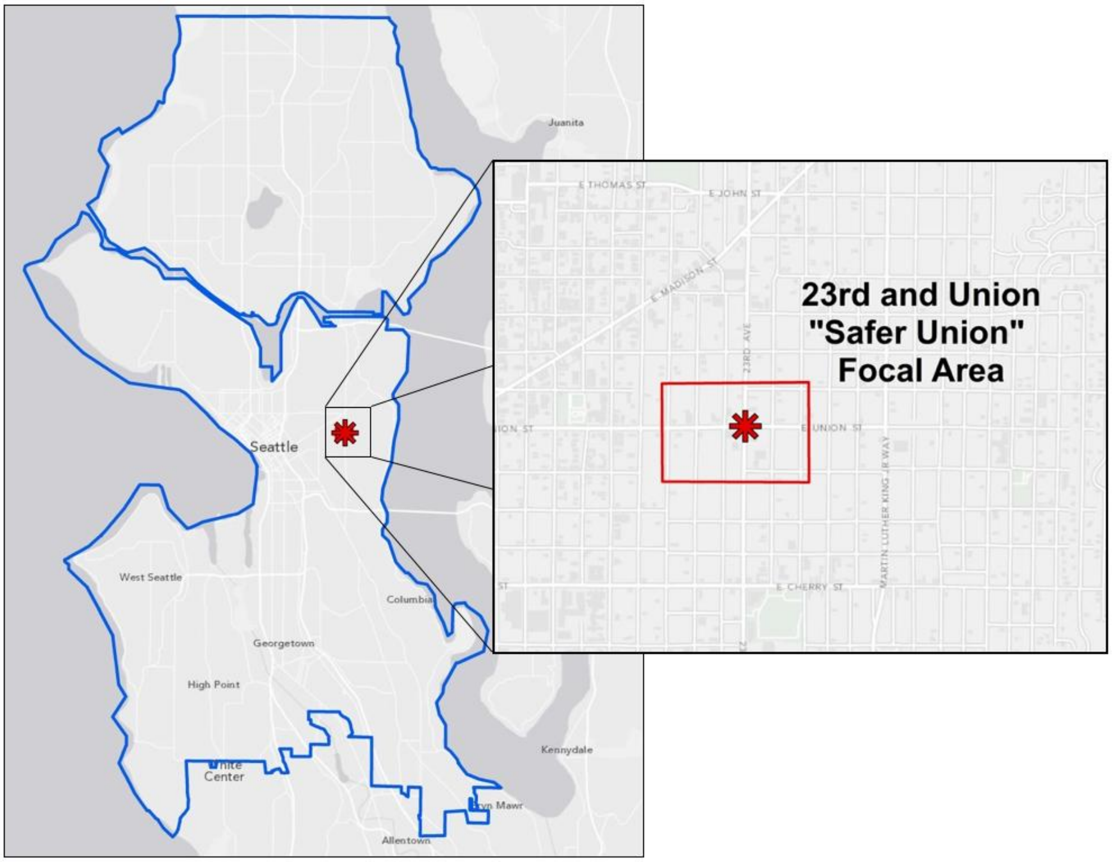

Figure 2: Racial Composition of Focal, Control, and Seattle Area – 2010 Census

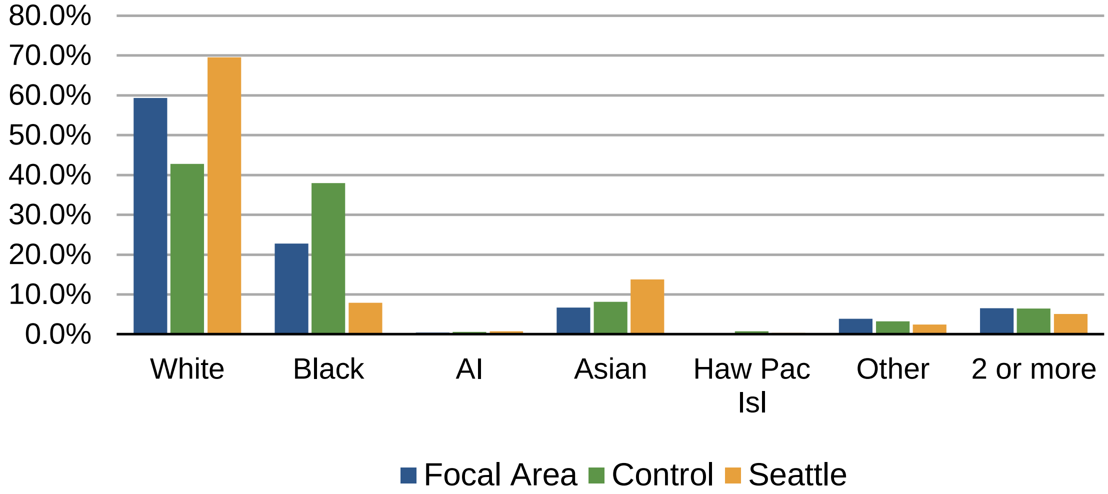

Figure 3: Focal Area, Buffer Zones, and Control Area

Figure 4: Raw Crime Counts

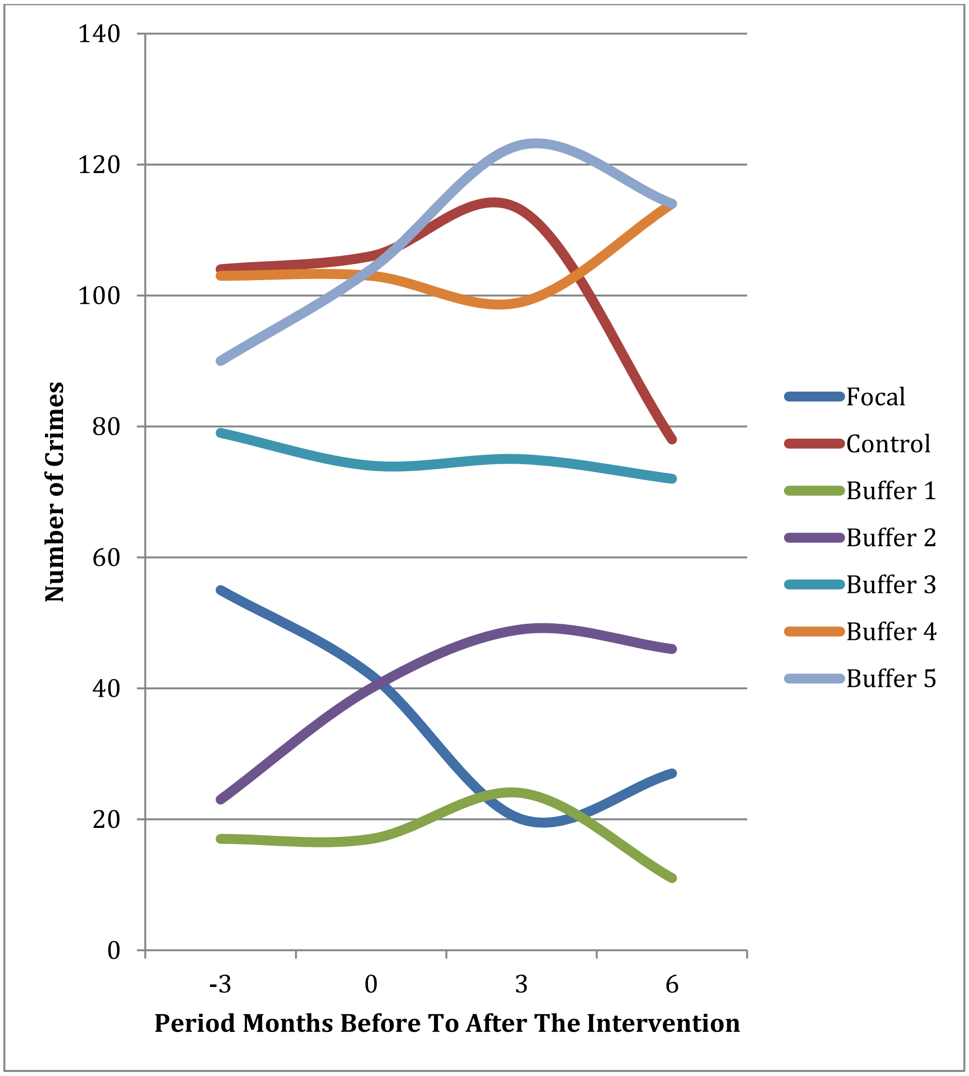

Figure 5: Weighted Displacement Quotient Rope-Ladder

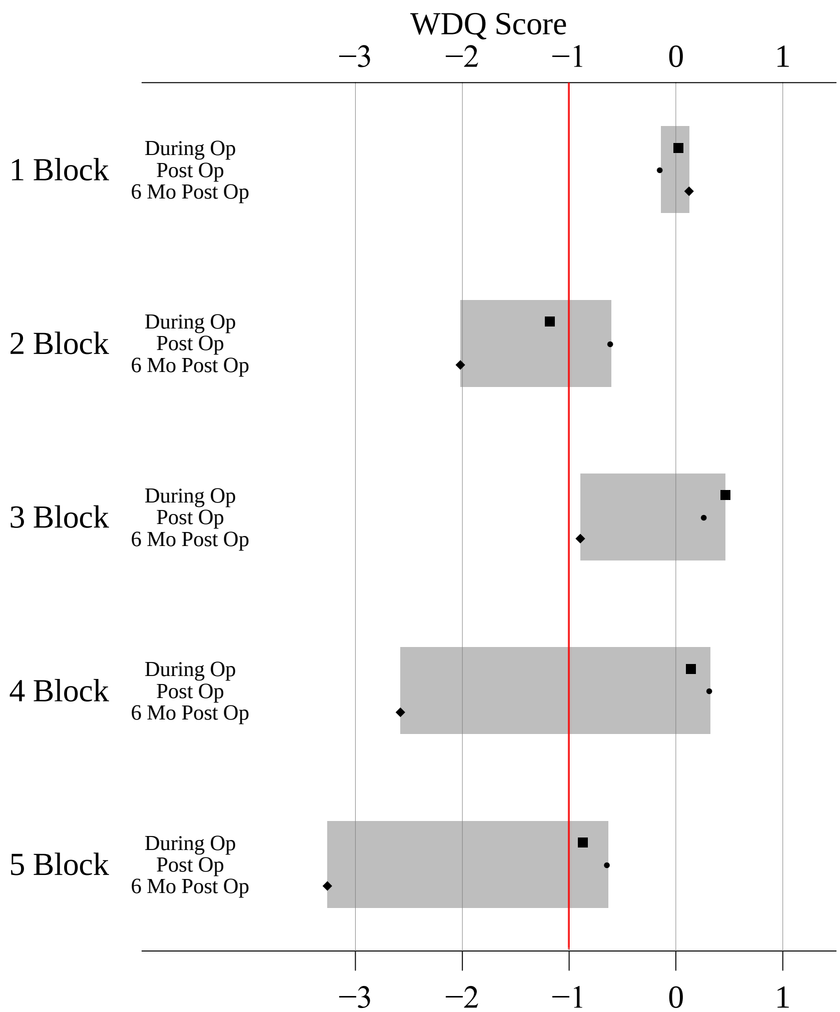

Figure 6: Total Net Effect Rope-Ladder

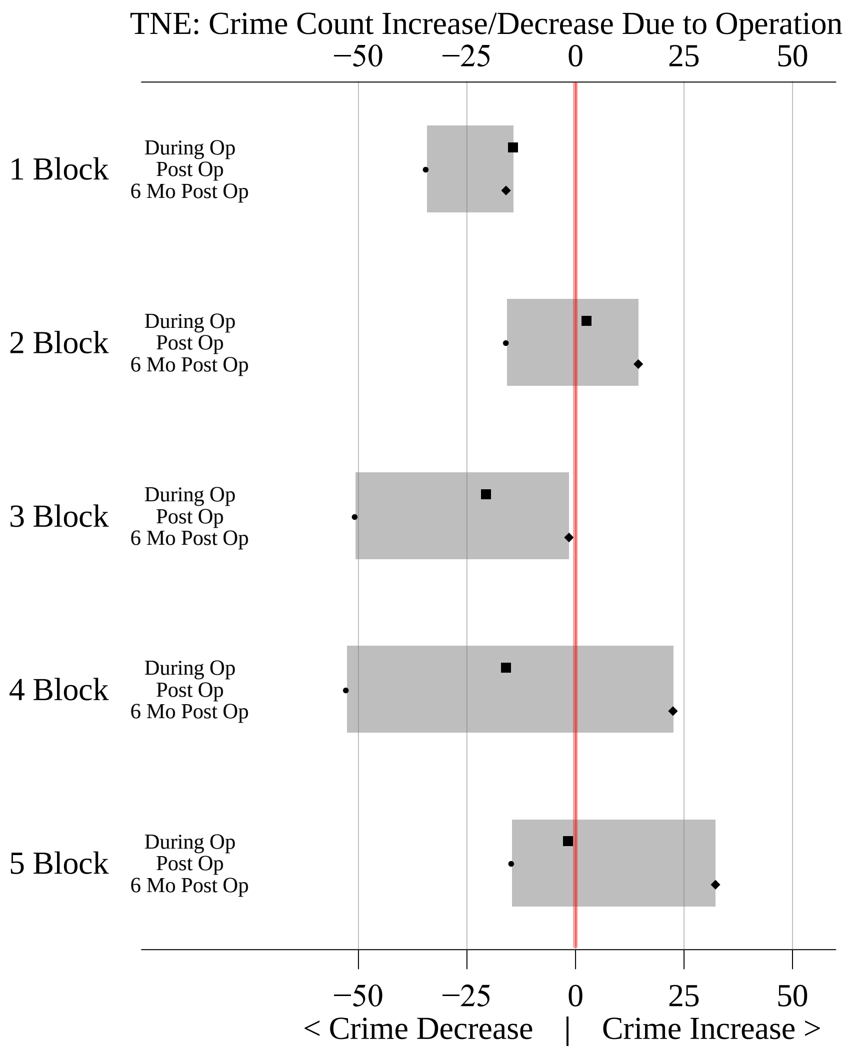

Table 1: Interpretation of the weighted displacement quotient

WDQ Value	Interpretation	
WDQ > 1	Diffusion greater than direct effects	Positive net effect of the program
WDQ near 1	Diffusion about equal to direct effects	
1> WDQ > 0	Diffusion but less than direct effects	
WDQ = 0	No displacement or diffusion	
0> WDQ > -1	Displacement but less than direct effects	
WDQ near -1	Displacement about equal to direct effects	No net benefit to program
WDQ < -1	Displacement greater than direct effects	Program worse than doing nothing

Table 2: Interpretation of Phi coefficient

Common metric	SEPTIC
-1.0 to -0.7 strong negative association.	Strong association. WDQ very questionable.
-0.7 to -0.3 weak negative association.	Moderate association. WDQ caution.
-0.3 to +0.3 little or no association.	>|0.1| to <|0.3| little association; <=|0.1| no association
+0.3 to +0.7 weak positive association.	Moderate association. WDQ caution.
+0.7 to +1.0 strong positive association.	Strong association. WDQ very questionable.

Table 3: All Crime - Pre vs.

All Crime - Pre versus:						
During Operation						
Area	Success Measure	Buffer Displacement	WDQ	TNE	Phi	Chi p-value
Focal	-0.133					
Buffer 1		-0.003	0.02	14.4	0.059	0.634
Buffer 2		0.156	-1.18	-2.5	0.197	0.020
Buffer 3		-0.062	0.46	20.6	0.050	0.514
Buffer 4		-0.019	0.14	16.0	0.063	0.334
Buffer 5		0.116	-0.87	1.8	0.097	0.125
Post Operation						
Focal	-0.352					
Post 1b		0.049	-0.14	34.2	0.314	0.001
Post 2b		0.212	-0.60	15.8	0.415	0.000
Post 3b		-0.096	0.27	50.6	0.210	0.002
Post 4b		-0.114	0.32	52.7	0.201	0.001
Post 5b		0.223	-0.63	14.5	0.273	0.000
Six-Months Post						
Focal	-0.183					
Six 1b		-0.022	0.12	16.0	0.058	0.703
Six 2b		0.369	-2.02	-14.5	0.336	0.000
Six 3b		0.163	-0.89	1.5	0.143	0.042
Six 4b		0.471	-2.58	-22.5	0.175	0.004
Six 5b		0.596	-3.26	-32.3	0.208	0.001

Bibliography

Barr, R., & Pease, K. (1990). Crime placement, displacement, and deflection. *Crime and Justice*, 277–318.

Blumstein, A., & Wallman, J. (2006). *The Crime Drop in America*. Cambridge University Press.

Boruch, R. et al. 2011. "Translational Criminology." *The Magazine of the Center for Evidence-Based Crime Policy - George Mason University*.

Bowers, K. J., and S. D. Johnson. 2003. "Measuring the geographical displacement and diffusion of benefit effects of crime prevention activity." *Journal of Quantitative Criminology* 19(3):275–301.

Bowers, K. J., S. D. Johnson, R. T. Guerette, L. Summers, and S. Poynton. 2011. "Spatial displacement and diffusion of benefits among geographically focused policing initiatives: a meta-analytical review." *Journal of Experimental Criminology* 7(4):347–74.

Braga, A. A. 2001. "The effects of hot spots policing on crime." *The ANNALS of the American Academy of Political and Social Science* 578(1):104–25.

Braga, A. A. 2005. "Hot spots policing and crime prevention: A systematic review of randomized controlled trials." *Journal of Experimental Criminology* 1(3):317–42.

Braga, A. A., A. V. Papachristos, and D. M. Hureau. 2010. "The concentration and stability of gun violence at micro places in Boston, 1980–2008." *Journal of Quantitative Criminology* 26(1):33–53.

Braga, A. A., and B. J. Bond. 2008. "Policing Crime and Disorder Hot Spots: a Randomized Controlled Trial*." *Criminology* 46(3):577–607.

Braga, A. A., and D. L. Weisburd. 2010. *Policing Problem Places*. New York: Oxford University Press.

Braga, A. A., and D. L. Weisburd. 2011. *Addressing Crime and Disorder in Seattle's "Hot Spots": What Works ?* Seattle, WA: City of Seattle.

Brantingham, P. J. 1984. *Patterns in Crime*. Prentice Hall College Division.

Brantingham, P. J., and P. L. Brantingham. 2003. "Anticipating the displacement of crime using the principles of environmental criminology." *Crime prevention studies* 16:119–48.

Brantingham, P. L., and P. J. Brantingham. 1981. "Notes on the geometry of crime." *Environmental Criminology*.

Canter, D., and P. Larkin. 1993. “The environmental range of serial rapists.” *Journal of Environmental Psychology* 13(1):63–69.

Clarke, R. V., and D. Weisburd. 1994. “Diffusion of crime control benefits: Observations on the reverse of displacement.” *Crime prevention studies* 2:165–84.

Clarke, R. V., and J. E. Eck. 2005. *Crime Analysis for Problem Solvers in 60 small steps*. U.S. Department of Justice Office of Community Oriented Policing Services.

Cohen, L. E., and M. Felson. 1979. “Social change and crime rate trends: A routine activity approach.” *American Sociological Review* 588–608.

Cornish, D. B., and R. V. Clarke. 1987. “Understanding crime displacement: An application of rational choice theory.” *Criminology* 25(4):933–48.

da Matta, R. A., and M. V. Andrade. 2011. “A model of local crime displacement.” *International Review of Law and Economics* 31(1):30–36.

Eck, J. E. 1993. “The threat of crime displacement.” Pp. 527–46 in, vol. 25.

Eck, J. E., and D. Weisburd. 1995. “Crime places in crime theory.” *Crime and Place, Crime Prevention Studies* 4:1–33.

Eck, J. E., R. V. Clarke, and R. T. Guerette. 2007. “Risky Facilities: Crime Concentration in Homogeneous Sets of Establishments and Facilities.” *Crime prevention studies* 21:225–64.

Fucoloro, T. 2011. “Thompson’s Point of View closed for unpaid taxes | Central District News.” *Central District News*. Retrieved April 9, 2013 (http://www.centraldistrictnews.com/2011/09/thompsons-point-of-view-closed-for-unpaid-taxes/).

Fucoloro, T. 2012a. “Med Mix is open at 23rd and Union (and they’re already busy) | Central District News.” *Central District News*. Retrieved April 9, 2013a (http://www.centraldistrictnews.com/2012/04/med-mix-is-open-at-23rd-and-union-and-theyre-already-busy/).

Fucoloro, T. 2012b. “The Neighbor Lady is open at 23rd and Union | Central District News.” *Central District News*. Retrieved April 9, 2013b (http://www.centraldistrictnews.com/2012/05/the-neighbor-lady-is-open-at-23rd-and-union/).

Gabor, T. 1990. “Crime displacement and situational prevention: Toward the development of some principles.” *Canadian J. Criminology* 32:41.

Guerette, R. T., and K. J. Bowers. 2009. "ASSESSING THE EXTENT OF CRIME DISPLACEMENT AND DIFFUSION OF BENEFITS: A REVIEW OF SITUATIONAL CRIME PREVENTION EVALUATIONS*." *Criminology* 47(4):1331–68.

Hamilton-Smith, N., & Tilley, N. (2002). Anticipated consequences: developing a strategy for the targeted measurement of displacement and diffusion of benefits. *Crime prevention studies*, *14*, 11–52.

Henry W McGee, J. 2007. "Gentrification, Integration or Displacement?: The Seattle Story | The Black Past: Remembered and Reclaimed." *blackpast.org*. Retrieved April 9, 2013 (http://www.blackpast.org/?q=perspectives/gentrification-integration-or-displacement-seattle-story).

Henry, M. T. 2001. "Seattle Neighborhoods: Central Area - Thumbnail History." *historylink.org*. Retrieved June 27, 2012 (http://www.historylink.org/index.cfm?DisplayPage=output.cfm&File_Id=3079).

Hesseling, R. 1994. "Displacement: A review of the empirical literature." *Crime prevention studies* 3:197–230.

Koper, C. S. 1995. "Just enough police presence: Reducing crime and disorderly behavior by optimizing patrol time in crime hot spots." *Justice Quarterly* 12(4):649–72.

Lawton, B. A., R. B. Taylor, and A. J. Luongo. 2005. "Police officers on drug corners in Philadelphia, drug crime, and violent crime: Intended, diffusion, and displacement impacts." *Justice Quarterly* 22(4):427–51.

Pease, K., and G. B. P. R. Group. 1998. *Repeat victimization*.

Peterson, R. D., & Krivo, L. J. (2010). *Divergent Social Worlds: Neighborhood Crime and the Racial-Spatial Divide*. Russell Sage Foundation Publications.

Ratcliffe, J. (2002). Burglary reduction and the myth of displacement. *Trends and issues in crime and criminal justice*, (232).

Ratcliffe, J. H., and C. Breen. 2011. "Crime Diffusion and Displacement: Measuring the Side Effects of Police Operations." *The Professional Geographer* 63(2):230–43.

Relations, M. 2010a. "Operation 'Safe Union' completed – UPDATED." *spdblotterseattlegov*. Retrieved June 25, 2012a (http://spdblotter.seattle.gov/2010/09/16/operation-safe-union-completed/).

Relations, M. 2010b. "'Safer Union' kicks off in the East Precinct | SPD Blotter." *spdblotterseattlegov*. Retrieved February 18, 2013b (http://spdblotter.seattle.gov/2010/11/01/safer-union-kicks-off-in-the-east-precinct/).

Rossmo, D. K. 1999. *Geographic Profiling*. CRC Press.

Sampson, R., Morenoff, J. D., & Gannon-Rowley, T. (2002). Assessing “Neighborhood Effects”: Social Processes and New Directions in Resaerch. *Annual Review of Sociology*, *28*(1), 443–478. doi:10.1146/annurev.soc.28.110601.141114

Sherman, L. W., P. R. Gartin, and M. E. Buerger. 1989. “HOT SPOTS OF PREDATORY CRIME: ROUTINE ACTIVITIES AND THE CRIMINOLOGY OF PLACE*.” *Criminology* 27(1):27–56. Retrieved (http://www.heinonline.org.offcampus.lib.washington.edu/HOL/Print?collection=journals&handle=hein.journals/crim27&id=37).

SPD. (2013). *Seattle My Neighborhood Map*. *web6.seattle.gov*. Seattle: City of Seattle.

Taylor, B., C. S. Koper, and D. J. Woods. 2010. “A randomized controlled trial of different policing strategies at hot spots of violent crime.” *Journal of Experimental Criminology* 7(2):149–81.

Taylor, Q. 1994. *The Forging of a Black Community: Seattle's Central District, from 1870 Through the Civil Rights Era*. 1st ed. Seattle: University of Washington Press.

Weisburd, D., and J. E. Eck. 2004. “What Can Police Do to Reduce Crime, Disorder, and Fear?” *The ANNALS of the American Academy of Political and Social Science* 593(1):42–65.

Weisburd, D., and L. Green. 1995. “Measuring immediate spatial displacement: Methodological issues and problems.” *Crime and place* 4(1947):349–61.

Weisburd, D., C. W. Telep, J. C. Hinkle, and J. E. Eck. 2010. “Is problem-oriented policing effective in reducing crime and disorder?” *Criminology \& Public Policy* 9(1):139–72.

Weisburd, D., L. Wyckoff, J. Ready, and J. Eck. 2006. “DOES CRIME JUST MOVE AROUND THE CORNER? A CONTROLLED STUDY OF SPATIAL DISPLACEMENT AND DIFFUSION OF CRIME CONTROL BENEFITS*.” *Criminology* 549–92.

Weisburd, D., S. BUSHWAY, C. Lum, and S.M. Yang. 2004. “TRAJECTORIES OF CRIME AT PLACES: A LONGITUDINAL STUDY OF STREET SEGMENTS IN THE CITY OF SEATTLE*.” *Criminology* 42(2):283–322.

2010. “Seattle Police Department Police Report Incident.” (Socrata Web):173247. Retrieved (https://data.seattle.gov/Public-Safety/Seattle-Police-Department-Police-Report-Incident/7ais-f98f).