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Evaluation of Fayetteville's ShotSpotter Installation

Results from the First 18 Months

WILSON
CENTER FOR SCIENCE AND JUSTICE
AT DUKE LAW

By Jessica Gettleman and Tyler Kendall

Acknowledgements

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Executive Summary

The City of Fayetteville contracted the Wilson Center for Science and Justice at Duke Law to conduct an independent evaluation of the impact of the deployment of the ShotSpotter acoustic gunshot detection technology across three designated coverage zones in Campbellton, Central, and Cross Creek districts, covering roughly 3% of the City.

This report examines gunshot-related notifications to the Fayetteville Police Department from ShotSpotter and 911 calls, and police responses to these notifications, in an 18-month period of ShotSpotter's implementation, from September 26, 2023 through March 31, 2025, and the 18 months before the implementation of ShotSpotter. This report compares incident patterns, notification volume, and police responses inside and outside the three ShotSpotter coverage areas based on data available to the evaluators.

The data examined come from three sources. First, they include firearm-related 911 calls for service, between January 1, 2022 and March 31, 2025, and ShotSpotter alerts in the calls for service system after ShotSpotter's inception on September 26, 2023. Second, they include the Fayetteville Police Department's ShotSpotter "Ground Truth Tracking Workbook" which contains detailed information about ShotSpotter alerts and the outcomes of police responses to the alerts during the post-ShotSpotter-installation period. Third, we supplement these records with public information from Fayetteville's Open Data Portal, which is used to add context.

These available data did not include outcomes from 911 call-only incidents or whether a reported gunshot was confirmed or not by the responding police officer(s). Thus, the evaluation cannot address differences between the outcomes and productivity of police responses to ShotSpotter alerts and 911 calls, or whether 911 calls regarding shots fired incidents were confirmed. This is a notable limitation of the study's ability to assess the efficacy of ShotSpotter's implementation in Fayetteville.

While this report offers information regarding certain observable features of the ShotSpotter pilot, it does not offer a recommendation on whether the City should continue to use ShotSpotter. This report is intended to inform the decisionmakers, but not to advise them.

Key findings:

- **Notification Volume:** Overall, the 911 call volume related to gunshots decreased citywide over the period being evaluated. At the same time, ShotSpotter

significantly increased the number of gunshot-related notifications received by the Fayetteville Police Department in the ShotSpotter coverage zones.

- **Police Response Times:** Police dispatch and arrival are notably faster following ShotSpotter alerts compared to 911 calls alone, primarily because ShotSpotter notifications enabled quicker officer dispatch. However, this study is unable to assess whether this faster response has resulted in improved investigative productivity or victim outcomes.

- **Incidence Trends:** Citywide gunshot-related incidents have declined since early 2022, with relatively stable incident levels within the three ShotSpotter zones. This trend mirrors national trends and complicates specifically attributing reductions to ShotSpotter.

- **Investigation and Victim Outcomes:** Evidence collection, victim identification, and arrests occur most frequently when ShotSpotter alerts are accompanied by 911 calls. ShotSpotter-only alerts produce comparatively fewer investigative or victim-related outcomes, reflecting challenges including possible false alarms.

- **Resource Efficiency:** Many ShotSpotter-only alerts involve detection of a small number of rounds or "probable gunfire" only. These are associated with lower productivity in terms of evidence collection and victim identification. Strategic prioritization of alerts—such as deprioritizing single-shot alerts lacking 911 confirmation—may improve efficient use of police resources.

Conclusion:

ShotSpotter provides Fayetteville with increased numbers of alerts about possible gunfire incidents and facilitates faster police response times in targeted zones. However, its impact on reducing gun violence and improving investigation and victim outcomes is limited when alerts are unaccompanied by traditional 911 calls. An integration of data from ShotSpotter, 911 calls, police incident reports, and investigations would allow direct comparison and evaluation of the relative benefits of each source of information.

A. Introduction

The City of Fayetteville contracted the Wilson Center for Science and Justice to conduct an independent evaluation of the impact of the ShotSpotter acoustic gunshot detection system deployed across three designated coverage zones. The ShotSpotter system uses a network of acoustic sensors to detect the sounds of potential gunfire and transmit location coordinates, here, to the Fayetteville Police Department (FPD). ShotSpotter can be viewed as a supplement to reporting from residents' calls using the traditional 911 call center system.

This report presents an independent evaluation covering the first 18 months of ShotSpotter's operation in Fayetteville, from September 26, 2023 through March 31, 2025. Our evaluation compares data on ShotSpotter alerts and gunshot-related 911 calls within the three ShotSpotter coverage zones to data from non-coverage areas. It further compares pre- and post-installation periods to identify potential impacts of ShotSpotter implementation.

The data examined for this report—911 calls for service, ShotSpotter's Ground Truth Tracking Worksheet, and public data on crime incidents—provide extensive detail about ShotSpotter alerts and some outcomes from the Fayetteville Police Department's responses to the ShotSpotter alerts. They also include detail about the timing of police responses to gunshot-related calls for service.

It is important to note that for many gunshot-related 911 calls—and for the majority of ShotSpotter alerts—officers are unable to confirm that a gunshot or other crime occurred, and no criminal incident report was created. The data do not allow us to determine whether some unconfirmed incidents are false positives or actual gunfire for which no witness or physical evidence could be found. The data also do not provide information on whether 911 calls or ShotSpotter alerts were confirmed as accurate notifications of gunfire incidents. Thus, this report is unable to assess the accuracy of ShotSpotter's alerts or the relative accuracy of ShotSpotter compared to resident 911 calls.

The primary goals of this evaluation are to provide an evidence-based assessment of ShotSpotter's effects within the limits of the available data, including gunshot notification patterns, police response and deployment times, investigative productivity, and outcomes for victims of gun violence. While this report offers information regarding certain observable features of the ShotSpotter pilot, it does not offer a recommendation of whether the City should continue to use ShotSpotter. This report is intended to inform, rather than advise, the decisionmakers.

B. Design and Purpose of the ShotSpotter Installation
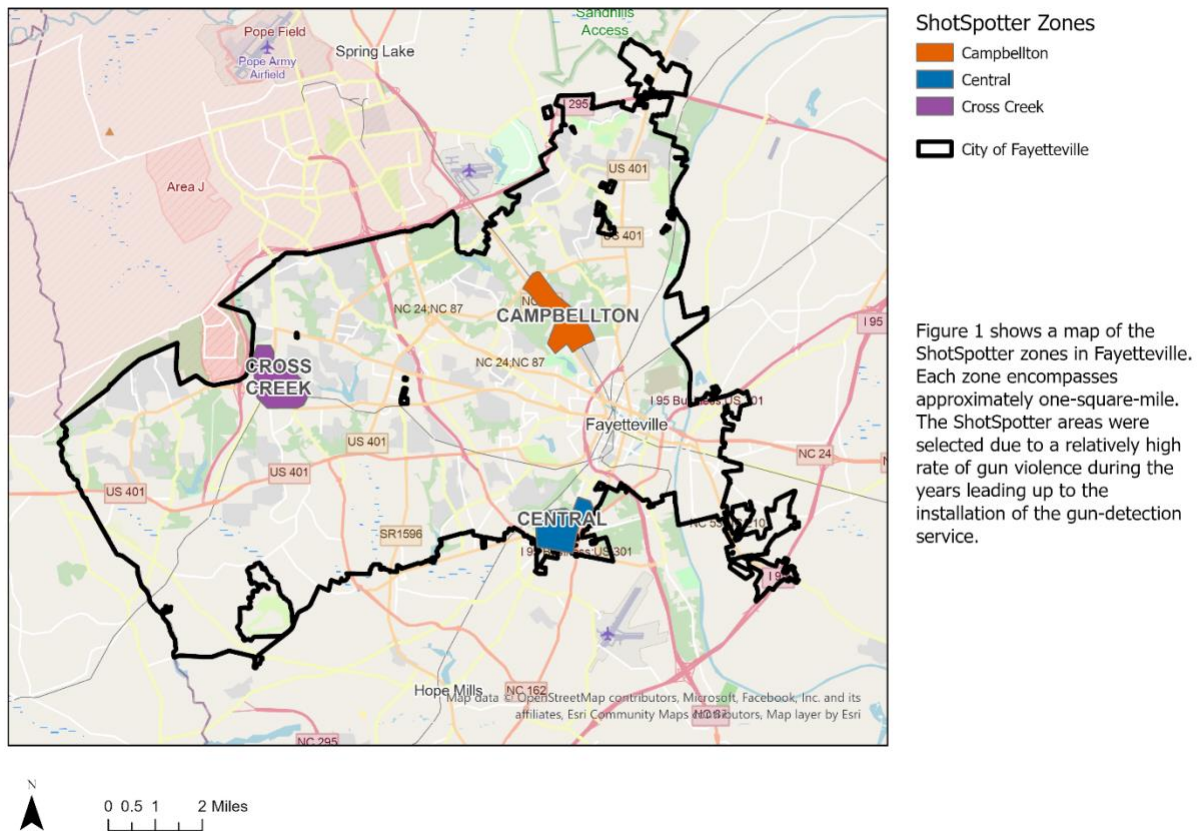
Target Areas and Coverage Zones

The Fayetteville Police Department divides the City into three primary response districts, Campbellton, Central, and Cross Creek. These districts are designed to facilitate equitable call distribution and strategic personnel deployment, based on call volume and geographic proximity (FPD Policy Manual, 2025).

The City of Fayetteville contracted SoundThinking for ShotSpotter services covering three zones, each approximately one square mile in size, within each of the primary response districts:

- **Campbellton Zone:** Along a section of the Murchison Road corridor (NC 210), near Fayetteville State University (1.04 sq. mi).

- **Central Zone:** Situated within the Massey Hill neighborhood (0.87 sq. mi).

- **Cross Creek Zone:** Located in west Fayetteville near South Reilly and Cliffsdale Roads (1.02 sq. mi).

The City entered an agreement with SoundThinking in 2022, with ShotSpotter coverage beginning on September 26, 2023. The three ShotSpotter zones, shown in Figure 1, collectively cover approximately 2.93 square miles, or about 3% of Fayetteville's total land area of 95.5 square miles.

Figure 1: Map of Fayetteville and ShotSpotter Zones

Figure 1 shows a map of the ShotSpotter zones in Fayetteville. Each zone encompasses approximately one-square-mile. The ShotSpotter areas were selected due to a relatively high rate of gun violence during the years leading up to the installation of the gun-detection service.

The City selected the three ShotSpotter zones due to their relatively high rates of gun violence leading up to ShotSpotter implementation. Incident data from Fayetteville's Open Data Portal (see Section D) indicate that the ShotSpotter zones experience a disproportionately high volume of gunshot-related incidents relative to their size. Specifically, of the 1,166 gunshot-related incidents recorded between January 1, 2019, and March 31, 2025, 139 incidents (approximately 11.9%) occurred inside ShotSpotter zones. Table 1 summarizes incident counts inside the ShotSpotter zones and outside the zones within the broader police districts.

Table 1: Numbers of gunshot-related incidents inside and outside ShotSpotter zones between January 1, 2019 and March 31, 2025, by district.

	Campbellton	Central	Cross Creek
Within ShotSpotter zone	68 (16.6%)	24 (7.5%)	47 (10.9%)
Rest of district	341 (83.4 %)	297 (92.5%)	385 (89.1%)

Note: Incidents involving gunshots from Open Data Portal's crimes against persons dataset, downloaded May 12, 2025. See Section D for more details. Percentages (included in parentheses) are within each district.

Protocol for Responding to ShotSpotter Alerts

The Fayetteville Police Department has a documented procedure that officers are instructed to follow to properly *receive*, *respond* to, and *report* outcomes of ShotSpotter alerts (FPD Policy Manual, 2025 [Operating Procedure 11.23]). All officers are instructed to log into the ShotSpotter application at the start of their shift and actively monitor the application throughout their entire shift (including on their city-owned mobile phones for officers who have been issued these devices). When a ShotSpotter alert is received, any available officer not engaged in a higher-priority assignment is required to self-dispatch to the alert location. Upon arrival, officers are expected to thoroughly check the area for evidence of gunfire, secure any evidence, preserve the scene and initiate proper crime scene protocols, and canvass the area for witnesses and surveillance cameras.

Officers are instructed to document all responses to ShotSpotter alerts in the computer-aided dispatch system (CAD) and any relevant incident reports. Even if no evidence or suspicious activity is located, officers are still required to log their response with appropriate notes detailing the search and outcome. Finally, if evidence of a shooting is located, the responding officer must immediately notify a field supervisor and update the ShotSpotter application.

While FPD's Policy Manual (2025) covers a wide range of topics, it does not include a specific procedure for how officers should respond to non-ShotSpotter notifications, such as 911 calls regarding potential gunshot-related incidents. Rather, responses and reporting following these incidents are guided by FPD's more general procedures for responding to calls for service. As discussed elsewhere in this report, the more detailed and explicit reporting procedures for ShotSpotter alerts means that much more data are available for this evaluation for ShotSpotter alerts than for 911 calls.

C. Data Examined

To support our evaluation, we were provided two primary datasets from the Fayetteville Police Department:

(1) *Firearm-Related 911 Calls for Service*, between January 1, 2022 and March 31, 2025:

This dataset includes individual firearm-related 911 calls and the ShotSpotter alerts recorded within the calls for service system during the period.[1] The data we were provided includes 11,471 records.[2] Each record corresponds to a unique call or alert, identified by a distinct call number and timestamped for key events, including when the call or alert was received, officer dispatch, first officer arrival, and when the last unit cleared the scene. Location information includes geocoordinates, street address (with varying specificity), and zonal identifiers. A field indicates the responding agency; while the majority of calls involve the Fayetteville Police Department, other agencies may also be recorded. Each record also specifies the type of complaint—which also indicates whether it was a ShotSpotter alert or ShotSpotter alert alongside a 911 call—and contains a disposition code and an OCA number if linked to a formal incident report. Our team processed the data to determine whether each call or alert occurred within or outside one of the three ShotSpotter coverage zones.[3] To focus on the 18-month period before and after the implementation of ShotSpotter (March 2022 – March 2025), we filtered the data to remove entries from January and February of 2022, leaving 10,863 records. Then, finally, to focus on gunfire incidents, we filtered this dataset to exclude complaints not explicitly related to gunshots, leaving 7,625 records.[4]

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[1] We were also provided a second data file of similar structure to this, which contained only the ShotSpotter alert information. Since this information was fully contained in the larger Firearm-Related Calls for Service data file, we did not use this second file for our evaluative work.

[2] The final data provided to us for the evaluation did not include calls that were marked in the system as duplicates or with certain cancel codes (e.g. ACC and REF).

[3] To do this, the geographical coordinates were mapped to geographical information about the three ShotSpotter zones. ShotSpotter notifications up to 600 feet outside the designated ShotSpotter zones that the City provided were assigned to the closest ShotSpotter zone in order to be included in the analysis. (~18% of ShotSpotter notifications fell outside of the designated zones, since ShotSpotter is able to detect noises just outside of the formal zone boundaries.)

[4] The full calls for service data included a wide range of firearm-related calls, including weapons incidents, concealed and open carry calls, and a large number of complaints coded simply as 135 WEAPONS / FIREARMS or as 135D1 WEAPONS INCIDENT. We filtered this list to focus on explicitly gunshot-related calls only, leading to the following complaint categories: 135B1 PAST SHOTS FIRED, 135B2 PAST SHOTS FIRED,

(2) *ShotSpotter Ground Truth Tracking Workbook*, which contains detailed information about ShotSpotter alerts and their outcomes:

This dataset originates from the Fayetteville Police Department's ShotSpotter software system. It contained 975 records, providing detailed information about each ShotSpotter alert and related police response outcomes for the ShotSpotter coverage zones during the post-installation period (September 26, 2023 – March 31, 2025). Each entry represents a ShotSpotter alert, with multiple entries possible per incident if multiple gunshots were detected with breaks in between. Thus, the 975 records contain 838 distinct calls for service entries (CAD identification numbers), with 93 CAD numbers linked to more than one ShotSpotter ground truth record. For each ShotSpotter alert, the data indicate whether there was a corresponding 911 call.[5] Key features include flags denoting whether the alert reflects multiple gunshots, a single gunshot, or probable gunfire, as well as the number of rounds detected. Time stamps for alert detection and publication are included. Location data comprise ShotSpotter zone assignments, geocoordinates, and associated street addresses. Each record carries a CAD identification number and optionally a case number. Importantly, these data include fields for several outcome measures reported by responding officers, including evidence collection (shell casings, property damage, firearms, other), victim presence and aid rendered, discovery of homicides, whether a witness was identified, and arrests. Additional fields are available to track NIBIN lead numbers, weapons recovered, victim details, offenses, and associated tags. The Ground Truth Worksheet does not contain a field that explicitly indicates whether gunfire was confirmed on the scene, but in Section G we use the available information to approximate which alerts can be considered confirmed.

In addition to the primary datasets, we also used:

(3) The *Incidents – Crimes against Persons data* file from Fayetteville's publicly accessible Open Data Portal:

135B3 PAST SHOTS FIRED (IN ARE..., 135C1 SHOT FIRED (HEARD ONLY), 135D1 SHOTS FIRED SUSP SEEN, 135D2 SHOTS FIRED SUSPECT SEEN, SHOTSPOTTER ALERT, SHOTSPOTTER ALERT W/ 911 CALL.

[5] In fact, two fields in the Worksheet describe whether the ShotSpotter alert had a corresponding 911 call ("Correlating 911 Call" and "ShotSpotter Alert with a Resident 911"). 19 entries in the Worksheet—primarily from the first few months of ShotSpotter's implementation—had opposing information in these two columns in the data we received. Based on our conversations with FPD, we used the Correlating 911 Call field for this determination throughout the evaluation. FPD has now corrected these discrepancies for the future, but only after the evaluation was complete (so those corrections are not reflected in the data presented in this report).

Data from the Fayetteville Open Data Portal are used supplementally to provide additional context for the evaluation. The full Incidents – Crimes against Persons data file was downloaded May 12, 2025, at 9:20 AM from the Fayetteville Open Data Portal, at https://data.fayettevillenc.gov/. This file contained 61,779 total records, and includes case numbers, dates, times, location details, premises types, offense descriptions, and incident statuses. We filtered the data to only include incidents that occurred between January 1, 2019 and March 31, 2025, leaving 31,633 records. For most uses, the data were further filtered to only include entries that involved offenses including the words "SHOOT(ING)" and "DISCHARG(E\ING) FIREARM," leaving 1,166 records related explicitly to gunshot-related incidents.[6] As with the calls for service data, our team processed the geographical information in the Open Data file to determine whether each incident was within or outside one of the three ShotSpotter coverage zones.

It is important to note the major differences between the ShotSpotter-specific data and the more general calls for service data. The Fayetteville Police Department's operating procedures include an extensive documentation process for all ShotSpotter alert responses and the ShotSpotter system collects this information from responding officers and stores it in the ShotSpotter Ground Truth Tracking Worksheet. As a result, the available data on ShotSpotter responses are much more extensive than 911 call responses, outside of the individual police reports. Most critically, we were unable to access data indicating whether 911 calls were confirmed as shots fired, or to assess the outcomes of those calls. These limitations prevent us from drawing conclusions and comparisons about the relative effectiveness of ShotSpotter versus traditional notifications about gunshot-related incidents (i.e., 911 calls).

Additionally, there is not a one-to-one correspondence between all ShotSpotter alerts in the ShotSpotter Ground Truth Tracking Worksheet and the calls for service data. Specifically, 73 of the CAD identification numbers across a total of 85 records in the ShotSpotter Ground Truth data do not occur in the main firearm-related calls for service

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[6] Multiple offenses can be associated with a single entry in the Crimes against Persons data. Our filtering process led to the inclusion of incidents that explicitly involved the following list of offenses: DISCHARGE FIREARM WITHIN ENCLOSURE TO INCITE FEAR, DISCHARING FIREARM INTO OCCUPIED PROPERTY, SHOOT INTO OCCUP DWELL FEL, SHOOT INTO OCCUP VEH FEL, and SHOOTING INTO OCCUPIED DWELLING. We note that this excludes a number of possible gun-related offenses, including the several ASSAULT WITH A DEADLY WEAPON incident types and CRIMINAL HOMICIDE – MURDER, which are only included in the data we examine when they co-occur with one of the explicit gunshot offenses.

dataset that we received. These may represent calls that were canceled or marked as duplicates in the system, but we cannot confirm the reasons for each discrepancy. Due to these differences, we did not merge these three datasets but rather focused the majority of the evaluation's analyses on individual datasets, only connecting between datasets when a particular question calls for it.

The data were analyzed quantitatively in several ways, with analyses using different methods and data files across sections. Methodological details, and more details about the data, are described in more detail throughout the report.

D. Recent Trends in Gunshot-Related Crimes in Fayetteville: Context for ShotSpotter Implementation

In this section, we review patterns of gunshot-related crimes in Fayetteville from 2019 through early 2025, utilizing the city's Open Data Incidents – Crimes against Persons dataset. This overview is meant to provide context for Fayetteville's adoption and deployment of ShotSpotter gunshot detection technology in September 2023, and the ShotSpotter notifications and 911 call data that are central to this report. For more information on gun violence in Fayetteville, see the report being prepared by UNC – Charlotte's Urban Institute.

Fayetteville's Open Data Portal provides a wide range of public data from across the City government's departments, including the Fayetteville Police Department. Crime data are available for crimes against persons, crimes against property, and crimes against society. For our purposes, we focus on the crimes against persons data, introduced in Section C, above.

We acknowledge the Portal's disclaimer that these data may vary from official recorded statistics after investigations. We also note that these data change over time as investigations are completed or other information comes to light. These data are not meant here to represent official crime statistics or to portray the precise number of gunshot-related crimes in Fayetteville in this period. As explored in Section G, where we compare the OCA (incident) numbers in the calls for service data to the Open Data, only a small number the incidents in the calls for service data can be traced forward into the crimes against persons data. Nonetheless, we believe these data provide valuable context for the gunshot-related calls and notifications that are central to this report. Thus, we use these

data to establish a general background for the 911 calls and ShotSpotter alerts received by the Fayetteville Police Department during the periods under examination.

Figure 2 presents monthly counts of gunshot-related incidents citywide in the crimes against persons data from January 2019 through March 2025, divided into incidents occurring within ShotSpotter zones and those outside. The figure includes smoothed trend lines (dashed lines), generated by locally estimated scatterplot smoothing (LOESS) methods, which help to identify the overarching temporal patterns among the natural month-by-month variability. Dashed gray vertical lines note the beginning of the overall evaluation period (March 1, 2022) and the beginning of ShotSpotter's implementation (September 26, 2023).

Figure 2: Reported Gunshot-Related Incidents involving Crimes against Persons in Fayetteville, January 2019 – March 2025.
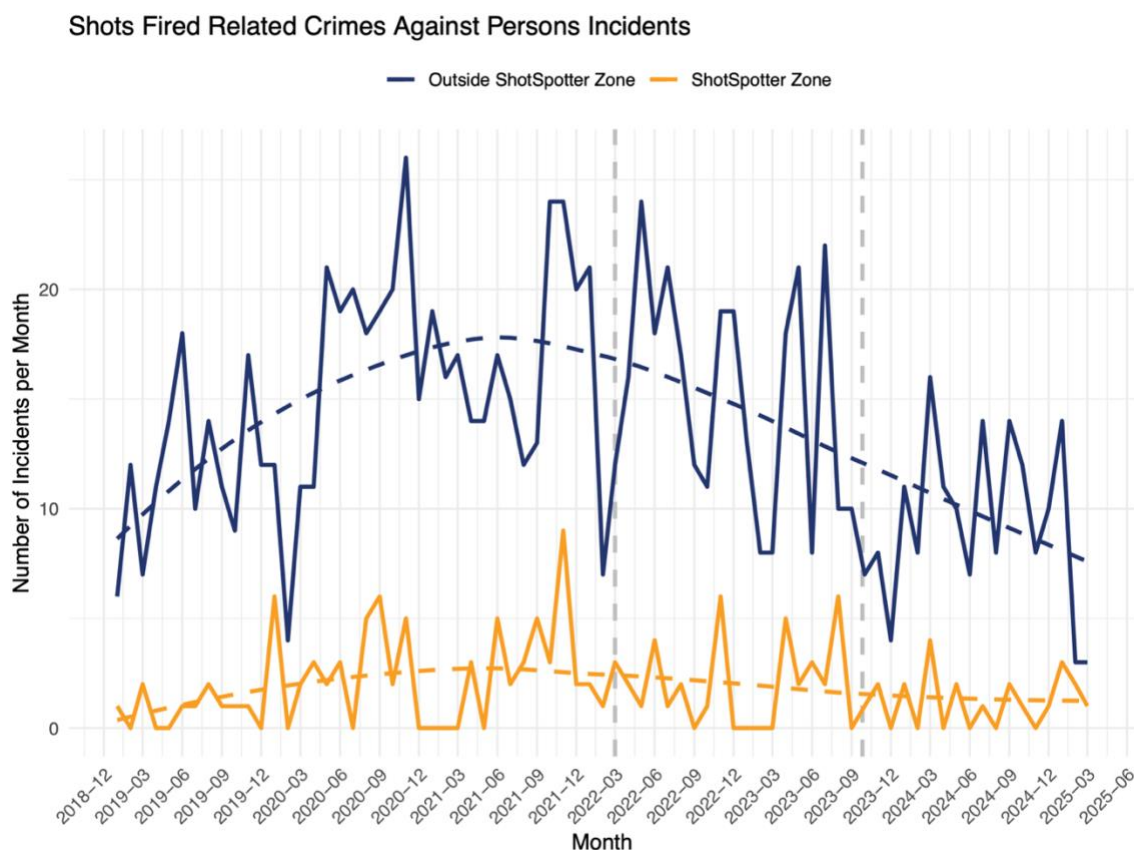
Note: Incident counts are separated by location within and outside ShotSpotter zones. LOESS smoothed trend lines (dotted) highlight underlying temporal patterns. Dashed gray vertical lines identifies the start of our evaluation period on March 1, 2022, and the start of ShotSpotter's implementation on September 26, 2023.

Important observations include:

- Gunshot-related incidents in Fayetteville peaked in 2020 and 2021 (during the COVID-19 pandemic), consistent with broader national and regional trends in gun violence (e.g., Gramlich, 2025; Lopez & Boxerman, 2025).

- A discernable decline in gunshot-related incidents began in 2022 and continued through 2025.

- Average monthly incident counts decreased from approximately 16.7 (January 2019–February 2022) and 17.1 (March 2022–September 25, 2023) to 10.6 (September 26, 2023–March 2025), corresponding with the period of ShotSpotter operations.

- Incident levels in the three ShotSpotter zones also peaked in 2020 and 2021, but consistently represent a higher proportion of the gunshot-related incidents (on average 11% of the city's gunshot-related incidents) compared to the land area of the zones (3%).

These data provide a baseline understanding of gunfire-related offenses in Fayetteville prior to and following ShotSpotter technology implementation. They also serve as a critical backdrop for interpreting 911 calls and ShotSpotter alert data in subsequent sections.

E. The Contribution of ShotSpotter to Gunshot Notifications

Before and since the implementation of ShotSpotter, the Fayetteville Police Department (FPD) is routinely notified of gunshot incidents through 911 calls from residents. ShotSpotter provides an additional source of alerts about potential gunshot incidents for the ShotSpotter zones during the implementation period. These ShotSpotter notifications typically arrive faster than traditional 911 calls and provide precise geolocations for the source of the noise detected as a gunshot.

As introduced earlier, FPD provided information on ShotSpotter alerts beginning with the onset of ShotSpotter in September of 2023, along with information on firearm-related 911 calls for service received between January 2022 and March 2025. For this analysis, we excluded all calls before March 2022, to examine two comparable 18-month periods: the

pre-ShotSpotter period (March 1, 2022 – Sept. 25, 2023) and the ShotSpotter implementation period (Sept. 26, 2023 – March 31, 2025).

In this section, we examine the number and proportion of gunfire notifications by source before and after ShotSpotter implementation (before: 911 calls only; after: ShotSpotter alerts only, 911 calls only, and ShotSpotter alerts with corresponding 911 calls). We also examine notifications within and outside of the ShotSpotter zones. This allows us to consider if and how the installation of ShotSpotter affected calls for service and overall notifications about potential gunshots within the city.

The data for this part of our evaluation come from the firearm-related 911 calls for service data that we received from FPD and filtered for only gunshot-related calls for service. As described in Section C, the data contain detailed information on call timing and several response time metrics (which are the subject of Section F), as well as the geocoordinates for each complaint. These coordinates enabled us to classify each call as occurring within or outside the designated ShotSpotter zones. As mentioned earlier, these data do not include information about outcomes of police responses, such as whether gunfire was confirmed or whether a witness was identified.

We divided the study period into two roughly equal timeframes (Periods):

- Before Implementation (March 1, 2022 – September 25, 2023)
- After Implementation (September 26, 2023 – March 31, 2025)

By examining gunshot-related notifications during these windows, both within and outside ShotSpotter zones, we explore ShotSpotter's influence on gunshot notification patterns.

Figure 3 displays gunshot-related calls for service and ShotSpotter notifications over the entire study period, separated by before and after implementation periods. The volume of 911 calls across the city declines after ShotSpotter installation, though this decline is smaller when combined with ShotSpotter alerts.

Figure 3: Gunshot-Related Calls for Service & Alert Types across Fayetteville, by Period, March 2022 – March 2025.
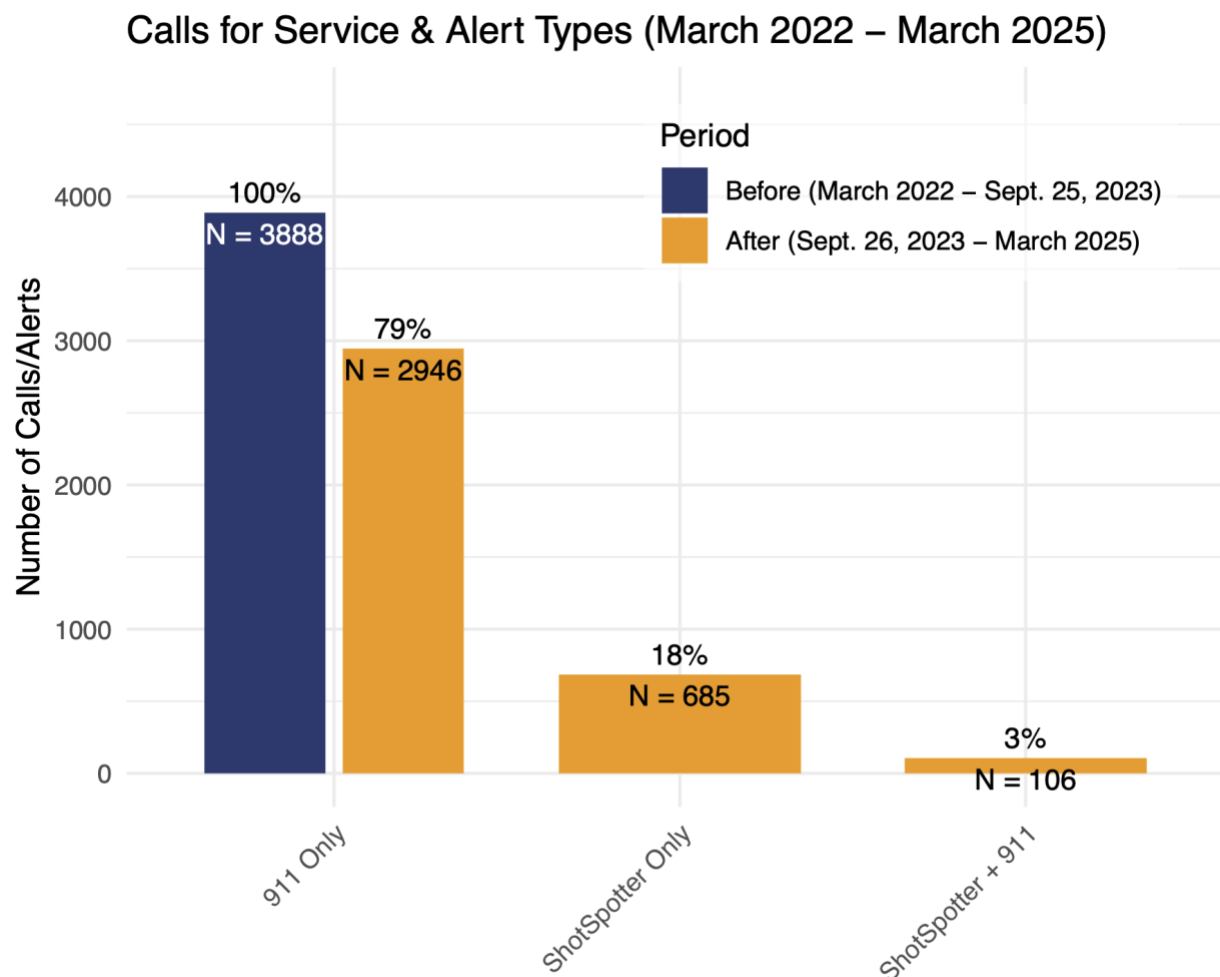
Note: Calls for service are separated by Period (Before or After Implementation). Percentages in the figure represent the number of calls or alerts relative to the total number of calls and alerts for the entire period.

During the ShotSpotter period, 3,737 total gunshot-related notifications were recorded. There were 2,858 911-only calls from outside ShotSpotter zones. Within zones, there were 88 911-only calls, 685 ShotSpotter-only alerts, and 106 ShotSpotter alerts that also had a corresponding 911 call. This is displayed in Figure 4.

Figure 4: Gunshot-Related Calls for Service & Alert Types, by Location, Sept. 26, 2023 – March 2025.

Calls for Service & Alert Types (Sept. 26, 2023 – March 2025)
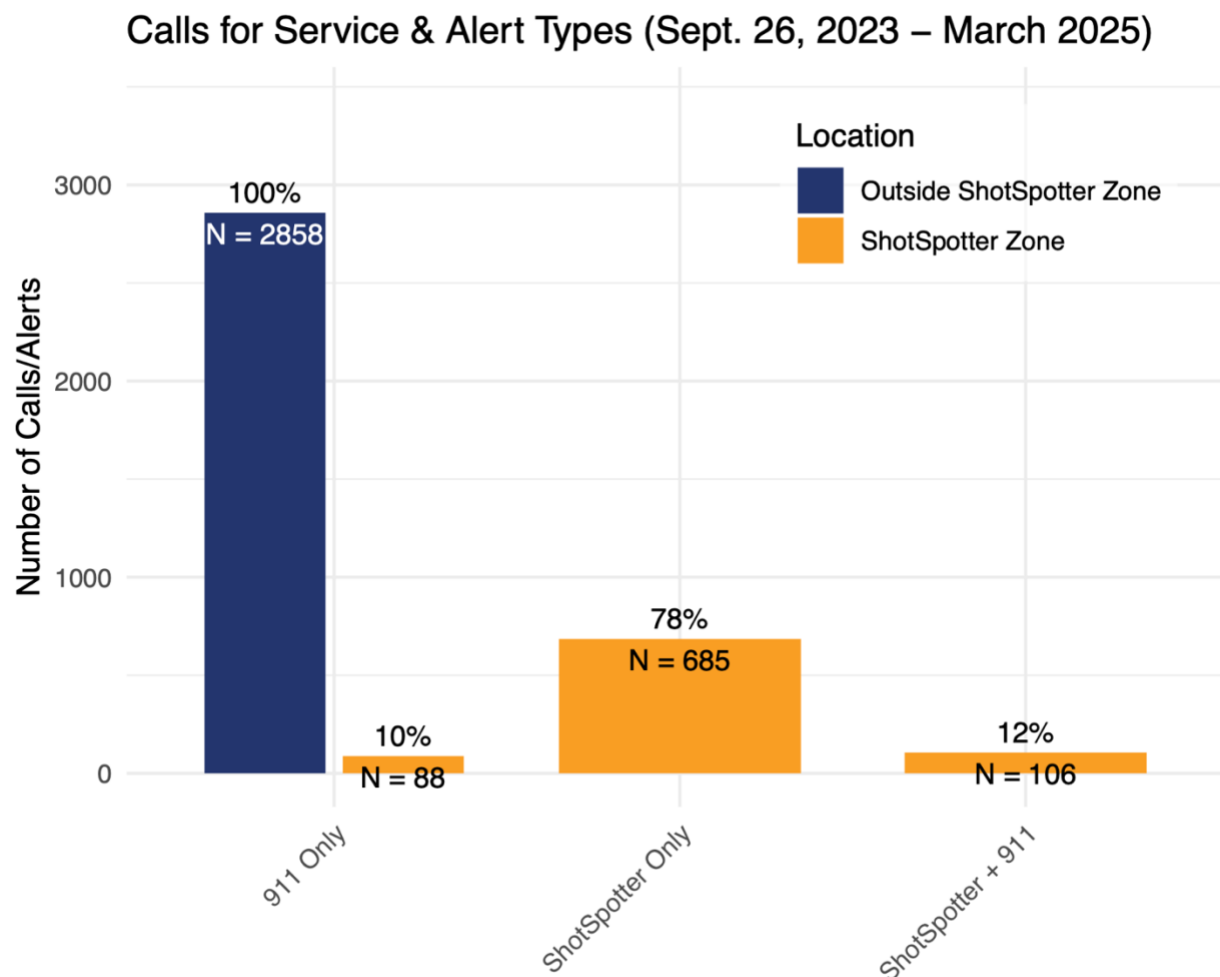
Note: Calls for service are separated by whether they occur within or outside a ShotSpotter coverage zone. Percentages in the figure represent the number of calls or alerts relative to the total number of calls and alerts for the entire period.

Figure 5 displays the month-by-month frequency of the calls for service and alert types, separated by whether they occur within or outside a ShotSpotter coverage zone. The dashed gray vertical line identifies the beginning of ShotSpotter in September of 2023. Several notable trends are apparent. Overall, the call volume related to gunshots decreased over the 36-month period we are examining. This is in line with the decrease in gunshot related incidents represented in the city's crimes against persons data (seen earlier in Figure 2).

Figure 5: Calls for Service & ShotSpotter Alerts, March 2022 – March 2025.
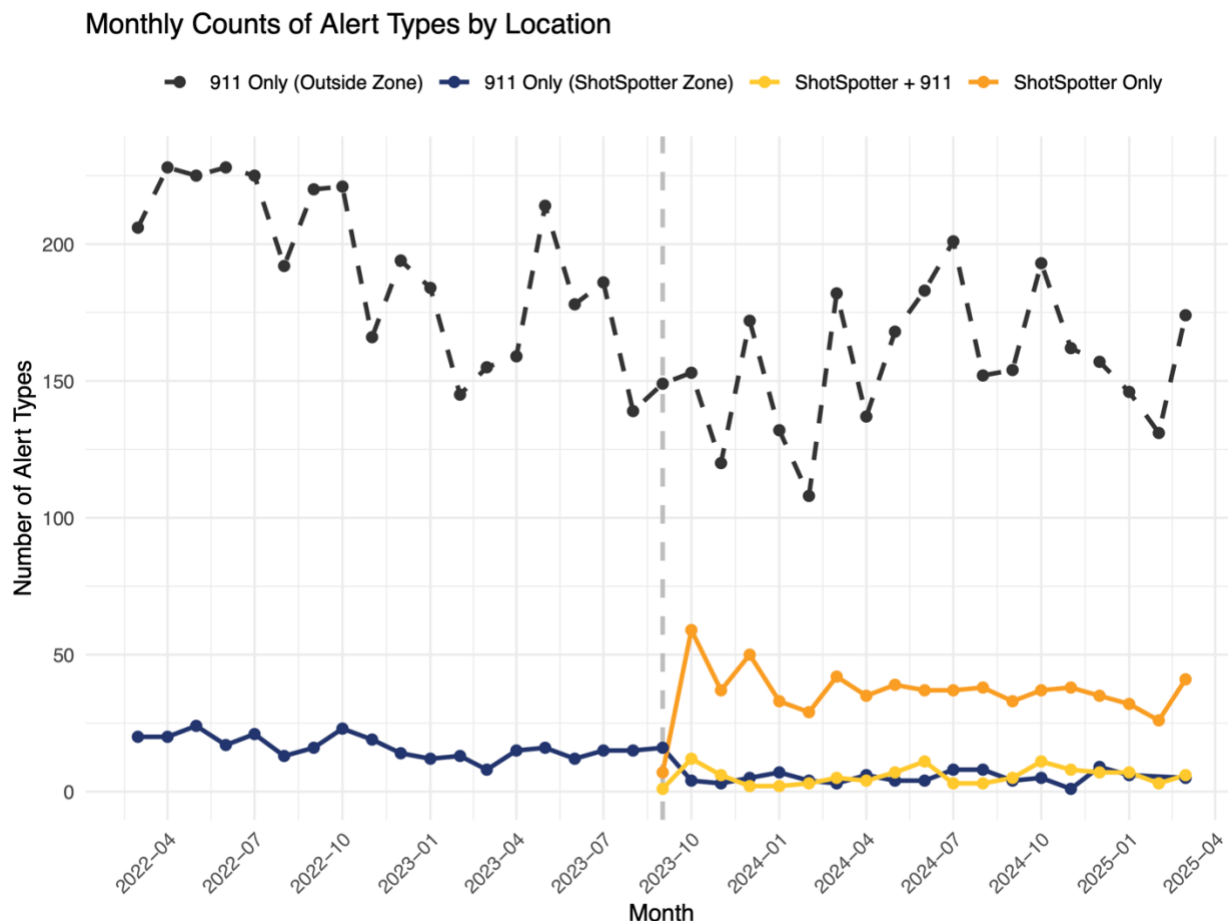
Note: The dashed gray vertical line identifies September 2023, when ShotSpotter implementation began.

As noted earlier with Figure 3, the onset of ShotSpotter corresponds with a decrease in 911 calls for service. This is particularly true within the ShotSpotter zones and is clearly visible in Figure 5. However, to interpret the data accurately, it is important to note that both the 911 Only (blue solid line) and ShotSpotter + 911 (yellow line) totals include 911 calls, and therefore must be considered together during the ShotSpotter period. While the total number of 911 calls in the SS zones decrease, the decline is smaller than appears at first glance in the figure. Table 2 displays the actual number of 911 calls inside and outside the SS zones.

Table 2: 911 Calls for Service Totals outside and within SS zones, by Period.

	Outside ShotSpotter Zone	ShotSpotter Zones
Before Implementation	3,581 (92.1%)	307 (7.9%)
After Implementation	2,858 (93.6 %)	194 (6.4%)

The difference in 911 calls within the ShotSpotter zones is small. However, a chi-square test of independence was conducted to examine whether the distribution of incidents between the ShotSpotter zones and the rest of the city differed across two time periods: before ShotSpotter implementation (March 2022 – September 25, 2023) and after implementation (September 26, 2023 – March 2025). The results indicated a statistically significant association between time period and location of incidents, χ^2(1, N = 6940) = 5.82, p = 0.016. This suggests that the relative frequency of calls across these two parts of the city did change following the introduction of ShotSpotter technology: Residents made relatively fewer 911 calls related to gunshots once ShotSpotter was in effect. However, we cannot attribute this change to ShotSpotter itself. It is possible that the relative decrease in 911 calls after the implementation of ShotSpotter corresponds to an overall decrease in gunshot-related incidents in this same time period, rather than a result of ShotSpotter itself.

ShotSpotter alerts were consistently received at higher rates than 911 calls within the ShotSpotter zones throughout ShotSpotter's implementation. Between October 2023 and March 2025, FPD received an average of 43.5 ShotSpotter alerts per month, with a low of 29 in February 2025 and a peak of 71 in October 2023, the first full month of ShotSpotter. In comparison, 911 calls for service in the same zones averaged 10.6 after the implementation of ShotSpotter, ranging from a low of 3 in February 2025 to a high of 16 in three separate months. Prior to implementation, the number of 911 calls for service in these zones averaged 16.3 per month, with a low of 8 in March 2023 and a high of 24 in May 2022.[7] Overall, the volume of ShotSpotter alerts is much higher than 911 calls—2.67 times higher than the pre-implementation average and 4.10 times higher than the post-implementation average. This may reflect ShotSpotter's increased sensitivity to detecting gunshots and the efficiency of its alert system, but likely also reflects a number of false alarms.

Finally, we compare the month-by-month crimes against persons data from the Open Data Portal with the calls for service data to examine how the volume of calls and ShotSpotter alerts relates to the longer-term outcomes of police investigations and gun-related crime in

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[7] The monthly averages reported here do not include September 2023, since ShotSpotter implementation began partway during the month.

Fayetteville. A 911 call and/or a ShotSpotter alert represents the initial notification to police about a *potential* gunshot-related crime incident, while the crimes against persons incidents represents the outcome of a police response or investigation (a criminal incident record of a gunshot incident). If the number of 911 calls and ShotSpotter alerts accurately reflect real-world gun crime, we would expect a correspondence between the two datasets.

Figure 6 displays two scatter plots. On the left are the total number of gunshot-related 911 calls per month (not including ShotSpotter notifications) plotted against the total number of gunshot-related incidents in the Open Data for the same month. On the right are all gunshot notifications (911 calls and ShotSpotter alerts) plotted against the same number of incidents. The line in each plot shows the correlation between the two values. The 911 calls alone are significantly correlated with the Open Data incidents ($r = 0.55$, $p < 0.001$). Once ShotSpotter notifications are added (plot on right), the correlation is no longer significant ($r = 0.257$, $p = 0.125$). This can be taken as useful evidence that the volume of 911 calls alone map onto the eventual outcomes of police investigations, but the total volume of calls and alerts, when including SS notifications, do not.

Figure 6: Correlations between Calls for Service & Alerts and Reported Incidents.
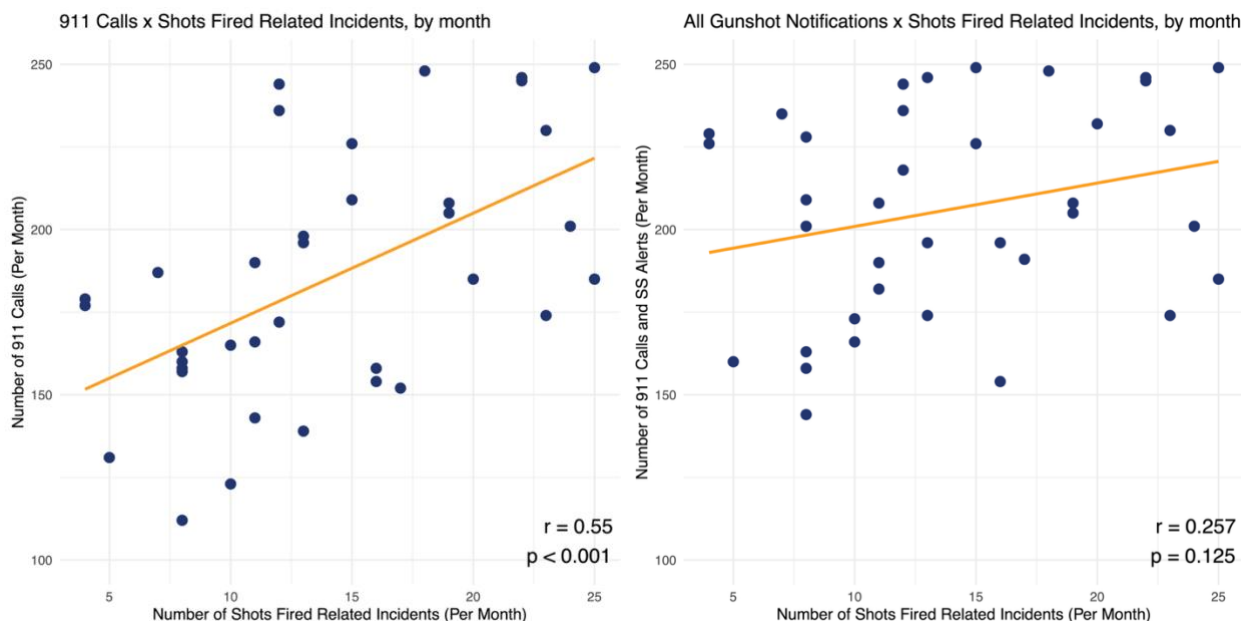
Note: The orange lines represent the linear relationship between the total number of shots fired related incidents and the total number of notifications.

It has been well established in examinations of ShotSpotter implementations across numerous jurisdictions that the number of ShotSpotter alerts is much higher than the number of 911 calls for service about gunshots, and that the majority of ShotSpotter alerts are unable to be confirmed (e.g., Cook & Soliman, 2024; New York City Comptroller, 2024; Piza et al., 2024). In Section G, we will examine confirmation rates for ShotSpotter alerts, and the productivity of police response to ShotSpotter alerts in Sections H and I. We do not have data to validate whether the higher volume of ShotSpotter alerts in the ShotSpotter zones corresponds to actual rates of shots fired. However, our analysis of calls for service and ShotSpotter alerts indicates that the increased number of gunshot-related alerts generated by ShotSpotter does not correspond to a greater number of actual (i.e., published) gunshot-related incidents.

F. Response Times

ShotSpotter is designed not only to increase the likelihood that a shooting will be known to the police, but also to reduce the time elapsed from the shooting until an officer arrives at the scene. This section examines whether police response times in ShotSpotter zones decreased following implementation.

We assessed FPD's response time to shots fired incidents citywide between March 1, 2022, and March 31, 2025, analyzing by ShotSpotter zone, alert type, and period, whether before or after ShotSpotter's implementation, using the gunshot-related calls for service data. We focused on three key metrics:[8]

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[8] One might also be interested in understanding the time between when ShotSpotter first detects a gunshot-like noise and when FPD was notified. This is theoretically calculable and the data we were provided includes an initial date- and timestamp for each ShotSpotter event in addition to the several timestamps available in the calls for service data file. However, comparing these to the receiving call timestamp uncovers variability in the ShotSpotter event date- and timestamps that make us hesitate to interpret the differences. From the 880 ShotSpotter events in the Ground Truth Tracking Worksheet that we can map onto the calls for service data, 51 have negative time differences between the ShotSpotter event and the time received by the calls for service system and 2 have time differences greater than 3 hours. Removing these 53 instances, the median time difference for the remaining 827 alerts is 56 seconds (mean = 64.0, standard deviation = 35.5). To the extent that we trust these data as a proxy for the lag between when ShotSpotter detects a gunshot-like noise and the notification of a gunshot alert being received by FPD, this suggests that it takes about 1 minute for ShotSpotter to process the detection and send it on to the calls for service system. While we have no way to measure the comparable delays with respect to 911 calls (the time between when a person hears a gunshot and the call for service is received), we think it is fair to expect that SS alerts almost always come first when there are both types of gunfire notification. We also note that FPD's protocols for ShotSpotter alerts mean that officers directly receive the ShotSpotter alerts and self-dispatch to respond. The timing of the

1. Time from *receiving call to dispatch*,
2. Time from *receiving call to first officer arrival*, and
3. Time from *first officer arrival to last unit cleared*.

Prior to calculating response times, we excluded cases where there were missing data in one or both fields used to compute these metrics. We also excluded response times outside three median absolute deviations for each metric.[9] In order to assess which differences were statistically significant, we conducted Kruskal-Wallis statistical tests between all possible combinations of ShotSpotter zones and alert types for each variable. We followed this with a Dunn test using the Bonferroni correction, a post-hoc test employed after a Kruskal-Wallis test when comparing multiple groups. This secondary test helps identify which specific pairs of groups have significantly different medians, after the Kruskal-Wallis test indicates an overall significant difference. Specifically, the Bonferroni correction is applied to adjust the significance level for multiple comparisons, reducing the chance of false positives.

Receiving call to dispatch measures the amount of time (in seconds) between FPD receiving an alert about a shots fired incident—via 911 call, ShotSpotter alert, or both—and when officers are dispatched to the scene. As shown in Figure 7, dispatch times were significantly longer when FPD received only a 911 call (~204 seconds on average across the three zones) compared to when FPD received either a ShotSpotter alert alone (~69 seconds) or a ShotSpotter alert in addition to a 911 call (~68 seconds): ShotSpotter alerts versus 911 calls, $Z = 29.27$, $p < .001$; ShotSpotter alerts + 911 calls versus 911 calls alone, $Z = 12.62$, $p < .001$. In other words, officers were dispatched over 2 minutes (~135 seconds) faster when a ShotSpotter alert was involved, regardless of whether a 911 call was also received.

There was no significant difference in dispatch times between cases involving only a ShotSpotter alert and those involving both a ShotSpotter alert and a 911 call. These patterns are consistent across all three ShotSpotter zones.

Finally, for incidents involving 911 calls only, dispatch times were similar in the ShotSpotter zones and the rest of Fayetteville. Put another way, the presence of ShotSpotter in a zone did not significantly affect dispatch times for 911 calls. These faster dispatch times for ShotSpotter alerts are consistent with FPD's operating procedure for responses to

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officers' notification could be different from when the ShotSpotter alert is logged into the calls for service system.

[9] While these cases were retained for other analyses, they were removed from response time analyses in order to prevent extreme outliers from skewing the results, as these values can disproportionately influence measures of central tendency and variability in non-normally distributed reaction time data.

ShotSpotter alerts, which has officers monitor for ShotSpotter alerts and self-dispatch to the alert location.

Figure 7: Response Time - Receiving Call to Dispatch by ShotSpotter Zone and Alert Type, March 2022 - March 2025.
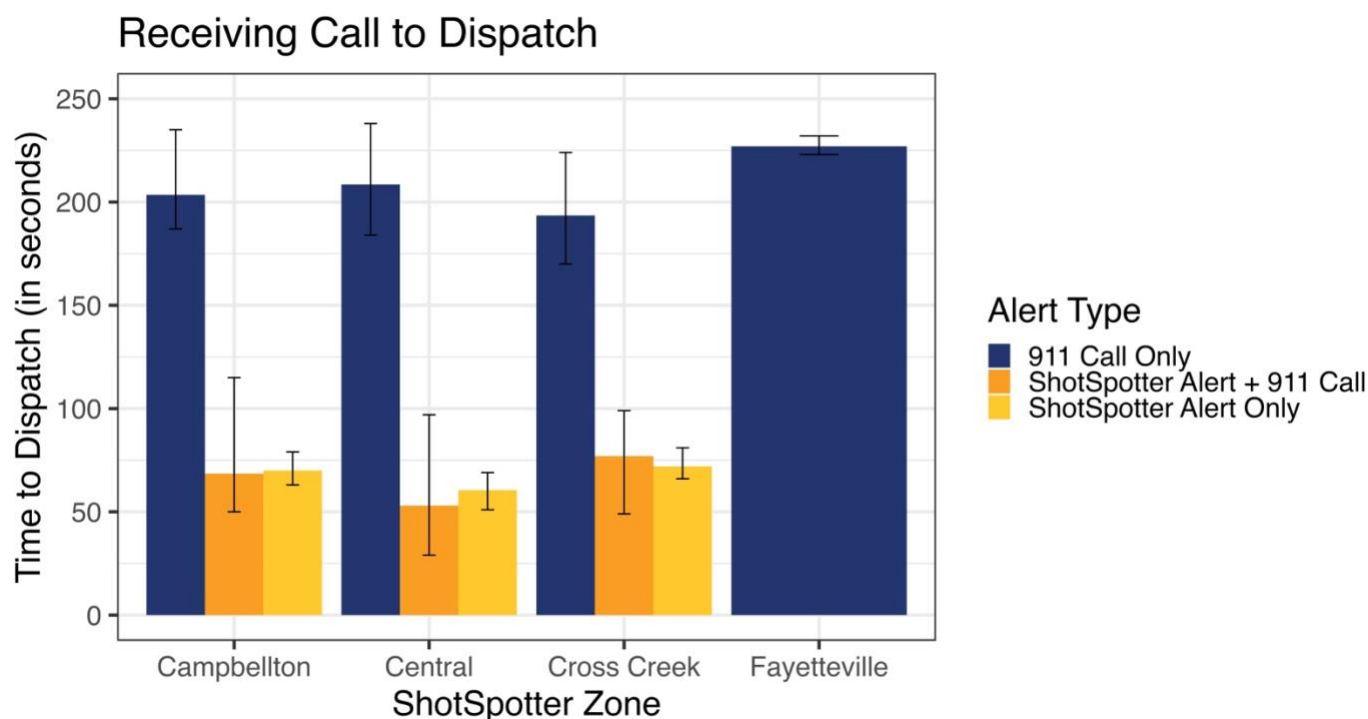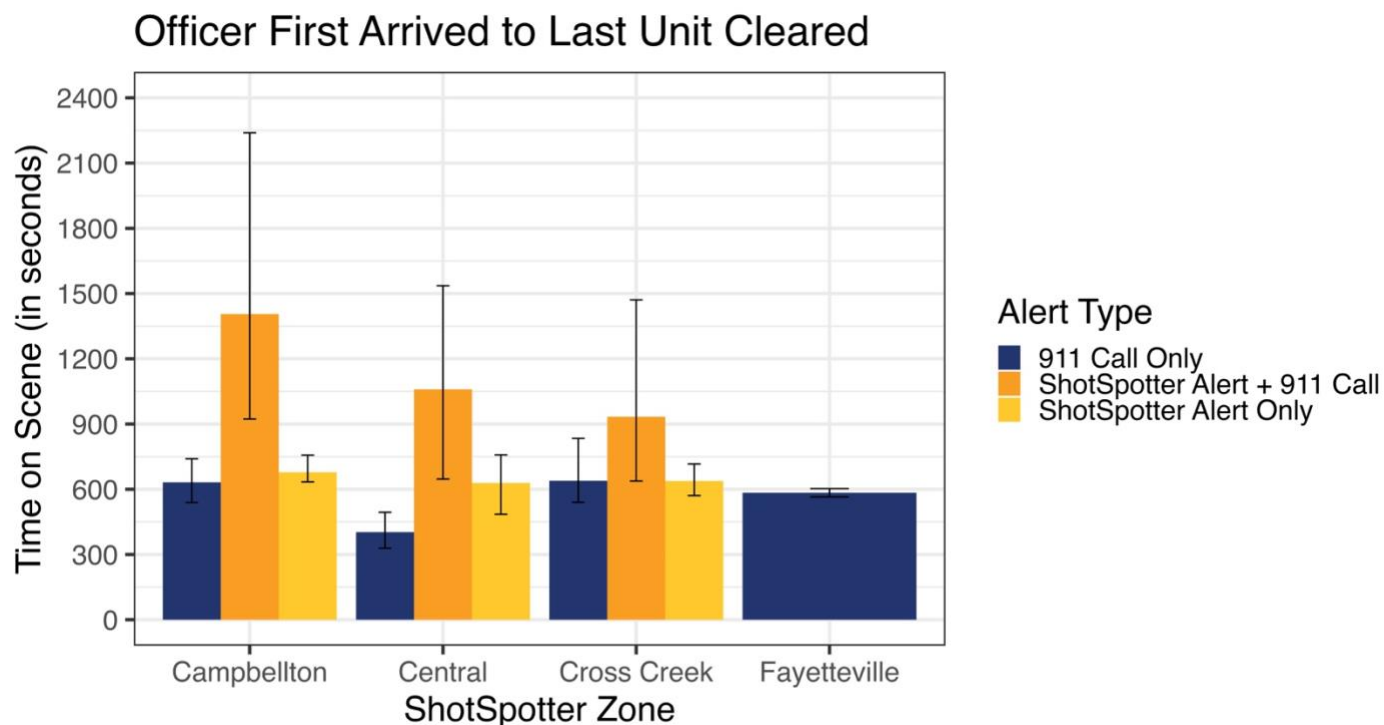

Note: Fayetteville refers to all areas of Fayetteville outside the three defined ShotSpotter zones. For this figure, the Time to Dispatch upper limit is 250 seconds. Error bars indicate 95% confidence intervals around the median.

Receiving call to first officer arriving measures the time (in seconds) between when FPD receives an alert about a shots fired incident—via 911 call, ShotSpotter alert, or both—and when the first officer(s) arrive on scene. As Figure 8 illustrates, FPD officers arrive on scene more quickly in response to ShotSpotter alerts (~422 seconds or about 7 minutes across the three zones) or ShotSpotter alerts paired with 911 calls (~375 seconds or over 6 minutes), compared to 911 calls alone (~541 seconds or about 9 minutes): ShotSpotter alerts versus 911 calls, Z = 18.01, *p* < .001; ShotSpotter alerts + 911 calls versus 911 calls alone, Z = 9.00, *p* < .001. These patterns are consistent with the faster dispatch times discussed earlier. Again, there was no significant difference in arrival times between cases involving only a ShotSpotter alert and those involving both a ShotSpotter alert and a 911 call. These patterns are again the same across all three ShotSpotter zones.

For incidents involving only 911 calls, officers in the Campbellton (~549 seconds or about 9 minutes) and Cross Creek (~505 seconds or about 8.5 minutes) zones arrived more quickly than in the rest of Fayetteville (~650 seconds or almost 11 minutes): Campbellton zone versus Fayetteville, $Z = 3.60$, $p = .014$; Cross Creek zone versus Fayetteville, $Z = 4.46$, $p < .001$. Note that there was no significant difference in response times between the Central zone (590 seconds or almost 10 minutes) and the rest of Fayetteville.

Although officer arrival times were faster when responding to ShotSpotter alerts than to 911 calls alone, the difference is smaller than the corresponding difference for the dispatch time. In other words, this suggests that ShotSpotter's most notable effect on response time occurs earlier in the process, by reducing the amount of time it takes to dispatch officers after receiving an alert.

Figure 8: Response Time - Receiving Call to First Officer Arriving by ShotSpotter Zone and Alert Type, March 2022 - March 2025.
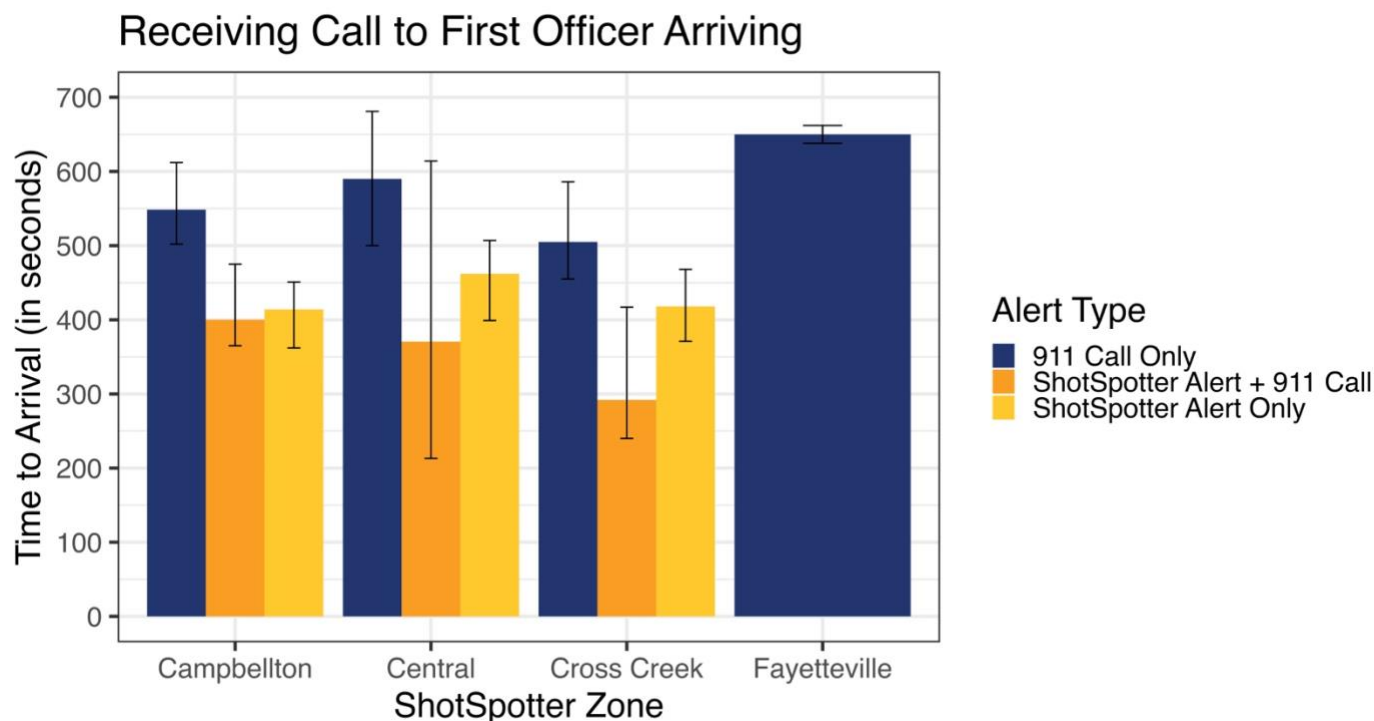
Note: Fayetteville refers to all areas of Fayetteville outside the three defined ShotSpotter zones. For this figure, the Time to Arrival upper limit is 700 seconds. Error bars indicate 95% confidence intervals around the median.

Officer first arriving to last unit cleared measures the time (in seconds) between the arrival of the first FPD officer on scene and the departure of the last FPD unit. In other words, this metric reflects the total time officers spent on scene responding to a shots fired incident, whether triggered by a ShotSpotter alert, a 911 call, or both. Figure 9 shows that—across all three ShotSpotter zones—officers spent the most time on scene when incidents were reported through *both* ShotSpotter alerts and 911 calls (~19 minutes) compared to those reported through only one source (~11 minutes for ShotSpotter alerts only and ~10 minutes for 911 calls only): both notifications versus ShotSpotter alerts only, Z = 4.40, *p* < .001; both notifications versus 911 calls only, Z = 5.54, *p* < .001. This difference may reflect that incidents triggering both types of alerts are more likely to be more serious or to be perceived as higher severity.

There were significant differences between a few individual comparisons of the time spent on scene between ShotSpotter-only and 911-only incidents. Specifically, officers spent more time on scene when responding to ShotSpotter-only alerts in the Campbellton zone than 911-only calls in the Central zone: Z = 4.60, *p* < .001. They also spent more time responding to ShotSpotter-only alerts in the Cross Creek zone compared to 911-only calls in the Central zone: Z = 3.32, *p* = .040. Finally, officers spent more time on scene in response to ShotSpotter-only alerts in the Campbellton zone than 911 calls in the rest of Fayetteville: Z = 3.31, *p* = .042.

The time officers spent on scene in response to 911 calls alone was largely similar across all three ShotSpotter zones and the rest of Fayetteville, with two exceptions: officers spent more time responding to 911 calls from both the Cross Creek zone (Z = 3.43, *p* = .027) and the rest of Fayetteville (Z = 3.31, *p* = .042), compared to 911 calls from the Central zone.

Figure 9: Response Time - Officer First Arrived to Last Unit Cleared, by ShotSpotter Zone and Alert Type, March 2022 - March 2025.

Note: Fayetteville refers to all areas of Fayetteville outside the three defined ShotSpotter zones. For this figure, the Time on Scene upper limit is 2400 seconds. Error bars indicate 95% confidence intervals around the median.

Overall, ShotSpotter reduced the time between FPD initially receiving an alert and dispatching officer(s) to the scene. This faster dispatch time carried over into how quickly officers arrived on scene. These patterns were consistent across all three ShotSpotter zones. Finally, FPD officers spent more time on scene for cases that were reported through both ShotSpotter and 911, as compared to incidents that received only either a ShotSpotter alert or a 911 call.

G. Approximating the Rates of Confirmed Gunshots

When police officers respond to a 911 call or ShotSpotter alert, they are responding to a *potential* instance of gun violence. But many 911 calls and ShotSpotter alerts cannot be

confirmed. Some are false alarms. The caller may have misheard or misinterpreted the situation, or the ShotSpotter system may have detected some other sound. In other cases, a gun may have been fired, but responding officers may find no evidence or witnesses to confirm it. Incidents can be resolved in numerous ways. If officers arrive to an empty scene with no evidence of a crime, the call might be closed. If a crime was discovered or the responding officers had reason to investigate further, the incident may receive an OCA (incident) number. In some cases, officers arrive on the scene to find a victim of a shooting, and sometimes arrests are made immediately in response to the 911 call or ShotSpotter alert.

If a police response follows a ShotSpotter alert, then the police officers also track any evidence or information collected in the ShotSpotter system, which feeds to the ShotSpotter Ground Truth Tracking Worksheet. As described earlier, without an explicit and similar procedure in place for other responses to potential gunshot-related incidents, information from the responses to 911 calls is not tracked as closely and appears only in the incident reports, which were unavailable for review in this evaluation.

In addition, the calls for service and ShotSpotter systems can be updated during or just after the police response. Information or an incident can also be added later, should additional information come to light. Thus, the record for what happened in response to a 911 call or ShotSpotter alert can change over time.

Ideally, we would have detailed data on the rates of confirmation for 911 calls and ShotSpotter notifications, as well as the outcomes from each police response to these alerts. However, this level of detail is not available to us. Specifically, we cannot examine whether individual 911 calls were confirmed by the responding police officer(s) as involving gunshots or assess the investigative results from those responses.

In this section, we seek to shed light on the rates at which FPD's responses to 911 calls and ShotSpotter alerts correspond to confirmed gunshot-related crimes. While we are unable to examine direct reports from responding police officers, we use two sets of information as proxies for whether shots were confirmed for a given call or ShotSpotter alert. First, we examine the presence or absence of an OCA (incident) number with each entry in the gunshot-related calls for service dataset. Second, we analyze the ShotSpotter Ground Truth Tracking Worksheet, which provides more detailed ground truth measures for each alert.

Estimating Outcomes Using OCAs

One simple measure of the severity of an incident that a police officer responds to is whether an OCA (incident) number was assigned to the call. While this does not confirm that a gunshot was specifically verified on scene (and the data do not indicate whether the incident report was created immediately or added later), the association of an OCA number with a call or alert suggests that the response was substantial enough to warrant an incident report.[10] Drawing from the 911 calls for service data, Figure 10 displays the numbers of 911 calls, ShotSpotter alerts, and ShotSpotter alerts with corresponding 911 calls, with associated OCA numbers over the entire period from March 2022 to March 2025. The figure also displays the percentages with OCAs for each call/alert type. While the overall number of 911 calls exceeds the amount of ShotSpotter alerts, it is notable that both 911-only and ShotSpotter-only notifications have similar rates of OCAs (18.0% for 911 calls, 17.8% for ShotSpotter alerts). At the same time, while an overall smaller total number, half (49.1%) of the ShotSpotter alerts with corresponding 911 calls have associated OCAs. As will be revisited in the following sections, this higher proportion suggests that the combination of ShotSpotter with community-driven 911 calls for service are the most productive. This could be indicative of incidents that are, on average, of greater severity than the calls or ShotSpotter alerts alone. It could also be a function of the faster response time associated with ShotSpotter alerts and a greater likelihood of an actual crime occurring due to both forms of notification. Ultimately, we cannot offer an explanation, but we note the higher "yield" resulting from both forms of police notifications.

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[10] While the association of an OCA number with a 911 call or ShotSpotter alert is not direct evidence that the responding officers initiated the incident report, the lack of an associated OCA number can be taken as an indication that an incident report was never created, meaning that the initial call or alert never evolved into a recorded criminal incident.

Figure 10: Calls for Service and SS Alerts with and without Corresponding OCA Numbers.

Calls for Service & Alerts with OCAs (March 2022 – March 2025)
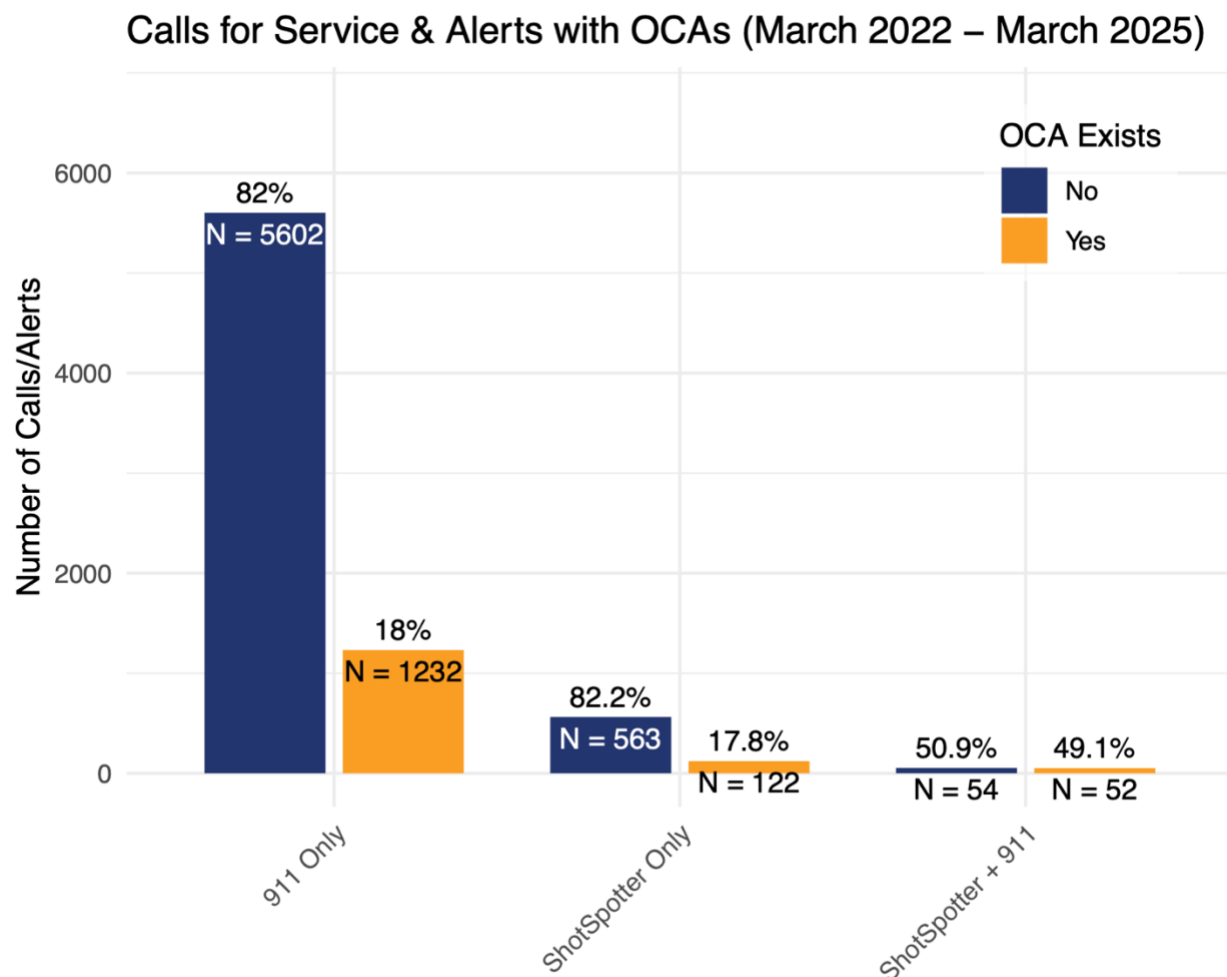
Note: Percentages reflect the rates within each call/alert type.

This roughly similar proportion of 911 calls and ShotSpotter alerts with OCAs (~18%) could be taken as an indicator that ShotSpotter alerts and traditional 911 calls have yielded similar numbers of confirmed shots fired incidents (again, with the assignment of an OCA serving as a rough proxy for whether a criminal incident was determined to have occurred).

A more stringent test can be done by identifying which OCA numbers in the calls for service data align with the incident numbers in the crimes against person offenses available in the Open Data, and using those matched incidents as the evidence for whether a 911 call, ShotSpotter alert, or combined ShotSpotter alert + 911 call resulted in a confirmed criminal offense. To do this, we compared all OCAs in the calls for service data set to the

case numbers in the full crimes against persons data.[11] Figure 11 displays the number of calls and alerts with OCA numbers that are able to be matched to a case number in the Open Data crimes against persons dataset. These matched OCAs are substantially lower than the counts of calls and alerts with associated OCA numbers. Here the number of ShotSpotter alerts with matched OCAs is quite low, with only 1.5% of the total number of ShotSpotter alerts matching an entry in the crimes against persons data (10/685). A somewhat higher number, 5.8%, of the conventional 911 calls yield matches (394/6834). The number of ShotSpotter + 911 calls with matched OCAs is lower than the ~50% total that have OCA numbers, but still has the largest proportional yield, with 13.2% of the alerts + calls (14/106) having an OCA number that matches an entry in the crimes against persons data.

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[11] For this process we used the entire incidents – crimes against persons data, not the version we filtered to remove incidents that did not explicitly reference gunshots. We also reiterate the disclaimer from the Open Data Portal, that the crimes against persons data are not to be interpreted as official records. The numbers we report here are meant to provide insights into overall patterns of gunshot-related crimes, and not official counts of charges filed or cases cleared.

Figure 11: Calls for Service and SS Alerts with and without Matching Incidents in Open Data Crimes against Persons.
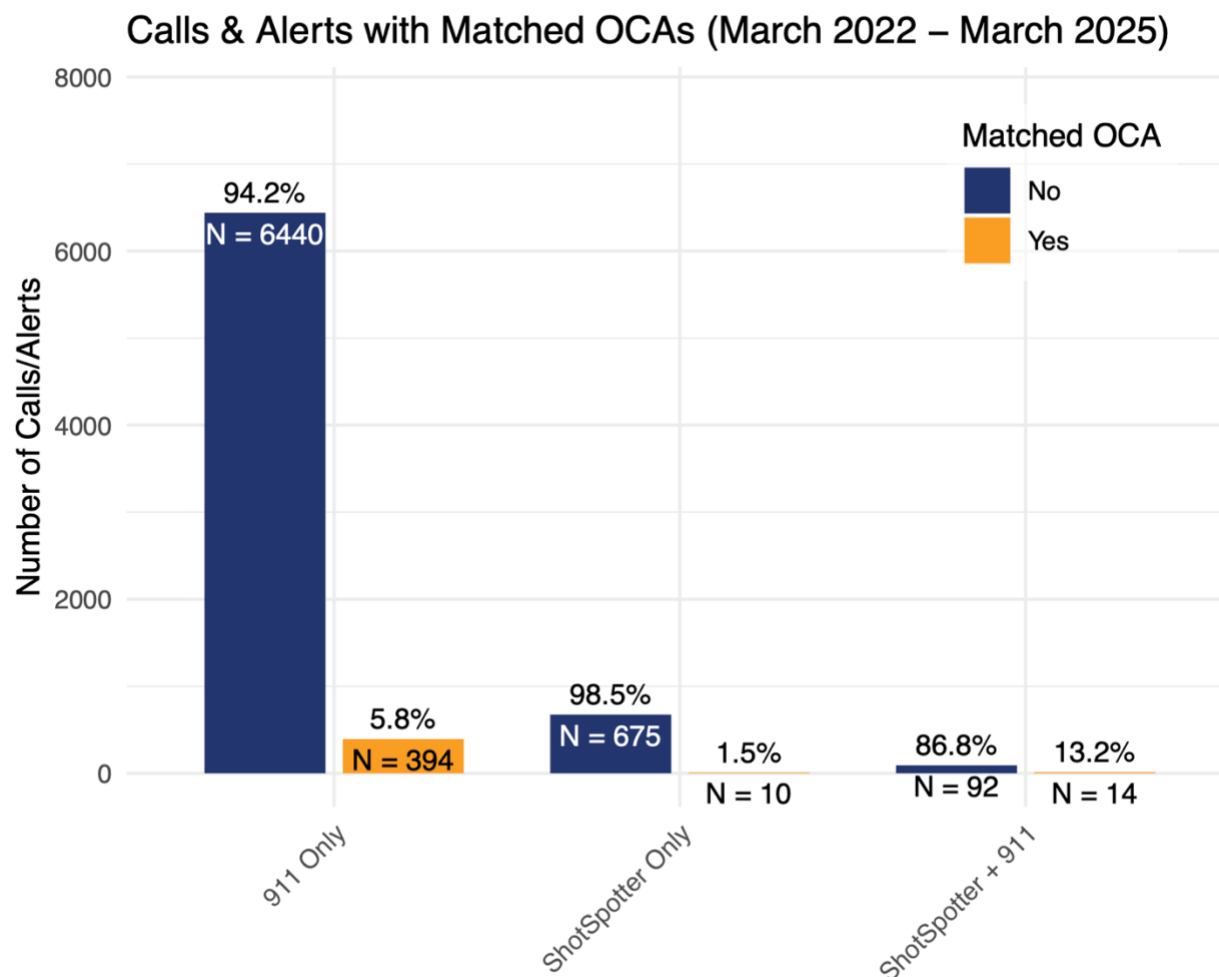
Note: Percentages reflect the rates within each call/alert type.

These are only rough approximations for the rates that gunshot-related 911 calls and ShotSpotter alerts yield conclusive evidence that a gun-related crime occurred and likely reflect conservative estimates. Nonetheless, this examination suggests that ShotSpotter-only alerts yield at best equivalent rates to 911 calls of confirmations for gunshot events. On the other hand, instances with both 911 calls and ShotSpotter alerts have substantially higher rates of being confirmed as an incident.

Assessing Confirmed ShotSpotter Alerts

Here we turn to the ShotSpotter (only) Ground Truth Tracking Worksheet data to approximate the number of ShotSpotter alerts with confirmed gunshot incidents using the more detailed data available from the ShotSpotter system. This worksheet contains information for each ShotSpotter alert about different types of evidence collected, witnesses located, arrests made, victim outcomes, and whether case or offense reports were created. Individual measures from this worksheet are examined in Sections H and I to consider the productivity of FPD's responses to ShotSpotter alerts in more detail. Here, we use the aggregate information to provide a general assessment of the rates at which ShotSpotter alerts can be interpreted as confirmed incidents.

To do this, we combined information from all of the relevant fields across the ShotSpotter Ground Truth Tracking Worksheet to label an alert as confirmed or not.[12] While many alerts were confirmed based on multiple forms of information (e.g., shell casing evidence was collected, a gun was recovered, and police determined the incident warranted a report), an alert only needed confirmatory information from *one* of the fields to be considered "confirmed" for the purposes of our analysis.

As shown in Figure 12, across all ShotSpotter zones, ShotSpotter alerts accompanied by 911 calls were much more likely to be confirmed than those that were not. 67.2% (137/204) of the ShotSpotter alerts with corresponding 911 calls in the Ground Truth data are confirmed by this measure. The Campbellton zone had the highest number of confirmed alerts (73.1%), followed by Central (68.2%) and then Cross Creek (55.4%). When ShotSpotter alerts were not corroborated by 911 calls, the confirmation rates are substantially lower, with 23.7% (183/771) of the total number of ShotSpotter-only alerts confirmed. 29.4% of these alerts were confirmed in the Campbellton zone, followed by 22.4% in the Central zone and 18.1% in Cross Creek.

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[12] Specifically, if *at least one* of the following fields for a given ShotSpotter alert had information indicating some type of evidence was collected, arrest was made, witness or victim was located, or report was created, we determined the given alert was "confirmed": GT – All Text, GT – Any, Evidence Located – Shell Casing(s), Evidence Located – Property Damage, Evidence Located – Firearm(s) Recovered, GT – Evidence Located – Other Evidence, Victim Identified, Aid Rendered to Victim, Homicide on Scene, GT – Other – Any, Witness Located, Resulted in Arrest, Number of Casings Found, Caliber (1st), Caliber (2nd), Caliber (3rd), Number of Guns Recovered, Number of Victims Hit, Number of Victims Found, Report/Case Number, and Offense Report.

Figure 12: Percentage of ShotSpotter Alerts Considered Confirmed, by ShotSpotter Zone and Alert Type.
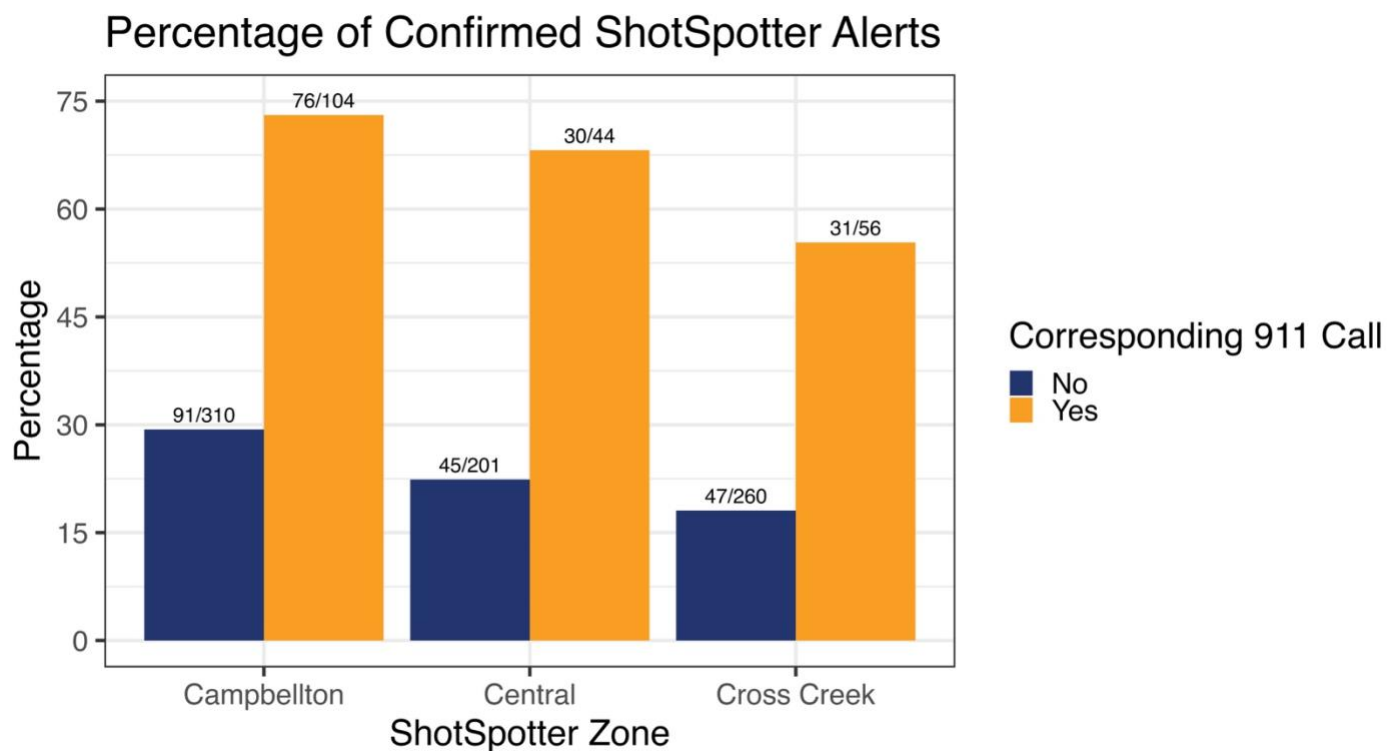
Note: For this figure, the percentage upper limit is 75%. Fractions on top of bars indicate the number of alerts that were confirmed out of the total number of alerts in the given ShotSpotter Zone x Corresponding 911 Call cell.

H. Productivity of Police Responses: Evidence

As noted, we are unable to assess the outcomes of 911 calls because no data were available concerning those incidents. This prevents direct comparisons of the effectiveness of traditional 911 calls versus ShotSpotter alerts. However, the ShotSpotter Ground Truth Tracking data allows us to examine several measures of the productivity of police responses to ShotSpotter alerts during the implementation period (September 26, 2023 – March 31, 2025), and we turn to that now.

We assessed Fayetteville Police Department's productivity in responding to incidents of gunfire in terms of two broad categories: collection of evidence (this section) and victim outcomes (Section I). For both categories, all analyses compare results across the three ShotSpotter zones and two alert types (ShotSpotter alert only or ShotSpotter alert with a

corresponding 911 call) for the period after the implementation of ShotSpotter. Note that there is no comparison between these three zones and the rest of Fayetteville, so any comparison here is highly limited and not as informative as it would be if we could examine data on such incidents more generally. First, we will discuss findings related to FPD's ability to collect different types of evidence for shots fired alerts. In doing so, we first refer to Figure 13.

Firearm Recovery

Figure 13a displays the percentage of alerts across the three ShotSpotter zones for which firearms were recovered. Regardless of ShotSpotter zone or alert type, firearms were recovered infrequently. However, firearms were more likely to be recovered in the Cross Creek zone (2.8% of incidents) than either the Campbellton (2.4%) or Central zones (0.0%). Across the Cross Creek and Campbellton zones, firearms were more likely to be recovered when ShotSpotter alerts were complemented by 911 calls (7.5%) compared to when they were not (1.2%).

Shell Casing Recovery

Figure 13b displays the percentage of alerts across the three ShotSpotter zones for which shells casings were recovered. Not surprisingly, shell casings were recovered more frequently than firearms across all three ShotSpotter zones. Shell casings were most frequently recovered in the Campbellton zone (31.4% of incidents), followed by the Central zone (20.8%) and finally, the Cross Creek zone (16.8%). Further, for all zones, shell casings were more likely to be recovered in cases that received 911 calls in addition to ShotSpotter alerts (52.5%) than those that received only ShotSpotter alerts (16.5%).

Property Damage

Figure 13c displays the percentage of alerts across the three ShotSpotter zones for which property damage was discovered. Property damage was discovered more frequently than firearms but less frequently than shell casings. Across all three ShotSpotter zones, police were much more likely to discover evidence of property damage in cases that received both ShotSpotter alerts and 911 calls (22.1% of incidents) compared to those that received ShotSpotter alerts alone (1.4% of incidents). While evidence of property damage was discovered most often in the Campbellton zone, differences between the three zones were minimal.

Figure 13: Percentage of Alerts where (a) Firearms, (b) Shell Casings, and (c) Property Damage Evidence was Collected, by ShotSpotter Zone and Alert Type.
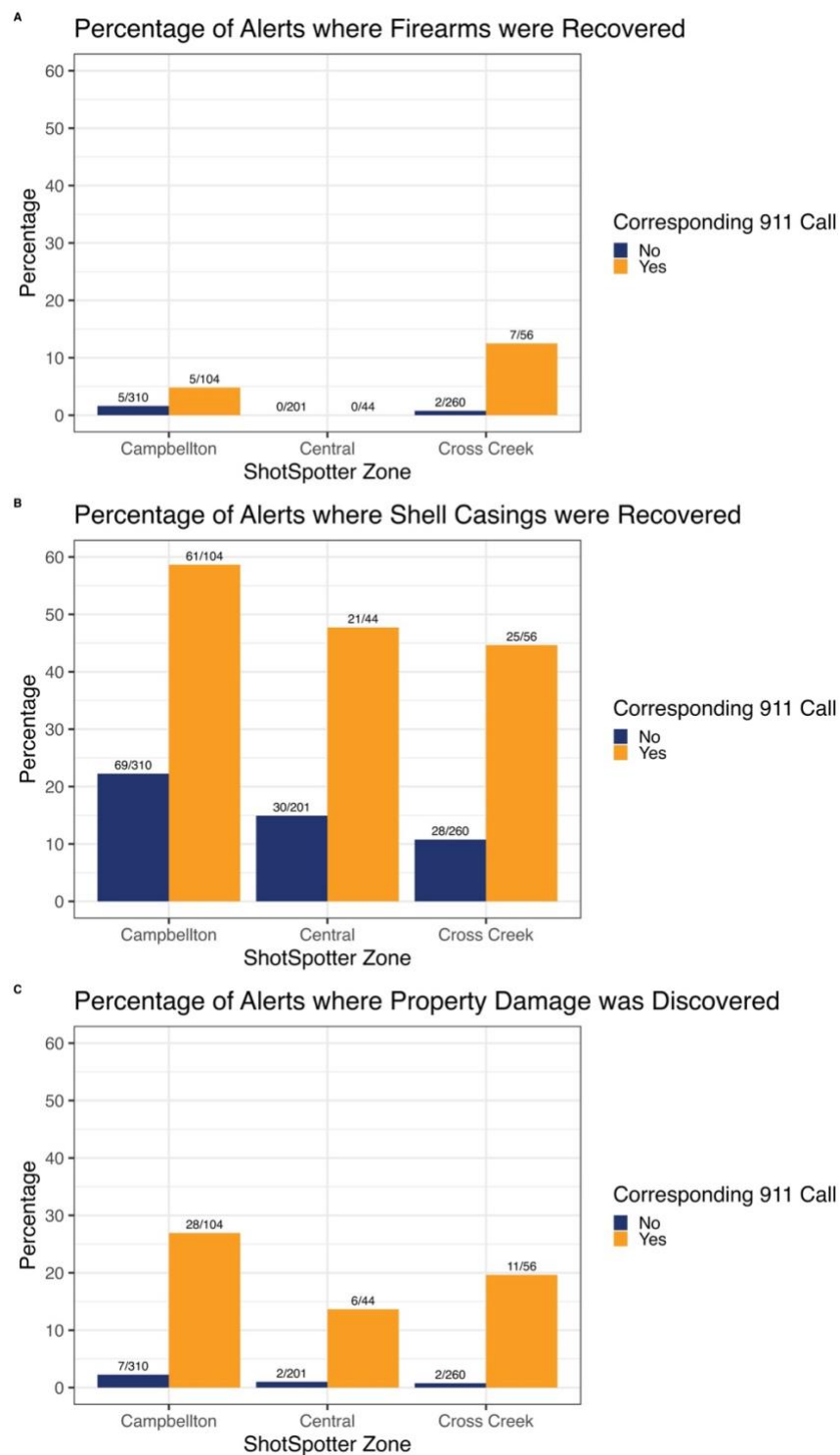
Note: For this figure, the percentage upper limit is 60%. Any missing bars indicate values of 0%. Fractions on top of bars indicate the number of alerts where the specified type of

evidence was collected out of the total number of alerts in the given ShotSpotter Zone x Corresponding 911 Call cell.

Figure 14 shows two additional measures by ShotSpotter zone and alert type (i.e., whether the ShotSpotter alert had a corresponding 911 call):

> (a) the percentage of responses where witnesses were located
> (b) the percentage of responses where arrests were made.

Witnesses Located

Figure 14a displays the percentage of alerts for which witnesses were located. FPD was more likely to locate witnesses in response to ShotSpotter alerts that also had corresponding 911 calls (28.4% of incidents) compared to ShotSpotter alerts that were not corroborated by 911 calls (7.4% of incidents). There were minimal differences in the percentage of cases where witnesses were located between the three ShotSpotter zones.

Arrests Made

Figure 14b displays the percentage of alerts for which an arrest was made. FPD was more likely to make arrests in response to ShotSpotter alerts with corresponding 911 calls (9.8% of incidents) compared to those without (1.8% of incidents). Overall, arrests were made infrequently, and there were no differences in their likelihood of occurring across the three ShotSpotter zones.

Figure 14: Percentage of Alerts where (a) Witnesses were Located and (b) Arrests were Made, by ShotSpotter Zone and Alert Type.
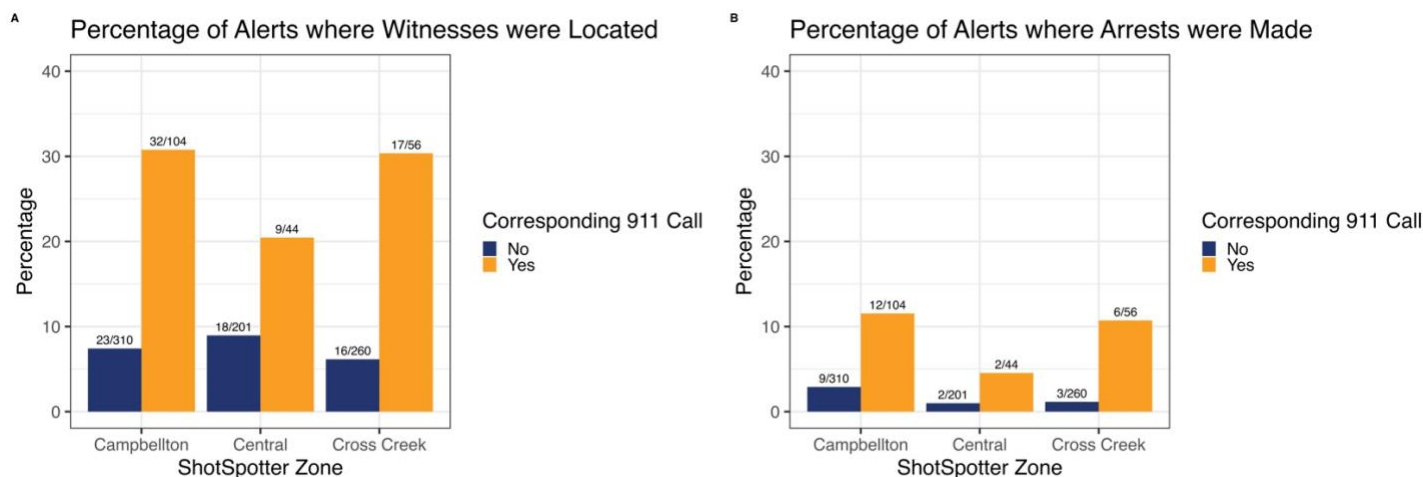
Note: For this figure, the percentage upper limit is 40%. Fractions on top of bars indicate the number of alerts where (a) witness were located or (b) arrests were made out of the total number of alerts in the given ShotSpotter Zone x Corresponding 911 Call cell.

In sum, evidence (in the form of firearms, shell casings, property damage, witnesses, and arrests) was recovered more frequently in cases where FPD received 911 calls *in addition to* ShotSpotter alerts compared to when they received ShotSpotter alerts alone. There were minimal differences in the number of cases where evidence was collected across the three ShotSpotter zones; though in general, the Campbellton zone had the highest percentage of cases where evidence was collected (as well as the highest number of ShotSpotter alerts).

I. Productivity of Police Responses: Victim Outcomes

As mentioned above, we also assessed Fayetteville Police Department's productivity in terms of various outcomes for victims of gun violence. As in Section H, above, we use the ShotSpotter Ground Truth Tracking Worksheet here, and we reiterate that, without comparable information for 911 calls, we are only able to examine these outcomes for ShotSpotter alerts (with or without corresponding 911 calls), for the period after the implementation of ShotSpotter.

The three outcomes we examine include:

> (a) the percentage of responses where victims were identified,

> (b) the percentage of responses where aid was rendered to victims, and

> (c) the percentage of responses that involved a homicide.

Again, these three outcomes are compared across the three ShotSpotter zones (Campbellton, Central, and Cross Creek) and two alert types (ShotSpotter alerts with versus without corresponding 911 calls), and they are illustrated in Figure 15.

Victims Identified

Figure 15a displays the percentage of alerts for which a victim was identified. Across all three ShotSpotter zones, victims were much more likely to be identified in cases where FPD received both ShotSpotter alerts and 911 calls (12.3%) compared to when they received ShotSpotter alerts alone (0.5%). Compared to the Central and Cross Creek zones, the Campbellton zone had the highest percentage of cases where victims were identified (and more victims identified overall).

Victims Received Aid from First Responders

Figure 15b[13] displays the percentage of alerts for which responders provided aid to victims, showing a similar pattern to Figure 15a. First responders were much more likely to provide aid to victims in cases where ShotSpotter alerts were complemented by 911 calls (9.3%) compared to when they served as FPD's only notification about a shots fired incident (0.4%). Further, while patterns were similar across the three ShotSpotter zones, the zone with the highest percentage of cases where victims received aid for gunshot wounds was Campbellton, followed by Cross Creek and Central.

Homicides

Figure 15c displays the percentage of alerts that involved a homicide. While homicides were rare overall, *all* homicides occurred in cases where FPD received *both* a ShotSpotter alert and a 911 call about shots being fired. The highest percentage of cases that resulted in homicide occurred in the Campbellton zone (1.9%), while only two homicides occurred in the Central zone during this time period (0.8%) and just one occurred in the Cross Creek zone (0.3%).

To summarize, positive outcomes for victims (victims being identified and receiving aid) occurred more frequently in cases where FPD received 911 calls *in addition to* ShotSpotter alerts compared to when they received ShotSpotter alerts alone. Further, homicides were only reported for ShotSpotter cases that were corroborated by 911 calls. Finally, compared to the Central and Cross Creek zones, the Campbellton zone had the highest percentage of responses with positive outcomes for victims as well as the highest percentage of homicides reported.

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[13] For Figure 15b, we note that the denominator for the *Campbellton* ShotSpotter Zone x *No* Corresponding 911 Call cell is 309 instead of 310, which is the denominator for this cell on all other evidence and victim outcomes plots. One of the rows in the original data (ShotSpotter ID #482-22991) had "*NA*" in the column regarding first responders providing aid to victims. It is also important to note that in two cases (both in the Campbellton ShotSpotter zone with corresponding 911 calls), first responders did not provide aid to victims because victims were dead upon the arrival of emergency services (DOA).

Figure 15: Percentage of Alerts where (a) Victims were identified, (b) Victims received aid from first responders, and (c) Homicide occurred, by ShotSpotter Zone and Alert Type.
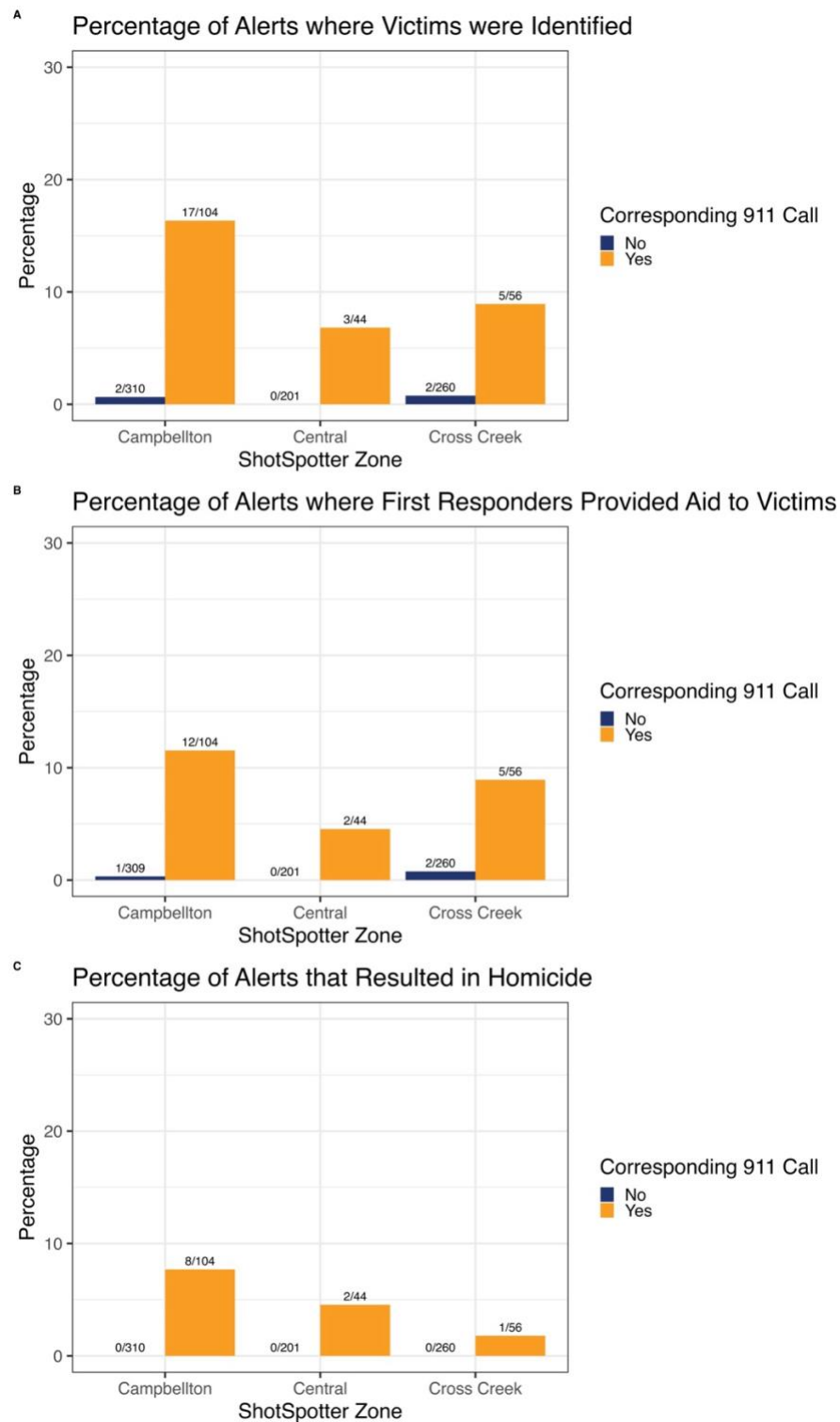
Note: For this figure, the percentage upper limit is 30%. Any missing bars indicate values of 0%. Fractions on top of bars indicate the number of alerts where the specified victim outcome occurred out of the total number of alerts in the given ShotSpotter Zone x Corresponding 911 Call cell.

J. Effects on Gun Violence Incidence and on Policing Resources

Due to the nature of the data available for this evaluation and the nature of the evaluation itself, we cannot directly address several questions of potential interest, for instance, whether the implementation of ShotSpotter has reduced overall levels of gun violence in Fayetteville and how ShotSpotter has affected policing resources in Fayetteville. Nonetheless, we address these two topics briefly, offering observations from our evaluation.

Did ShotSpotter Reduce Gun Violence in Fayetteville?

Proponents of ShotSpotter argue it may deter gun violence through faster police response times. As described in Section F, FPD were significantly faster to arrive on scene following a ShotSpotter alert than a 911 call due to faster dispatch times with ShotSpotter alerts. While we cannot assess whether faster response times affected investigation effectiveness due to lack of access to investigation outcome data, the patterns of gun-related criminal incidents examined in Section D and presented in Figure 2 indicate that gun violence was on a decline in Fayetteville before ShotSpotter was installed. Further, the relative stability of gunshot-related incidents in the ShotSpotter zones throughout the ShotSpotter period, relative to the overarching decrease across the rest of the city, would suggest that ShotSpotter has not served as a deterrent to gunfire in the city.

Increased Deployments and Policing Resources

We did not have access to comprehensive cost data to directly assess ShotSpotter's impact on policing resources (such as expenditures). However, we can examine patterns in police deployment that relate to resource utilization. With the implementation of ShotSpotter, the number of alerts about *potential* gunfire in the ShotSpotter zones increased, meaning that police officers spent more time and energy responding to alerts than they would have otherwise. It is valuable to consider whether these additional deployments are an effective use of FPD's resources.

One way to consider this is in terms of the productivity of those extra responses. As explored in Sections H and I, the productivity of police responses to ShotSpotter alerts varied significantly depending on whether ShotSpotter alerts corresponded with 911 calls. For ShotSpotter-only alerts, shell casing recovery rates ranged from a high of 22% in the Campbellton zone to a low of 11% in Cross Creek. When ShotSpotter alerts corresponded with 911 calls, shell casing recovery increased to 59% in Campbellton and 45% in Cross Creek. Clearly, responses to ShotSpotter alerts that corresponded with a resident 911 call were more productive than responses to ShotSpotter alerts alone. Here, we explore whether additional information available through ShotSpotter could be used to help prioritize certain kinds of alerts over others.

The ShotSpotter Ground Truth Tracking Worksheet contains a field indicating whether the detected gunfire was "probable gunfire" (N = 117 entries), a "single gunshot" (N = 371), or "multiple gunshots" (N = 487). These flags could usefully serve as a proxy for how to prioritize responses to the alerts. The scale of magnitude from "multiple gunshots" to "single gunshots" to "probably gunfire" corresponds with whether a 911 call was also received, with 30.8% (150/487) SS alerts flagged as "multiple gunshots" having also received a 911 call, 11.6% (43/371) SS alerts flagged as "single gunshot" having a 911 call, and 9.4% (11/117) of the "probable gunshot" alerts having a 911 call. These flags also correspond with important response outcomes, for instance whether shell casings were recovered by the responding officer(s). For ShotSpotter-only alerts, alerts for "multiple gunshots" yielded the highest rate of recovery of shell casings, with 22.6% (76/337) of the alerts leading to the recovery of shells. Alerts for a "single gunshot" had 11.3% (37/328) yield. Alerts for "probable gunfire" had only 7.5% (8/106) yield.

ShotSpotter also provides data on the number of rounds detected per alert. Among the 771 ShotSpotter-only alerts, 399 (51.8%) involved detection of a single round, 111 (14.4%) involved 2 rounds, 76 (9.9%) involved 3 rounds, and the remaining 185 alerts involved 4 or more rounds. Response outcomes varied by number of rounds detected, with evidence recovery rates generally increasing as the number of detected rounds increased, as displayed in Figure 16 for shell casings recovered.

Figure 16: **Shell Casings Recovered and the Number of Rounds Detected by ShotSpotter**.
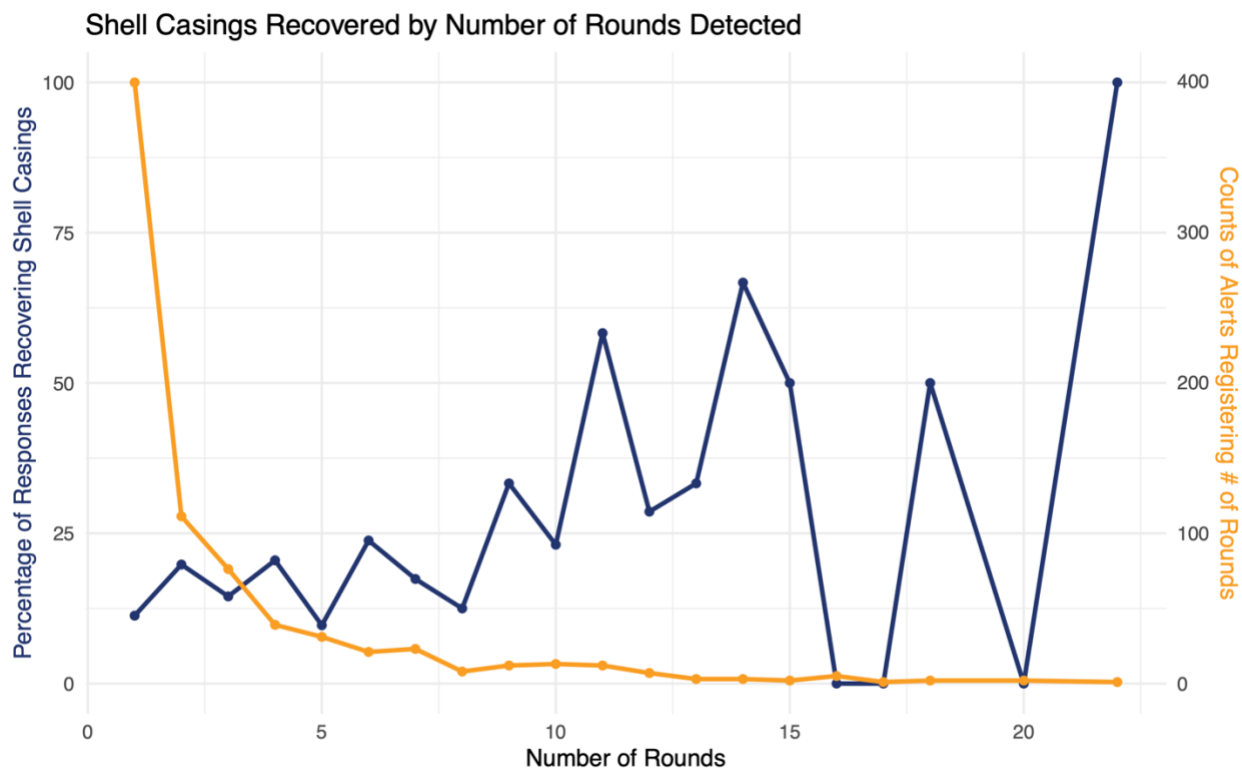
Note: The blue line, with axis labels and scale on left, presents the percentage of shell casings recovered; the yellow line, with axis labels and scale on right, presents the numbers of alerts corresponding to each number of rounds.

Figure 17 displays witness location rates by number of rounds detected. Witnesses were located for 30 of the 399 ShotSpotter-only alerts for one round. This represented the largest total number of witnesses found from ShotSpotter-only alerts, but just 7.5% of the single-round alerts. ShotSpotter-only alerts for multiple rounds had higher percentage yields for witnesses located. Overall, witnesses were located in only 57 of the 771 ShotSpotter-only alerts (7.4%).

Figure 17: Witness Located and the Number of Rounds Detected by ShotSpotter
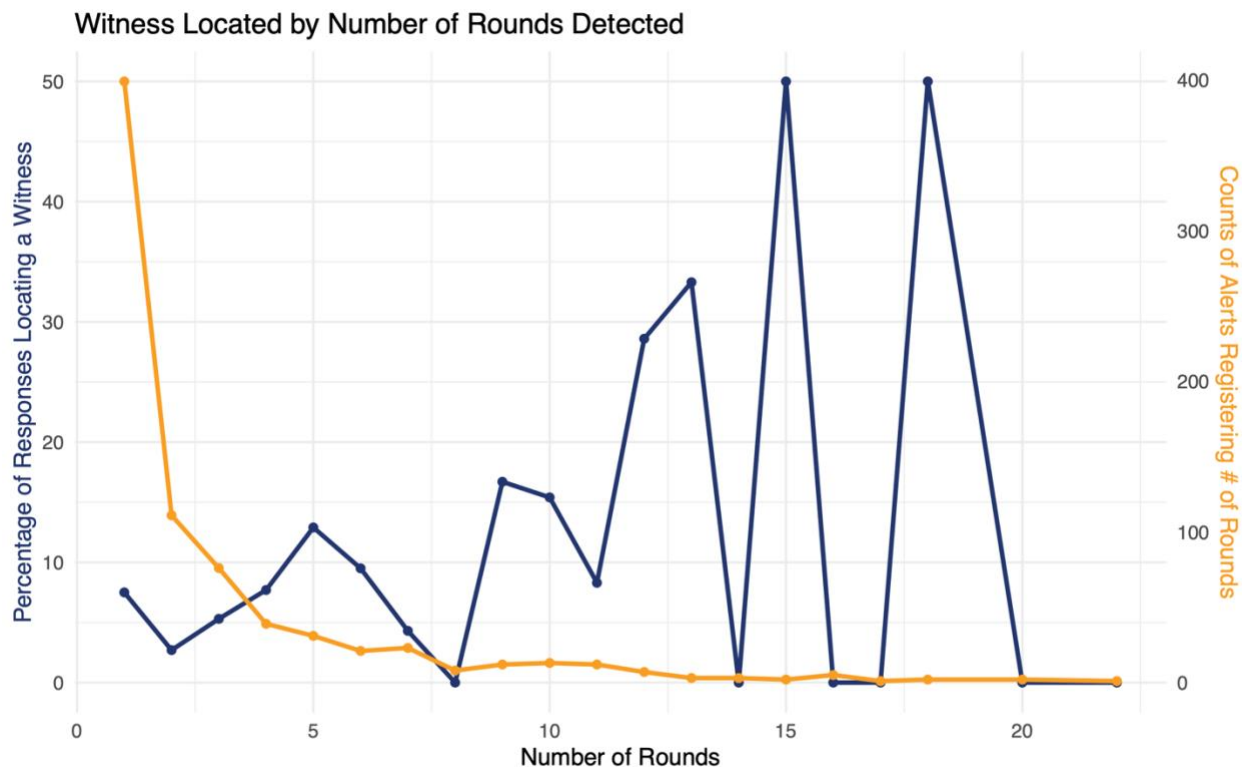
Note: The blue line, with axis labels and scale on left, presents the percentage of alerts resulting in witnesses being located; the yellow line, with axis labels and scale on right, presents the numbers of alerts corresponding to each number of rounds.

Altogether this consideration, along with the observations from earlier sections and the cumulative evidence from other recent ShotSpotter evaluations (including the Wilson Center's evaluation for Durham, NC; Cook & Soliman, 2024), would suggest that ShotSpotter alerts for "probable gunfire" or for single rounds that do not have accompanying 911 calls from residents could be deprioritized if the increased deployments due to ShotSpotter are taxing FPD's resources.

K. Conclusions

The findings reported here are based on 18 months of ShotSpotter's implementation, from September 26, 2023 to March 31, 2025, in three roughly one-mile square area zones in Fayetteville, North Carolina, along with an 18-month period before ShotSpotter's implementation. We examined data from Fayetteville Police Department's calls for service system and ShotSpotter tracking worksheet, as well as public information available from Fayetteville's Open Data Portal.

The main conclusions from this evaluation are:

- **Crime and Alert Patterns:** Gunfire incidents and gunfire-related 911 call volumes declined citywide during the evaluation period while ShotSpotter alerts increased notifications within coverage zones. ShotSpotter alert volumes in coverage zones exceeded 911 calls by factors of 2.7 compared to the period before ShotSpotter implementation and 4.1 after ShotSpotter implementation. However, we cannot attribute crime reductions directly to ShotSpotter.

- **Response Time:** Police are dispatched more quickly following ShotSpotter alerts compared to 911 calls alone. Dispatch times were over 2 minutes faster for ShotSpotter alerts than for 911 calls alone in the ShotSpotter coverage zones. We are unable to assess, however, whether this faster response has resulted in improved investigative or victim outcomes.

- **Alert Effectiveness:** Despite the high volume of ShotSpotter alerts, we do not have evidence that ShotSpotter-only notifications significantly improve police productivity or outcomes without corroborating 911 calls. Alerts confirmed by both ShotSpotter and 911 calls produce more evidence collection, victim identification, and arrests than ShotSpotter-only alerts. ShotSpotter alerts alone, when not accompanied by a 911 call, however, have low yields. We estimate that at most about 24% of ShotSpotter alerts can be linked to a confirmed shots fired incident.

- **Resource Efficiency:** A majority of ShotSpotter-only alerts involve detection of a small number of rounds, and many alerts are for "probable gunfire" only. These alerts are associated with lower productivity in terms of evidence collection and victim identification. Strategic prioritization of alerts—such as deprioritizing single-shot alerts lacking 911 confirmation—may improve efficient use of police resources.

- **Data Integration Challenges:** Since we are unable to examine data on the outcomes or confirmation of 911 calls for shots fired (without a corresponding ShotSpotter alert), we are unable to speak to the outcomes of ShotSpotter relative to 911 calls. Better integrating data from ShotSpotter, 911 calls, police incident reports, and investigations would allow deeper evaluation insights.

- **Overall Assessment:** We do not offer a conclusion on whether ShotSpotter's benefits exceeded costs. While ShotSpotter provided more alerts about potential gunfire than 911 calls alone and enabled faster response times, it remains unclear to what extent these increased alerts represent false positives. The value of increased alerts and faster responses, including if some portion of them are false positive alerts, must be weighed against budgetary and opportunity costs.

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Appendix: Evaluations of ShotSpotter in Other Cities

Here we provide summaries of eight (8) recent independent evaluations of ShotSpotter's implementation in other US cities with respect to their main findings and whether the city chose to subsequently renew its ShotSpotter contract. We offer these summaries to provide the City of Fayetteville with additional context – in terms of key results about ShotSpotter evaluations throughout the country.

Disclaimer: We do not offer commentary on, nor can we guarantee the scientific rigor, of these studies or reports. Specifically, we cannot attest to the quality of the data presented, the methodology or statistics used, or the writing decisions made in creating the reports.

Report Overview			Outcomes			ShotSpotter Renewal Recommendations	
Author of Study	**Summary**	**City Studied**	**Positive Outcomes (in favor of ShotSpotter)**	**Negative Outcomes (against ShotSpotter)**	**Neutral Outcomes/No Effect**	**Recommendation of Report**	**City's Renewal Decision (Yes/No)**
National Criminal Justice Reference Service	This study evaluated ShotSpotter implementations in two cities: Kansas City, MO and Chicago, IL. As part of its analysis, the project explored three questions: (1) the effect of ShotSpotter on officer response and search	Kansas City, MO	Officers stopped their patrol cars closer to the reported/detected location of gunfire for shots fired incidents, fatal shootings, and non-fatal shootings.	Officers took longer to arrive on the scene for non-fatal shootings.	ShotSpotter did not significantly influence the likelihood of evidence collection or case clearance in fatal and non-fatal shooting incidents.	No explicit recommendation given	Yes
			Officers arrived faster on the scene when responding to shots fired				

		Positive findings	Negative findings	Neutral findings	Recommendation	
behavior, (2) the effect of ShotSpotter on crime occurrence, and (3) the effect of ShotSpotter on evidence collection and case clearance.		incidents and fatal shootings.				
		Ballistic (NIBIN) evidence collection was ~30% higher in ShotSpotter area than the weighted control area.	Shots fired calls for service occurring in the ShotSpotter target area were 18% more likely to be classified as unfounded as compared to non-target-area cases.			
		There were 22.2% fewer shots fired calls for service (i.e., 911 calls) in the ShotSpotter area.				
		The increase in gun recovery (11.2%) in the ShotSpotter target area only approached statistical significance.				
	Chicago, IL	Officers stopped their patrol cars closer to the reported/detected location of gunfire for shots fired incidents, fatal shootings, and non-fatal shootings	More fatal shootings, non-fatal shootings, and gun assaults and robberies occurred in ShotSpotter target areas.	ShotSpotter did not significantly influence the likelihood of case clearance in fatal and non-fatal shooting incidents.	No explicit recommendation given	No
		Officers arrived faster on the scene when responding to	Officers took longer to arrive when			

			shots fired incidents and non-fatal shootings. Firearms were 45% more likely to be recovered from fatal shootings within ShotSpotter areas.	responding to fatal shootings.			
Office of the Inspector General, City of Chicago	Chicago PD launched ShotSpotter in 2017 as part of the launch of its Decision Support Center. It was deployed alongside expanded mobile technology for officers and as an expansion of the department's Police Observation Device Crime Camera program. In 2021, the City's Inspector General released its evaluation of ShotSpotter, which included data between January 1, 2020 and May 31, 2021. The OIG	Chicago, IL	The ability to more quickly dispatch officers to gunfire events *may* be an operational benefit.	Evidence of gun-related crimes is rarely produced. ShotSpotter alerts rarely led to to investigatory stops. Recovery of gun crime-related evidence during investigatory stops rarely occurred. Negative impact on policing behaviors (generalized perceptions of ShotSpotter alert frequency in a given area may substantively	N/A	Do not renew	No

	report concluded that it was likely not possible to conclusively determine whether ShotSpotter was a worthwhile operational investment, in part because the ability to match ShotSpotter events to other police records was limited. After the release of this report, the City of Chicago ultimately declined to renew its contract with ShotSpotter.			change policing behavior). Frequent ShotSpotter alerts impacted reasonable suspicion during investigatory stops.			
New York City Comptroller	After a decade since the NYPD's contractual relationship with ShotSpotter began in 2014, the NYC Comptroller published its audit of the city's more than 2,000 sensors installed across the five boroughs. The Comptroller's audit revealed very large	New York City, NY	Response times were 1 minute and 38 seconds faster for ShotSpotter alerts to outdoor shots fired than 911 calls for the same issue. However, the time difference the auditors found was less than what was stated in publicly available information,	Large discrepancies between total alerts and confirmed shooting incidents (notably in March 2023 with 1,239 alerts compared to 104 confirmed shooting incidents). As a result, the performance	N/A	Do not renew	Yes

discrepancies between total alerts and confirmed shooting incidents. The Comptroller's audit also found that the performance standard adopted by the NYPD resulted in artificially high ratings for ShotSpotter. Additionally, the report's evaluation of the unconfirmed alert data (presumably alerts that did not result in a confirmed shooting) found hundreds of hours of officer time spent on unconfirmed alerts. The audit also found that the NYPD's data collection should be improved, analyzed more critically, and published in the interest of transparency before		which claimed a five-minute difference (~4 minutes for ShotSpotter alerts versus ~9 minutes for 911 call response).	standard adopted by the NYPD resulted in artificially high ratings for ShotSpotter, as it did not consider false positives or otherwise directly assess the tool's ability to identify confirmed shooting incidents.
			High level of noise, construction in Manhattan's Harlem area, and density of buildings contributed to a high number of false negatives (ShotSpotter missed 10+ confirmed shooting incidents in 10 of 12 studied months).
			Hundreds of hours of officer time spent on unconfirmed alerts (a single month showed 426.9 hours).

	ShotSpotter's contract was renewed, as the data collected and published at the time of the audit's publication did not adequately support a comprehensive assessment of the tool's effectiveness. Ultimately, the audit did not support renewal of the contract.						
Wilson Center for Science and Justice	This report evaluated Durham's 12-month implementation of ShotSpotter, from December 15, 2022 to December 14, 2023. The report assessed ShotSpotter's effects on the amount and type of gunshot notifcations Durham PD received, Durham PD's response time and time on scene when responding to	Durham, NC	Officers responded more quickly to gunshot notifications in the target ShotSpotter area (median response time of deployed officers to the scene for 911 notifications decreased by 1.2 minutes in the pilot area compared to the rest of the city). Median dispatch time dropped by 54 seconds, while the response time (dispatch +	ShotSpotter more than doubled the total number of gunshot notifications during 2023, with 2.3 "extra" deployments per day on average. Evidence of gunfire was not found in 91% of the "extra" instances.	Likelihood of arrest or evidence collection did not increase for incidents that generated both 911 calls and ShotSpotter alerts.	No explicit recommendation given	No

	shots fired incidents, and the productivity of police responses to ShotSpotter alerts versus 911 calls for service in terms of arrests made, witnesses interviewed, and evidence collected. They found that ShotSpotter more than doubled the number of gunshot notifications received by Durham PD for the three-square mile area it covered, and it notably improved police offer response times to shots fired incidents. They also noted that overall, ShotSpotter did not improve the productivty of police responses; however, there were 7 cases in which arrests were made for incidents only		travel) dropped by 130 seconds, compared to a 56-second drop in the control area.		
			Plausible that in one particular incident, rapid deployment made possible by a ShotSpotter alert actually saved the life of a gunshot victim.	DPD increased the priority for responding to gunshot notifications when ShotSpotter was installed, which may have come at the cost of slowing DPD deployments for other calls for service.	
				For most ShotSpotter alerts, the subsequent police investigation did not find confirmation that a crime occurred. Only 9% of ShotSpotter-	

	known to police due to a ShotSpotter alert (i.e., there were no 911 calls for these incidents). The report states that the authors cannot provide recommendations about whether ShotSpotter's benefits exceeded its costs or advice regarding whether the City should renew its contract with the technology.			only alerts resulted in confirmation of a shooting, and this percentage was still lower for alerts with just one or two shots. ShotSpotter did not notably enhance the productivity of police investigations. Only 4% of ShotSpotter alerts that resulted in confirmed shootings resulted in arrest, 11% resulted in collection of evidence, and 7% in witness interviews.			
Nebraska Center for Justice Research, University of Nebraska at Omaha	This report evaluated the ShotSpotter implementation in Omaha, NE. The main purpose of the study was to analyze how dispositions (or outcome of arrest) in these gunshot events	Omaha, NE	ShotSpotter-initiated calls were almost 40% more likely to result in a police report being made.	ShotSpotter-initiated calls were roughly 20% less likely than non-ShotSpotter-initiated calls to result in an "arrest" disposition.	N/A	Report provided suggestions to improve ShotSpotter implementation and data management	Under consideration. Request to renew submitted November 2024.

	differ depending on the call source. The research question was as follows: "Do shots fired calls initiated by ShotSpotter differ substantially from shots fired calls initiated by 911 in terms of the case dispositions logged by responding officers?"						
Dennis Mares, Emily Blackburn, Southern Illinois University Edwardsville	This study examined the effectiveness of the ShotSpotter implementation in St. Louis, MO. This study used a quasi-experimental study; results of interrupted time-series analysis indicate that the ShotSpotter installation in St. Louis may be related to a drop in citizen reports of "shots fired," but failed to find an impact on reported gun-related crimes.	St. Louis, MO	ShotSpotter may be responsible for a drop in citizen reports of "shots fired." Officers do appear to spend less time investigating ShotSpotter incidents versus citizen reports. Officers were dispatched faster and completed their investigations in less time when ShotSpotter was involved.	Poor accuracy. Of the 890 unique incidents recorded in the two experimental neighborhoods between August 20, 2008 and October 31, 2009, only 17 led to the identification of a violent crime (1.9%), and an arrest was only made in one case (0.1%). Over 93% of incidents failed to turn up	No impact on reported gun-related crimes.	No explicit recommendation given	Yes

				evidence of a violent crime.			
Ratcliffe et al.	Using a partially block-randomized experimental design, this study examined whether the introduction of Philadelphia's 17-sensor ShotSpotter pilot increased the frequency of confirmed incidents of shots fired by bringing awareness to gunfire events in public places that were not reported by the public. The study found that the ShotSpotter implementation did not significantly affect the number of confirmed shootings, but it did increase the workload of police attending incidents for which no evidence of a	Philadelphia, PA	N/A	ShotSpotter did not significantly affect the number of confirmed shootings. ShotSpotter increased the workload of police responding to incidents for which no evidence of a shooting was found. The 259% increase in gunshot-related incidents over the 8 months post-ShotSpotter implementation was not matched by a significant increase in "founded" events, suggesting a substantial increase in	N/A	No explicit recommendation given	Unsure

shooting was found.			events where there was no independent evidence of gunfire. Police workload increased but without an associated increase in founded incidents.	