Analysis courtesy Seattle Police Department

Analysis of Shots Fired, 2021 to August 2024

Summary of Performed Models

The following table displays the season and trend parameters for each of the time series discussed in this report.

Series	Seasonal	Trend
Shots Fired (all)	Yes	No
Gang activity	Yes	No
Domestic Violence	No	Yes
Juvenile	Yes	No*
Nightlife	Yes	Yes
Road rage	No	No*
Robbery	Yes	No*
Uncooperative victims and/or subjects	No	No*

* Although some of the shots fired with nexus showed a significant p-value for linear trends, the series marked with a (*) computed R-Squared Values below 0.3 meaning weak to very weak relationships (linear, polynomial, and exponential) between the shots-fired nexus and time (refer to appendix 1).

Shots fired show seasonality:

Shots fired crime-events, visualized in Figure 1, exhibit seasonal behavior. With the highest counts occurring during the summer months. This behavior aligns with the general seasonality of violent crime, which also peaks during the summer.

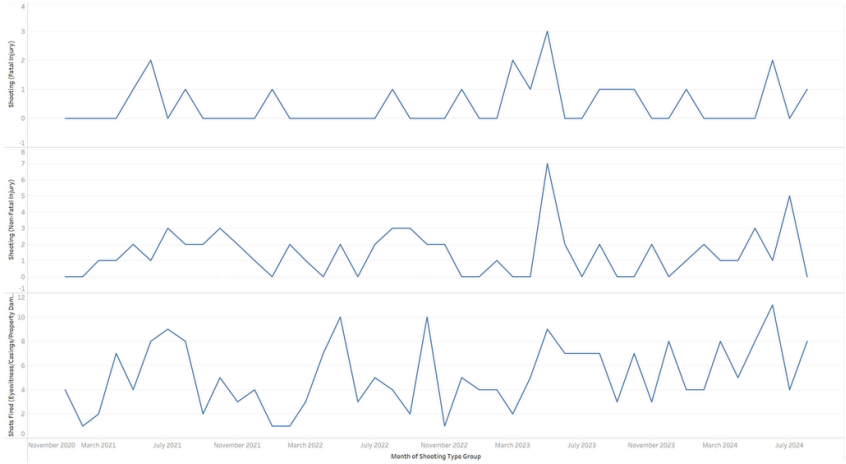

Figure 1. Shots Fired Events, top: fatal injury, middle: non-fatal injury, and bottom: eyewitness, casing, property damage. From January 2021 to August 31, 2024.

Historical trends and analysis of the number of shots fired per month forecast

See Figure 3, below, for the forecasted values for shots fired from September 2024 to August of 2025. It is important to note that the accuracy of all forecasts diminishes as we project further into the future. While this forecast provides a reliable estimate for the near term, the inherent uncertainty in predicting complex events like shots fired incidents increases over time. Consequently, forecast made for more distant periods should be interpreted with caution (refer to appendix 2 for model details).

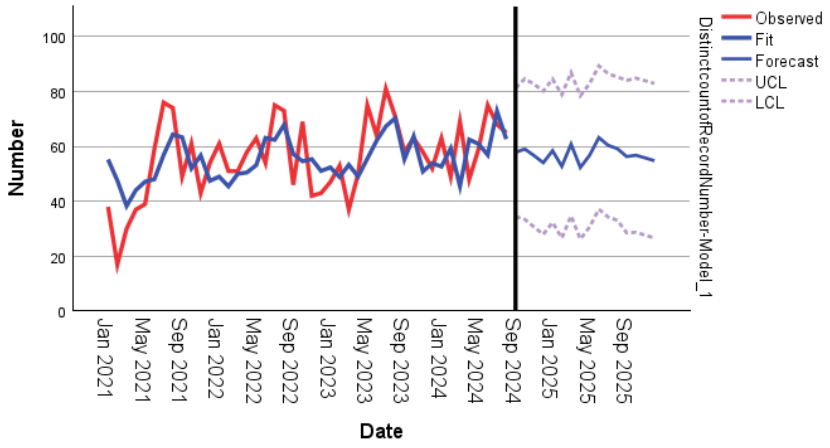

Figure 2. Observed, fit, and forecast number of shots fired incidents per month. Forecast starts at September of 2024

Assessing shots fired and their nexus to different factors such as gang activity, domestic violence, juvenile involvement, narcotics involved, nightlife related, road rage incidents, robbery incidents, and uncooperative victims and/or subjects.

Part of the investigative work done by SPD's Crime Analysts includes the analysis of each shots fired casefile an identifying its nexus to different factors such as gang activity, domestic violence, juvenile involvement, nightlife related, road rage incidents, robbery incidents, and uncooperative victims and/or subjects. The statistical review of shots fired by their nexus with the previously mentioned factors, from January of 2020 to August of 2024, did not provide a significant trend showing very little counts (i.e., sparse series) that do not allow for statistically significant forecasting.

Seasonality on shots fired with nexus to gang activity

The visual inspection of the monthly counts of shots fired with gang activity nexus shows seasonality, with the highest counts registered during the month of July. Although the peak values appear to decrease, the order of the decrease is only one incident per year, this year over year different is not significant and requires further review (see figure 4 below).

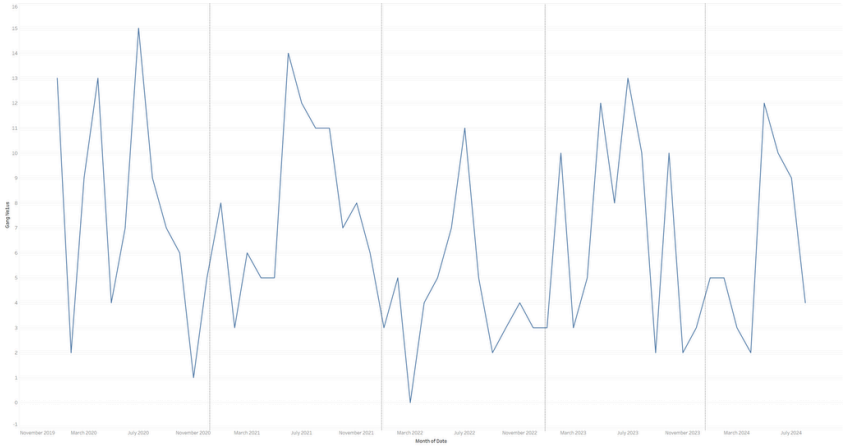

Figure 3. Shots Fired with Gang Activity Nexus, monthly count 2020-2024.

Observationally, the Covid-19 emergency lockdowns (stay-at-home orders) impacted the behavior of shots fired with a nexus to domestic violence and shots fired with nexus to nightlife. This impact was not sustained after the stay-at-home orders were terminated.

The outbreak of the COVID-19 pandemic in 2020 and the subsequent global emergency measures significantly impacted various aspects of society, including incidents of shots fired. This section focuses on incidents of shots fired with nexus to domestic violence and with nightlife, specifically comparing the years 2020-2021 (pandemic) with 2022-2024 (post-pandemic). Notably, 2020 and 2021 were the years when the nation's emergency response was in place.

The incidence of shots fired with domestic violence nexus were affected by the pandemic.

Visually, after the COVID-19 stay-at-home orders ended, these types of events increased and have remained at higher level than during the pandemic. There is no significant trend identified from June 2021 to 2024. The moths of August and November 2023 experienced the highest counts (8 events) of shootings with a nexus to domestic violence in the period under review.

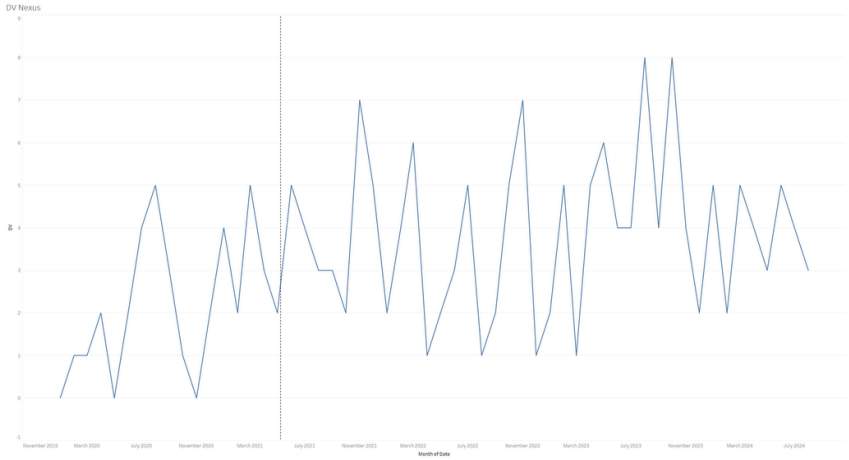

Figure 4. Count of Shots Fired with Domestic Violence Nexus, 2020- August 2024

Observationally, closure of businesses and stay-at-home orders during the COVID19 pandemic reduced the incidents of shots fired with Nightlife related nexus.

The COVID-19 emergency lockdowns and business closures impacted the behavior of shots fired with a nexus to nightlife. This impact was not sustained after the stay-at-home orders were terminated.

The outbreak of the COVID-19 pandemic in 2020 and the subsequent global emergency measures appear to influence the decrease in incidents of shots fired related to nightlife. However, after June 2021, these incidents have increased. Notably, there were peaks in August of both 2022 and 2023.

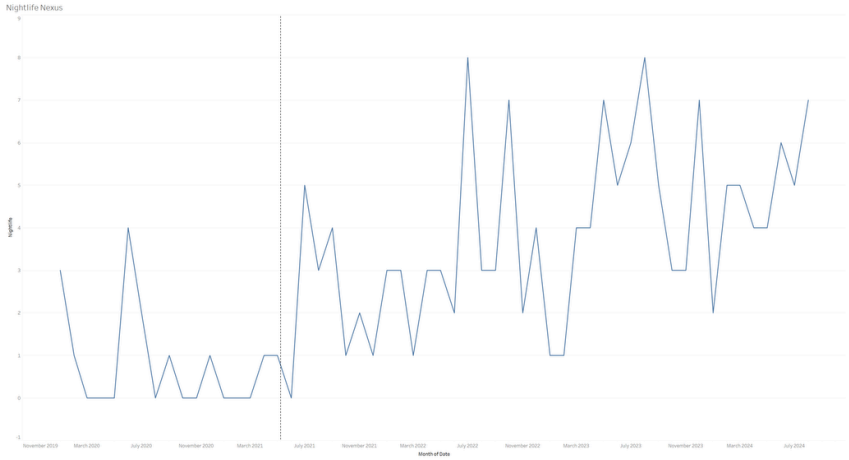

Figure 5. Count of Shot Fired Events with a Nexus to Nightlife, January 2020 to August 2024

Shots fired with juvenile involved (nexus)

From January 2021 to August 31 of 2024, shots fired with a nexus with juvenile involved shows a similar seasonality than shots fired as a whole. Summer months exhibit a higher frequency of these events. The months with the higher count of shots fired with a nexus to juveniles was July of 2024, followed by April 2022, May 2024, and February of 2024. Although we can calculate a significant linear trend for juvenile shots fired it showed a very weak relationship.

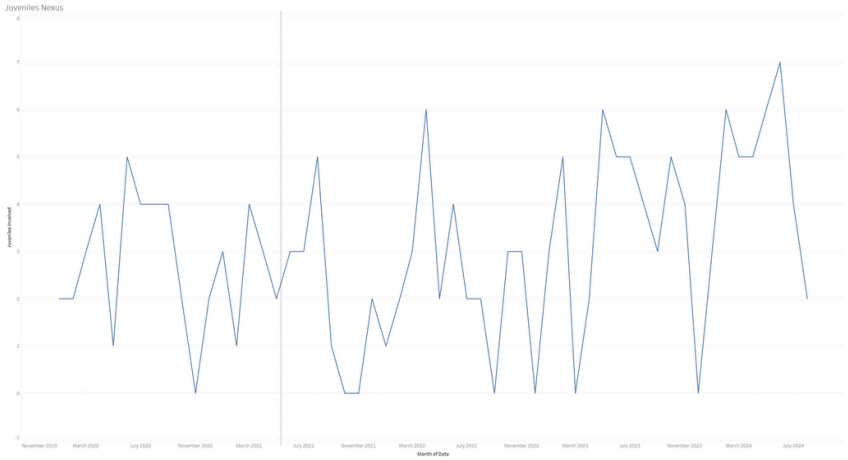

Figure 6. Count of Shot Fired Events with a Nexus to Juvenile (victim/suspect/witness)

Shots fired with a nexus to Robbery

Shots fired with a nexus to robbery behave differently to other type of shots fired by not exhibiting higher frequency of events during the summer.

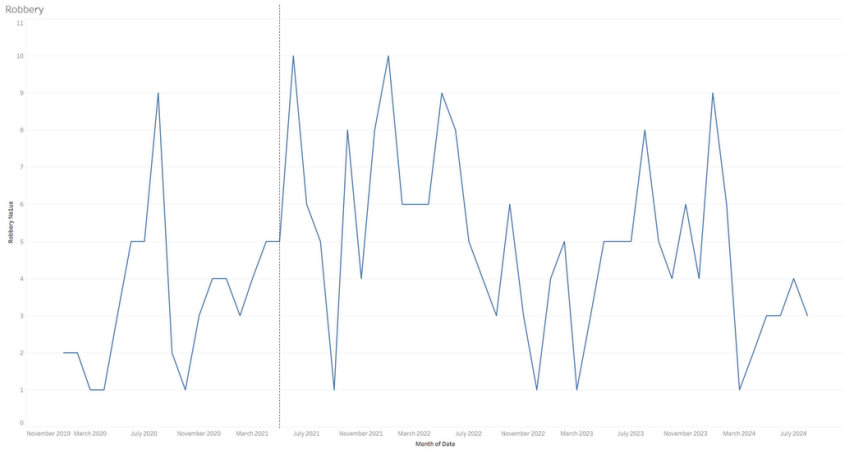

Figure 7. Count of Shot Fired Events with a Nexus to Robbery

Shots fired with a nexus to uncooperative victim and/or subject

When a victim and/or a subject choose not to cooperate with the investigation of an incident the solvability of shots fired criminal investigations is affected. The data from 2020 to August of 2024 on the number of subjects and/or victims who choose not to cooperate with investigations of shots fired shows variability from month to month. As a result, predicting non-cooperation on a monthly trend is challenging.

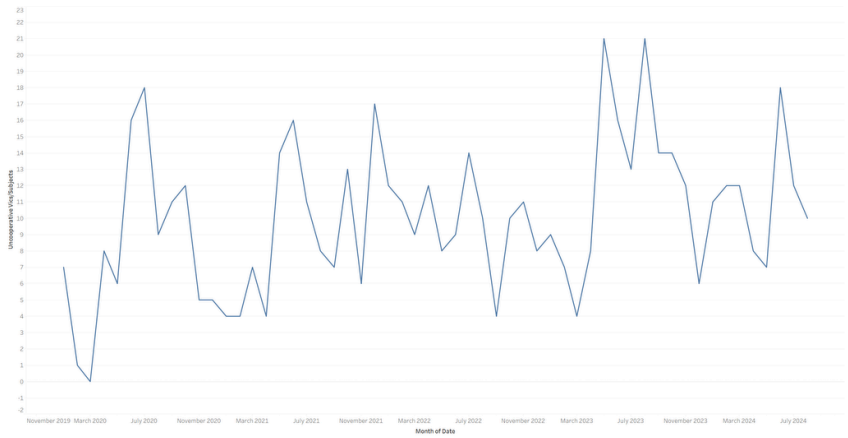

Figure 8. Shots Fired with Nexus to Uncooperative Victim and/or Subject

Appendix 1

A trend analysis was conducted for all the shots fired with a nexus to gang activity, domestic violence*, juvenile involvement*, nightlife related*, road rage incidents*, robbery incidents*, and uncooperative victims and/or subjects*. Although some of the nexus showed a significant p-value for linear trends (see the ones with an asterix on its side), all of them showed R-Squared Values below 0.3 meaning weak to very weak relationships between the shots-fired nexus and time.

R-Squared Value	Interpretation
0.0 - 0.1	Very weak relationship. The model explains very little of the variability of the response data.
0.1 - 0.3	Weak relationship. The model explains some of the variability, but not much.
0.3 - 0.5	Moderate relationship. The model explains a fair amount of the variability.
0.5 - 0.7	Strong relationship. The model explains a significant portion of the variability.
0.7 - 0.9	Very strong relationship. The model explains most of the variability.
0.9 - 1.0	Extremely strong relationship. The model explains nearly all the variability.

Appendix 2

An ARIMA (1,0,0)(1,0,0) time series forecasting model was used to fit the data and forecast the expected monthly count of shots fired events in the Seattle area. This model has a seasonal element but do not show a trend coefficient.

While ARIMA (1,0,0)(1,0,0) model is a good fit that accounts for seasonality and long-term patterns, it is most accurate in predicting shots fired in the short term, the longer the period of prediction the least accurate that the forecast will be.

Model fit:

The number of shots fired can be described with an ARIMA (1,0,0)(1,0,0) seasonal model. Figure 1 below, shows how the observed number of shots fired incidents, and the fit (forecasted) values followed a similar pattern; the values shown starting from September 2024 are estimated.

ARIMA Model Parameters

					Estimate	SE	t	Sig.
Distinct count of Record Number-Model_1	Distinct count of Record Number	No Transformation	Constant		55.255	4.451	12.415	<.001
			AR	Lag 1	.443	.139	3.175	.003
			AR, Seasonal	Lag 1	.403	.153	2.645	.012

Table 3. ARIMA (1,0,0)(1,0,0) Parameters. Both AR coefficients are significant with one lag, and the constant is also significant.

Refer to Figure 3 in this report for the visual representation of this forecasting model. The forecasted values start at September of 2024.