Impact Areas

Data Analytics Lab

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1 Introduction

The purpose of this work is to consider the impact that officers have in these areas in comparison to similar areas that are not designated Impact Areas. The Impact Area programme was set up in 2019 to focus attention on certain areas within NPUs. The Force was to work with partner agencies to develop a long-term strategy to reduce problems within these areas. As such the work presented here is clearly looking at the early stages of the initiative and should be seen as developing a benchmark against which the initiative can be measured at a later date. Some of the data used in the work has only been made possible since the inception of the newer systems and so further back-dating is not possible.

The Impact Areas are those areas designated by NPUs as areas for long-term partnership focus within their areas (they are areas where high levels of demand for WMP resources are located). The comparison areas are those areas again in the NPU where the selection was not made. The two areas have similar levels of deprivation as measured by the Index of Multiple Deprivation (IMD).

The analysis here is based on the movements of officers in and out of the impact and comparison areas as well as the time spent in each over the day. This study is a short-term consideration of the current state of play, in order to understand the impact of partner projects, which are longer term in their scope. The true effect of the impact areas approach will not be visible until time for these partner projects to fulfil their potential has passed. This data will need to be made available to ascertain the outcome of the impact area programme. Any follow-up analysis will also need to take into account the changing lock-down requirements and the COVID-19 pandemic on the outcomes and the implementation of the partner projects.

This emphasis on certain areas in the West Midlands is not a new one; specific areas around the region have been the focus of attention over many years. The exact approaches might differ, as might the areas targeted, but the aspiration is similar- to empower local communities to work, hand in hand, with the police to help reduce crime and to improve the outlook for specific areas that are the areas of focused community activity. The emphasis in this report is the policing activity during a three month period (June – Sept 2021) across the designated impact areas and comparison zones to see if there are any differences currently visible in the data concerning incidents and crimes. A number of crimes are highlighted as is the number of 999 calls in the area.

There appears to be a small effect based on the designation of an area as an impact area; it is small however and non-linear. This suggests that there is the start of changes in behaviour, as the data generating process that is in essence captured by all statistical models might be slightly different in the impact areas. It should be emphasized that these changes are extremely small and it is still possible for more changes, good or bad to take place. In future, partner data would also be advantageous to try to isolate the effect of the types of partner activity to help certain communities improve their outcomes.

As a secondary aspect of the work, an opportunity was taken to look at the influence of police resources in a specific impact area within grids of various sizes, linking incidents, crimes and presence. This can be considered as a modification of the Philadelphia Foot

Patrol Experiment[1] in this case using the last radio presence in the grid to represent police presence.

The work finds that there is some residual effect of police presence in the areas, dependent upon the grid size considered. Larger grids naturally see the effect degrade quickly, whereas smaller grids have a little more sustain. This result is primarily due to the scale under consideration- a big square will have more going in, than a smaller one.

1.1 Main Findings

- There is a small difference in the impact and comparison areas.
- The impact areas appear to have a small number of incidents greater than the comparison areas
- Policing time has a very small effect on the number of incidents in the impact areas.
- The relationship between time and number of visits and incidents and crimes in the areas is non-linear, suggesting diminishing returns to policing activity.
- The relationship with crimes is less strong than that of incidents and there is minimal difference between impact areas and comparison areas.
- Examining a micro level impact of officer presence within an example impact area (Hillfields in Coventry), officers have an impact for approximately 45 minutes though there are times where this is reduced to less than half that.
- The influence of officers tends to be on incidents rather than crimes, which might be more premeditated than incidents.

[1] https://www.jratcliffe.net/phila-foot-patrol-experiment

2 Areas under Consideration

The Impact Area initiative was set up to consider how best to address known areas with long-term problems in association with partner agencies. The areas were selected by considering police data, which was considered as the demand side of the balance and the need for the assistance, based on non-policing data. This work in 2018/19 used a number of crime types and information such as violent crime levels and weapon possession as well as the residency of offenders to identify a number of potential areas for especial focus.

These demand data are used in conjunction with the need of the areas. This was assessed using the 2010 Index of Multiple Deprivation (IMD). This includes 7 domain indices across socio-economic indices. In addition to this, the concentration of young people across the area is used as an additional indicator of need in the area. There are similarities between these IMD indices and those provided by the Jill Dando Institute.

The method of highlighting the relevant areas was to consider 125m radius circle around a grid of squares of 50m^2. The number of the relevant incidents were counted and associated with that centroid of the circle. The average from the non-zero count areas were calculated. Each area was standardised by the mean, such that if the overall average is 3 and a grid has a value of 4, then the standardised value is 4/3=1.33.

An example of this is given in the chloropleth map below. Grid squares area highlighted based on their score. This process was repeated across the region to give NPUs a selection of areas to designate as Impact Areas.

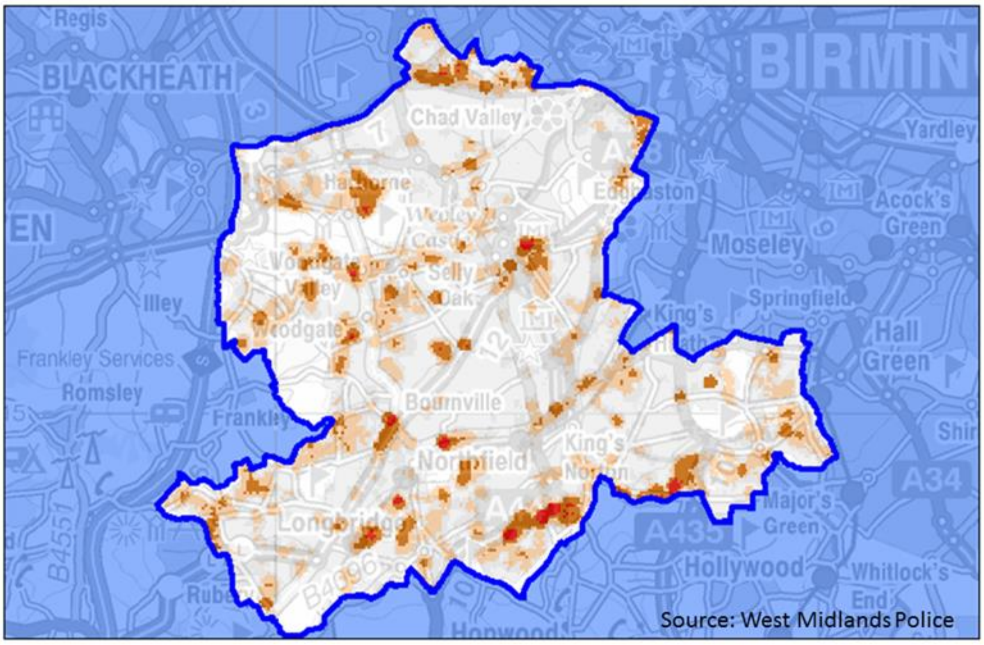


Figure 1 Index of Police Demand Map centred on Selly Oak

The demand side of the selection is only half the story. Some areas have greater need as measured by IMD metrics and the prevalence of young people. The IMD is publicly available and an example is presented in Figure 2.

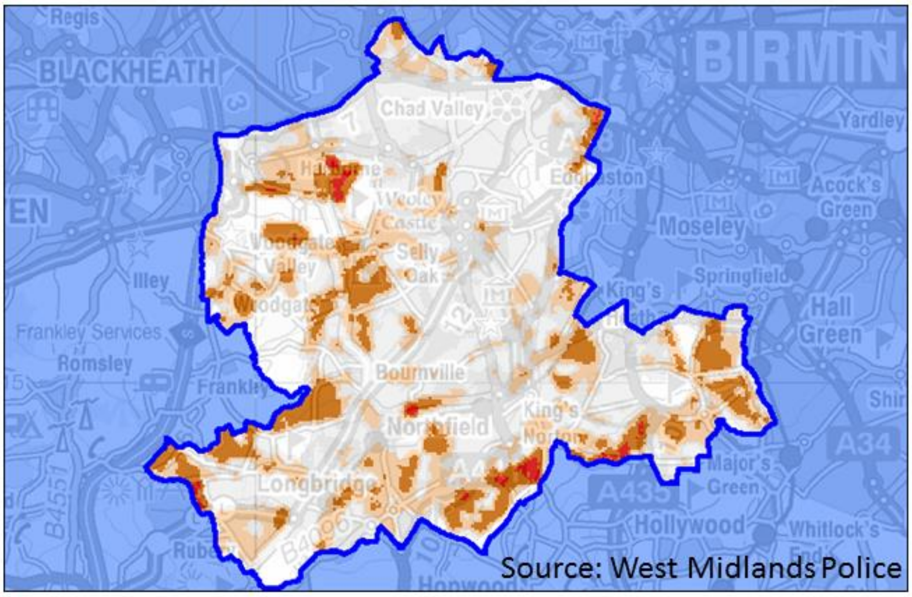


Figure 2 IMD Income Measure for south Birmingham

The combined need and demand gives rise to a number of priority zones (ie impact areas). These areas are those selected in the study as impact areas. The comparison areas were those that were similar to the impact areas in a number of dimensions but did not finally get selected as impact areas. They tend to have similar IMD scores and crime levels, though perhaps not consistently so.

The areas under consideration are presented in Table 1. It can be seen that Dudley does not have a control. The Dudley NPU's priority areas are not as clear as those presenting in other areas and using an area that does not compare well is not considered useful. The methodology used in this paper limits some of this impact by comparing impact and comparison areas across all the NPUs, while conditioning the various intra-regional discrepancies.

Table 1 Impact Areas and Comparison Sites

NPU	Control	Impact	NPU	Control	Impact	NPU	Control	Impact	NPU	Control	Impact
BE	Balsall Heath	Bordesley Green	CV	Coventry City Centre and Spon End	Hillfields	SW	Smethwick West	Princes End	WV	All Saints and Blakenhall	Bilston
BE	Saltley	Erdington	CV	Edgwick	Wood End and Bell Green	SW		Smethwick Soho and Victoria	WV	Heath Town and Park Village	Whitmore Reans
BE	Kingstanding	Sparkbrook and Sparkhill	CV	Willenhall Four Closes		SW		West Bromwich Central	WV	Low Hill and The Scotlands	
BW	Aston	Lozells	DY		Brierley Hill	WS	Birchills Blakenall Coalpool	St Matthews Caldmore	WV	Pennfields	
BW	Handsworth	Three Estates	DY		Dudley Central	WS	St Matthews Caldmore	Willenhall	WV	Wolverhampton City Centre	
BW	Newtown	Birmingham City Centre	SH	Kingshurst	Chelmsley Town	WS	Bloxwich				
BW	Soho Rd		SH		Smiths Wood						
BW	Summerfield and Winson Green										

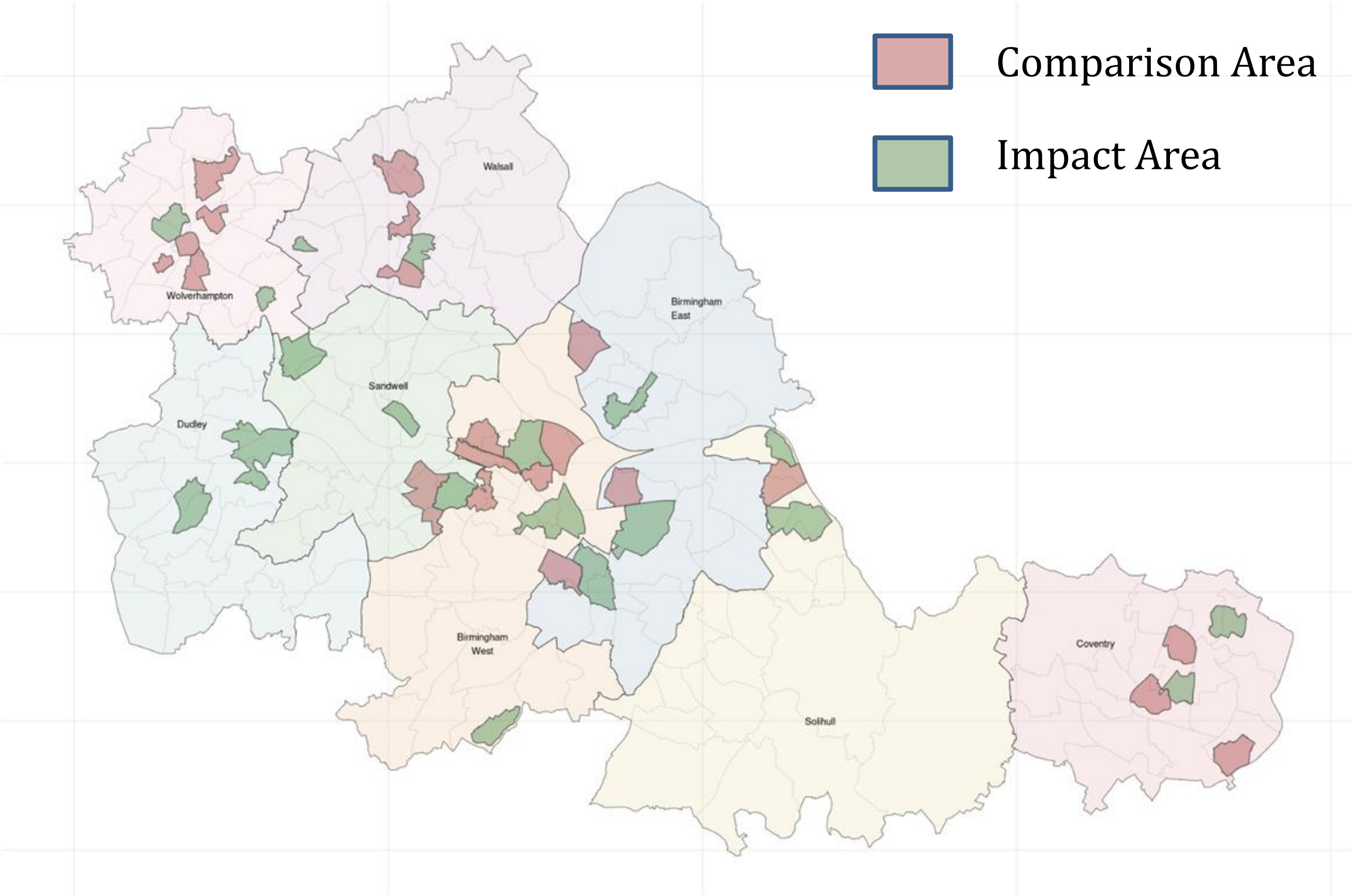


Figure 3 Geographical Spread of Impact & Comparison Areas

3 Data

The study focuses on a number of specific aspects of local policing. The role of policing within the Impact Areas and the comparison areas is considered in terms of the stop and search numbers (however, see below), and the powers under which these are used, the number of crimes in the areas as well as the number of incidents reported. The data will be used in an aggregated manner with numbers of each of the dependent variable and the independent variables aggregated to the impact area or comparison areas.

The officer time and number of visits will also be considered as potentially useful explanatory factors. These data are extracted from radio locations available for each officer. Though the data has a degree of uncertainty associated with it, the location is though sufficiently close to the actual location to be used as a location determinant. The radio signals are intermittent and thus we can use these data to determine how long the officer was in a specific area. This allows us to remove a fleeting officer visit, say in a car passing through an impact area. These 'flying visits' are removed as they are, as with time in stations, of limited influence on the behaviours of individuals within an area.

The data used in the overall panel is based on the period 01-06-2021 to 29-09-2021. The main reason for this is the size of the radio data, the four month data set involves 10,555,321 observations, expanding to April 1st involved 16,327,793 which, though preferable leads to computational issues.

Analysis focuses on the incidents and crimes reported. The number of stop and searches is informative with regards to policing in the areas, but is not modelled as this is extremely endogenous- the police's very presence is required for a stop and search. The model's statistical properties would suffer because of this ensuring that the inference and understanding extracted would be too limited. It is included here to give an understanding of the differences in impact and comparison areas.

3.1 Stop & Search

The first factor to consider is the absolute numbers of the various aspects in each of the areas both in terms of the Impact areas and their comparisons and the NPU as a whole. The areas are presented as an average number of searches across the area as a number of Impact Areas might have a different number of neighbourhoods compared to the comparison areas. Taking an average across these will mitigate this. For the NPU as a whole, an absolute number of searches are presented in Figure 4 . This gives a context for the averages. Impact areas have higher numbers of stop and searches with more resulting as 'no further action', though proportionately these appear to be similar.

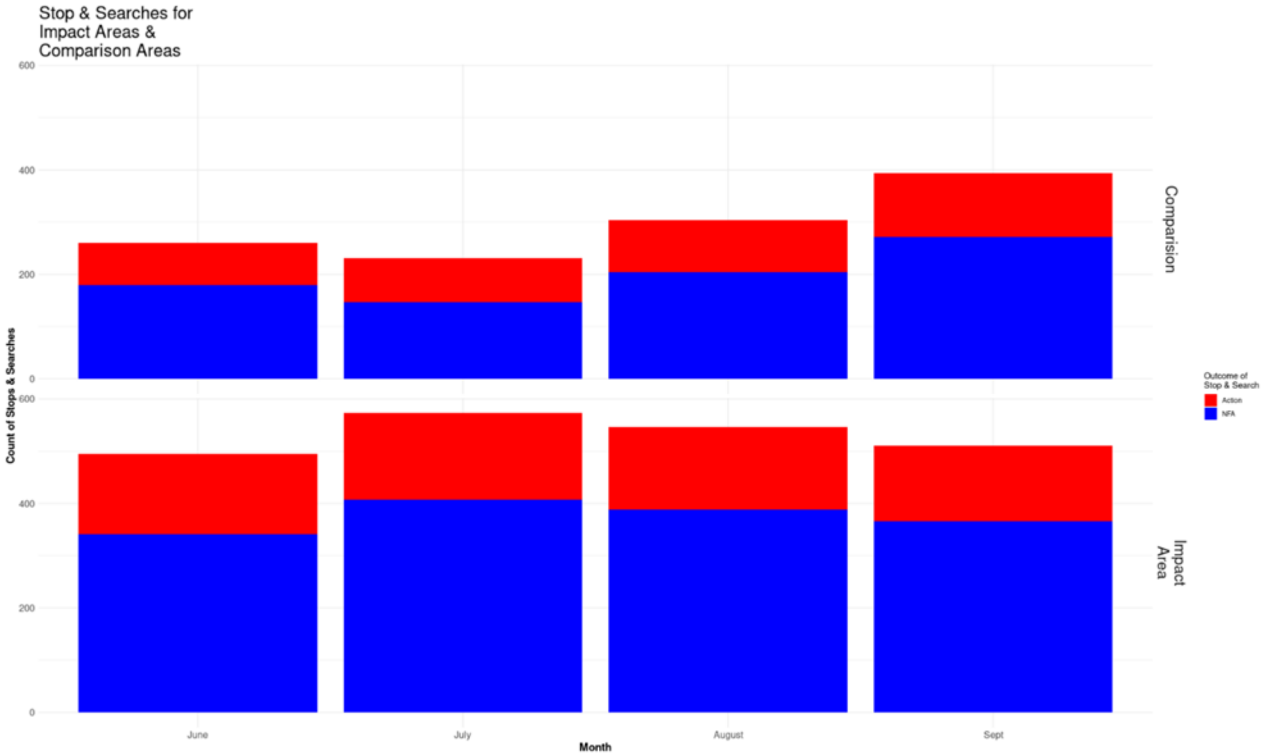


Figure 4 Stop & Searches across Areas By Month

We can see a different split by NPU of use of powers and (reported) ethnicity. This allows us to see the impact area and comparators relative to the whole NPU. The ethnicity was collapsed into Asian, Black, Mixed, Unknown and White. There were four cases where the stop and search involved someone not in these groupings. Not all ethnicities were plotted as they contained very few records and it therefore does not change the overall picture. Taking the proportion of Actions taken (Actions were defined as not No Further Action) of the total stop and searches either in the sub-areas or the NPU as a whole and comparing these, we can see that the Impact Areas can vary relative to the NPUs overall. An odds ratio of 1 suggests that the actionable stop and search is equally likely in the Impact Area compared to the NPU.

$$\ln(odds) = \left(\frac{\left(\frac{\text{Impact Area}_{Action}}{\text{Impact Area}_{Action}+\text{Impact Area}_{NFA}}\right)}{1-\left(\frac{\text{Impact Area}_{Action}}{\text{Impact Area}_{Action}+\text{Impact Area}_{NFA}}\right)}\right)\left(\frac{\left(\frac{\text{NPU}_{Action}}{\text{NPU}_{Action}+\text{NPU}_{NFA}}\right)}{1-\left(\frac{\text{NPU}_{Action}}{\text{NPU}_{Action}+\text{NPU}_{NFA}}\right)}\right)^{-1}$$

A value above 1 suggests that stop and search resulting in action being taken is more likely in the impact Area than the NPU as a whole.

Table 2 Log Odds of Stops & Searches

NPU	Asian	Black	Mixed	Unknown	White
BE	1.1305	1.4566	0.6494	0.8644	0.6261
BW	1.1103	0.8134	0.4473	0.8446	0.8994
CV	1.1078	1.0581	1.2308	0.8175	0.9049
DY	1.1433	1.2308	1.4945	0.9722	1.4906
SH	0.3086	0.4286	0.3222	0.3235	0.9616
SW	0.6702	0.6544	0.1750	1.5000	0.7947
WS	0.8464	0.6731	0.9867	0.3889	0.6923
WV	0.1418	1.1316	0.3529	0.2321	0.6164

From the table we can see that the Stop & Searches in the Impact Areas in Dudley and Coventry have a proportionately higher actionable rate than the NPU as a whole. In all other areas, there are some groups that see more successful stop and searches compared to the rest of the NPU. The powers under which people were stopped shows some comparability across the areas, though the impact areas exhibit higher levels of stops. Approximately 100 people were stopped using Section 47 of the Firearms Act (1968); these have not been plotted as they are too low level to be noticeable in the graphs. Figure 5 & Figure 7 show the average number (using a median has little impact) of stops and searches in the months under consideration, split by outcome as well as by ethnicity and the powers used. Figure 6 looks at the proportion of the stops and searches in a specific area that are successful to consider any differences. One would hope that the interaction with the community in the impact areas might lead to an improvement in the stop and search actions. There is no obvious trend in the data though this might be obfuscated by any operational intelligence not directly observed.

We can conclude that from the data there is little difference between impact areas and the comparisons, as one might expect in the short term using stop and searches as a metric.

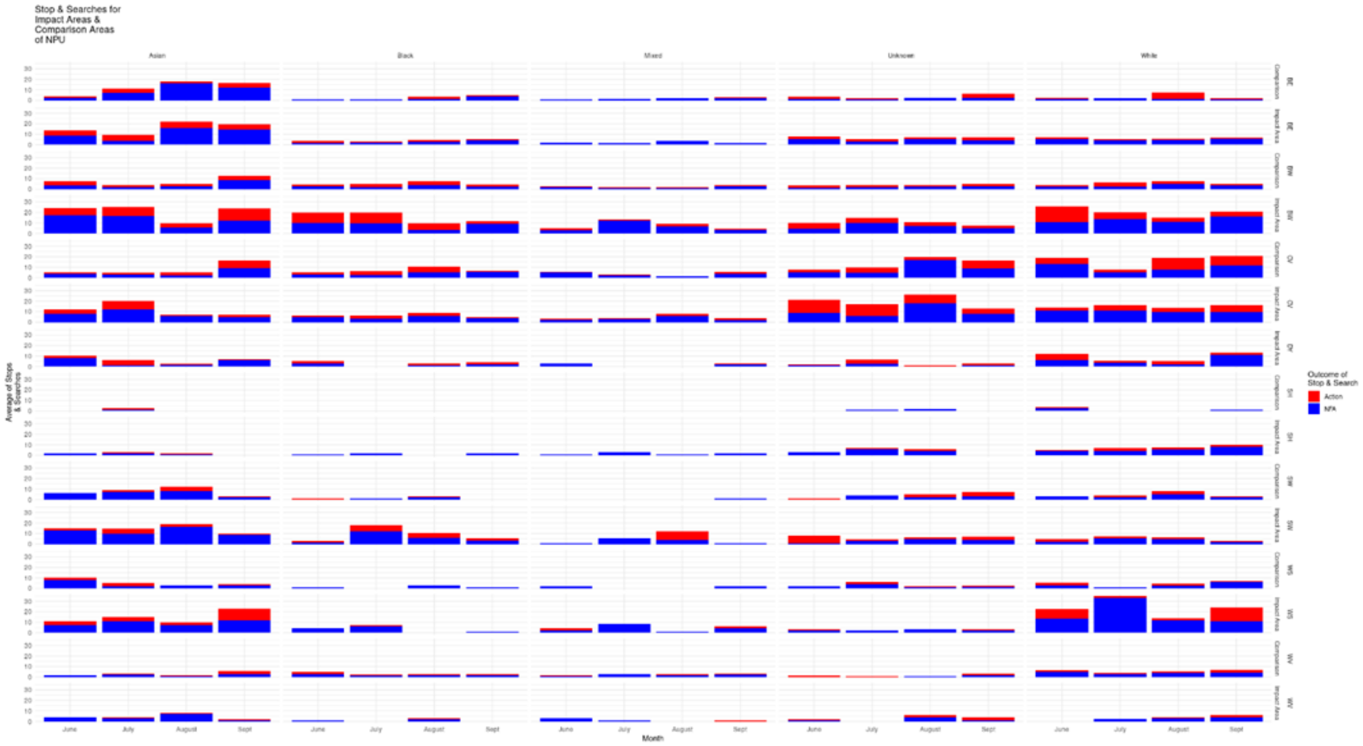


Figure 5 Stop & Search Comparison by Ethnicity

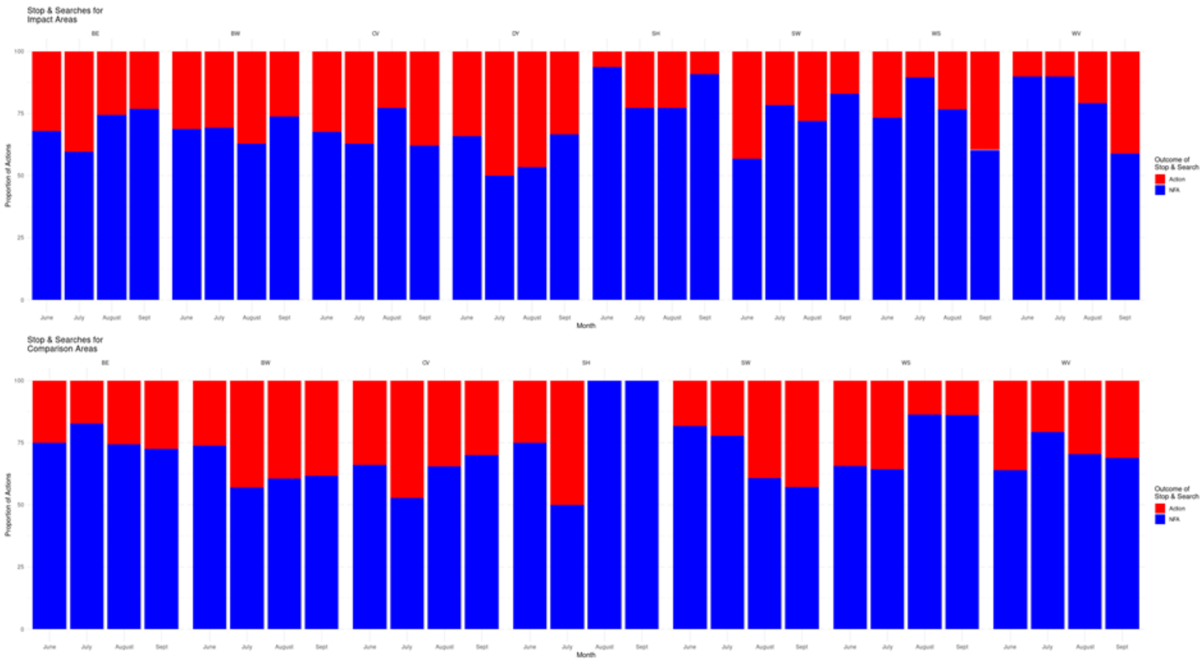


Figure 6 Proportions of Actions on Stop & Searches

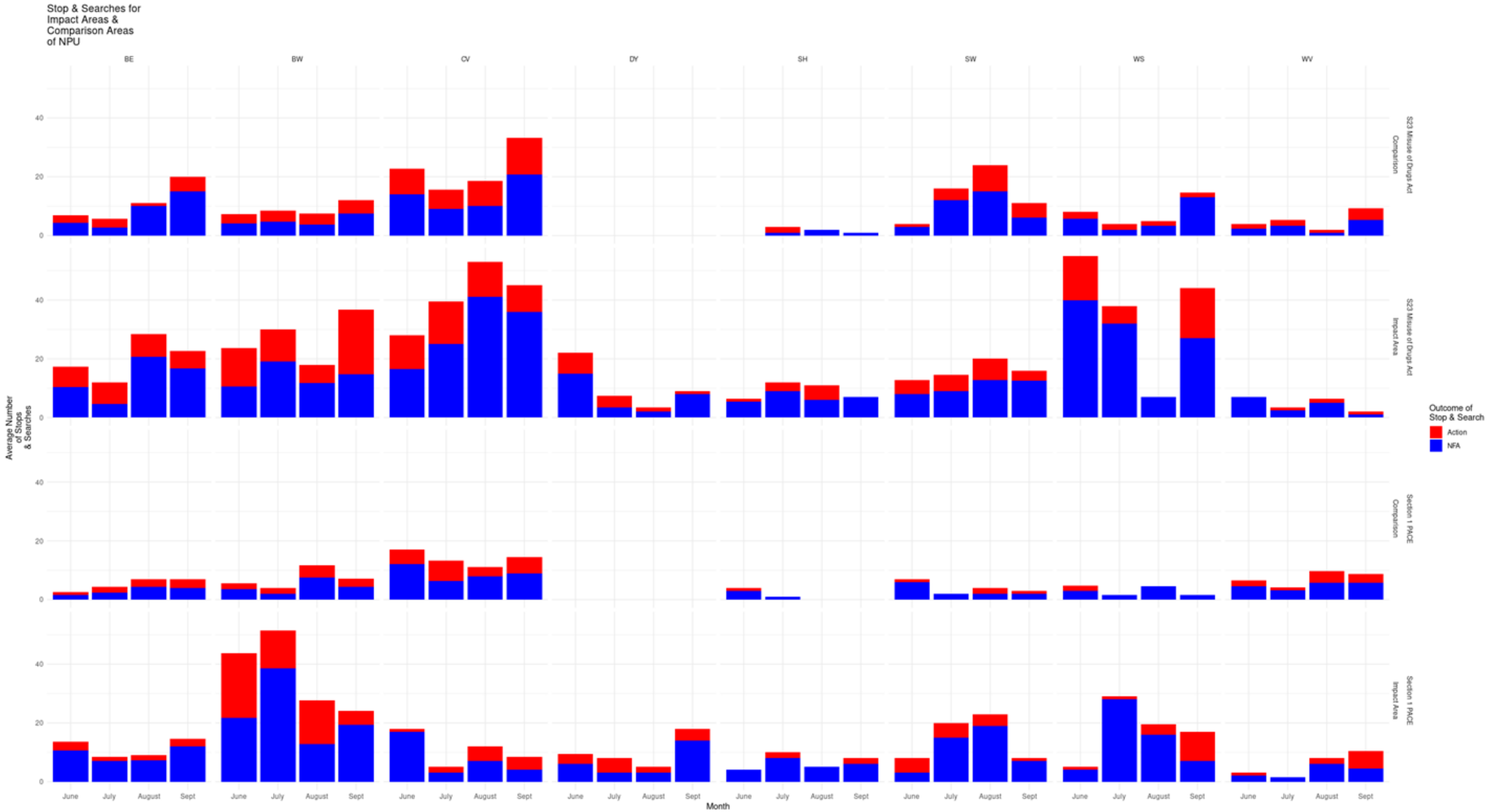


Figure 7 Stop & Search Comparison by Power Used

3.2 Crimes

There is somewhat different data associated with the crime perpetrated in the various areas. It is useful to consider the impact areas initially. We can see that in a majority of cases the impact areas have higher overall crime levels (Dudley does not have a comparison area). In the graph below, the crime classification has been simplified to Non- Crime (when the incident was subsequently not considered to have been a crime or has expired; this is not the same as a non-crime in WMP parlance) or a crime (irrespective of the type of crime). Given the relatively short time span the crimes can be seen to be flat, or near so.

The average number of crimes (by number of impact areas per NPU) over the time considered is generally a little higher in the impact areas, though this is not the case in Coventry and Solihull. These areas show little variation through time and Solihull in particular shows approximate parity. Note that the first chart in Figure 8 is the count across the NPU, not the impact areas/ comparison areas. The second chart is of the areas of interest (comparison or impact).

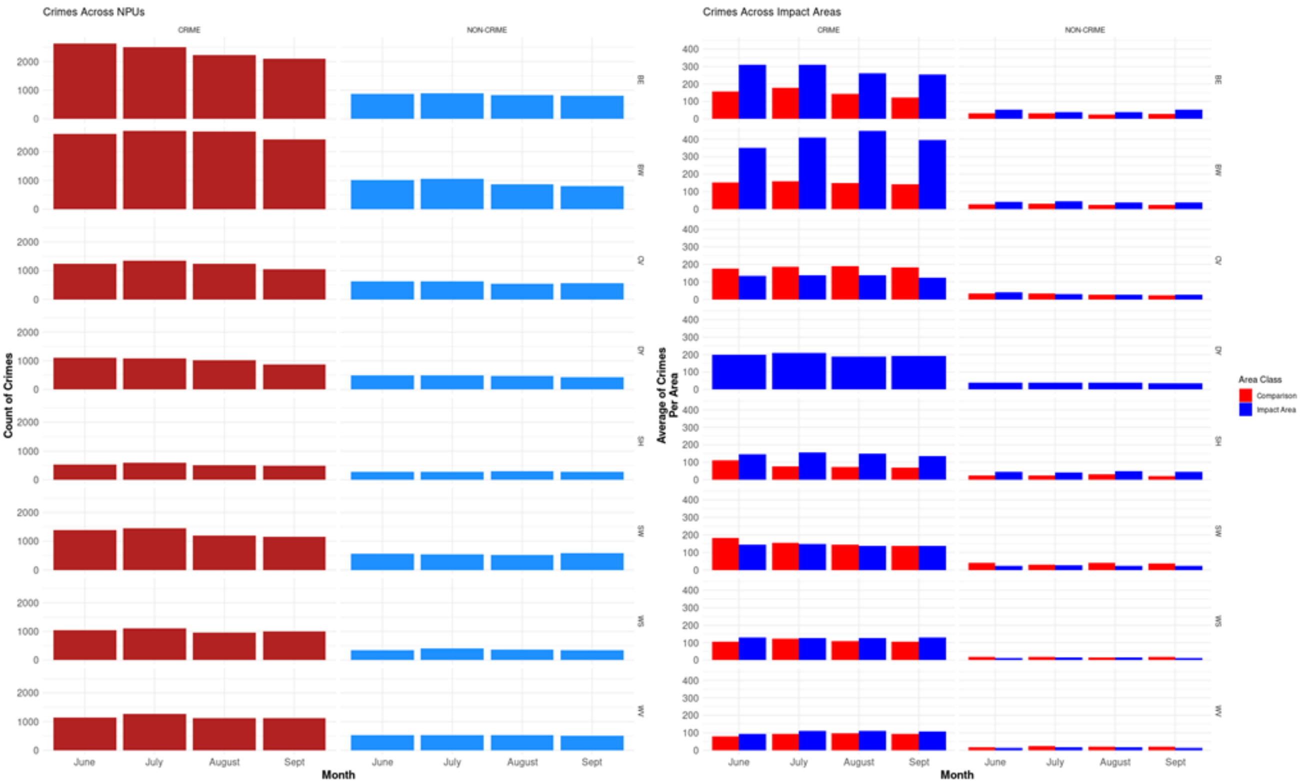


Figure 8 Crimes across the NPUs

It is also possible to consider the crime types associated with the impact areas across the time period. These have been arranged by broad crime type. The impact areas are generally higher on average with violence against the person, though this is driven by relatively high levels of inter-personal violence in Birmingham (West and East), Sandwell & Solihull. This story is repeated for public order offences. These would be suggestive of offending relating to the Night Time Economy (NTE), (possibly alcohol based) fights and the like. Thefts are also generally higher in the impact areas than the comparison sites.

The growth rates for the comparison and impact areas are presented in Table 3. There is a diversity of changes over the period; miscellaneous crimes have fallen over the last quarter, but this is also during the COVID period and thus might in part be put down to the effect of various factors associated with this. Burglary has fallen in the same period which is an encouraging sign, but again this is relatively widespread and cannot be solely attributed to the impact area initiative.

Figure 9 Crime Types by Area Type

Table 3 Average Growth Rates (month on month) by NPU and Crime Type

NPU	ARSON & CRIMINAL DAMAGE		BURGLARY		DRUG OFFENCES		MISCELLANEOUS CRIMES AGAINST SOCIETY		POSSESSION OF WEAPONS		PUBLIC ORDER	
	Comparison	Impact Area	Comparison	Impact Area	Comparison	Impact Area	Comparison	Impact Area	Comparison	Impact Area	Comparison	Impact Area
BE	0.0957	0.1842	0.0000	0.0775	0.0000	-0.0680	-0.1014	0.0358	0.2452	0.2052	0.0923	-0.0034
BW	0.0218	0.0550	-0.0063	-0.1221	-0.1971	-0.1014	-0.1175	-0.0656	0.0143	0.0478	0.0267	0.0685
CV	-0.0591	0.1653	0.0401	-0.0558	0.3466	0.0200	0.0294	-0.1014	0.0000	-0.0558	-0.0104	0.0750
DY	-	0.0814	-	0.0143	-	0.0238	-	-0.0558	-	0.4024	-	0.0882
SH	0.0841	0.0349	-0.0841	-0.3617	0.1733	0.1515	-0.3466	0.1733	0.0000	0.1277	-0.0294	0.0683
SW	0.3466	0.1014	-0.1014	0.0385	-0.1014	0.2027	0.0000	-0.0719	0.0000	0.2189	-0.0919	-0.0075
WS	0.0485	0.0000	0.2747	-0.0385	0.2574	0.1733	-0.0385	0.3466	0.1014	0.2747	0.0302	0.0303
WV	0.1014	0.1733	-0.0591	0.1515	0.0719	0.2747	-0.0841	0.2291	0.2291	-0.1733	-0.0587	0.0456

NPU	ROBBERY		SEXUAL OFFENCE		THEFT		VEHICLE OFFENCES		VIOLENCE AGAINST THE PERSON	
	Comparison	Impact Area	Comparison	Impact Area	Comparison	Impact Area	Comparison	Impact Area	Comparison	Impact Area
BE	0.1399	0.1933	0.3760	0.0528	0.0977	0.0000	0.1356	0.0067	0.0603	0.0075
BW	0.0694	0.0000	0.0841	0.0418	0.0247	0.0941	0.0907	0.1595	-0.0592	0.1371
CV	0.0456	-0.0294	0.0656	0.1733	0.0703	0.1335	-0.0558	-0.0185	0.0120	0.0639
DY	-	0.0841	-	0.0000	-	0.0470	-	0.1315	-	0.0886
SH	0.0000	0.0841	-0.2747	0.0294	0.4024	0.0841	-0.4024	-0.1149	0.0000	-0.0036
SW	0.4024	0.0334	0.3466	-0.0719	-0.0719	-0.0351	0.1399	0.0334	-0.0308	0.0014
WS	-0.1733	0.1277	0.0000	0.1733	0.0558	0.0263	-0.0741	0.0775	0.0260	0.0661
WV	0.2452	0.4479	0.1277	0.0841	0.1159	0.1581	0.0349	0.1733	0.0428	-0.0138

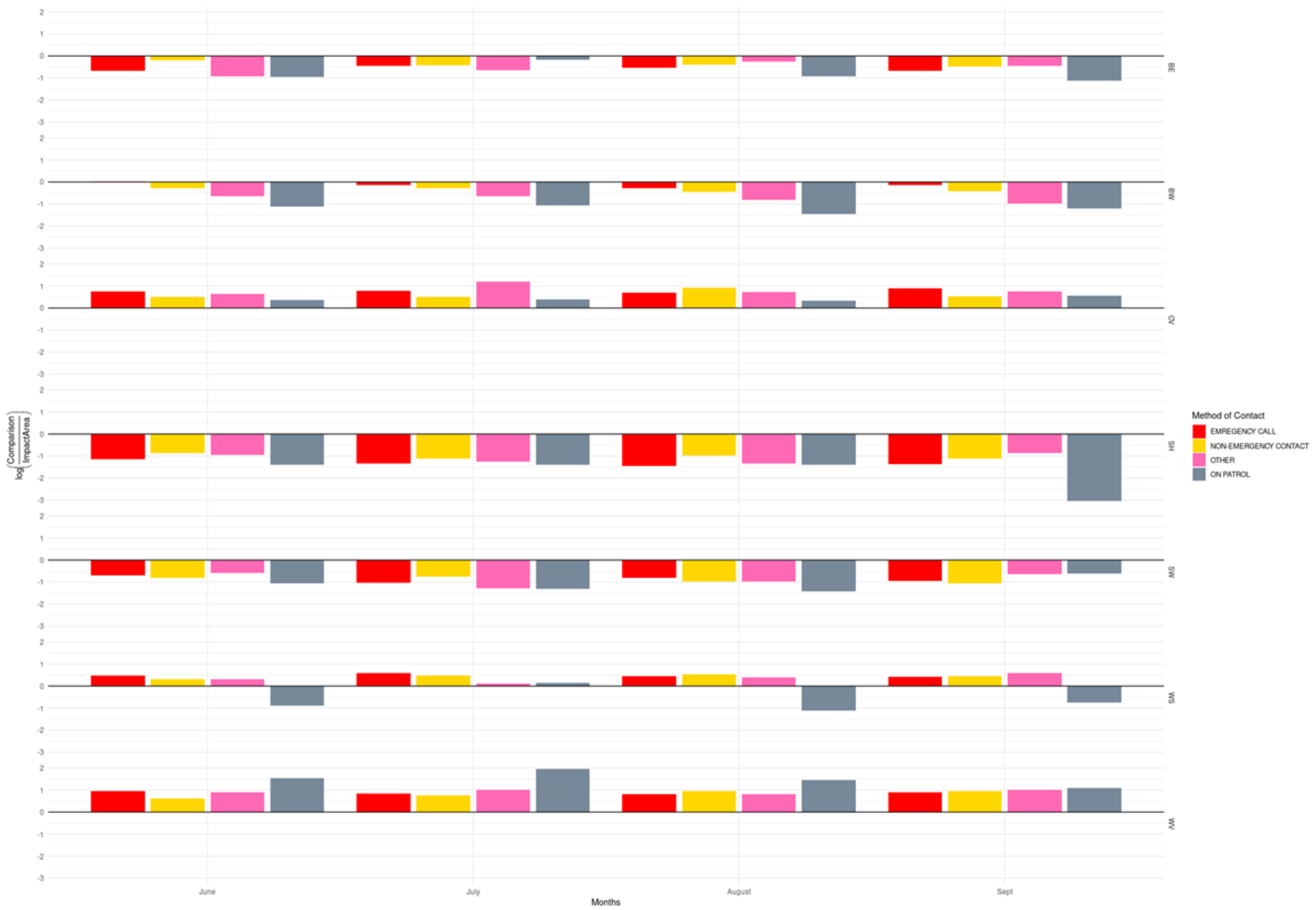


Figure 10 Contact to report crimes

With the long-term relationship and partnership projects involved in the impact area programme between the residents of the impact area and the officers on the beat, one would *hope* that there would be greater interaction with crime via patrols rather than other methods. There is some evidence of this, however it is not universal. In Figure 10, a positive number represents the situation where the number of crimes reported to officers 'on patrol' is greater in the comparison area than those in the impact area (the logarithm is taken to stretch the differences for clarity). Negative numbers suggest that communities within the impact area use that form of communication more than the comparison. This can be thought of being a measure of how likely a caller is to use alternatives relative to "flagging an officer down whilst on patrol". So Solihull has seen greater contact with patrols in the impact area than in the comparison, whereas Coventry has seen a near parity between the two areas in their use of patrols to report crime. To some extent this will reflect the geography of the areas, but there is some useful information contained in the data. Emergency contact (999 calls) should be seen as somewhat different- after all if it is an emergency then that will be the most likely and probable approach to get immediate help, unless a patrol happens to be nearby.

The trend of these figures is also interesting and are presented in Table 4. There is a slight tendency in the Birmingham West NPU for communities in the impact areas to use patrols compared to the comparison area, which might be in part attributable to this area including the City Centre where there are more foot-patrolling officers. Though as the patrol classification also includes "discovered by patrol" there might be more happening as well as pro-active seeking out of patrols.

Table 4 Table Showing Overall Mean Proportions of Comparison and Impact Area Contact Methods for Recorded Crimes

NPU	Emergency Contact	Non- Emergency Contacts	Other	Contacted Patrol
BE	58.24%	62.58%	53.10%	60.26%
BW	111.80%	77.09%	65.83%	39.28%
CV	210.23%	179.11%	214.01%	136.08%
SH	26.71%	35.73%	32.04%	16.84%
SW	40.72%	42.87%	36.89%	22.04%
WS	166.00%	173.51%	169.11%	93.31%
WV	231.96%	254.85%	276.91%	511.39%

>100% Comparison has a higher number of contacts; <100% Impact Area higher

3.3 Incidents

The incidents were split by the priority last given to the incident according to the Grading Framework[2]. P4-P6 were removed from the graphs for clarity, as the numbers associated with them were small. We can see that each of the NPUs have a high number of the more critical, P1 & P2 incidents. The first part of Figure 11 on the following page shows the count of incidents by month and NPU to give an understanding of the relative scales involved. The first graph also includes areas not in the study. The second graph gives an average number of incidents across the impact areas and comparison areas by month per NPU. In Birmingham (East and West) the impact areas have a higher average number of incidents, whereas in Coventry and Sandwell the comparison areas are higher. In other NPUs, there is a greater balance. This may be in part due to the initial selection of the areas.

As with crimes, the method of reporting is also used to dissect the data. With the aspiration that as the local community becomes more empowered and trusting of the policing activities there will be a shift away from 999 calls towards other methods of reporting. We can see in Figure 12 that 999 calls are still the pre-dominant method of accessing the police in these areas. Non-emergency includes front desk access (which may or may not be in the area of the event), emails and 101 telephone calls as recorded in the data. There is a degree of variation between the NPUs with some areas having more 999s from impact areas than the comparison areas and other NPUs see the opposite. There is an effort over a number of years to move the less urgent incidents away from 999 and towards the other non-urgent access routes, such as email and 101 calls. In this data, there is only partial success demonstrated in this attempt but also reflects and is reflected by the relative numbers of higher levels of urgency (P1 vs P8 & P9) that the various areas encounter.

Across the areas, there is a degree of variation which suggests that the designation of ‘impact area’ has differing effects across the NPUs. The severity of the incidents as reflected in the use of 999 as opposed to other forms of communication is diverse across the areas. This is suggestive of work required in terms of encouraging victims to use other forms of contact. There is some encouraging signs in the use of non-emergency contacts in Birmingham East and West where these forms of contact were higher for the impact areas than non-impact areas.

[2] This is available in Appendix 8.4

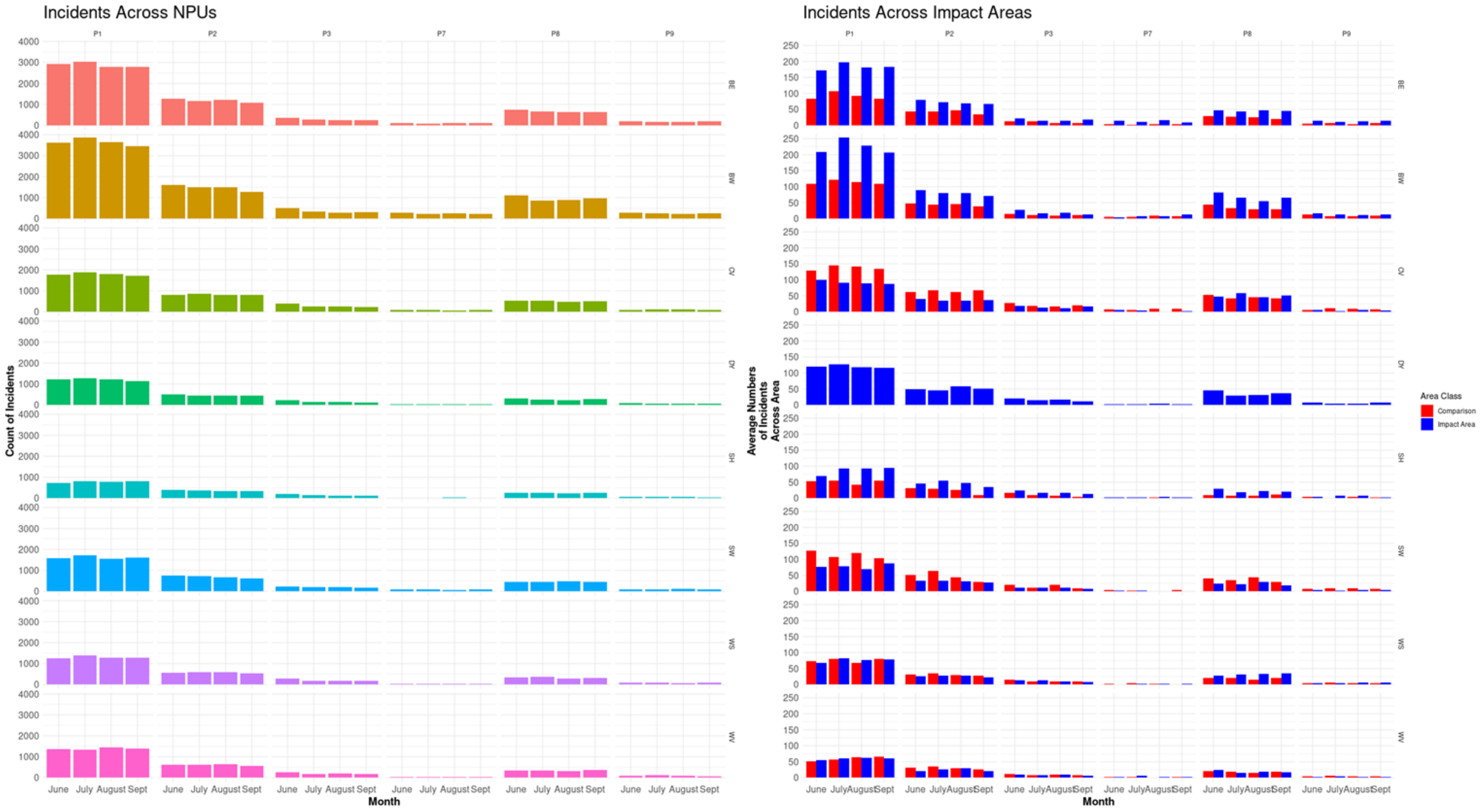


Figure 11 Average Number of Incidents

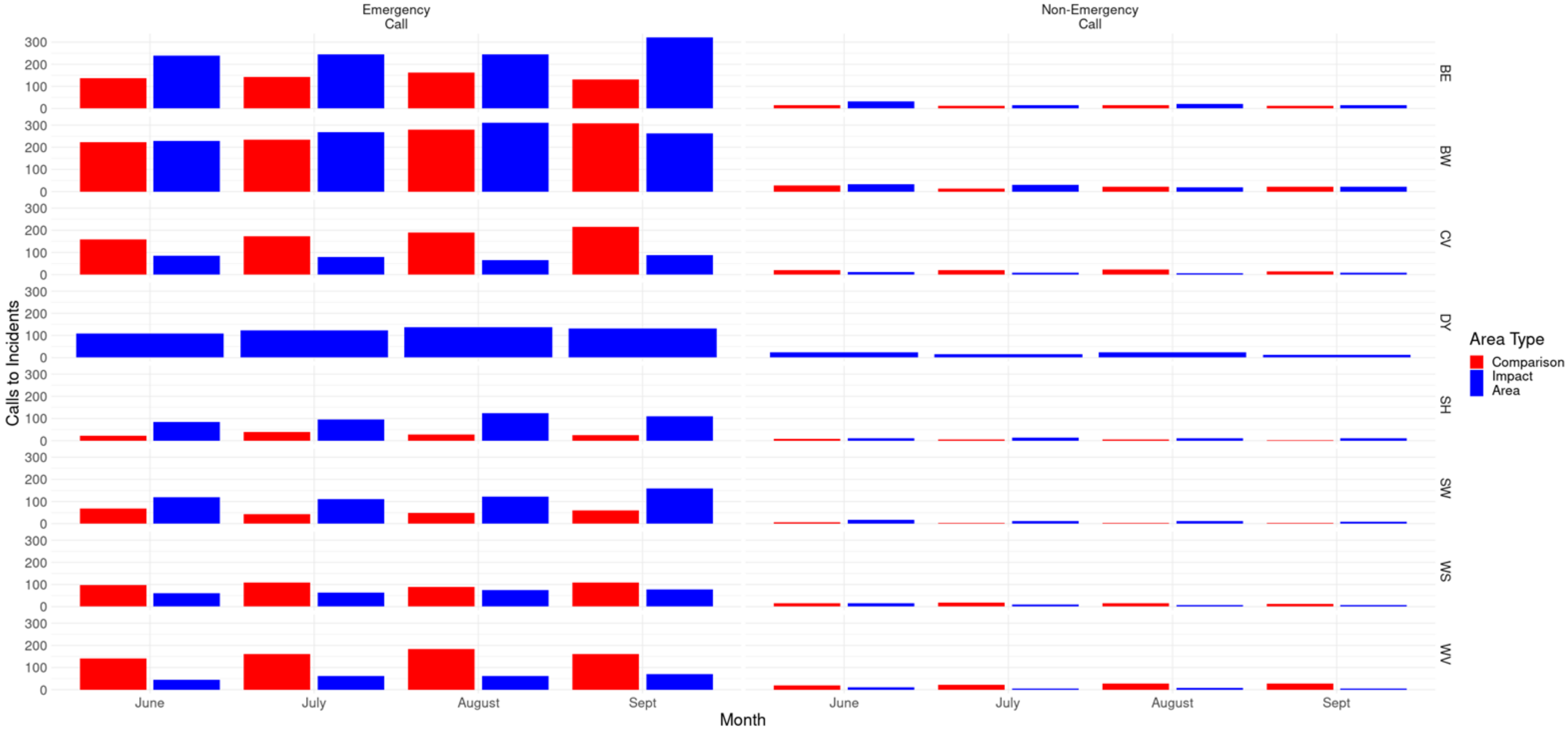


Figure 12 Incidents by Call Type

3.4 Officers

Officer locations were gleaned from the radio affiliations. During a shift, the radio reports its location at regular intervals. This allows the duration of an officers' stay to be estimated. This data was used to give overall time within the various areas of interest over each part of their shift.

The data is extensive, as one can imagine. In order to use this information the total time in each of the impact and comparison areas was calculated for the analysis. This was a summation of all the individual times in an area. An example is given below in Figure 13, the total time in the area is 65 minutes, but looking at the data it is clear that visit 3 (65s) is clearly a pass through and would hardly have a meaningful effect on crime in the area. A cut-off of two minutes was used to limit the drive-through aspects that would have little effect.

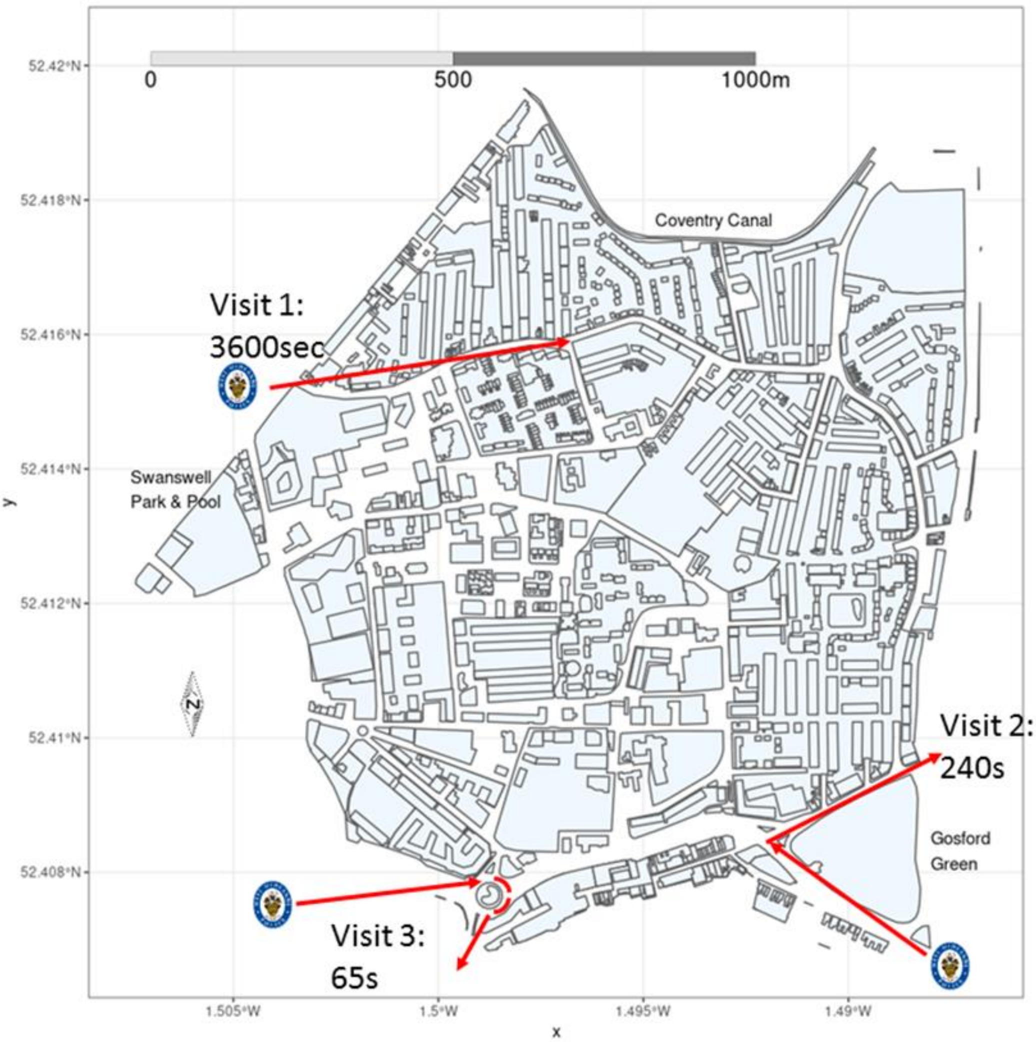


Figure 13 Example Time in Area

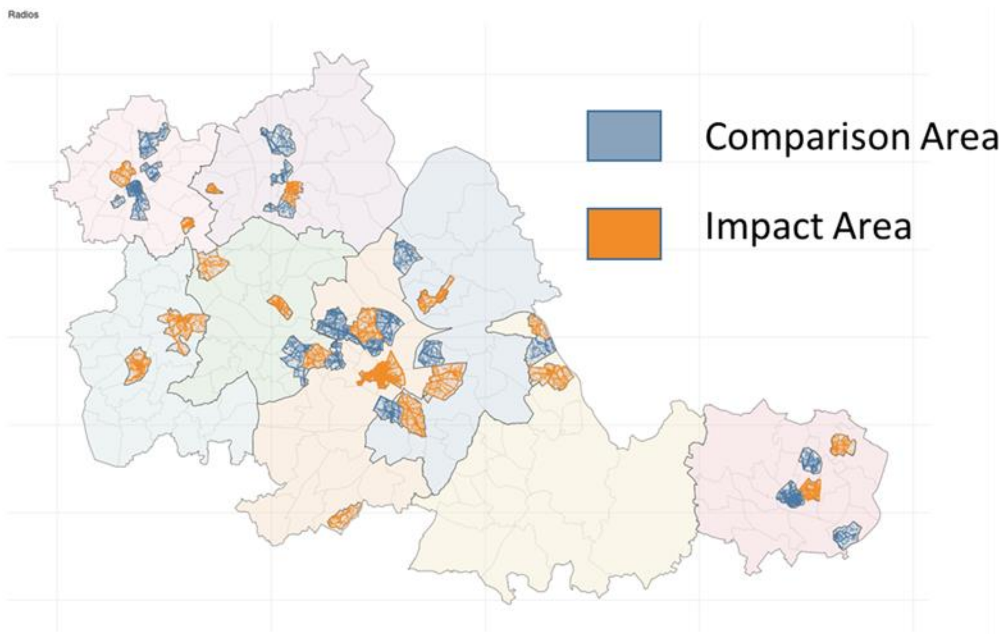


Figure 14 Location of sample of officers in areas of interest

Officers present in an area for more than 2 minutes are designated to have been in the area; the belief is that those passing through in less than 2 minutes will either be in a car and so moving relatively quickly or passing through the edge of the area and thus have little impact on the area as a whole or that the incident is cleared up very quickly and the officers immediately leave the scene, departing the area.

In general, across each of the impact areas and comparison areas we can see the time spent and the number of visits by officers (when including times of more than 2 minutes). There are some areas where there have been a vast amount of time spent in the area, for example an area in Dudley on 8th May 2021 saw a lot of activity. This appears to be associated with a fatal fire in the area and thus is constituted of many officers' time, often for long periods. There is a danger that some of these longer periods are technical issues in addition to bona fide presences at serious incidents. For periods longer than 12 hours, this constitutes about 1.5% of the data. In light of this, two data summaries are created; one with the whole data set and one with the shift limited to 12 hours. These are presented in Section 8.3. They are presented to ensure transparency and to show that there is no estimable impact of excluding these extremities.

By reducing the officer movement data to exclude very short and very long visits, we get a very slightly different picture of the officers' movements; but given that the process is removing those "flying visits", where the officers might be in the area but are actually just on the edge and not *effectively* in the area or the officer appears to be in the area for a very long time (which is itself unlikely to be very common) the overall picture is intrinsically the same.

The time spent inside a police property such as a police station might be considered as not contributing to the anti-criminal impact of policing; it is expected that some of the time inside stations will be breaks, administration and the like. The data therefore discounts this time, despite the fact that some of this time will be productive.

4 Methodology

In order to assess the current effectiveness of the policing of impact areas, a number of approaches were used. The underlying approach was to use **three-way interaction effects** to capture the influence of the area designation, the time of the year as well as the variable of interest. This allows the impact of the activity to vary considerably within the model- so impact areas can see different effects of policing by month of the year. This is **not** a model of crime and incident incidence that explains all the variation seen in the data. It tries to isolate a number of important variables and uses location and temporal variables to control for any other processes that are not caught by the variables of interest.

The policing activity, be it number of visits (of more than 2 minutes) or time (person hours) was used to explain the number of incidents and crimes. It is accepted that there is a degree of endogeneity in the model but it is believed that the use of the relevant number of incident grades, P1-9, might assist in conditioning out some of the problems.

There is no reason why lagged values of the explanatory variable would be an acceptable instrumental variable as investigations of the data suggest that there is little to no autocorrelation across the data. This suggests that the basic requirement of the instrument – that the instrument should be correlated with the "problem" variable, is not satisfied. Such weak instruments do little to aid in the understanding of the relationships. The impact area flag can act at least in part as an instrumenting variable as it has no relationship with the number of crimes or incidents (at least insofar as its designation was concerned) and it is directly related to policing activity.

During the modelling phase, daily data was used. This allows the impact of the day's policing activity to be related to the outcomes of that day. Though there might be issues with the time of day, the overall picture of policing activity is valid for the purposes of the analyses.

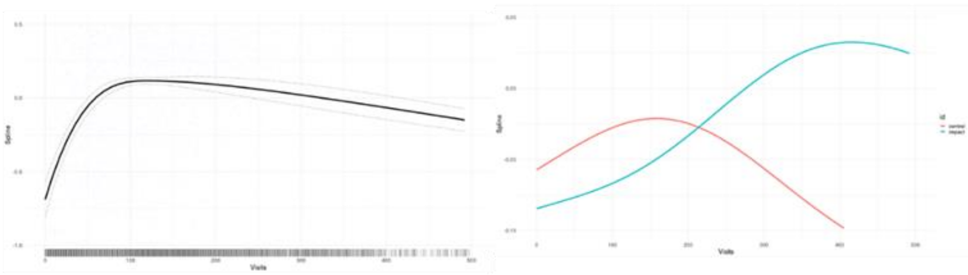
The hypothesis is that the effect of the policing activity measured either by time or number of visits is different in impact areas. This would be evidenced by a non-zero coefficient on the interaction of the impact area variable and the police activity variable. This shows how the number of visits, say, reduces the number of incidents in a day *if* the area was an impact area. If this coefficient is not credibly different from 0, then the impact of the visits is not visible within the data.

An initial investigation suggested that there was a non-linear relationship between the number of incidents and the visits by officers and the time spent in an area by officers. This can be seen in Figure 15. This would be reflective of the inter-relationship at lower levels where officers are visiting an area with lower levels of incidents and as the number of visits increases the number of incidents declines; the opportunity for events would be expected to decrease as the number of officers in the area (and outside stations) increases. This non-linearity was strongest for the number of visits. Note the difference in scale; the time spent is in hours with 139 representing an average of 5.79

officers in the area per hour for more than 2 minutes. The splined[3] approach is considered beneficial for both the number of visits & the time. The non-linearity was found to be robust to the choice of the spline dimension.

The approach utilized is the Generalised Additive Model (GAM) which allows the estimation of the non-linearities as well as interaction effects. These models are estimated using Restricted Maximum Likelihood (REML). This gives access to the usual diagnostics and fit measures as reported in the Appendix. The models are reported for the fullest specification; a regularization was considered on the additive model element but, as would be expected this lead to a deterioration of metrics (such as increases in the BIC, which is reported for completeness and a reduction of $\bar{R}^2$). The R package used (`mgcv` (Wood (2011)) employs a Bayesian ethos to the estimation of the GAM and thus the confidence intervals should be interpreted in that light[4].

In addition to the spline for the direct policing activity, a spline was set up to allow for different approaches to the control, i.e. impact area or not. This allows for a more flexible impact of policing in the two area types, rather than a shift alone which would occur if only a standard interaction term was included. This is demonstrated in the right-hand diagrams of Figure 15. We can see from these that there is a *small* impact on the transformation based on the presence in an impact area or not.

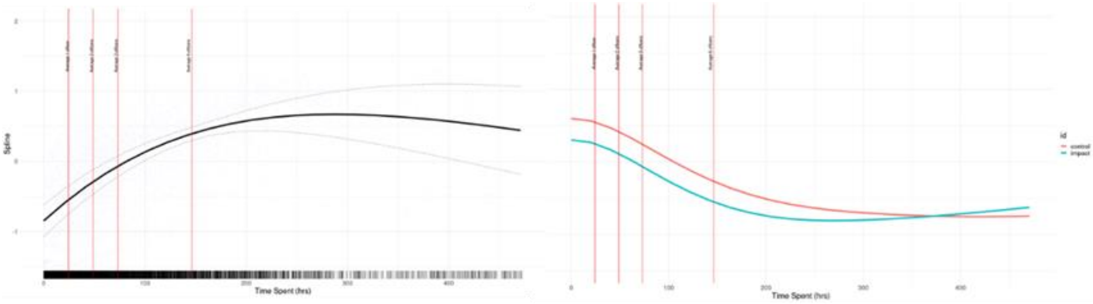


Non-linear Transformation of Visits

Non-linear Transformation of Visits With Impact Area taken into account

[3] Rather than a cubic spline, an adaptive smoothing approach was used (Wood (2003)). This approach allows the *wiggliness* of the spline to vary across the range and thus creates a smoother curve than one fitted with a vanilla cubic spline.

[4] There are linkages between GAMs and Bayesian modelling in that the structure of the data are taken into account (using splines) which leads to a similar ethos as employing a prior. The estimation, being REML, is not the same as fully Bayesian estimation (it's an empirical Bayes method). Given that the confidence intervals are ascertained via a distribution, these are more akin to credible intervals.



Non-linear Transformation of Time in Area

Non-linear Transformation of Time in Area
With Impact Area taken into account

Figure 15 Estimated Non-linearities in the Policing Explanatory Factors

A number of interaction effects were used. These allow us to consider the impact of being in an impact area relative to a non-impact area, specifically the police activity variable was conditioned on the impact area as well as those linked to the month. This allows the examination of the impact of any projects that were rolling out over the period considered but variables not specifically discovered to assess them.

The modelling approach uses both non-linearities as well as interactions of these in order to ascertain the influence of the activities associated with the designation of impact area. The linear interaction effects are demonstrated below in Figure 16. The addition of non-linearities are more complex and the impact of the modelling is ascertained using a ceteris paribus simulation as in Figure 17.

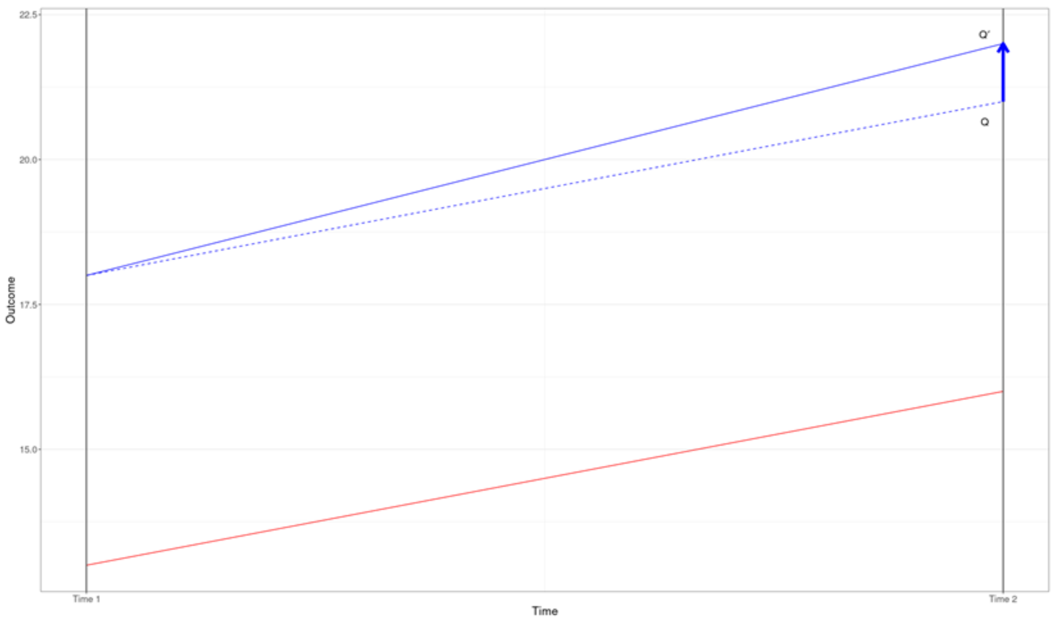


Figure 16 Interaction Effects

The coefficients from the regressions can be interpreted as the differential impact of an area being designated an impact area. A positive coefficient on the impact area suggests that such an area has a higher effect associated with that variable.

The family used for the regressions was the negative binomial. This allows for a level of more general dispersion (where the mean and the variances are not the same, which is required by the Poisson distribution). In many cases, the estimate of the ϑ parameter that accommodates the dispersion was found to be large which suggests that the mean and the variance were similar; however the generality was used to allow specific situations where this could not be asserted.

The underlying model took the form:

$$
\begin{aligned}
f(y;\theta,\delta) &= \frac{\Gamma(y+1/\theta)}{\Gamma(1/\theta)\Gamma(y+1)} \left(\frac{1}{1+\delta\theta}\right)^{1/\theta} \left(1-\frac{1}{1+\delta\theta}\right)^{y} \\
\text{where} & \\
\delta &= exp(X^T\beta) = \mu \\
\text{mean} = & \ \mu \\
\text{variance} &= \mu(1+\theta) \\
\text{dispersion} &= \frac{\text{variance}}{\text{mean}} = (1+\theta)
\end{aligned}
$$

Variables included in the model were the splined variables where appropriate, the level of incidents or crimes elsewhere in the region and the time and location (NPU) dummies. These were supplemented by two and three way interactions of the policing activity with impact area dummy and the month to allow time varying impacts as the impact area initiative develops with partner projects such as Gro-Mentoring, Step Together and the like becoming more embedded within the communities.

5 Results

In general terms there is a relationship between the number of incidents in a day and the number of visits and time spent in the area. There is a small effect in the parametric element of the model suggesting that the impact areas have a slightly higher number of incidents than the control groups (on average) and a small negative impact for the interaction term suggesting that the policing time in the impact area is reducing the number of incidents in that area *relative to* the control groups. The net effect is that the control groups have a small positive effect and the impact areas' policing time reduces this to approximately zero.

In order to examine the impact of being an impact area, simulations based upon the estimations and predicted values have been undertaken. A large number of data points were sampled off the data set, with the incident levels set at the mean and the month set at September. The size of the simulated data set ensured that the distribution of the variables of interest were sufficiently close to those of the actual data that inferences can be drawn.

The NPU and the time spent and the number of visits were sampled out of the main data set to give some variation. These were all set as Control groups and the data replicated to give the Impact area group. None of the points were specified as being in the city centres. The data was therefore identical except in the allocation of impact or control groups. Predictions were made from both of these data sets. This therefore isolates the impact of being an impact area. This approach generated a set of impact area responses for Dudley even though these are not present. This is a true hypothetical and demonstrates the potential for the NPU.

The first set of graphs demonstrate the role of time spent in the various areas (above 2 minutes) on the fitted number of incidents. This is labelled Model A in the Appendix. This is not a diagnostic plot for the model, rather it is isolating the impact of the designation as an impact area. The predicted level is for a particular level of the variables and is **not** the model fit from the data set in general. In all the following graphs the impact area effect is shown in blue and the control area in red.

We can see that for the lower values of the variables the outcome is in essence identical. There is an amount of time associated with incidents irrespective of the location or designation of the area. However this figure shows that there is a small change in the relationship as the time rises above this. It is not significant (statistically speaking) and it is small, however given the nascent nature of this designation it is encouraging. In non-impact areas, this suggests that there is a slight reduction in the number of incidents with the time of officers in the area, *ceteris paribus* for the middle range of the data.

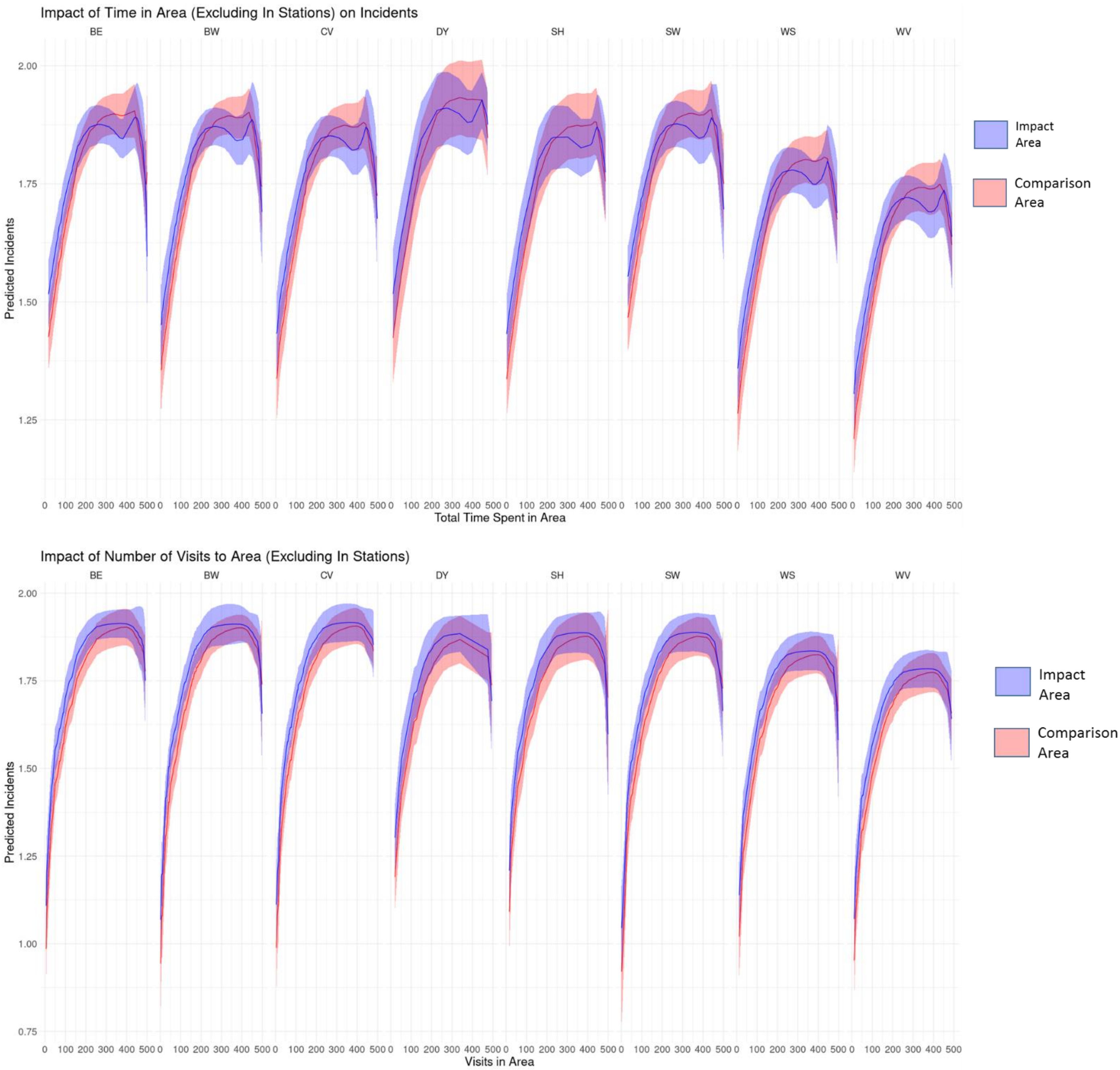


Figure 17 Impact of Designation of Impact Area on the Effect of Policing Actions

This would suggest that in the day-to-day policing evidence is potentially present for a change in behaviours. In the more extreme levels of policing time spent in the area this divergence disappears. This is intuitively sensible. The lower times are suggestive of responding to occurrences and the larger more extreme values are that- a more serious event where there is no chance of differential response. The levels where there is some difference is in the range which might be considered normal policing levels as shown in Figure 15. There also appears to be a slight difference between the NPUs and their reaction to officer time. These are based on the parametric coefficients and their interaction with the outcomes of the model.

A similar process was followed looking at the impact of visits to the area, rather than time spent. The relationship is more pronounced and visible in this case with fewer visits to the area for a given number of incidents. Alternatively one can think that 100 visits to an impact area can deal with more incidents than a non-impact area. This highlights the increased effectiveness of the policing activity within the impact area, albeit small in the current examples. As with the time spent in the area, the middle range shows the largest deviations from the control areas.

The equivalent results for crimes fitted the data less well with adjusted R^2 being lower and explained deviance lower across all models. Whereas the incident based outcomes were around 80%, the crime based relationship was weaker at around 50%. The simulations isolating the impact areas demonstrate that there is currently little difference between the impact and control areas when crimes are considered. Indeed for the equivalent models for crimes (models C &D in the Appendix) the two graphs lie almost on top of each other, suggesting that there is no effect as yet on the crimes by the policing activity.

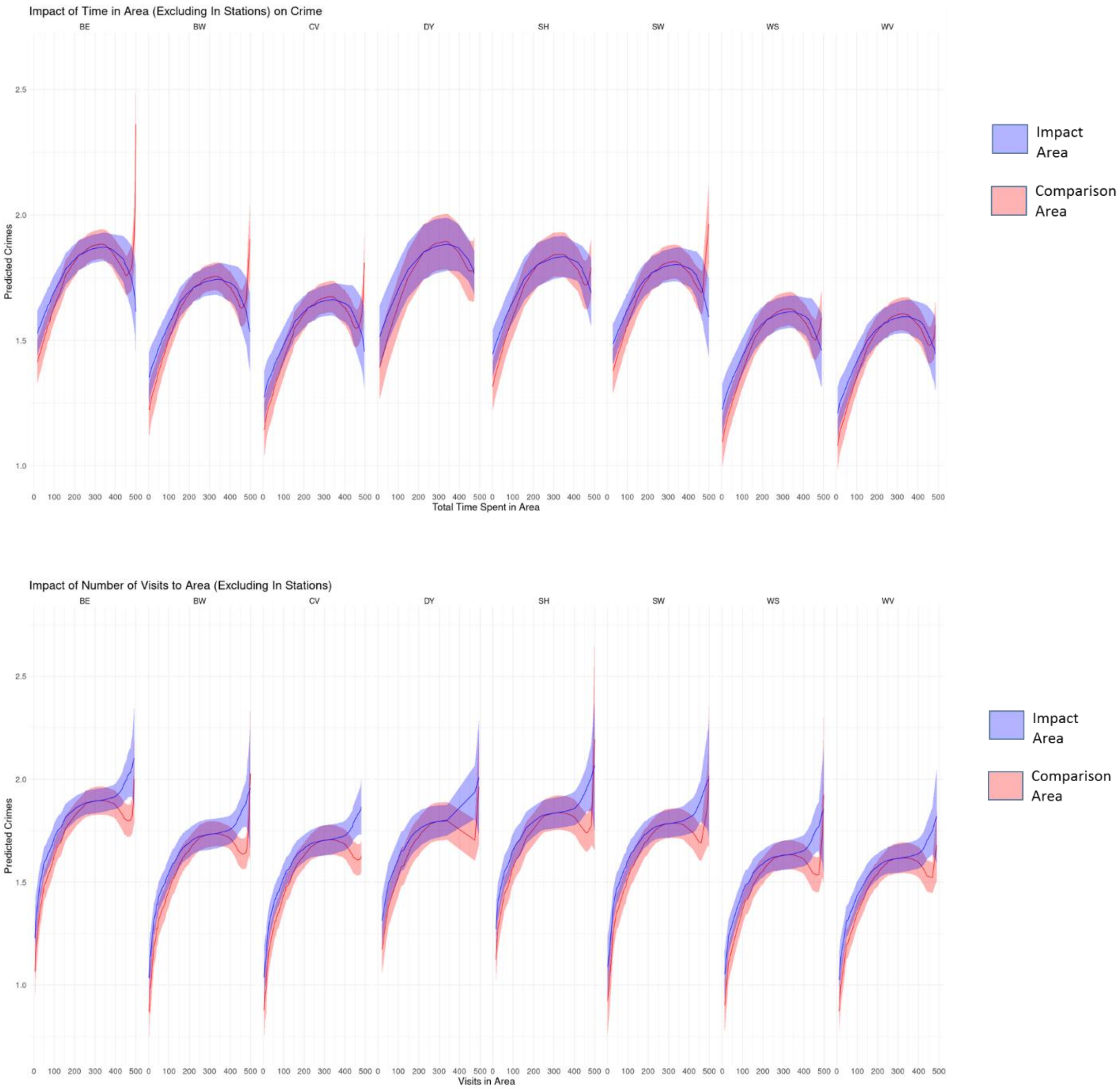


Figure 18 Effect of Area Designation on the Effect of Policing Activity

This might be because crime is more entrenched in all areas and thus it will take longer to overcome and thus changes in behaviour have yet to come to pass. There is an appearance of a difference at the more extreme levels of visits and time spent in the areas. The impact of visits on the area is more pronounced but of the same basic form when considering Model E in the Appendix. A number of parallel models are included in the Appendix. Models using the number of 999 calls to both crimes and incidents, drugs and violence based offences were also used but are not reported due to low power.

It appears that overall there is some weak evidence that currently there is differing responses to policing activity in the impact areas. The evidence is currently far from conclusive but points to some progress being made. The impact of the designation of impact area should be returned to at a later date when more time has passed and there has been a more substantial opportunity for the partner groups to be involved in building the necessary elements to support policing activity.

6 Officer Impact- Hillfields Analysis

The regression approach considered above allows us to consider the more macroscopic picture; does the impact area see different outcomes dues to the higher police presence? At a more micro- level a different approach is necessary. The obvious choice would be a scan statistic, where a baseline of a regression is commonly used to identify areas or clusters of an entity (often diseases). Tango, Takahashi, and Kohriyama (2011) and Tango and Takahashi (2005) consider the use of a spatial scan statistic with either circular frameworks or a more flexible shape. The scan statistic as proposed by Kulldorff (1997) is considering what is observed against the null hypothesis of a Poisson or Negative Binomial count model. This considers the impacts of a factor through time and space, in a regular circle (or ellipse) or an irregular shape. These models take as a null hypothesis, that the observed count is distributed in a particular manner with the alternative hypothesis proposing a cluster. In general, the null is based on the assumption of no cluster. The nature of what is the benchmark is of course up for discussion. The traditional options include Bernoulli, Poisson and negative binomial distributions of outcomes, depending upon the characteristics exhibited by the data[5].

The approach here is a little different; the officer/ resources' presence in a grid is compared to the presence of an incident or crime in other grids (of a similar scale) in the future. The count of the events per grid in the area is used to generate an informational surface. This surface will be non-zero when an event occurs. This is represented using a heatmap. The sooner the event occurs, the closer to the origin the point or spike occurs and the further away it is geographically, the point is further away. As the value increase, the hotter the colour becomes. The heatmap is interpolated to aid in the visualization. A strong coloured peak is indicative of events occurring across the area at that time and distance.

A simple measure is presented at a number of different scales for both crimes and incidents (non-crimed). This demonstrates the time taken and distance from a resource, on average, before an event within the range of the grid. This grid range was limited in each case to what might be considered feasible given the scale of the grid squares.

[5] An interesting approach would be to use a Bayesian posterior measure and to compare the distribution of the predicted and actual observations via measures such as Kullback- Leiber (Kullback and Leibler (1951)) or Jensen- Shannon divergenes, using the maximum statistic as the sup Log-likelihood as used in the scan statistics. The use of the KL- divergence has been suggested in, for example Gelman et al. (2004) to measure the differences in prior and posterior or two posterior distributions. The asymmetry of the KL distance is often seen as a problem in using this as a distance; however in this situation it might be an advantage that will accommodate the relative differences and the starting points (KL Divergence is sometimes called the relative entropy of the two distributions). Further it will exaggerate differences giving a clearer signal in the statistic, though if there is mutual information then symmetry is established. This informational statistic will capture the overall differences rather than the single likelihood of the estimates. Belov and Armstrong (2011) shows that under reasonable assumptions that the KL divergence can be seen to be distributed (asymptotically at least) as χ_1^2, which is a direct parallel to the LR statistic which is also distributed as χ_n^2 where n is the number of restrictions under consideration.

Using Hillfields as an example of the impact of the officers, the map is split into grid squares. This is an impact area and thus is associated with higher levels of policing than other areas. The area is shown in red below. A number of grids were created of varying sizes (25-150m). Officers and crimes were placed in grids across the area according to the radio logs. This allows for the impact of an officer's presence to be considered. Though not used in this approach, a path for the officer is also discernable with a sphere of influence around them. The current data is too coarse to give an exact path, rather it goes between the two points as the crow flies rather than the wolf runs, it does however demonstrate a further approach when the data is more exact. The data shows the diversion of the resources to the incident during that day and then the return to the 'normal' patrol routes.

Figure 19 Hillfields Area of Coventry

Figure 20 Grids Around Hillfields

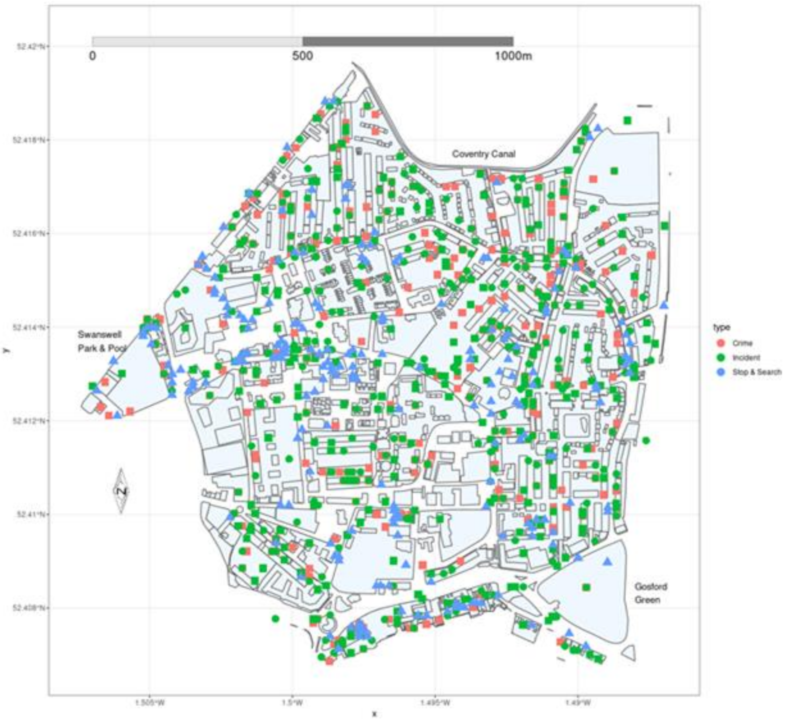
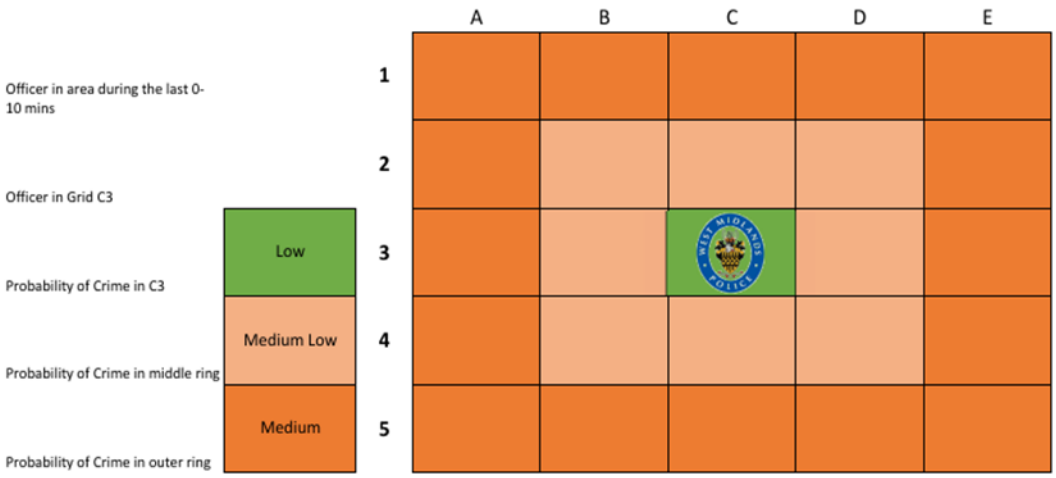


Figure 21 Policing Events in Hillfields

Figure 22 Anonymized officer route around Hillfields Impact Area

It is possible to see the routing of officers around the area. The officers' route is used to ascertain a policing presence in a grid square as described above. These squares are used to count the events in that grid square (and those nearby). These counts are averaged across the grids, times etc. with over statistical quantities also calculated.



The maps in the following figures (Figure 23) demonstrate the impact of the changing the radius on the number of incidents, crimes and stop and searches. The data is constrained to be *after* the officer was in the grid area. There is therefore for each square grid, a countable number of crimes, incidents etc. and these can be time discounted. It should be noted that as the grids increase in size, the time differences can be considerably smaller, thus the time discounting is larger.

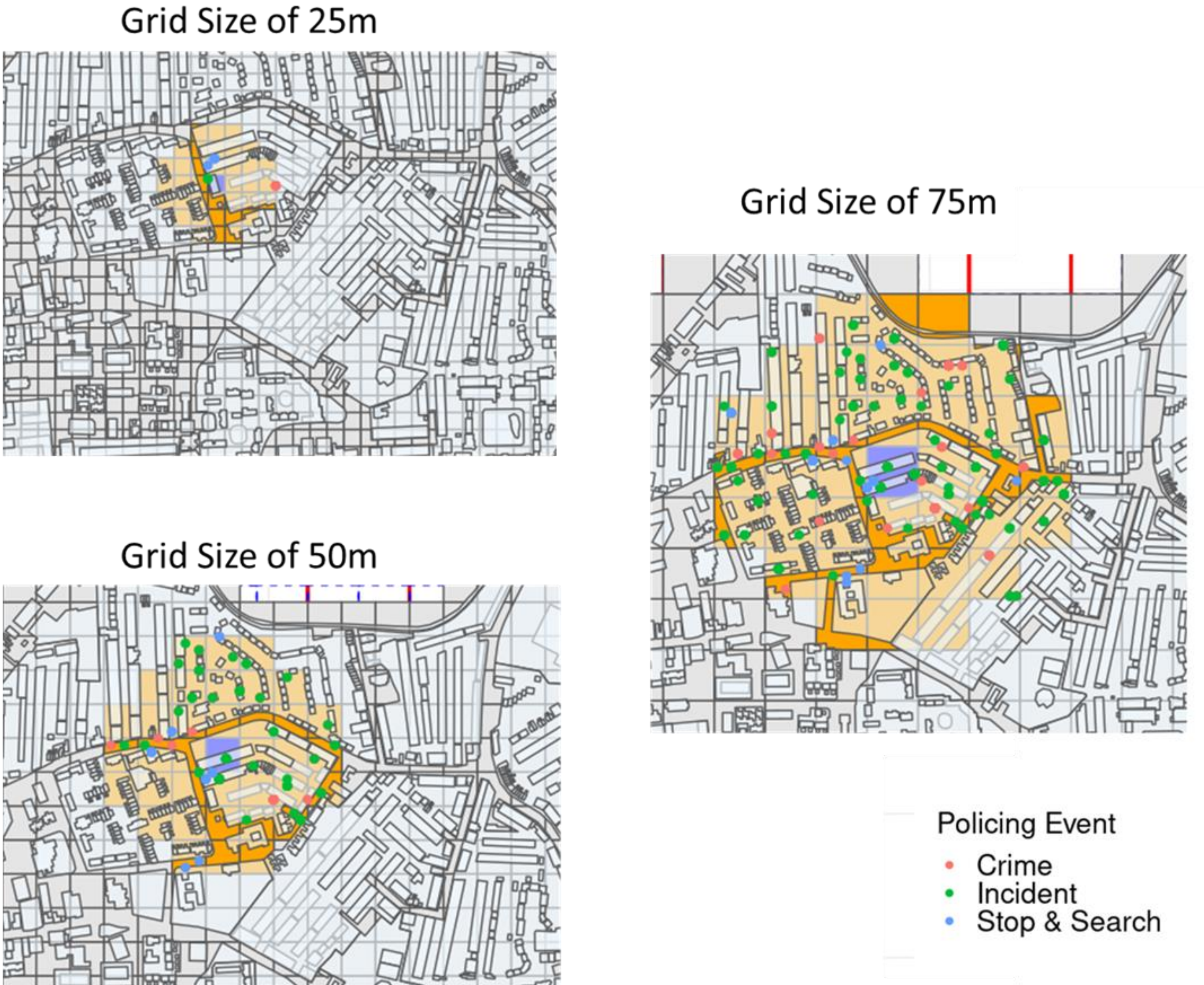


Figure 23 Policing Events in Increasingly Wider Grids

The analytical approach uses grids to link officers and resources to incidents and crimes, placing officers in grids of varying sizes and looking at whether crimes and incidents occur within a certain distance and time. The time and distance *between* the centroids of the grids are used as a weighting, with two distance weighting hypothesised in the first case- the first being a gravity based square of the distance, the second an exponential decay.

Using the grid reference for the officer with a range of various sizes; these are shown in Figure 20. The range used in the work is from 25m-75m radius. Other sizes of grid were considered, however in the case of smaller squares, the number of grids that this generated were too numerous to use and analyze and larger squares were too coarse to be informative.

The approach used is to group the number of squares and to sum across distances and times. The count of events is averaged using the number of squares in the various ranges, allowing edge cases to be properly dealt with. This allows the calculation of the mean number of events as well as the standard error of the estimate.

The measures used are plotted across time and space. Rather than coming up with a single number, it is informative to look at heatmaps, with hotter colours representing higher levels of average event. The areas where there are peaks in the colours represent higher levels of activity. This approach allows us to see where the peak areas and times where there is likely to be another event. Hotter colours reflect more events (incidents or crimes) per resource interaction, which might be considered a decline in influence of their presence. The last police officer presence is used for the calculations of the times etc.

The different grids allow a magnification of the effect of the policing presence. A mean & median count for the grids are presented. These give an underlying picture for the likely times and distances for another policing event. In addition, the 75th and 95th percentiles are also presented. These are the more extreme cases. The stories from each of the scales are similar. One can see general spikes that suggest points where the effects of officers are reduced to a lower impact. Some of these spikes are robust to discounting through time and space (the discounting lowers the impact of more distant events). This is exhibited by a smoothing of the surface, though there are a number of spikes that can still be seen. It is these spikes that are the most important and informative for the loss of effect of the officers. The colours themselves are not informative, it is the changing colours and shapes that are the information bearing elements. The scale will change colours of the heatmaps due to the interpolation carried out. This does not mean that the levels are different rather it means that the start and end point are different and so the colour gradient is different.

6.1 Incidents

The incidents are considered as separate from crimed events. As discussed the measure is based upon the number of grids contiguous to the grid in which the resource was based and the time to the next (and following) incidents. The heatmap is smoothed for legibility and the time axis starts at between 5 and 10 minutes from the resources' departure from the grid. As can be seen in Figure 24, there is some influence in the police presence, but this subsides relatively quickly in that incidents tend to occur relatively soon afterwards. This is most likely due to the clustering of the incidents across the area, they appear to occur in lumps and thus are perhaps more likely to re-occur in the same areas or greater grids as before and this is exhibited in this clumping of the data. The upper quantiles are suggestive of the more extreme situations where events are more likely within 50m of the officer (though there is some evidence of 60m also clustering) and within the hour of a resource leaving (though there are earlier incidents as well). Looking at the median heatmap, two hours seems to be the critical time for new events to occur in the vicinity of the relevant grid.

This story is further supported by the 50 m and 75 m grids. There are more incidents, obviously as the grid is larger, but the influence of the resources is reduced after approximately 45 minutes with a distinct set of peaks at approximately 2 hours, though with the higher quantiles this time is reduced to nearer 20 minutes. The higher quantiles do not have sufficient information to be plotted in these graphs.

In the 50m & 75m grids, the scale for the non-mean measures is changed to show the detail of the outcomes for the quantile measures.

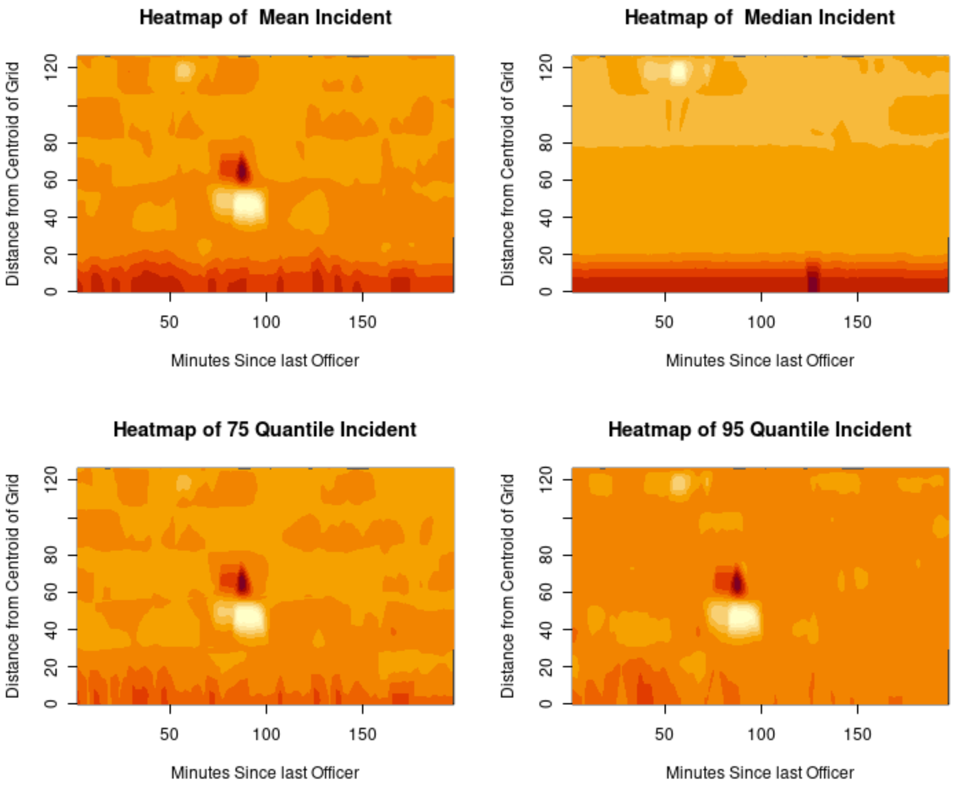


Figure 24 Heatmap of 25m grids showing incidents after departure

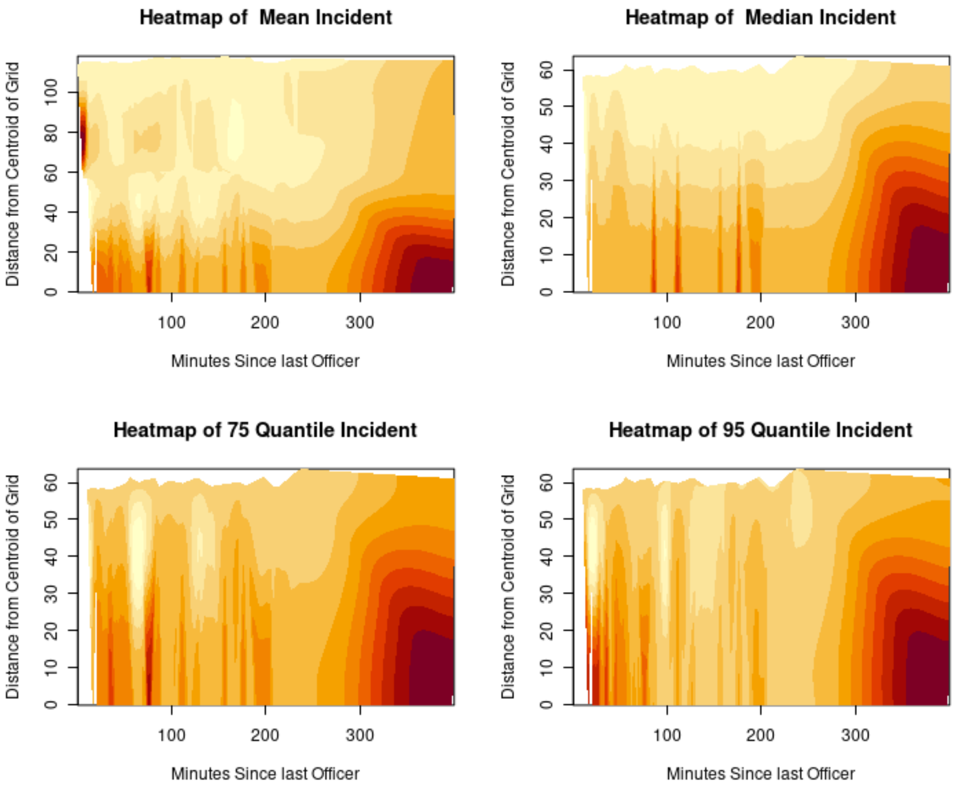


Figure 25 Heatmap of 50m grids

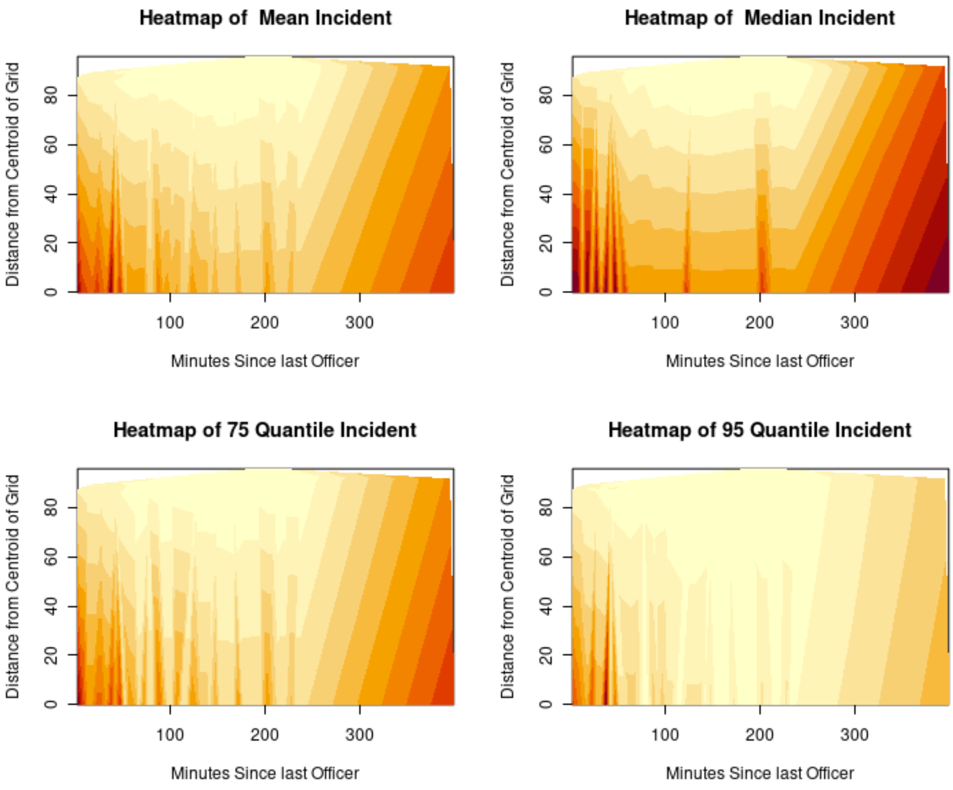


Figure 26 Heatmap of 75m grids

This means that in a simple count of events within the grids surrounding resources (officers or cars) **there is a short term and micro level impact of officers within the locality of their presences**. Time is the more important factor, rather than distance as we can see similar patterns across the scales, and this leads to some impact at the broader scale. The strength of the colour suggests that the resources are in the right areas, within the relevant grid size, with most events nearby happening within 2 or 3 of the grids. The frequency of the resource coverage might also account for the clustering at around 45 minutes, a resource is often not long in or out of the relevant area, perhaps reminding those in the area of police awareness and availability.

6.2 Crime

In a similar vein, crimes were also considered. These are less frequent in general and there will be a somewhat different mindset associated with a crime rather than an incident, which does not rise to that level. As with the incidents, each grid size is presented.

At the most microlevel one can see peaks of about an hour and a geographical influence of between 50 and 25 metres at best for that influence. As the grid size increases to 50m the time the resources influence the outcomes is reduced to less than an hour and nearer 45 minutes or less, especially taking into account the higher quantiles. At a more course grid, the influence is far more restricted with the impact being more immediate, nearer 30 minutes or less for the first cluster of crimes. Though not explicitly considered, it is proposed that the longer time spikes are more likely to occur in the evening when the larger grid in particular are harder to extend influence over and also harder to see activity requiring a follow up.

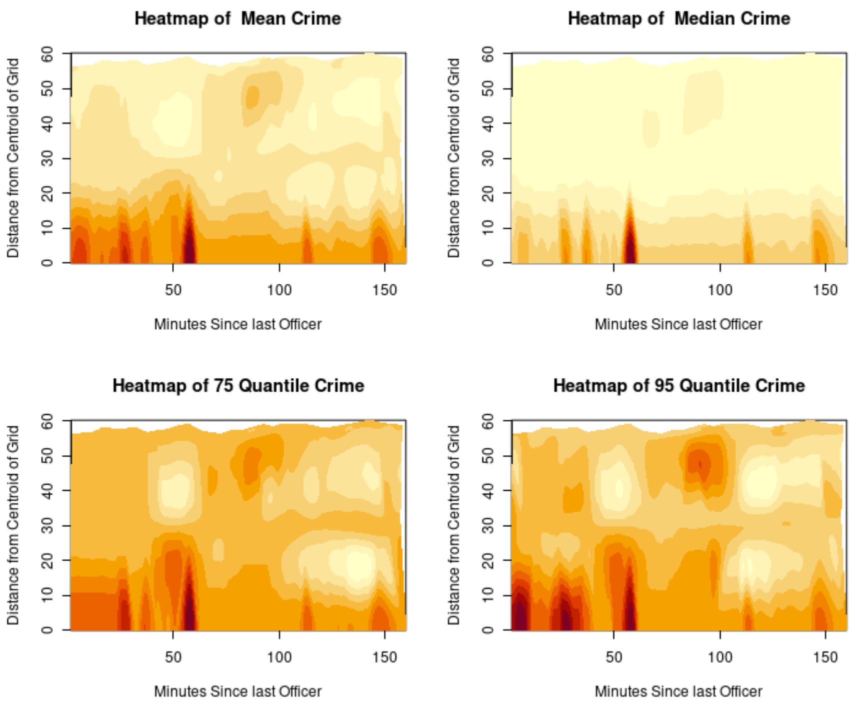


Figure 27 Heatmap of 25m grids

At greater scale as shown in Figure 28, the information in Figure 27 can be seen to extend further with hot spots developing further out. The underlying data is the same (the scales differ and show other patters further to the north-east).

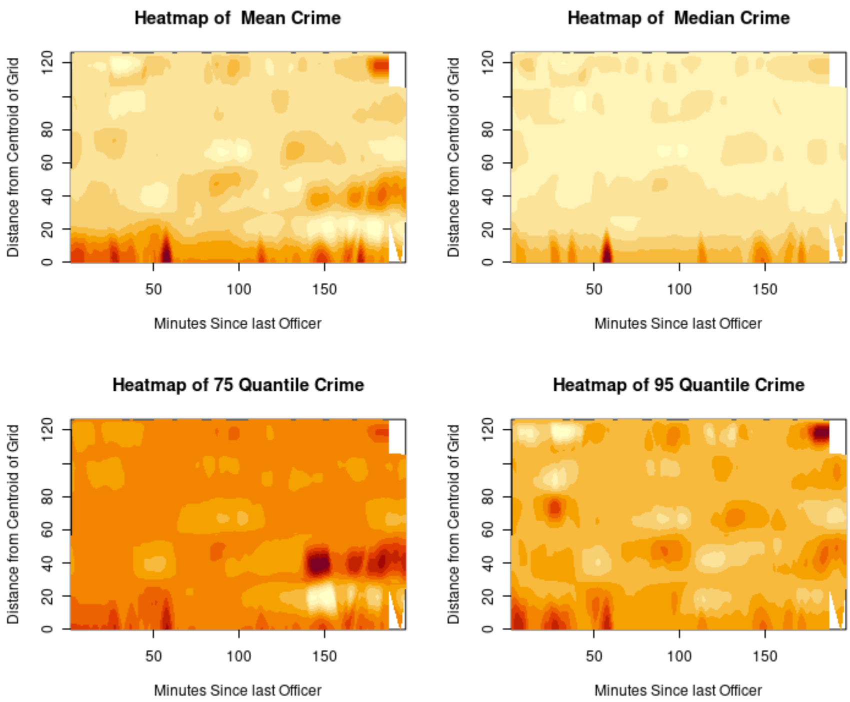


Figure 28 Heatmap of 25m Grids Expanded Time & Space

For the crimes information, the peaks are more prominent at the hour mark and there is a second peak at two hours. This suggests that the impact of officers is dissipated within two hours, with a significantly reduced effect at the 60 minutes point. The grid distances are generally small suggesting that influence is limited to line of sight or proximity.

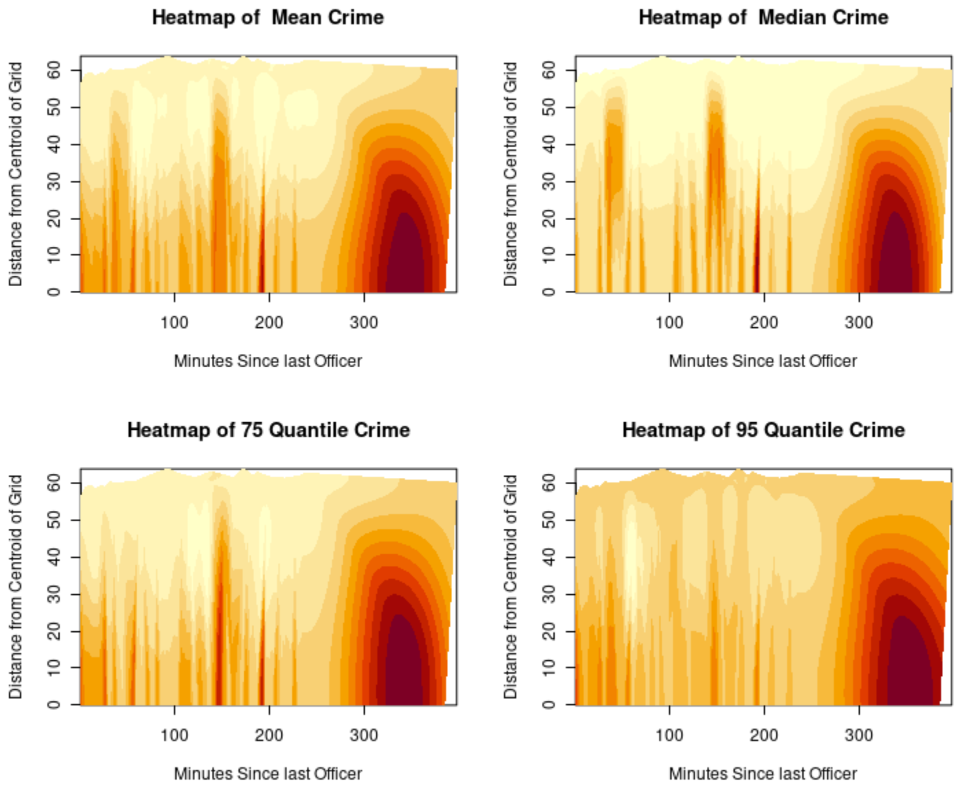


Figure 29 Heatmap of 50m grid

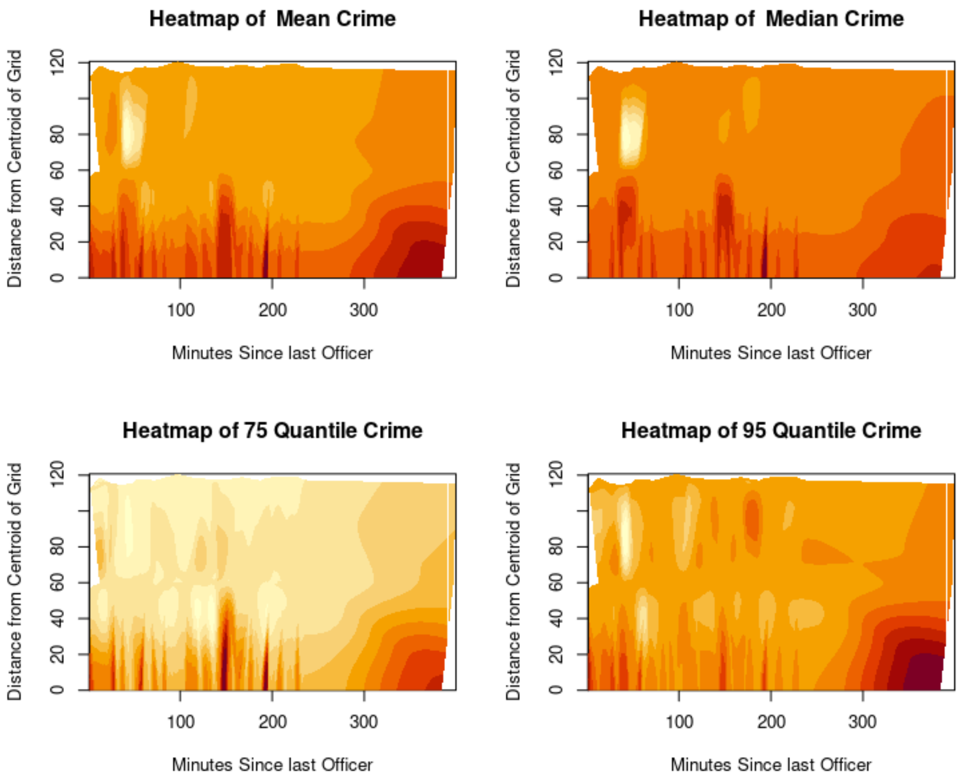


Figure 30 Extended 50m Grid heatmap

The larger grids exaggerate the time dimension, showing that though the earlier peaks exist, the bands at three hours are suggesting that the impact of the policing activity is completely discounted. This is not a surprise; the data is not partitioned by time of day which might be a factor and furthermore in order to have an impact from presence three hours ago, there would be need for no real changes in population in that grid. With larger grids, this is very unlikely- in essence I would not know if there was an officer in my vicinity 3 hours ago if I have entered that 75m grid on the other side, five minutes ago.

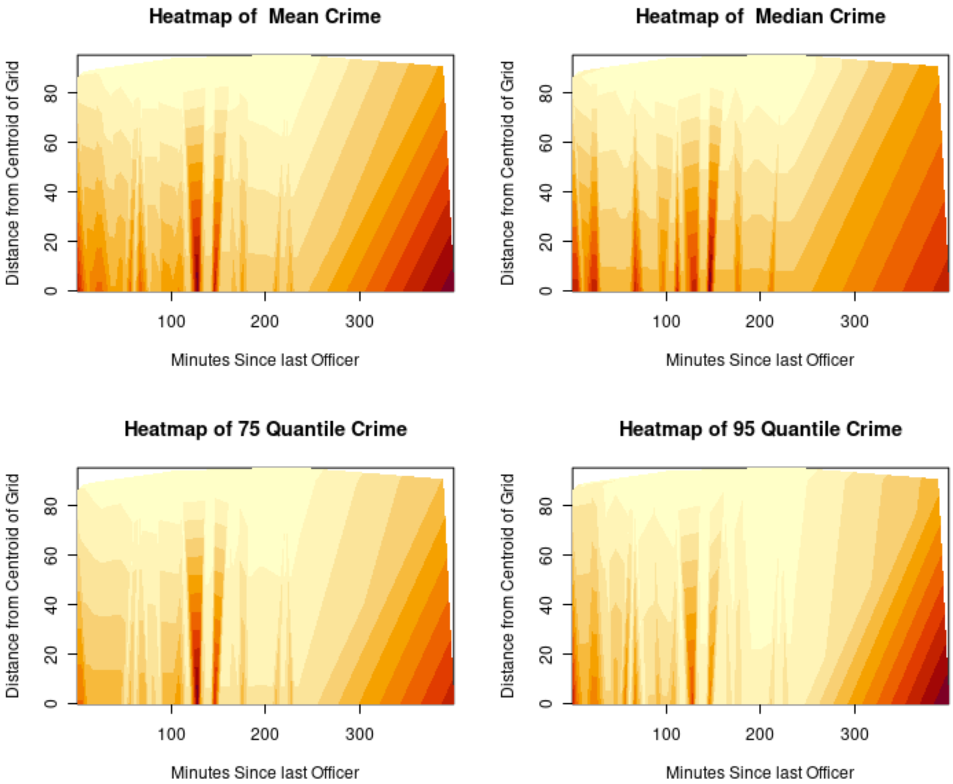


Figure 31 Heatmap of 75m grid

The resource's influence on crimes is somewhat more limited than on incidents. This is likely due to the more intentional nature of crimes. The more extreme cases as highlighted by the quantiles show that the mean and medians might be the best case scenarios. Investigations of the impact of discounting by space and time, either using an inverse square (such as proposed by Newton's gravity) or a negative exponential function (as with continuous compounding) limit the effects in both dimensions, as would be expected, limiting the impacts to times and locations nearer the resource. This still gives rise to spikes of a similar nature with similar though more limited insights as the count is no longer a true count, rather it is an effective count.

7 Conclusion

This report looks at the impact of the designation of an area as an impact area. It compares these areas to areas of similar demographic characteristics in order to assess whether the impact of policing activity has seen any effect on the crime or incident levels in the impact areas.

Given the current situation with the pandemic, the partnership elements associated with the impact areas is yet to be fully implemented and information is limited at the current time. It is therefore not a surprise that, though there is a statistically significant impact of being an impact area, this is currently small. This might be seen as a success- it is statistically significant, and as a failure- it is a small effect, the best interpretation is constrained optimism; there has been a small effect in the early days of implementation coming out of a true, one in a million event. With the assistance of the partner bodies, the impact of the impact area programme has the potential to help areas reduce the number of incidents and crimes within them.

The second part of this work uses the information gathered from radios affiliated with resources, either officers or cars to look at when events occurred in the vicinity to the resource's presence. The impact was assessed at increasingly larger scales. The impact of resources is limited in effect to around an hour for crimes and a little less for incidents. The geographical influence was about 50m but also more effective at a more local level (within 25m or 50 m of the grid). These results might be because of resource movements through the areas where events occur regularly, but even if this was to be the case there is some impact of the officers which would limit the maximum time between officers leaving the area and the event. The influence on the occurrence of crimes is more limited as one might expect with a sphere of influence of on average an hour, but this is reduced when one considers the upper quantiles of the grids.

References

Arellano, Manuel, and Stephen Bond. 1991. "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations." *The Review of Economic Studies* 58 (2). Wiley-Blackwell: 277–97.

Belov, Dmitry, and Ronald Armstrong. 2011. "Distributions of the Kullback-Leibler Divergence with Applications." *The British Journal of Mathematical and Statistical Psychology* 64 (May): 291–309. https://doi.org/10.1348/000711010X522227.

Gelman, Andrew, John B. Carlin, Hal S. Stern, and Donald B. Rubin. 2004. *Bayesian Data Analysis*. 2nd ed. Chapman; Hall/CRC.

Imai, Kosuke, and In Song Kim. 2019. "When Should We Use Unit Fixed Effects Regression Models for Causal Inference with Longitudinal Data?" *American Journal of Political Science* 63 (2): 467–90. https://doi.org/https://doi.org/10.1111/ajps.12417.

Index of Multiple Depriviation (Ministry of Housing, Communities and Local Government) (2010). https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/6871/1871208.pdf

Kullback, S., and R. A. Leibler. 1951. "On Information and Sufficiency." *The Annals of Mathematical Statistics* 22 (1). Institute of Mathematical Statistics: 79–86. http://www.jstor.org/stable/2236703.

Kulldorff, Martin. 1997. "A Spatial Scan Statistic." *Communications in Statistics-Theory and Methods* 26 (6). Taylor & Francis: 1481–96.

Tango, Toshiro, and Kunihiko Takahashi. 2005. "A Flexibly Shaped Spatial Scan Statistic for Detecting Clusters." *International Journal of Health Geographics* 4 (1). BioMed Central: 1–15.

Tango, Toshiro, Kunihiko Takahashi, and Kazuaki Kohriyama. 2011. "A Space–Time Scan Statistic for Detecting Emerging Outbreaks." *Biometrics* 67 (1). Wiley Online Library: 106–15.

Wood, S.N., 2003. Thin plate regression splines. *Journal of the Royal Statistical Society: Series B (Statistical Methodology),* 65(1), pp.95-114.

Wood, S.N. 2011. Fast stable restricted maximum likelihood and marginal likelihood estimation of semiparametric generalized linear models*. Journal of the Royal Statistical Society (B)* 73(1):3-36

Yirga, A.A., Melesse, S.F., Mwambi, H.G. and Ayele, D.G. 2020. Negative binomial mixed models for analyzing longitudinal CD4 count data. *Scientific Reports* 10, 16742 https://doi.org/10.1038/s41598-020-73883-7

8 Appendix

The following Tables show the coefficients and model metrics for the main models discussed in Section 5. Results not discussed in the paper are available but removed for the sake of brevity.

All models use a Negative Binomial distribution. The standard errors of the spline coefficients are estimated using the main diagonal of variance-covariance matrix of the estimation. For results presented here the basis dimension diagnostics suggest that the dimension was sufficiently high with the k –index around 1 with all reporting full convergence of the restricted maximum likelihood function.

The Effective Degrees of Freedom (EDF) reported is the estimated degrees of freedom and is a measure of the 'wiggliness' of the spline fitted to the data. A value of 1 suggests a linear function, whereas above 2 a highly non-linear function. The χ^2 statistic is a test against the null hypothesis of a flat function across all observed values rather than the usual estimated coefficient being 0.

8.1 Incidents

Dependent Variable: Incidents

Parametric Coefficients	Model A Estimate	Model A SE	Model B Estimate	Model B SE
(Intercept)	0.8984	0.3306	0.9621	0.3007
Citycentre	-0.6742	0.0593	-0.5227	0.0736
Otherincidents	-0.0001	0.0001	0.0000	0.0001
P1	0.1011	0.0020	0.0972	0.0020
P2	0.1222	0.0037	0.1182	0.0037
P3	0.1215	0.0069	0.1142	0.0069
P4	0.1058	0.0144	0.1047	0.0144
P5	0.1558	0.0265	0.1499	0.0264
P6	0.1359	0.0224	0.1274	0.0224
P7	0.1346	0.0109	0.1249	0.0109
P8	0.0955	0.0038	0.0903	0.0038
P9	0.1242	0.0096	0.1180	0.0096
July	-0.0109	0.0172	-0.0061	0.0172
August	-0.0030	0.0187	0.0017	0.0186
September	0.0215	0.0186	0.0286	0.0185
BW	-0.0042	0.0199	-0.0016	0.0218
CV	-0.0241	0.0228	0.0031	0.0225
DY	0.0344	0.0357	-0.0281	0.0279
SH	-0.0236	0.0302	-0.0259	0.0278
SW	0.0014	0.0249	-0.0249	0.0247
WS	-0.0964	0.0240	-0.0782	0.0242
WV	-0.1550	0.0244	-0.1291	0.0241

	Estimate	SE	Estimate	SE
controlimpact	0.3900	0.1754	0.1521	0.3386
controlimpact:July				
controlimpact:August				
controlimpact:September				
controlimpact:timescaled	-0.0010	0.0004		
controlimpact:timescaled:July				
controlimpact:timescaled:August				
controlimpact:timescaled:September				
controlimpact:visitsreduced			-0.0007	0.0010
controlimpact:visitsreduced:July				
controlimpact:visitsreduced:August				
controlimpact:visitsreduced:September				
timescaled	0.0011	0.0005		
timescaled:July				
timescaled:August				
timescaled:September				
visitsreduced			0.0007	0.0008
visitsreduced:July				
visitsreduced:August				
visitsreduced:September				

Splined Terms	Estimate	SE	Estimate	SE
s(timescaled).1	5.0198	0.8157		
s(timescaled).2	4.5282	0.4810		
s(timescaled).3	0.9479	0.3783		
s(timescaled).4	0.0146	0.3019		
s(timescaled).5	-0.1969	0.2080		
s(timescaled).6	-0.2770	0.1080		
s(timescaled).7	-0.3526	0.0364		
s(timescaled).8	-0.4266	0.1112		
s(timescaled).9	-0.5024	0.2116		
s(timescaled,factor(control)).1	0.6930	0.1134		
s(timescaled,factor(control)).2	-0.2563	0.2487		
s(timescaled,factor(control)).3	0.0000	0.0722		
s(timescaled,factor(control)).4	0.7098	0.1131		
s(timescaled,factor(control)).5	-0.0421	0.2444		
s(timescaled,factor(control)).6	0.0000	0.0722		

Splined Terms	Estimate	SE	Estimate	SE
s(visitsreduced).1			2.2431	0.2592
s(visitsreduced).2			3.6578	0.3379
s(visitsreduced).3			1.7850	0.1704
s(visitsreduced).4			0.5907	0.0692
s(visitsreduced).5			0.0646	0.0382
s(visitsreduced).6			-0.1782	0.0307
s(visitsreduced).7			-0.3576	0.0350
s(visitsreduced).8			-0.4815	0.0473
s(visitsreduced).9			-0.5970	0.0672
s(visitsreduced,factor(control)).1			0.0817	0.0890
s(visitsreduced,factor(control)).2			-0.0890	0.1062
s(visitsreduced,factor(control)).3			0.0520	0.1174
s(visitsreduced,factor(control)).4			0.0000	0.0722
s(visitsreduced,factor(control)).5			0.0000	0.0705
s(visitsreduced,factor(control)).6			0.0224	0.0915
s(visitsreduced,factor(control)).7			0.1242	0.0886
s(visitsreduced,factor(control)).8			-0.0017	0.0844
s(visitsreduced,factor(control)).9			0.0000	0.0722
s(visitsreduced,factor(control)).10			0.0000	0.0705
R^2(adj)	0.8028		0.8256	
BIC	19298.2677	31.7203	19126.5149	29.2955
Deviance Explained	0.8568		0.8655	
Smoothing Term Significance	**EDF**	**X^2**	**EDF**	**X^2**
s(timescaled)	3.2118	*93.3992*		
s(timescaled,factor(control))	3.5084	*61.2060*		
s(visitsreduced)			2.0727	*113.4566*
s(visitsreduced,factor(control))			2.2227	*4.3751*

8.2 Crimes

Dependent Variable

	Crimes		Crimes		Crimes		Crimes	
	Model C		*Model E*		*Model D*		*Model F*	
Parametric Coefficients	**Estimate**	**SE**	**Estimate**	**SE**	**Estimate**	**SE**	**Estimate**	**SE**
(Intercept)	0.0972	0.3137	0.5107	0.7874	0.0332	0.2966	0.5068	0.7896
Citycentre	0.1442	0.0835	-0.1447	0.1314	0.1186	0.0835	-0.2190	0.1328
Othercrimes	0.0008	0.0001	0.0008	0.0001	0.0008	0.0001	0.0008	0.0001
P1	0.0930	0.0031	0.0880	0.0031	0.0930	0.0031	0.0882	0.0031
P2	0.0740	0.0057	0.0693	0.0056	0.0753	0.0057	0.0709	0.0056
P3	0.0903	0.0104	0.0840	0.0103	0.0906	0.0104	0.0845	0.0103
P4	0.1162	0.0209	0.1191	0.0207	0.1186	0.0209	0.1221	0.0206
P5	0.1525	0.0398	0.1625	0.0392	0.1481	0.0399	0.1550	0.0393
P6	0.0581	0.0325	0.0496	0.0322	0.0600	0.0324	0.0524	0.0321
P7	0.0634	0.0168	0.0556	0.0167	0.0602	0.0168	0.0515	0.0167
P8	0.0360	0.0061	0.0335	0.0061	0.0372	0.0061	0.0352	0.0061
P9	0.0593	0.0146	0.0580	0.0144	0.0600	0.0146	0.0593	0.0144
July	0.0339	0.0212	0.0356	0.0210	0.0681	0.0427	0.0885	0.0538
August	0.0357	0.0227	0.0391	0.0224	0.0563	0.0437	0.0889	0.0551
September	0.0511	0.0227	0.0578	0.0225	0.0717	0.0437	0.1044	0.0550
BW	-0.1287	0.0266	-0.1614	0.0293	-0.1286	0.0266	-0.1625	0.0292
CV	-0.2096	0.0303	-0.1905	0.0299	-0.2110	0.0303	-0.1907	0.0298
DY	0.0109	0.0506	-0.0982	0.0385	0.0079	0.0506	-0.0966	0.0384
SH	-0.0376	0.0383	-0.0586	0.0353	-0.0358	0.0382	-0.0577	0.0352
SW	-0.0691	0.0318	-0.1094	0.0316	-0.0689	0.0318	-0.1097	0.0315
WS	-0.2574	0.0309	-0.2635	0.0311	-0.2579	0.0309	-0.2639	0.0310
WV	-0.2770	0.0303	-0.2781	0.0297	-0.2756	0.0303	-0.2763	0.0296
controlimpact	0.9002	0.2309	0.1258	0.8561	0.9023	0.2336	0.3765	0.8648

controlimpact:July					-0.0576	0.0594	-0.0881	0.0708
controlimpact:August					-0.0811	0.0602	-0.1516	0.0720
controlimpact:September					-0.0749	0.0604	-0.1410	0.0718
controlimpact:timescaled	-0.0029	0.0006			-0.0031	0.0006		
controlimpact:visitsreduced			-0.0011	0.0017			-0.0018	0.0017
controlimpact:timescaled:July					0.0002	0.0003		
controlimpact:timescaled:August					0.0006	0.0003		
controlimpact:timescaled:September					0.0004	0.0003		
controlimpact:visitsreduced:July							0.0004	0.0003
controlimpact:visitsreduced:August							0.0011	0.0003
controlimpact:visitsreduced:September							0.0009	0.0003
timescaled	0.0030	0.0006			0.0030	0.0006		
timescaled:July					-0.0001	0.0002		
timescaled:August					-0.0002	0.0002		
timescaled:September					-0.0001	0.0002		
visitsreduced			0.0018	0.0015			0.0020	0.0015
visitsreduced:July							-0.0002	0.0003
visitsreduced:August							-0.0004	0.0003
visitsreduced:September							-0.0003	0.0003

Splined Terms	**Estimate**	**SE**	**Estimate**	**SE**	**Estimate**	**SE**	**Estimate**	**SE**

s(timescaled).1	4.4374	0.8266			4.2122	0.7844		
s(timescaled).2	3.2406	0.5452			3.1686	0.5330		
s(timescaled).3	0.2881	0.3491			0.4774	0.3216		
s(timescaled).4	-0.3864	0.3088			-0.1777	0.2901		
s(timescaled).5	-0.4920	0.2461			-0.3328	0.2285		
s(timescaled).6	-0.4042	0.1605			-0.3232	0.1509		
s(timescaled).7	-0.2830	0.0757			-0.2805	0.0806		
s(timescaled).8	-0.1538	0.1264			-0.2256	0.1229		
s(timescaled).9	-0.0256	0.2591			-0.1707	0.2526		
s(timescaled,factor(control)).1	0.5445	0.1246			0.5284	0.1217		
s(timescaled,factor(control)).2	-0.3822	0.2272			-0.4392	0.2102		
s(timescaled,factor(control)).3	0.0000	0.0728			0.0000	0.0728		
s(timescaled,factor(control)).4	0.3583	0.1254			0.3577	0.1224		
s(timescaled,factor(control)).5	0.1222	0.2194			0.0354	0.1990		
s(timescaled,factor(control)).6	0.0000	0.0728			0.0000	0.0728		

s(visitsreduced).1			1.8479	0.3060			1.8440	0.3030
s(visitsreduced).2			3.0410	0.4163			3.0143	0.4142
s(visitsreduced).3			1.4310	0.2300			1.4198	0.2259
s(visitsreduced).4			0.4461	0.1116			0.4432	0.1071
s(visitsreduced).5			0.0249	0.0675			0.0254	0.0635
s(visitsreduced).6			-0.1627	0.0457			-0.1599	0.0434
s(visitsreduced).7			-0.2963	0.0447			-0.2929	0.0440
s(visitsreduced).8			-0.3839	0.0675			-0.3809	0.0658
s(visitsreduced).9			-0.4645	0.1043			-0.4620	0.1003

s(visitsreduced,factor(control)).1			-0.1154	0.2046			-0.1041	0.2011

s(visitsreduced,factor(control)).2			-0.5910	0.2494			-0.6003	0.2482
s(visitsreduced,factor(control)).3			0.1544	0.3495			0.1766	0.3499
s(visitsreduced,factor(control)).4			0.0000	0.0728			0.0000	0.0728
s(visitsreduced,factor(control)).5			**0.0000**	**0.0710**			**0.0000**	**0.0710**
s(visitsreduced,factor(control)).6			-0.1146	0.2092			-0.1964	0.2086
s(visitsreduced,factor(control)).7			0.2992	0.1923			0.2714	0.1910
s(visitsreduced,factor(control)).8			-0.1517	0.1995			-0.0479	0.2053
s(visitsreduced,factor(control)).9			0.0000	0.0728			0.0000	0.0728
s(visitsreduced,factor(control)).10			0.0000	0.0710			0.0000	0.0710

Rsq(adj)	0.4754		0.5088		0.5021		0.5399	
BIC	23802.2519	31.3754	23721.6916	30.3851	23867.2712	40.1407	23779.2924	39.3343
Deviance Explained	0.5466		0.5538		0.5476		0.5557	
Smoothing Term Significance	**EDF**	**X^2**	**EDF**	**X^2**	**EDF**	**X^2**	**EDF**	**X^2**
s(timescaled)	3.1026	39.9149			2.7721	37.8780		
s(timescaled,factor(control))	3.2728	35.0245			3.3686	31.7940	23779.2924	39.3343
s(visitsreduced)			**1.8046**	**34.3224**			**1.7411**	**38.9885**
s(visitsreduced,factor(control))			3.5805	15.0501			3.5932	15.8934

8.3 Summary Statistics for Officer Time

This is a summary table to demonstrate the impact of removing the extremely short and long visits to the various areas. This shows that the number of visits is not significantly affected. Time is however reduced with mean levels, trivially affected most.

Table 5 Summary Statistics Demonstrating Effect of Removing Extreme Durations

	Area Type	Month	Mean Number of Visits	Median Number of Visits	Max Number of Visits	Mean Duration of Visit[1]	Minimum Duration of Visit	Median Duration of Visit	Longest Duration
Full	Comparison	Jun	153.7508	112	506	702,239.1	1,452	331,179.0	4,735,660
Reduced	Comparison	Jun	150.6222	112	506	497,462.2	1,452	311,456.5	3,198,464
Full	Comparison	Jul	147.2104	105	528	707,994.5	942	297,493.0	5,473,685
Reduced	Comparison	Jul	143.6667	105	524	474,974.5	942	285,800.0	2,494,365
Full	Comparison	Aug	134.1905	118	499	718,679.4	3,477	190,405.0	3,989,022
Reduced	Comparison	Aug	130.8571	118	476	470,064.3	3,477	190,405.0	2,292,688
Full	Impact Area	Jun	153.7561	125	686	809,520.2	4,480	413,417.0	5,244,801
Reduced	Impact Area	Jun	150.8246	122	679	603,214.7	4,480	402,187.0	3,014,374
Full	Impact Area	Jul	146.4567	116	705	786,061.7	1,230	387,232.0	5,606,921
Reduced	Impact Area	Jul	143.3090	113	682	563,832.0	1,230	367,294.0	3,012,183
Full	Impact Area	Aug	137.8947	126	533	703,813.2	9,595	279,070.0	3,256,718
Reduced	Impact Area	Aug	135.0000	119	516	492,146.6	9,595	266,992.0	2,004,579

[1]Times are in seconds

8.4 Response Grading

The table shows the grading framework for incidents. Each incident is graded according to the THRIVE principles: Threat, Harm, Risk, Investigative opportunities, Vulnerability and Engagement. The speed of response matches the level of priority.

Grade	**Definition**	
P1	*Immediate - an incident where (one of)*	
	There is a danger to life/use (or threat of) violence/ serious injury The crime is in progress or the incident is ongoing and continues to present a risk to others An offender has been disturbed at the seen or has been detained and poses or is likely to pose a risk to others The police staff/officer has reason for believing the incident should be graded as immediate	
P2	*Priority Response - an incident where (one of)*	
	There is a concern for someone's safety A key witness or other key evidence is likely to be lost if we do not attend An offender has been detained at the scene by a member of the public but poses no risk The police staff/officer has reason for believing the incident should be graded as a Priority Response	
P3	*Priority Investigation - an incident where*	
	There is a concern for an individual's welfare but the risk can be safely managed	

	There is a need for an investigation and it is time critical to prevent key witness or other key evidence being lost The police staff/officer has reason for believing the incident should be graded as a Priority Investigation	
P4	*Scheduled Investigation - an incident where (one of)*	
	There are proportionate lines of enquiry and these enquiries cannot be completed other than by physical attendance by an officer There is a need for an investigation but it is not time critical (i.e. no perishable evidence or particular safeguarding needs) And any THRIVE+ concerns can be managed until a suitable appointment is available	
P5	*Initial Investigation - an incident which*	
	Can be investigated via phone or other means by engaging with the caller The incident demonstrates a low THRIVE+ requirement	
P6	*Neighbourhood Resolution - an incident which has*	
	Manageable THRIVE+ concerns which require preventative problem solving to prevent crime, antisocial behaviour or repeat demand	
P7	*Support Incident - an incident where (one of)*	
	A police resource is required to complete a task which requires completing in a reasonable time frame	

	An incident which is being developed prior to a resourcing decision The police staff/officer has reason for believing the incident should be graded as a Support Incident	
P8	*Internally Generated Task - an incident which*	
	Is internally generated Is resourced by the departement/officer creating the ticket The incident demonstrates a THRIVE+ requirement	
P9	*Contact Resolution - an incident where*	
	There is no requirement for the police to attend It can be resolved via phone or other means It doesn't demonstrate any THRIVE+ requirements It has been resolved by Contact Staff	