Is there value, and a practical application for the use of ‘risk terrain’ analysis in the rural county of Lincolnshire?

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Abstract

Risk terrain modelling (RTM) has been demonstrated to work in identifying locations at future risk of crime, with most published research in highly urbanised areas of the America's. This research investigates the applicability of RTM, using the Simsi RTMdx software, in rural Lincolnshire for two contrasting crime types. It explores how RTM can identify properties at risk to being used by out-of-town drug dealers to facilitate their business, and the identification of areas which are at risk of hare coursing, the chasing of hares by hounds. Following a literature review to identify potential influential spatial risk factors, georeferenced data sets were obtained from Ordnance Survey, Office of National Statistics, and open sources for inclusion in the modelling process, modelled against historical locations of cuckooed properties and hare coursing for Lincoln and Lincolnshire respectively.

The research looked to determine whether there was value in using the RTM method for one or both crime types, and to assess whether officers saw practical application in the results generated. Two phases of semi-structured interviews of a small number of police officers were undertaken. Phase one, before the analysis focused on their general understanding of analysis and analytical products and their views on the crimes being modelled. Phase two, after the modelling process focused on the results of the RTM analysis and the presentation of results.

The RTM analysis results supported the technique for determining high risk areas for county lines cuckooing, and hare coursing in Lincolnshire. Officers interviewed found RTM to be of value and could offer a valuable and practical contribution to policing in a rural setting.

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1 Introduction

Crime analysts are required to analyse and interpret crime trends and intelligence to support police departments, by providing information that can be acted upon to prevent or detect crime. A key aspect of crime analysis is the use of crime mapping tools to understand the geolocation and spatial distribution of crime. Risk Terrain Modelling (RTM) (Caplan & Kennedy, 2010) is one such tool which aims to identify areas at increased risk to future crime events. This research examines the value that RTM (Caplan & Kennedy, 2010) can have in providing actionable intelligence, and whether, when provided to police officers they do indeed see themselves as being able to make use of it. The remainder of this chapter will briefly discuss the background to the research, the relevance and significance of it, before detailing the aims and objectives, and finally the anticipated limitations.

1.1 Background To The Research

Over the last twenty years the development of geographical information systems has enabled research into the spatial distribution of crime, particularly in relation to spatial concentrations of crime, known as hotspots. Research has shown that police intervention at hotspots in urban areas can be successful in reducing crime (Bowers et al., 2003; Chainey et al., 2008). Similar research in rural areas has been lacking and this research aims, in part to address this via the use of risk terrain modelling.

Research into crime concentrations lead to the development of the theory of risky places (Kennedy & Caplan, 2012) and subsequently into the technology of risk terrain modelling. Risk terrain modelling is based on the theory that all places are at risk to crime, but some more than others; it seeks to determine those risk factors that significantly contribute to a location being at increased risk to crime compared to others. The development of the RTMdx software which utilises geographical information systems to automate the process of identifying areas at risk has been successful in identifying risky locations, typically in urban areas for crimes such as burglary and violence and is discussed in chapter four.

1.2 Relevance And Significance Of The Research

Fortunately, crime is a rare event (Curiel et al., 2018; Rumi et al., 2018) and within rural areas it is up to three times lower than urban areas (Cebulak, 2004), however, Donnermeyer (2007:17) argues 'rural crime is neither exceptional nor unique, but more common than previous generations of criminologists ever imagined it'. Criminological theory relevant to rural crime, (specifically focused on agricultural locations and commodities) and crime in rural areas, is discussed in chapter 4.2 and 4.3. Hansen & Lory (2020) state that there has been a disproportionate amount of attention been given to rural crime given the amount of 'rurality' in the United States and with only 0.1% of police in England and Wales dedicated to fighting rural crime (Stevenson, 2024) it could be argued the same applies in the United Kingdom. Concerns caused by rural crime are not diminishing. The cost of rural crime increased by 22% in 2022 (NFU, 2023) and 80% of survey participants stated rural crime disrupted farming activities (NFU, 2023). Lincolnshire was the most financially affected county in England and Wales for rural crime in 2021 and 2022 (NFU, 2023).

A large proportion of police recorded crime is concentrated in a small number of micro-places (Buil-Gil et al., 2022) and the application of the law of crime concentration (Weisburd, 2015) has facilitated policing strategies which target crime control at specific places (Anselin et al., 2000). In urban areas this may manifest as clearly defined hotspots which can be effectively policed (Braga et al., 2012; Koper et al., 2021; Sherman, 1995; Weisburd & Telep, 2014); in rural areas opportunities for crime are likely to be more disparate as 'physical distance and isolation of rural areas shape not only the picture of crime in the countryside but also social response to it' (Cebulak, 2004:73) including longer response times for police attendance and smaller dispersed hotspots. Rural crime is discussed in more detail in chapter four.

Understanding the distribution of rural crime and crime in rural areas is hindered by the number of criminological events and a bias of criminological theories being applicable to urban settings.

Numerous research studies (Anyinam, 2015; Caplan et al., 2017; Caplan et al., 2015; Caplan et al., 2013; Drawve et al., 2016; Drawve et al., 2019; Escudero & Ramirez, 2018; Gimenez-Sanatan et al., 2018; Piza et al., 2018) have been conducted over the last ten years which demonstrate the utility of RTM but in urban areas. A recent systematic review (Marchment & Gill, 2021) of twenty-five RTM research studies confirmed the success of the technique, but the review had a strong emphasis on American research, with seventeen from the United States and continental America, one from Japan and seven from Europe. All studies related to large urban areas but did cover a diverse range of crime types affecting large populations including burglary, violence, terrorism, and traffic collisions. One of the conclusions made in the systematic review was in relation to the ease of use of the relevant RTMdx software:

'*RTM as an overall approach is relatively simple and user-friendly, and the associated RTMDx software provides an opportunity for practitioners to readily utilize the approach with minimal resources and time spent on learning new processes. This means that it is within the reach of many operational crime analysts in practical law enforcement settings*.' (Marchment & Gill, 2021:9)

The systematic review demonstrates that RTM is a technique which can aid the crime analyst to provide actionable intelligence, not only on which locations are more at risk to future offences, but because of the identified risk factors, why this is the case. If offers a compelling argument for using the technique, but does the technique work across all crime types? The review focused on large urban areas, and there were no studies from Great Britain included. More importantly for this research, there were no studies identified in the systematic review, or elsewhere, which utilised the technique in more rural areas.

This research is conducted in a rural policing area in England and seeks to determine if the technique can be successfully used in a rural environment, and whether it is useful where the distribution of offences is less concentrated than in highly built-up areas. In broad terms, this

research aims to answer both these questions. It aims to discover whether RTM can successfully identify locations at risk to future offences of hare coursing and the take-over of addresses by drug dealers, known as cuckooing. But in addition, it considers if the technique works, will local officers accept the results of analysis, will they see how it can provide information to support their work at a local level?

Crime analysts are required to provide information that officers can realistically and practically act upon, but officers also need to accept, understand, and value the information that it provides. There have been several research studies that argue that police officers rely on their 'craft' and experiential knowledge, in preference to the information provided by a civilian crime analyst (Cope, 2004). If the results of analysis fail to influence police officers when they determine how to address a crime issue, it will become worthless, regardless of the success or accuracy it has in determining which locations will be at increased risk of future criminological events.

1.3 Research Aims And Objectives

In a policing climate with political emphasis on utilising evidence to better inform policing responses, which maximise impact with reducing resources, this research aims to answer the question:

Is there value in a 'risk terrain' analytical approach, and can it have a practical application in reducing crime in the rural county of Lincolnshire?

To answer this overarching question several sub-questions will form the basis of the research, which when combined, will provide an understanding of the significant determinants of the chosen crime types affecting rural Lincolnshire, the practicality of producing the analysis and the feasibility of the analysis for reducing the chosen crime types. These questions include:

- *Where are the offences of hare coursing and county lines cuckooing most prevalent or damaging within rural Lincolnshire?*
- *What are the aspects of the location which attract offences or deter offenders?*
- *Which of those attractors or deterrents should be included in the analysis?*
- *Does the analysis have the capability to predict the areas at increased risk?*
- *Are police officers open to the use of a risk terrain analysis product?*
- *Is the product proficient in conveying the analytical results to officers in a way that they can understand and utilise the risk terrain analysis to develop tactics?*

Hare coursing is described as:

"*Hare coursing is the pursuit of hares with sight hounds, which chase the hare by sight and not by scent. This type of offending can also be known as hare poaching. Hare coursing can take the form of organised events in which dogs are, by the use of live hares, assessed as to skill in hunting*

hares. Often this is a competitive activity, in which substantial sums of money are bet." (Crown Prosecution Service, 2021)

County lines cuckooing is when person or persons from out of town take over a person's home and exploit the resident and property to facilitate the sale of drugs.

The research can be seen to have three distinct aspects: understanding cuckooing and hare coursing and determining whether the risk terrain model is able to identify areas of risk to future crimes (chapters four, five and six) and if it is successful, whether officers see the utility in the analysis to help them to prevent and detect crime in Lincolnshire (chapter seven).

1.4 Research Contribution

As already discussed, RTM has been determined to be successful in large urban environments with high crime counts. To date there have been no identified research studies which have considered the success or otherwise of using the analytical technique in rural areas, or to help address hare coursing or the take-over of homes by drug dealers (cuckooing).

County lines drug dealing, discussed in more detail in chapter five, involves drug dealers from large urban areas coming to smaller towns to deal drugs. To facilitate this, they take over vulnerable persons homes to use as a base for the sale, distribution, or storage of drugs. County lines is a relatively newly identified business model used by drug dealers and research on county lines dealing has been developing over the last five years (Coomber & Moyle, 2018; Spicer, 2019 & 2021; Stone, 2018; Windle et al., 2020). Research on understanding who and why persons are exploited in this way has been the result of a small number of qualitative studies (Clark et al., 2021; Coomber & Moyle, 2018; Moyle, 2019; Robinson et al., 2019; Whittaker et al., 2020; Windle & Briggs, 2015). This research will be the first use of RTM methodology to identify residential properties at an increased risk to cuckooing. In a situation where many vulnerable exploited victims could also be seen by some as complicit with those offenders utilising their home, or subject to intimidation, reporting of cuckooing is likely to be limited. If successful at identifying locations at future risk to cuckooing, this will enable police and partner agencies to focus safe-guarding activities to identified areas. Proactive work can be undertaken in those at-risk areas to reduce the likelihood of victimisation, and when it is suspected dealers are actively cuckooing addresses in an area, focus resources into those areas most probable to be affected.

Hare coursing (see chapter six) is an issue which impacts farmers financially but also their health and sense of security. A situation many police forces in England encounter, on an annual basis, is determining where to actively patrol or target harden, as hare coursing occurs in typically isolated large rural areas. If successful, the RTM analysis will not only provide focused areas of risk to

future offences, but aid understanding of what is contributing to this risk, and therefore provide potential opportunities to mitigate this risk. It will provide an evidence base for police and partners on where and why to target interventions in a subject that has previously relied on hotspot mapping of past offences, intuition, and local knowledge.

1.5 Limitations

This research is focused on the value of RTM on the two crime types of hare coursing and county lines cuckooing of addresses in Lincolnshire and Lincoln respectively. It utilises police crime and incident data and is reliant on those offences or incidents which have been reported to police. By the nature of the offending, in that many of the crimes, for differing reasons will go unreported, these offences will be below the true number of offences. Although this is not ideal, it is reflective of the reality facing crime analysts and police forces alike. The scope of the research includes assessing whether the RTM is successful in identifying locations at increased risk to offences in the following year assessed via the Predictive Accuracy Index (Chainey et al., 2018). The research does not extend to assessing interventions or police response to the RTM, other than to seek the views of officers on the analysis.

The research will utilise geographical data available from open source, Ordnance Survey and Digimap services. Social and demographic data will also be obtained from open source and sources available through Keele University. The research aims to be reflective of research which any police analyst could replicate with access to the RTMdx software, and as such will not include any paid for data sets. Consequently, this will impact on the types and format of data available for inclusion in the analysis, which if included could impact not only on those areas identified at significant risk but the contributing risk factors.

The final part of the research seeks to determine the views of police officers on the RTM models, and how to best portray results to be affective in provoking use by officers. Due to the time constraints the number of officers interviewed will be limited, and where possible the same officers used for the duration of the research. When this is not feasible additional officers will be approached. Both my experience as a semi-structured interviewer, and as an insider-researcher could also influence the officers' responses and their interpretation, and as there is no triangulation process this is a clear limitation in the second part of the research. As such, and due

to the small numbers of officers involved in the interview process the results will be indicative only, and not provide a representative sample. The implications of being an employee of, and simultaneously conducting research within the police service in which I work are discussed in chapter 3.4.

This research provides two alternative uses of RTM analysis in contexts not previously researched. The results are not expected to be generalisable in terms of utilising the identified risk factors in other areas for the same crime issues. It is however, hoped that it can determine the relevance of RTM for use in less populous areas, and for understanding hare coursing and cuckooing such that the technique could be used in other areas.

1.6 Thesis Overview

The previous sections have provided a brief introduction to the research and the following provides a brief overview of each chapter. Chapter two provides a more detailed context to the research starting with the changes in policing which led to the introduction of a new management model, known as the National Intelligence Model. This leads into the development of spatial and crime pattern analysis which are fundamental concepts used within this research. The third section of chapter two looks at the developments and issues around rural criminology before finally detailing my personal context for undertaking this research.

Chapter three provides the broad methodological approach to the research. The research was part funded by the College of Policing which promotes the value of evidence-based policing, and this is discussed before detailing why the pragmatic realist approach was taken. The research aims to determine if risk terrain modelling can be successfully used to identify locations of risk, and the remainder of the chapter discusses the concept of RTM before detailing its general method and that used for assessing if the analysis is successful in identifying future locations at risk to offences of hare coursing and cuckooing. The second aspect of the research is to determine if officers perceive value in the analytical results and the method. The chapter is completed by discussing the methodology to be used to understand police officers' opinions of the analysis and its results.

Chapter four is focused specifically on risk terrain analysis. A detailed literature review is provided which further examines the fundamental concepts used within RTM and this is followed by literature reviews on rural crime and crime theory relevant to risk terrain analysis and agriculture and rural crime. The aim is to provide a thorough understanding of the criminological concepts which are relied upon when determining the risk factors for hare coursing and county lines cuckooing of homes which are detailed in chapters five and six.

Chapter five is focused on the risk terrain analysis of county lines cuckooing. It begins by providing a literature review of county lines and county lines cuckooing. It then moves on to detailing how

and why certain risk factors have been chosen for inclusion in the research analysis and includes a comparative case analysis of county lines incidents in towns across Lincolnshire. The next section details the specific methods used to generate the risk terrain models using the RTMdx software and the manual model. The chapter finishes with the results of the analysis, including a comparison of the manual and RTMdx models, before summarising the value of the models in determining locations at significant risk to future events of cuckooing.

Chapter six follows the same format as chapter five, providing a literature review of hare coursing before detailing the methods used for generating the RTMdx models and comparative manual models. As in chapter five, the results follow next including a comparison of the RTMdx and manual models and the chapter culminates in a summary and conclusion as to the success or otherwise of the hare coursing risk terrain analysis and manual models.

Chapter seven is concerned with the second aspect of the research question; do officers value the analysis, and could it be used in practical application in Lincolnshire? This extensive chapter commences by considering the literature around organisational and police culture, before considering how culture influences the use of analysis. This literature review section considers how rank and role influence experience and understanding of analysis and analytical products and the impact that police 'craft' has on the acceptance of researcher and analyst's findings. The chapter then moves on to the methods used to obtain the views of Lincolnshire Police officers on hare coursing and county lines drug dealing, and to analysis in general. It specifically details the two-stage interview approach, and the use of the analysis results in the second stage interviews to focus officers on firstly the findings, and then the presentation and interpretation of the results. The final sections of the chapter interpret and discuss those opinions raised by officers in both phases of the interviews, culminating in a summary of the findings.

Chapter eight concludes the thesis, summarising the findings of the RTM analyses of both hare coursing and county lines cuckooing. It briefly contrasts the differences noted when applying the

RTM to the two crime types, and how they compared to alternative manual models. It then summarises how the models were interpreted by officers. The chapter also includes limitations of the research and areas for future research before culminating in recommendations for practice.

The thesis is completed by the provision of references in chapter nine and the data sources used in chapter ten.

2 Research Context

2.1 Research context: National

The police service of England and Wales has been undergoing continued change, with a growing emphasis on intelligence and evidence in policing practice, since the introduction of the Police and Criminal Evidence Act, 1984 (PACE). Government acknowledged that there was a need for better investigation techniques and use of advancing technology (Maguire & John, 2006). Following the struggles of the 1970's and the policing implications of the miners' strike, the Association of Chief Police Officers (ACPO) acknowledged that a fully integrated national intelligence system was required (Keane & Kleiven, 2009; Ratcliffe, 2003; Woodman, 2019) to understand and deal with future threats.

The focus on intelligence-led policing in both policy and then practice, continued, pushed by increases in urban crime through the 1980s and 1990s, the need for rationalisation and professionalisation of the police service (Keane & Kleiven, 2009; Maguire & John, 2006; Ratcliffe, 2003). The publication of the Audit Commission's (1993) report '*Helping with enquiries: tackling crime effectively*' and Her Majesty's Inspectorate of Constabulary (HMIC, 1997) report '*Policing with intelligence*' emphasised performance management (Keane & Kleiven, 2009) to reduce and detect crime, which would in turn increase public confidence.

Heightened police and community tensions were apparent in the race riots of Brixton and the northwest which resulted in officers being attacked and shops ransacked. A subsequent HMIC report (1997) '*Winning the race- policing plural communities'*, raised concerns over race relations, and from this political and community backdrop came *The Crime and Disorder Act, 1998* which brought with it new forms of policing to reduce the risk of crime (Fielding & Innes, 2006; Maguire & John, 2006; Yarwood, 2007). These national concerns (Keane & Kleiven, 2009) continued and

were further detailed in follow-up reports by the Home Office (Home Office, 2001a). The Crime & Disorder Act emphasised community-based policing such as community safety partnerships, and reassurance and neighbourhood policing (Maguire & John, 2006). Fielding & Innes (2006) argue that the implementation of performance measures was a 'surrogate trust' mechanism when trust in police was falling and police and community tension was high, and that reassurance policing was a method of bridging the gap between reducing crime risk and decline in public confidence. In a similar vein Bullock (2013) argues that community policing is a mechanism to legitimise police and community relations, but the promotion of community and reassurance policing is concurrent, but incongruent to performance management policing.

Intelligence led policing really came to the forefront of policing practice following the 2000 Government White Paper- *Policing a New Century*. The paper detailed the plan for policing which included modernisation of the service, identifying prolific offenders, hotspots of crime and best practice; included the creation of a national policing plan and the National Centre for Police Excellence. All of which would adhere to the National Intelligence Model (NIM) (Home Office, 2001b). Seen as a management tool (Maguire & John, 2006), NIM was to be a structured mechanism to problem solve (Kirby & McPherson, 2004), enable proactive policing and using a wide range of data sources inform decision making (Bullock, 2010) from an objective and evidence-based approach (Maguire & John, 2006). The Government's expectation was that all police forces in England and Wales would be NIM compliant by 2004 (Kleiven, 2007; Maguire & John, 2006) and analysts providing analysis for decision making was a key function of NIM (ACPO, 2005).

Furthermore, the report (Home Office, 2001b) detailed how increased funding of the police service would lead to the public expectation that this should be used efficiently and effectively (Home Office, 2001b). The better use of technology and scientific advances, combined with increased numbers of police officers supported by civilian staff, would be the way to tackle crime, reduce the fear of crime and antisocial behaviour and reassure the public. It acknowledged issues

of persistent offenders, repeat victimisation and the geographical concentration of crime needed to be the focus of police attention, but that legitimacy, trust, consistency and professionalisation required addressing. Partnership working of the new wider police family, including civilian staff and police community support officers (PCSO's) alongside Crime and Disorder partnerships and local authorities was flagged as the only way to make a real difference to communities. Problem orientated policing (POP), a process to diagnose, understand and solve crime problems, typically in high crime areas, was an example given, when the contribution of other agencies could greatly help (Home Office, 2001b).

In 1998 Lawrence Sherman wrote the first published paper on the use of evidence in policing practice, stating that it 'should be based on scientific evidence about what works best' (Sherman, 1998:2). Over the last twenty-plus years the emphasis on how and what type of evidence has changed, but in the interim 'evidence' was seen as an integral element of intelligence-led policing (Bullock, 2013; Maguire & John, 2006; Ratcliffe, 2003) and other problem-solving tools such as POP (Goldstein, 1979) and the Scan, Analyse, React, Assess (SARA) model (Ratcliffe, 2003). Analysts can, and are providing that evidence, through analysis which identifies and prioritises problems, and theoretically, through results analysis determining if the strategy works, putting analysts at the centre of professionalising the police reforms (Keay & Kirby, 2018). However, Belur & Johnson (2018) found that this aspect of the 'evidence' process was rare, including evaluation of the analysis towards crime prevention, resource allocation, or the success of the intervention. It is probably why there remains a drive from some areas of government and law enforcement for the integration of evidence-based policing throughout policing practice.

At the beginning of the 21st Century, following the launch of the new policing agenda, to increase reassurance to the public by reforming and modernising the police service, three reports were published that re-emphasized the need for neighbourhood policing, intelligence gathering and professionalisation of the service. Povey's (2001) report *Open All Hours*, recognized that police visibility, accessibility and familiarity were as important to the public as detections in reducing

crime (Maguire & John, 2006) and reassuring the public. It was identified in (Povey, 2001) that there was a cultural emphasis on real policing over community-based work, and that this needed to be changed. Reassurance was to be seen as a legitimate objective and The Reassurance Challenge Fund was created (Povey, 2001). Consequently, funding was provided to policing command units to tackle crime and disorder at a local level, as agreed with the relevant crime reduction partnerships (Home Office, 2003).

This was followed in 2004 by the government's report *Building Communities, Beating Crime* (Home Office, 2004). This emphasized police citizen focus and instigated neighbourhood policing teams to be in place by 2008. This built on the introduction of police community support officers (PCSO's) following the *Policing a New Century* report (Home Office, 2001b). The need to be more efficient and professional was the emphasis of the *Narrowing the Justice Gap* report (Justice Gap Taskforce, 2002). It focused on the need for best practice, introducing the volume crime management tool, targets, and the professionalising investigations programme, to bring all forces to a higher working standard.

The need to manage and understand risk in the wider community took on political and social relevance in the aftermath of two tragic but significant events. The first, in 2001 was the Soham murders of two ten-year-old girls by school caretaker Ian Huntley. Huntley had resided in several police force areas and concerns had been raised around his relationships with underage girls. A subsequent Bichard Inquiry Report (Bichard, 2004) found that there had been system wide communication and intelligence sharing errors. The second event was the London bombings in 2005, intelligence had been sent to the police prior to the attack and 'potential risks of persons known to the police was apparently discounted by police' (Keane & Kleiven, 2009:330). Both cases highlighted the marginalisation of information and intelligence which dealt with a potential future event (Keane & Kleiven, 2009). The NIM required the submission and use of intelligence by police forces, but the emphasis was on intelligence to help law enforcement. There was no interest or mechanism to deal with information that did not relate to a specific offence but dealt with risk.

Consequently, the need for community policing and community intelligence gathering sought to manage this risk with neighbourhood policing becoming a significant part of the policing agenda (Bullock, 2013).

As discussed, the first decade of the 21st Century saw renewed government commitment to funding an efficient and effective police service and provided funding for improved technology and for an uplift in police and civilian staff numbers including analysts. In the last few years, the police service has been under enormous stress due to the crisis in funding stemming from the UK governments' austerity measures (Dodd, 2018; HMIC, 2011) with the ongoing limitations and implications having a drastic impact on police resources (Caveney et al., 2020). Police budgets were cut by 22% over six years, resulting in the loss of 32,000 police officer and police staff roles (Warrell, 2017). The introduction of the College of Policing in 2012 and the launch of the 'what works network' (Hunter et al., 2019; Sherman, 2013) supports ongoing, and ever-increasing emphasis on evidence-based policing, the 'what works' agenda and professionalisation, in parallel with the financial cuts (Barton, 2013; Lumsden & Goode, 2018; Palmer et al., 2019).

2.2 Research Context: Rural Policing

Police forces considered to be 'rural' such as Lincolnshire, Norfolk, Cumbria and North Wales all have cities with which rural areas are competing against for resource allocation. Yarwood (2007) identified that changes in policing during the early 2000's which included police administrative areas becoming larger to achieve targets, clustering of resources and the use of intelligence-led policing to maximise efficiency saw the removal of policing from low crime areas, and the perception that the countryside was unpoliced. Smith & Byrne (2017:192) argue the 'continuing reality is that crime numbers in urban areas are much higher than in rural areas' and this is where 'police resources will be focused'. Ratcliffe (2003) called it a return to reactive policing, which through resource demand and distribution will be urban centric. Morris et al. (2019:6) acknowledge that rural policing is changing in response to 'new challenges and increasing threats' and because of the scale of the geographic areas covered and lack of immediate back-up support, the urban models of policing are of 'little use' (ibid.).

Tonnies et al. (2001:18) referred to the countryside as the 'gemeinschaft', the opposite of the urban, 'foreign land' - 'gelleschaft'. Perpetuated by the Chicago school of criminology, the rural was conceptualised as all that the urban environment wasn't. Criminological research focused on social disorganisation and collective efficacy theory, has traditionally fixated on urban areas, with one of the resulting consequences being that rural areas are considered more cohesive, and as such idyllic low crime areas (Carleton et al., 2014; Donnermeyer, 2015; Scott & Hogg, 2015; Shucksmith, 2018). Criminological theory relevant to rural crime and communities is discussed in more detail in chapter 4.2 and 4.3. Marshall & Johnson (2005) argue that annual crime figures continue to support crime being less in rural areas with English and Welsh rates lower per person or per household. Carrington et al. state that 'rural scholarship demonstrated that for certain crime types, such as violence, substance use and trafficking, and environmental crimes and harms their occurrence is likely higher in more rural settings' (Carrington et al., 2014:473). Jones writing

in 2012 noted that there was an 'increasingly serious and organised element to criminality in the countryside' (Jones, 2012:9).

In 2014, twenty-eight of the Police and Crime Commissioners for England and Wales joined with other rural organisations to establish the National Rural Crime Network (NRCN), (NCRN, 2022). Population statistics which estimate over 17% of the population living in rural areas in 2020 (DEFRA, 2011), and the involvement of almost three quarters of England and Wales Police and Crime Commissioners demonstrate the importance of policing rural crime. The NRCN Rural Survey (2018) (NCRN, 2018) highlighted that it was not only traditional offences such as burglary, that were of concern, but also the impact on residents in terms of increased fear of crime and lack of confidence in policing and underreporting of crime.

2.3 Research Context: The Growth Of Spatial Analysis And Influence On Crime Pattern Analysis

The National Intelligence Model (NIM) was identified as the business model for intelligence led policing in England and Wales in response to the Police and Criminal Evidence Act, 1998 (Maguire & John, 2006) in the Home Office (2001b) report Policing a New Century- a blueprint for reform. It put 'analysts at the centre of police professionalisation' (Keay & Kirby, 2018:265) in a process that uses analysis in an evidence-based approach of risks and trends for decision making, prioritisation (Maguire & John, 2006) and problem solving (Kirby & McPherson, 2004).

The importance of analysis stems from an intelligence led policing approach that acknowledges the uneven distribution of crime (Sherman et al., 1989; Weinborn et al., 2017) for both people and places and repeat victimisation (Haining, 2009; Maguire & John, 2006). The uneven distribution of crime and the exploration of why that is the case, led to the Chicago school of criminology adopting social demographics to explain the distribution of offences (Shaw & McKay, 1942) in the emerging area of environmental criminology.

Environmental criminology brings together several interlinked theories to explain the locations of crime. These include why people commit crime in certain locations (crime pattern theory), that people make a rational decision on when and where to commit crime to maximise results and minimise risk (rational choice theory) and that the sense of ownership within community spaces can deter offenders (defensible space theory). Chainey and Ratcliffe (2005:80) describe it as the 'practical subset' which 'underpins crime mapping' and two theoretical perspectives have developed within it. The Chicago School of criminology theory, or ecological crime theory, was developed by Robert Park and Ernest Burgess (Kitchen, 2006) and expanded by Clifford Shaw and Henry McKay. The theory explains that the uneven distribution of crime is due to the interactions between humans and their surroundings and is not down to the 'kinds of people' involved but where they live (Stark, 1987:905). The second perspective is that of opportunity theory (Clarke &

Felson, 1993) which developed from routine activity theory (Cohen & Felson, 1979). However, Yarwood (2001) argues that through realism (a pragmatic approach to solving problems as and when they occur) and structuration (acting within the roles of social structures and through compliance reinforcing these structures), environmental criminology has been modified. Consequently, any assessment of crime patterns should reflect structures of culture, politics, economics and society of both the local, national and international level.

Routine activity theory stipulates that for a crime to occur there needs to be a likely offender, suitable target and a lack of a guardian to prevent offending (Felson, 1987). How these are organised in space and time, through daily life, impacts on whether an offence occurs (Cohen & Felson, 1979). Felson (1987) explains that humans adhere to the least effort principle. For example, when travelling, choosing the shortest, quickest easiest routes (Bernasco & Kooistra, 2010; Boivin & D' Elia, 2017; Boldrini & Passarella, 2010; Reid et al., 2014), and that as part of the least effort approach will likely select the most obvious target. Regardless of the legitimacy of the activity, human behaviour typically follows these principles and can be used to explain offending patterns. Brantingham & Brantingham (1984) refer to this similarity of actions as aggregate criminal spatial behaviour and Cornish & Clarke (1986) developed rational choice theory to explain the decisions on deciding to commit a crime, and then those leading to the actual crime. This logical thought process could include the crime to commit, possession of the necessary skills and tools to be successful, probability of being caught, consequences of apprehension, where are the targets and whether successful completion brings rewards that outweigh any risks.

Chainey & Ratcliffe (2005) describe crime pattern theory as the convergence of rational choice and routine activity theories. Also known as offender search theory, it considers the interactions of criminals with both the physical and social environment. Brantingham & Brantingham (1981 & 1984) model this as the offenders' awareness space between activity nodes and pathways, frequented and travelled during routine activities, which overlap areas of criminal opportunity, which result in areas of crime. Later research has identified that not only do activity nodes attract

offences but also the pathways between them (Brantingham & Brantingham, 1993; Davies & Johnson, 2015).

Routine activities are governed by our social and functional activities. Where do we work or shop? Who do we socialise with? Where do our friends and family live? The answers to these questions impact on when and how we travel (Axhausen, 2006; Boldrini & Passarella, 2010; Carrasco & Miller, 2006 & 2009; Costello & Wiles, 2001; Páez & Scott, 2007) and our familiarity to geographic locations, and ultimately where crimes are committed (Bernasco & Kooistra, 2010; Boivin & D'Elia, 2017; Brantingham & Brantingham, 1981; Cohen & Felson, 1979; Malm et al., 2008; Menting, 2018; Van Koppen & Jansen, 1998).

As technology has advanced, the sophistication and processing power of computers has enabled the development of geographic information systems (GIS). They utilise a geographic location to link data and can be used to create hotspot and modelling maps (Haining, 2009) and can exploit digital data to explore spatial criminology (Chainey & Ratcliffe, 2005). The capabilities of GIS to map and analyse crime data has evolved rapidly (Craglia et al., 2000) leading to the advancement in the understanding of crime concentration.

The value of GIS within criminology to test and expand crime theory has been highlighted since the 1990's (Fotheringham & Rogerson, 1993; Hirschfield et al., 1995; Luini et al., 2012; Luini et al., 2015; Tita & Radil, 2010). In the last ten years it has been specifically used to understand the spatial awareness of offenders (Beken & Daele, 2011; Bernasco & Kooistra, 2010; Boivin & D'Elia, 2017; Davies & Johnson, 2015; Lammer, 2018; Menting, 2018; Menting et al., 2016) and to develop the relatively recent theory of risky places (Kennedy & Caplan, 2012). This postulates that all places are at risk of crime, but some more than others, to determine different risk levels within geographic areas, and that this risk stems from the combination of vulnerability and exposure across a landscape.

The location of crimes and crime concentration has been researched using several different methods which have evolved over time, and with the greater application of geographical information systems. These include nearest neighbour analysis (Anselin, 1995; Craglia et al., 2000), repeat victimisation (Farrell & Pease, 1993; Farrell et al., 1995; Townsley et al., 2003), dasymetric mapping (Eicher & Brewer, 2001; Poulsen & Kennedy, 2004; Tapp, 2010), hotspot analysis (Block & Block, 1995; Bowers et al., 2004; Braga et al., 2014; Chainey et al., 2008; Eck et al., 2005; Eck & Weisburd, 1995; Sherman et al., 1989; Weisburd & Green, 1995), harm spots (Curtis-Ham & Walton, 2017; Ratcliffe, 2015; Sherman et al., 2016; Weinborn et al., 2017), density trace analysis (Philips & Lee, 2011) and burglary risk (Davies & Johnson, 2015).

A more recent innovation is the modelling of risk developed at the Rutgers Institute, New Jersey and is a move away from analysis of incidents to that of crime risk. It offers a good opportunity to model risk, allowing numerous variables which may impact positively or negatively on crime location and frequency, to be considered for inclusion.

'Essentially, risk terrain modelling is an analytical tool that allows for the creation of an intuitive and detailed analysis of the underlying risk factors present in a landscape, assisting in our understanding of why crime is occurring in specific locales' (Drawve et al., 2016:21).

In essence it brings together the work on crime concentration and broader knowledge of environmental criminology, routine activity theory and offender behaviour with digital information, via GIS, on the topology of the environment, hotspots of crime and demographic data, alongside practitioner understanding of the local environment to identify those areas most at risk to crime. The theoretical concepts which underpin RTM are discussed in chapter four.

Hot spot policing has already been assessed as an evidence-based approach for use in police practice and Fox et al. (2019) argue that RTM allows 'police to merge their knowledge of hotspots with a more sophisticated understanding of why certain places are crime prone (2019:10). However, RTM is not without its critics, among which are the concern over racial bias within

forecasting tools (Berk, 2021; Valasik, 2018, Valasik et al., 2019). Valasik (2018) identified that RTM was able to identify areas at increased risk to crime 'without relying upon the beliefs and biases of law enforcement officers' (2018:19). This sentiment was echoed in the work of Barton et al. who commented that 'the avoidance of using prior criminal events avoids incorporating any potential bias or beliefs of police officers opaque in the crime data' (2021:139). Brantingham (2018 in Valasik et al., 2019:194) supported this when evaluating place-based predictive policing methods at the micro-level finding that they did 'not generate racially biased arrests'.

Berk (2021) offers a different slant on the use of RTM and its association with artificial intelligence. They state that RTM is an example of synopsis-based data analysis, which uses empirical summaries of crime in time and space, which are typically displayed as a map. They also comment that model-based analysis uses statistical models giving multiple regression or factor analysis as examples. They argue that although predictive policing is often captured under the umbrella of artificial intelligence, neither synopsis based or model-based analysis should be classed as such, and the corresponding concerns of bias are misplaced.

Another concern raised in the RTM literature was that the majority of RTM utilises micro-units for the analysis of crime (Drawve et al., 2016). This has been raised due to the nature of publicly available demographic data, which is typically aggregated to census output areas. More recent research has identified methods of incorporating aggregated data (Barton et al., 2021; Drawve et al., 2016) and Mazeika and McCann concluded from their research that 'RTM is also capable of integrating socio-economic metrics' (2023:6).

Additional data concerns relate to the integration of neighbourhood data with micro-unit data, and the inclusion of the interaction between the two levels of data. Jones and Pridemore found that there is 'support for an integrated theory between routine activities and social disorganisation theories' (2019:564), consequently there is 'compelling evidence for including neighbourhoods in models of micro-spatial crime patterns' (2019:568).

A failure to take account of the interactions between different risk factors was a criticism made by Wheeler and Steenbeek (2021) who also raised limitations of RTM due to a restriction to one variable parameter and one distance parameter for each risk factor. They argue that the effect size of a risk may not be linear across space, and both proximity and distance may be contributing variables, but only one can be chosen in the model. They concluded that the limited variables within RTM 'may not reflect reality' (Wheeler & Steenbeek, 2021:450).

RTM has a reliance on official sources of data (Lersch, 2020), typically that which is used in many other analytical products and limited by reporting bias and under-reporting, and in the case of socio-demographic data not designed for the analysis within which it is utilised. Possible significant risk factors may be omitted from the analysis because they are overlooked (Valasik, 2018) or the lack of available data sets. Despite the criticisms and limitations that exist with the use of RTM, it has been identified as valid method for determining areas vulnerable to future events of crime. It also has the advantage of diagnosing 'the spatial influence of those environmental risk factors that significantly influence crime' (Valasik, 2018:11) to aid the understanding of why a location is at risk.

The application of environmental criminological theory has seen practical success particularly in small areas with persistently high levels of crime known as hotspot policing (Braga et al., 2014). Townsley et al. (2003) highlight the successful reduction of burglaries when police attention is focused on homes near recent burglaries, known as near repeat victimisation. Situational crime prevention, where the focus is on the settings of crime as opposed to the criminal, has also been successful (College of Policing, 2022). Risk terrain modelling has proven successful in identifying locations of increased risk and those situational factors which contribute to that risk, and has value in crime prevention, strategic planning, and assessment of interventions (Caplan, 2011; Caplan et al., 2011).

Environmental criminology including the ecological perspective of understanding place and opportunity, rational choice, routine activity theory and crime pattern theory underpin the rise in preventative policing seen in NIM (Haining, 2009; Keane & Kleiven, 2009; Maguire & John, 2006; Yarwood, 2007), particularly in neighbourhood policing (Bullock, 2010). The use of crime pattern analysis is a key aspect of the analyst role as detailed in the NIM guidance (ACPO, 2005), but research by Cope (2004) highlighted that despite analysis being integral to the theory of intelligence-led policing, analyst's products were often overlooked, and difficulty in integrating analysis was due to police culture. This will be explored in more detail in chapter seven.

Utilising these theories to understand the physical characteristics of locations, the crime attractors, and generators (Cohen & Felson, 1979; Brantingham & Brantingham. 1981; Malm et al., 2008) will determine those variables which will contribute to modelling risk of crime in this research and will be discussed in more depth in chapter four. This research is concerned with crimes in rural communities and although on the surface environmental criminology offers a valuable contribution to understanding the risks for geographical distribution of crime there may be some hidden pitfalls. Bottoms & Wiles (1997:307) raised that 'the environmental approach has not been applied to rural areas and similarly Yarwood raises the concern that 'geographical studies of crime are firmly entrenched in the urban environment' (Yarwood, 2001:201). Mears et al. (2007) were more specific in relation to opportunity theory when they commented that it was focused on urban areas and the generalisability of target hardening was unknown. They agreed with Smith & Byrne (2017) that guardianship of property was much more difficult in rural areas, particularly farms. Rational choice and travel to crime proposes that most criminals commit crimes close to home, but again the 'evidence for this is derived from predominantly urban perspective' (Marshall & Johnson, 2006:39).

Another criticism of environmental criminology posed by Cullen & Kulig (2018) is the lack of concern regarding why an offender arrives in situations motivated to commit an offence. They also raise that environmental criminology neglects the role of social inequality, understanding of

the risk of victimisation and relies on social control. Risk terrain modelling allows for the inclusion of multiple factors for consideration and can in some respect mitigate these short-comings of environmental criminology by the inclusion of socio-demographic and economic factors. However, these are limited within the model to those which can be represented spatially, and this is seen as a benefit by some as the focus is on environmental context as opposed to victim blaming or profiling (Berk, 2021).

2.4 Research context: Rural Crime

2.4.1 A definition of rural

A key theme which researchers have identified as inhibiting academic and criminological research into rural crime is the lack of a consistent definition of rural and what constitutes rural crime (Donnermeyer, 2015; Morris et al., 2019; Scott & Hogg, 2015; Smith & Byrne, 2017; Smith, 2014, Smith & Somerville, 2013; Smith, 2010 & 2013; Weisheit & Wells, 1996; Yarwood, 2001). Classification of rurality can be based on demography, economics, social structure, and cultural values, depending on the relevance to the research or the researcher standpoint. Even within these four classifications there is no definitive interpretation.

Traditionally crime in rural areas was a seen as a low priority due to the low level of victimisation, but in 2000 the British government acknowledged that crime in rural areas should be a high priority (Marshall & Johnson, 2005). In 2002, to address the problem of a lack of universal definition, the UK government implemented a project to define and classify rural and urban areas of England and Wales known as the *Rural Urban Classification*. The results were based on hectare-sized land parcels, the settlement type, number of households in neighbourhood areas and the number and type of commercial addresses within the area. The conclusion was to categorise Census output areas as one of four urban or six rural settlement types. Areas are classed as rural if 'they fall outside of a settlement with more than 10,000 resident population' (Bibby & Brindley, 2013).

Despite the 2002 rural classifications for England and Wales (Bibby & Brindley, 2013), Kaylen & Pridmore (2013) argue that there is more than one type of rural community that researchers need to consider. In terms of demography there are differing uses of aggregation sizes including population and density, particularly apparent when rural areas of America and Australia are the foci of the research. Rural communities are perceived to be 'living off the land' or agriculturally based. However, statistics indicate that this is an outdated misconception due to the

technological advancements in farming and the motorisation of transport, those living within rural communities, and being employed in agriculture has dwindled (Zayed & Loft, 2019).

Social structure is another concept used when defining rural communities. Rural communities are perceived as having a close-knit social structure, an intimacy between residents. However, rural populations and settlements have continued to evolve bringing changes in social structure through in migration and out migration, the loss of local amenities and changes to employment opportunities.

The final classification for rural is based on culture and presumes rural communities have their own distinct attitudes and beliefs- culture. Often associated with this is a traditional bias and an intolerance of outsiders (Garland & Chakraborti, 2006; Kellog, 2001). The attitudes, beliefs and traditions of such communities have strong ties with the social structure. Little et al. (2005) and Yarwood (2001) postulate changes in population due to in migration, materialise as intolerance of outsiders whose attitudes may differ, developing fear of crime through lack of trust and changes in the perceived way of life residents are accustomed to. Yarwood and Gardner (2000) and subsequently Yarwood (2001), state both new inhabitants, who are moving into a way of life, and those established residents aim to protect against the perceived crimes of non-conforming and the blurring between criminal and cultural threat which Wood et al. (2004) explain is through the development of exclusionary policing practices.

Contemporary academics (Morris et al., 2019) have flagged the issue of rural crime lacking a specific definition. Characteristics of small rural towns may make them vulnerable to a particular crime, whilst isolated properties, surrounded by fields could be vulnerable to an altogether different rural crime risk. This is supported by Ceccato (2015) when he asserts that assuming crime patterns in rural areas are homogeneous is a mistake. The heterogeneity of rural crime (Ceccato, 2015; Donnermeyer, 2015; Marshall & Johnson, 2005; Mears et al., 2007; Smith & Byrne, 2018; Smith, 2010; Somerville et al., 2015; Weisheit & Wells, 1996) raised across the rural

crime literature will be acknowledged in this research through the selection of the crime types under analysis.

As discussed above, there are many and differing views on what is, and can be, classified as 'rural'. Lincolnshire is a predominantly rural county based on the Rural Urban Classification system (Bibby & Brindley, 2013) as illustrated in Figure 1, which shows Census output areas classified as rural (shaded olive). At the higher aggregated level of local authority districts, five are classified as 'predominantly rural' and a sixth is categorised as 'urban with significant rural' (Bibby & Brindley, 2013). Only Lincoln district comes under the 'predominantly urban category'. The research is looking to consider whether RTM is applicable in a rural county, and to put this to the test, two very different crimes which are believed to target rural areas, in terms of distribution and target victims have been selected for analysis.

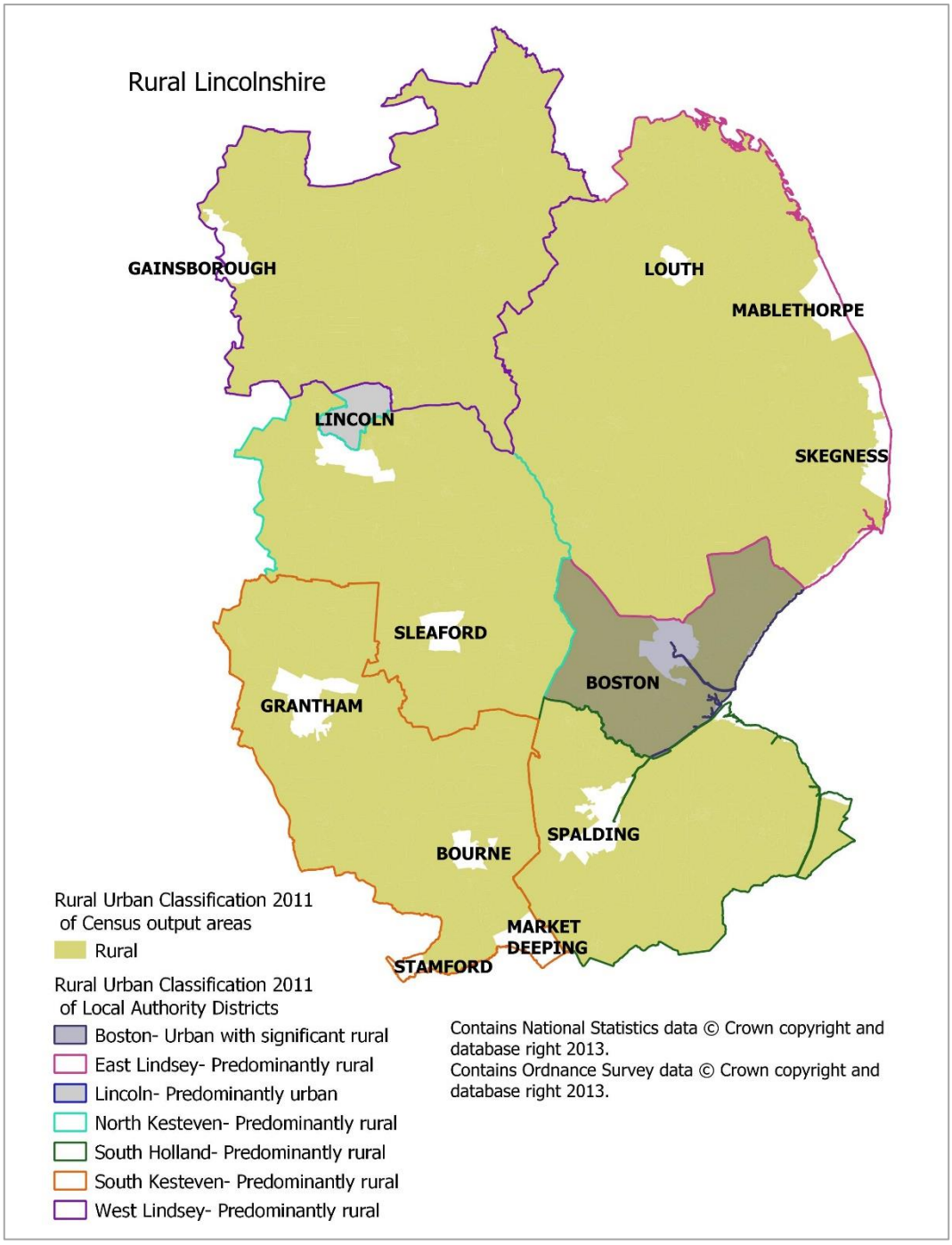


Figure 1: Map showing areas of Lincolnshire classified as rural.

Hare coursing is expected to be more prevalent on isolated farms within the county, in contrast to county lines drug offenders, who are looking to capitalise on the drug users within rural settlements such as small market towns. It will be important to understand the differing conditions for county lines and hare coursing and its relationship to the victim and community

and this is detailed in chapters five and six respectively. This will enable relevant criminological theory to be selected and hypotheses of risk to be tested in different rural crime contexts and allow comparison of the risk terrain methodology between the crime types and areas.

2.5 Research context: Personal

As a crime analyst with twenty years' experience with Lincolnshire Police I have been involved in the analysis of crime patterns and hotspots of numerous criminality types. One area which the Force has suffered for many years is rural crime and according to the National Farmers Union Lincolnshire was the most affected county in 2020 and 2021 (NFU Mutual, 2022).

Lincolnshire Police have a responsibility to rural residents to detect and prevent crime. As an analyst for the Force, I share the analytical responsibility of developing an understanding of rural crime which can improve the policing response. The demands of real time policing frequently limit the amount of analytical time that can be devoted to in-depth research of crime problems which could offer a more strategic response, as opposed to a reactive tactical outcome.

In the UK, the National Intelligence Model (NIM) acknowledges the importance of understanding the spatial distribution of crime when it specifies that chief officers should ensure the provision of appropriate mapping technology is available and utilised for decision making and problem solving (ACPO, 2005). A key function within NIM is analysis, and police forces were directed to have 'sufficient numbers of trained analysts' (ACPO, 2005), a requirement that led to my appointment as an analyst. The NIM also highlights crime pattern analysis as one of the fundamental analytical techniques to be used to inform intelligence products, and ultimately senior management to support decision making.

I have developed a keen interest in crime mapping and over my career have seen the use of geographical information systems (GIS) grow in both use and capabilities. The United States, National Institute of Justice (NIJ) funded evaluations on place-based policing strategies and the development of mapping technologies to incorporate statistical techniques, predictive policing and the evaluation of place-based strategies for policing (Hunt, 2019). Academics at University College London researched the use of GIS in relation to burglary concentrations and repeat victimisation (Chainey, 2004a & b, 2012; Chainey et al., 2001; Chainey & Ratcliffe, 2005; Chainey

et al., 2008; Eck et al., 2005). As a result of both the American and UK research, opportunities for analysts to incorporate the research findings and make use of the tools created became more widely available and promoted as good practice.

I furthered my interest and understanding in crime distribution whilst obtaining a MSc in Geographical Information Systems (GIS). The course allowed me the flexibility to research long-standing burglary issues and provided access to the technology to facilitate the research. I was able to identify strategic issues which could be addressed to reduce offences, and consequently this fuelled my interest in the use of GIS to explore crime locations, including the use of predictive policing (Perry et al., 2013), evidence-based policing (Sherman, 1998) and near-repeat victimisation (Pease, 1998).

Whilst evaluating the feasibility of predictive policing within the main urban areas of Lincolnshire I came across the alternative approach of risk terrain modelling (RTM) (Caplan & Kennedy, 2010), developed by the Rutgers Center On Public Safety. Published reports show the model proved successful in identifying areas of long-term risk to residential burglaries, and it has a logical approach to identifying locations which were more vulnerable to risk. As Lincolnshire Police are moving towards a 'what works' (Hunter et al., 2019) approach in tackling threat and risk, I am interested in exploring the use of the model for rural crime. Moreto (2010:3) sums the approach as presenting 'the opportunity to utilize theory, technique and technology in a concerted and proactive way'. This sentiment mirrors my personal motivation for the research: to further my understanding of crime mapping theory and the application of the geographical information systems' capabilities, whilst testing the modelling approach on a completely different environment to that utilised in current academic literature. The research also has the additional practical benefits, if successful, in identifying a model of risk to be used proactively within Lincolnshire against rural crime.

A crime which has emerged over the last five years is county line drug dealing. I have been the Lincolnshire analyst for county lines since the identification of the issue as a national priority and feel furthering my understanding is an important part of my continuing professional development. The county lines business model is that persons from outside of the area attend to sell drugs. These out-of-town dealers (OTD) utilize exploitation and the fear of violence to establish supply into a local drug market, typically in market towns, which the UK Government described as being at the 'heart of economic growth' (Hansard, 2000) of rural communities. This relatively new criminal activity has the potential to bring big city criminal and gang mentality to rural market towns. Understanding this new marketing approach will be key in reducing the impact and managing the risk in these communities and it is hoped the research can evidence areas where the police and partner agencies can make a difference in Lincolnshire.

Whereas county lines drug dealing is focused within towns the second crime type I have chosen to analyse using the risk terrain approach is hare coursing. Lincolnshire has annual problems with hare coursing, and this is policed under an approach called Operation Galileo. Due to the reoccurring nature of the crime and the specific rural nature of the locations this is an ideal crime type to try this new analytical approach.

This research is not only considering the feasibility of the risk terrain analysis in identifying areas of future risk, but also whether officers accept and make use of the results. I feel the contrast between the two crime types in terms of the geographic locations, towns and rural fields, and the expected difference in distance between offence locations will offer different challenges for the risk terrain approach. In addition, I think those officers policing the two crime types, due to the disparity in the spread of offences and how the areas are policed will bring different perspectives and that this would be reflected in officer opinions of the analysis results.

3 Methodological Approach

3.1 General Approach To The Research

The first part of the research question '*Is there value in a 'risk terrain' analytical* approach' is in essence looking to understand the feasibility of mapping hare coursing and county lines cuckooing incidents, before determining if the spatial distribution is appropriate for further analysis. It then aims to determine if risk terrain analysis can identify significant factors which influence positively or negatively, the location of these crimes in rural communities. If the first part of the research is successful, the second aspect of the research '*can it have a practical application in reducing crime in rural Lincolnshire?'* seeks to assess the practical potential of the model; can it identify at risk areas successfully, how does the predictive accuracy of the RTM models compare to other analytical processes, do officers accept the analytical results and see it as a worthy contribution to policing practice? In the context of the current policing climate and the drive for evidence-based policing this section considers the ontological and epistemological issues of evidence and establishing evidence to answer both aspects of the research question.

The police service, as with all public sector organisations is under pressure to deliver more for less, becoming more efficient and effective, 'determining "what works"' (Laycock & Mallender, 2015:654). Evidence-based policy, according to its proponents 'allows for both the mining of new discoveries and the shelving of policies that are ineffective' (Sherman & Murray, 2015) and is currently promoted by the College of Policing (College of Policing, 2023). How these 'discoveries' and decisions are made, are determined by the approach taken. From the research of Sherman, the emphasis over the last fifteen years has shifted from experimental criminology, 'best summarised as "to develop and test"' (Sherman, 2006:393), to evidence-based policing of what works (Sherman, 2013).

The evidence-based approach appears ideal for the purpose of improving policing: Using facts to determine the truth without bias and is endorsed by the Home Office (Hough, 2010; Laycock & Mallender, 2015), the international social science research network known as The Campbell Collaboration (Hough, 2020) and the College of Policing (Sherman, 2013). However, the determination of a relevant 'fact' and the value given to certain 'facts' is determined by the types of questions and those seeking the answer. There are examples in the medical profession as the forerunners of evidence-based practice, and in criminology where the provision of evidence, the 'fact', is insufficient to generate policy change (Monaghan et al., 2012). In 2009, the UK government went against scientific evidence and the recommendation of the independent Advisory Council on the Misuse of Drugs to downgrade ecstasy from a class A drug (Kmietowicz, 2009). The UK government argued this was a necessary precaution as the long-term effects of ecstasy were unknown. In September 2023, the government also went against the Advisory Council on the Misuse of Drugs. On this occasion they advised against laws to ban nitrous oxide, but at the end of 2023 it became a class C drug (Gillett, 2023).

In recent years this 'precautionary principle' (Monaghan et al., 2012; Pawson et al., 2011:526) has instigated actions in contrary to evidence, and in real terms 'crime policy is almost always politicised' (Carr, 2010:7; Monaghan et al., 2012). Ratcliffe (2003:4) agrees noting that schemes that work are 'overshadowed by schemes that have significant public appeal, but for which the crime reduction evidence is disputed'. This highlights that strong evidence needs to be congruent to political, cultural, and organisational ethos to instigate action.

Fleming and Rhodes note that evidence-based policy is not restricted to randomised control trials (RCTs), but they are 'fashionable' and there is a predilection towards RCT in public policy making, particularly in the What Works Centre for Crime Reduction (Fleming & Rhodes, 2018). They argue that 'proponents of EBP in the UK cannot present themselves as neutral scientists with objective evidence', but that they are part of the 'political game', 'persuaders' and 'negotiators' and 'not bearers of truth' (Fleming & Rhodes, 2018:6).

The evidence-based positivist approach to what works identifies the RCT as best practice (Braga et al., 2014b; Pawson et al., 2011; Shepherd 2003; Sherman, 2013; Sherman & Strang, 2004). It offers potentially reliable and valid results, easily comparable data with a clear theoretical focus, all based on the 'most trustworthy of knowns, namely evidence from randomised control trials' (Pawson et al., 2011:519). John (2022:16) argues that the 'modern trial is grounded in the theory of causal inference' and is a method of improving causal claims in public policy. Pawson (2000) counterclaims that RCT's prioritises causal outcomes at the expense of 'adequate mechanisms and contexts' (Pawson, 2000:301), and Greene (2014a) agrees that there is a lack contextual information without other supporting qualitative research methods which can aid full understanding of the true complexity of research. Thus, there is a high internal validity but a loss of generalisability (Hough, 2010; Pawson, 2019b), meaning it would not be appropriate to assume the same intervention would be equally successful elsewhere under different conditions.

Consequently, RCT's can determine if something does or does not cause an expected outcome, but not why. The nature of the trials, focused on very specific and controlled contexts can only answer one question and can overlook crucial findings (Pawson, 2000; Sherman & Strang, 2004) as it focuses on the narrow research question of did x cause y. This is an approach which can work well, and is best suited to a laboratory setting, when the environment can be controlled and changes between the control data and the test data can be restricted, planned, and monitored.

Weisburd (2000) acknowledges that RCTs are not appropriate for every evaluation study and as Tilley (2000), and Laycock & Mallender (2015) support, experimentation requires a more realist consideration of context, mechanism and implementation as advocated by Pawson's (2000) pragmatic realism. Policing is not carried out within controlled conditions and, what works under the control, needs to have a generalisability into a real-world context to benefit policing practice. As Hough (2010) states, questions in policing are far more complex than those assessing the impact of pharmaceutical treatments. Cartwright & Hardie (2012) are in agreement when they discuss whether trustworthy evidence will predict whether policy will work 'here' if it worked

'there'. They argue that you need 'facts about causal roles and support factors' (Cartwright & Hardie, 2012:22).

As discussed earlier in the chapter, the current evidence-based approach in policing has a narrow focus on the use of randomised control trials (RCT) and scientific research methods (den Heyer, 2022). But in the medical profession the Institute for Health and Clinical Excellence have a broader view of evidence which includes stakeholder opinions and expert knowledge (Fleming & Rhodes, 2018). Lumsden & Goode argue 'many officers and staff valued qualitative research' but these methods were 'not compatible' as 'evidence of what works in practice' (Lumsden & Goode, 2018:821). Greene (2014b) states that these evidence-based experimental methods have contributed only marginally to the knowledge base of what works, and the approach excludes a large proportion of police research. Field studies, systemic observation, surveys and research of police records, Greene (2014b) argues, have been the mainstay of policing knowledge but are dismissed under the evidence-based approach.

Experimentation has an important role to play, but these experiments need to be 'constructed realistically if valid and useful conclusions are to be drawn' (Tilley, 2000:211). The research question in this study combines quantitative data for the generation of the risk terrain analysis and the qualitative interpretation of officers' responses to determine if the model is valid and practical. The results are, as Lumsden and Goode (2018) indicate more likely to be acceptable to officers, and potentially lead to greater adoption. However, this research would not be classified as evidence based under the guidelines of the College of Policing, who advocate for randomised control trials (RCT) or the systematic review. In the broader, social science context, this research is using a methodology, RTMdx, which has been shown to work in multiple applications and via systematic review (Marchment & Gill, 2021) and adding context through officer interviews in terms of what works for them in the presentation of the model, and professional practical knowledge for inclusion in the model's generation.

The RCT approach is too restrictive for this study, as my research question is seeking to determine what factors and their interactions contribute to increased risk. It is not looking for a yes or no answer which the RCT could provide, but searching for where intervention is required. The planned research, using the risk terrain modelling methodology seeks to identify the contextual aspects which increases risk at locations to hare coursing and the take-over of addresses by drug dealers, known as cuckooing. It also seeks to understand the level of acceptance and most favourable context in which police officers will act upon the analysis results which an RCT cannot determine.

Thus, a move from a purely positivist approach has been applied in this research to develop an understanding of how, and why rural crime is distributed as it is and to develop effective policing policy. A return to the 'develop and test' (Sherman, 2006:393) approach advocated by Sherman in his early work and the pragmatic realist approach of finding 'what works in what circumstances' (Pawson, 2002:342; Tilley, 2000:203), was deemed to be the best methodological approach to understanding the factors that lead to locations being at an increased risk and officers accepting and acting on the analytical results.

3.1.1 Pragmatic realist approach

Kaushik & Walsh (2019) offer two important points on why a pragmatic research approach should be undertaken for this research. The first is that it 'orients itself towards solving practical problems in the real world' (Kaushik & Walsh, 2019:4) and secondly, it recognises that knowledge is always based on experience. Ansell & Geyer state that knowledge needs to 'be assessed in terms of 'whose problems' are being addressed' (Ansell & Geyer, 2017:153) and in this research the problems being addressed are two-fold: to determine for officers, where and why the areas at greatest risk to hare coursing or county lines are, for them to provide the best policing response, and for the analyst/researcher to present the research results to maximise officer understanding which leads to positive action. The production of 'useful and actionable knowledge' is a 'central

tenet in pragmatic inquiry' (Kelly & Cordeiro, 2020:3) and should be the police analysts' or researcher's core role.

Feilzer champions the freedom that pragmatism can bring to research as it 'aims to interrogate a particular question, theory or phenomenon with the most appropriate research method' (Feilzer, 2010:13) with a goal of being 'useful' (Feilzer, 2010:8). In practical criminology, developing a working policy is frequently the driver and instigator of research. RCT results lack generalisability which could inform and generate new policy and is why ardent supporters of situational crime prevention have frequently been the most critical of randomized control trials (Shepherd, 2003), and why RCTs remain the exception (Braga et al., 2014b; Weisburd, 2000 & 2003) in criminological evaluation.

The aim of this research is to determine if Risk Terrain Modelling (Caplan & Kennedy, 2010) is a valid and practical tool, and whether it generates combinations of risk factors that realistic action can be planned and implemented to reduce or eliminate those risks. Those risk factors are part of the context of the pragmatic realist approach endorsed by Pawson (2000:294) because:

'A realist research design will suppose that its task is to discover what made these events go together and this will involve uncovering certain of the 'causal powers' of individuals and institutions' .

Although broadly following a 'what works' philosophy, the pragmatic realist approach of Tilley (2000) and Pawson (2000) has been used to understand the context of why areas are at increased risk and is a return to the interpretivist experimental criminology of Sherman (2003 & 2006) through the development and testing of the RTMs. The research question shifts from 'did x cause y?', to identifying the contexts which result in different x's producing different y's in both a rural crime and policing response context. This "what works in what circumstances" (Nielsen & Miraglia, 2017; Tilley, 2000) approach translates to identifying those different contextual risk factors 'x' and the 'mechanisms' of their interactions to produce the visible 'outcomes' of

increased risk of y. The need to understand the context of when a risk factor, 'x' is relevant and to what extent, is just as important in generating a model of risk as the identification of x. Equally, understanding the policing context in which a positive reaction and response is more likely to follow from the analysis will allow for a more viable analytical product.

The research question "*Is there value in a 'risk terrain' analytical approach, and can it have a practical application in reducing crime in rural Lincolnshire?*" steers the methodological approach to one of experimental realist pragmatism. What are the contextual conditions which induce offenders to commit crime within certain locations in rural communities? Can these be identified and generated into a predictive model of risk? This research project explored the underlying facilitators and inhibitors of the geographic distribution of rural crime and tested them to assess their contribution to increased risk in order that a model of risk could be developed. This approach develops a theoretical and geographical understanding of the risk factors for hare coursing and county lines cuckooing and considers the context in which they are impactive within risk analysis. A successful model will provide increased knowledge on aspects which influence crime location and infer potential intervention strategies to prevent future offences. It is moving beyond explanatory positivism towards interpretivist understanding through pragmatic and realist analysis providing those with the responsibility of policing actionable intelligence to better inform tactical and strategic responses. It identifies for officers where interventions could be applied and what those interventions might focus on and could subsequently form part of an evaluation process of those interventions.

In terms of the overall research approach, RTM allows mechanisms which increase or decrease crime density, and the context in which they are relevant, to be considered. When reviewing other methods of identifying concentrations of crime: hotspots (Bowers et al., 2004; Chainey et al., 2008; Sherman et al., 1989); dasymetric (Poulsen & Kennedy, 2004; Tapp 2010); harm spots (Ratcliffe, 2015; Sherman et al., 2016) and density trace analysis (Philips & Lee, 2011), RTM was the only one which allowed multiple contexts and mechanisms to be considered.

Running parallel to the criminological contexts and mechanisms are those of the situational context in which the model will be used, and the mechanisms for its use in the policing environment. Police culture, officers' knowledge and their response to the RTM will contribute to the context and mechanisms to which the research is designed, produced, and implemented. Understanding of police attitudes, action and reaction to analytical products could potentially have a great impact on producing successful practical outcomes. Consequently, how officers receive, interpret and act on the results of the analysis was investigated from the start of the project. The aim being to identify the aspects of research (x's) that cause analysis (y's) to be utilised or discarded by officers. By understanding the motivation, reservations, knowledge, and misapprehensions of police officers to analysis, and how they may interpret and react to analytical products, the analysis can be developed and presented in a way to maximise adoption.

Fleming and Rhodes (2018) support the use of officer experience in evidence-based policing. They argue that the 'craft' of policing acknowledges the value and importance of officer experience and that knowledge gained from any type of research will be 'evaluated through the lens of an officer's own experience' (Fleming & Rhodes, 2018:20). Den Heyer argues 'research is more likely to be successful when officers' experience is valued and taken advantage of when designing and implementing a strategy or tactic' (den Heyer, 2022:8) and gathering officers' experiences of analysis and knowledge of county lines and hare coursing prior to the risk terrain analysis was judged to help to maximise officer acceptance to the analytical findings.

Although RCT's have and are promoted in other areas of social science as the gold standard for research (Cartwright, 2018 & 2019; Cartwright & Hardie, 2012; John, 2022; Oancea & Pring, 2008; Rycroft-Malone et al., 2004) there is a broader more inclusive view of what can count as evidence in evidence-based social science research. Rycroft-Malone et al. note that quantitative research evidence is more valued in health service delivery, but that the nature of nursing and social and relational aspects of patient care suggest evidence is broader than that solely from this type of research, and that evidence should be considered 'to be knowledge derived from a wide range of

sources' (Rycroft-Malone, 2004:83). They propose it should be comprised of two types of knowledge: propositional, formal, explicit research focused on generalisability and non-propositional which is informal, implicit, incorporating professional craft knowledge. They also note that non-propositional knowledge can become propositional, but to do so and be seen as credible as a source of evidence 'it needs to be explicated, analysed and critiqued' (Rycroft-Malone, 2004:84).

Just as Rycroft-Malone et al. (2004) acknowledge that personal values and experiences are a source of knowledge in medicine, Diery et al. (2020) support the integration of empirical evidence with professional expertise to direct evidence-based practice in teaching and echo the opinion of Flemming and Rhodes (2018) above. Elliott (2001:556) agrees that in education 'practical decisions are context-bound' with research knowledge 'supplementing' policy-makers existing knowledge. They conclude that the future of social and educational research should be focused on creating 'actionable knowledge' for policy-makers and practitioners (Elliott, 2001:557) a direct parallel to the aim of the National Intelligence Model for policing to generate actionable intelligence through research and analysis.

So, although this research is not in the orthodox tradition of evidence-based policing focused on the RCT, it is still maintaining an evidence-based approach in the broader social science context and retaining a pragmatic approach through using the best available research techniques to answer the research questions. Green (2008) postulates that one of the most promising methods of making research relevant is by bringing or producing 'research closer to the actual circumstances of practice' (Green, 2008:i23) including action research and participatory research, and using real data, in a true context involving those who are most likely to benefit from the results. This research uses real police data, by a current force analyst, incorporating the opinions of officers via interviews, who are actively involved in policing those crimes under analysis and represent the typical audience of the RTM results. In the words of Green (2008) above, it could not get closer to the 'actual circumstances of practice'.

3.2 Understanding Risk Terrain Modelling

The research is looking to determine the risk factors which contribute to the locations of county lines cuckooing and hare coursing incidents within Lincolnshire. Both offences can be considered as instrumental offences- those committed for profit or gain by a motivated offender (Felson, 1987). These offences are more likely to be planned (Miethe & Drass, 1999) and due to the nature of the offences will involve travel into or across Lincolnshire.

The discrete choice model can be used to explain how individuals choose between two or more discrete options and was developed in the field of travel demand and has several concepts pertinent for modelling rural crime. Offenders committing rural crime, are, by necessity of limited opportunity going to have to travel to commit offences. In addition, discrete choice has origins in ecology and combines elements of rational choice theory (Bernasco, 2010), whilst allowing offenders to make sometimes impulsive choices. From the perspective of the offender, choices need to be made, known as the spatial decision tree (Bernasco, 2010). An area is chosen from which a neighbourhood is selected, then a street and finally the property to target. In terms of developing, and understanding rural crime, this offers a different perspective with offender decisions taking priority. Owing to the implications of geographic permeability due to the road network (Boivin & D'Elia, 2017), offender awareness space (Brantingham & Brantingham, 1981), routine activity (Cohen & Felson, 1979) and effort versus reward (Clarke & Felson, 1993) all contributing to target selection, the discrete choice framework offers a viable method to understand offender choices. These concepts are discussed in chapter four.

The discrete choice framework raises key questions for consideration in a risk terrain analysis. What factors make this area or town more favourable? What are the opportunities that this area has to offer? Where are the best opportunities located? How accessible are these opportunities? How profitable are these opportunities? Which opportunity is likely to result in success? Risk terrain modelling (RTM) brings together the data to enable these questions to be answered. It

examines the environmental backcloth, the physical elements of the environment, socio-economic and cultural influences and how people interact and move within it (Drawve et al., 2016: Moreto et al., 2014). These multifactored considerations are akin to the interconnected theories associated with rural and community crime and the RTM 'offers a probabilistic interpretation to crime analysis' designed with the 'replicability' by analysts using commonly available tools to enhance decision making at tactical and strategic levels' (Caplan et al., 2011:364 & 366).

Utilising environmental criminology, RTM identifies aspects of space and human social interaction which can impact on the opportunity for crime to occur and the principle that crime is a function of 'dynamic interaction between the social, physical, and behavioural factors that occur at places' (Piza et al., 2010:1). It identifies those with the most influence on the likelihood of a crime occurring and operationalises them as risk. RTM includes the negative influence of crime generators, but also the impact security measures, and guardianship, can have in reducing the likelihood of offences (Moreto, 2010:3).

Risk terrain modelling has been used in variety of research contexts. The military have used a type of risk terrain analysis for over thirty years in the form of intelligence preparation for the battlefield (Glinton et al., 2004). This process involves defining the battlefield, describing the battlefield effects such as terrain, weather, and local alliances, then developing a combined obstacle overlay. This overlay is merged with areas identified as defensible terrain, avenues of approach and engagement areas before evaluating the threat. Risk terrain modelling in the policing context refers to the process of attributing real-world qualities to places within a terrain, and then combining these terrains (Caplan, 2011) resulting in a map representing the compounded risk.

Marchment and Gill (2021) highlighted the rapid growth of knowledge occurring in the last five years of RTM as a spatial modelling technique for law enforcement. Burglary (Andresen &

Hodgkinson, 2018; Dugato et al., 2018; Gale, 2013; Moreto, 2010; Vildosola et al., 2019), robbery (Barnum et al., 2017; Caplan et al., 2017), violent crime (Anyinam, 2015; Caplan et al., 2011; Connealy, 2020; Drawve et al., 2016; Gimenez-Santana et al., 2018; Szkola et al., 2021), drug markets (Escudero & Ramirez, 2018), marijuana cultivation (Richardson, 2019), homeless victims and offenders (Yoo & Wheeler, 2019) and child abuse victimisation (Daley et al., 2016) have all been the focus of RTM analysis. The results of Marchment and Gill's (2021) systematic review confirmed the predictive capabilities of RTM and noted two studies related to drug crime in Columbia and Canada. The extant literature has been focused on urban environments within the United States.

Successful intelligence crime analysis requires the evaluation and interpretation of the results to anticipate risk and influence action (Ratcliffe, 2010). Research has shown that RTM not only identifies areas of increased risk but also identified specific locations and land use features for targeting action. Caplan (2011) found 14% of shootings concentrated in only 1% of the analysed area: Yoo and Wheeler (2019) found that 68% of homeless related crime in Los Angeles was in only 4% of the city. Gerell (2018) used what he described as a crude form of risk terrain modelling to investigate violence in relation to bus stops in Malmo city, with 73% of violent crimes being identified within the areas identified as high or medium risk, 12% of the area analysed.

Garnier et al. (2018:4) found that risk terrain analysis identified 'eleven land use features that have a criminogenic spatial influence on robberies' in Newark, New Jersey. But they also identified the potential for the model's predictability to be improved using a combination model of risk terrain analysis with recent previous offences. Likewise, Sieveneck & Sutter (2021) used predictive policing techniques to identify places at risk to road traffic collisions. They found that a combination of risk terrain modelling and hotspot analysis produced the best predictive results. Both examples support the work around risky facilities which acknowledges some facilities are more vulnerable to crime, but prior exposure contributes to the heightened risk (Steinman et al., 2021), with the RTM focused on aspects of vulnerability and hotspots on exposure. The results of

Marchment and Gill (2021) confirmed that there was an increase in predictive strength and practical utility when RTM is used in conjunction with other spatial analysis such as crime hotspot analysis.

The theoretical notion behind the RTM model is the concept of risk, which is described as a function of threat, vulnerability, and consequences (Barnum et al., 2017; Drawve et al., 2019; Kennedy & Caplan, 2012). The concept of risk is understood in the policing environment and used to prioritise resources. Kennedy & Caplan (2012) developed the theory of risky places which expresses that all places are at risk to crime, but some are at a greater risk. High levels of vulnerability with limited exposure to crime have a low risk. When criminogenic features overlap vulnerability increases and crime emerges at locations of high vulnerability and high levels of exposure to crime.

The aim of analysis is to provide information which is meaningful and actionable. Police action can be seen in terms of the 4P's- prevent, protect, pursue, and prepare. Risk terrain analysis provides a mechanism to understand not only the where, but also the why. It can show the locations where resources or interventions could be most effective in the prevention and pursuing of crime and criminals. Perhaps more importantly, it can also inform on the aspects which make areas vulnerable and the factors which need to be addressed to prevent crime or protect locations from criminal activities. Caplan et al. (2020:115) purport that RTM provides that 'viable method for analysts to define target areas for resource allocation and intervention'. This is supported by Gerell's (2018) assessment that it provides a strong focus on visualisation and usability giving it greater potential for practical adoption outside of academia. Marchment and Gill (2021:11) support this in their statement that the approach is 'within the reach of many operational crime analysts in practical law enforcement settings'.

Caplan et al. (2015) identify the following ten steps to completing RTM, and the research emulates this model.

‘1. Select an outcome event.

2. Choose a study area.

3. Choose a time period.

4. Obtain base maps.

5. Identify all possible base maps.

6. Select the model factors.

7. Map spatial influence.

8. Weight risk map layers.

9. Combine risk map layers.

10. Communicate meaningful information’ (Caplan et al., 2015:9)

Risk factors were generated from a combination of hypotheses stemming from the literature review and analysis of the sociological and topological aspects of the crime locations. Although not part of this study, the additional value of the method is that it becomes a cyclical process. Once the risk factors have been determined and translated into meaningful actionable intelligence for decision makers, it can be used to assess whether measures implemented in response to the analysis have been successful. If measures are carried out to mitigate selected risks, and the subsequent analysis shows no change in risk factors then it can be determined that the intervention was not successful and can be further investigated to understand why.

The RTM modelling process uses regression analysis to identify those influencing factors which are significant in the distribution of rural crime. Tobler’s Law- everything relates to everything, but closer things more so (Kennedy & Caplan, 2012) manifest itself within the analysis as spatial correlation. The variables which are influencing the location of offences may lack independence. The type of closeness maybe a physical closeness within the underlying topography or due to

other social influences. The spatial structure or weighting to be used is added to the regression model, and different variables may require different spatial weighting.

The variables included are based on a proximity or density calculation. For some variables a level of aggregation was needed. Careful consideration was necessary as data aggregation can change the outcome of the analysis (Fotheringham & Wong, 1991; Openshaw, 1977) because of ecological fallacy (Weisburd et al. 2009) caused by modified areal unit problem (MAUP)(Dark & Bram, 2007). MAUP occurs when spatial point data are aggregated into areas of different shapes and sizes. The changes in size and or shape influence the quantity and characteristics of the data within those areas, which subsequently reflect different characteristics of the data.

3.3 Assessing The Validity Of The Models

The modelling process used subsequent years' data to generate and then test the models and was repeated twice for both county lines cuckooing and hare coursing. This allowed models to be created for 2019 and 2020 which were tested for accuracy against actual incidents in 2020 and 2021 respectively. The value of this was that the accuracy of the model was assessed, before being presented to officers for discussion, and negates the arguments often presented against hotspot analysis, that if criminal activity has reduced the hotspot was wrong.

The appropriateness of the models for both county lines and hare coursing was assessed using the Predictive Accuracy Index, (PAI) (Chainey et al., 2008) which was calculated for each of the models using the formula:

PAI=Hit Rate / Percentage area

where hit rate is the number of events in the high-risk area/ total events in the district * 100,

and percentage area is the area of high risk / total area of the district * 100.

When calculating the area of risk and total area, only the areas which could be subjected to an offence was considered. For example, when calculating the total area for county lines this was the total area of residential properties, not all properties within Lincoln. This helped to minimize problems arising from MAUP, research degrees of freedom and erroneously concluding superior success of a model (Drawve & Wooditch 2019:44).

Models were generated for 2020 and 2021, both using data from the preceding years. All models, both manual and RTMdx analysis were opened in the QGIS software and the offence data for 2020 and 2021 added for county lines and hare coursing. Utilising the QGIS filter and basic statistics functions the values required to complete the PAI calculations were obtained and added to an Excel table. These were then used to generate the PAI for all the models for 2020 and 2021

and show how data mapped from one year was able to predict the following years incident locations.

3.4 Assessing The Perceived Value Of The Analysis

The value of risk terrain models is not just in their ability to accurately predict the locations of increased risk of future offences, but also in providing actionable intelligence which police officers and managers can utilise to reduce the risk of offences occurring. As part of the 4P plan process to protect, prevent, pursue, and prepare, this research assumes that a model which can inform this process will have a greater value than one which informs on only those locations to protect or prevent crimes. However, the research is concerned with the validity of the RTM analysis for Lincolnshire. To this end, the opinions of officers working for Lincolnshire Police on the information it provides, and their perception of its reliability and value is of equal importance to whether accurate areas of risk are identified. If officers do not accept the results, the success or otherwise of the analysis to identify areas at increased risk is irrelevant.

To address the important factors identified for successful research and improved receptivity to translating the results into action, the views of officers within Lincolnshire were obtained. The research is focused on producing actionable analysis on county line criminality and hare coursing. Hunter et al. (2019) and Heyer (2022) agree that the incorporation of officer knowledge on these offences will not only enrich the model, but also increase the likely acceptance of the analysis. In addition, the analysis will require presentation to, and interpretation by Lincolnshire officers for appropriate action to be determined, so establishing opinions to analysis and analytical products of officers in the context to which the research aims to be utilised will be of equal importance to the generation of models that work.

3.4.1 Insider research

This research, as part of a professional doctorate brings a requirement to 'focus on integrating academic and practical knowledge' (Coghlan, 2007:335) and steers towards insider action research, whereby myself, as the researcher, is already emersed through over twenty years as an employee of a police force. Through second person enquiry with police officer colleagues within

the organisation, the research aims to generate knowledge that is actionable in both an academic and practitioner sense (Coghlan, 2007) and was part funded by the College of Policing and facilitated by Lincolnshire Police who allowed access to the relevant data and officers for interviews.

Insider research has traditionally been seen as biased (Fleming, 2018) in contrast to the outsider perspective, which asserts that 'only a neutral outsider can achieve an objective account' (Mercer, 2007:5) and this is due to the degree of detachment by the researcher from the subjects of the research. However, scholars have argued that there are benefits to being an insider researcher (Chavez, 2008; Corbin-Dwyer & Buckle, 2009; Edwards, 2002; Fleming 2018; Mercer, 2007) and that distinction and separation of the two dichotomies is flawed, being 'deceptively simple and socially fallacious' (Ademolu, 2024:345). They argue, as do Chavez (2008) and Fleming (2018), that there is a sliding scale from outsider to insider and that the location of the researcher on that scale can vary throughout the research process.

What is clear is that as an insider to the police force in which I am conducting interviews with officers, I will, to varying degrees have different challenges and opportunities based on my prior relationships with the participating officers and general familiarity with the research setting. Hockey (1993 cited in Mercer, 2007) and Fleming (2018) purport that insider status may influence the whole research process, and within this research has certainly been a factor. Brannick & Coghlan (2007 cited in Fleming, 2018) state that bringing pre-understanding to a research design is an advantage and (in this research) is evidenced in the selection of the structured interview as opposed to the use of a survey, which was determined from my own insider knowledge of the negative reaction and perception of officer colleagues to prior anonymous surveys.

In addition, the initial selection of candidates was biased towards those perceived to have the requisite experience and knowledge of the research areas and be amenable to participating. The selection of officers and the interview process is described in chapter 7.5. This selection of officers

resulted in participants with whom I had a prior working relationship. This brought with it the complication of preconceptions I had used in the selection process but also those that the participants possessed in relation to myself, as a colleague, analyst and then researcher. For those officers with whom I had no prior contact, these preconceptions would have been lacking, but instead necessitated the requirement to quickly build trust and rapport (Edwards, 2002). In these cases, the requirement to explain my position in the organisation as both employee and researcher was required to establish credibility and trust. Mercer (2007) states it is unclear whether the presence of a prior relationship between researcher and participants is more susceptible to this informer bias. Ademolu agrees that shared commonalities do not 'provide an intuitive interpersonal bias any more than it does for one without mutual researcher/researched reciprocity' (Ademolu, 2024:350).

Scale of familiarity and different levels of preconceptions, trust and rapport would be expected for each participant and each interview. Prior relationships would expect to provide more acceptance by participants who provide greater depth and openness (Corbin-Dwyer & Buckle, 2009), but equally others fearful of the consequences of being too open, are more candid with an outsider (Mercer, 2007). Power relations are also likely to play a part, but to what extent this is difficult to determine. On one hand as a civilian member of staff the power relations would be seen to be in the favour of the officers, especially when these are officers of rank, and who I could be expected to provide analysis for in the future. Conversely, as an analyst, and with the research focused on analytical techniques and the use of analysis, the power balance may tip towards myself as researcher. Just as in the insider/outsider relationship, this power balance is on a sliding scale, a shifting balance depending on the topic, prior relationships, and knowledge of the subject currently under discussion.

Coghlan argues that 'any form of research in an organisation has its political dynamics' (Coghlan, 2007:340), and that insider researchers need to utilise their pre-understanding of organisational politics and power structures. In this research, this would be around the mechanics of the tactical

processes, resource allocation, general political climate in relation to resource availability and prioritisation, crime processing and analysis. My insider position gives me the advantage of common terminology, past successes and failures and organisational restructures that may be reflected in the attitudes and opinions of participants understanding of why, and how, things are done (Edwards, 2002). Conversely, I will need to be cautious that my familiarity with local situations and or relationships with some officers do not preclude the identification of important and relevant findings because I see them as 'familiar' and therefore undervalue their contribution to the research (Chavez, 2008; Edwards, 2002; Mercer, 2007). An advantage identified by Fleming (2018), which also pertains to this study, is that as the research forms part of a doctoral study there will be discussions of the findings with a university supervisor whose perspective, opinions and view will be more akin to the outsider. Thus, what is 'familiar' to me as the researcher will be unfamiliar to the supervisor.

As already discussed, being an insider or an outsider should be seen on a sliding scale, changing dependent on the subject and persons involved. I will be an outsider in terms of officers, their skill sets, training, background, and challenges; but my insider status as an employee should facilitate the interpretation of situational contexts, local language conventions and terminology such that officer responses are less likely to be misunderstood (Fleming, 2018).

The nature of the research question in determining if risk terrain modelling is a viable and practical analytical technique accepted by police officers working for Lincolnshire Police, and my role as an analyst within the Force results in my involvement as an insider researcher to some lesser or greater extent. As academics have shown this should be viewed as neither advantageous or disadvantageous but requires a mindfulness of the insider/outsider continuum which is 'fluid, variable, factor into, and complicate the research process' (Ademolu, 2024:362) through bias, preunderstanding, preconceptions, power and positional relationships, trust, and rigor.

3.4.2 Officer interviews

Whilst working for Lincolnshire Police, colleagues and I have been presented with surveys on different aspects of working life including health and well-being and the implementation of new systems. Over the last twenty years I have experienced officers frequently voicing opinions on the perceived waste of time that these represent, and suspicion on the lack of anonymity that the so-called anonymous surveys provide. These negative attitudes towards surveys and the nature of the topic, which my perception is, could be seen by some as emphasising a lack of knowledge or being remiss in some way, would not provide reliable and representative results. In addition, the closed nature of questions within a questionnaire would not allow the development of in-depth understanding of the attitudes and requirements of officers to commissioning and utilising analysis.

The alternative approach of semi-structured interviews opens the possibility of focusing on those issues which are meaningful to the participants (Kallio et al., 2016), by gaining similar information without the restriction of a specific response from interviewees. It would be expected that each participant would have different knowledge and understanding regarding analytical techniques, analysis and the two crime types of hare coursing and county lines drug dealing. The semi-structured approach allows a reciprocity, allowing further questions based on the responses provided. It is particularly useful for the collection of more in-depth information on thoughts, experiences, and opinions (Easwaramoorthy & Zarinpoush, 2006) and used to gain a better understanding by exploring meaning and perceptions (DiCicco-Bloom & Crabtree, 2006).

My position in the organisation and pre-existing professional relationships with some of the interview participants brings with it the acknowledgement that the interviews will not be wholly objective (Fontana & Frey, 2000). The importance of reflexivity on my part as interviewer is essential (DiCicco-Bloom & Crabtree, 2006) in understanding the power balance between myself and officers of different rank and my experience of analysis compared to the interviewee.

Awareness of potential bias in interpretation of responses based on preconceived interactions or perceptions should be minimised and acknowledged (Whiting, 2008). In addition to being reflexive, the production of an interview guide will provide a focused structure to illicit similar types of information from all participants. It will contribute to the confirmability via objectivity and dependability through repeatability of the qualitative interview process and ultimately the trustworthiness of the method (Kallio et al., 2006).

During my time working for Lincolnshire Police as an analyst in the divisional intelligence unit I have worked with and for a wide range of police officers of differing ranks. Officers were initially identified based on their role within the organisation as likely to have experience of using analytical products and of at least one of the crime types to be analysed and is in keeping with the pragmatist epistemology. From this perspective I approached officers, in person where possible, to introduce the idea of becoming involved in the research. This was followed up by providing written information regarding the purpose of the research, details of what would be expected of the participants and consent forms for both participation and use of quotes.

Not all officers felt that they had the relevant experience to provide useful insights, and when this was the case suggested other officers to approach who they believed could provide meaningful perspectives. These officers were subsequently contacted via e-mail including the written information and were asked to respond with the completed consent forms if they wished to be involved, or to contact myself via telephone or e-mail for further information.

Two interview stages were planned, each with a separate interview guide. The first phase focused on learning about the existing knowledge and perceptions of analysis officers have and their understanding of the crime types. Prior to each interview the process was explained to the officers and consent forms signed. Each stage of interviews was conducted over several weeks due to the availability and work patterns of officers.

The second phase focused on officer reactions to the risk terrain analysis. When and where feasible the officers involved in the first set of interviews were interviewed again, and when this was not feasible additional officers were approached. When required, this was based on my perceived knowledge, that they had, of either hare coursing or county lines. I felt this would help to illicit informed opinions on the model as providing useful and practical information for operational use. The interviews took place in person with a Teams meeting running in the background to record and transcribe the interviews.

The next three chapters focus on understanding risk terrain analysis and the production of the models for county lines and hare coursing. These are followed in Chapter 7 with a literature review on police culture, analysis, and research, before details of the interviews and the subsequent analysis can be found in sections 7.5 and 7.6.

3.5 Methodology Overview

As already referred to in section 3.2 this research aims to emulate the ten-step model (Caplan et al., 2015) to completing the risk terrain analysis whilst integrating an alternative manual approach to the analysis obtained using the RTMdx software and incorporating police officer knowledge into the models. Ultimately, understanding the value as an analytical tool in its own right, and as determined by police officers who would be the end users is the aim of the research consequently leading to the inclusion of officer opinions within both the modelling process and the assessment of the model's success. The remainder of this chapter will explain how the process was followed, in a broad sense, with the specific methods employed detailed in chapters five and six.

3.5.1 Steps 1 to 3: what, when and where

Steps one to three require an outcome event to be selected, a relevant study area and a time period for the analysis. The research uses two different outcome events- hare coursing and cuckooing of properties to look at the differences if any, in the applicability and validity of the RTM analysis of the two outcomes and the officer opinions. Cuckooing is a relatively new issue, whereas hare coursing has been a long established, more traditional problem for policing. Cuckooing takes place in residential areas as opposed to open countryside which is subjected to hare coursing. These two contrasting circumstances will influence the knowledge that officers may have of the problem, the importance of the problem and how the issues can be tackled which could affect their assessment of the effectiveness of the analysis.

Urban policing will lead to a level of familiarity, as officers attend a range of incidents and visit witnesses, suspects and victims in residential areas, revisiting and travelling through housing estates on multiple occasions. For officers policing hare coursing the vast area covered would typically mean they visit the same area sporadically, as incidents, victims, witnesses and suspects in rural areas are more sparsely distributed. Thus, the opportunity to understand an area and its

resident population will be limited in comparison to their city counterparts, and consequently an officer's geographical knowledge cannot be sufficient to understand all areas which could be subject of a hare coursing incident.

As the crime types varied in their geographic spread, county lines cuckooing was focused on Lincoln city, the area with the greatest number of identified victims for the analysed period, and the only city or town with sufficient locations to run the model. Hare coursing has a far greater number of recorded incidents dispersed across the county. The county has a diverse topography and to understand the impact that this could have on the modelling process several risk terrain analyses were conducted using the RTMdx and manual methods. Analysis was conducted on the county as a whole before being split into three areas comprising of East and West Lindsey, North and South Kesteven and Boston and South Holland and the analysis generated for these. Finally, analysis was run separately for the two districts with the greatest number of incidents, which were Boston and South Holland.

The analyses were conducted and assessed using data spanning from 2018 to 2021. As hare coursing is seasonal the period used for modelling the hare coursing covered September to April. The initial models were produced using data from 2018-2019 (hare coursing) and 2019 (county lines). The predictive accuracy of the model was tested against the locations of recorded incidents for 2019-2020 and 2021 respectively. The process was repeated using data from 2019-2020 (hare coursing) and 2020 (county lines) with the 2020-2021 and 2021 data used to assess the predictive accuracy of the second set of models.

A summary of steps one to three is shown in table one.

Table 1: Risk terrain modelling- steps one to three.

Step	Outcome 1	Outcome 2
1. Select an outcome event	County lines cuckooing of residential properties	Hare coursing
2. Choose a study area	Lincolnshire focused on Lincoln	Lincolnshire county Three sub areas of East & West Lindsey; North and South Kesteven; Boston and South Holland Individual districts of Boston and South Holland.
3. Choose a time period	2019, 2020, 2021	September to April, 2018-19, 2019-20 and 2020-2021

3.5.2 Steps four and five: select and obtain base maps

Steps four and five relate to determining the GIS data sources and maps used for the analysis and obtaining these. County lines cuckooing outcomes required a base map of Lincoln city, and as cuckooing can only occur in residential properties these needed to be separated out from other types of buildings. Hare coursing required a county wide base map, then one for each of the six districts. Hare coursing occurs in fields and so a separate base map of fields was required for the county and subsequently the districts. Other maps were required to model the risk factors, and these were determined once the potential risk factors had been identified. In general, the maps used were Ordnance Survey maps and the specific maps utilised are detailed in the sections 5.2 and 6.2 for cuckooing and hare coursing respectively.

3.5.3 Step six: select the model factors

Selecting the potential model risk factors is an important area of the modelling and analysis process which requires an understanding of the general geography of an area and the 'outcome' event. If there is limited understanding of the geography, or how an outcome is facilitated then it

is possible that the analysis would be flawed by failing to include as a potential risk factor something which could be a significant factor in identifying future areas of risk.

To ensure that all appropriate and relevant risk factors are identified three sources of knowledge will be utilised. The first is the analyst's own professional knowledge and understanding of the issue and geography obtained from crime pattern analysis and comparative analysis of incidents. The second is existing academic and theoretical knowledge on the crime outcomes and criminological theory regarding the commissioning and the geographical distribution of incidents, obtained via literature reviews including rural criminology (chapter four), county lines drug dealing and cuckooing (chapter five) and hare coursing (chapter six).

The third area, officer knowledge, is important for two reasons. Firstly, it provides a practical experienced context to understanding the outcomes of the analysis and what might be influencing the distribution, that is specific to a local area or region. The practical aspect of attending scenes and dealing with suspects and offenders gives a perspective that is unlikely to be seen as an analyst or obtained from prior academic or theoretical reports. The second reason for the inclusion of officer opinion is to engage with those who it is hoped will utilise the results of the research. Engagement with officers, valuing their opinions and testing their viewpoint allows them the opportunity to be collaborators and partners in the research. The benefits of including officers are expected to be seen through a decrease in suspicion and increased understanding of the research, the process, limitations and results. The invested interest of the officer(s) as a collaborator should lead to greater use of the analysis (Hunter et al., 2019; Lum et al., 2012; Tilley & Laycock, 2017). To obtain information regarding the two outcomes, hare coursing and cuckooing, officers with experience of these crimes and incidents were interviewed prior to the modelling as described in chapter seven.

On completion of the literature review and officer interviews the information was analysed for potential risk factors for each event outcome. Table three shows a list of those potential risk

factors identified from officer interviews and the literature review which may influence which property is cuckooed alongside how they may be represented in the modelling process. Table 23 lists the potential risk factors identified from the literature review on hare coursing habitat and food sources whilst table 24 lists the risk factors identified by officers with experience of policing hare coursing. Once these potential risk factors have been determined, these are translated into a geographical risk factor for testing by obtaining or creating separate maps for each of the risk factors. An example is the potential increase in risk flat fields have to an outcome of hare coursing. Contour maps are used to determine which fields are flat and which are not. Once a map of flat fields is obtained this is used within the modelling process. Details of risk factors and maps used can be found in chapters five and six.

3.5.4 Steps seven, eight and nine: modelling the risk

Steps seven, eight and nine are different when considering a manual approach or utilising the specifically designed RTMdx software (Simsi.com). Step seven is to determine the spatial influence, step eight to weight the risk map layers and step nine is to combine the layers into the final risk terrain map and the Simsi software completes these three steps automatically following the uploading of geolocated files for the event outcomes, base map and risk factors. The analyst can select the parameters and distances to test the model with and typically within minutes a risk terrain model is produced showing those areas at significantly increased risk. The output generated also includes the weighting of each risk factor.

In the manual model the process takes considerably longer, although both use an iterative process for determining if one risk factor is likely to be geographically influencing the location of event outcomes. Proximity and buffer calculations are used to identify when a risk factor is contributing, and the predictive accuracy index was used to distinguish between potential risk factors for the manual models. Statistical tests were also used to determine if there were significant differences in the number of outcomes based on certain characteristics. Once

individual risk factors had been established these were combined, and again assessed as to whether combining risk factors increased the predictive accuracy of the models. Finally, the risk factors were combined and mapped to show those areas determined to be of greatest risk to future outcomes. This process of combining the layers considers the combination of vulnerability from the modelling and exposure through prior victimisation. The individual processes used for county lines cuckooing and hare coursing are detailed in chapters five and six respectively.

3.5.5 Step ten: communicate meaningful information

One of the most important parts of an analyst's role is to communicate meaningful information in the form of actionable intelligence to those officers who are in positions to act on it. When meaningful information has been identified, finding the most appropriate method of communicating can facilitate the translation of information to understanding and subsequent action. If, and when, the risk terrain modelling identified significant areas of future risk to county lines cuckooing or hare coursing this needed to be presented to officers. The RTMdx model results were shown directly to officers, and the results were also exported into QGIS and using my professional experience annotated maps were generated to show the results with and without the risk factors and relative risk values displayed. Manual models were also presented using QGIS and shown to officers.

The mapped results were provided to officers during the second phase of interviews and facilitated discussion on the analysis, results and presentation. This second phase of interviews was to ascertain whether they sufficiently conveyed the results to officers, they understood the model results and whether they have confidence in the analysis to see how they could act on the information contained within them. The different analytical models also aimed to draw out opinions on whether the officers' preferred models that were purely based on analytical expertise or a computer-generated model. The interview process, results and analysis are discussed in chapter seven.

3.5.6 The analyst becoming a 'pracademic'

Risk terrain modelling has been identified for use by and is used by analysts working in real policing environments. It is promoted in academic literature as requiring minimal training by the analyst but can make important and significant contributions to identifying areas at risk. In UK policing there is little available funding for training of analysts, but there is momentum around the promotion of pracademics, upskilling those within a police force to carry out research within their own organisation to further understand, generate and use evidence-based policing. Taking a pragmatic approach to research in terms of the use of available technology, such as RTMdx and using officer and analytical experience to generate models of risk for crime problems is a commonsense approach to growing the idea and skills of pracademics within police forces.

Integrating the assessment of the risk terrain analysis for different crime types following the ten-step approach with the officer's knowledge and experience enables the research to answer the question of whether it is a viable technique in untested geographical areas and crime types, and whether it can provide a practical solution to understanding and prioritising riskier locations which officers both accept and value.

4 Risk Terrain Analysis Literature Review

4.1 Fundamental Theoretical Concepts Used Within Risk Terrain Analysis (RTM)

Crime opportunities are impacted by the 'dynamic interaction between the social, physical and behavioural factors that occur at places' (Piza et al., 2010:1). Risk terrain analysis (RTM) identifies aspects of topography, the built environment and human interaction, through environmental criminology which are manifest in locations of greater risk to crime. The following summarises key aspects of environmental criminology relevant to developing risk factors for consideration in the risk terrain analysis.

Routine activities (Cohen & Felson, 1979) are those carried out regularly by everyone for criminal and legitimate reasons, such as commuting, leisure pursuits or domestic chores such as shopping. During these activities potential offenders become aware of potential targets, whether locations or persons. They develop an awareness of places and the routes between these locations in what Brantingham & Brantingham (1981) refer to as 'nodes' and 'pathways' which develop to form 'awareness spaces' and is the basis of crime pattern theory (CPT) (Brantingham & Brantingham, 1993 & 1995).

Rational choice (Cornish & Clarke, 1987) is the impetus to which a person may choose to take a particular route, and the internal process a potential offender undertakes when determining whether to commit an offence at a particular time and place on an identified potential target. Offenders working from the motivation of profit decide to embark on an 'exploitative' (Felson,

1987) crime and weigh the risk and effort involved against the possible profit available from a successful offence. For instrumental offences, part of this decision-making process is the search for a target. Rational choice and crime pattern theory propose that this is probable to be within a would-be offender's awareness space (Brantingham & Brantingham, 1981) and with minimal effort. This minimal effort is likely to include the choices made when travelling to a crime location (Zipf, 1949) along with travel costs and familiarity with an area (Bernasco & Kooistra, 2010: Biovin & D'Elia, 2017).

Social network analysis (SNA) has similarities with CPT. A network consists of actors/nodes and links, in the same way CPT consists of nodes and pathways. Each link is the relationship between two actors/nodes in which commodities such as information, goods or people flow. SNA can be used to analyse the structure of the nodes as a whole or partial network (Borgatti & Halgin, 2011; Burt, 1992; Wasserman & Faust, 1994). Fuhse & Mutzel (2011) identified three approaches to SNA resulting in the analysis of networks in terms of structure and position of nodes or the relationships defining the structure.

Relationships between nodes in SNA have three main concepts: centrality, cohesion and structural equivalence (Liu et al., 2017). Betweenness centrality is the frequency with which a node lies on the shortest path between nodes and is a method of identifying bridges within a network (Mintz & Schwartz, 1987; Scott, 2000). Those routes more frequently travelled- high in betweenness- are identified as having an increased risk of burglary (Davies & Johnson, 2015). Network cohesion measures the degree of interconnections among nodes and is a method of identifying sub-groups or clusters (Liu et al., 2017). This could reflect areas of travel within a confined geographic area.

When analysing the risk locations for hare coursing or property crime, developing an understanding of Lincolnshire's road and rail network, combined with identified travel patterns could provide information as to the connectivity of areas. Weak ties (Granovetter, 1973) are

significant in terms of the 'bridge' (Liu et al., 2017; Valente & Fujimoto, 2010) they provide between network clusters. Structural holes, (Kilduff & Brass, 2010; Knox et al., 2006; Labun & Wittek, 2014) or the absence of links, in this case no travel routes, may indicate an area of reduced accessibility or lower risk of offender activity.

In contrast social network analysis of personal networks, and relationships, may be of greater significance than travel networks when considering the locations vulnerable to county lines drug dealing. Social networks influence when and where people travel to and from, and why they travel (Arentze & Molin, 2013; Carrasco & Miller, 2006 & 2009), who are they travelling with, who they meet, and where they meet, influence when and how travel is conducted, and the awareness spaces of individuals and groups.

Similarity within, and of network systems, is consistent within social network literature and homophily (similarity in network systems) is one of the oldest identified social network characteristics (McPherson et al., 2001). Additionally, homogeneity is a characteristic of personal networks; people typically have contact with those like themselves which in turn reinforces their position in relation to others. In terms of drug users, Moore (1993) found a broad set of rules amongst drug users, which provide support for the notion of reinforcement. These include only buying from known dealers, use recommendations from other users, and some drugs should be taken in the company of others. This is also articulated by Pokhrel et al. (2016) as networks acting as conduits for beliefs, attitudes, and behaviours through personal interaction. Koo et al. (2008) reported that in their study of drug users, all reported knowing at least one other drug user and 61% reported over half of their associates also used drugs. This has parallels with a person more likely to smoke if they have high numbers of smokers in their social network (Pokhrel et al., 2016). They also argue that the illegal status of drug use encourages the development and maintenance of user networks.

The simplest level of homophily is space, and in line with the least effort principal purports that persons are likely to have the greatest contact with those that they are closer to geographically (McPherson et al., 2001). This has implications on when and where individuals will interact and form relationships. Combined with the expected homophily of social demographics implying similar residential and employment situations, their routine activities would likely overlap, which in turn promotes the continued bonds of friendship and trust.

The following section reviews criminological research in rural contexts to understand how these concepts have been used by researchers to explain and understand the distribution of crime. Understanding the implications of crime theory and how it could be used to understand offender behaviour, and the resultant distribution of offences will lead to more informed decisions on those aspects of risk which are likely to be relevant when identifying and selecting risk factors for the two risk terrain models.

4.2 Understanding Crime In Rural Areas

Rural areas are often perceived as a crime free and safe place to live (Little et al., 2005; Yarwood, 2001). However, Jones (1989a, 1989b), argues that crime has always been present within the countryside, but historically attributed to 'vagabonds and rootless criminals' the 'influence of the town' leading to public disorder and drunkenness or 'contested crimes; and labour or political crimes' (Smith & Byrne, 2018:67). Crime is a fluid concept (Coombes et al., 1994) and rural crime is no exception, influenced by history and politics (Yarwood & Gardner, 2000; Young, 1999). The changes in law, pertinent to the lower classes of society, have, from the 1600's been made by, and for, the benefit of the ruling elite including for example, the criminalisation of wood theft (Smith & Byrne, 2018). Theft became punishable by death, but leniency was often shown, due to an empathy with offenders, and this is likely to be the origin of the association of rural culture with snubbing authority and living by local rules (Somerville et al., 2015).

The perception of a crime free countryside (Donnermeyer, 2007; Riley, 2013; Smith, 2019) has long been perpetuated by the lack of recorded crime (Riley, 2013), an emphasis on the urban dystopia and urban crime research (Smith & Byrne, 2017). The perception of crime as an urban problem by rural residents materialise as lower levels of crime prevention due to a false sense of security (Jones & Phipps, 2012; Smith & Byrne, 2017). This consequently increases the vulnerability of such areas by making them attractive targets (Yarwood, 2001). However, not all rural areas are equally affected (Ceccato, 2015) and understanding of the spatial patterns of rural crime can help to identify what constitutes rural crime risk. Smith & Byrne (2017) identified that an increase in farm crime led to a discussion on the value of environmental criminology in understanding and explaining victimisation, moving forward from the position of twenty years earlier when it had yet to be applied in rural areas (Bottoms & Wiles, 1997).

Rural crime is not typically national news, but the extent to which rural communities are affected is a growing and costly issue for those police forces who have such a responsibility, and those who

become or fear becoming victims. The policing of rural crime has been affected by the public and political concerns of the UK Government, and it was acknowledged in the Rural White Paper (Department of the Environment Transport and the Regions, 2000) which allocated funding specifically for rural policing from the Police Modernisation Fund (LGA, 2000). The public response to Tony Martin shooting dead a burglar at his remote farm, further added to the pressure on the UK government to tackle rural crime (Morris, 2001; Yarwood, 2001), and the Rural Policing Fund to increase visibility and accessibility to police (Aust & Simmons, 2002) continued until 2006.

The introduction and promotion of partnership and community policing at the end of the 20th Century put the emphasis on citizens and the community for solving crime problems (Jones & Phipps, 2012; Yarwood, 2010). With the move to risk-based strategies and the implementation of the intelligence led National Intelligence Model (NIM) rural crime issues became relegated as they failed to meet a 'nationally defined crime problem benchmark' (Jones & Phipps, 2012:9). Thus, despite the emphasis on the need to tackle rural crime, the requirements of NIM meant resource prioritisation typically went to those areas of highest demand or risk (Case, 2019c; Jones & Phipps, 2012; Smith, 2010; Smith & Byrne, 2017; Yarwood, 2007).

Understanding rural crime often involves a protracted investigation and analysis. Offences may be separated in time and by many miles, making the association between linked offences more difficult (Smith, 2010). This could be compounded by the offence location being within different policing districts or even different police force areas. Developing intelligence on offenders who may commit multiple crimes, but only sporadically visit a particular force district becomes almost impossible. The importance of technology such as automatic number plate recognition (ANPR) to determine when vehicles are in an area maybe the only potential clue to those involved. These difficulties all combine to limit the extent to which rural crime features as a priority under an intelligence led policing model.

In what Smith & Somerville (2013:350) describe as one of the 'contradictions that plague British policing' the push for neighbourhood and community policing in urban areas was matched by the demise of rural policing and the rural 'bobby' (Smith & Somerville, 2013), a way of policing seen as the 'very embodiment of community policing' (Weisheit et al., 1994:554). Consequently, rural areas saw the closure of police stations, and the withdrawal of officers justified under the intelligence led policing model (Yarwood, 2010) and linked to performance management (McLaughlin, 2008; Smith & Somerville, 2013; Waddington & Neyroud, 2008), to increase efficacy (Carter, 2016; Fielding & Innes, 2006; Keay & Kirby, 2018) and as part of the reduction in police budgets (Smith & Somerville, 2013). 'Since 2000, approximately 1,017 police stations have been closed in the UK' (Smith et al., 2012;2) and with '1 police officer for 1,037 people in rural areas in 2011-2012, compared with 581 people in urban areas (Smith & Somerville, 2013:352) it should be no surprise that farmers were reporting minimal contact with the police (Holmes & Jones, 2017) and villagers thought police visibility could be improved (Yarwood, 2010; Yarwood & Gardner, 2000).

Unsurprisingly, concerns continued and specific reference to the policing of rural areas is made in the 2017 Rural White Paper Action Plan (Department of Agriculture and Rural Development, 2017). In 2018 the National Rural Crime Survey (NRCS) found that 69% of farmers and rural specific businesses had been a victim of crime in the last twelve months. The NRCS has evidenced the under reporting of crime, with 27% of victims stating they did not report their crime to police in 2015. Reasons given for underreporting included difficulties with the 101 system, but more significantly was the fear and intimidation farming communities felt from offenders (Durham, 2023). Underreporting increased in 2018 by a third for residents and two thirds for rural businesses. In a survey reported by Farmers Weekly, 82% of respondents believed rural crime had increased in the last year and 78% were concerned about becoming a victim (Case, 2019a). Common complaints were the large areas covered by officers in rural areas and a lack of visible police presence (Case, 2019a). Similar themes were seen in the NRCN (2018) research which

identified that confidence in policing was low. Only 27% of survey respondents agreeing that the police did a good job. Over two-thirds of farmers and rural business owners identified as being a victim in the last twelve months. Non reporting of crime by this group was up by two thirds since the last survey in 2015 and they believe that they are being specifically targeted by organised criminals (NRCN, 2018). Organised and semi-organised rural and agricultural crime has been receiving increasing recognition over the last ten years (Jones & Phipps, 2012; Smith, 2010; Smith & McElwee, 2015; Smith et al., 2012).

The surveys highlight that very little has changed over the last twenty-years in the way rural policing is able to meet the challenges of solving and preventing crime or building confidence and reassurance in the service provided. The Association of Police & Crime Commissioners and the National Police Chief's Councils (2016) published *Policing Vision 2025*. The report laid out the continued focus on prevention and vulnerability, and effective risk management, through a service focused on local policing (Sellick, 2017). However, both operational and policy challenges remain for rural policing (Nurse, 2014) with many areas too big for effective policing (Barclay & Donnermeyer, 2002) and which criminals can capitalise on (Smith, 2010).

The NRCN made several recommendations, including a change to the way rural areas are policed, increase understanding of rural crime and the impact of rural crime, and to help rural residents and businesses to prevent crime (NRCN, 2018). Morris et al. (2019:5) summed up the need for better reporting and robust statistics to 'support evidence-based policing' if government and private organisations were to tackle rural and farm crime successfully. This research project aims to develop knowledge and understanding, and begin to build an evidence-base on two crimes' impact on rural areas and communities in Lincolnshire.

4.3 Crime Theory And Agriculture And Rural Research

Yarwood (2001) suggests that the study of rural crime patterns would be a sensible position to start in the study of rural crime. Rural crime consists of several crime types and to lump all crime together for analysis will miss the specific risk factors at work. For example, Barclay and Donnermeyer (2011) used crime pattern theory to explore the interactions of social and physical environments of Australian farms. Their literature review highlighted that there was merit in pursuing this framework, but, that different studies had produced varying results. They found that farm crime and security was 'highly situational' (Barclay & Donnermeyer, 2011:14) with farm building visibility associated with less thefts, but not so for the theft of stock.

Situational aspects of visibility and accessibility for Australian farms are different to those situational conditions that effect crime in American and Great Britain. A key aspect of this is the extent to which a property maybe isolated or accessible in Great Britain compared to Australia. The most recent Agricultural Census for Australia (Australian Bureau of Statistics, 2018) identified the average farm size was 4,331 hectares. This compares to 101 hectares in the East Midlands and 85 hectares for England in 2021 (Department for Environment, Food and Rural Affairs, 2022b). The average farm size in the USA in 2020 was 445 acres, (NASS, 2022). Again at 180 hectares (445 acres), the USA average farm size is double that of the average English farm. The accessibility of an average farm in the East Midlands would be expected to be somewhat easier than that of the typical American or Australian farm.

Therefore, although the research results of Barclay & Donnermeyer (2011) are relevant for theory application, in determining risk of crime within the thesis research, the specific relationships identified should be considered with caution. This agrees with the assertion made by Smith & Byrne (2017) that agricultural research is not transferable across countries due to differences in agricultural processes and topological and geographical variations.

Shaw & McKay (1942) of the Chicago School of Criminology developed the long-standing social disorganisation theory based on their findings that delinquency rates were highest in the most deprived areas of Chicago and declined the further the distance out into the affluent suburbs. This allowed them to conclude that delinquency was a consequence of sociological factors, and in those deprived areas where community organisation and ingrained values where lacking, delinquency thrived. In contrast those areas where social organisation existed to guide and monitor the youthful population the opposite occurred. Since the introduction of social disorganisation theory, criminological research has had an urban bias: A consequence of the theory was the belief in a crime free rural (Smith & Byrne, 2018). This has been cited by Donnermeyer (2015) as one of the reasons rural criminology has been ignored for many decades or utilised rural areas to exemplify the lack of crime (Donnermeyer & DeKeseredy, 2008; Scott & Hogg, 2015).

Pertinent to social disorganisation theory are the effects poverty, ethnicity, residential stability and family disruption have on members of a community, and the community's ability to work together for a common good. A diverse ethnic population is viewed as a negative contributor towards community cohesion. The differing beliefs and cultural expectations between ethnic groups can be seen as divisive. Residential instability leads to constant changes in the community and long-term relationships are not developed, residents fail to develop a sense of belonging or a protective bond to their neighbourhood.

Researchers previously perceived that a crime increase in rural areas was due to the loss of the 'gemeinschaft' character (Donnermeyer & DeKeseredy, 2008; Weisheit et al., 2006). Thus, social disorganisation theory has been used as a theoretical starting point to research to understand criminal behaviour, and explain crime concentration in urban areas, but little research has been conducted within rural areas. Where this research has occurred, there has been a difference of opinion on its relevance and applicability to rural communities, and inconsistency with urban findings (Donnermeyer & DeKeseredy, 2008; Weisheit & Wells, 1996).

Research on rural crime in the 1990's and 2000's focused on social disorganisation theory, social efficacy and the lack of cohesion and solidarity. Donnermeyer (2015) found that in counties in the United States, social variables were less successful in explaining crime variance the more rural the county became. Smith & Byrne (2018) argue that social disorganisation is becoming more evident within rural communities and agrees with Cloke & Davies (1992) cited in Marshall and Johnson (2005) that migration is partly responsible. Mawby (2015) identified that crime rates were consistently and significantly linked to socio-economic variables. Kaylen & Pridemore (2011) agreed with the positive association of crime with residential mobility, ethnic heterogeneity, and family disruption consistent with social disorganisation and crime literature in rural areas. They do argue that traditional measures of social disorganisation may not be reflective of disorganisation within a rural community, something that Mawby (2015) agrees with. They cite the ownership of a vehicle, perceived as a luxury in urban areas where public transport is usually frequent, convenient, and inexpensive, in contrast, in rural areas public transport is generally anything but, and vehicle ownership becomes a necessity, particularly the more remote the residence.

In their paper Kaylen & Pridemore (2013) argued that no social disorganisation studies had utilised the full social disorganisation model in rural areas. Despite previously agreeing that individual aspects of social disorganisation had been positively associated with crime in rural areas, Kaylen & Pridemore (2011), found that the evidence to support the full model was invalid based on the British Crime Survey data for rural areas. Conversely, Barnett & Mencken (2002), tested the interaction effect of population change and socio-economic status on crime rates in a non-metropolitan US city for violent and property crimes. They found that resource disadvantage did not influence property crime if the population was stable, the greater the population change the greater the effect of resource advantage. Conversely, resource disadvantage influenced violent crime regardless of whether the population was stable, concluding that population stability is effective at controlling non-intimate crimes. Weisheit & Wells (1996) detail findings that demonstrate rural crime increasing as economic conditions increase, and Barclay et al. (2004)

and Donnermeyer (2007), that collective efficacy can facilitate crime within rural communities, particularly violent abuse.

This collective efficacy enabling and facilitating crime was developed into primary socialisation theory (Oetting & Donnermeyer, 1998). The concept of the close social networks seen within collective efficacy provide a means for communicating and learning behaviours, attitudes and beliefs that can constrain or enable criminal behaviour. The work of Garriott (2013) exemplified this in the research regarding methamphetamine production and consumption in West Virginia. There are also parallels with the work in Kentucky (Websdale & Johnson, 1998) and Australia (Alston, 1997) on the violent and controlling behaviour of men on their partners, which developed into Male Peer Support Theory (Dekeseredy, 1988 & 1990) . The close peer group of the abusers acted to facilitate, educate, and normalise the abusive behaviour whilst the community tolerance compounded the impact and helplessness of the victim. From this perspective it can be anticipated that collective efficacy can enable the spread of out-of-town dealers (OTD) using the county line model through tight knit groups of drug users within small rural settlements.

Smith (2014) asserts that rural crime is becoming more organised and that there is a need for industry knowledge to facilitate many forms of organised rural crime. This agrees with Morris et al. (2019) and Smith et al. (2012:2) who state that 'rural social capital and working knowledge of rural practices' are evidently required for some rural crime. They acknowledge the work of European organised crime groups in the facilitation of machinery thefts and disposal abroad. The organised nature of rural offending has consequences for the development of hypotheses for testing within the analysis to develop an understanding of what increases risk of crime at locations. Hare coursing is seen as a planned criminal enterprise and allows us to consider the 'rational choice' (Cornish & Clarke, 1986; Mayhew et al., 1976) the offender(s) are making when deciding upon the criminal enterprise. Likewise, drug dealers from other areas are making a choice of where to expand their dealing activities. They have choices to make when considering a

relocation. Both hare coursers and county lines out-of-town drug dealers are making conscious choices around minimising effort and risk against perceived gains.

Offenders are perceived to make a 'rational choice' (Cornish & Clarke, 1986) regarding whether to offend and how to complete the task. Little research has been completed on acquisitive criminals' decision-making processes; when this has been undertaken, burglars are the subject of the research. Although this research does not include domestic burglary, the research can offer useful insights to understanding what factors may be relevant when devising the risk factors for inclusion in the research analysis. Hearnden & Magill (2004) found that the situational cue burglars most strongly linked to a property being targeted was whether there was ample property worth taking. Other considerations were the ease of approach and exit, lack of security including technological guardians such as CCTV or alarms, physical guardians, such as residents at home and a ready market for the property. Some of these considerations are likely to feature in offenders reasoning when embarking on hare coursing or cuckooing of properties for drug dealing.

Travel to crime is an important consideration in crime pattern theory. Ratcliffe (2003c) found on average offenders travelled less than three miles to commit offences. Criminals in Sheffield travelled similar distances (Wiles & Costello, 2000). However, Menting (2018) identified that the opportunities available within rural communities may lead to an increased distance travelled by offenders. Davies & Johnson (2015) and Axhausen (2006) identified street layout as a factor for both travel and awareness space, whilst Johnson and Bowers (2010) researched the impact on offence location. The level of connectedness between streets increased burglary risk, particularly when connected to major roads (Johnson & Bowers, 2010) supporting the work of Davies and Johnson (2015), that streets more frequently travelled (high betweenness) are also at a greater risk of burglary. Boivin & D'Elia (2017) found that major roads act as facilitators to accessibility and consequently influence travel patterns. It could be expected that this would be particularly relevant in the selection of fields by hare coursers.

To understand the implications of the road infrastructure and how it may facilitate offenders, social network analysis will provide an additional theoretical framework to the research. Networks are made up from a series of nodes or actors and the links/relationships between them. When considering crime pattern theory there is a strong parallel between the activity nodes and pathways creating awareness space and the actors and relationships in social network analysis. Whereas crime pattern theory and environmental criminology consider the geographical influence, social network analysis looks at the influence of relationships, interdependence, and network structure (Borgatti & Halgin, 2011; Chang, 2016; Fuhse & Mutzel, 2011; Kilduff & Brass, 2010; Malm et al., 2008; Marshall & Staeheli, 2015).

Key features of networks which have already been identified as relevant to the research, in terms of street patterns and arterial routes, are the concepts of centrality and bridges. Bridges are those links which reduce overall distance between nodes in a network (Valente & Fujimoto, 2010) and pathways which 'link two otherwise unconnected network clusters' (Liu et al., 2017:5). In the context of hare coursing these are the major roads through an area (Boivin & D'Elia, 2017). It has already been noted that offenders are unlikely to take lengthy detours (Reid et al., 2014) so network analysis can add a valuable perspective in understanding probable offender travel routes and those areas of increased risk to crime.

Betweenness is another area of research which has already been highlighted as increasing the risk of burglary offences (Davies & Johnson, 2015; Johnson & Bowers, 2010). Betweenness centrality is another concept in social network analysis and is defined as the frequency with which a node lies on the shortest path between nodes (Liu et al., 2017). High betweenness centrality is also indicative of network bridges (ibid.) and have the potential to control resource flow (Chang, 2016; Valente & Fujimoto, 2010).

Figure 2 below shows how crime pattern theory and social network analysis complement one another in understanding crime distribution and will form the theoretical basis of my research into crime in rural Lincolnshire.

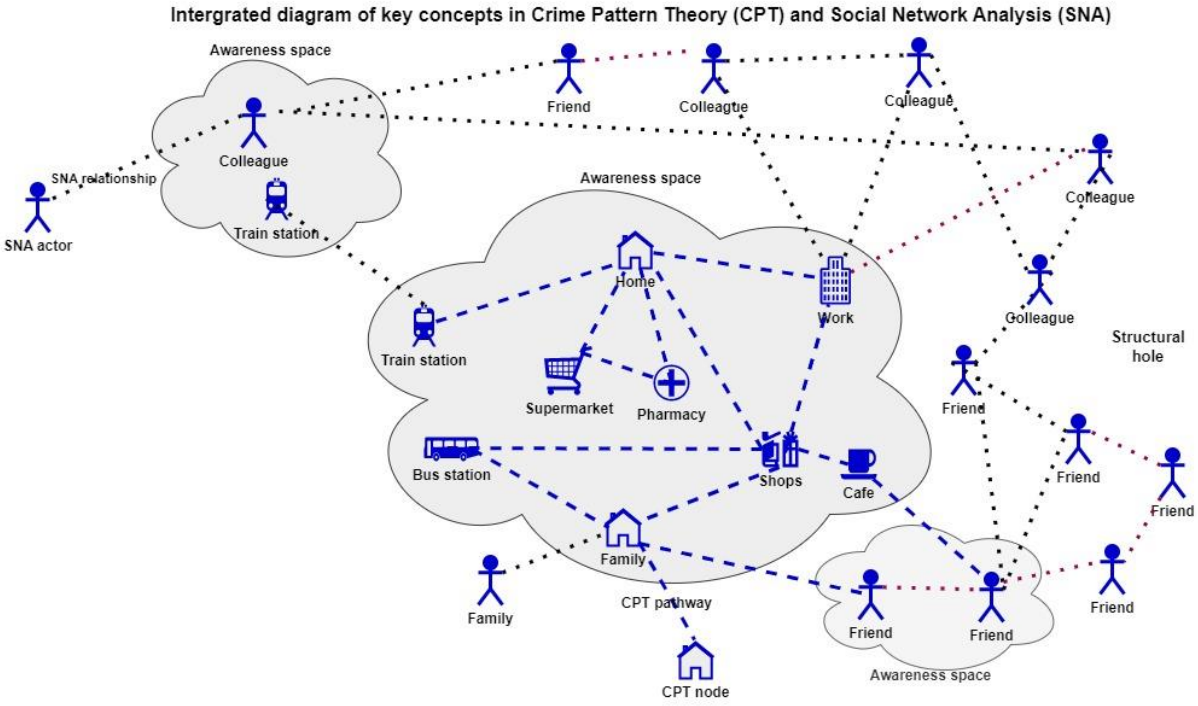


Figure 2: Key concepts in social network analysis and crime pattern theory.

Researchers have identified that changes and advancements across the country have impacted on crime in rural communities. Smith & Byrne (2017) raise road and infrastructure improvements as facilitating rural crime, whilst the growth and sophistication of CCTV in urban areas during the 1990's led to displacement of crime to the countryside. However, there is little or no research available to corroborate this hypothesis; CCTV's effectiveness in reducing and displacing crime has been questioned (Welsh & Farrington, 2004) and in a review of research evidence, CCTV could displace crime but infrequently and inconsistently across offence type and space (Waples et al., 2009). Additionally, the displacement theory would counter the rational choice and opportunity perspective of criminals, and it is the lack of security, easy access, and plentiful profitable targets (Nurse, 2014; Smith, 2019) that I feel are influencing criminals in the spatial target selection. Hare

coursing by its very nature requires open countryside and it is this target availability which draws in offenders.

One of the key theories my research is based on, is that criminogenic characteristics make some places more vulnerable to crime than others. Situational aspects of crime work at different levels (Brantingham & Brantingham, 1981) with crime pattern theory primarily at the meso level (Barclay & Donnermeyer, 2011), and hotspots of crime at the micro. Cohen et al. (1981) identify target attractiveness and guardianship as micro level processes, for example street segments; exposure and proximity as macro level processes working at a delimited geographical area such as census area or town but are also likely to be active at the neighbourhood, meso level. In terms of the selection of targets by offenders it is consistent with the hierarchical target selection model of Taylor & Gottfredson (1986). The ecological factors that increase the risk of household property crime, are most probably transferable to all property crime, and to cuckooing of properties, with offenders first selecting at the larger macro area, before selecting a neighbourhood at the meso level and then a specific target (Lynch & Cantor, 1992).

With proximity reflecting the distance between targets and offenders the importance of the rural context cannot be overestimated. Locations which are considered proximate or convenient for residents in a rural community, such as the nearest school or amenities would be out of the way within the city with an increased density of schools and shops. Mears et al. (2007) acknowledge this aspect of ecological theory stating it must meaningfully reflect the structure of social life within rural communities. In terms of the research, it is possible that different areas of rural Lincolnshire may differ in their contextual structure, acknowledging, identifying, and understanding this could considerably affect the success of any analysis.

The influence of cities and their resident's accessibility to local rural areas in Cornwall was noted by Mawby (2015) to increase the number of burglaries by non-rural residents due to increasing the proximity of offenders. The research supported that of Barclay & Donnermeyer (2011), but

Mawby (2015) points out that data available to test where offenders travel from to commit offences is lacking. Six years on, this certainly remains the case in Lincolnshire, where a suspect's address at the time of the offence cannot be ascertained. Their address at the time of arrest will be captured but is subsequently updated when they change residence. To match arrest date to a residency address would be a manual process for each offence, offender, and address. It may be possible to determine if an offender is from out of the county based on the address given in custody, and any previous addresses. For detailed analysis on the travel to an offence technological analysis would be required involving the use of telecommunications data or that collated by automatic number plate recognition cameras. Both of which would be problematic from a researcher's point of view, as this data would only be available for a limited amount of time and under strict data accessibility conditions.

The feasibility of studying offender travel patterns for acquisitive crime would be considerably low. The nature of serious acquisitive crime may offer opportunities for this type of research. However, it would be very much dependent on the suspects being identified and investigating officers obtaining the necessary communications data as a proportional part of the investigation. The obtaining of communications data brings into the fore the ethical implications of invasion of privacy, collateral intrusion, and proportionality. For the purposes of purely academic research this would not be appropriate.

Several researchers have utilised ecological and opportunity theory to understand the risk of crime, particularly affecting farms. Accessibility was identified in several studies to influence the risk of offences. Sugden (1999) found that machinery left in fields in the English county of Rutland was highly vulnerable to theft; Barclay & Donnermeyer (2011) that farms in New South Wales, Australia were more vulnerable to livestock theft when market accessibility was good, and they also found that properties close to the highway received more trespassers, illegal hunters, and damage. This was supported by the George Street Research (1999) and Martin (1995) in Scotland where properties near to semi-urban areas or near main roads were at increased risk. Vandalism

occurring more on farms closer to urban areas was also a conclusion made by Farmer & Voth (1989) from their study in Arkansas, US.

Street layout is an important aspect of accessibility. It is already noted above that the proximity to a highway or major road has apparent positive correlations to some crime types. The road network and the street layout can influence not only accessibility but also the flow of people, predatory offenders, guardians, or potential victims (Johnson & Bowers, 2013). Gill et al. (2017) propose that there is something substantially different about street segments which affects the variability of crime concentration, and they determine this to be due to the distribution of offenders, guardians and targets brought together through the routine activities of life. It is established that street layout influences crime in urban areas (Beavon et al., 1994; Hillier, 2004; Johnson & Bowers, 2010 & 2013). Gill et al. (2017) also found support for the theory in suburban areas. Research on road networks in truly rural areas is lacking, but the impact on awareness spaces will need some acknowledgement in the analytical process, particularly as Andresen (2006) indicates, it may be that the visiting population to an area can better predict crime than residents. This naturally leads to the questions of why do people come to an area and how do they get there?

So far, discussion on rurality and crime has considered relevant crime theories as separate entities. However, to gain an in-depth understanding of crime and rurality, and consequently rural crime, an appreciation of the overlapping and interconnectedness of these concepts is required. The following diagram shows the interwoven elements which must be considered when analysing rural crime. It also displays the importance of macro, meso and micro level theories, from global influences, through local community theory and ecology to routine activity and crime concentration at place.

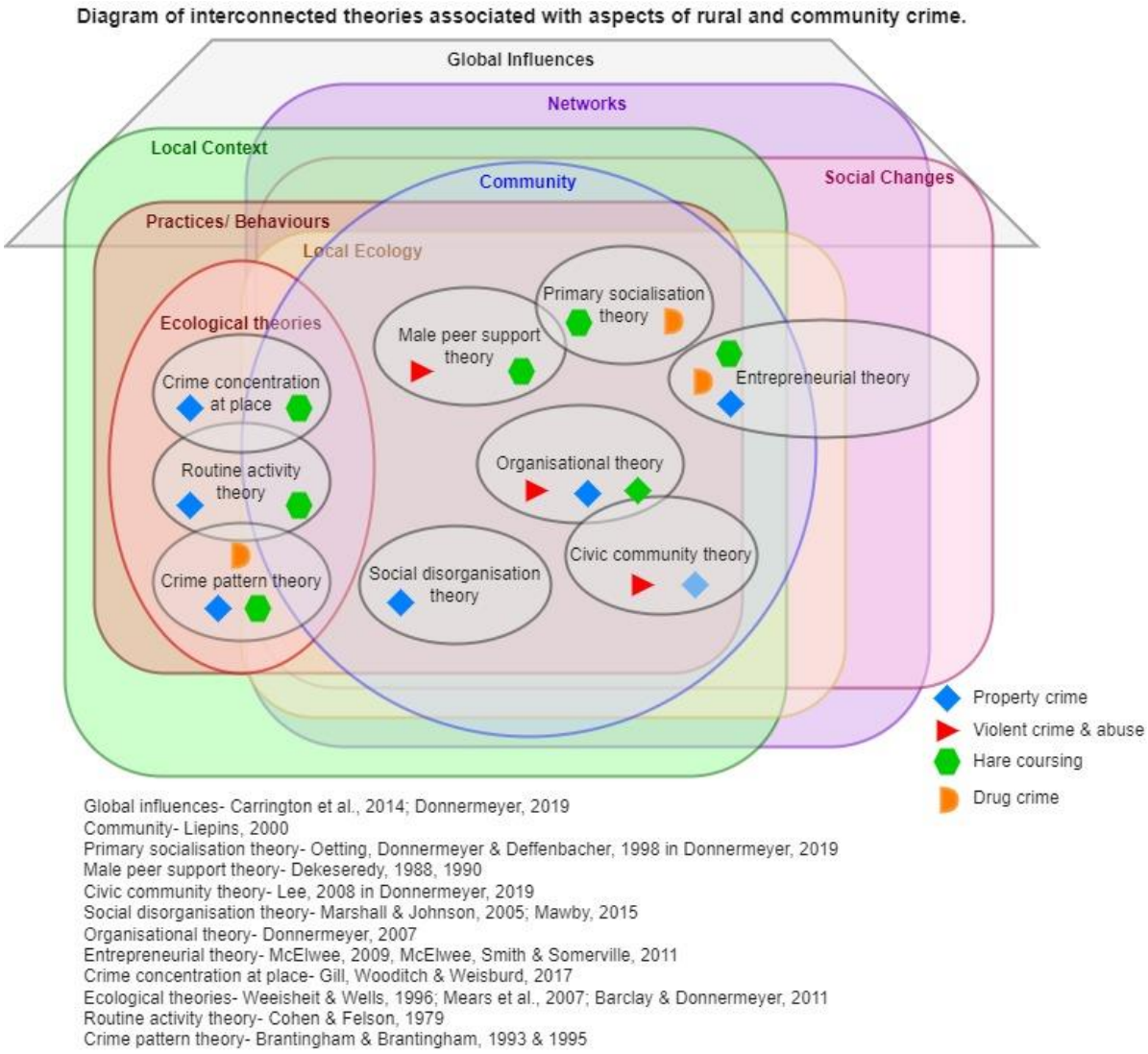


Figure 3: Interconnected theories associated with aspects of rural and community crime.

Figure 3 also demonstrates that each individual theory builds and utilises on multiple broader concepts. For example, global changes and trends, such as the recent Covid-19 pandemic reduced travel and physical social interaction but increased the use of social media networking. Those traveling on the rail network for county lines became more noticeable to officials, whilst imposed travel restrictions gave police additional reasons to stop out of county vehicles, before potentially being involved in hare coursing. The local context of the pandemic response changed the behaviours of people in public places, and their routine activities, as less people went to a physical

workplace (Office for National Statistics, 2020) or ate out (Office for National Statistics, 2021). Less people used public transport, but more people took up walking and cycling (Department of Transport, 2021; Lill, 2021). The more entrepreneurial took advantage of the changes in these social, commercial, and retail conditions to launch new businesses, diversify or adapt, particularly in relation to e-commerce and delivery (Austen, 2021; Lill, 2021; OECD, 2020).

In the context of county lines drug supply, the diagram shows the links of specific theory and concepts which should be considered when analysing the risk location for offences. Global influences may include for example, the rise and promotion through social media of drill music featuring lyrics about violence and drug dealing, limitations on travel or difficulties in obtaining the drug of choice, perhaps, but not limited to, the implications of Covid-19 restrictions. This in turn will have some impact on the local context and ecology of drug availability, the activity of local drug dealers and users. Networks of people and transport will affect how communication is disseminated, whilst social changes can also impact on the marketplace. An increase in the student population may increase demand in one area, or a downturn in economic activity may result in the development of a different market such as heroin.

Multiple networks are a part of Liepins' (2000) community theory as members of the community form different types of relationships across their normal daily activities, some positive, and some negative, but affected by the broad social and local context. There will be those individuals who are more susceptible to contact with drug users or dealers because of their daily, routine activities and the social or domestic circumstances they find themselves in. It maybe the opportunities that this contact provides, as in primary socialisation theory, which reinforces and educates younger, pliable associates into the county lines business or the perceived kudos or street capital they can gain. Finally, it is the idea of business that helps us to understand the market forces involved in the logistics of county line drug activity. A network of contacts is required to obtain the necessary illegal commodity, and a likely different network of contacts is needed to generate customers.

Entrepreneurial theory leads us to understand the exploitation, adaptation of operating practices and the enticement of others to become involved or discarded.

Hare coursing is a totally different type of crime and can be seen as having motivational factors in both financial gain and as a sporting pastime. The location of hare coursing activities is again influenced by several factors including the change in local laws, such as the ban on hare coursing in England 2004. Internationally the impact of the European Union Agricultural Policy on the types and quantities of crops grown by farmers also affects the amount of suitable land for coursing activities. Likewise, the local practices of farmers and the farming ecology and traditions will determine size of fields, distribution of livestock, woodlands, and hedgerows.

Social changes in the acceptability of hare coursing may lead to more clandestine organisation and growth of networks of coursers to exchange information and arrange meetings. The road network will also influence accessibility to land, and travel times linking into the routine activity theory of knowledge of place in the selection of targets. Male support theory, whereby particular communities reinforce the committing of certain crimes through support and knowledge exchange; primary socialisation theory of group members learning the skills and acceptance of the illegal activity from a young age are encompassed within organisation theory and subsequently community theory, whereby some community organisation facilitates crime such as hare coursing. Finally, the entrepreneurial aspect of adaption, promotion and networking in a fluid non-hierarchical manner assist in the continued success of the offenders to maximise gain and minimise risk.

5 Risk Terrain Analysis Of Cuckooed Addresses By County Lines In Lincoln

5.1 Understanding County Lines

In 2015 the Home Office (National Crime Agency, 2015) identified an emerging issue of London gangs exploiting young people for street level dealing in what has become known as county lines drug dealing. In its initial assessment, the National Crime Agency (NCA) described the use of mobile phone lines by groups to expand drug dealing into new rural locations outside of their home areas as "county lines". Groups set up a secure base and use "runners" to deal drugs to local customers on a day-to-day basis. These rural locations area seen by the group to offer greater market opportunities, increased profits, and increased anonymity with law enforcement for the sale of class A drugs- heroin and crack cocaine.

The current National Police Chief's Council's (NPCC) definition of a county line is:

'The 2018 Home Office Serious Crime Strategy states the NPCC definition of a County Line is a term used to describe gangs and organised criminal networks involved in exporting illegal drugs into one or more importing areas [within the UK], using dedicated mobile phone lines or other form of "deal line". They are likely to exploit children and vulnerable adults to move [and store] the drugs and money and they will often use coercion, intimidation, violence (including sexual violence) and weapons.' (National Crime Agency, 2021a)

County lines activity typically involves the exploitation of vulnerable persons, including children to facilitate the running of the line (National Crime Agency, 2021a; Stone, 2018). This can include the use or takeover of a person's home, commonly referred to as cuckooing or using individuals to transport, store, deliver, and sell drugs. Those often involved in the transport and delivery of crack

and heroin are likely to experience pressure to plug drugs, the secretion of drugs inside the body, to avoid detection and loss of the commodity if encountering law enforcement (National County Lines Coordination Centre, 2021). Those recruited and/or exploited by the county lines organisers are exposed to squalid living conditions (Stone, 2018), drug use and are at risk of physical and sexual violence. The prevalence of knife crime linked to county lines nationally (Winchester 2019), is evident in the associated violence and weapons seized during focused county line enforcement in Lincolnshire (Grantham Matters, 2019; Lincolnshire Police, 2021a & b; Lincolnshire Police-South Kesteven, 2021; Stone, 2018; Verney, 2019).

The county line model minimises risk to those facilitating the activity by providing physical distance from themselves and the sale and exchange of money and drugs. A dedicated mobile phone number is used for the marketing of crack and heroin to local users but is controlled by persons usually many miles away, in for example, London or Nottingham. Typical police enforcement would focus on the visible activities of drug runners and any identified cuckooed addresses. Enforcement on the line controllers would require longer and more involved technical investigation processes resulting in much lower risk of detection to those remaining in the exporter city base. The risk of apprehension is focused on those lower-level members and exploited vulnerable persons suspected of being coerced into dealing, transporting, or selling to local users. This physical separation of the line controller from the marketplace is a key aspect of county lines activity alongside the county line mobile number, which is promoted as the out-of-town dealers (OTD's) brand.

Mid-level members of a group are believed to visit a potential new area to assess the current drug market before younger, more vulnerable members of the group are sent to retail the drugs. Cities will have several groups each selecting a location they believe will be profitable. Multiple groups could be active in the target town depending on market size. Lincoln has simultaneously had county lines activity originating in Nottingham, Lancashire, and London. New markets are characterised by ample users and little resistance from local drugs dealers (NCA, 2015). The drugs

sold are thought to reflect the customer base and methods of sale, therefore the sale of cocaine more usually for the night-time economy is not typical of the county line model which focuses on retailing heroin and crack cocaine. The initial assessment by the NCA identified that those new areas of business were coastal towns, market towns and commuter towns close to London.

The creation of the National County Lines Co-ordination Centre (NCLCC) in 2017, funded by the Home Office, increased the awareness of county lines and the associated exploitation of vulnerable people. It brought in a national tracker which police forces completed monthly and the definition was tightened, removing some of the subjectivity of the returns identified above. The national intelligence assessment reported that the work of the NCLCC suggested that there were over 1000 branded lines, those with a marketed name and mobile number, in the UK (NCA, 2019a) but that there was still incomplete understanding of the full extent of county lines activity.

Evidence and intelligence collated by the National County Line Co-ordination Centre and the National Crime Agency between 2015 and 2019 show that the model has adapted but not significantly changed since it emerged in London and the southeast of England. Police forces who have groups which go out to new areas to supply drugs are known as exporters or exporting forces. Those towns where the group set up their retail supplies are the importing forces. The biggest exporting forces are the Metropolitan Police, West Midlands, and Merseyside (NCLCC, 2021). Lincolnshire is an importing force, and the force's information to the NCLCC show that Nottinghamshire is Lincolnshire's biggest exporter. Other exporting forces to the county have been identified as Cambridgeshire, Humberside, Lancashire, Leicestershire, Metropolitan, South Yorkshire, and the West Midlands.

A key feature identified by the Home Office (NCA, 2015) was the receptibility to exploitation of individuals and higher than average levels of deprivation within target towns. This was particularly noted for coastal towns, whilst more affluent market/commuter towns were targeted with good links to London. The initial NCA assessment was reliant on information provided by police forces

and the drug supply model was not identified as active across the United Kingdom. The extent of the problem was identified within seven police force areas. The demographic factors identified in the early reports (Drug Threat Team, Organised Crime Command, 2016; NCA, 2015) which could be seen to influence new market location should be considered with caution. In the last three years county lines activity has expanded and now includes counties like Lincolnshire, which did not feature in the original seven police force areas.

The NCA assessment in 2016 (Drug Threat Team, Organised Crime Command, 2016) identified that the problem was growing, and the themes seen in the initial assessment were ongoing with exploitation of the vulnerable a key area of threat. All police forces in England and Wales were required to provide details of county lines activity to the NCA, and 71% reported that they had established county lines identified in their area; a further 12% had emerging county lines. It is important to consider that at this stage there was still no official definition of county lines. In 2017 the Home Office issued a standard definition for a county line, which assisted to some extent to creating a more accurate picture of the problem. However, as a practitioner involved in the collation and reporting of figures, I have first-hand experience of the variation of its application both inside my own police force and across different force areas.

The NCA baseline assessment (NCA, 2015) stated that those locations affected were coastal and market towns, predominantly white British residents, lower than average minority ethnic communities and an older than average population. Just under half the towns identified (46%) with a county line had at least one issue with deprivation, 65% had decent links to a major city and 30% were coastal towns all with poor transportation links (NCA, 2015). The report suggests more affluent London commuter towns had been targeted, but whether they had any issues with deprivation is unknown from the available literature. It is unclear why these areas are chosen, but in line with routine activity theory (Cohen & Felson, 1979) it would be anticipated that the group involved in moving to the location would have some knowledge of the town.

It was suggested by one force in the initial baseline assessment that this could have stemmed from a prison release or local authority relocations (NCA, 2015). A year later, potential triggers for new locations included towns with prisons, as gang members may learn of a town's potential whilst visiting incarcerated associates: new networks of associates developed whilst in prison; provision of local authority housing to group members or associates; new relationships and even travelling drug users identifying their hometown as a potential opportunity for drug supply (Drug Threat Team, Organised Crime Command, 2016).

Transportation links to new potential markets appear to be very important. The county lines methodology utilises the exploitation of young people to transport drugs and act as runners in the new markets. These runners are typically too young to drive (NCA, 2019a) and need to be either driven or able to use the rail network. In 2017, 67% of forces reported to the NCLCC that county lines were using the rail network in their area, 51% stated hire cars, 42% privately owned vehicles and 33% taxis (Drug Threat Team, Commodities 2017).

Academic research on county lines is currently limited due to its relatively new emergence as a specific and identified issue in the United Kingdom. To date academic research on county lines has been split into two methodological areas. The first has focused on the literature and information which has come from the National Crime Agency and other national organisations providing a theoretical perspective of how and why persons become involved in the activity (Andell, 2019; Coliandris, 2015; O'Hagan & Long, 2019; Williams & Finlay, 2019; Windle et al., 2020). There has been an emphasis on the vulnerability and push-pull dynamics resulting in the involvement of young people within county lines (O'Hagan & Long, 2019; Robinson et al., 2019).

The second dominant methodology has been small qualitative studies involving interviews and focus groups with practitioners, residents, purchasers and dealers for county lines, exploited victims, and gang members (Clark et al., 2021; Coomber & Moyle, 2018; MacDonald et al., 2022; Moyle, 2019; Robinson et al., 2019; Whittaker et al., 2020; Windle & Briggs, 2015). The purpose of

these studies has been similar and centred around trying to understand the mechanics of how the county line drug supply business model is able to be so successful and why and how people become involved. The research was carried out predominantly in the south of England with one study based solely in Scotland (Clark et al., 2021) and another in Glasgow and Merseyside (Robinson et al., 2019).

There were some slight differences in the organised crime origins within Scotland (Clark et al., 2021) compared to England, which were thought to have historically facilitated the street drug markets, with 'family firms' previously having a strangle hold in cities like Glasgow. Within England, there was an underlying perception particularly from the National Crime Agency (Drug Threat Team, 2017) that county lines were a gang related issue. There has and continue to be debate around gang definition which will not form part of this study. However, where gang involvement is identified within the research it will relate to a gang as defined under Section 51 of the Serious Crime Act 2015 which stipulates that it *'Consists of at least three people and has one or more characteristics that enable its members to be identified by others as a group' (Home Office 2015:2)*

For researchers involved in the qualitative analysis there was a deliberate avoidance of the term county line dealers. 'Out of town dealers' or OTD (Coomber & Moyle, 2018; Moyle, 2019) were used to refer to those responsible for organising county lines activity, regardless of whether this was an identified gang. This terminology will also be utilised within this study and OTD will be used to refer to those involved in the organisation of county lines activity.

There is a consensus among both those researchers which have carried out quantitative research and those who have utilised agency data that the vulnerability which is used by OTD stems from deprivation (Drug Threat Team, 2017; Moyle, 2019; NCA, 2015, O'Hagan & Long, 2019; Robinson et al., 2019; Spicer, 2021), community and particularly personal. Academic research on county lines has considered the vulnerability and push-pull dynamics resulting in the involvement of

young people within county lines (O'Hagan & Long, 2019; Robinson et al., 2019). The exploitation and specific targeting of vulnerable persons is a major theme which runs through the agency and authority literature including social isolation, mental health, family breakdown, abuse, and children in care (Coliandris, 2015; Drug Threat Team, 2017; NCA, 2015, Windle et al., 2020). Police authorities and third-party practitioners have been steered over the last five years to see the exploitation and victimisation, particularly in juvenile participants of county lines and OTD activity of runners and user dealers. Emphasis on safeguarding and the use of the Modern Slavery and Human Trafficking Act and the National Referral Mechanism has been widely promoted by the NCA via the NCLCC (2021).

It is however apparent that those persons 'exploited' do not necessarily view their situation in this way. In an environment with little opportunity, juveniles and drug users take advantage of perceived opportunity for tangible and intangible gains and transcend their marginal position (Coomber & Moyle, 2018; Moyle, 2019; Spicer, 2021). These gains manifest in a sense of purpose, feeling wanted and included (Irwin-Rogers, 2019; Moyle, 2019; O'Hagan & Long, 2019; Robinson et al., 2019; Showalter, 2020; Windle et al., 2020) and materialism (Irwin-Rogers, 2019; NCA, 2019; Spicer, 2019).

Research on gangs has also identified the growth of 'capital' (Bourdieu, 1986) as a benefit perceived by many young people and local user dealers. The development of 'street capital' (Holligan et al., 2020) via involvement in crime and violence, bolstering reputation and self-esteem; bonding social capital providing 'mutual support' (Andell, 2019) and helping them cope with life (Andell & Pitts, 2018). Further analysis of exploitation and vulnerability is not within the scope of the current research, although it is important to understand the general motivations of victims and offenders and the relevance of 'capital' in the growth of county lines.

Small towns, as with rural communities have high levels of density of acquaintanceship, where many people know each other, even if only on a superficial level (Coomber & Moyle, 2018; Moyle,

2019; Showalter, 2020). Showalter (2020:3 & 4) argues that people compete for social capital but in small towns these densely acquainted social networks and local inequalities create 'acquainted marginality and small-town habitus' resulting in exposing those who partake in drug use to exploitation (Clark et al., 2021), 'discrimination, stigma and violence' (Showalter, 2020:3). Consequently, peers become known to one another leading to inter peer user dealing and the development of vulnerable sub-populations (Clark et al., 2021) which OTD can then exploit (Stone, 2018) through exchange of contacts (Moyle, 2019) and local user/dealers providing services for multiple OTD (Drug Threat Team, 2017) and the recruitment of peers (ibid.).

Qualitative research by academics with practitioners and gang members supports the motivations cited by the National Crime Agency regarding the drivers of OTD drug markets. Whilst it is acknowledged that some gangs have focused on financial gain from drug supply (Coomer & Moyle, 2018; Whittaker et al., 2020) county lines service the retail drug market for heroin and crack cocaine drug users (Drug Threat Team, 2017; Moyle, 2019; Spicer, 2021). Consequently, those more entrepreneurial minded individuals and groups are utilising principles of capitalism competitiveness to provide drugs in a less crowded marketplace of small and coastal towns (Irwin-Rogers, 2019; Malm & Bichler, 2011; Whittaker et al., 2020; Windle & Briggs, 2015). OTD saw coastal and small towns as an alternative to the saturated city markets, turf wars and an easy market (Robinson et al., 2019), in addition to maximising profits (Clark et al., 2021; NCA, 2015; Robinson et al., 2019).

Due to the distance between the physical exchange of money and drugs, OTD are also able to reduce their risk and exposure to law enforcement activities, whilst those who commute to these towns have the advantage of group support from city associates (Baika & Campana, 2020; Holligan et al., 2020; Windle & Briggs, 2015). This support makes it easier to obtain drugs and can be utilised for enforcement against rival dealers and to aid in personal security when threatened by other groups.

There are several areas where academic research is lacking in relation to county lines. Baika & Campana (2020) note that in literature on drug dealing in the United Kingdom there is little differentiation between drugs. County lines is centred around the supply of crack cocaine and heroin which has a specific customer and market profile (Spicer, 2021) and should be differentiated from cocaine supply.

Little academic research has been undertaken with regards to specifically how OTD operate in these new locations. The qualitative research undertaken indicates that social networking with local users is a key aspect (Clark et al., 2021; Coomber & Moyle, 2018; Moyle, 2019; Stone, 2018); the NCA (2019) suggested that recovery units or drug dependency units may also facilitate connections with the local market of drug users.

To understand the differing risk that county lines OTD pose to towns across Lincolnshire the research will contribute in part to the research gaps identified by Windle & Briggs (2015), Coomber & Moyle (2018) and Baika & Campana (2020). Research has indicated why OTD choose to set up activities in smaller communities but there is a gap in knowledge into how they make connections with other towns (Windle & Briggs, 2015). The NCA (Drug Threat Team, Organised Crime Command, 2016; NCA, 2015) has suggested that this could be due to relocation into social housing or for safeguarding, prison release accommodation, familiarisation due to prison visits or from travelling drug users. The use of the railway has been identified by the NCA (Drug Threat Team 2017; Drug Threat Team, Organised Crime Command, 2016; NCA, 2015) as one of the most common methods of transport and this could also be a factor.

This is linked to the gaps identified around journeys to illicit drug supply (Johnson et al., 2013), travelling dealers supplying directly to users and local user dealer involvement over extended geography (Coomber & Moyle, 2018). This is associated to the gap identified by Baika & Campana (2020) on the structures and mechanisms which underpin drug markets and operations. The interconnected nature of both users, dealers and exploited persons involved in county lines retail

drug supply suggest that risk levels can only be understood by incorporating the network aspect of the supply model. By developing an understanding at a local level using crime and intelligence information, in the little used social network approach (ibid.) it will further establish support for the use of the technique and show the importance of networks in the facilitation and expansion of county lines activity.

A crucial aspect of county lines activity that must not be lost sight of is that this is a retail supply and demand commercial operation. Drug supply has been identified as organised as small networks or loose entrepreneurial connections by contemporary researchers (Baika & Campana, 2020; Holligan et al., 2020). Those more commercially motivated dealers being more likely to be organised (Densley et al., 2018; Pearson & Hobbs, 2001 cited in Holligan et al., 2020). In a 'network enterprise' (Castells, 2000a) individuals utilise their networks for support and commodity acquisition before embarking on capitalist marketing and retail activities, building alliances to better facilitate their objectives to maximise profits and discarding those areas or persons that cease to offer value to activity. Castells (2000a & b) highlights the adaptability of networks in the disposal of nodes within a network which no longer offer value. This can be seen in the exploitation of vulnerable persons within a county line which are seen as quickly replaceable if arrested or pose intolerable risk to the lines' activities.

The dynamic fluidity, improvisation and enterprise of networks are embedded in social networks (Castells, 2010; Coomber & Moyle, 2018; Hobbs, 1998; Malm & Bichler, 2011; Morselli, 2009 & 2010; NCA, 2015; Sparrow, 1991; Whittaker et al., 2020). The development of alliances and franchises for profit are evidenced by Whittaker et al. (2020) and the NCA (Drug Threat Team, Organised Crime Command, 2016) reported that research had shown that gangs had been co-operating in county lines activity. The NCA (Drug Threat Team, 2017) also reported that local drug users had been identified as working for multiple lines and this is also seen within the county line activity in Lincolnshire.

The entrepreneurial aspect of county lines activity is not only evident in those dealers which set up the lines in new towns, but also in those local users who decide to become more actively involved. Both users and dealers, it can be argued, are making the most of opportunities to cultivate skills and capital to seize better opportunities (Andell, 2019; Coomber & Moyle, 2018; Drug Threat Team, 2017; Holligan et al., 2020; Moyle, 2019; Robinson et al., 2019; Windle & Briggs, 2015; Windle et al., 2020). Robinson et al. (2019) and Irwin-Rogers (2019) highlight the entrepreneurial exploitation of the disadvantaged to maximise profit and reduce risk.

Conversely, Windle et al. (2020) and Coomber & Moyle (2018), emphasize county lines victims making the best choices available given their socially disadvantaged position. A specific example from Coomber & Moyle (2018), states that recognition should be made, that not all supposed cuckooed victims have been exploited, but see themselves as renting their rooms out, an example of themselves grasping an opportunity to better their situation.

Holligan et al. (2020) focuses on the entrepreneurial and social capital gained by more powerful dealers in urban areas, they then utilise this, and extensive networks to extend drug supply activity into rural locations. Alternatively, dealers branching out into rural locations could use their connections with city organised groups or gangs as leverage against local dealers (Holligan et al., 2020). Baika & Campana (2020) agreed with the value of having group co-operation in illicit class A drug dealing, speculating that this was for protection. Alternatively, Robinson et al. (2019) express that it is the apparent lack of social and criminal capital which is insufficient for success in the larger home cities which pushes them into more rural locations.

Social ties can thus be argued are extremely important for the success of county lines and crucial to the success of networks (Hobbs, 1998). Castells (2000a:20) goes as far as saying that persons become reliant on networks of social ties particularly in the absence of family support to ‘survive and reinvent forms of togetherness’. The success of any network is dependent on the levels of cohesiveness and tie strength, potency and reach of the individuals involved, and the type of

capitals they can contribute. This could be resources such as money or commodities, or access to these or new opportunities (Coomber & Moyle, 2018; Schwartz & Rouselle, 2009; Somerville & McElwee, 2011). It is probable that successful criminals have high levels of such capital (Clark et al., 2021).

Networks are fundamentally social and develop and adapt through social interaction. The importance of shared activities in the development of acquaintanceship and friendship is posed by Browning et al. (2017). They argue that the more social contact is developed through routine activities, the stronger the relationship and trust will become. The relatively confined communities of drug users within small towns will establish interconnected networks of users and dealers as paths cross in the fulfilment of obtaining drugs from an illicit marketplace. The socio-economic status of crack cocaine and heroin users and low-level dealers, implies they are likely to be acquainted through accessing social support services, welfare support, Probation, Addaction and temporary accommodation.

The analysis of networks in the context of criminality is limited, but the potential is acknowledged (Sparrow, 1991; Xu & Chen, 2005). County lines methodology has only been identified as an issue in the last seven years, but the entrepreneurial network approach it utilises is clearly indicative that a social network analysis can offer valuable insight into its understanding. Three network ideas offer insights on how this approach could be adopted with county lines.

The ‘small-world phenomenon’ developed by Stanley Milgram (1967) showed through experimentation that there exist short paths of friendship linking most of society. In small towns and rural areas this is likely to be particularly evident due to the presence of a high density of acquaintances (Showalter, 2020). The relevance of the small world principle for understanding criminal networks is put forward by researchers over the last twenty years (Coles, 2001; Malm & Bichler, 2011). The NCA (2019a) and Moyle (2019) give examples of persons involved in county lines making use of the phenomenon through the exchange of phone numbers and contacts. It is

further demonstrated in the recruitment of local drug users to work for multiple lines (Drug Threat Team, 2017) and in the interviews of those involved in county lines (Coomber & Moyle, 2018).

The second concept relevant to understanding county lines activity and how risk might spread is the position of a broker in a network. Brokers act in a pivotal role and profit from others as they extend the collective venture or reach of the network (Coles, 2001; Morselli, 2010). Examples in the street drug retail market include people who use drugs selling to their peers (Showalter, 2020), mass marketing texts from local users (NCA, 2019a) and out of town dealers latching onto a local dealer before taking over or exploiting it for themselves (Stone, 2018).

The third network characteristic of importance in considering drug supply and social networks, are those links or people which act as bridges between subgroups, linking 'small worlds' (Coles, 2001; Malm & Bichler, 2011). Xu & Chen (2005) identified that narcotics networks were typically in the form of chains demonstrating the value of these bridges linking together commodity supply, distribution, and retail. Granovetter (1973) stressed the importance of weak ties, one link between subgroups, to link subgroups within a network to gain valuable access to information and resources not available inside the core group. Bellair (1997) stated weak ties were crucial for linking smaller groups and wider community organisation. In terms of county lines activity an example can be seen in Clark et al.'s (2021) research where the out-of-town dealers latch on to vulnerable subpopulations of drug users. Coomber & Moyle (2018) describe user dealers linking the street drug market to middle level dealers. Andell (2019) identifies gangs as providing opportunities and access to the lucrative career of a drug dealer, another example of social network bridges within the county line business model.

It could then be argued that county lines activity in utilising a social network entrepreneurial business model provides a mechanism for understanding how it might spread to other towns utilising social connections already in existence, exploiting the brokerage potential of local users

and small-scale dealers and bridging the gap between local users and access to drugs. Through their routine activities of daily lives, a community of local users develops its own network and subgroups to support and facilitate their need for class A drugs. If patterns of activities, common locations, and routines (Brantingham & Brantingham, 1984 & 1995; Cohen & Felson, 1979) can be identified this will help determine how and where out of town dealers begin to act as bridges and brokers into a new network of sales in a community.

Currently the police response to county lines varies between forces and the type of county lines activity causing the greatest threat. Typically importing forces see the consequences of county lines activity in terms of vulnerable people cuckooed or exploited, the influx of city drug dealers with gang mentality increasing violence and the propensity to carry weapons. Nationally, the NCLCC co-ordinates periodic weeks of actions when the activities of dealers are specifically targeted using the 4P approach to prevent, pursue, prepare and protect (Eastern Region Special Operations Unit, 2021; NCA, 2021b; Newcastle Safeguarding Board, 2021; Sky News, 2021). This is a strategy used across many individual forces in tackling identified problems. Traditional enforcement is carried out on those found to be involved in the dealing and supply, including warrants and arrest followed by relevant prosecutions; prevention activities occur in many forms and in partnership with both public and private organisations including taxi companies, hotels, local councils, schools, and homeless and drugs charities. These are often focused towards education on the business model of county lines and those likely to be vulnerable. Protection activities often run in parallel to prevention activities, with organisations being empowered to identify those who may be at risk to exploitation, displaying behaviours suggestive of susceptibility or involvement with county lines and then applying safeguarding measures or support to those involved (NCLCC, 2021).

Understanding the factors which contribute to locations at a greater likelihood of having victims of cuckooing or exploitation can provide more efficient and timelier preventative and protective police and partner actions. In addition, it can direct local resources to where intelligence gathering is likely to be fruitful in identifying where new county lines to the area have set up activities.

5.2 County Lines Risk Terrain Analysis

In Lincolnshire there are a small number of identified cuckooed addresses, but offenders are targeting vulnerable persons at risk of exploitation. It is important to understand whether these events are randomly distributed in order that an informed decision can be made on whether the use of geographic crime mapping techniques are relevant. The greatest number of addresses and victims has been in Lincoln, and although not officially categorised as a rural town, it is targeted due to its geographical location in a rural county.

A nearest neighbour analysis was completed to verify that the distribution of incidents was not random within the city. A csv file[1] of cuckooed addresses was imported into the QGIS[2] software and nearest neighbour analysis calculated. The resulting analysis is shown below:

Observed mean distance: 385.26951602959093 metres

Expected mean distance: 569.1886330558614 metres

Nearest neighbour index: 0.676874929777067

Number of points: 25

Z-Score[3]: -3.0908045437608376

The Z-score of -3.0908045437608376 shows that the location of cuckooed addresses as reported and recorded by Lincolnshire Police in 2020 is significantly clustered and further analysis of their distribution is valid. The following sections detail how the manual, and RTMdx risk terrain models were generated.

[1] .csv files contain data separated by commas, which are used to store tabulated data which can be utilised within differing spreadsheet and database software.
[2] QGIS is an open-source geographical information software which allows the mapping of georeferenced points through the importing as a csv file. QGIS also has geospatial analytical functionality which can be used to format, process and analyse data.
[3] A Z score is a measure of how many standard deviations a raw score is above or below the population mean and is used to compare results against a normal population.

5.2.1 Identifying county lines risk factors

The previous section has discussed current research on county lines and the theoretical concepts which are likely to contribute to the establishment in new towns. Research on the adoption of analysis by officers identified that they were more likely to accept research findings if they felt their expertise was valued and included. To address this, six police officers from sergeant to chief inspector were interviewed prior to the risk terrain analysis to elicit their knowledge and experience of county lines, which would then be incorporated as risk factors within the model for cuckooed addresses. A summary of their views is provided below in Table 2.

Table 2: Risk factors identified by police officers for the location of cuckooed properties.

Officer opinions on where county lines will cuckoo an address
Bail hostels (Sgt B)
Coastal towns, holiday makers needing to buy (Ch Insp, R Insp A)
Communal entry to flats (Sgt B)
Flats (phase 2 PC)
Homeless accommodation (phase 2 N Insp A)
Homes of drug users (N Insp A)
Home of vulnerable persons (N Insp A, Sgt B) (phase 2 PC)
Local authority housing, housing association housing (Ch Insp, N Insp A, Sgt B)
Missing people (R Insp A, Sgt B)
Proximity to the railway station (Sgt B) (phase 2 N Insp A, N Insp B)
Repeat victims (phase 2 N Insp A)
Specific individuals (phase 2 N Insp A, PC, N Insp B)
Supported accommodation (phase 2 PC)
Towns with a sufficient population such as Boston and Spalding (R Insp A)
Vulnerable youths (R Insp A, Sgt B)
Youth hostels, children's homes (Sgt B)
No experience (R Insp B)

The literature review, section 5.1 of this chapter, has identified numerous areas for consideration in an analysis of increased risk for towns to the activities of county lines by out-of-town dealers. A number of these risk factors mirror those suggested by the officers including proximity to railway stations and social housing. If county lines and the corresponding risk factors are considered against Figure 3 we can see how or why certain factors need including in the model. Social changes in the local area promote young people to become drawn into gangs, and primary socialisation and peer support teaching those within the gang acceptable behaviour. Social networks help to identify new communities where the drug lines can try to establish a county line, whilst the most entrepreneurial learn to maximise profit by utilising vulnerable members of society and target customers, identified through their routine activities at shared locations. These activities could include attendance at support services, transport hubs, possible involvement in petty crime to support drug habits, visiting needle exchanges or through developing links into local drug user social networks.

Table 3 shows how all these potential risk factors, identified from the literature review and officer interviews can be split into three areas: facilitating factors, local market factors and vulnerability factors and how these could be incorporated into the analysis.

Table 3: Identified risk factors to county lines cuckooing identified from the literature review and officer interviews.

Potential Risk Factors	Potential Analysis Measures
Facilitating factors	
Prison releases	Prison in the town
'Capital'	Network connectivity and density from associations and telephone
Railway network	Presence of railway station and direct services available between cities
Sharing of contacts	Network connectivity and density from associations and telephone
Mass marketing text messages	Network connectivity and density from associations and telephone
Alliances	Intelligence and criminal associations
Local user/ facilitators	Intelligence and criminal associations
Density of acquaintanceship	Network connectivity and density from associations and telephone
Network territorialism	Network connectivity and density from associations and telephone
Local market factors	
Lack of established local 'gangs'	Intelligence and criminal associations
Inter-peer dealing	Intelligence and criminal associations
Recovery/ dependency units	Proximity or density of local facilities
Drug availability	Number of needle exchanges, pharmacy supervised drug administration
Social housing	Locations and quantities of multiple accommodation so-cial housing
Vulnerability factors	
Levels of socio-economic deprivation	Index of multiple deprivation Levels of unemployment Levels of persons with no academic qualifications Population of over 65 years Population of white ethnic origin

Table 3 shows five vulnerability factors which are likely to contribute to the conditions which would result in the presence of a county line in a particular town. These were identified as high levels of social deprivation and social disadvantage, high proportions of persons over 65 years and low levels of ethnic heterogeneity.

Eight settlements in Lincolnshire, including Lincoln, were identified as having a county line in 2019 and notified to the National County Lines Co-ordination Centre. Fourteen towns in Lincolnshire were designated as having no identified county lines during 2019. Data from the Census 2011 on each of the twenty-two towns was obtained from the NOMIS.co.uk[4] website and collated in Excel. Data included population size, percentage of population aged 65 years and over, percentage of persons of white ethnic origin, percentage unemployed, and percentage of persons with no academic qualifications. Although now ten years old the Census data was the most comprehensive data and easily available for research. Open-source online searching was used to identify the location of homeless shelters, hostels or short-term emergency accommodation, the locations of prisons and open prisons, drug rehabilitation centres and whether a location is classed as a market town.

The number and location of pharmacies which provide a needle exchange service and those which offer pharmacy supervised administration of drugs was obtained for Lincolnshire from the '*List of pharmaceutical service providers, Appendix A*' in the Pharmaceutical Needs Assessment for Lincolnshire (Lincolnshire Health & Wellbeing Board, 2018). This is the most current available report and due to the date of publication most likely to represent the services available in 2019.

4 show these towns including Lincoln city, alongside relevant demographic characteristics identified in the literature review as possible factors in county line activity.

[4] NOMIS provides labour market and UK Census data and is a service provided by the Office for National Statistics.

Table 4: Characteristics of locations in Lincolnshire with previously identified county line activity.

Location Characteristic, data source, characteristic source	Boston	Gainsborough	Grantham	Lincoln	Louth	Sleaford	Skegness	Spalding
Population- census day 2011 source NOMIS	41340	20842	41998	114879	16419	17359	24876	31588
Average age (Years)-census day 2011 source NOMIS	40.2	39.6	39.4	38.3	42.2	40.6	45.7	41.5
Percentage of usual white ethnic origin % source NOMIS	95.8	97.6	96.3	96	98.4	97.6	97.8	97
Percentage of 65 year and older source NOMIS	18.3	17.3	16.2	15.6	20.7	17.7	26.3	20.4
Level of unemployment- Percentage economically active 16-74 years, unemployed % source NOMIS	4.4	7.1	4.3	4.5	4.2	4.2	6	4
Levels of low education, usual residents 16 and over no qualifications % source NOMIS	32.7	28.6	23.7	22	27.5	22.4	43	29
Direct city rail link	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Rail link	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Prison	No	No	No	Yes	No	No	No	No
Open prison	Yes	No	No	No	No	No	No	No
Young offenders institute	No	No	No	No	No	No	No	No
Homeless hostel	Yes	No	Yes	Yes	No	Yes	Yes	Yes

Table 4 Continued: Characteristics of locations in Lincolnshire with previously identified county line activity.

Characteristic, data source, characteristic source	Boston	Gainsborough	Grantham	Lincoln	Louth	Sleaford	Skegness	Spalding
Market town https://lincolnshire.org/lincolnshire-market-towns/ accessed 25.4.2021	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Coastal town	No	No	No	No	No	No	Yes	No
Drug rehabilitation / We Are With You centre https://www.wearewithyou.org.uk/services accessed 25.4.2021	Yes	No	Yes	Yes	No	No	Yes	Yes
Pharmacy needle exchange (Lincolnshire Health & Wellbeing Board, 2018)	4	1	1	2	1	1	2	2
Pharmacy supervised administration (Lincolnshire Health & Wellbeing Board, 2018)	9	3	6	16	2	2	2	2

Table 5: Characteristics of locations in Lincolnshire with no previously identified county line activity.

Location Characteristic, data source, characteristic source	Alford	Bourne	Caistor	Chapel St Leonards	Coningsby	Holbeach
Population- census day 2011 source NOMIS	3459	13961	2489	4674	5021	7914
Average age (Years)-census day 2011 source NOMIS	43	42	44.7	52.9	36.4	45.1
Percentage of usual white ethnic origin %	98.7	97.4	98.6	98.8	98	97.8
Percentage of 65 year and older	23.8	20.4	23.0	36.3	13.9	26.9
Level of unemployment- Percentage economically active 16-74 years, unemployed %	4.3	3.1	2.8	4.8	4.1	4.6
Levels of low education, usual residents 16 and over no qualifications %	32.1	22.7	25.3	49.2	22.1	34.9
Direct city rail link	No	No	No	No	No	No
Rail link	No	No	No	No	No	No
Prison or open prison	No	No	No	No	No	No
Young offenders institute	No	No	No	No	No	No
Homeless hostel	No	No	No	No	No	No
Market town https://lincolnshire.org/lincolnshire-market-towns/ accessed 25.4.2021	Yes	Yes	Yes	No	No	No
Coastal town	No	No	No	Yes	No	No
Drug rehabilitation / We Are With You centre https://www.wearewithyou.org.uk/services accessed 25.4.2021	No	No	No	No	No	No

Table 5 continued: Characteristics of locations in Lincolnshire with no previously identified county line activity.

Location Characteristic, data source, characteristic source	Horncastle	Mablethorpe	Market Rasen	Market Deeping	Saxilby	Spilsby	Stamford	Woodhall Spa
Population- census day 2011 source NOMIS	6815	12531	4773	13574	3992	3440	19701	4331
Average age (Years)-census day 2011 source NOMIS	45.1	51.8	43.1	42	45.3	42.4	42.2	50.7
Percentage of usual white ethnic origin %	98.1	99	97.7	97.9	98.8	98.3	96.9	97.9
Percentage of 65 year and older	26.6	37.3	23.6	17.4	24.5	21.1	20.1	37.5
Level of unemployment- Percentage economically active 16-74 years, unemployed %	3.3	4.6	4.4	3.3	2.7	3.9	3.3	2.1
Levels of low education, usual residents 16 and over no qualifications %	29.7	46.7	26.4	19.1	22.1	30.6	20	25.1
Direct city rail link	No	No	No	No	No	No	Yes	No
Rail link	No	No	Yes	No	Yes	No	Yes	No
Prison or open prison	No	No	No	No	No	No	No	No
Young offenders institute	No	No	No	No	No	No	No	No
Homeless hostel	No	Yes	Yes	No	No	No	Yes	No
Market town https://lincolnshire.org/lincolnshire-market-towns/ accessed	Yes	Yes	Yes	Yes	No	No	Yes	No
Coastal town	No	Yes	No	No	No	No	No	No
Drug rehabilitation / We Are With You centre https://www.wearewithyou.org.uk/services accessed 25.4.2021	No	No	No	No	No	No	No	No

Two separate tables were produced: one for those towns which had been identified as having county line activity and one for those which had not. Each table also included the average for each of the demographic categories, standard deviation, and values for the upper and lower values for two standard deviations from the mean. The residuals of the mean were calculated for all groups and categories and the single factor ANOVA test conducted for each category. The result was used to determine whether the groups had equal variance based on the p-value of the test result.

A p-value represents the probability that the null hypothesis was rejected in error. The lower the value the less likely it is that the null hypothesis is rejected when it was in fact true and can be calculated using a test statics (t-test or z-test). It was determined that only population variance displayed evidence of difference.

Independent sample t-tests can be used to compare mean values of two different groups of data assuming the observations are independent, continuous values for dependent variables, distributed normally and there is equal variances. When the assumption for equal variance cannot be met an alternative t-test is used. Therefore t-tests based on unequal variance of group one and two were carried out in Excel for population, and the t-test with equal variance for all other demographic categories.

T-tests were carried out to assess whether there was a significant difference in the means of socio-demographic data in locations which had no recorded county line activity in 2019 (group 1) and those which had (group 2). The null hypothesis tested was Ho had equal means, Ho: $x=\mu$.

Table 6: T-tests for the significance of demographic data and county lines activity in Lincolnshire.

Hypothesis: Mean of group one, no identified county line = Mean of group two, identified county line activity, Ho: $x=\mu$					
Data	**Mean group 1, x**	**Mean group 2, μ**	**T-Test type**	**Probability**	**Significant at $p<0.05$**
Population	7,619.64	38,662.63	Unequal variance	0.0301	Yes
Percentage of population of white ethnic origin	98.14	97.06	Equal variance	0.0038	Yes
Average age	44.76	40.94	Equal variance	0.0349	Yes
Percentage of population aged 65 and over	25.17	19.05	Equal variance	0.0378	Yes
Percentage of economically active population unemployed	3.66	4.84	Equal variance	0.0106	Yes
Percentage of population with no educational qualifications	29.00	28.61	Equal variance	0.9192	No

The null hypothesis for equal means is rejected for population, percentage of population of white ethnic origin, average age, percentage of the population aged 65 years and older and the percentage of economically active people who are unemployed. This indicates that the towns with county lines activity have different levels of population, average age, percentage of unemployment, percentage of persons aged 65 and over and of white ethnic origin to those with no county lines recorded.

The null hypothesis for equal means is not rejected for the percentage of persons with no qualifications, meaning there is no significant difference in the percentage of persons without qualifications, between towns with or without recorded county lines.

However, caution needs to be taken due to the small number of samples within the analysis. It is recommended that the test be carried out on a much wider sample to confirm the wider validity and generalisability.

5.2.1.1 Comparative case analysis to identify risk factors.

In simple terms the risk terrain model is built up by combining the identified risks for each crime type. Where all identified risks combine spatially, it is the belief that these locations will be most at risk to future offences. However, in terms of where four of a possible five risk factors are spatially located, conjunctive analysis can help to determine whether each of the four risk combinations are likely to pose the same level of risk (Caplan et al., 2012). Conjunctive analysis of comparative cases (CACC) can be utilised to understand the relationships between the presence or absence of variables on an outcome such as crime. Additional advantages of CACC is in testing hypotheses. However, the main limitation is that is does not specify the strength of interrelationships or the overall model fit.

CACC has been used in research to explore the contexts of situational variables for rural violent crime (Rennison & DeKeseredy, 2017) and routine activity theory and the likelihood of arrest (Drawve et al., 2017). Rennison & Dekeseredy (2017) found that only 17% of a possible 605 situational contexts were dominant settings for rural violence, whilst (Drawve et al., 2017) found over 35% of all assaults were in one of the top ten observed contextual configurations. The method has also been used to research sexual homicide (Chopin & Beauregard, 2019), robbery (Hart & Miethe, 2015), carjacking (Miethe & Sousa, 2010) and victimisation and lifestyle risks (Eggers, 2016) among others. The wide variation in crime types analysed using this technique led me to believe that it will increase the understanding of the situational contexts that materialise as increased risk for county lines drug dealing. It also further embeds the research in the pragmatic realist domain to provide evidence of the influences to risk in situational and locational contexts. As Drawre et al. (2019:109) state, conjunctive analysis can improve understanding of the context

of risky places and ‘supplement risk terrain modelling to identify dominant behaviour settings (combination of risk factors) associated with each place’.

Miethe et al. (2008) discuss how exploratory data analysis can identify problems within the data such as skewness, non-linearity and outliers that will impact on the reliability and validity of further analysis or modelling. One of the assumptions used within regression modelling is that the variables have a single main effect on the dependent variable. However, this is not always the case, and the combination of variables may have different impacts on the dependent variable. They promote the use of CACC which (Hart, 2014) states the purpose is ‘to find patterns in data which have multiple characteristics associated with crime’.

CACC can be used to investigate the interrelationships variables have with one another to identify situational clustering (Miethe et al., 2008) via the use of a conjunctive matrix or truth table. The level of clustering can be clearly seen within the matrix, as can those outlying combinations with low frequencies which affect statistical estimates in multivariate analyses. A paired-comparison of the matrix will identify if a main-effect model is valid for the data set as identified by (Drawve et al., 2017). They used conjunctive analysis of comparative cases to explore the likelihood of arrest and found that the main effects model for routine activity theory on the likelihood of arrest, provided evidence of the limitation of a main effect model and evidence of context-specific effects.

In their explanation of CACC, Hart et al. (2017) give three key points which are pertinent to this research study. It ‘focuses on the situational contexts constructed using relevant variables’, ‘it evaluates the nature and magnitude of conjunctive relationships’ and it ‘offers the ability to identify main effects and contextual effects’ (Hart et al., 2017:114). The aim of this study is to identify the situational contexts which increase the risk of county line drug dealing within rural communities. The CACC method supports RTM in identifying the differing situational contexts which influence crime location.

Comparative case analysis was completed on the locations of county lines activity. A truth table was generated for the demographic data and for lifestyle activity information obtained from NOMIS for those locations which were known to have county line activity and those that did not in 2019. Due to the number of possible combining factors the demographic data was considered separately to the lifestyle activity data. This was to enable a clearer comparison and ease the determination of those factors likely to be impacting on the presence of a county line at the location. Truth tables were completed to show the total number of occurrences of the specified combination, and the number of combinations which are positive locations for county lines activity. The proportion of the total combinations which have county lines was calculated.

The demographic and the categoric tables were then reduced to show only those combinations which corresponded to a county line. A third truth table to include population and category data was produced. Those categories which appeared to have little impact, based on the proportions of county lines were removed from the final truth table of the comparative case analysis.

Comparative case analysis was completed on towns within Lincolnshire in two phases: socio-demographic characteristics and facilities/category. The results of the analysis are shown in Tables 7 and 8.

Table 7: Comparative case analysis for Lincolnshire towns- demographic data.

Location	County line 2019	Population Census 2011, >15,000	Average age, over 50	% white ethnic origin, >=98.6 (mean +1sd)	Percentage >= 65 (mean+1sd)	Percentage unemployed Economically active > 5.15 (mean+1st)	Percentage no qualifications >37 (mean+1sd)	Demographics Pattern
Alford	0	0	0	1	0	0	0	001000
Boston	1	1	0	0	0	0	0	100000
Bourne	0	0	0	0	0	0	0	000000
Caistor	0	0	0	1	0	0	0	001000
Chapel St Leonards	0	0	1	1	1	0	1	011101
Coningsby	0	0	0	0	0	0	0	000000
Gainsborough	1	1	0	0	0	1	0	100010
Grantham	1	1	0	0	0	0	0	100000
Holbeach	0	0	0	0	0	0	0	000000
Horncastle	0	0	0	0	0	0	0	000000
Lincoln	1	1	0	0	0	0	0	100000
Louth	1	1	0	0	0	0	0	100000
Mablethorpe	0	0	1	1	1	0	1	011101
Market Rasen	0	0	0	0	0	0	0	000000
Market Deeping	0	0	0	0	0	0	0	000000
Saxilby	0	0	0	1	0	0	0	001000
Sleaford	1	1	0	0	0	0	0	100000
Skegness	1	1	0	0	0	1	1	100011
Spalding	1	1	0	0	0	0	0	100000
Spilsby	0	0	0	0	0	0	0	000000
Stamford	0	1	0	0	0	0	0	100000
Woodhall Spa	0	0	1	0	1	0	0	010100

Table 8: Comparative case analysis for Lincolnshire towns- life style and activity factors.

Location	County line 2019	Direct city rail link	Prison/ Open Prison	Homeless hostel	Market or coastal town	Drug rehabiltation / We Are With You centre	Pharmacy needle exchange	Pharmacy su-pervised admin-istration, 3 or more	Category Pattern
Alford	0	0	0	0	1	0	0	0	00001000
Boston	1	0	1	1	1	1	1	1	10111111
Bourne	0	0	0	0	1	0	0	0	00001000
Caistor	0	0	0	0	1	0	0	0	00001000
Chapel St Leonards	0	0	0	0	1	0	0	0	00001000
Coningsby	0	0	0	0	0	0	0	0	00000000
Gainsborough	1	1	0	0	1	0	1	1	11001011
Grantham	1	1	0	1	1	1	1	1	11011111
Holbeach	0	0	0	0	0	0	0	0	00000000
Horncastle	0	0	0	0	1	0	0	0	00001000
Lincoln	1	1	1	1	1	1	1	1	11111111
Louth	1	0	0	0	1	0	1	0	10001010
Mablethorpe	0	0	0	1	1	0	1	0	00011010
Market Rasen	0	0	0	1	1	0	0	0	00011000
Market Deeping	0	0	0	0	1	0	1	0	00001010
Saxilby	0	0	0	0	0	0	0	0	00000000
Sleaford	1	1	0	1	1	0	1	0	11011010
Skegness	1	1	0	1	1	1	1	0	11011110
Spalding	1	1	0	1	1	1	1	0	11011110
Spilsby	0	0	0	0	0	0	0	0	00000000
Stamford	0	1	0	1	1	0	1	1	01011011
Woodhall Spa	0	0	0	0	0	0	0	0	00000000

The truth tables were condensed into Table 9 and Table 10.

Table 9: Truth table for Lincolnshire towns with county lines- demographic data.

Demographics Pattern*	Total Count	County Lines Count	Proportion of County Lines
000000	7	0	0
001000	3	0	0
010100	1	0	0
011101	2	0	0
100000	7	6	0.86
100010	1	1	1
100011	1	1	1
Total	22	8	

*Population >15,000: Average age >50: % white ethnic origin>98.6: % unemployed>5.15: % no qualifications>3*Population >15,000: Average age >50: % white ethnic origin>98.6: % unemployed>5.15: % no qualifications>37

Table 10: Truth table for Lincolnshire towns with county lines- activity and lifestyle factors.

Category Pattern*	Total Count	County Lines Count	Proportion of County lines
000000	4	0	0
001000	5	0	0
001010	2	1	0.5
011010	1	0	0
100000	1	0	0
101011	1	1	1
111000	1	0	0
111010	1	1	1
111011	1	0	0
111110	2	2	1
111111	3	3	1
Total	22	8	0.36

*Rail link: Homeless hostels: Market or coastal town: Drug rehabilitation centre: Pharmacy needle exchange: Pharmacy supervised administration>3

The demographic and the categoric tables were then amalgamated and reduced to show only those combinations which corresponded to a county line. Those categories which appear to have little impact, based on the proportions of county lines are removed from the final truth table.

Table 11: Truth table for Lincolnshire towns with county lines- combined results.

Population Facility Pattern	Total Count	County Line Count	Proportion of County Lines
0000000	4	0	0.0
0001000	5	0	0.0
0001010	1	0	0.0
0011010	1	0	0.0
0100000	1	0	0.0
0111000	1	0	0.0
1001010	1	1	1.0
1101011	1	1	1.0
1111010	1	1	1.0
1111011	1	0	0.0
1111110	2	2	1.0
1111111	3	3	1.0
Total	22	8	

*Population>15,000: Rail link: Homeless hostels: Market or coastal town: Drug rehabilitation centre: Pharmacy needle exchange: Pharmacy supervised administration>3

This left seven categories to be considered in the final comparative case analysis. These were:

Population>15,000

Presence of a rail link

Presence of homeless hostels/shelters (Bail hostels)

Location is a market or coastal town

Presence of drug rehabilitation centre

Presence of a pharmacy needle exchange and

Presence of three of more pharmacy supervised administration facilities.

Table 12: Comparative case results for Lincolnshire towns with county lines.

Total County Line Count	Proportion of County Line towns	Factors
8	1	Population >15,000
7	0.875	Population >15,000 and railway station
7	0.875	Population >15,000 and railway station and needle exchange
5	0.625	Population >15,000 and railway station and homeless hostel
5	0.625	Population >15,000 and railway station and homeless hostel and market town/coastal
5	0.625	Population >15,000 and railway station and homeless hostel and market town/coastal and drug rehabilitation

The comparative case analysis identified the characteristics of a town which would encourage or support county lines drug dealers. The results are shown in Table 12 and show that there is a watershed population for which county lines are viable, and this is 15,000 people. Railway stations and needle exchanges are also identified as important elements of a town representing accessibility and the likelihood of a market for drugs. Offenders are known to use the train (NCA, 2015; Drug Threat Team, 2017) and this has been supported in Lincolnshire by intelligence submission reports, suspect arrests, and police officer experience. Homeless hostels were included by officers under aspects of disadvantage and can be used by offenders to identify targets for cuckooing, as can needle exchanges. Officers also identified that youth hostels, sheltered housing and buzzer entry flats all offer potential locations and opportunities for victim identification.

The comparative case analysis identified characteristics of a town which appear necessary to facilitate county lines, and officers interviewed also identified four of these key areas (sufficient population, coastal towns, presence of a railway station and hostel accommodation). Officers also identified personal characteristics that could make someone more susceptible to becoming a

victim of cuckooing and these observations from experience in many respects mirror those identified from the literature review.

The literature review identified that persons involved in county lines were likely to be from a disadvantaged background (Coomber & Moyle, 2018; Drug Threat Team, 2017; Irwin-Rogers, 2019; NCA, 2015; O'Hagan & Long, 2019; Robinson et al., 2019, Spicer, 2021; Windle et al., 2020). The research of cuckooed victims in Lincoln supports this with the majority having had prior contact with the police. Between two and three fifths of victims in 2019 and 2020 admitted to using heroin or cocaine, with a small number of additional victims admitting to taking methadone. O'Higgins (1998:46) states that problem drug users tend to be 'educationally disadvantaged and unemployed' and their 'residence tend to cluster in neighbourhoods characterised by poverty and general disadvantage'. Police records also show that for periods of time victims may have also been resident at charitable short stay accommodation underlying the social disadvantages of those victimised.

5.2.2 Lincoln city risk analysis

Lincoln, although not itself rural, is situated in a rural county, and it is this rurality which has enticed out of town dealers to set up county lines drug businesses. It has experienced the greatest number of lines within the county and has the greatest number of addresses which have been previously cuckooed. The number of cuckooed addresses is still relatively small but is sufficient to complete the analysis using both the automated RTMdx software (Rutgers Centre On Public Safety, 2021) and by a manual approach. The method to be used for creating the risk terrain model in Lincoln is detailed in the following sections.

As part of Lincolnshire Police's requirements to report to the NCLCC the location of the cuckooing activity as well as the victims' details are recorded. This was completed by me as an ongoing process during 2019 and 2020, with information obtained from intelligence assessment, crime reports, incident reports and police warrant activity. The type of property was explored using

open-source enquiries and the website www.homipi.co.uk (HOMIPI. 2022). The site provides a list of addresses giving details of the property including the type, number of bedrooms (when known), and the price and year of last sale (if known).

This information is summarised in 13; flats are the dominant residence type for victims. It is known from the work carried out as part of police investigations that some of the properties are owned by the local council, or by the Framework social housing group. It has not been possible to obtain information on property ownership or felt appropriate to request ownership details for the purposes of this research. However, this information would be valuable in confirming the inference that the properties are predominantly rented, and likely to be socially rented. Collaboration with local councils may result in this information being available for future research. The lack of available sale details on open-source property websites, alongside local knowledge of the property locations, adds support to this hypothesis that most Lincoln victims live in socially rented accommodation.

Table 13 also shows a summary of victim characteristics of persons identified as cuckooed in Lincoln during 2019 and 2020 collated for the purpose of reporting to the National County Lines Co-ordination Centre and/or as part of strategic analysis for Lincolnshire Police. The victims are predominantly white and British with only two non-British victims. Approximately 90% of victims have been involved with the police, as suspects, prior to their cuckooing, evidenced by the allocation of a Police National Computer (PNC) number. This is not the only vulnerability which contributes to victimisation but is a frequent and dominant characteristic of those exploited (NCA, 2019; Spicer et al., 2020).

When a person is brought into custody a risk assessment is carried out. As part of this evaluation detainees are asked if they have any health issues, including mental health issues or addiction, and whether they take any prescribed medication. From the responses recorded most detainees are happy to give this information, even if they refuse to say which drugs they use. As noted

above, 90% of cuckooed victims had at some previous point been in police custody and undergone a risk assessment. This information was used to identify vulnerability factors which may have put them at risk to exploitation by out-of-town dealers. Mental health, the use of prescription drugs (not including methadone) and the use of heroin or cocaine are the most prevalent amongst the identified cuckooed victims in Lincoln for both 2019 and 2020.

Table 13: Victim characteristics of persons cuckooed in Lincoln.

Property and Victim Characteristics	2019	2020
Number of victims	26	25
Average age	42 years	35 years
Oldest/Youngest victim	56 years/ 19 years	52 years/ 16 years
Female/ Male victims	12/14 victims	14/11 victims
Ethnicity	100% white	White, exception of one mixed race female
Identified vulnerability- mental health*	22	20
Identified vulnerability- prescription drugs*	14	9
Identified vulnerability- heroin, cocaine user*	10	15
Identified vulnerability- alcohol*	3	4
Identified vulnerability- methadone user*	3	2
Identified vulnerability- recorded on the Police National Computer	22	23
Living in a flat#	17	20
Living in a terrace property#	5	3
Known to be a one-bedroom property#	12	12
Property recorded as previously sold#	4	5

*Identified from custody record information provided by the victim, warning markers and police interviews.

Identified from the www.homipi.co.uk website on the 1st and 2nd September 2021.

The elements identified from the comparative case analysis and the Lincolnshire victim data for consideration in the risk terrain analysis have been translated into the following risk factors:

- areas where property is highly likely to be rented, a flat or terraced property with a household compromising of one person or a couple of people
- areas of social-economic deprivation
- proximity to support services such as the local council and unemployment offices
- proximity to Probation Service offices
- proximity to drug support services
- proximity to areas of social housing
- proximity to areas of high proportions of one-bedroom properties/flats
- proximity to railway station

The importance of local networks of drug users, and the density of acquaintanceship was acknowledged as an important aspect of county lines activity (Clark et al., 2021; Coomber & Moyle, 2018; Drug Threat Team, 2017, Moyle, 2019; NCA, 2019a; Stone, 2018). The extent to which individuals are involved in the same activities (Browning et al., 2017) increasing the trust between persons and leading to locations and routes- nodes and pathways- which generate similar and overlapping awareness spaces (Brantingham & Brantingham, 1984 & 1995; Cohen & Felson, 1979) will be represented in the analysis by locations of key support services to provide a generalised awareness space. Table 14 lists the risk factors which will be included in the analysis of risk to cuckooing in Lincoln.

Table 14: Potential risk factors for inclusion in the risk terrain modelling.

Risk Factor	Modelled as	Unit Size	Source
Social rented accommodation	Census 2011– tenure of property	Census output area	ONS Using: EDINA Society Digimap Service
Accommodation type	Census 2011– accom-modation type	Census output area	ONS Using: EDINA Society Digimap Service
One person households	Census 2011– house-hold composition	Census output area	ONS Using: EDINA Society Digimap Service
Ethnicity	Census 2011	Census output area	Ethnicity is considered in the social grade and so will not be considered separately
Social grade	Classification– Con-strained City Dwellers	Census output area	ONS Using: EDINA Society Digimap Service
Routine activity hubs – council, addiction support services, Probation Service and High Street area	Distance from property	Metres	Manually created area using QGIS to include support services.
Potential new dealers	Distance from property to railway station	Metres	Lincolnshire Police records
Heroin, cocaine, and methadone users	Distance from property addiction services and needle exchanges	Metres	Lincolnshire Police records
Previously targeted– exposure (removed following discussions with Caplan & Kennedy 2022)	Previously cuckooed addresses	Property	Lincolnshire Police records

The process for generating the risk analysis is slightly different depending on whether the manual approach is taken or the automated method using the RTMdx program. Both commence with identifying those factors which have the potential to influence positively or negatively the risk levels across the geographic space. The manual model requires each aspect to be assessed for its likely impact on the issue under research. Once those factors have been determined these are mapped and combined to create the risk terrain analysis. In contrast the RTMdx considered all

possible risks and whether the impact is due to the proximity to the potential risk factor or the density of the risk factors. It then processes all the factors based on the distance parameters stated and if a significant model is found displays the corresponding map and the relative risk values of those factors included in the model. The flow chart below summarises the main steps in the process.

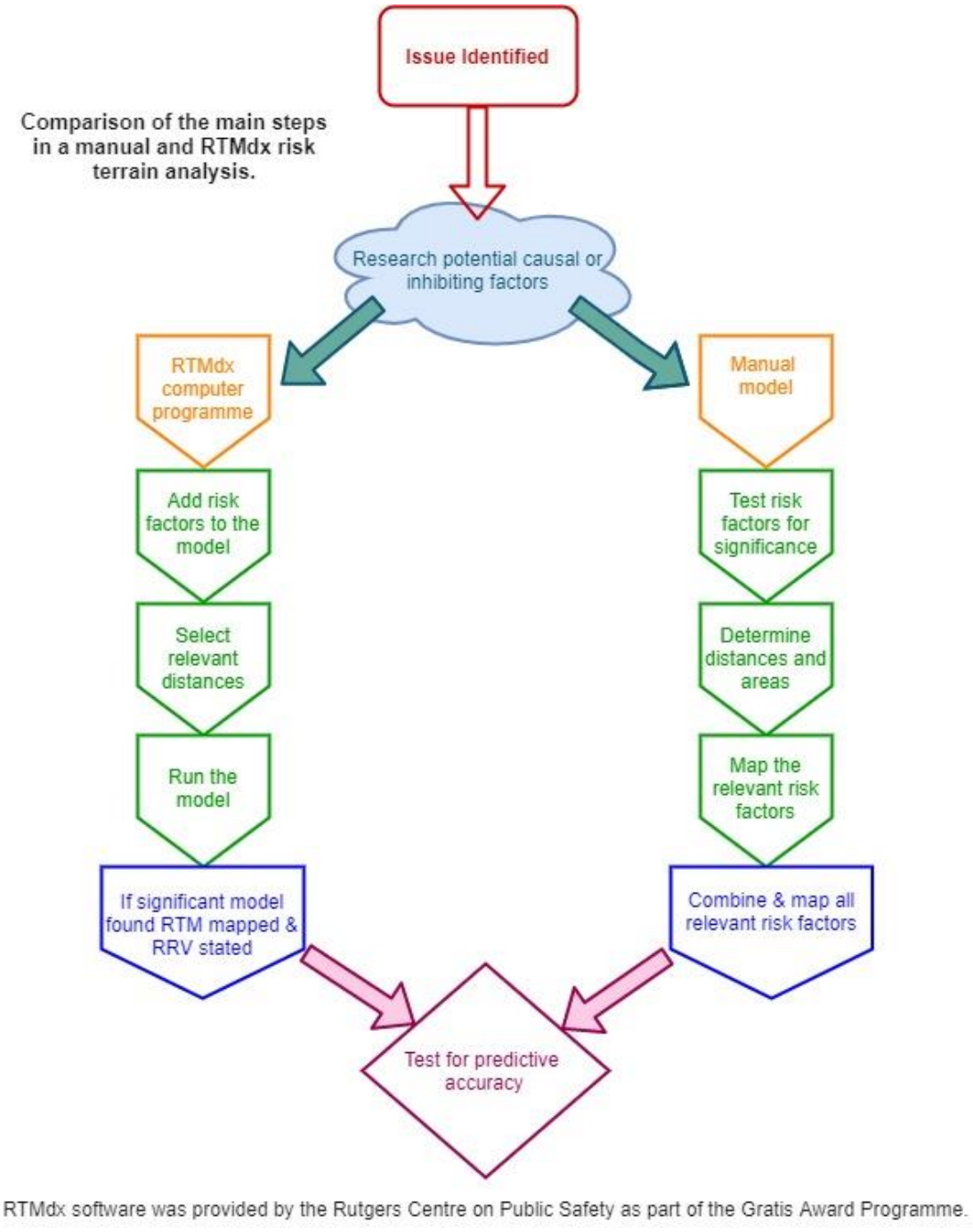


Figure 4: Risk terrain modelling process for manual and RTMdx method

Both the manual and RTMdx analysis make use of previously identified locations in the modelling process to identify areas at risk for the next year. For example, locations of cuckooing for 2019 are used to generate models of risk for 2020. The actual locations of recorded incidents of cuckooing are then compared against the areas of identified risk for 2020, and the predictive accuracy index calculated to determine whether the models are successful, and to compare the manual against the RTMdx models.

5.2.2.1 RTMdx Models

The RTMdx software was provided by the Rutgers Centre on Public Safety and was initially awarded to me for this specific research project as part of their Gratis Program. This allowed three months' use of the software without cost. Following the completion of the three-month period and meeting with Professors Caplan and Kennedy a student license was purchased to revise the models based on feedback received.

The software runs over the internet with the user determining the extent of the research area, the topic which the model generates the relevant risk terrain model, and those factors considered to be relevant to increasing or decreasing the risk of the chosen 'topic' occurring. Files are uploaded as ESRI shape files, and the software told which files correspond to the area, topic, and risk factors. The user determines the relevant place size and units of measurement and designates whether the risk factors should be considered based on their density or proximity to the 'topic'. Finally, the user selects the extent to which the model will consider the risk factors' influence, up to a maximum of 4 and whether to confine the modelling process to full or half units of the chosen place size.

During the production of the individual risk maps data aggregation and the potential effects of the modified areal unit problem (MAUP) was considered. The use of theory to identify the most appropriate size for the unit of analysis is important (Hipp, 2007) as the creation of the raster grids within the model could be affected by MAUP (Dark & Bram, 2007). Gehlke & Biehl (1934),

Openshaw (1977) and Fotheringham & Wong (1991) identified that variations in the size and shape of bounding areas can lead to unreliable results when used in multivariate statistical analysis. With the RTMdx model the place size considered is the street length within the city of Lincoln. This is in keeping with the recommended use of typical block size in American studies (Caplan et al., 2013). When the use of socio-economic variables are incorporated the centroid of the census output area will be used in line with the methodology used by Gimenez-Santana, et al. (2018).

The software completes an automated risk terrain analysis with the risk factors as the independent variables and the crime locations as the dependent variable. The spatial influence of the variables is operationalised based on the place size specified up to four times the distance, or as the bandwidth in a kernel density estimation depending on whether a density or proximity relationship has been chosen for the variables.

The software assumes a Poisson distribution and builds an elastic net penalized regression model to create a model where all selected variables are useful. A stepwise regression process is an automatic step-by-step iterative method of constructing a regression model by adding and removing independent variables and testing for significance after each iteration. The process continues until the model cannot be improved. A Bayesian Information Criteria Score (BIC) is calculated for the optimum model. The process is carried out first assuming a Poisson distribution and then assuming a negative binomial distribution. A Poisson distribution is one where events are independent, the average rate of events remains constant, and the data refers to events. It also assumes the mean and variance are equal. A negative Binomial distribution has an additional parameter to the Poisson distribution to adjust the variance independently of the mean and is best suited to distributions where the variance is greater than the mean. The model with the best BIC is used to generate the risk terrain analysis.

The program can take seconds or minutes depending on the size of the places and number of risks being considered. Once completed either a final report is given on screen, or a message is displayed stating that 'no significant risk terrain model could be found'.

The output includes details on the relative risk scores obtained from the analysis, including the range of scores, mean and standard deviation. It identifies how many places in the analysed area have a score greater than two standard deviations above the mean and the percentage of area that this covers. Standard deviation measures how much the values in a distribution are spread from the mean. The higher the standard deviation the greater the spread of the data. Approximately 95% of a distribution will be within two standard deviations above or below the mean. The data which is beyond two standard deviations is less than 5% likely to have occurred by chance and is the most used value for determining if the results of a statistical test are significant. In terms of the risk terrain analysis, the results identify those areas which have a significantly higher level of risk than the rest of the analysed area. The RTMdx output includes four maps of the analysed area which show:

- Highest Risk- those areas in the top 5% of highest risk values and those over two standard deviations above the mean.
- Above average risk- those areas with relative risk scores over two standard deviations above the mean, and those above the mean to the mean plus two standard deviations.
- All relative risk scores.
- Priority Places- those places with relative risk scores two standard deviations or more above the mean that intersect with locations of past exposure and those locations with relative risk scores equal to or greater than the top 1%.

A pdf report can be produced which details the parameters and risk factors included in the research, the relative risk values of those risk factors that have contributed to the final significant risk model and images of the risk terrain maps. Also included is a summary of the analysis

including the risk factors and the R script results for the selected regression model with coefficients, standard error, and t-values. An example of the RTMdx report is shown in Appendix 3. Files can be downloaded of the risk terrain maps for use in other GIS software or as images to incorporate in reports. The 'highest risk' results were exported into QGIS before being presented to officers for discussion in phase two of the interviews.

The software program allows easy and quick analysis, compared to the manual approach of multiple place sizes and combinations of risk factors. For the research the area was kept constant and was the Lincoln district shape file. The distance multiplier was constant at four times and the unit was kept at half. The topic was the location of cuckooed addresses in Lincoln during 2020, and the process repeated for cuckooed addresses in 2021.

Lincoln is a city that has grown organically with distinctive housing areas added to the city over several hundreds of years. Determining an optimum place size- typically a standard block size in American based research was not immediately obvious. A comparison of streets across the city identified that there was a range from short cul-de-sacs to longer street segments. Based on this I decided to run the model with place sizes of 150 metres, 100 metres, 75 metres and 50 metres.

Three separate models were generated, each with the differing place sizes. The first model comprised of those locations linked to routine activities of drug users, previously cuckooed victims, and the locations of addresses cuckooed in 2019. Proximity measures were used for those risk factors comprising of a single entity and both density and proximity for those with multiple entities. The second model comprised the 2019 exposure locations of previously cuckooed victims and the social demographic characteristics thought to be relevant. These were considered by proximity and density. The third model included all the risk factors from the first and second models and used the same density and proximity calculations as those models.

As part of the conditions for the RTMdx Gratis Award I produced a report of the results which was submitted to Professor Joel Caplan in January 2022. This included a brief overview of the

research, risk factors included in the model and an example of the results. Shortly after I took part in a Teams meeting with Professor Joel Caplan and Professor Les Kennedy who are responsible for the theory of risky places (Kennedy & Caplan, 2012) and the RTM methodology (Caplan & Kennedy, 2010). The purpose of which was to explain my research in further detail, the risk factors and relevance of the research. I was also given valuable feedback on how to improve my models. This was specifically in relation to the inclusion of exposure factors within the RTMdx model, which I had represented using 2019 cuckooed addresses when modelling 2020 data.

Crime is more likely to occur in areas which are both vulnerable to crime and have had previous exposure to crime. Initially I had incorporated this exposure to crime as one of my risk factors. Caplan and Kennedy advised that the model could be subject to undue bias and lead to unreliable models when included as a risk factor and should be considered post modelling to direct where intervention might be best utilised. I subsequently took their advice onboard and ran the analysis without the exposure events of 2019 included.

Revised models were generated with all twenty-one potential risk factors with fifty, one hundred, and a hundred and fifty metre place sizes. These risk factors included locations likely to be frequented by potential cuckooed victims and/or offenders based on routine activities. Proximity measures were used for those risk factors comprising of a single entity and both density and proximity for those with multiple entities. Due to the data availability on social demographic data at the census output area the analysis utilised the centroid of each area as successfully used in the research of Gimenez-Santana et al. (2018).

To focus on those output areas which would be most likely to impact on the levels of risk, only those output areas which had levels of social rented property, single person households or flats with a percentage higher than the mean plus one standard deviation were included. The index of multiple deprivation was used as a risk factor with centroids of areas within the worst ten percent and those within the worst 20% included in the modelling process. The final inclusion were the

areas which were designated ‘constrained city dwellers’ (Office for National Statistics, 2015) from the Census 2011 output area classification supergroups.

5.2.2.2 Manual models

A manual model of risk of county lines was created using the information available for the RTMdx models. The QGIS software facilitated the creation of buffers around locations identified as potential contributing factors to a location being vulnerable, and then residential properties within the buffered areas were selected. For each buffer created, a separate mapping layer was produced of the residential properties within it. The buffered layers were created as detailed in Table 15.

Table 15: Buffer layers in the manual county line model.

Potential Risk Factor	Buffer Size
Cuckooed locations 2019	100 metres
Cuckooed locations 2020	100 metres
Cuckooed locations 2019	150 metres
Cuckooed locations 2020	150 metres
Routine activity area	150 metres
Supported accommodation	200 metres
Supported accommodation	500 metres
Support services	200 metres
Support services	500 metres
Train station	1km
Train station	1.5km

Due to data availability aggregated data was used to represent flats, rented accommodation and property occupied by single persons. It was also the case when representing areas of deprivation through areas of multiple deprivation and areas categorised as ‘constrained city dwellers’. The

same criteria as for the RTMdx model was used to identify these locations before the residential properties within them were selected to create the map layers.

The layers were added to the mapping system and the number of cuckooed addresses from the following year falling within the geographic extent of the individual layers and combination of layers identified, using the QGIS select by location function. QGIS was also used to calculate the area of the layers which was used to calculate the area as a percentage of the total area of Lincoln containing residential properties. The predictive accuracy index (PAI) (Chainey et al., 2008) was then calculated for identified single risk factors and different combination of risk factors.

PAI is the most used evaluation methodology to assess the accuracy of prediction and forecasting analysis (Drawve & Wooditch, 2019) and 'is defined as the percent of crime in the forecasted hotspots divided by the percent of the geographic area forecasted to be a hotspot' (Drawve & Wooditch, 2019:43). The PAI is a method of standardising a model's accuracy at predicting the location of future events and facilitates comparisons between different analysis techniques. It is calculated using the formula:

PAI=Hit Rate / Percentage area

where hit rate is the number of events in the high-risk area/ total events in the district * 100,

and percentage area is the area of high risk / total area of the district * 100.

The results of the predictive accuracy index calculations were used to refine the combination of layers to maximise the index score and minimise the percentage area required to achieve this. As the manual modelling process builds up layers identified as contributing to risk, the exposure layer, represented by the proximity to previous offences can be incorporated into the modelling process.

The same iterative process continued to identify those layers which had the greatest influence on risk, based on the ratio of the area at risk to the predictive accuracy index score, and the final model determined.

5.2.3 Assessing the success of the models to identify areas at increased risk

All models, both manual and RTMdx analysis were opened in the QGIS software and the identified addresses of victims of cuckooing in 2021 added to the map. Utilising the QGIS filter and basic statistics functions the values required to complete the PAI calculations were obtained and added to an Excel table.

When calculating the area of risk and total area, only the areas which could be subjected to an offence are considered. For example, when calculating the total area for county lines this was the total area of residential properties, not all properties within Lincoln. This helps to minimize problems arising from modifiable areal unit problem, research degrees of freedom and erroneously concluding superior success of a model (Drawve & Wooditch, 2019:44).

PAI scores were calculated, and hard copies of the final model maps created to be used in the second stage of interviews with police officers. Several versions of the model results were provided during the interview with varying levels of information: a blank map of the analysed area, the analysis maps, and the analysis maps with details of the relative risk scores and or predictive accuracy index scores.

5.3 Risk Terrain Results

5.3.1 RTMdx results

The RTMdx software was utilised to run models of risk of residential properties to county line cuckooing. Twelve models were generated with place sizes ranging from 50 metres to 150 metres. The results are summarised in Table 16.

Following discussions and feedback from Professor Joel Caplan and Professor Les Kennedy the RTMdx models were revised removing the exposure factors, as detailed in 5.2.2.1. As the previous models had no significant results at a 75-metre place size, this was not included when the analyses were repeated. For the second round of analyses the risk factors were not split (social demographic and routine activity) and included as one analysis. Table 17 shows the revised risk factors used in the RTMdx modelling and the results of the revised analysis are shown in Table 18.

The results were tabulated to show the model description, place size, number of places, the relative risk scores of the model generated including range, mean, standard deviation, and number of places and percentage of places with scores above two standard deviations above the mean. Finally, the risk factors included in the model with the relevant distance parameter, distance and relative risk value are stated. An example of the Simsi RTMdx output for county lines can be found in appendix 3.

Table 16: Results of county line RTMdx modelling analysis for Lincoln

Model Factors Description	Place size, metres	Total number places	RRS range	RRS Mean	RRS SD	Number places RRS >mean+2SD	Percentage places >mean+2SD	Risk Factors	Risk factor type & distance	RRV
Density & Proximity Routine activity factors 2019 locations	150	1716	1-33.656	1.171	2.359	9	0.52%	Homer House	p=300m	33.656
	100	3775	1-131.268	3.108	11.545	28	0.74%	2019 locations Support services	p-200m d-800m	12.537 10.471
	75	6592						No significant risk terrain model found		
	50	14643	1-271.999	1.731	9.92	54	0.37%	YMCA Homer House 2019 locations	p-150m p-200m p-150m	35.336 17.676 7.698
Density & Proximity social and demographic factors & 2019 locations	150	1716	1-1197.411	11.688	51.22	44	2.56%	Centroids of single people Centroids of socially rented 2019 locations	p-300m p-150m p-150m	25.649 8.434 5.536
	100	3775	1-115.917	11.99	31.628	316	8.37%	Centroids single people Centroids constrained city dwellers	d-300m p-200m	14.1 8.221
	75	6592	1-405.211	8.261	34.692	101	1.53%	Centroids single people 2019 location Centroids constrained city dwellers	p-225m p-150m p-150m	13.859 6.531 4.477
	50	14643	1-529.652	18.96	67.382	211	1.44%	Centroids constrained city dwellers 2019 locations	p-200m d-150m	82.335 6.433
All factors with relevant density and proximity	150	1716	1-1656.569	23.159	118.017	8	0.47%	Centroids socially rented Centroids of single people Nacro services	p-150m p-300m p-900m	13.571 13.216 9.237
	100	3775	1-1424.106	24.572	115.254	22	0.58%	Centroids city dwellers Addaction Centroids of single people	p-200m p-800m d-300m	17.453 9.128 8.939
	75	6592						No significant risk terrain model found		
	50	14643	1-8078.531	26.296	195.469	227	1.55%	Centroids constrained city dwellers Railway station 2019 locations	p-200m p-400m d-150m	94.396 13.917 6.15

Table 17: Revised RTMdx analysis for county lines.

Model Inputs Risk Factors Considered	Operationalised as:
Percentage of flats- output area greater than mean plus one standard deviation	Proximity
Bala House	Proximity
NACRO services	Proximity
Probation Service	Proximity
Support Services	Density and proximity
Routine activity area	Proximity
Addaction	Proximity
Homer House	Proximity
Nomad Centre	Proximity
Railway station	Proximity
Support accommodation	Density and proximity
Lincoln City Council offices	Proximity
Percentage of single households- output area greater than mean plus one standard deviation	Proximity
Needle exchange	Proximity
YMCA centre	Proximity
Constrained city dwellers- output areas	Proximity
Percentage tenure is rented- output area greater than mean plus one standard deviation	Proximity
Framework	Proximity
Jobcentre	Proximity
Pathways Centre	Proximity

Table 18: RTMdx revised model results.

Model Inputs	Operationalised as:	Model results		
Risk factor considered		50m model	100m model	150m model
Probation Services	Proximity			1200m influence and RRV 7.43
Support services	Density and proximity		Density influence 800m and RRV 9.344	
Homer House	Proximity	200m influence and RRV 66.74	200m influence and RRV 14.887	
YMCA	Proximity	100m influence and RRV 202.573		
Constrained city dwellers- output areas	Proximity		100m influence and RRV 12.675	300 influence and RRV 23.03
RRV* mean		1.326	8.491	18.738
RRV* standard deviation		6.176	45.504	40.699
Significant RRV*		13.69	99.499	100.136
Percentage area of study area		1.19%	5.61%	11.85%
Number of 2021 victims in model area		2	5	11
Percentage of victims in model area		10.53	26.32	57.89
PAI#		8.85	4.69	4.88

*** Relative risk value**
 # Predictive accuracy index

Table 18 shows the results of the revised RTMdx models for the highest risk areas to county lines and the corresponding PAI scores for the nineteen 2021 locations. The extremely small percentage area identified as highest risk in the 50m analysis skews the PAI, as there are only two locations in 2021 which are within the highest risk area, despite this having the highest PAI. The number of locations which were encompassed in the analysis area is extremely low in comparison with the other two models. In contrast the analysis based on a place size of 100m has a PAI score less than half of the 50m model but incorporates over a quarter of the 2021 locations. In addition, the extent of the area comprising this area of highest risk is still less than 6% of the total area of

residential buildings. The 150m model has a slightly higher PAI at 4.88 and double the risk area at 12% of the area of residential properties in Lincoln, but it does capture over 55% of the identified homes of victims recorded for 2021.

Map showing residential properties at high risk to county line cuckooing in Lincoln city.

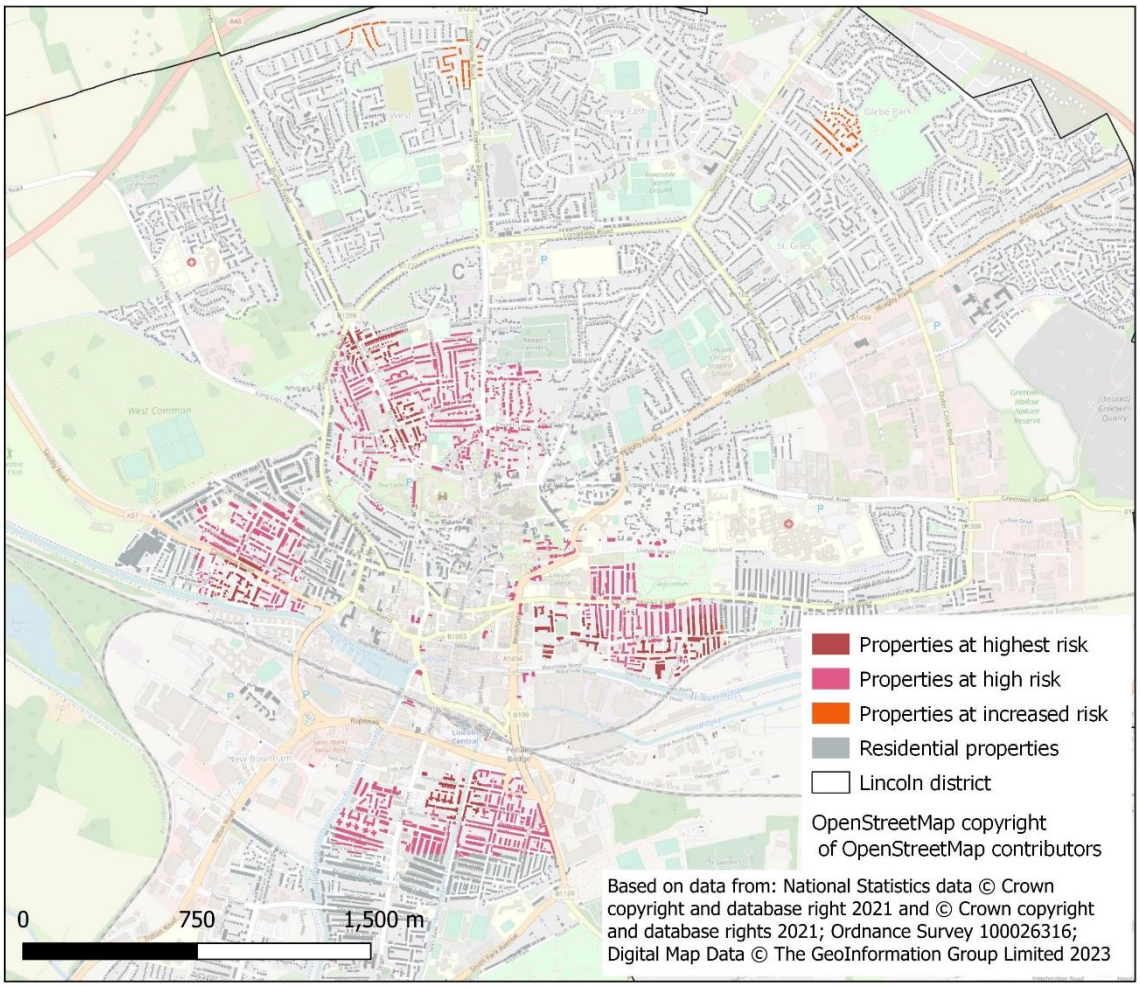


Figure 5: Risk terrain analysis map of for county lines in central Lincoln, RTMdx 150m model.

Figure 5 shows the final risk terrain analysis in QGIS for Lincoln based on a place size of 150m. Those areas in the darkest red, highest risk locations are those areas which were at statistically significant higher risk to being cuckooed and in areas previously exposed to cuckooing. Those at high risk are those areas statistically significant risk of cuckooing, but with no previous exposure. Those at increased risk are those with previous exposure.

5.3.2 Manual model results for county lines

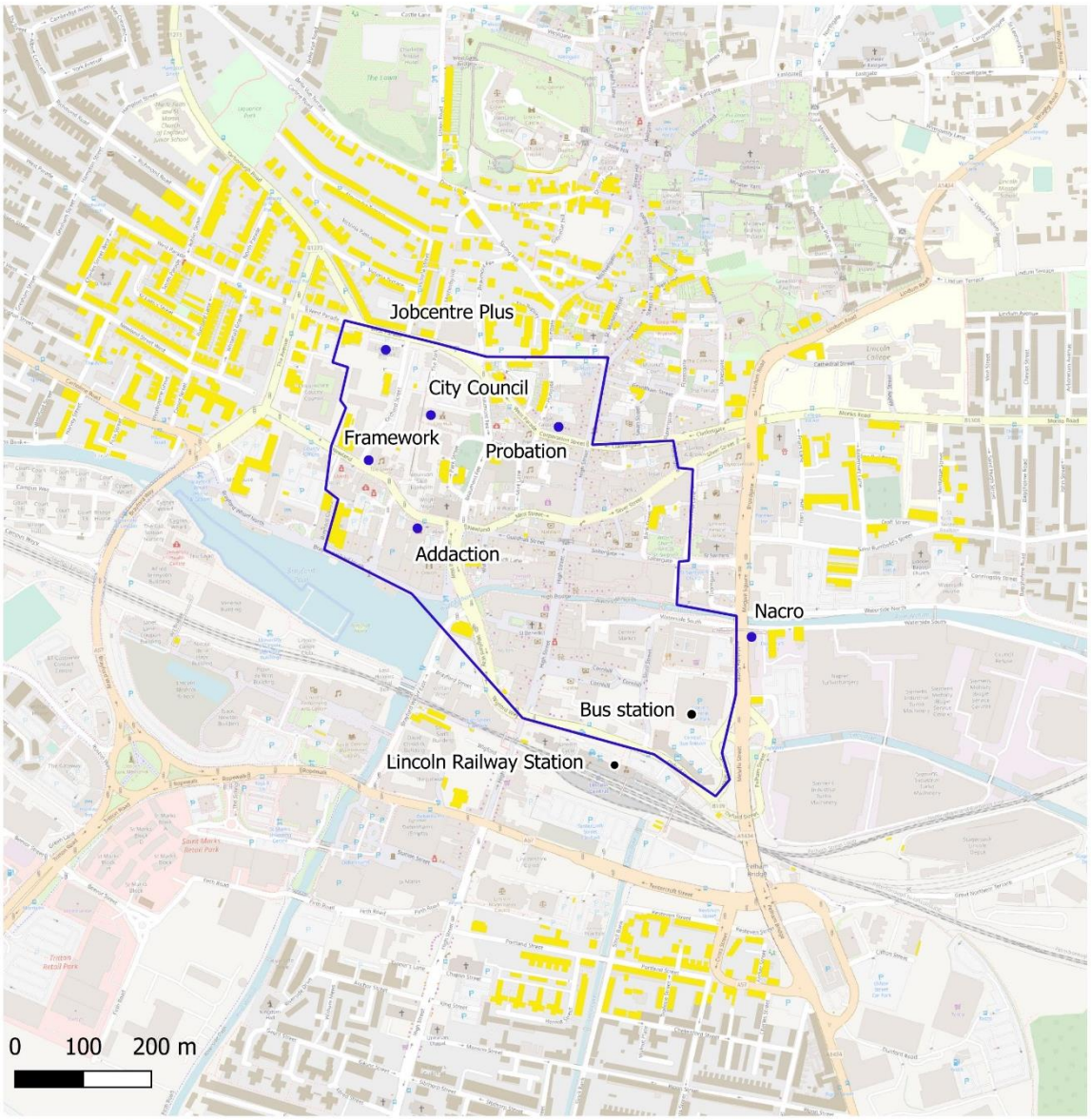
Unlike the RTMdx model, the manual model identified individual risk factors, and assessed the PAI score for the number of 2021 cuckooed addresses that were contained within the geographic extent of that risk factor. Risk factors were assessed singularly and in combination with other risk factors and the results of these assessments are contained within Table 19.

The single risk factor with the highest PAI was 400 metres from the routine activity area. This was an area within the centre of Lincoln containing locations likely to be visited by potential victims of cuckooing, based on perceived routine activities. Figure 6 shows these locations and the routine activity area which also includes Lincoln bus station and the main retail area of the city.

Table 19: Initial manual model factors and resulting PAI scores.

Description	Risk factor combination	Area	Count	Hit Rate	Area Percentage	PAI	Single risk factor PAI
10% most deprived	A	2153921.7	14	63.64	14.38	4.43	2
Single, rented, flats	B	4450392.5	18	81.82	29.71	2.75	4
Within 400m from routine activity area	C	847495.6	8	36.36	5.66	6.43	1
150m buffer of previous locations	D	2321991.3	11	50.00	15.5	3.23	3
Within 1.5km from railway station	E	8082070.9	14	63.64	53.95	1.18	6
Within 1km from railway station	F	4550663.7	9	40.91	30.38	1.35	5
Mean plus 1 standard deviation of flats	G	1876111.3	15	68.18	12.52	5.44	
10% most deprived and within 150m from previous location	A&D	444150.9	8	36.36	2.96	12.26	
Single, rented, flats and within 150m previous location	B&D	881679.1	10	45.45	5.89	7.72	
Within 400m from routine activity area and within 150m from previous location	C&D	93227.4	6	27.27	0.62	43.82	
Within 150m from previous location and within 1.5km from railway station	D&E	1493308.4	7	31.82	9.97	3.19	
10% most deprived and single, rented, flats and within 150m previous location	A&B&D	930443.6	10	45.45	6.21	7.32	
10% most deprived and within 400m from routine activity area and within 150m previous location	A&C&D	67364.4	5	22.73	0.45	50.54	
Single, rented, flats and within 150m previous location and within 400m from routine activity area	B&C&D	85540.8	6	27.27	0.57	47.76	
10% most deprived and single, rented, flats within 400m from routine activity area and within 150m previous location	A&B&C&D	67891.8	6	27.27	0.45	60.18	
10% most deprived and single, rented, flats and within 150m previous location and within 1.5km of the railway station	A&B&D&E	448153.9	7	31.82	2.99	10.64	
10% most deprived and within 400m from routine activity area and within 150m previous location and within 1.5km of the railway station	A&C&D&E	68462.5	6	27.27	0.46	59.67	
Single, rented, flats within 400m from routine activity area and within 150m previous locations and within 1.5km of railway station	B&C&D&E	85729.8	6	27.27	0.57	47.65	
Constrained city dwellers and single, rented, flats within 150m previous locations		707161.8	6	27.27	4.72	5.78	

Map of Lincoln showing the routine activity area and residential properties within 400 metres.



Contains Ordnance Survey data © Crown copyright and database right 2021.

- Bus station
- Railway station
- Lincoln support services

Residential properties within 400m of routine activity area

Residential properties

Routine activity area

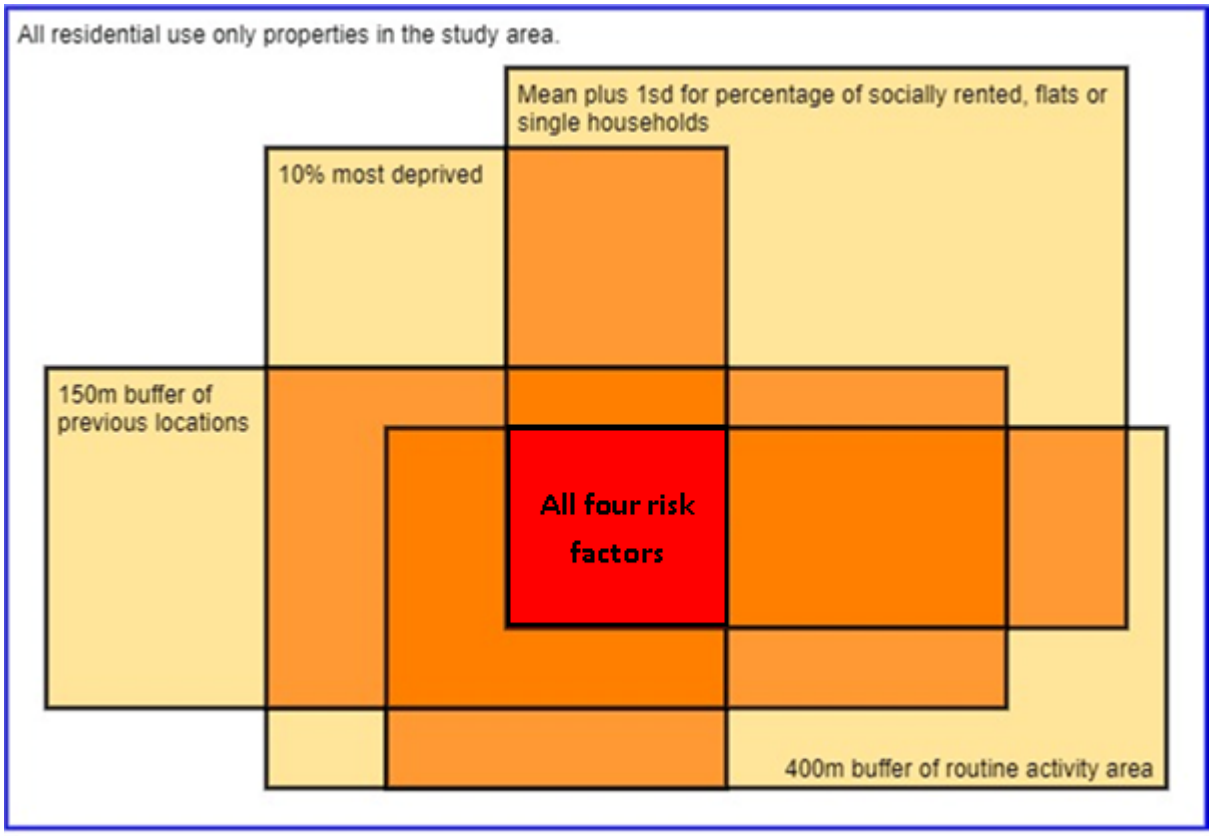
Lincoln district

OpenStreetMap copyright OpenStreetMap contributors

Figure 6: Map showing routine activity area in Lincoln city centre.

Table 19 shows the combinations of risk factors and their associated PAI scores which were used to determine the most appropriate model based on the percentage area covered and the likely number of future events this would incorporate.

Figure 7 shows the manual model chosen for county lines cuckooed addresses. The predictive accuracy index was the highest of all the initial models at over sixty; with an extremely small area of risk at only 0.4% of the total residential area it contained six cuckooed locations of the subsequent year within the identified risk area. As the manual model is built up of the different risk factors, and the exposure represented by the buffer of previous locations, the diagram shows how the differing risks compound together to identify those areas of greatest risk in a small percentage of area.



Venn diagram of risk terrain analysis risk factors for residential only use properties in Lincoln district.

Figure 7: Venn diagram of increased risk for cuckooed properties.

Table 20 shows the final competing models, the percentage area and predictive accuracy index scores for cuckooed locations in 2020 and 2021.

Table 20: Final manual risk terrain models.

Model and Predictive Accuracy Index (PAI) Score	2020 Locations	2021 Locations
Number of cuckooed locations during the year	24	19
100m exposure previous year (Locations identified & percentage area)	10 4.62%	10 4.04%
PAI	9.02	13.03
150m exposure previous year (Locations identified & percentage area)	10 7.82%	11 7.33%
PAI	5.33	7.90
10% deprivations, rented, single, flats and 400m from RA area (Locations identified & percentage area)	6 0.77%	3 0.77%
PAI	32.64	20.62
Risk factors and 100m exposure (Locations identified & percentage area)	6 0.27%	2 0.47%
PAI	92.18	22.57
Risk factors and 150m exposure (Locations identified & percentage area)	6 0.39%	3 0.60%
PAI	64.61	26.27
Constrained city dweller, single, rented, flats and 400m RA area buffer (Locations identified & percentage area)	6 2.29%	4 2.29%
PAI	4.17	5.26
Risk factors and 100m exposure (Locations identified & percentage area)	6 0.31%	2 0.55%
PAI	79.94	19.18
Risk factors and 150m exposure (Locations identified & percentage area)	6 0.49%	3 0.72%
PAI	51.11	21.92

Figure 8 is the final manual risk terrain analysis map. It shows the highest risk locations, which are all those residential properties which meet all four risk criteria shown in Figure 7.

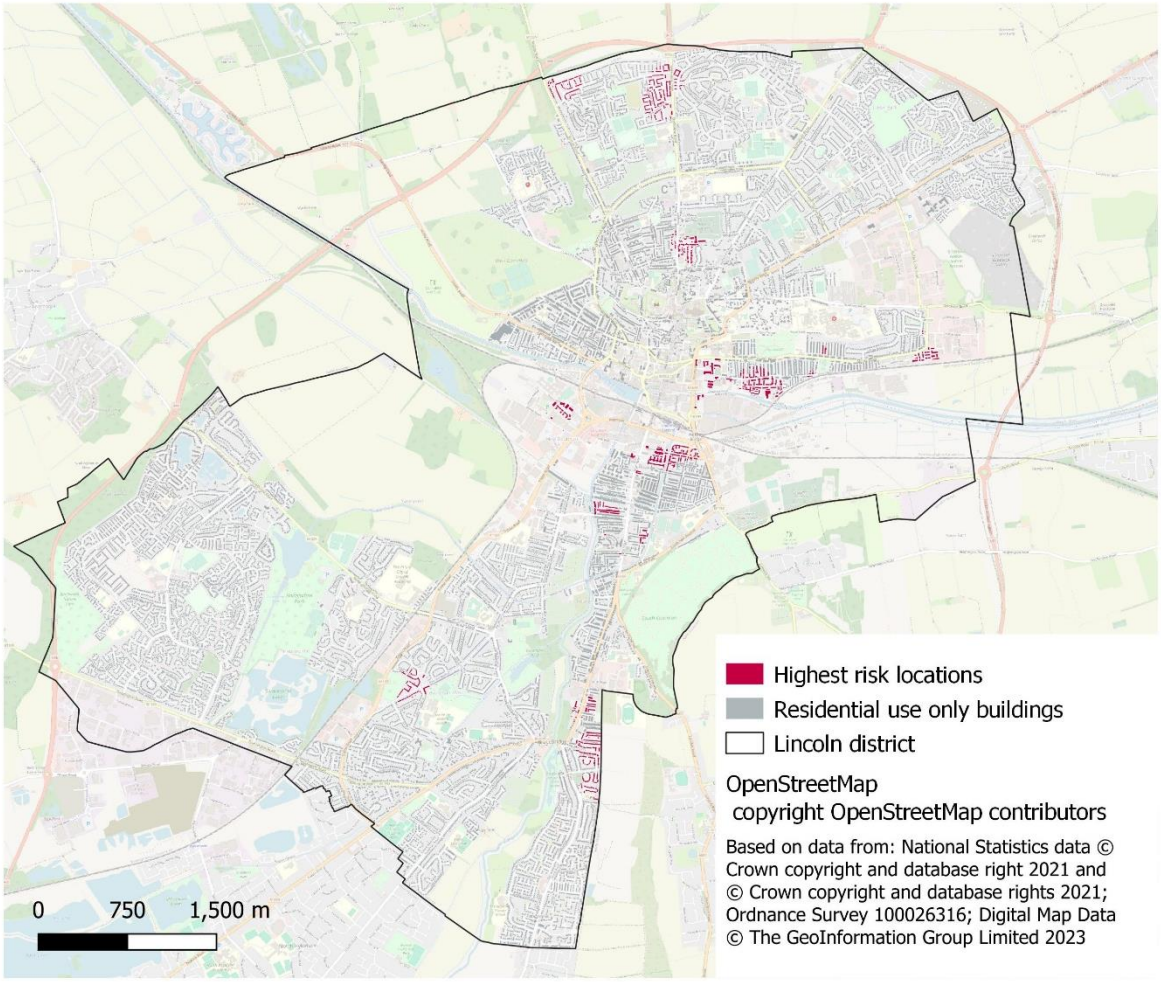


Figure 8: Risk terrain analysis map of for county lines in Lincoln, analyst's manual model.

5.3.3 Comparison of the best manual and RTMdx models and conclusions

Table 21 shows the comparison of the risk terrain models created using the RTMdx software and the two manual models. The manual model is that shown in Figure 7 and includes areas above the mean and one standard deviation of accommodation that is rented, single occupant or flats; areas in the worst 10% of social deprivation which are with 400m of the routine activity area and within 150m of previous year's cuckooed addresses. Manual model 2 replaces the areas of rented, single occupant or flats with areas of constrained city dwellers. These are not incorporated within the same model as they represent similar demographic characteristics.

Table 21: Comparison table of predictive accuracy index scores for the Lincoln county line RTMdx and manual models.

2021 Cuckooed Locations	PAI	PAI (risk factors and 100m exposure)	PAI (risk factors and 150m exposure)
50m RTMdx Model (highest risk)	8.85	13.04	10.91
100m RTMdx Model (highest risk)	4.69	9.36	7.15
150m RTMdx Model (highest risk)	4.88	17.83	12.11
Manual Model	20.62	22.57	26.27
Manual Model 2	5.26	19.2	21.92

5.4 County Lines Risk Terrain Analysis Summary And Conclusions

A literature review combined with experiential knowledge of police officers identified several potential geographic and socio-economic factors which could influence the presence of county lines activity within a town in the county of Lincolnshire. These risk factors were subjected to t-tests and comparative case analysis to assess whether there was any difference between characteristics of towns with county lines, and those without.

Table 22: Typical characteristics which impact on the presence of county line activity in a town.

Towns with no county line activity	Towns with county line activity
Population less than 15,000	Population greater than 15,000
Typically, no homeless shelters	Coastal or market town
Typically, no needle exchanges	Pharmacy needle exchange
Less than three pharmacy drug administration centres	Railway station
	Homeless shelters
	Drug rehabilitation services
	Three or more pharmacy drug administration centres

The analysis identified that there was a threshold population size for a town to be a viable marketplace for county lines. All but one of the locations with county lines activity had a railway station. It was not sufficient for a town to have a railway station; it also required a population size greater than 15,000 people. All towns with a county line also had pharmacy needle exchanges. Other contributing factors in five of the eight locations were the presence of homeless shelters and drug rehabilitation services, and half the locations had three or more pharmacy drug administration centres.

The characteristics shown in Table 22 above, in relation to risk factors for towns provide a good indication on where county lines should be expected in the future. For towns which have many of the key characteristics it will be important for local police teams to understand the specific

circumstances which are either preventing or deterring county lines activity. It will be important to understand whether this due to strong and resilient local dealers who have resisted the establishment of county lines, or whether there is insufficient intelligence coming from the local community regarding active lines.

The comparative case analysis identified key areas which could impact on the likelihood of a county line in a particular town within Lincolnshire. They are also likely to influence where county lines are active within a town. Twenty different potential risk factors identified from the literature review, comparative case analysis and officer experiential knowledge were added to the RTMdx software to generate several risk terrain models. Data from the following year was used to calculate the predictive accuracy index for these and assess whether the model could identify areas that would be at future risk for offences. Examples of the completed risk terrain analysis are shown in Figure 5 and Figure 8, and a summary of the results in Tables 18 and 20. The optimum RTMdx model identified that 57% of the following year's cuckooed addresses were within 12% of possible residential properties.

A manual model was also generated using an iterative process using those factors which were identified as impacting on the locations, and combining and comparing the success of identifying future events on balance with the size of the area in which they were likely to occur. The final model utilised four factors: 150 metres from previously cuckooed addresses, 10% most deprived areas, areas with greater than one standard deviation from the mean of socially rented properties, flats, or single person households and within 400m from an identified area of likely routine activities. This manual model identified that 25% of the following year's cuckooed addresses were within 0.39% of possible residential properties.

Both models were successful in identifying areas of future risk to county lines cuckooing and demonstrate that the technique is a valid analytical approach to understanding what factors might be contributing to the risk. The manual model used broader categories and aggregated data

which in an ideal scenario would be replaced by point based information. The RTMdx again would benefit from point-based accommodation data on tenure, occupancy and type but did allow for testing of a greater number of risk factors. The results also provided more specific information on the risk factors that were likely contributing to properties being targeted.

The inclusion of the exposure area, based on a 150-metre buffer from the previous year's cuckooed properties increased the PAI of the RTMdx model from 4.88 to 12.11 and replicates the research findings of Caplan et al. (2020) in that RTM is improved when exposure is included when determining the at-risk locations. The inclusion of this exposure still results in a PAI score which is lower than the manual model but is still superior at identifying areas at future risk than basing this identification on prior exposure only.

The use of the RTMdx software requires police forces to buy into the technique and the software license, and this is likely to prevent adoption of the software. However, there are good reasons to consider it as a viable option, particularly as police forces aim to become more evidence based. The systematic review by Marchment & Gill (2021) tested the efficacy of RTM as a forecasting tool and concluded it was effective at identifying locations at greatest risk of an event and for targeting responses to crime problems. The findings in this study support those of Marchment and Gill (2021) and demonstrate that the use of the technique is relevant to understanding non-traditional crime types in non-traditional urban areas.

6 Risk Terrain Analysis Of Hare Coursing Incidents In Lincolnshire

6.1 Understanding Hare Coursing

"*Hare coursing is the pursuit of hares with sight hounds, which chase the hare by sight and not by scent. This type of offending can also be known as hare poaching. Hare coursing can take the form of organised events in which dogs are, by the use of live hares, assessed as to skill in hunting hares. Often this is a competitive activity, in which substantial sums of money are bet*." (Crown Prosecution Service, 2021)

In Britain the brown hare is classed as a 'priority species of concern' (Smith et al., 2005) and is a priority in the UK's Biodiversity Action Plan (Department for Environment, Food and Rural Affairs, 2022a). It is the brown hare which is the target of hare coursers. Hare coursing was a legal sport in the UK up until 2004 and remained legal in Northern Ireland until 2011. White et al. (2003) believed there was a disproportionate number of hares killed by lethal control to prevent the recreational sport of hunting hares with dogs. The public found hunting hares with dogs to be the least acceptable of population control measures when accessed prior to the ban (White et al., 2003), and 41% of landowners saw brown hares as pests as they 'encouraged' poaching, and two-thirds stated they managed hares on their land because of the sport of hunting with dogs (White et al., 2003). Hare coursing continues in the UK as an illegal activity.

The activity uses grey hounds or lurchers to chase and turn a hare that has been flushed out into open freshly ploughed flat fields (Yates, 2019). Hare coursing is a lucrative activity, 'a sport of criminal gangs' (Boggan, 2002) with betting taking place on the chases, and often live streamed. Hare coursing is illegal under the *Hunting Act 2004*, and prosecutions may also be undertaken

using the Game Act (*Game Act 1831 and the Night Poaching Act 1828*). Campaigners continue to petition for tougher penalties for those involved (NFU Online, 2023) as the limited legislation (Case, 2019b) and difficulties in policing across wide swathes of countryside offer little to dissuade coursers from the financial benefit (Henderson, 2020b; Swift, 2019) of involvement.

Hare coursing is most prevalent in the East of England and the Scottish Borders (Yates, 2019), with southern England and East Anglia (Case, 2015) also affected. The practice has long been an issue for rural residents in Lincolnshire (Brown, 2011; Henderson, 2020b; Price, 2004). Operation Galileo is the annual Lincolnshire Police operation to deter and detect those involved. Inspector Andy Ham of Lincolnshire police, who was head of the operation in 2011 'said that the Fens' vast open spaces represent a challenge for his officers as well as offering ideal territory for the gangs to hide' (Brown, 2011).

In addition to the animal welfare concerns, the offences and offenders' impact local landowners and farms through the destruction of property and crops during the commissioning of offences (Brown, 2011; Spalding Guardian & Lincs Free Press, 2015a & b). Those involved in hare coursing are known to be involved in wide ranging criminality and organised crime. Guns, ammunition, and cannabis (Swift, 2019) were recovered from one hare courser's home by police. The National Wildlife Crime Unit (NWCU) identified that 'given an opportunity poachers have diversified into thefts, burglaries, assaults, and other rural crimes' (NWCU, 2013).

They are known to intimidate farmers (Bawden, 2015; Brown, 2011; Dean, 1997; Henderson, 2020b; Swift, 2019) and use unlicensed vehicles on the road. All aspects of hare coursing impact on residents' fear of crime and sense of security (Bawden, 2015; Spalding Guardian & Lincs Free Press, 2015a & b) resulting in some being unable to report offences for fear of retribution (Henderson, 2020a &b; Swift, 2019). It also has a negative impact on the levels of trust and satisfaction with the police service (NRCN, 2018). This in turn impacts on the willingness to report offences to police, resulting in a lack of understanding of both the problem and its extent,

insufficient evidence for the allocation of resources and minimal police response (Smith, 2019 in Smith, 2020).

Rural crime including hare coursing is readily acknowledged to have financial impact as well as the impact on farmers safety and security, but the recent study of Smith (2020:529) reported that '88% of participants' had their mental health harmed by agricultural crime concluding that it had 'significant negative impacts on farmer mental health' (Smith 2020:530). Police acknowledged that many rural people viewed the hare coursing problem as 'symptomatic' of failures by the police (Dean, 2005:22). The NRCN (2018) also identified that not only was trust lost in the police, but also lead to a loss of self-confidence and then to general lack of trust in their local community.

The impact of hare coursing on both the rural environment, hare welfare and farmers health and well-being are clearly an issue of concern for those unfortunate enough to experience it. The National Farmers Union identified that police understanding of rural issues and crime, including hare coursing, needs improving. Hare coursing is one of those reoccurring issues which Lincolnshire Police are duty bound to address, and due to the size of the county and the potential plethora of suitable locations, risk terrain modelling could provide an efficient intelligence analysis tool. It is hoped that it will aid the understanding of the underlying risks which influence offence location and potential factors to address, which may reduce offences and finally, it may offer areas for patrol or reconnaissance to increase efficacy in locating offenders. Wellsmith (2012) argues that wildlife crime needs to adopt a problem orientated approach as tougher sentencing is unlikely to materialise in significant reductions. It is hoped that my research will provide support for risk terrain analysis to become part of that problem solving approach.

6.1.1 European Brown Hares: Lepus Europaeus

To understand the underlying risk locations have to hare coursing, it is crucial to understand the habitat of the brown hare, as hare coursing activity can only take place where hares are located. Farmland is the primary habitat of European hares (Mayer et al., 2018; Smith et al., 2004). Hares are common in arable areas, but intensive farming can impact on their numbers (Smith et al., 2005). However, a more detailed understanding of the preferred habitat is required to diagnose the risk factors most relevant for inclusion in a risk terrain analysis of hare coursing.

Hares require different habitats depending on the time of year and the activity, whether resting or foraging (Mayer et al., 2018; Smith et al., 2004). Hares become most active prior to sunset (Schai-Braun et al., 2013), when they leave resting places to forage for food before returning to shelter before sunrise (Tapper & Barnes, 1986). To ensure they have access to the food and habitat necessary for survival, hares will have a home area, or range. Home ranges vary in sizes and are influenced by topography, climate, field size and vegetation (Mayer et al., 2018; Schai-Braun & Hackländer, 2013; Ullmann et al., 2020). Schai-Braun & Hacklander (2013) collated and compared average field size and mean home range for seven studies between 1982 and 2004, with a general trend of the larger the field size the larger the home range. More recent studies found ranges up to 10 hectares in Austria (Schai-Braun et al., 2015), an average of 34 hectares (Smith et al., 2004) in Britain, a mean of 27.3 hectares (Weterings et al., 2016) on Schiermonnikoog island, Netherlands, and averages of 23.9 hectares in northeast Germany and south Germany 8 hectares (Ullmann et al., 2020).

Schai-Braun et al. (2013) identified that hares avoided urban, unfarmed, grassland, forests and dwarf orchards during spring and autumn, but preferred tree-covered areas in the spring. Inactive hares, (those which moved less than 75% of average hourly distance moved) avoid sugar beet and fodder (Mayer et al., 2018). In the main breeding season habitat structure was selected which provided cover and shelter; in spring and summer taller minimum and maximum vegetation

heights were selected than those chosen in winter (Smith et al., 2004). Set-aside fields were shown by Schai-Bruan et al. (2020) to benefit leverets, increasing their survival rate and that they prefer 'cover-rich structures, especially in field track edges, ditches and fallow-like strips' (Schai-Bruan et al., 2020:6).

Mayer et al. (2018:11627) found that 'vegetation height was most important for habitat selection of active hares, with short vegetation (1-25cm) being preferred', vegetation height was also related to field sizes and proximity to field edges. Higher vegetation has limited forage value, reduced predator visibility, and provided physical obstacles to escape. Vegetation type was the most important factor for inactive hares. Fabaceae, fallow, and maize were preferred, simultaneously providing forage and cover (Mayer et al., 2018).

Research has found that field size can have a negative impact on hare density (Smith et al., 2005) and Vaughan et al. (2003:173) acknowledged that there was 'likely optimal field sizes and habitat densities' for hares, and it is resource availability which is a key limiting factor. Mayer et al. (2018) found that large fields with high and dense vegetation were avoided, a factor not apparent in small fields. Schai-Bruan et al. (2020) compared different studies of brown hares and concluded that field size was not correlated with hare density.

Several crop types were positively associated with hare abundance, and this was thought to be because of nutritional value and or cover that the vegetation provided. Winter wheat, rape, beet and legumes were identified by Smith et al. (2005) as being positively associated with hare abundance. This was supported by farmers who believed hares were 'more common on arable farms, especially on those with wheat, beet, or fallow land (Vaughan et al., 2003). Cereal crops provide a dual role firstly as forage, and then later cover for the hares, especially leverets (Smith et al., 2005). Fallow and low-level permanent pasture is also associated with high numbers of hares (Smith et al., 2005). Smith et al. (2004) identified that fallow land and cattle grazed pasture

was preferred to arable crops, except in winter, with Tapper & Barnes (1986) stating pastures were important throughout the year.

The abundance of hares in proximity to the crops identified by Smith et al. (2005) is supported by the research of Reichlin et al. (2006). They studied the diet of hares and argue that it is diet selection from available options which leads to differences in abundance. They found that in autumn and winter the hare preferred winter wheat, tubers of sugar beet and carrots. In spring and summer soy and weeds were 'positively selected, especially after cereal crops were harvested' (Reichlin et al., 2006:109). They concluded that hares preferred weeds and wild grasses and would select these if available.

Pastureland is associated with high hare numbers (Smith et al., 2004; Smith et al., 2005), however the research of Lush et al. (2016) found that intensive grazing was negatively associated with hare abundance. They report that within a grazing season, 'intensive grazing by large numbers of livestock, grazed continuously, resulted in less field use by hares' (Lush et al., 2016:63). They also acknowledged that although not apparent in their study, hares have shown a preference for cattle fields and avoided sheep grazed fields. Schai-Braun et al. (2013) identified that fertilised pastures were avoid by hares and reasoned this was due to the lack of plant diversity.

Smith et al. (2005) also raised the findings of other researchers in understanding the value woodland and hedgerows can have on hare numbers, and the importance of understanding scale within the landscape. They cited Schneider & Maar (1997) and Vaughan et al. (2003) as researchers who had positively linked small woodlands and abundant populations in contrast to the negative association with large woodland areas. Tapper & Barnes (1986) also noted the importance of hedges and woodlands for the shelter they provided the hares. Schai-Bruan et al. (2013) considered specific habitat characteristics and found that hares avoided forests, dwarf orchards, hedges and thickets in spring and autumn, but in spring preferred tree covered habitats. This was also supported by Johann & Arnold (2021:328) who specified that scattered woody

vegetation ‘increased the spatial and temporal heterogeneity in agricultural landscapes’. Hedgerows, bushes and small tree groups providing both food and shelter.

Mayer et al. (2020) researched hare activity and their choice of habitat in response to the spraying of pesticides. They found that there was little or no avoidance by hares of fields which had been sprayed with pesticide, but hares were temporarily disturbed by the agricultural machinery which applied it. Ullman et al. (2020) researched the response to agricultural practices by brown hares in Germany. They were able to show that agricultural management events affect hare movement behaviour. ‘After management events without resource changes, hares shift their ranges and avoid wheat fields, but not grassland, maize, and rapeseed fields. On the other hand, they profit from harvested fields, spending more time on them incorporating them into their range’ (Ullman et al., 2020:9).

Smith et al. (2005) and Mayer et al. (2018) suggested that a diverse habitat was preferred for the promotion of hare populations. This was reinforced by Schai-Braun et al. (2015) when they concurred with Reichlin et al. (2006) that hares were selective feeders. They also found that food choice was seasonal and included non-crop plants, a finding in line with that of Tapper & Barnes (1986) who identified hares preferred short crops, but this waned once cereals had developed past the tillering stages. Reichlin et al. (2006) concluded that increasing habitat heterogeneity including differing crop types and fields left to pasture/fallow would be beneficial for hare populations supporting the research of Smith at al. (2004). Vaughan et al. (2003:163) concurred recommending ‘pastural farms should have some woodland, improved grasses and arable crops; arable farms should have wheat, beet and fallow land’. Smaller field sizes, and higher structural heterogeneity was also the conclusion made by Ullman et al. (2020:9) to increase hare populations and ‘improve human-wildlife coexistence’.

The available research identifies a range of crops and habitat types in which hares are likely to be found and which they have preference for. Schai-Bruan et al. (2013) raised the issue of differing

opinions on the preferences identified in the research studies. They identified that studies could not be directly compared as the majority had used broad categorisations of habitat which could bias the results. They also identified that where hare abundance was particularly high in studies, competition for food resources could result in a preference being shown that would not necessarily be shown if the population were lower. Understanding habitat and food preferences will be important when producing a risk model as it will inform the selection of parameters which could be more favourable for hares, and consequently offences. Table 23 shows a summary of the type of vegetation/ habitats research identified as preferred or avoided. It does not include those which were neither actively avoided nor preferred.

Table 23: Overview of hare preferences to habitat and crops.

Season	Avoided Crop	Preferred Crop	Source
Farmed land- Spring	Winter oilseed rape, Winter grain, Grassland	Grubbed acres, Germinating seed, Species rich pasture	Schai-Bruan et al. (2013)
Farmed land- Spring & Summer		Soy	Reichlin et al. (2006)
		Weeds	Reichlin et al. (2006), Johann & Arnold (2021)
Farmed land- Autumn	Winter oilseed rape, Winter grain, Germinating seed, Harrowed acre, Grassland	Grubbed acres, Ploughed acres, Intertillage, Vegetables, Stubble fields, Species rich pasture	Schai-Bruan et al. (2013)
Farmed land- Autumn & Winter		Winter wheat, Tubers of sugar beet, Carrots	Reichlin et al. (2006)
Season	**Avoided Habitat**	**Preferred Habitat**	**Source**
Unfarmed land- Spring	Hedges, thickets & set asides, Residential areas & gardens, Roads, Allotments, Graveyards, Forests, Dwarf Orchards	Rivulets & field margins, Fallow	Schai-Bruan et al. (2013)
Unfarmed land- Autumn	Hedges, thickets & set asides, Residential areas & gardens, Roads, Allotments, Graveyards, Forests, Dwarf Orchards	Rivulets & field margins	Schai-Bruan et al. (2013)
Active hares	Forests, Dwarf orchards, Tree nurseries	Sheep grazed pastures- winter only	Schai-Bruan et al. (2013)
		Open land with short vegetation	Tapper & Barnes (1986)
		short vegetation (1-25cm)'	Mayer et al. (2018:11627)
Unactive hares	Sugar beet, Fodder	Fabaceae, Fallow, Maize	Mayer et al. (2018)
Season/ Activity not specified		Pasture	Smith et al. (2005), Tapper & Barnes (1986) & Smith et al. (2004)
	Intensively grazed pasture		Lush et al. (2016)
	Fertilised pastures		Schai-Bruan et al. (2013)

6.1.2 Hare coursers

Hare coursing as a pastime can be dated to 150 A.D (Graham, 1910) and there is a longstanding tradition of hare coursing in the United Kingdom particularly with the gentry, with the first club being established in Norfolk by Lord Orford in 1776 (Graham, 1910). High profile events took place around the county on privately owned estates, including one at Sleaford, Lincolnshire. However, even before hare coursing was made illegal there were illegal hare coursers, a 'nationally organised criminal network' (Dean, 1997:22). These illegal coursers travelled extensive distances to trespass on land to commit these offences with large amounts of money bet on the outcomes (Dean, 1997 & 2005; Owen, 2022; Yates, 2019).

Filteau (2012:219) describes poaching as 'common, relatively unstigmatized, differentially treated by the legal system, and lacks a human victim' with officials often treating it as a minor offence. Hare coursing falls into this category, and by those with little knowledge or experience it is often seen as inconsequential. Hare coursers are typically entrenched into the illegal behaviour through long standing family culture (Green, 1990 in Filteau, 2012), for example members of the travelling community who comprise many of those involved (Dean, 2005) and view hare coursing as a traditional pastime.

Those involved in hare coursing are known to travel extensive distances (Bawden, 2015; BBC News, 2023; Dean, 2007; Spalding Guardian & Lincs Free Press, 2015a & b). For example, offenders who pleaded guilty to offences in Basingstoke originated from London and Surrey (Case, 2021) and in an operation near Sleaford four men from Birmingham were fined over £2500 (Dean, 2005). Despite government lockdown rules during the pandemic, Lincolnshire Police arrested three males from County Durham (Whitelam, 2021) demonstrating the willingness of offenders to travel long distances.

Hare coursers wish to facilitate the chase and turn of the hare by dogs. To do this, they will require hares in locations which can facilitate this activity. Open, unstructured homogeneous land

with limited cover gives good visibility to both the hares and dogs and facilitates movement (Weterings et al., 2016). For hares, predator encounters in open habitats would be expected to produce fast reactive movement alternating with directional changes. Weterings et al. (2016:111) conducted research when the hares were most active and found a 'strong reactive movement response' to predators in short vegetation; 'Vegetation structure was the most important vegetation parameter' affecting the hares' response, 'followed by the distance to the nearest vegetation patch and patch edge length'. For hare coursers they will be looking for fields which best facilitate the hare's strong reactive response.

The Lincolnshire Fens in the south of the county mirror the characteristics of the bordering county of Cambridgeshire. Dean (1997:22) remarks that this 'remarkably flat landscape' is perfect for racing. It also has the added advantage that lookouts can spot approaching vehicles from a considerable distance (Dean, 1997) and so can avoid police intervention.

6.2 Hare Coursing Risk Terrain Analysis

In Lincolnshire there are a large number of hare coursing events annually. It is important to understand whether these events are randomly distributed in order that an informed decision can be made on whether the use of geographical crime mapping techniques are relevant. A nearest neighbour analysis was completed to verify that the distribution of incidents was not random across the county. A csv file of hare coursing incidents was imported into the QGIS software and nearest neighbour analysis calculated.

Nearest Neighbour Analysis of hare coursing incidents between 2018 and 2020.

Observed mean distance: 403.99336831218

Expected mean distance: 11059.34888009522

Nearest neighbour index: 0.03652957988

Number of points: 2044

Z-Score: -83.33159881422

The Z-score of -83.3 shows that the location of hare coursing incidents as reported and recorded by Lincolnshire Police between 1st April 2018 and 31st March 2020 is significantly clustered and further analysis of their distribution is valid. The following sections detail how the manual, and RTMdx risk terrain models were generated.

6.2.1 Preparing the data files for the risk terrain analysis

Data on incidents and occurrences of hare coursing were provided by the rural crime analyst for the period 2018 to 2021. The data included date and time, brief description, summary location data and British National grid easting and northings. The data had been obtained from scanning incidents and occurrences and cleansing the location data as appropriate. The data was

specifically collected by the rural crime analyst for the purpose of analysing hare coursing over the period stated.

The Land Cover® Plus: Crops © 2019 (Morton et al., 2020) extracted from digimap.edina.ac.uk was added into the QGIS software. A vector boundary layer of Lincolnshire was used to crop the Land cover plus crops to contain only those fields within Lincolnshire. The land cover plus crops details all land categorised as agricultural which is greater than two hectares in size providing the crop type for every field determined from satellite imagery.

From the Open Roads Ordnance Survey data 'road links' were merged and cropped to generate a file of roads within Lincolnshire. The woody linear features data set (Morton, et al. 2019) were obtained from Digimap and added to the QGIS software and those woody areas within Lincolnshire selected to create a file for Lincolnshire data. From the Open Roads data set, road nodes from tiles TF, TA, SK and SE were merged and those within Lincolnshire created as a new data set. Separate data sets were created for the different classification of roads: A road, B road, classified and not or unclassified.

Ordnance Survey contours 5DTM were obtained for Lincolnshire from digimap.edina.ac.uk. They were added to the QGIS software and used as a selection parameter to select all fields within the county which have at least one contour running through them. Applying an inverse selection identified those fields with no contours running through them, to signify a potential flat field.

Several crime theories offer plausible inferences as to factors which could increase the risk of hare coursing offences in a location as can be seen in Figure 3. Routine activity would suggest that locations would be in areas typically travelled; opportunity and least effort principle that these locations would be easy to get to in comparison to others. Environmental criminology indicates that the locations would be easily accessible with limited potential guardianship from occupied premises and have multiple escape routes.

Network theory would indicate that arterial routes would acts as 'bridges' to ease access and escape potential, whilst areas where there are structural holes in the road network would be at a lesser risk to offences. The underlying habitat of the hares' will provide the base for any potential offences, and the topography and land use, whether it be farmland, woodland or wasteland would also be likely to impact on the locations at risk to offences. Considering the law of risky places, the location's vulnerability to previous offences is also a risk factor for inclusion in the model.

QGIS functions were used to calculate the field size in square metres for all the Lincolnshire fields and the 'select by location' to determine those fields which had a recorded hare coursing incident between 2018 and 2020. These selected fields were exported to Excel. Fields which did not contain hare coursing incidents were selected by 'inverting' the selection and exported to Excel.

Basic summary statistics were calculated for each of the data sets in Excel including number of fields of each crop type, percentage of fields and average field size. T-tests were then used to compare the average field size for those with hare coursing incidents against those without.

Proportionality tests using the Chi squared distribution were completed on the crop type and field slope. The null hypothesis tested is that there was no significant difference in the proportion of each type of crop between those fields which had an incident of hare coursing and those which did not.

Using the QGIS system the number of incidents in each of the field types were calculated. Likewise, the total number of each crop type and the number of fields of each crop type which did not record an incident of hare coursing was obtained using the QGIS select by location. Contingency tables of observed and expected frequencies for each crop type and presence or absence of hare coursing were calculated using the formula:

Expected value= category column total * (category row total/sample total)

This was completed for the period 2016-2017 and for 2018-2020.

Degrees freedom calculated as: (number of columns-1) * (number of rows-1)

The Chi squared points values were calculated using the formula:

Chi squared points value= (observed value-expected value)^2/expected value

Excel function =CHISQ.TEST(range of observed values, range of expected values) were used to calculate the Chi Test (P) value for fields identified with no contour features and all other fields.

6.2.2 Determining the risk factors

During the first round of interviews officers were asked about their prior knowledge of hare coursing and what aspects of the landscape they believed encouraged or facilitated hare coursing. Table 24 shows the physical features of the landscape, identified by police officers, which promote or deter hare coursing. Two officers interviewed had no experience of hare coursing and did not offer any risk factors for consideration. Those with more experience, such as the rural sergeant were able to provide several valuable suggestions which could be quantified in terms of the modelling process. For example, wheat fields and flat fields. Others such as insecure fields are more problematic to obtain data for inclusion in the modelling analysis.

Table 24: Risk factors to hare coursing locations identified by officers.

Rick factors influencing the location of hare coursing incidents identified by officers
Ditches (phase 2 Sgt B)
Flat land (Sgt B) (phase 2 Ch Insp, Sgt B)
Hedgerows- berries for the hares, but not too many hedges to restrict running (Sgt A)
Insecure fields (R Insp A)
Isolated areas (phase 2 Ch Insp, Sgt B)
Multiple criminality of offenders (Ch Insp, R Insp I)
No hedges (phase 2 Sgt B)
Offenders travel into the county (Ch Insp, R Insp A, Sgt A) (phase 2 Sgt B)
Park on the main roads (Sgt A)
Short crops (Sgt A)
Use arterial routes (R Insp A) (phase 2 Ch Insp, Sgt B)
Wheat fields (Sgt A)
No experience (R Insp B, N Insp A)

Officers suggested that wheat fields or fields with short crops influence the location of hare coursing incidents. Statistical analysis was completed to understand if field size and or crop was linked to the number of hare coursing incidents, as described in section 6.2.1.

Table 25 shows the basic statistics generated for fields with incidents of hare coursing and those without, including a T-test for the null hypothesis that the average field size is the same regardless of whether it has recorded an incident of hare coursing. Field size shows significant differences when the crop is oilseed rape, winter wheat, and other crops at 99% significance level. Oat fields also show as significant, but as there were no hare coursing events recorded in these fields then this will not be included in the analysis. Oilseed rape fields were determined to be significantly smaller in size when subject of a hare coursing incident compared to winter wheat and other crops which were larger.

Table 25: Basic statistics for fields with and without hare coursing incidents.

Crop	Number fields No Hare Coursing (NHC)	Percentage NHC fields	Number fields Hare Coursing (HC)	Percentage HC fields	Above NHC %	Total area NHC fields	Average NHC field size	Total area HC fields	Average HC field size	T-test	Significant at 99%	Significant at 95%
Beet (sugar beet / fodder beet)	2095	3.72	19	5.11	yes	194483429	92832.2	2222268	116961.5	0.056024052		
Field beans	1680	2.99	5	1.34	no	161473167	96115.0	665673	133134.6	0.115844534		
Grass	11977	21.29	60	16.13	no	632866330	52840.1	3414751	56912.5	0.235165735		
Maize	1735	3.08	12	3.23	yes	156158407	90004.8	1346178	112181.5	0.138609589		
Oilseed rape	6333	11.26	31	8.33	no	650561839	102725.7	4172650	134601.6	0.008957897	yes	yes
Other crops	4944	8.79	47	12.63	yes	415482849	84037.8	5261590	111948.7	0.00203481	yes	yes
Peas	985	1.75	8	2.15	yes	102684844	104248.6	1127339	140917.4	0.082403334		
Potatoes	1317	2.34	12	3.23	yes	111494433	84657.9	1449798	120816.5	0.015855602		yes
Spring barley	4465	7.94	26	6.99	no	425782951	95360.1	2604069	100156.5	0.364881078		
Spring wheat	2159	3.84	14	3.76	no	203239367	94135.9	1395950	99710.7	0.386267387		
Winter barley	2636	4.68	10	2.69	no	254123778	96405.1	1357554	135755.4	0.046405611		yes
Winter oats	132	0.23				14077917	106650.9				yes	yes
Winter wheat	15808	28.10	128	34.41	yes	1579581071	99922.9	15121529	118136.9	0.002693787	yes	yes
Grand Total	**56266**		**372**			**4902010382**	87122.1	**40139349**	107901.5	0.00000000396	yes	yes

Table 26 shows the Chi squared tests for testing the hypothesis Ho: the proportion of crop fields is the same for fields with hare coursing incidents as those fields without hare coursing incidents, against the alternative hypothesis that the proportion of crops is different for fields with hare coursing incidents.

The Chi squared value was calculated from the sum of the Chi squared points values and compared with the Chi squared critical value of 21.026, based on 12 degrees freedom and a critical value of 0.05 using the Excel function =CHISQ.INV.RT(0.05,12). The Chi Test (P) value was calculated using the Excel function =CHISQ.TEST(range of observed values, range of expected values).

Table 26: Chi-squared test result for crop types and hare coursing incidents.

	Observed values			Expected values			Observed values			Expected values	
Crop 2019-20	Non HC	HC	Crop total	Non HC	HC	Crop 2016-2017	Non HC	HC fields count	Crop total	Non HC	HC
Beet (sugar beet / fodder beet)	2104	10	2114	2105.377979	8.62202055	Beet (sugar beet / fodder beet)	2092	22	2114	2100.04	13.96
Field beans	1682	3	1685	1678.12767	6.87232953	Field beans	1679	6	1685	1673.87	11.13
Grass	12004	33	12037	11987.90669	49.0933119	Grass	11980	57	12037	11957.52	79.48
Maize	1738	9	1747	1739.874801	7.12519863	Maize	1732	15	1747	1735.46	11.54
Oilseed rape	6346	18	6364	6338.044211	25.9557894	Oilseed rape	6334	30	6364	6321.98	42.02
Other crops	4959	32	4991	4970.644038	20.3559624	Other crops	4929	62	4991	4958.04	32.96
Peas	986	7	993	988.9500159	4.04998411	Peas	984	9	993	986.44	6.56
Potatoes	1320	9	1329	1323.579629	5.42037148	Potatoes	1315	14	1329	1320.22	8.78
Spring barley	4474	17	4491	4472.683304	18.3166955	Spring barley	4467	24	4491	4461.34	29.66
Spring wheat	2163	10	2173	2164.137346	8.86265405	Spring wheat	2158	15	2173	2158.65	14.35
Winter barley	2640	6	2646	2635.208199	10.7918006	Winter barley	2633	13	2646	2628.53	17.47
Winter oats	132	0	132	131.4616335	0.53836647	Winter oats	15829	107	15936	15830.77	105.23
Winter wheat	15859	77	15936	15871.00448	64.9955154	Winter wheat	132	0	132	131.13	0.87
HC total	56407	231	56638			HC total	56264	374	56638		
Degrees Freedom	12										
Chi squared value	27.01703					50.93784					
Chi squared critical value	21.02607					21.02607					
Chi Test (P) value	0.007684					0.00000					

Table 27: Chi-squared test results for flat fields and hare coursing incidents

2018-2020	Observed values			Expected values	
Fields	No Hare Coursing	Hare Coursing	Total	No Hare Coursing	Hare Coursing
No contours	22511	215	22726	22576.73498	149.265016
Other fields	33755	157	33912	33689.26502	222.734984
Total	56266	372	56638		
Degrees Freedom	1				
Chi squared value	48.66889				
Chi squared critical value	3.841459				
Chi Test (P) value	0.00000				
Reject Ho. There is a significant difference in the field proportions					
There is a 0.001 percent chance of the difference occurring by chance.					

Table 27 shows the results of the Chi squared test for the null hypothesis that there is no difference in the proportion of flat fields (fields with no contours) whether there are hare coursing incidents recorded or not.

The null hypothesis is rejected in favour of the alternative hypothesis that there is a difference in the proportion of flat fields in the fields where a hare coursing event has been recorded within Lincolnshire and so should be considered as a risk factor in the risk terrain analysis.

The opinions of officers, information obtained from the literature review and the statistical analysis were combined to provide the potential risk factors for use in the risk terrain analysis. Table 28 shows the potential risk factors for consideration in the RTM modelling for hare coursing.

Table 28: Potential risk factors impacting on the location of hare coursing incidents.

Risk Factor	Theory	Represented by	Data Source
Habitat of hares	Field size	Field size	OS Landcover plus crops (2019)
	Proximity to woods & hedges	Locations of woods & woody linear features	OS Land use- woods, woody linear features
	Field suitability	Crop type	OS Landcover plus crops (2019)
		Field slope	OS Terrain contours 5m
		Wetlands & river courses	OS Open Rivers, OS Land use
Vulnerability to offences (initially included in the RTM modelling but following advice from Caplan & Kennedy, 2022 removed as a risk layer and the analysis rerun.	Law of risky places	Previous offences	Hotspot of previous incidents and offences
Well known areas	Routine activity theory	Arterial routes & A roads	OS Open Roads
Accessibility	Opportunity theory, environmental criminology	Arterial routes & A roads	OS Open Roads
		Road network	OS Open Roads
Permeability of the area	Opportunity theory, environmental criminology	Road network	OS Open Roads
		Road nodes– junctions	OS Open Roads
		Water course	OS Open Roads
Guardianship	Opportunity theory, environmental criminology		OS land use– residential and farms
Network theory	Bridges facilitate access	Location of arterial routes	OS Open Roads
	Structural holes limit activity	Road network	OS Open Roads

6.3 RTMdx Models

The Simsi RTMDx software uses the same process for all risk terrain analysis. Files are imported into the software as .shp files. Firstly, a base area is selected for the analysis. This is in the form of a polygon or multiple polygons. Next the events to be analysed are selected and the standard place sizes stated. These are chosen to be relevant to each analysis. Once this has been nominated the risk factors are added. For each factor it is stated whether the model should consider the density, proximity, or both of each risk, and how far to extend the analysis, up to a maximum of four times the place size and whether to use full or half intervals. Once all selections have been made and parameters set, the analysis is run. The time for the analysis to run and the creation of the reports varies depending on the extent of the place size in comparison to the overall area and the number of risk factors under consideration. This could be as quickly as a few minutes or over four hours.

Hare coursing takes place in fields, but the base maps used for the analysis were the county and district boundaries for Lincolnshire. This is because it is known that although offences take place in the fields, the reported incident is not always a field but on an adjacent road. The field's importance is not forgotten and will feature as one of the risk factors and for the calculation of the standard and place sizes within the analysis. Due to the size of the county and the heterogeneity of the topography, the Wolds area in the north and the flat fenlands in the south, additional analyses will be produced for the three main districts of Lincolnshire- East and West Lindsey, North and South Kesteven and Boston and South Holland. Boston and South Holland are the two districts with the most hare coursing events in the period 2018 to 2020 and for this reason analyses will also be run on these individual districts.

The place size is an important consideration within the analysis set up and should be relevant to the activity under analysis. The size of fields provides the relevant unit but as the fields are of different sizes an average will be calculated for both those which had recorded a hare coursing

event and those which had not. Hare coursers travel in a vehicle to the area, and the nature of the roads could reduce their speed from the national speed limit of 60 miles per hour. At 40 miles per hour a vehicle would travel 0.666 miles in one minute, approximately 1065 metres. If their speed was nearer 60 miles an hour then this would be in the region of 1600 metres.

Average field size=87258 square metres: √average field width size=295 metres

Average field size for hare coursed fields=107901 square metres: √107901=328 metres

Distance travelled at 40 miles/per hour in one minute=0.666 miles, ≈1065 metres

Based on these figures a place size of 300 metres was selected, which resulted in a 300-metre grid being assessed for risk factors based on a 600 metres standard place distance and a factor of four times, including half and full distances for the risk factors.

T-tests were conducted to compare whether the proportion of hare coursing events for each crop type occurred by chance. Those crop types which were found to have a significant difference in the proportions between those with hare coursing events and non-event fields, as shown in Table 25 are included in the model. Table 27 shows that there was a significant difference between the number of hare coursing incidents in flat fields. Flat fields are therefore included in the model. The risk factors used in the model are detailed in Table 28.

Both proximity and density parameters are to be used in an aggravating model. This means that the analysis looks for those risk factors which increase the likelihood of an offence occurring based on either the proximity of the risk factor to a hare coursing event, or due to the density of the risk factors around the hare coursing event. I feel it is important to use both density and proximity despite risk factors such as roads usually being considered as proximity only. This is because the density of roads and junctions could act as an indication of network density and accessibility, which simple proximity will not provide.

On completion of the analysis the results were exported as .shp files to be used in the QGIS software to calculate the PAI and prepare the results for presentation to officers.

6.4 Manual Models

The literature review and officer interviews identified several physical features of the landscape which could increase the likelihood of finding hares. These are detailed in Table 23 and Table 24. Due to the extensive nature of the area covered two different manual models were generated to best compare the RTMdx analysis with that which could be produced by an analyst without access to this software. A form of hotspot mapping using grids was one method and the second was a consideration of proximity to various identified physical aspects of the landscape which could affect the habitat of hares or offender accessibility.

6.4.1 Grid maps

Grid maps were created for all the areas for which RTMDx maps were generated. The QGIS Visualist, Grid Map function facilitated this. The extent of each layer being the boundary maps used for the county and district RTMDx analyses. The number of hare coursing events for the period 2018-2020 was the basis of the point parameter for each grid created. The grid size was set at 300 metres, with each grid square having a median area of 90049.745m^2, to coincide with the RTMDx models. After generation of the grids, they were reduced using the QGIS clip function to the county or district boundaries. However, it must be acknowledged that the results could be subject to edge effects, a form of MAUP as the analysis was confined to bounded regions ignoring any potential for relationships with incidents occurring outside of these areas. As the data was not available for areas outside of the county this could not be avoided.

The count points in polygon function of QGIS was used to calculate the number of hare coursing incidents between April 2018 and March 2019 within each of the grid squares for all districts and the county of Lincolnshire. The QGIS basic statistics function was used to calculate the mean number of hare coursing events and the standard deviation of events for each area grid based on the number of events in each grid square. The value of the mean plus two standard deviations was calculated for each district to represent high-risk areas. Each district grid file was then filtered

by the calculated mean plus two standard deviations to identify only those grid squares which exceeded this value. These became the risk areas for the grid map models. Finally, the select by location function was used to select only those hare coursing events which occurred between April 2019 and March 2020, within those selected high-risk areas and this value used in the Predictive Accuracy Index (Chainey et al., 2008). The area of the districts and high-risk areas, and the number of hare coursing events within these areas are detailed in the results section, in Table 32. The process was repeated using the 2019-2020 data to identify grids at risk and test with 2020-2021 date to determine the PAI.

6.4.2 Proximity method

The literature review and officer interviews identified several physical features of the landscape, both natural and manmade which can influence the residence of hares but also the locations hare coursers might see as preferable to offend. These locations and physical features were added to QGIS as map layers. Roads and junctions were represented as lines and points in the mapping software.

Exploratory data analysis took place to understand the number of hare coursing events within each district and occurring in different types of landscape, the results are shown in Table 29. Charts were created to identify any potential correlation between the percentage area of landscape features and the percentage of hare coursing incidents in that landscape type and are shown in Figure 9.

Table 29: Percentage of hare coursing per district and corresponding landscape type.

District	Percentage area	Percentage of hare coursing events	Percentage area woody linear features	Percentage water course	Percentage classified roads	Percentage woods
Boston	6.2	10.0	3.6	3.5	7.8	1.2
East Lindsey	29.9	10.1	30.3	29.9	27.4	29.4
North Kesteven	15.6	11.7	17.1	20.4	16.2	14.4
South Holland	12.7	49.3	8.0	5.4	16.8	2.1
South Kesteven	16.0	11.4	18.6	18.7	17.0	22.5
West Lindsey	19.6	7.5	22.4	22.2	14.8	30.4

The results suggest that the amount of woody linear features, woods and water courses in the landscape may indicate a decrease in hare coursing incidents. Section 6.2.2 has already determined the main risk factors to hare coursing, these being flat fields, represented by fields with no contours; wheat fields, other crop fields, grass fields, proximity to woods and woody linear features and accessibility represented by roads and junctions.

Roads and junctions were represented as lines and points in the mapping software.

To incorporate these into the model the area surrounding them was selected using the buffer function. Roads within the county were buffered to 500 metres and junctions 250 and 300 metres. For individual districts, roads were buffered to 250 metres.

Different aspects of the landscape were selected and the number of hare coursing events within the selected area calculated, along with the size of the area. Various combinations of landscape features were generated to determine if this improved the predictive accuracy index. The context of the topography was also considered, for example in the south of the county where the landscape is predominantly flat, as highlighted in Figure 10, flat fields were not included as a risk factor. To account for a variable landscape preferred by hares, an area around the centroid of each field was calculated based on a home range of 25 hectares. This was then used to select

fields containing different crops and woody linear features. A summary of the main combinations are shown in Table 30.

Table 30: Main landscape characteristics used within the proximity model.

Model	Code
Within 250m of junctions	A
Within 300m of junctions	B
Flat fields	C
Within 500m of A roads	D
Within 500m of B roads	E
Within 500m of classified roads	F
Within 250m of unclassified roads	G
282m buffer from the centroids of fields	H
282m buffer from the centroids of other crop fields which overlap winter wheat and other crop fields	I
282m buffer from the centroids of fields which contain linear woody features	J
282m buffer from the centroids of fields which overlap grass fields	K
Intersection of wheat, other crops, grass fields and woody areas (Intersection of IJK)	L
Flat fields, wheat, other crops, grass and woody areas (Intersection of C and L)	M
Wheat, other crops, grass fields and woody areas within 250m of unclassified roads (L within G)	N
Wheat, other crops, grass fields and woody areas within 500m of classified roads (L within F)	O
Flat fields, wheat, other crops, grass, woody areas within 500m of A roads (N within D)	P
Flat fields, wheat, other crops, grass, woody areas within 500m of B roads (N within E)	Q
Flat fields, wheat, other crops, grass, woody areas within 500m of classified roads (N within F)	R
Intersection of 250m from junctions and wheat, other crops, grass fields and woody areas (Overlap of A and L)	S

Graphs showing the correlations between percentage of land cover and percentage of hare coursing events for districts in Lincolnshire.

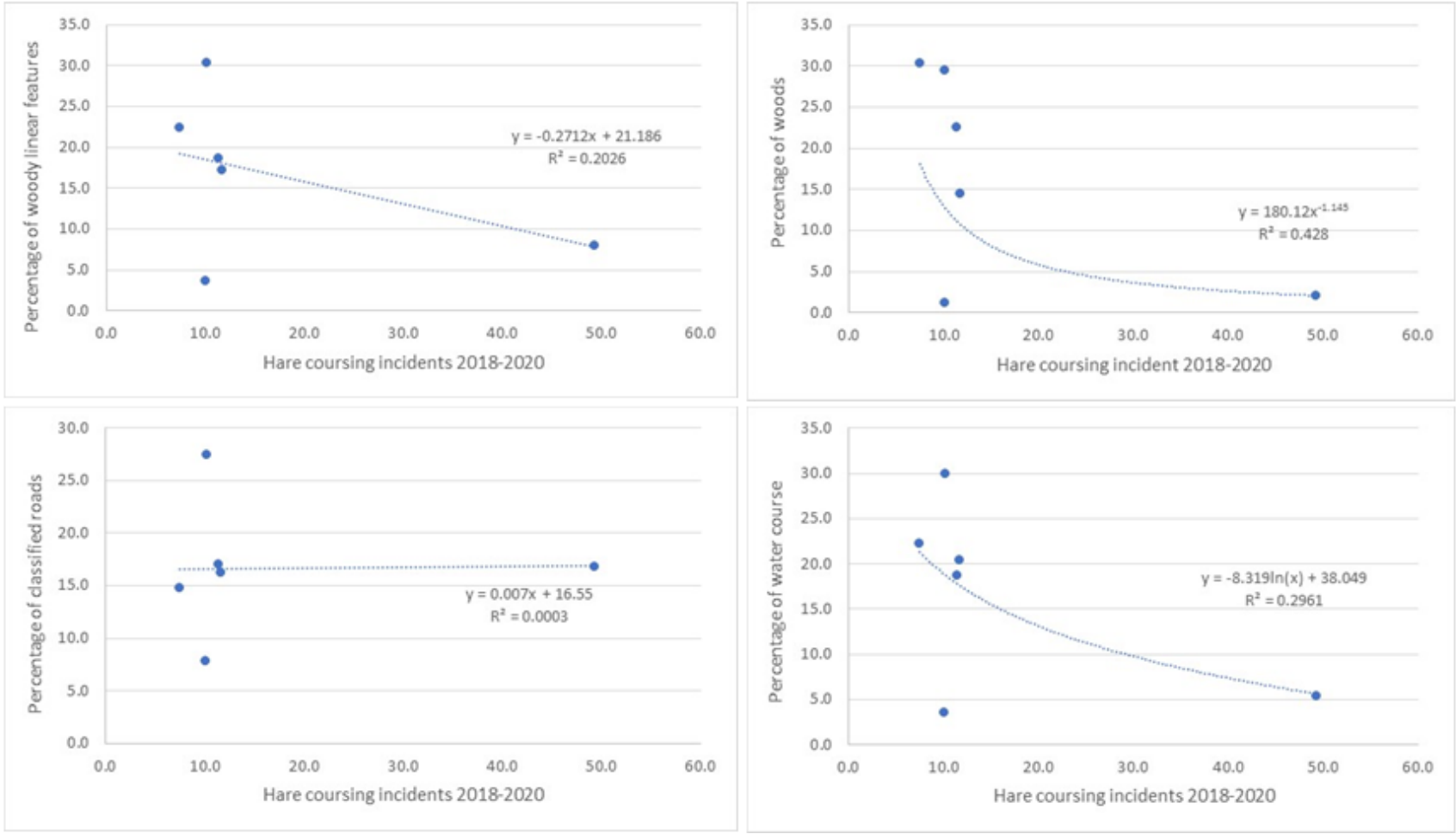


Figure 9: Graphs showing potential correlations between the percentage of hare coursing incidents and the percentage of Lincolnshire districts covered by woody linear features, woods, water course and classified roads.

The QGIS functionality was used to identify the corresponding sizes of areas and the number of hare coursing events within the potential risk factor layer. Information on size and number of previous events within an area was added to Excel and PAI scores (Chainey et al., 2008) were generated and used to compare the potential risk factor layers. An iterative and intuitive process was used to combine these layers to maximise the PAI whilst still providing an area size which I perceived, based on analytical experience, to be practical for policing.

Once this process was completed the final analysis map was generated along with the corresponding PAI for comparison against the grid model and the RTMdx models.

6.5 Risk Terrain Results

6.5.1 RTMdx results

Table 31 shows the risk factors determined as significant by the RTMdx software generated models with the data for 2018-2019 and 2019-2020 for Lincolnshire, Boston and South Holland, North and South Kesteven, East and West Lindsey, Boston and the South Holland district.[5] A total of twelve models were produced with differing significant risk factors and associated proximity and density parameters. For example, the model generated for Boston and South Holland using data from 2019-2020 provides five significant risk factors. Proximity to junctions to a distance of 300 metres has a relative risk value of 2.959. Fields containing winter wheat, residential areas, B roads and classified roads up to 600 metres are also significant and included in the model. Classified roads have a relative risk value of 1.538 which means that junctions have almost twice the risk to a future hare coursing event than classified roads.

Considering the model for Boston district, the model based on 2019-2020 data still includes junctions and winter wheat fields as significant factors for hare coursing risk in 2021, but A roads now feature as risk factors. The different risk factors included in the model demonstrate the importance of understanding the basic geography and the context in which the modelling process takes place. Although a model is generated for the entire county, the topological heterogeneity, particularly between the north and south result in a model likely impacted by the MAUP.

In the north of the county (East and West Lindsey, North and South Kesteven) flat fields become a significant contributor to the risk of future events, in contrast in the south of the county in the district of South Holland they are not a significant factor. This is due to the south of the county being predominantly flat as Figure 10 illustrates. Boston district and South Holland district have 58% and 59% of their respective areas covered by flat fields (those with no contours) compared to

[5] The RTMdx report for hare coursing in South Holland can be found in appendix 4.

13% for South Kesteven and West Lindsey.

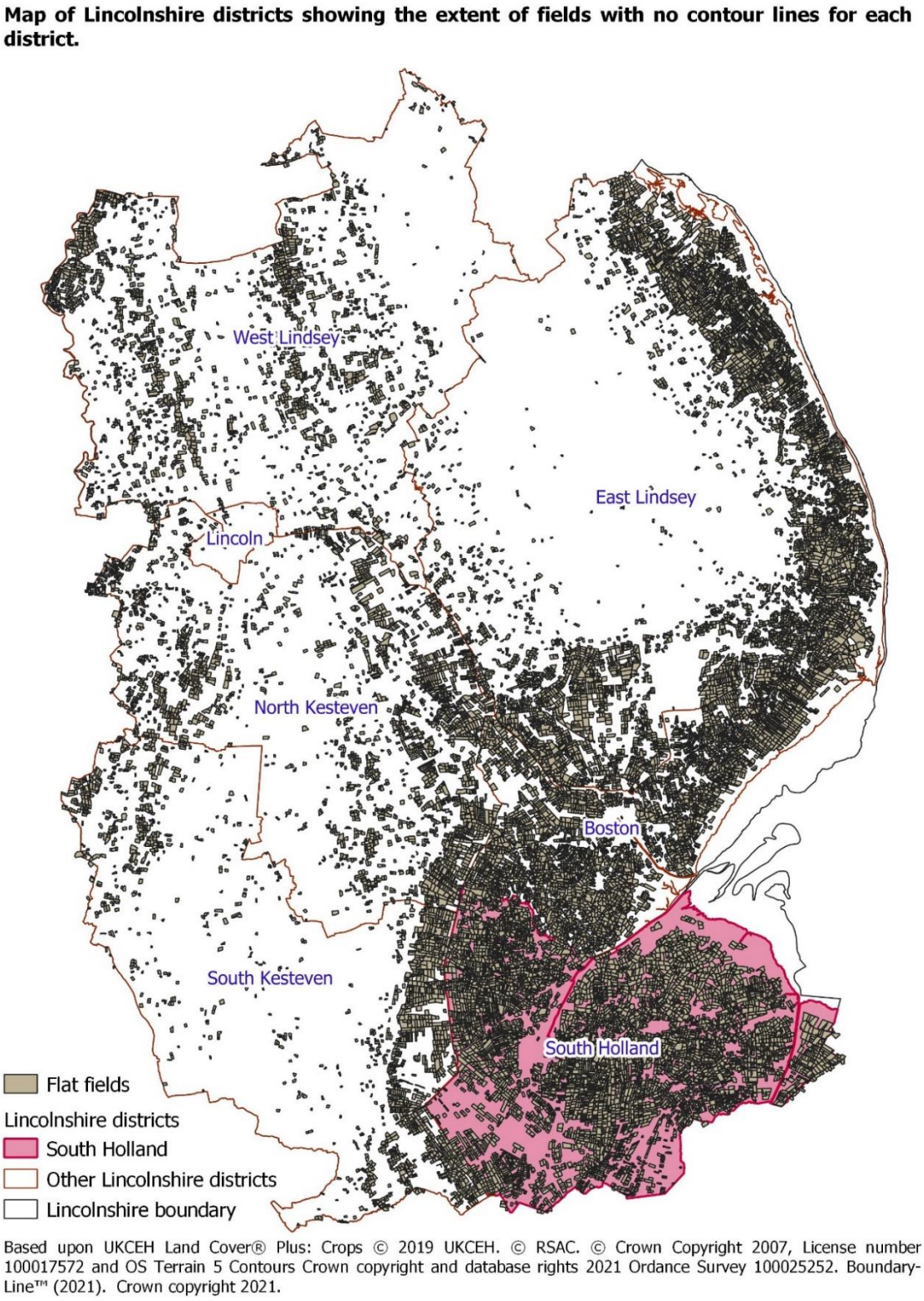


Figure 10: Map showing the extent of fields with no contours in Lincolnshire.

Table 31: Relative risk values for hare coursing RTMdx models.

2018-2019 Risk Factors	Distance/ Density (D) or Proximity (P)	Relative Risk Value	2019-2020 Risk Factors	Distance/ Density (D) or Proximity (P)	Relative Risk Value
Lincolnshire					
Junctions	300P	3.721	Junctions	300P	4.088
Fields no contours	600P	2.318	Fields no contours	600P	2.371
Winter wheat	600P	1.937	Winter wheat	600P	1.744
Classified roads	300P	1.879	Other crops	1500P	1.719
Other crops	1500P	1.650	Residential areas	600P	1.605
Residential areas	600P	1.618	Farms	600P	1.517
Farms	600P	1.449	Classified roads	600P	1.515
B roads	2400P	1.443	B roads	2400P	1.438
Inland water	600P	1.389	Inland water	600P	1.432
Not and unclassified roads	600P	1.293			
Boston & South Holland					
Winter wheat	600P	2.826	Junctions	300P	2.959
Junctions	300P	2.682	Winter wheat	600P	2.660
Residential areas	300D	1.883	Residential areas	600P	1.609
Farms	300P	1.761	B roads	600D	1.607
B roads	600D	1.697	Classified roads	900D	1.538
Classified roads	300D	1.635			
East & West Lindsey					
Fields no contours	1800P	6.066	Fields no contours	1800P	8.111
Junctions	300P	3.682	Junctions	300P	4.762
Inland water	300P	2.961	Classified roads	600P	1.937
Classified roads	600P	1.968			
Roads	300P	1.642			
North & South Kesteven					
Junctions	300P	4.407	Junctions	300P	3.792
Fields no contours	1500D	3.005	Fields no contours	1500D	3.219
Residential areas	300P	1.949	Farms	600P	1.762
Winter wheat and other crops	1500P	1.000	Residential areas	300P	1.698
Boston					
Winter wheat	600P	3.777	Winter wheat	600P	3.196
A roads	1200D	3.209	A roads	1200D	2.933
Junctions	300P	1.991	Junctions	300P	2.184
South Holland					
Junctions	300P	3.265	Junctions	300P	3.303
Winter wheat	600P	2.008	Farms	300P	1.826
Residential areas	300D	1.802	Classified roads	300D	1.728
Classified roads	2400D	1.595	Residential areas	600P	1.609
B roads	900D	1.559			

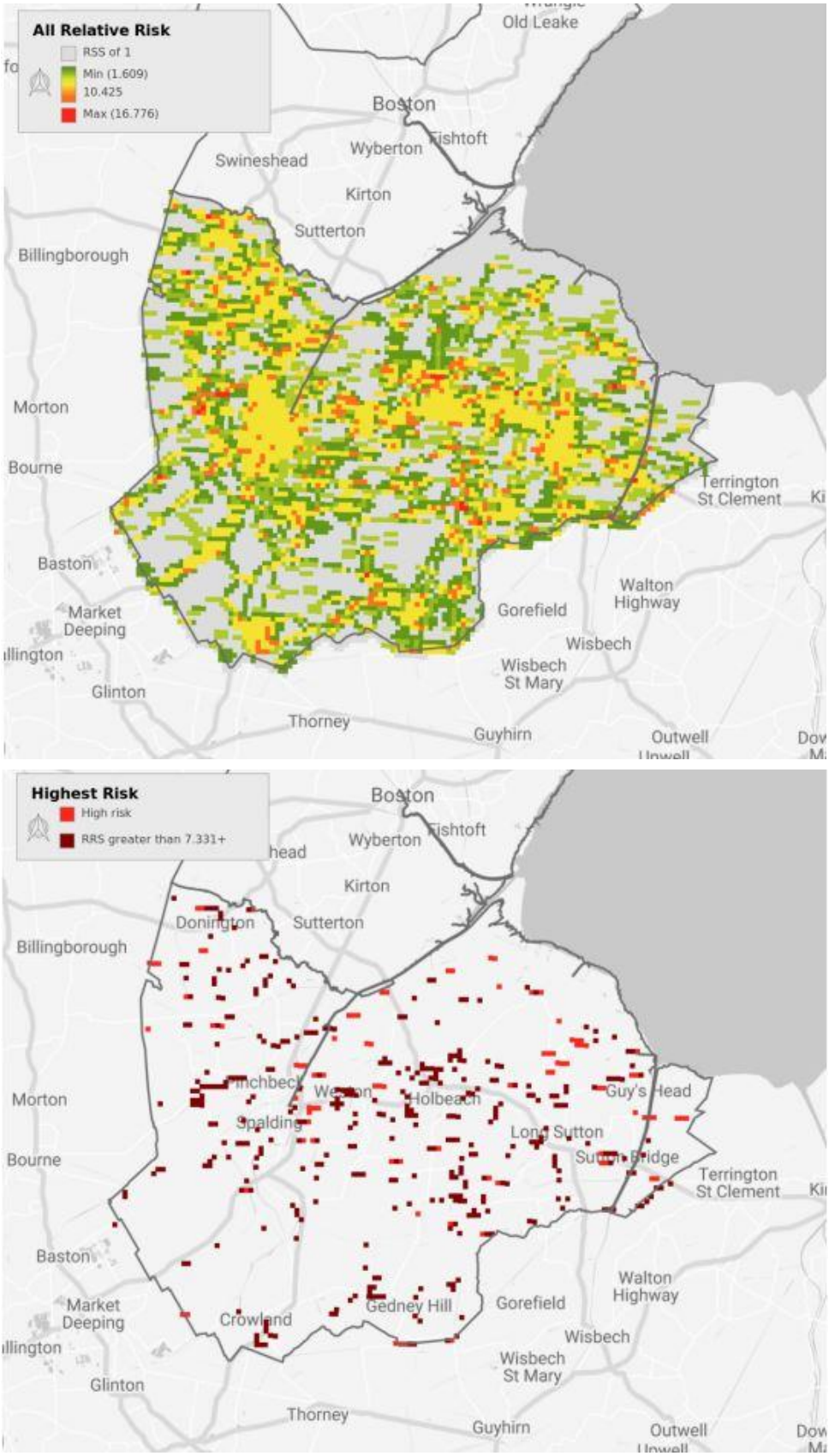


Figure 11: RTMdx output images of hare coursing risk using 2019-2020 data for South Holland.

Figure 11 shows an example of the output produced by the RTMdx software of areas of high risk for South Holland. A full set of RTMdx results for South Holland can be found in appendix 4. The results are based on the incidents reported in 2019-2020 and firstly show all risk levels for the analysed area, the second map focused on only those areas identified as significantly at risk to future offences.

6.5.2 Manual model results

Two different methods were used to create the manual models, the grid method and proximity method. The results of the 300-metre grid manual model are shown in Table 32.

The grid squares selected as high risk are those with values greater than the mean plus two standard deviations. Despite each area having high risk areas calculated individually, due to the vast number of grid squares without an incident of hare coursing, Table 32 shows the high-risk areas are all grid squares with one or more hare coursing events. The result is that despite the differing PAI calculations for the districts which range from 21.19 to 79.3 the areas of risk for the individual districts of Boston and South Holland are the same as those calculated for the combined two districts. These areas are also the same areas of risk which the Lincolnshire model identifies within these two districts. The results of these can be seen in Figure 12 and Figure 13.

The concentration of risk areas in the south of the county particularly in South Holland, could have potential for directing patrols. However, the sparsity of high-risk areas in most of the county, combined with each identified risk area being the location of at least one incident in the previous year I do not feel adds any additional analytical value than asking officers to patrol in areas of previous offences.

Table 32: Results of the 300m grid manual risk model.

Model:	Mean	Standard deviation	Mean plus 2 standard deviations	Area, sq metres	Area high risk, sq metres	Percentage area	Total points	High risk area points	Percentage points	Predictive Accuracy Index, PAI (Chainey et al., 2008)
Previous incident location 300m grid, High risk for 2019-2020 hare coursing incidents										
Lincolnshire	0.0125	0.1606	0.33	6106567603.83	54635470.97	0.89	1122	527	46.97	52.5
Boston & South Holland	0.0388	0.3122	0.66	1116446077.25	27178390.07	2.43	679	396	58.32	24.0
East & West Lindsey	0.0056	0.0890	0.18	2922499654.10	14026503.84	0.48	163	62	38.04	79.3
North & South Kesteven	0.0083	0.1122	0.23	1866381739.78	12812231.5	0.69	280	77	27.50	40.06
Boston	0.0239	0.2617	0.55	365086328.47	5836535.1	1.60	96	45	46.88	29.32
South Holland	0.0456	0.3322	0.71	751345536.92	21350392.76	2.84	583	351	60.21	21.19
High risk for 2020-2021 hare coursing incidents										
Lincolnshire	0.0163	0.2236	0.46	6106567603.83	56447218.42	0.92	1721	744	43.23	46.8
Boston & South Holland	0.0529	0.4414	0.94	1116446077.25	29385653.02	2.63	1004	542	53.98	20.5
East & West Lindsey	0.0049	0.0918	0.19	2922499654.10	10948817.22	0.37	293	58	19.80	52.8
North & South Kesteven	0.0132	0.1766	0.37	1866381739.78	16039795.23	0.86	421	144	34.20	39.80
Boston	0.0223	0.2420	0.51	365086328.47	5475784.49	1.50	175	57	32.57	21.72
South Holland	0.0674	0.5089	1.09	751345536.92	10616885.78	1.41	829	359	43.31	30.65

Areas in Lincolnshire identified as high risk to hare coursing in 2019-2020 using the 300m grid model.

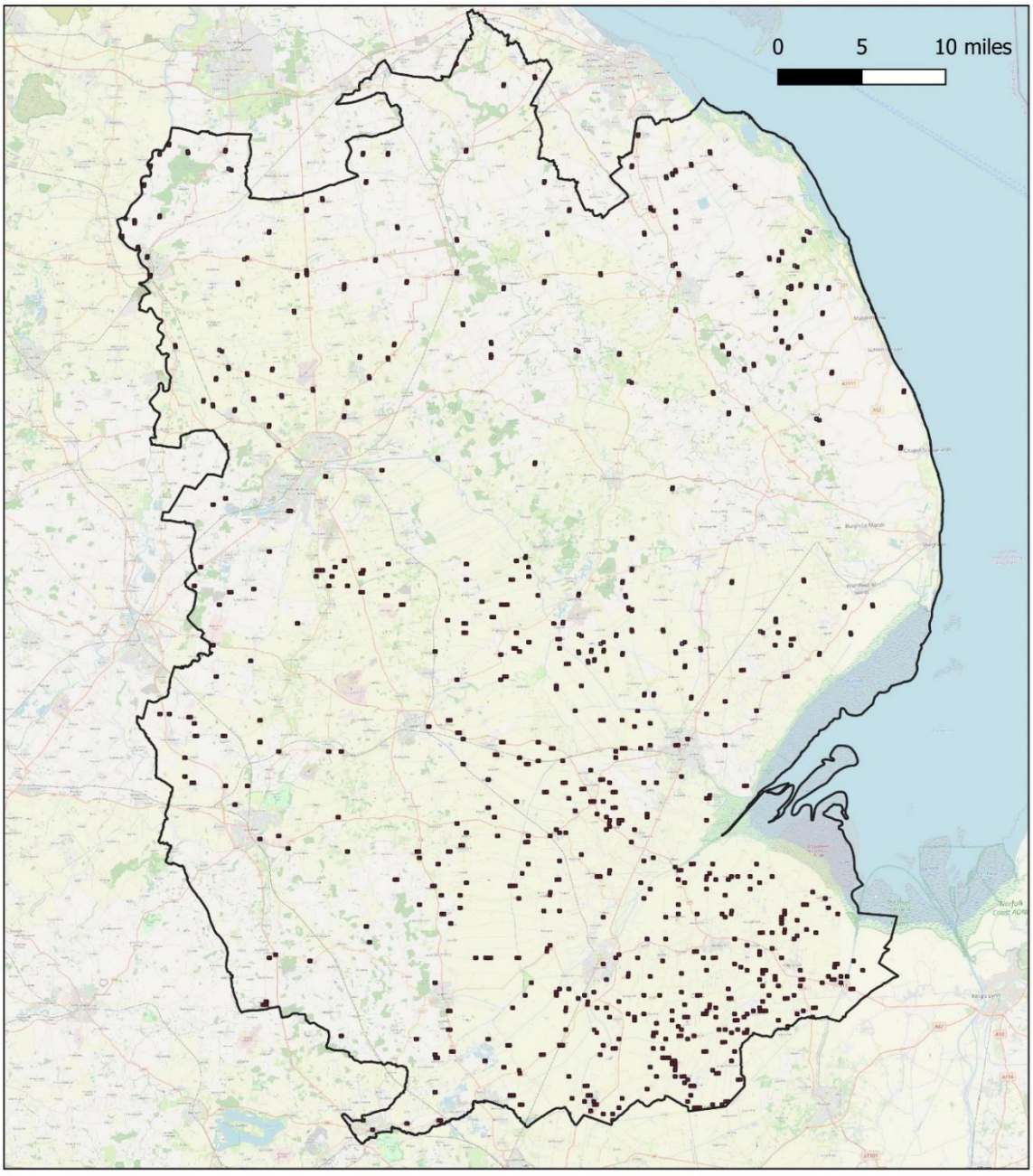


Figure 12: Map showing the high-risk areas to hare coursing in Lincolnshire based on the 300-metre grid model.

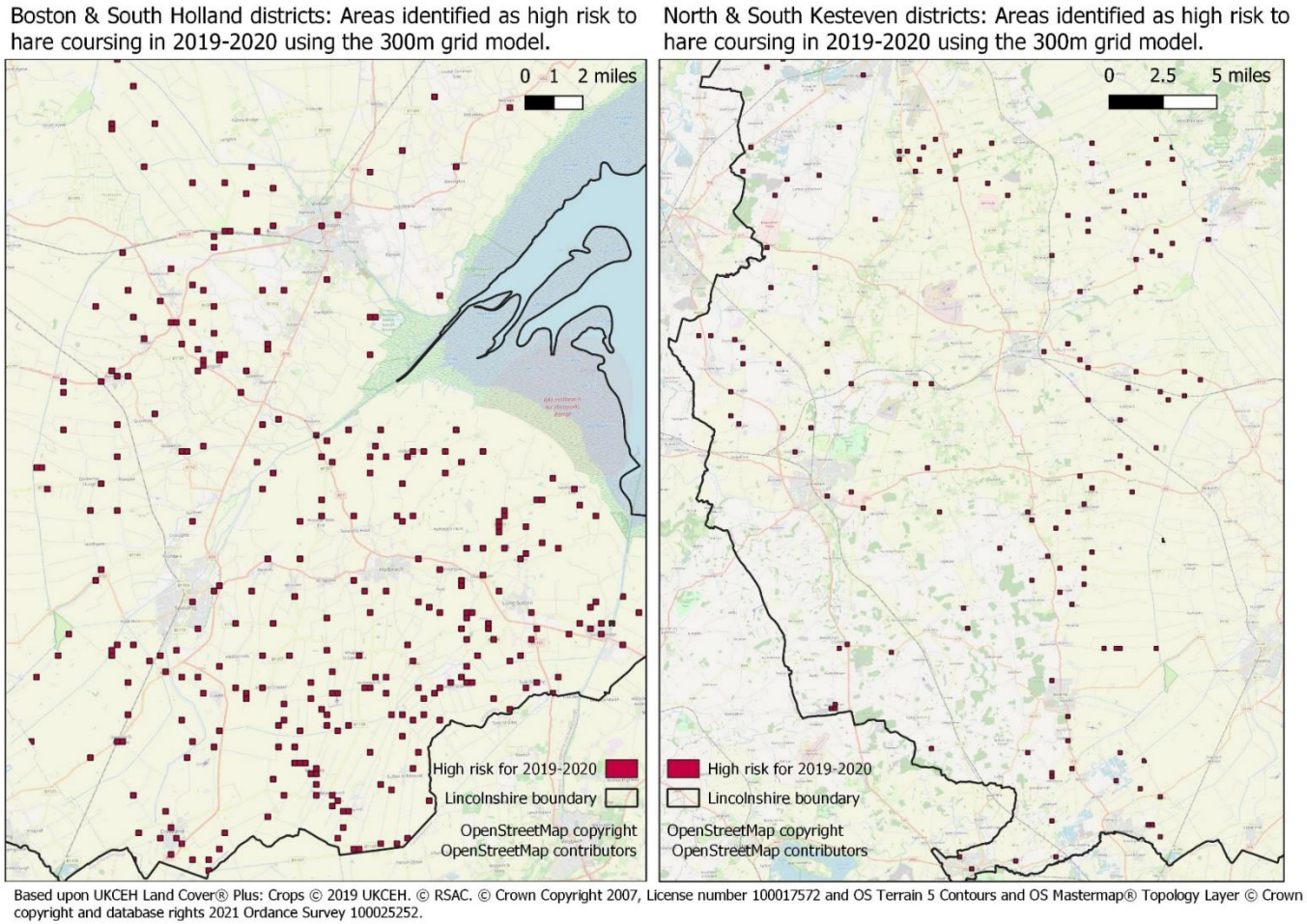


Figure 13: Maps showing the high-risk areas to hare coursing in 2019-2020 for Boston and South Holland and North and South Kesteven based on the 300m grid model.

The second manual method utilised aspects of the topography to determine where future offences might occur and is the proximity method model.

Table 33 shows the proximity model results for Lincolnshire. There is a large variation in the percentage of the areas which the models identify as high risk, (1.7% to 27%), but there is little variation in the PAI scores, ranging from 0.5 to 1.3. The low PAI scores for all the Lincolnshire models indicate they do not offer any value in determining the risk of future offences.

Table 34 shows the results of the proximity to road junctions' analysis. The comparative results for 2020 and 2021 show that there is little change in the PAI scores between the two years, indicating that proximity to junctions is a relatively stable predictive geographical feature. Unfortunately, on their own, proximity to non-residential junctions identifies between 18% and 26% of a district's area as high risk. Considering that the area to target is dispersed across the districts there are no clearly defined optimum locations identified to target policing responses. In addition, the predictive accuracy has a highest value of 2.9 for the North and South Kesteven area, and although much more favourable than for Lincolnshire models I would not be recommending this model for action as it covers over 18% of the area.

Boston and South Holland has the greatest number of hare coursing incidents during the analysed period compared to the other areas of Lincolnshire and further models were created specifically for these areas. Table 35 shows the PAI scores for models generated for Boston and South Holland, which used combinations of physical features of the landscape. The models which include flat fields have PAI scores of less than one, and despite the areas to focus on being smaller than those identified using non-residential junctions, the combination of area size and percentage locations of future incidents identified leads to the conclusion that none of these models would warrant practical use by officers.

Table 33: Manual model results for Lincolnshire.

Model for Lincolnshire	Period	Area sq metres	Area high risk, sq metres	Percentage area	Total incidents	High risk incidents	Percentage high risk incidents	Predictive Accuracy Index, PAI (Chainey et al., 2008)
Flat fields	2019-2020	6106631316.67	1593479315.17	26.09	1122	279	24.87	1.0
	2020-2021	6106631316.67	1593479315.17	26.09	1721	400	23.24	0.9
Flat fields, wheat, other crops, grass, woody areas within 500m of A roads	2019-2020	6106631316.67	124899789.11	2.05	1122	24	2.14	1.0
	2020-2021	6106631316.67	124899789.11	2.05	1721	25	1.45	0.7
Flat fields, wheat, other crops, grass, woody areas within 500m Broads	2019-2020	6106631316.67	102894126.31	1.68	1122	9	0.80	0.5
	2020-2021	6106631316.67	102894126.31	1.68	1721	30	1.74	1.0
Flat fields, wheat, other crops, grass, woody areas within 500m classified roads	2019-2020	6106631316.67	354183802.56	5.80	1122	87	7.75	1.3
	2020-2021	6106631316.67	354183802.56	5.80	1721	122	7.09	1.2
Flat fields, wheat, other crops, grass and woody areas	2019-2020	6106631316.67	715855096.05	11.72	1122	123	10.96	0.9
	2020-2021	6106631316.67	715855096.05	11.72	1721	173	10.05	0.9
Within 300m of junctions	2019-2020	6106631316.67	3062052116.08	50.14	1122	643	57.31	1.1
	2020-2021	6106631316.67	3062052116.08	50.14	1721	915	53.17	1.1

Table 34: Results of the 250 metres from road junction model for Lincolnshire districts.

District Model, 250 metres from road junctions	Period	Area sq metres	Area high risk, sq metres	Percentage area	Total incidents	High risk incidents	Percentage high risk incidents	Predictive Accuracy Index, PAI (Chainey et al., 2008)
Boston & South Holland	2019-2020	1116446916.00	239221670.94	21.43	681	329	48.31	2.3
	2020-2021	1116446916.00	239221670.94	21.43	1004	395	39.34	1.8
Boston	2019-2020	365098241.00	93805200.64	25.69	96	48	50.00	1.9
	2020-2021	365098241.00	93805200.64	25.69	175	79	45.14	1.8
South Holland	2019-2020	751348675.00	148608327.31	19.78	585	283	48.38	2.4
	2020-2021	751348675.00	148608327.31	19.78	829	319	38.48	1.9
North & South Kesteven	2019-2020	1866428229.00	344880790.58	18.48	280	150	53.57	2.9
	2020-2021	1866428229.00	344880790.58	18.48	421	214	50.83	2.8
East & West Lindsey	2019-2020	2922514587.00	608216564.88	20.81	165	84	50.91	2.4
	2020-2021	2922514587.00	608216564.88	20.81	293	165	56.31	2.7

Table 35: Combined physical features models for Boston and South Holland.

Physical Feature Model for Boston & South Holland	Period	Area sq metres	Area high risk, sq metres	Percentage area	Total incidents	High risk incidents	Percentage high risk incidents	Predictive Accuracy Index, PAI (Chainey et al., 2008)
Flat fields, wheat, other crops, grass, woody areas within 500m of A roads	2019-2020	1116446916.00	46273731.92	4.14	681	16	2.3	0.6
	2020-2021	1116446916.00	46273731.92	4.14	1004	20	2.0	0.5
Flat fields, wheat, other crops, grass, woody areas within 500m B roads	2019-2020	1116446916.00	49662921.13	4.45	681	6	0.9	0.2
	2020-2021	1116446916.00	49662921.13	4.45	1004	19	1.9	0.4
Flat fields, wheat, other crops, grass, woody areas within 500m classified roads	2019-2020	1116446916.00	151404065.04	13.56	681	68	10.0	0.7
	2020-2021	1116446916.00	151404065.04	13.56	1004	99	9.9	0.7
Flat fields, wheat, other crops, grass and woody areas	2019-2020	1116446916.00	237118695.04	21.24	681	89	13.1	0.6
	2020-2021	1116446916.00	237118695.04	21.24	1004	124	12.4	0.6
Wheat, other crops, grass fields and woody areas	2019-2020	1116446916.00	378617848.61	33.91	681	347	51.0	1.5
	2020-2021	1116446916.00	378617848.61	33.91	1004	497	49.5	1.5

Table 36: Combined physical features models for South Holland.

Physical Feature Model for South Holland	Period	Area sq metres	Area high risk, sq metres	Percentage area	Total incidents	High risk incidents	Percentage high risk incidents	Predictive Accuracy Index, PAI (Chainey et al., 2008)
Wheat, other crops, grass fields and woody areas	2019-2020	751348675.00	253549472.9	33.75	585	288	49.2	1.5
	2020-2021	751348675.00	253549472.9	33.75	829	412	49.7	1.5
Wheat, other crops, grass fields and woody areas within 250m of unclassified roads	2019-2020	751348675.00	119093091.7	15.85	585	141	24.1	1.5
	2020-2021	751348675.00	119093091.7	15.85	829	206	24.8	1.6
Wheat, other crops, grass fields and woody areas within 500m of classified roads	2029-2020	751348675.00	170480381.5	22.69	585	218	37.3	1.6
	2020-2021	751348675.00	170480381.5	22.69	829	329	39.7	1.7

The results of the combination model for South Holland district shown in Table 36 highlight the influence of a large percentage area identified as high risk has on the PAI score. All PAI's are below two and based on the high percentage of area identified at potential high risk, these models would not be recommended for practical use by officers. Physical feature combination models were generated for Boston with typical PAI scores of less than one and highlight along with the results in Table 36 that the combination models are unsuccessful at determining areas at risk to future offences, even when smaller districts are used within the analysis.

6.5.3 Comparison of manual and RTMdx models

Table 37 compares the best manual models to the RTMdx models for hare coursing in Lincolnshire, with the 2018-19 model tested with 2019-2020 data showing the best performance of the two RTMdx analyses. As already discussed, the percentage area identified with the grid model is too small and fragmented to offer any value to practical policing and is no better than choosing an offence location from the previous year so is not included in the comparison table.

The RTMdx models have a PAI score which is approximately four times greater than the best of the manual models, demonstrating that it is a viable method of determining risk of future offences when considering the county of Lincolnshire.

Table 37: Comparison of risk models for Lincolnshire.

Lincolnshire Models	Mean	Standard deviation	RRS>mean plus 2 standard deviations	Percentage area	Predictive Accuracy Index (Chainey et al., 2008)
RTMdx model for 2018 - 2019	14.521	19.063	52.647	4.45	7.5
RTMdx model for 2019 - 2020	14.246	19.165	52.576	5.09	5.7
Manual model: flat fields, wheat, other crops, grass, woody areas within 500m of classified roads				5.80	1.3
Manual model: intersection of 250m from junctions and wheat, other crops, grass fields and woody areas				2.72	1.9

As already referred to, the districts of Lincolnshire are topologically different with the north being particularly hillier than the flat south of the county. To improve the models, RTMdx was run on the three large areas of the county, East and West Lindsey, North and South Kesteven and Boston

and South Holland. Table 38 shows the comparison of results between the manual and RTMdx models, with the best manual model selected for comparison.

Table 38: Comparison of risk models for three areas of Lincolnshire.

Area Models	Mean	Standard deviation	RRS>mean plus 2 standard deviations	Percentage area	Predictive Accuracy Index (Chainey et al., 2008)
District: Boston and South Holland					
RTMdx model for 2018-2019	5.807	4.903	15.613	3.09	6.9
RTMdx model for 2019-2020	6.526	5.185	16.896	6.50	2.8
Manual model: wheat, crops, grass and woody areas				33.91	1.5
District: North and South Kesteven					
RTMdx model for 2018-2019	3.993	3.924	11.841	5.23	4.0
RTMdx model for 2019-2020	3.785	3.841	11.467	5.23	3.5
Manual model: within 250m of non-residential road junctions				18.48	2.9
District: East and West Lindsey					
RTMdx model for 2018-2019	13.181	15.646	44.473	3.17	9.6
RTMdx model for 2019-2020	15.339	17.307	49.953	5.72	4.2
Manual model: within 250m of non-residential road junctions				20.81	2.7

For all areas the RTMdx models outperform the best manual model in terms of PAI. A more noticeable difference can be seen between the RTMdx results from those used to identify areas of risk for 2019-2020 to those used for high-risk areas in 2020-2021. The first-year results have over twice the PAI score for East and West Lindsey and the district areas of Boston and South Holland.

Table 39: Comparison of risk model results for the district of Boston and the South Holland district.

Area Models	Mean	Standard deviation	RR$>mean plus 2 standard deviations	Percentage area	Predictive Accuracy Index (Chainey et al., 2008)
District: Boston					
RTMdx model for 2018-2019	6.891	6.397	19.685	10.02	3.0
RTMdx model for 2019-2020	6.005	5.361	16.727	10.02	1.9
Manual model: within 250m of non-residential road junctions				25.69	1.9
District: South Holland					
RTMdx model for 2018-2019	4.763	3.986	12.735	3.04	5.9
RTMdx model for 2019-2020	2.756	2.288	7.332	4.27	2.1
Manual model: wheat, other crops, grass, woody areas with-in 250m unclassified roads				15.85	1.5

Table 39 shows the results for the two Lincolnshire districts with the greatest number of recorded incidents, Boston district and the district of South Holland. The RTMdx produces better PAI scores and the percentage of area identified as significantly high risk to future offences is lower for both districts than those of the best manual models.

6.6 Hare Coursing Risk Terrain Analysis And Conclusions

The previous section has shown that for incidents of hare coursing the RTMdx models have much better PAI scores than the manual models explored using different combinations of topological features.

The grid models, because of the sparsity of incidents across the area resulted in any grid square having a previous offence being identified as high risk. When individual districts were analysed, South Holland was the only area identified as having a mean plus two standard deviations of previous incidents value of over 1, resulting in the identification of grid squares with multiple incidents as being at increased risk.

The RTMdx models had different PAI scores for the two years tested. This was particularly noticeable when the areas of Lincolnshire were compared. East and West Lindsey and Boston and South Holland had a PAI in the first comparison year of up to four times that of the following year. There are likely to be several contributing factors, but the first at the forefront of consideration is the impact that Covid-19 travel restrictions would have on the number of recorded offences, and potentially the location of these. Offenders may be willing to travel into the county to commit offences but may not wish to travel extensive distances for fear of being stopped. The second consideration is the number of incidents per year.

The second factor is that the analysis uses the number of incidents from the previous year to identify areas of risk for the current year. When the number of incidents increases or decreases this will influence the percentage of incidents within the PAI calculation.

In the two years analysed there were between 30% and 58% increases in the number of hare coursing incidents in the test data, and as Figure 14 shows, there is some indication that these changes are influencing the PAI values. However, the value of R^2 =0.6677 shows that this is only one contributing factor, but that it accounts for two thirds of the change in PAI.

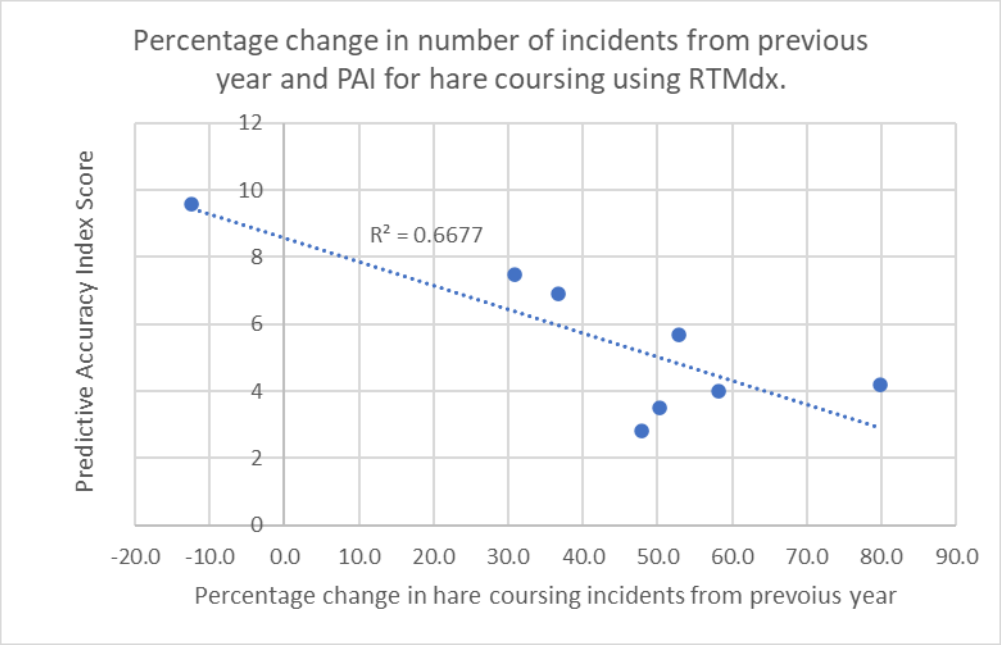


Figure 14: Comparison of PAI scores and percentage change in recorded incidents of hare coursing from the previous year.

The RTMdx models for the districts and county outperformed both manual models and could offer benefits to the policing of hare coursing in Lincolnshire by focusing on smaller areas at risk and taking into consideration the contributing factors. The risk factors identified vary for each of the areas analysed and this highlights the importance of focusing on specific areas when undertaking the risk terrain analysis.

The models shown in Table 31, except for Boston district are slightly different for the two test data years. It has already been noted above that large increase and decreases in the number of incidents from one year to the next can seemingly impact on the overall PAI, and further research would be needed to understand if this was also impacting on the individual risk factors in each model, or the combinations of risk factors. It raises the important point that the models improve with better quality and range of data, but also that those interpreting the models should have, or work in partnership with someone who has a good understanding of the offending and offences. An example of this understanding was raised in the interviews by the CInsp. He commented

regarding the data, which was included in the model, raising the point that in a previous year, there had been prolonged heavy rainfall which left certain areas waterlogged. Consequently, the area was not suitable for hare coursing, and this would be reflected in the distribution of incidents and correspondingly influence the risk factors and PAI score.

One of the benefits of the risk terrain analysis is that it does identify factors which are contributing to the increased risk. This ability to identify risk factors and then determine interventions to lower or prevent future risk is what elevates risk terrain analysis from simple hot spot mapping. In the results shown in Table 31 the risks identified, such as road junctions, locations of farms and residential areas, and road networks cannot be repositioned. Even the types of crops grown in a field cannot be redistributed at the polite suggestion of police. Tackling the risk factors to reduce their impact may not be possible, but the analysis can still add value and provide actionable intelligence on where police activity could be positioned to maximise impact. The following chapter considers whether police officers find any practical value in the results that it provides.

7 Officer Interpretation Of Analysis

The following chapter considers the influences and experiences of police officers which may impact on their attitudes and opinions of research or analysis. These views and perceptions can affect the level of value and subsequent action officers take in response to analytical, research results and inputs from civilian analysts, ultimately effecting the successful implementation of the research's recommendations. It briefly considers how organisational culture, that of public and specifically police organisations impact on attitudes and values. It then considers the importance of police culture on attitudes towards analysts and analysis.

The second half of the chapter investigates the attitudes and opinions of a small group of Lincolnshire Police officers to analysis. The risk terrain analysis detailed in chapters five and six are the focus, with the aim of understanding how officers interpret the results and how similar analysis can be best presented to officers, to maximise tactical and strategic action based on the research and analytical results.

7.1 Organisational Culture

Organisational culture is widely accepted as made up of a collection of fundamental beliefs and values which give meaning to the organisation and is created from 'a broad range of internal and external influences' (Wallace at al., 1999:553), not all of which can be controlled by the organisation's management. Westrum (2004:ii22) argues that 'culture shapes an organisation's response to problems' but is 'mutable' (Westrum, 2004:ii27). This changeability can be influenced by new management, working conditions or wider national or international context, for instance the influence of Covid-19 on office versus home working. Pettigrew states 'for people to function within any given setting they must have a continuing sense of what that reality is all about to be acted upon. Culture is the system of such publicly and collectively accepted meanings operating for a given group at a given time' (Pettigrew, 1979:574). By expressing culture as accepted meaning at a given time implies agreement with Westrum, in that this meaning could change with time, but for people to retain a continuing sense of culture the change will be a slow evolving process.

More simplistically Martins and Terblanche (2003:65) describe organisational culture as 'the right way in which things are done or problems should be understood in an organisation' and that it 'fills the gap between what is formally announced and what actually takes place'. 'Through socialisation processes in organisations, individuals learn what behaviour is acceptable and how activities should function' (Martins & Terblanche, 2003:68), influenced by the actions of leaders in their use of information, rewards, and punishments (Westrum, 2004).

Researchers have identified several different structures and characteristics to understand organisational cultures. These include interpretive and structural views, Johnson & Schole's cultural web model, Charles Handy's Four Power Structures, Geert Hofstefe's Five Cultural Dimensions, Edgar Schein's three levels of organisational culture, Fons Trompenaars four corporate cultures and Deal and Kennedy's four generic culture types (Cacciattolo, 2014). Despite

the differences in interpretation there is agreement that 'organisational culture is not completely homogeneous' (Cacciattolo, 2014:7) with an organisation displaying overlapping and even contrasting cultures (Caccaittolo, 2014; Parker & Bradley, 2000).

Two theories relating to culture, Sackmann's cognitive perspective and Bourdieus' relational theory offer explanations as to the development of multiple cultures within organisations. Sackmann (1991) splits cultural knowledge into four dimensions: dictionary, directory, recipe and axiomatic. Dictionary knowledge is the definitions and labels of things and events within an organisation and directory knowledge is the descriptions of how things are generally done. The fundamental assumptions of why things are done the way they are is the axiomatic knowledge of an organisation, and recipe knowledge relates to what should or should not be done in specific situations (Chan, 1996).

Bourdieu's theory recognises the interplay between the different cultural positions (habitus) and structural positions (field) of individuals within an organisation, alongside the social and political contexts of their work. Habitus can be thought of as the unconscious thoughts and actions acquired through socialisation of what is acceptable or unacceptable in certain circumstances. In the same passive way habitus gives a sense of position within a social structure and the opportunities that this offers. The skills and knowledge required for success in one habitus could be little use in another.

7.2 Public Organisations

Public organisations commonly have hierarchical cultures which have 'under-emphasised developmental and rational aspects of organisational culture because they have lacked an orientation towards adaptability, change and risk taking' (Parker & Bradley, 2000:130). In a hierarchical culture, information management and communication are the basis of stability and control, with 'individual compliance achieved through the enforcement of formally stated rules and procedures' (Parker & Bradley, 2000:129). If better acceptance is to be achieved since Cope's (2004) research on intelligence analysis, and movement towards embracing evidence-based policing research and new analytical practices it is likely to require some cultural shift by officers, and organisations. Both these issues are discussed in more detail in the following two sections.

Martins and Terblanche (2003) acknowledge that managers can create a culture that supports change, but they describe several obstacles which hinder creativity. These include values associated with hierarchical structures such as rigidity, control, and order; rewarding personnel for using trusted methods and not making mistakes; and pressure on employees to work harder, emphasising efficiency and effectiveness, doing more for, and with, less. Doing more with less has been one of the political drivers forced on public organisations over the last decade, emphasised under austerity measures. It is a further example of how public organisations are 'subject to political rather than market controls' (Parker & Bradley, 2000:130) as witnessed in the 1980's and 1990's 'application of private-sector management principles in the public sector' (Fielding & Innes, 2006:131). Emphasising productivity and downsizing are counterproductive to creativity and change in organisations (Filipczak, 1997 in Martins & Terblanche, 2003), so as the UK government pushes for cultural change and innovation whilst concurrently reducing funding and emphasising productivity (Palmer et al., 2019) a lack of change in public organisations should not be unexpected.

Filipczak identifies how the impact of austerity measures and performance management will stifle attempts to change (Martins & Terblanche, 2003), and the findings of Parker and Bradley (2000:137) 'are suggestive of the proposition that culture in the public sector remains aligned with a traditional bureaucratic model'. The next section discusses police culture specifically with an emphasis on where and how this might influence the adoption of research and analysis to support evidence-based policing.

7.3 Police Culture

The classic literature of Reiner (2010) 'not only points to the importance of hierarchy and discipline as values, but also depicts the police as typically conservative, reactionary, resistant to change and even racist' (Caveney et al., 2020:1212). This implies that there is only one policing culture, but research points to the contrary (Demirkol & Nalla, 2020; Farkas & Manning, 1997; Manning, 1994; Paoline, 2003; Reiner, 1992). It could also be considered as static, due to the enduring nature of some cultural characteristics (Loftus, 2016; Skolnick, 2008) and resistance to change (Caveney et al., 2020). However, Kingshott et al. argue police culture is a 'constantly changing concept of acceptable ideas bound in historical and anecdotal fact and myth that have been accepted as being representative of the attitudes and perceptions of serving officers' (Kingshott et al., 2004:197).

Police organisational culture has been found to have substantial impact on police officer behaviour (Brough et al., 2016) and is often the reason given for officers' failure to embrace change (Belur & Johnson, 2018), and as barriers to the acceptance of crime analysis within policing culture (Cope, 2004, Willis et al., 2007, Boba Santos & Taylor, 2014) which still exist. Palmer et al. (2019:97) identified that there were 'diverse cultures at work that impact on the attitude, commitment and engagement' with evidence-based analysis and research.

Culture, in policing contexts, can be described in several ways, with Fenn and Bullock (2021:229) stating it is 'generally taken to refer to the informal assumptions, values and 'craft' rules that underpin and help officers make sense of their day-to-day experiences and which are transmitted across members'. Farkas et al. (2020:77) describe organisational culture as the 'norms, rules, procedures, symbols, and beliefs, all organised in a system, deeply embedded in the collective conscience of the members of the organisation, thereby influencing their cognitive and affective behaviours, and even their performance in an indirect way'.

Cop culture was originally perceived to be monolithic and stable, but later researchers challenged this view (Chan, 1996; Cordner, 2017; Manning, 2007; Paoline, 2003; Reuss-Ianni, 1993). Reuss-Ianni identified cultural differences between police officers and those of management rank in what they referred to as 'Street cop' and 'Management cop' cultures (Reuss-Ianni, 1983:1), which often have contrasting views on policing. The street cop sees the immediate response to crime and public safety in the communities in which they work as top priority. They see themselves as professionals acquiring on the job experience to develop street craft to 'recognise "dirty" people and situations which require police intervention' (Ruess-Ianni, 1983:6). Ruess-Ianni (1983) stipulates that it is the street cop culture which determines everyday policing practice, and the work of Brough et al. (2016) supported the findings of Ruess-Ianni.

In later work, Manning (1993) extended the idea to include street cop, middle management, and command cultures. Management cop culture is mindful of the politics of policing, accountability both socially and financially and the increasing scrutiny both from inside and outside of the department and organisation. As a result, they seek to be cost effective and efficient, making decisions which are both rational and objective (Ruess-Ianni, 1983). Street cops and management cops share the goal of combating crime, but they view the how and where differently. Management cops have a broader sense of local crime fighting, they need to manage responses and resources over cities and districts. They need to prioritise, justify, and plan appropriate responses.

Skolnick in *Justice Without Trial* published in 1966 identified three shaping factors of police culture, and this was an officer's exercise of authority, their response to danger from offenders and those in authority, and the pressure to produce results. They further explain how these factors differ across environments. This is what Reiner (2017) argues demonstrates an understanding that there are multiple cultures in response to these differing environments, and a concept which was ignored for several years. Like Skolnick, Bourdieu has a structuralist approach to culture and as Reiner (2017) highlights, Skolnick probed the differences between patrol,

detective and specialist officers in his fieldwork. Despite being seen as a monolithic account of police culture by preceding researchers Reiner (2017) argues that this was based on the ideal type sketched by Skolnick of cop culture.

Police cop culture usually refers to street cop culture (Chan, 1996), but research evidences that police culture is not monolithic (Demirkol & Nalla, 2020; Loftus, 2016; Reiner, 2015 & 2017). As organisational cultures are developed through, and by the situations dealt with by their members, there are logically likely to be more than one police culture. Potential sources of variation are organisations, departments, rank, and officer styles (Farkas & Manning, 1997; Paoline, 2003). How these different cultures manifest can be explained through the cultural development theories of Sackmann and Bourdieu.

Chan (1996:115) discusses how Bourdieu's theory 'allows for existence of multiple cultures since officers in different organisation positions operate under different sets of field and habitus'. As referenced above, Sackmann (1991) identified that different cultures emerged due to four categories of knowledge: 'dictionary knowledge', 'directory knowledge', 'recipe knowledge' and 'axiomatic knowledge'. My interaction with officers, over twenty-years leads me to believe there are multiple cultures within both 'street' and 'management', which can be explained in part by their knowledge requirements from Sackmann's dictionary, directory and recipe knowledge, but also from the contextual basis in which they work, explained by Bourdieu's field and habitus. That is not to say there are no overlaps, but role, rank, length of service and work environment bring with them differing expectations, pressures and reliance on others.

Referring to the cognitive perspective of Sackmann in relation to police culture there is a logical narrative on how differing cultures develop within police organisations. For street cops dictionary knowledge represents the types of people they regularly encounter, and how they go about doing their day-to-day work is the directory knowledge. Axiomatic knowledge gives the basic rationale of policing and the menu of acceptable and unacceptable practices and situations, their recipe

knowledge. It can be seen how the street cop's dictionary and recipe knowledge would be different to that of management cops. The reactionary public facing activity of the street cop would require them to make distinctions between 'rough' and 'respectable' (Chan, 1996:119), likely suspects and suspicious circumstances. The craft of policing combining dictionary and directory knowledge to be proactive and look for the unusual. In contrast management cops are removed from this frontline activity. They must deal with resources, planning, meetings, and justification of decisions. Socially constructed these dimensions of culture are reinforced through organisational processes and become habit through repeated application (Chan, 1996).

In terms of Bourdieu's explanation of habitus and field, a field can be seen as a relational space dedicated to an activity (Hilgers & Mangez, 2014). Alternatively, it can be seen as the game, with the habitus being the rules. From this perspective it follows that the activity of street patrol would have different rules to that of an office-based manager attending resource, community, and senior officer meetings. A successful manager with the skills to negotiate policy and resources may have little success if called to deal with irate members of the public, like wise the quick-thinking instincts of a patrol cop maybe of little value when planning a long-term strategy. The environment within which officers work will pose different challenges, rural knowledge would be redundant in an inner-city estate and vice versa. The rules will be different, expectations different, and consequently there will be the emergence of cultural divergence.

Although their explanation of how differing cultures develop, Sackmann and Bourdieu agree that the social aspects of the role's officers hold, and the environment in which they perform them expose them to different tasks, expectations, and social interaction. This in turn reinforces the social understanding of culture and is passed on to those new to the role. It also explains the differing priorities between street cops and senior officers (Brough et al., 2016; Ruess-Ianni, 1983). Like culture, craft 'involves passing on beliefs and practices from generation to generation' and comprises 'the knowledge, skill, and judgement acquired by daily experience' (Fleming & Rhodes, 2018:8 & 9). The craft of policing is valued by officers (Sanders & Condon, 2017) but

reforms, and attempts to professionalise by government initiatives have been viewed by officers as moving away from traditional 'craft' practices and eroding the core police role (Bacon et al., 2023).

The frameworks of Sackmann and Bourdieu illustrate why and how individuals and groups would require and develop different skills pertinent to their specific roles, which in turn influence their work culture (Chan, 1996; Paoline, 2003). Lower rank officers are concerned with the reactionary, and immediacy of policing and develop a 'street craft'. Those in command positions have a political culture, accountability, and strategic oversight of departments and organisations, more akin to the professional police role, externally accountable, embracing evidence-based policing, management techniques and the policing of threat, harm, and risk (Bacon et al., 2023).

There is a 'separation of cultures between senior and frontline officers' (Palmer et al., 2019:97). Police culture stresses law enforcement as 'real police work' over other service or maintenance roles (Paoline, 2003:202). 'Incidents that failed to conform to dominant conceptions of 'proper' police work were accorded an inferior status within officers' sense of crime hierarchy' (Loftus, 2010:5). This difference in perception of 'real police work' frames officers' perception of how they view and deal with information.

Planning and decision making rely on quality information, and it is the street cop who is in the optimum position for eliciting valuable organisational intelligence. Unfortunately, organisation theory postulates that subordinates, in this case street cops would seek to distance themselves from management controls (Ruess-Ianni, 1983). For street cops this can be achieved by failing to submit all or part of the intelligence gathered through daily engagement with the public and offenders, they retain power over managers by restricting knowledge. Additionally, they may only gather or submit information which they see as of value, and this would be biased towards information and knowledge 'they believe will be useful for facilitating the enforcement of the criminal law' (Bullock, 2013:131). This is a likely consequence of officers' preoccupation with

fighting crime and the ‘inferior status’ of the service element of policing in the crime hierarchy (Loftus, 2010:5). Sanders and Condon agree that information stored in police records are ’products of police practice and subjective decision making on the ground’ (Sanders & Condon, 2017:239).

It is postulated that the flow of information within an organisation reflects the values leaders show when using information, their actions communicate what is seen by others as culturally important (Westrum, 2004). However, ‘all too often those in authority lack the quantity and quality of information required’ (Reuss-Ianni, 1983:125). Heyer (2022), points out that it is often the control and dissemination of information which is a cultural barrier to reform. The use of information, and as an extension, information technology, can be seen as a power struggle between the street cops maintaining autonomy over management, withholding information which could be perceived as a tool for controlling officers, against the need for information for analysis, evaluation, and objective decision-making by managers.

It can be seen as not only a tool for ‘policing of citizens but also for policing the police’ (Chan, 2001:141), which researchers have identified can lead to officers’ resistance to use technology (Chan, 2001). Whereas the management cop may find technological advances aid their understanding of broader crime issues, strategic analysis, problem solving and resource allocation, street cops are only likely to see it as valuable if it leads to arrests.

Additionally, ‘adopting a computer algorithm is complicated by police cultures that often emphasise traditional patrol and response functions’ (Ratcliffe et al., 2020:2). The craft knowledge of officers is perceived to be overlooked, officers question whether their knowledge is being discounted, or trying to replace aspects of their role (Ratcliffe et al., 2020). Officers feel they are overlooked as algorithms which lack transparency and not understood generate judgements, and ‘reliance is placed instead on something as mysterious as dark matter’ (Ratcliffe at al., 2020:3).

Patrolling officers see a ‘black box technology’ (ibid.) which poses a direct challenge to the police craft of street cops.

A cultural aspect relevant to this research on police acceptance of analysis is the attitude of suspicion, and associated attitude of cynicism (Herbert, 1998; Brough et al., 2016) including police management (Cochran & Bromley, 2003; Ingram et al., 2013). Loftus (2010:14) identified suspicion as a ‘pivotal characteristic’ of police culture, and police officers are trained to be suspicious (Demirol & Nalla, 2020). This notion of suspicion was linked to a good bobby being street wise (Loftus, 2010), an ability to understand neighbourhoods, based on what was relevant to policing. For example, those places associated with crime or criminality and incongruence as a basis of suspicion were identified by Loftus (2010) as valuable aspects of an officers’ knowledge and experience. This craft culture of policing, gained through practical policing experience on patrol was cited by Sherman (2015) as the explanation as to why officers did not perceive research would improve their practices. Flemming and Rhodes (2018) expand on the idea of experience arguing that it comprises of the four entwined aspects of occupational culture, institutional memory, local knowledge, and craft.

In summary police culture is not homogeneous, or static (Cordner, 2017; Fenn & Bullock, 2022; Herbert, 1998; Manning, 2007). As explained by Sackmann and Bourdieu, and evidenced in research, ‘police culture is context-based’ and ‘pluralistic’ (Caveney et al., 2020:1222) and can be influenced by an officer’s ethnicity, education and social background, their experience within the organisation and department, and the rank and role in which they are employed (Brough et al., 2016; Cordner, 2017; Fenn & Bullock, 2022; Ingram et al., 2022; Paoline, 2003; Paesen et al., 2019; Ruess-Ianni, 1983). It has also been determined that despite changes in policing priorities, organisation, and employee diversity there remains a cultural emphasis on action orientated and enforcement of law (Brough et al., 2016; Caveney et al., 2020; Fenn & Bulluck, 2022).

Caveney et al. propose that 'specific societal context, and the influence of organisational factors, will affect police culture differently according to the environment' (Caveney et al., 2020:1213). In 2004 the government introduced the National Intelligence Model (NIM) in response to a growing need to increase public confidence and be more affective with resources. The model formalised intelligence led policing in England and Wales, emphasising the use of evidence-based prioritisation to assess and manage future risk, as opposed to a reactionary response to reported offences (Maguire & John, 2006). This forward focus is a direct contrast to the 'reactionary' (Caveney et al., 2020:1212) characteristic of police culture. The introduction of civilian analysts and intelligence to inform patrol plans began a culture shift away from autonomous beat officers determining when and where they would police.

'Police departments have long been recognised as exceptionally resistant to change' (Campeau, 2019:71), but the literature would indicate that this is not because of police culture specifically, but is due to the underlying alignment to the traditional bureaucratic model of public sector organisations (Parker & Bradley, 2000) and the robust demands of both a police organisation and occupation which create and sustain cultural responses (Loftus, 2016; Reiner, 2017). With a political drive for money saving, improvement (Caveney et al., 2020; Fielding & Innes, 2006; Warrell, 2017) and the use of evidence-based policing (Palmer et al., 2019), it could be the public bodies who in essence are demanding change that are hindering the embedding of evidence and research driven practice into police culture.

A move by the police service to embrace evidence-based policing would seemingly require a cultural shift away from the reactionary focus and to embrace change. This change, argues Bacon et al. (2023), has already occurred. Their research found that occupational craft was 'either limited in their application or discarded' and 'that the core police role and traditional police craft have been reformed almost out of existence' (Bacon et al., 2023:20). It may also be a consequence of the growing proportion of officers with less than five years police service, 34% nationally and 30% for Lincolnshire as at March 2022 (Home Office, 2022). These officers with

limited experience and exposure to street craft may have a reluctance to immerse themselves in engagement with the public due to increased scrutiny, public recorded interactions, and risk aversion to potential disciplinary action. This risk aversion is acknowledged by the College of Policing (College of Policing, 2023).

The officers included in my research all have over five years' experience, so it would be expected that the research would show varying levels of suspicion or scepticism towards the results of the analysis, particularly if this in direct conflict to their own understanding or beliefs. Some may view the more holistic approach to crime prevention and vulnerable victim support less favourably than direct action against criminals (Ingram et al., 2013).

'The main barriers to adopting evidence-based policing are the culture and management in a police agency' (Heyer, 2022:7) in contrast, analysis, as part of the National Intelligence Model, has for over twenty years 'placed police analysts at the centre of police professionalisation' (Keay & Kirby, 2007:265). It could therefore be expected that analysts and the analysis and research they provide has become part of accepted management practice and culture. Analysts and analysis can offer a gateway into incorporating evidence-based research into police practice (Belur & Johnson, 2018; Carter, 2016; Piza et al., 2021) and the next section considers whether, according to previous research, analysts and analysis has become an integrated and culturally accepted part of policing.

7.4 Understanding Police Cultural Influence On Analysis

7.4.1 Introduction

'Analysis represents the antithesis of traditional action-orientated police work' (Cope, 2004:197).

Reviewing the integration of analysis and analysts into police forces as part of intelligence-led policing, Cope (2004:202), identified a 'structural difficulty' involving 'the integration of analysis into existing working principles that are embedded in police culture' and that the analytical process can 'undermine core knowledge officers rely on to make sense of their world' (Cope, 2004:200). Cope focused on the bias for action orientated and experiential knowledge of officers compared to the research focused knowledge of analysts. They also saw the collective solidarity of officers, to retain knowledge and expertise, to the detriment of analysis as a negative side effect of 'cop culture' (Reiner, 1992).

Cope (2004) identified culture as a strong contributing factor, but other issues impacted on the effective use of analytical products including:

- Poor quality of analytical products,
- Trust in the analytical product,
- Police officer acceptance of civilian staff making recommendations and 'encroaching' on their role,
- Lack of understanding of analysis by police officers and
- Lack of evaluation of analytical products and police responses.

This chapter will consider the issues raised by Cope (2004) and research since, to understand whether -almost twenty years on- the effective use of analytical and research products is now commonplace and accepted within police cultures.

Although the approaches of Bourdieu and Sackmann are different, both theories allow for multiple cultures within a policing organisation. Different roles, ranks and departments will have different fields and habitus, and different dictionary and recipe knowledge (Chan, 1996). Paoline (2003) and Brough et al. (2016:33) agreed that there was cultural variation within the police and found officers identified cultural variation 'across job roles, ranks and police stations'. Paesen et al. (2019) comment that police culture is neither homogenous or stable and agree with Cordnor (2017) and Paoline (2003) that there is significant variation between police departments. The remainder of this section considers the cultural impact specifically focused on research and analysis.

7.4.2 Variance between officer rank and role on analysis

If we reflect on the definition of police culture earlier in the chapter, it is clear to see how various cultures would develop as different ranks and job roles comprehend their unique working environments, challenges, and guiding practices. Changes in policing organisations, politically and demographically have led researchers to postulate that these have resulted in changes in police culture (Brough et al., 2016; Fenn & Bullock, 2022). This section focuses on analysis, and how police cultures can promote its utilisation or dismiss it as irrelevant.

It should be anticipated that officers of different ranks and roles would view the analysis provided as part of this research differently depending on dominating cultural views and behaviour. Cultural aspects which may influence officer's views towards analysts, research and analysis, especially 'street cops' include suspicion (Loftus, 2010; Demirkol & Nalla, 2020) and mistrust. Police training and detecting crime and deception, promote attitudes of suspicion (Brough et al., 2016), the requirement to build trust with other officers and maintain control of information (Reuss-Ianni, 1983).

Recent studies identified that attitudes towards research were generally positive, but the implementation or use of research and analysis remained low (Lum et al., 2012). It has been

determined that different ranks perceive analysis and research differently (Boba Santos & Taylor, 2014). They also require different products (Lum et al., 2012) and tailoring the research to the 'characteristics, expectations, and responsibilities of different types of ranks and units can help make knowledge more digestible' (Lum et al., 2012:85) which make it easier to understand and more likely to produce action (Tilley & Laycock, 2000).

Suspicion and mistrust form a valuable aspect of a police officers' street craft. 'On the ground, certain places stood out in the police mind as relevant to the contingencies of policing' (Loftus, 2010:14). Officers developed the 'craft' of identifying those people and situations which were incongruent to the normal routine activities of people and places, and a deep-seated understanding of people and the places crime situates. This invaluable experience on the street was identified as a sub-cultural threat to the acceptance of research and analysis when it was in contradiction to 'gut instinct' (Brown & Ballucci, 2022:11), imbedded experience or organisational priorities (Belur & Johnson, 2018).

The craft of policing and reliance on experience in decision making is another cultural aspect which has been used to explain officer reluctance to use analytical products or research. A focus on the experiential and street knowledge gained overtime takes precedence over knowledge and insights gleaned from analysis (Bullock, 2013; Lum at al., 2012; Palmer et al., 2019; Willis et al., 2007). However, as discussed above, there are multiple cultures within the police, and for street cops this may remain dominant, but for management cops looking to see the wider implications there is the potential for analysis to be welcomed. Bullock (2013:138) found that amongst officers and analysts working in a local intelligence office there was 'no evidence that analytical products intrinsically "lack credibility"' because they are not 'founded in experiential knowledge gained "working the streets"'.

This finding, along with those of Evans & Kebbell (2012) and Lum et al. (2012) could indicate that after almost a decade there is some hope that civilian analysts and their products are being seen

as a legitimate aspect of policing. The reason behind this could be the civilianisation programme or imbedded nature of NIM. Equally, given the thirty-year average career span of an officer, the service has experienced a turnover of around half of police officers during this time, consequently the exposure of intelligence led policing and the use of analysts is more endemic and part of some if not all police officers' culture, especially those in management roles. Two contemporary research studies provide contrasting viewpoints on the acceptance of analysts and analytical results. A Canadian study (O'Connor et al., 2022) found that many of the issues identified by Cope (2004) and others in relation to poor quality analytical products, and lack of training and technology resulted in analysts being underutilised and consequently reinforce reactionary police responses. They stated that it was 'not surprising that analysts maybe highly supported' (O'Connor et al., 2022:468& 469) because of their role in maintaining the status quo, but they 'might be perceived as less so' if they began to challenge this. In an alternative theory Bacon et al. (2023) argue that it is not a change in cultural attitude towards analysts, but a change in culture that has occurred. They argue that reforms over recent years to professionalise policing have eroded the street craft and traditional forms of police knowledge 'almost out of existence' (Bacon et al., 2023:20) which opens opportunities for analysis and research to fill the void.

Community policing is a relatively new method of policing, with a focus on problem solving and community engagement. It is often seen as outside the traditional crime fighting ethos of policing (Fenn & Bullock, 2022), resistance to which is often attributed to police culture (Cordner, 2017). A survey of over 13,000 US sworn police officers found that '73% somewhat or strongly support' (Cordner 2017:16) community policing. Bullock (2013) identified that police managers working in neighbourhood policing roles used analysis to direct patrols for better crime control effect. Palmer et al. (2019:97) found that research had 'more purchase' with senior officers because of their oversight of the bigger picture. It would be anticipated that those officers utilising analysis will be more accepting if they have had exposure to analysis from a community policing role or as a senior manager. Lincolnshire Police practices community policing in the form of Neighbourhood

Policing and is one area where crime analysts contribute to understanding problems within the community and two neighbourhood inspectors have been involved in the officer interviews detailed in section 7.5.

7.4.3 Analytical products

A leading concern voiced by Cope (2004) was the quality of analytical products. They stated there were three main contributors to a substandard product, and these were the skills and knowledge of the analyst, the appropriateness of the submitted request by the officer and the data quality (Cope 2004). Ratcliffe (2005) in his Australian research, alluded to the same issues when he gave training, and the lack of agreed methodologies and techniques leading to a misunderstanding of analysis.

Cope (2004:193) identified that analytical products reflected the quality of information available and that officers did not trust them, as they themselves knew officers 'put crap on the system' which was then utilised for analysis. Bullock (2013:136) identified delays in information being put into the system also resulted in analysis 'being viewed by officers as less useful'. As noted in the previous section, officers also withhold information to retain 'power' through knowledge and often were reluctant to share information.

Analysts rely on information to provide accurate and detailed reports. This information comes from a range of sources, the two mains being intelligence submitted by police officers and crime reports. The quality of the information used to produce reports was identified as flawed by officers and analysts, and officers consequently judged products based on this information would likewise be of little value (Cope, 2004; Kirby & McPherson, 2004). In opinions that reflect the work of Cope (2004), Bullock (2013:131) states 'officers reported that they value knowledge that they believe will be useful in facilitating the enforcement of criminal law' and that this influenced their decisions on what information would be valuable intelligence worthy of submission.

Analytical product quality was also found to be an issue (Chainey, 2012; Evans & Kebbell, 2012; Innes et al., 2005; Ratcliffe, 2005). Typically, criticisms by researchers were that analytical products are of little practical use and tell officers what they already know. The emphasis is on describing the problem and analytical content to enhance understanding is often lacking. Belur & Johnson (2018) found little had changed with 'knowledge gaps' found both individually and collectively of analysts. They also highlighted that 'gaps in the process of commissioning analytical products and disseminating results undermined their contribution' (Belur & Johnson, 2018:769). My interviews, with officers aims to understand how presentation can improve the dissemination and assimilation of this research's results.

7.4.4 Operational experience versus analytical results

Belur & Johnson (2018) identified that when analysis contradicted operational experience or went against organisational priorities there was a greater resistance to its acceptance. This is in keeping with the work of (Sherman 2015) who states officers have a 'longstanding mistrust of research' and prefer to rely on experience, which Tilley (2010) notes, is down to valuing of can-do practical skills. As discussed in the police culture section, different officers in various roles and ranks have different cultural perspectives, and without clarification of rank, role and level of experience we cannot accept these results on surface value.

Even without prior knowledge or experience, Fyfe & Wilson (2012:312) note that student officers resisted engagement in higher education 'because of its perceived irrelevance to professional development' and likely due to their street cop ethos of crime fighting. It will make interesting research to see if this perspective changes with the increase in police recruits in the UK who are undergoing undergraduate degree programs as part of the police professionalisation program, or if the findings of O' Connor et al. (2022) on the erosion of street craft materialise in greater analytical acceptance.

Another cultural aspect, particularly within the cultures of street cops is the enduring nature of action-orientated and enforcement aspects of the police role (Fenn & Bullock, 2022). Street cops are reported to have a preoccupation with fighting crime (Loftus, 2010) and officers afford high value to proactive patrolling due to the parallels with crime fighting and detecting crime. Hot spot patrolling based on analysis of crime patterns and concentration have become an acceptable part of policing practice by officers and managers (Braga, 2007). Although not empirically tested this could be due to the natural lean towards catching criminals and detecting crime. It could be argued that risk terrain analysis is another way to identify areas of crime, through a culturally accepted methodology of crime mapping, and thus seen as an acceptable analysis for action.

Acceptance of ideas is more likely when they do not go against personal beliefs or daily routines (Lum et al., 2012), and Fyfe & Wilson (2012) noted that research findings were more likely to be used if they fitted current thinking. Research findings which are suggestive of ill-founded or unsuccessful policy decisions are 'unwelcome, and can be resisted, side-lined or neglected' (Tilley & Laycock, 2000:215) and a 'sub-cultural resistance' if products contradicted experience or organisational priorities (Belur & Johnson, 2018; Cope, 2004; Kleiven, 2007).

In 2004 Cope identified that there was prejudice of police officers towards civilian staff due to the hierarchical policing structure, which resulted in an undervaluing of the analysts and their products which has endured for at least ten years (Boba Santos & Taylor, 2014; Chainey, 2012; Kleiven, 2007). Encouragingly however, the research of Evans and Kebbell (2012:214) found that 'little mention was made of the effectiveness of an analyst being correlated with them being either sworn or unsworn police members'. On a similarly positive note, Lum et al. (2012) found more officers felt that analysts were integral to the day-to-day work of policing than not; Philips (2012) found similar positive attitudes towards analysts in America, further supporting the idea that analysts and their work are permeating into police culture. In more recent research however, Sanders & Condon (2017:248) comment that analysts with limited available technology and data 'reaffirm traditional ways of knowing and policing', which O'Connor et al. (2023) use as their basis

to explain why analysts have become more accepted. On the surface, increased acceptance of analysts would seem positive, but if this is solely due to supporting the status quo, it can only be detrimental in the long-term, as it fails to progress the analytical profession, use sound techniques or truly support the ethos of the NIM or evidence-based policing.

Analysts who were ex-police officers reported that it gave their work legitimacy in the eyes of police officers (Cope, 2004), others understood that acceptance and use of products was about building trust (Belur & Johnson, 2018; Cope, 2004). Hunter et al. (2019:251) summarised a decade of research when they stated, 'fundamental is the importance of practitioners' involvement in and/or co-production of research' and that it was important that the researcher understood the context and reality of practice. In the research conducted by (Caveney et al., 2020) they acknowledge that being a member of the organisation, having an 'insider status' by those conducting research, had significant advantages aiding its acceptance by police officers.

7.4.5 The impact of research and analysis

The evaluation of analytical products and research implementation was identified by Cope (2004) as lacking and is not limited to analytical products, as noted by Tilley (2009), in relation to problem orientated policing (POP). Research since has continued to document the limited, or absence of evaluation, of responses to analytical work (Boba Santos & Taylor, 2014) and the work of the analysts themselves. Absence of knowledge of the responses which have been successful are compounded by the challenges of evidence legitimacy in the current political backdrop of evidence-based policing (Lumsden & Goode, 2018).

The implementation of analysis and research into policing practice has 'organisational challenges' (Hunter et al., 2019:259) which researchers, analysts and practitioners can have no individual impact on, and likely why much research has little impact on practice (Fyfe & Wilson, 2012; Tilley, 2009). Political and media pressures (Lum et al., 2012; Tilley & Laycock, 2000; Willis et al., 2007) are probable contributing factors why 'concern over the gap between research and practice'

reoccurs (Lum et al., 2012:63). In addition to public opinion, financial constraints and employee unions can all pull against evidence of what works and best practice within policing (Ratcliffe, 2003a).

Ratcliffe identified that there was a training need to 'address the inability of law enforcement management to understand and act on the crime analysis they were given' (Ratcliffe, 2004:80). Fourteen years on from the research of Cope (2004) the incongruency between methodologies and techniques used by analysts and the interpretation of these by police officers still existed. Belur and Johnson (2018:768) describe it as 'shortfalls in organisational knowledge about analysis and the process of commissioning and using analytical products'. Officers did not know or understand the range of analysis available to them, or which process was the most appropriate for achieving their objectives. This was an issue subconsciously acknowledged by officers, who when interviewed commented that they were unable to task analysts 'intelligently' (Belur & Johnson, 2018) an issue also raised by Ratcliffe (2010) and Chainey (2012). This inability to understand and appreciate the analyst and their role had hindered the integration and impact of analysts work (Belur & Johnson, 2018; Boba Santos & Taylor, 2014; Keay & Kirby, 2018) and was consistently identified as a training need of analysts and officers (Belur & Johnson, 2018; Ratcliffe, 2004; Willis et al., 2007).

Research has arguably had a very negligible impact on policing practice (Fyfe & Wilson, 2012; Lumsden & Goode, 2018; Tilley, 2009). The drive towards basing more decision making on analysis and an evidence-based approach will continue to have problems with impact as 'few police managers are trained in the art of interpreting criminal intelligence and crime analysis' (Ratcliffe,2010:9). For successful implementation the analysis or research must influence the decision maker. Research presentation can often detract from the evidence of effectiveness it can provide because of lengthy academic documents (Ratcliffe, 2010). Perhaps more importantly when analysts can interpret and convey this to police mangers, they lack the necessary training

and skills ‘to convert that intelligence into practical and effective long-term crime reduction policies.’ (Ratcliffe 2010:9).

Research and analysis have been established within policing since the introduction of POP (Goldstein, 1979) requiring the use of scanning, analysis, response and assessment (SARA). Although relatively new additions to the policing family due to the introduction of the NIM, and subsequently evidence-based policing, the roles of analysts and researchers neatly fit the analysis and response requirements of the SARA model. The issues of implementing analysis are no different to those of successful implementation and evaluation of POP, of which ‘chronic difficulties’ have been identified (Tilley, 2010:189). It is, however, important to see the problems not as a personal attack on analysts and their abilities but as a challenge to utilise the research to devise the most effective method of researching and disseminating the results to the right people.

Ratcliffe (2010) describes intelligence-led policing as ‘anticipating risk and influencing action’ and this integrates analysis with decision making. To be affective, the analyst/researcher must seek to collate both scientific data and officer expertise to develop an explanation of crime patterns or answer specific questions on crime. Tilley & Laycock (2000) and Chainey (2012:110) support the use of the hypothesis testing approach as a key principle which can ‘generate intelligence and evidence that can be used to determine how best to deal with crime problems’.

This also goes to address other key factors in the process of successful implementation- that the results are useful, relevant, clear and user friendly (Bullock, 2013; Fyfe & Wilson, 2012; Lum et al., 2012). The importance of communicating the results in a way that meets with the expectation of officers and/or decision makers, and demonstrate that the research can bring results, alongside a summary of research implications (Tilley & Laycock, 2000) are more likely to influence policy and practice.

Barriers to analysis becoming core to policing ‘stem from specific shortfalls in organisational knowledge about analysis and the process of commissioning and using analysis, amongst other

factors' (Belur & Johnson, 2018:768). Hunter et al. (2019) agreed that there were organisational challenges to using research, but that there had been a perceptible positive change in the attitudes of chief officers to evidence-informed decision making and the importance of research for policing. The rank of an officer on their perception of research and evidence to inform policing showed a positive correlation (Hunter et al., 2019) with lower ranked officers more inclined to see it as offering little of value. Palmer et al. (2019) also found evidence to support a distinct difference in perception and use of research and analysis by rank which agreed with these findings. They found that constables were more likely to argue that both knowledge and experience were important, but that experience is of the greatest relevance, and that this is likely due to frontline officers who 'observe the benefit of experience and street craft on a daily basis' (Palmer et al., 2019:97). In contrast officers of higher rank are likely to have more exposure to research, a need to understand the bigger picture and to be seen to be following national professional direction.

Despite the political and organisational barriers to the implementation of analytical or evidence-based research into practice, there are identified areas where improvements can be made to research, analysis, and the presentation of results for action. The research process can influence the likelihood of increasing officer receptivity by the inclusion of officer insights (Lum et al., 2012) and having the benefit of improving the overall project, and the demonstration by researchers that officer expertise is valued, increases willingness to cooperate. Tilley & Laycock (2017) and Hunter et al. (2019) both flag the importance of practitioner involvement or co-production of research, bringing together experience and scientific knowledge. Caveney et al. (2020) identified that being a member of the organisation offered advantages, and the negativity of officers towards unfocused tasks or those which they had little design control over, supported the findings of Hunter et al. in relation to co-production and 'researcher proximity to and understanding of the realities of practice' (Hunter et al., 2019:251).

Tied to co-production and the inclusion of officer insights is the need for the research to be locally relevant (Hunter et al., 2019) as findings may not be transferable (Tilley & Laycock, 2000) and the context of its introduction is key to its acceptance by officers (Lum et al., 2012). Lum et al. (2012) identified that officers were suspicious of outside experts or high-ranking officers bringing in new research ideas, and especially of any which they saw as 'fads'. Goldstein (1979:258) acknowledged that when an innovation is represented as a 'new response to an old problem' particularly one which officers have struggled with, they are much more likely to be supportive. Goldstein (1979) also notes that problem orientated policing (POP) is not seen as a 'challenge' to current policing practices; with POP focused on the practical aspects of what works (Tilley, 2009), and the positive connection officers have to solving the causes of problems (Caveney et al., 2020), POP perhaps provides an opportunity to not only improve researcher/analyst- officer involvement but also the use of analysis and evidence into practical policing (Lum, et al. 2012).

Officers' response to research and analysis was more positive when it gave them the opportunity to provide a better service to the public, solve community problems or deal with the cause of a problem (Caveney et al., 2020). Dissatisfaction and disengagement were more likely when they were given tasks they perceived as unfocused or they had no control in the design, and where engagement had occurred before the tasking, it was believed that officers would be more motivated (Caveney et al., 2020).

7.4.6 Summary

Culture continues to influence officer perceptions of analytical products and the resulting ability of analysis to create impact. Officers at different levels within the organisation have been exposed to various analytical products, intelligence-led policing, and the use of problem-solving initiatives such as POP and the SARA model increase exposure. They provide the opportunity for analysts and officers to work together, build trust and understand each other's needs and expectations. The requirements of officers in different departments and different roles would not only require

different types of analysis to support their roles, but also the presentation of this should be tailored to the target audience.

The successful commissioning and effective use of analysis is the joint responsibility of the organisation in which officers and analysts work, the officer's making the request and the analyst in providing a suitable product. An organisation can devalue the analytical product by failing to provide adequate training for officers and analysts, and a failure to recognise the importance of the information it provides. Officers can fail to understand the limitations of the data, be inadequate at conveying what questions the analysis should answer or interpreting the results. Analysts too, have a responsibility to ensure they understand the issues and expectations of commissioning officers, the data sources available, and to provide actionable intelligence in a manner that is readily understood in a digestible format.

The remaining sections look at how information was gained from Lincolnshire Police officers to compliment current literature, to understand their analytical interpretation, their product requirements, and contributing to taking forward this area of research.

7.5 Methodology: Understanding Officer's Views Of Analysis And Risk Terrain Modelling.

The interview process methodology is detailed in chapter three section 3.4 and below details the results of the interview process.

A total of six officers took part in stage one of the interviews, ranging from a sergeant to a chief inspector. Due to covid-19 restrictions and the spread of their workplaces across the county the interviews took place over Teams. Limitations of the internet connection resulted in this being a voice only interview as opposed to a video conference interview. All the interviews were recorded using the Teams functionality and a transcript downloaded on completion. Interviews lasted between thirty minutes and an hour and twenty minutes. Each interview followed the interview plan with open questions designed to bring out the officer's views on analysis, analytical products, and any barriers in place to fully utilising the analysis, as well as their knowledge on hare coursing and county line drug dealing. Each participate was offered a copy of their interview transcript but only two participants wished to receive it, and this was subsequently provided after the transcript had been checked for accuracy against the audio recording.

The second stage of interviews took place after the risk terrain analysis had been completed. In total eleven interviews over phases one and two were carried out with officers ranging from police constables to chief inspectors. There was a range of experience including uniform and detective officers, working in specialist departments and response policing. Not all officers had commenced their policing career within Lincolnshire, with two interviewees commencing their careers in other forces. It is acknowledged that there is a bias towards the views of management level officers as opposed to constables. This was because of focusing on officers likely to have analytical knowledge and then, in phase two of the interviews, in selecting officers with hare coursing or cuckooing experience. This was to allow their understanding of the issue to be

compared with the analytical results and to better assess how their acceptance of the analysis related to their prior understanding generated through the craft of policing.

Five officers took part in the second phase. A chief inspector and two inspectors took part in both phase one and two. A sergeant and police constable were included in phase two, selected due to their experience of policing hare coursing and county lines respectively. In phase two the interviews commenced with the officers being asked to draw on a map where they believed county lines or hare coursing occurred.

Those officers with experience of county lines were provided with RTM output maps for cuckooing without (Figure 15) and with (Figure 16) the relative risk values, and their opinions and understanding of the maps sought. Officers were prompted to identify those aspects of the results which were either lacking or surplus to requirements and encouraged to discuss the value and usability of both the outputs and the information generated through the analysis.

Those with experience of hare coursing were provided with the same map options for Lincolnshire and the South Holland and Boston areas. Figure 17 shows the map for the Boston district including the relative risk values. Officers were also provided with a copy of the alternative manual models for county lines and hare coursing, examples of these are shown in Figure 18 and Figure 19.

Map showing residential properties at high risk to county line cuckooing in Lincoln city.

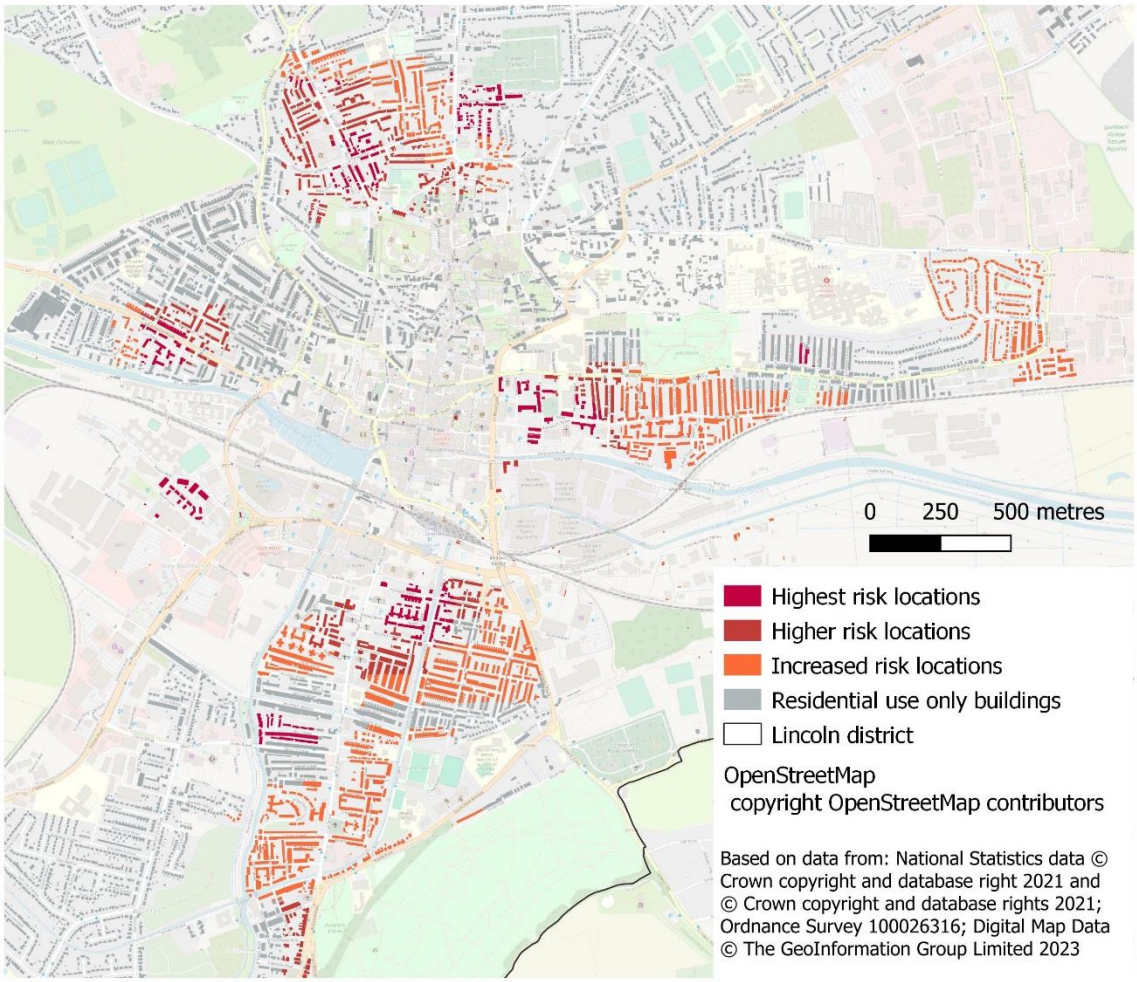


Figure 15: Example of county line cuckooing risk analysis used in phase two of the officer interviews.

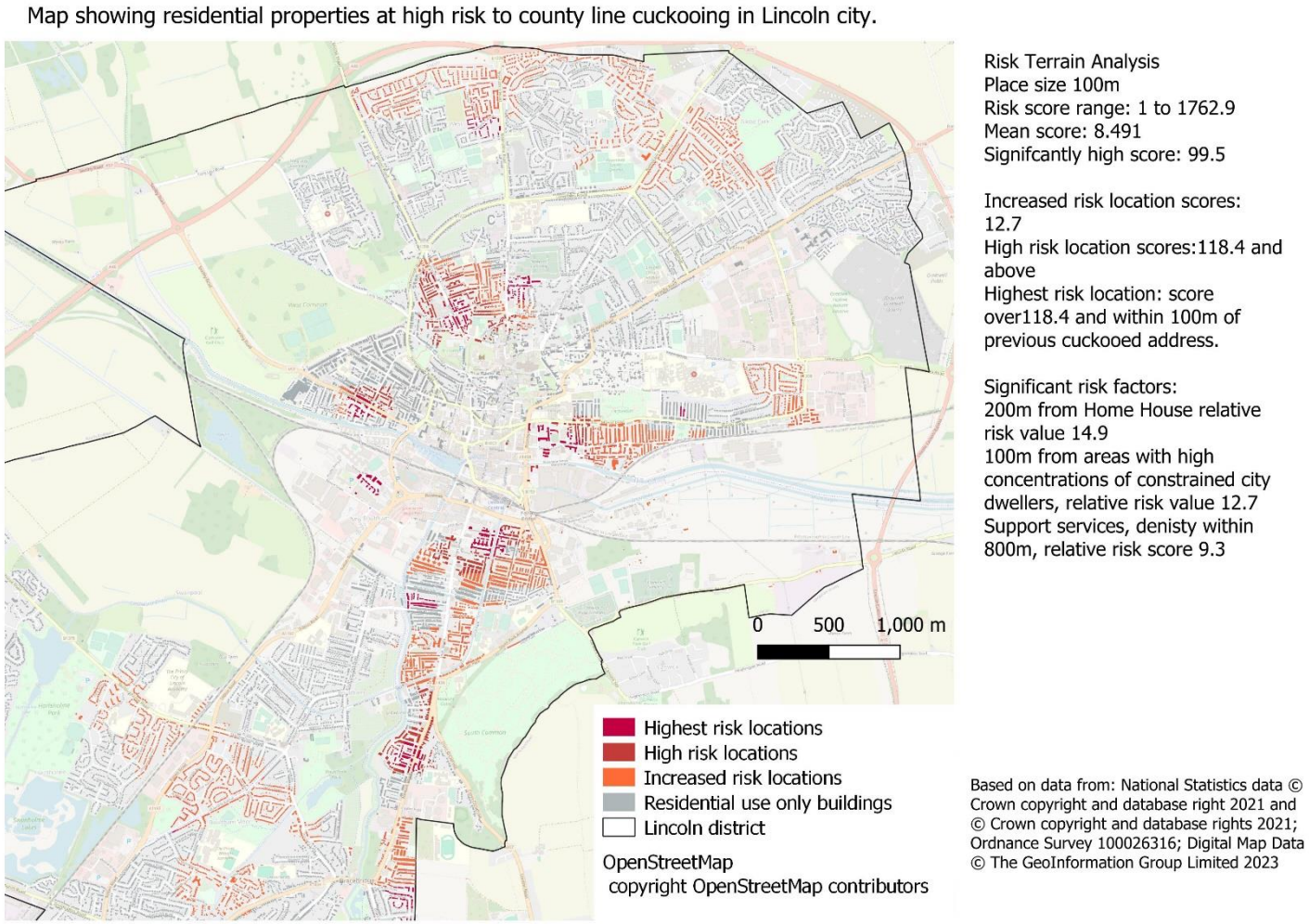


Figure 16: Example of county line cuckooing risk analysis used in phase two of the officer interviews which includes the identified risk factors.

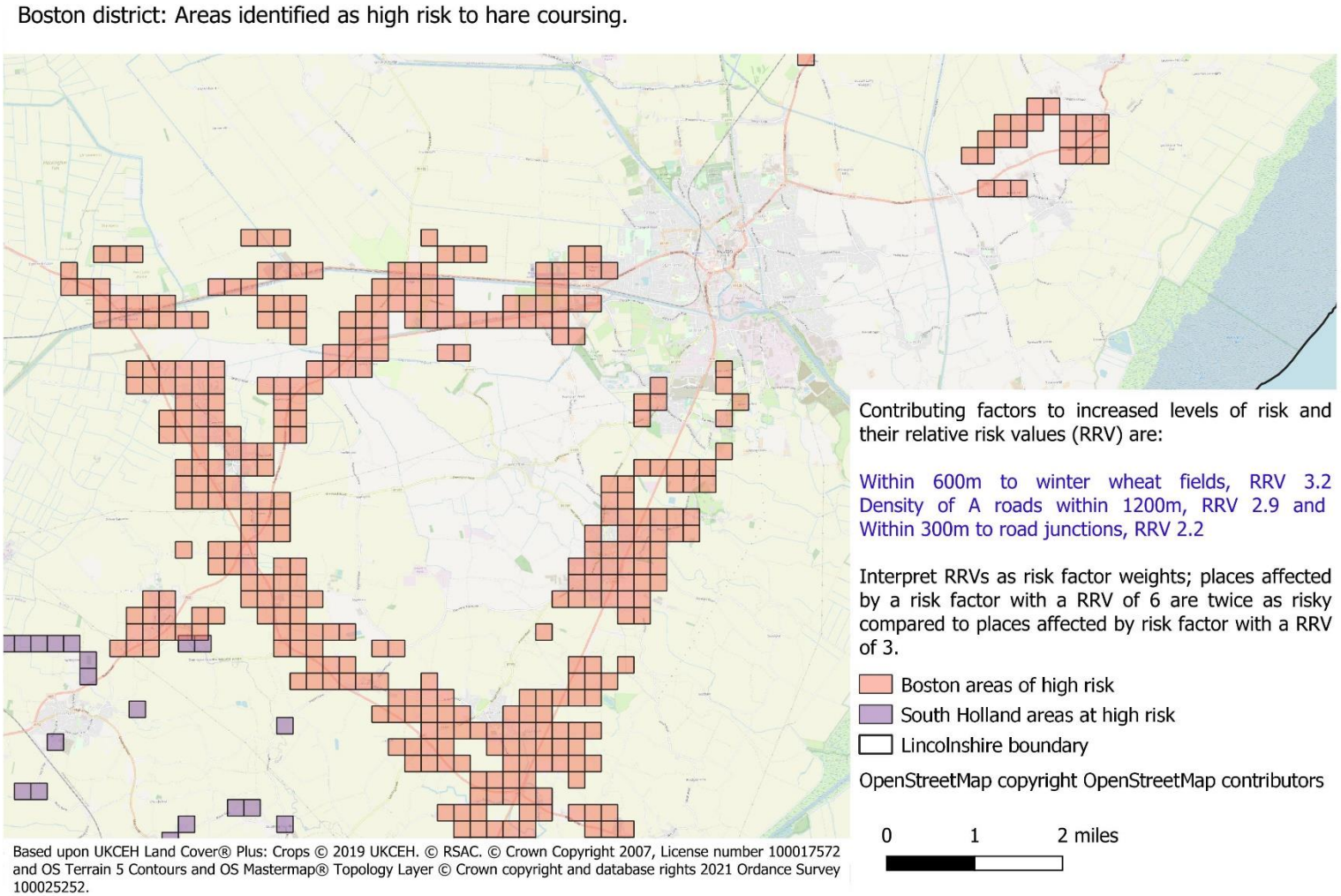


Figure 17: RTMdx analysis with risk scores provided to officers in phase two interviews.

Map showing residential properties at high risk to county line cuckooing in Lincoln city- Analyst model.

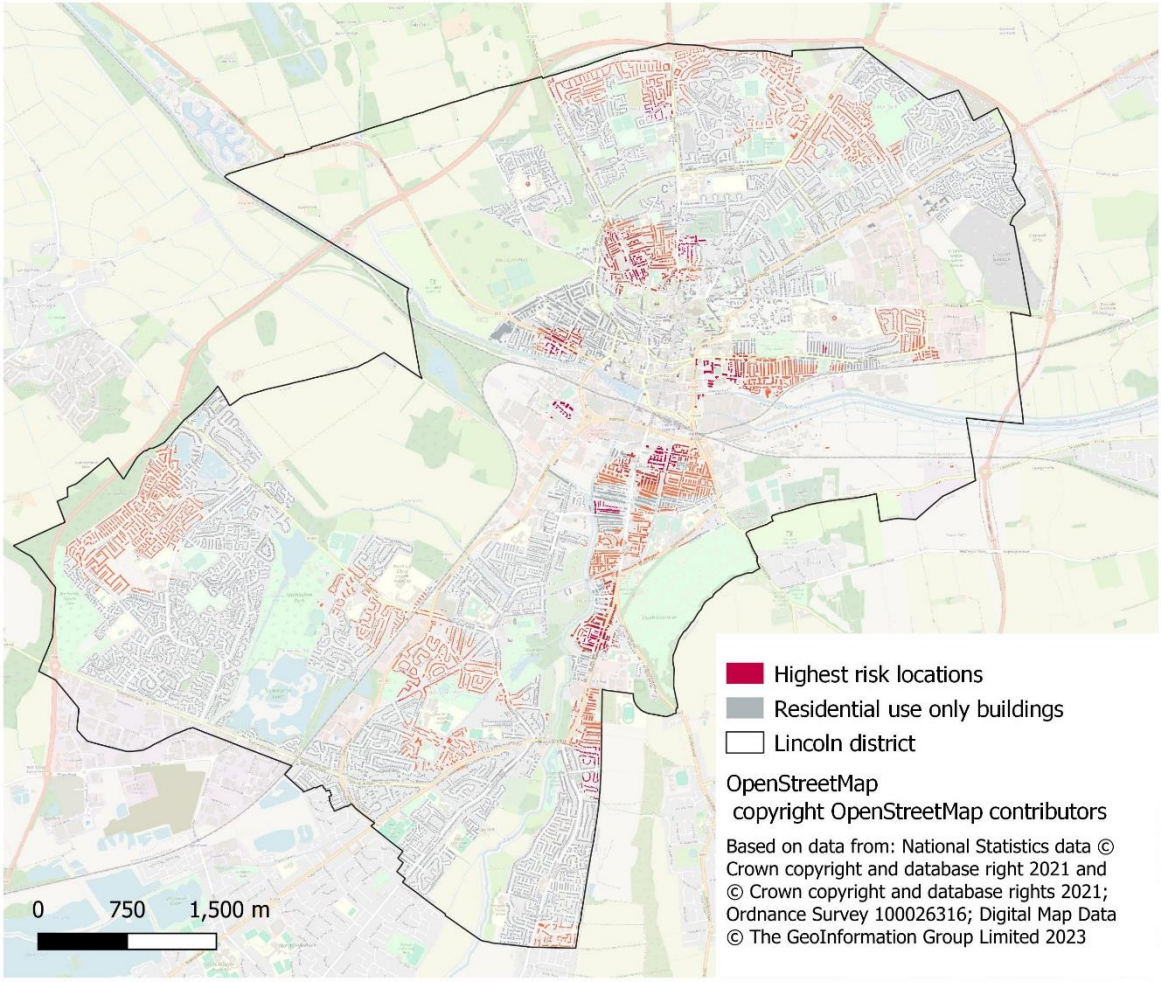


Figure 18: Manual county lines risk terrain analysis provided to officers in phase two interviews.

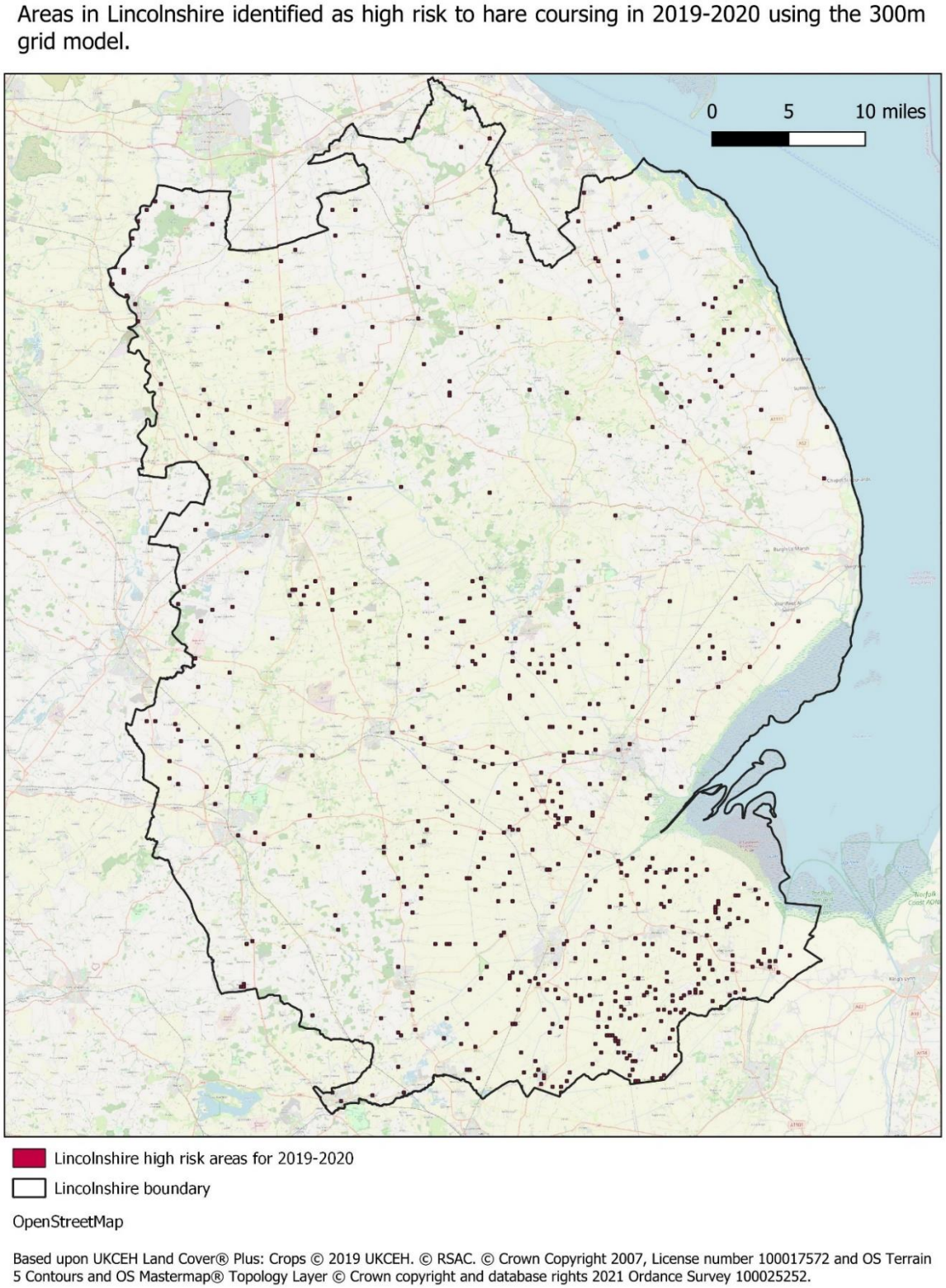


Figure 19: Map provided to officers in phase two interviews showing high risk areas for hare coursing identified using the grid method.

It was important that officers could view and comment on actual risk terrain analysis results. The preliminary task of marking on a blank map helped to focus their knowledge of the offences, but also enabled them to compare their own understanding of the offence distribution with that of the analytical results. They could clearly see whether the results were complimentary to their understanding, at odds with the analysis or provide awareness into areas which may be targeted but was a new insight for them.

The different presentation of the same model, and the contrast between the manual and risk terrain models prompted officers to discuss what they found acceptable, agreed, or disagreed with, or challenged their thinking. The maps are also a true reflection of analytical products they could receive and eliciting comments to understand how they interpret them is important so that the presentation of results can be optimised for officer understanding and to provoke action.

The remainder of the interview focused on eliciting their understanding of the model, what value or practical application they saw in it, and their preferred presentation and content.

7.5.1 Interview analysis

A reflexive thematic analysis with an inductive latent approach was used to capture the themes within the interviews important to the research questions in line with the methodology detailed in Braun & Clarke (2006). The six-stage approach commenced with familiarisation of the interview content through comparing the audio recording with the interview transcript. A process of listening, reading, comparing, and contrasting the recording with the transcript continually editing and replaying the audio until the transcript accurately represented each interview. Based on the familiarity gained through this process each interview was analysed and sections of the interviews highlighted, and colour coded under broad codes which had become apparent in the familiarisation process. Further analysis of the interviews, particularly focused on the codes, took place to identify aspects of the interviews which should be incorporated within the codes, or any additional codes which should be included. Extracts of quotes per theme were collated and

reviewed to identify any sub themes within the codes, (see appendix 10 for details). A mind map (Figure 20) was generated to help understand the links between the themes and subthemes and how they related to the research. These are discussed in the following section, 7.6.

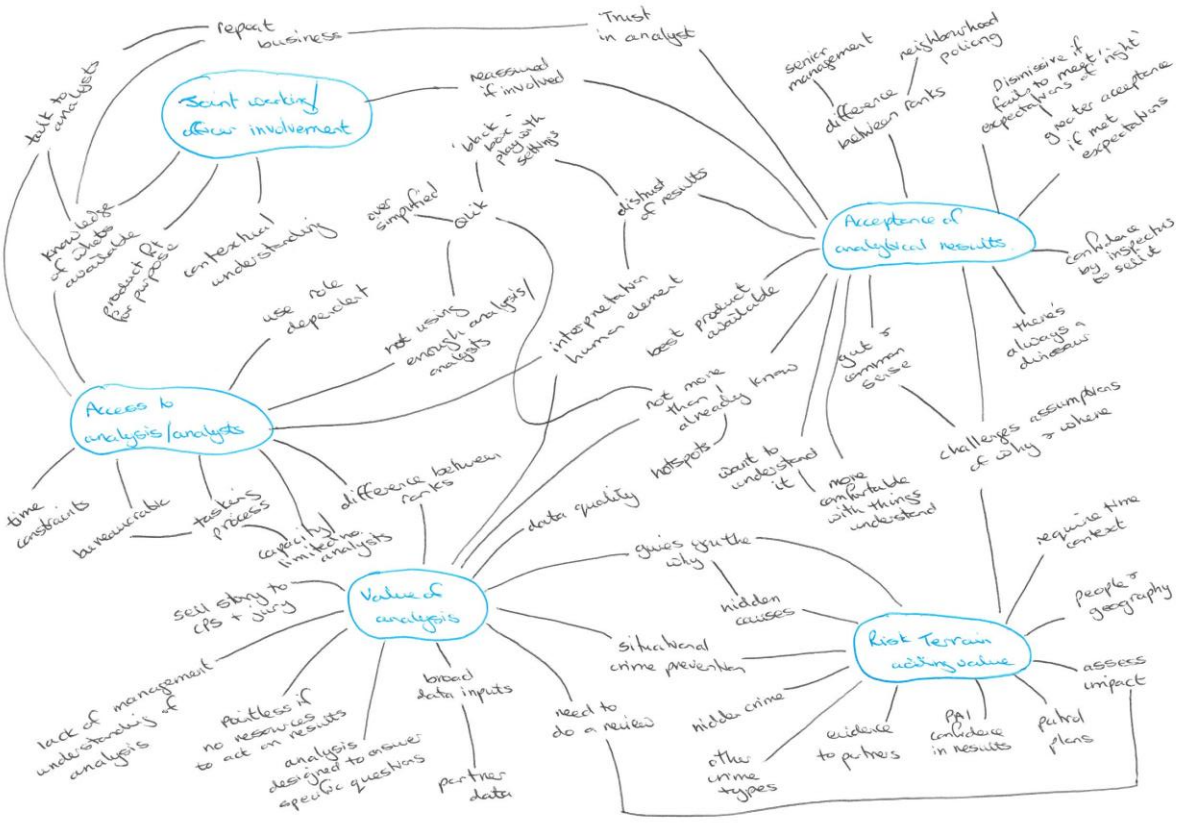


Figure 20: Mind map of themes from the officer interviews.

The views from officers in relation to county lines and hare coursing, and in particular what aspects they considered contributed or deterred these types of offences or influenced their location are shown in Table 2 and Table 24 respectively. Two officers interviewed had no experience of hare coursing and did not offer any risks for consideration. Those with more experience, such as the rural sergeant, were able to provide several valuable suggestions which could be quantified in terms of the modelling process. For example, wheat fields and flat fields. Others such as insecure fields are more problematic to obtain data for inclusion in the modelling analysis. Officer's views on analysis and the risk terrain analytical results are discussed in chapter 7.6.

7.6 Lincolnshire Police Officers Knowledge And Perception Of Analysis

Interviews with officers took place pre analysis (phase 1) and post risk terrain analysis (phase 2) as detailed in the methodology, section 7.5 above. A total of eleven interviews were completed with three officers taking part in both rounds of interviews. There were separate interview plans for each of the phases- to inform the risk terrain analysis and initial results presentation and after completion of the analysis to determine their feelings on the analysis and the presentation of the results. Those who took part in the phase 2, post analysis interviews, had or currently worked in a role which gave them exposure to, and consequentially experience of, either hare coursing or county lines policing. Officers who took part in phase 1 were asked about their analytical knowledge and of the two crime types directly. However, it was noted that those officers who took part in both rounds talked more freely and articulated their understanding of the crime type better in the second round of interviews.

It appears that the visual aid of the map showing analysis results provided a gateway to this knowledge, as they discussed and digested the analysis results alongside their own understanding of the crime types. In many ways this reflected how experience is 'crucial to the notions of evidence-based policing because the police draw on a variety of knowledge based on whether it makes sense to them and fits what they 'know' directly' (Fleming & Rhodes, 2018:4). Information provided by the officers in both rounds of interviews on the crime types is detailed in the hare coursing and county lines results sections.

The literature review provided guidance on question areas, but the interviews underwent an inductive latent analysis (Braun & Clarke, 2006), and numerous themes emerged with some indication of difference based on rank and experience. However, the small number of interviewees means that the results are suggestive only and further work would be required to establish if these were generalisable.

The main themes identified in response to questions about analysis, analysts and the risk terrain analysis specifically were:

- Perception of analysts and analytical products
- Culture, craft, and data
- Understanding analysis and analytical limitations
- Is it what we already know?
- Police craft and experiential knowledge
- Risk terrain analysis adding value
- Analytical presentation

The remainder of this section will discuss each of these themes in turn.

7.6.1 Perception of analysts and analytical products

The interviews identified that there was a wide spread of officer knowledge, experience and understanding of the range of analytical products available. However, the sample is biased towards inspectors, particularly in phase 1 of the interviews. Those of a higher rank generally had more experience of analytical products which is in line with the research of Fyfe & Wilson (2012) and Bullock (2013). This was typically limited to hotspot mapping of volume crime, crime pattern analysis of series, or strategic analysis of crime themes, as the following quotes demonstrate.

"My only real experience where, is with it, have been in terms of crime pattern analysis where you, I've already have a series of events that you want to try to link together…or looking at other events to workout and see if you can see patterns and trends, to give you pointers towards who might have committed offences" (R Insp B phase 1)

This response inspector acknowledges that they have limited exposure to crime analysis, and this is focused on retrospective analysis and catching the offender, and still veers towards the needs of the 'street cop', possibly due to their management role of response patrol officers.

This neighbourhood inspector's experience is focused on the retrospective analysis, they are requesting what they perceive to be analysis, but is at the very basic descriptive level.

"then we normally request, err the analyst do some work around providing the hotspot maps and the breakdown of when offences are occurring." (N Insp B phase 1)

The CInsp commenting below implies they are aware of different types of analysis, but within their current position the most relevant is that at a strategic level, focused on the area in which they are employed as a 'management cop':

"OK, so the top level for me in this area is the strategic assessment around rural and wildlife crime" (Ch Insp phase 1)

The previous quotes also show how the role of officers impacted on the types of analysis they had utilised, mirroring the findings of Boba Santos & Taylor (2014) and the areas where interviewees had previously been posted in line with Bullock (2013). This was particularly apparent in an officer who had transferred from a large urban force, where in their old department the use of a range of analytical and research products was well established.

"Ok, so in my old role I used analysis an awful lot, and since I've moved to Lincolnshire, I haven't used it a great deal, that's mainly because of the role I do here. I'm a response inspector…" (R Insp A phase 1)

"in my previous role… that involved er working a lot with analysts to look at repeat callers and not just individuals but also businesses and other third sector to understand what demand looked like…looking at trends among antisocial behaviour hotspots…doing some work with a geospatial analyst…so risk terrain maps I saw a lot of" (R Insp A phase 1)

The level of exposure to analytical products implied in this response goes beyond retrospective analysis or that targeted on the identification and apprehension of a culprit. It reflects an understanding of the collaborative nature of analysis, as the officer comments that they worked 'with' analysts and geospatial analysts. It also implies that the analysis provided went beyond descriptive analysis of an issue, as they worked to 'understand' the problems.

The response of the neighbourhood inspector (N Insp B) and response inspector (R Insp B) noted earlier, pointed to analysis as hotspot mapping and crime pattern analysis, and it is probable that for many officers at street and management level, their only experience of analysis is being presented with a hotspot map and instructed to patrol in that area. Consequently, a request for analysis may be dismissed as officers assume analysis results in a hotspot map and this outcome would not meet their needs. Belur and Johnson (2018:775) noted 'some officers interviewed admitted that they perhaps underutilised the capacity of analysts, mainly because they were unable to task them intelligently', which agrees with Cope's (2004) findings:

"The paucity of training on analysis affects police officers' ability to ask the right questions of analysts in order to ensure the products are useful operationally" (Cope, 2004:194).

Due to limited understanding of the analyst role, abilities, and types of products available, officers would request products which would not be the most appropriate as R Insp A explains:

"Rather than come, say honestly and say, right I want, I want 20 minutes with you so I can talk through what my problem is, this is what I need to do?...But they [referring to other senior officers] don't, they will say, oh can I just have a problem profile" (R Insp A phase 1)

Those with a crime investigative background or first-hand interaction with analysts understood that analysis covered a much broader range of processes and products than they were aware of. The following quotes from R Insp B and N Insp A reflect that this inability to task 'intelligently', or know what to ask for, can be addressed through the development of personal working relationships and trust with analysts.

"From experience I learned very early on that rather than me ever trying to say this is definitively what I want, I'm better off having conversation with said analysts say this is what I have. And I want you to look at or what's available to you. This is what I want to do with it as an end result, or this is where I'm heading with it. What have you got? You know, what are my options? What can you provide?" (R Insp B phase 1)

"I'm quite comfortable, you know, sort of having worked with some of the analysts, erm almost nodding towards what I require to then get one allocated, to then have the conversation about what they can offer me, erm, and what's the best way of going about it. And, and, you know, without having the skills of an analyst it's quite difficult at times to ask for what you want." (N Insp A phase 1)

Both interviewees articulate the value of involvement and negotiation with the analyst from the instigation of an analytical request. They provide evidence to indicate the value of this negotiation process is threefold: It provides an indication, that in similar situations the trust and respect between officer and analyst, and perceived usefulness of the finished product, is more likely to result in positive reception of analytical results in line with the findings of Lum et al. (2012). The second potential benefit is that it starts to edge towards co-production of products. The interaction between officer and analyst from the start allows the officer the opportunity to shape the analysis to their needs, whilst the ongoing relationship can facilitate the inclusion of officer knowledge to enrich and ground the finished analysis in an operational context. Thirdly it provides some evidence against cultural undervaluing of analysts by officers.

Police craft is learned day to day, building up knowledge, skills, and refining judgments. These officers demonstrate that in their role as an inspector, experience has provided them with the knowledge and previous incidents which have demonstrated that analysis is worthy of consideration and action. Fleming and Rhodes (2018:4) purport that officer experience is 'crucial'

within evidence-based policing as police select varieties of knowledge and combine them in a way that makes sense to them and fits with their prior knowledge.

Sherman (2015) argues police resistance to use of research evidence is due to their perception of policing as a craft, and police culture is the most popular explanation of why police resist change (Belur & Johnson, 2018; Chan, 1996). Local organisational culture provides the counter argument to this, which these inspectors demonstrate. Local organisational culture which provides the basic assumptions and activities which have historically worked well, and considered the correct way to proceed is exemplified in the comments and inferences made by the neighbourhood inspectors. There is an expectation that if there is a problem within a neighbourhood that the local inspector will determine if additional research or analysis is required, commission this work and report back at monthly management meetings, in what is known locally as the "bidding process" or putting in a bid. Sackmann (1991 in Chan 1996) refers to this as the 'directory knowledge', how things are generally done, and 'recipe knowledge', what should or should not be done in specific situations. The monthly management meeting process reinforces the value of the research/analysis amongst those at the meeting, and to new members of the management team. It is therefore perhaps not a cultural dismissal of evidence that is an issue, put the provision and access to appropriate research, analysis and evidence which leads to a lack of utilisation.

Since the introduction of analysts into law enforcement agencies, researchers have identified that they have been subjected to prejudice based on their civilian status, with their perceived lack of operational understanding and experience leading to their analysis being dismissed (Belur & Johnson, 2018; Boba Santos & Taylor, 2014; Cope, 2004; Lum et al., 2012). Typically comments from inspectors and the chief inspector did not support this, and were in keeping with Bullock (2013), who found no evidence that analytical products intrinsically lacked credibility because of a lack of policing craft knowledge.

"I would say, if I had to reduce and reduce, and keep on reducing until there was only one person left, the last person left standing for me would be the analyst because, I keep on saying 'witchcraft', I gotta stop doing this. So, but uhm, making sense of the data, of the information that's out there and making effective use of it, that we can all have an opinion. That's great, but it's, it's the analyst that that says "you get most bang for your buck this way"". (Ch Insp, phase 1)

Inspectors, and the chief inspector commenting above, neither demonstrated or inferred any prejudice towards the legitimacy of civilian analysts that Cope (2004) first identified, and which researchers argue persists (Boba Santos & Taylor, 2014; Belur & Johnson, 2018). The chief inspector explicitly expresses his appreciation of analysts, while the R Insp A quoted earlier, implies, through their wish that officers requesting analysis talk to analysts, ask questions, and clarify what they can provide or what product would be most fit for purpose, their respect for the analysts' knowledge and expertise. It must be acknowledged that most interviews were with inspectors, and researchers have identified that managerial ranks are more likely to value analysis (Belur & Johnson, 2018; Hunter et al., 2019; Phillips, 2012).

Phillips (2012:15) argues that senior ranks see the funding of analysts as an 'acceptable allocation of resources' which was clearly a view held by the chief inspector above, and a manifestation of 'management cop culture' who have the emphasis on efficiency, rational decision making and objective accountability. It should also be acknowledged that those interviewed are not necessarily a representative sample of all officers across the Force. In phase 1 they were selected for their likely knowledge of analysis and the crime types relevant to this research, and for the post-analysis interviews, phase 2, for their knowledge of the crime types. I had worked with five of the eight officers interviewed, which could influence the responses or their interpretation due to 'insider bias' or 'a projecting one's own views onto participants, or the data analysis' (Greene, 2014c:4). Greene (2014c) notes that individuals are more likely to be open to the insider researcher who is familiar with the organisation and understands some of the issues they raise.

Trust between officers and researchers was identified as pivotal in the successful use of analysis (Belur & Johnson, 2018) and this was reflected in the officer interviews. Those interviewed who had previous experience of using analysis and a prior working relationship with the interviewer, showed a greater acceptance of the analytical product. It is unclear whether this was due to this historical working relationship, better understanding of the analytical process or to them being involved in the first round of interviews. However, the opinion of one neighbourhood inspector, when asked whether they had reservations about analysis, highlights that these considerations should not be overlooked.

"No, not really. She says hesitantly. So it sounds like I do, and I don't simply based on and, and part of this if I'm honest, is the longer that I've known you and listen to things you talked about over the years, etc. The I've understood a little bit more and, and if somebody that you know and trust has faith in it, then it gives you a certain amount of faith. And it's silly as that might sound" (N Insp A phase 1)

Key aspects of 'street cop' culture are suspicion (Loftus, 2010) and scepticism which remains towards crime analysis (Brown & Ballucci, 2022). Senior officers have the management oversight resulting in analysis, and consequentially evidence-based policing, having 'more purchase' (Palmer et al., 2019). The following two observations from inspectors demonstrate that they themselves believed in the value of analytical products, but that they felt some of their subordinates would demonstrate reluctance in line with the expectations of street cop culture. These feelings are in keeping with the findings of Hunter et al. (2019:253) that junior rank officers were 'less convinced about the role of evidence in police policy and practice'.

"I try and get this data out to my neighbourhoods officers. Now whether they wanted to use it or not, I'm not clear. I I'm not, I'm not convinced they were overly fans. I think they'd rather trust the policeman's nose" (R Insp A phase 1)

"I think as long as it depends how you sell it, if you sell it well and show them pretty pictures that back up what you say, and I think you'll get a lot more buy in then if you gave them some monstrous beast of a portfolio that you expected them to read, digest themselves and then go off and do, in which case they probably just revert back to "we know the problems here. This is what we're going to do", but if they know you are buying into it and you are presenting it as it were, so you're there in briefing showing them the pictures and talking it through and saying this is the patrolling plan UM, certainly again amongst some of my team I think you get a really good buy in. You're always gonna get a dinosaur." (R Insp B phase 1)

Both inspectors allude to being conscious of police officers continuing to prefer their own experiential and craft knowledge, with the latter acknowledging that there is variation between officers. Their reference to 'how you sell' the product points to not only the value of 'leadership' in valuing the analysis but also the potential of selling the product as advantageous towards the fighting crime and catching criminals aspect of street cop culture. They show an understanding that officers respond better to analysis which they see as beneficial to this element of street cop culture (Bullock, 2013).

As identified, variability in acceptance of analysis and analytical products does remain, but less so for inspectors. The officers in this research, predominantly of management level support this. A recommendation for future research would be to assess the opinion of constables within Lincolnshire to ascertain whether this has permeated to street cops, and whether the demands of reactive policing facilitate the perceived value of analysis or negate its relevance depending on officer role.

7.6.2 Culture, craft, and data

The value of analytical products was expressed by all officers interviewed, but there was also an acknowledgement that products were not perfect, and officers reflected that this was due to available systems and data, not those producing the analysis.

“In fact, that that's probably it for me, that I I recognized that the analytical products that we get are often the best that's available. But that's not to say they’re perfect” (Ch Insp phase 1)

‘If we were more data minded then I think we’d see improvements in the data going in’ (R Insp A, Phase 1).

Culturally the value of data quality and accuracy is not seen or promoted as important across the wider organisational management, or the consequences of that lack of data and data quality on the management information used by the organisation has failed to have an impact. It is used to create information, without understanding that the data is flawed due to errors and incompleteness.

Unfortunately, the day-to-day pressures of policing has not only increased the amount of information required, collated, processed and analysed by multiple departments, police officers and civilian staff, but also reduced the time available for quality control and data checking. Mandatory reporting by police forces on a regional and national level to understand crime trends or bid for additional resources continues as they are required to be accountable for anything and everything to multiple stakeholders. In contrast individual accountability and a cultural emphasis on quality information has not been maintained.

Except for the constable, all those interviewed reflected on the importance of data and data quality. An obstacle raised by the interviewees with greater analytical understanding, was the availability of data. They demonstrated an understanding that the quality and breadth of information included in analytical products lead to greater enrichment and better understanding of the issues analysed. This was in terms of access to a broad range of data sources from police, partner agencies and the wider community. Issues dealt with by the police are not always solely due to crime problems, and crime is a complex response to social and environmental contexts. In the research of Cope (2004) they identified that analytical products reflected the quality of available information. Almost twenty years on, access to data is difficult, and obtaining this in a

timely manner adds to the problem, and the officers interviewed showed there was an acceptance that the availability of such data was a limiting factor in its inclusion. This is exemplified in the comments from a response and a neighbourhood inspector.

"It might apply to all of these, but I think essentially an, it's often the case that we hold the least data as an agency to analyse, so I think going wider, mmm with the data request.' … 'And, and sharing all that kind of original data, and children services and getting all of that in one place for analysis. Uhm, I think is one of the most helpful things." (N Insp A phase 1)

"But what I found in my experience is the more data from diverse organizations you get, the better the risk terrain maps you get." (R Insp A phase 1)

The concept of additional information from partner agencies and third parties extends outside of the confines of Lincolnshire Police. Piza et al. (2018) found in their review of agencies using RTM that there was a requirement to purchase data in order to adequately model risk factors concluding that agencies should invest in data collection and analytical training and resources. It was also an observation raised by an officer previously from a large urban force:

"But what the, the, geospatial analyst was looking at was how to develop risk terrain models or maps to not just look at police data, but also look at data held by other organisations, so, so that the risk terrain was more accurate" (R Insp A phase 1)

Data accessibility for this research was vastly improved due to my status as a Keele University student, which through the library service provided easy access to online academic literature, and via Digimap, map and digital data. Data availability was better, particularly around mapping products which could be obtained directly from the EDINA mapping service when needed. The same, if not superior, detailed GIS data is available under the *Public Sector Geospatial Agreement*, but in practice is at best long winded and problematic, especially when this relates to specific data files and is hindered by technology, bureaucracy, and technical knowledge of those with access to the relevant files.

The sergeant also identified the value data from diverse non-policing organisations could add if incorporated into the model when determining risk for hare coursing. This was demonstrated through questions relating to factors included in the model, and suggesting others:

"OK. I'm satisfied with it. Would you consider contacting things like the land management and consulting [inaudible] hedgerows and things like that, use to overlay a map would that be able to increase your accuracy?" (Sgt B phase 2)

So, despite showing some initial suspicion and scepticism of the model, the officer identified the potential of it to improve their working practices. When confronted with technology or analytical output, Ratcliffe at al. (2020) purport that officers ask themselves a series of questions:

'Does it intrude on officers' areas of 'craft'? At a more personal level, the officer maybe asking: Is the computer helping me do my job better? Or is it taking over parts of my job wholesale?' (Ratcliffe et al., 2020:2).

Through the process of the interview and discussions the officer (Sgt B), has or is erring towards the analysis assisting them in their job, by reducing the areas which require focused attention. It is not telling them where to go or what to do, but providing information on what may be useful considerations on deciding on an operational response. They can see that it has considered officer experience and a range of acceptable data sources, if not specifically their own and consequently supports their 'craft'.

A sergeant, only involved in phase 2 interviews, showed various levels of doubt in the analytical results throughout the interview and demonstrated that they would be far happier if involved from the initial onset of similar future research as this interview extract highlights:

"Would you feel more reassured if you were involved at an earlier stage?" "Yes" "and putting in" "Yes" "suggesting those parameters?" "Yes Yes" (Sgt B phase 2).

Their response to the analysis was in line with the suspicion of 'black box' technology with the 'black box' representing the hidden algorithms, inputs, calculations, and assumptions that are used by computer programs to generate different forms of analysis. The lack of transparency in what is included or not, and the methodology being used, caused concern and suspicion, and would be a cultural expectation, particularly of operational officers, as this sergeant was. Further along in the interview *Sgt B* asked questions in relation to parameters included in the model, drawing from their experiential knowledge, highlighting aspects which they felt were important considerations.

"Yeah, you know coursers just really like flat ground and ditches, they don't like big tall hedges, they don't like, but I don't know how accurate the computer is to find out that information?" (Sgt B phase 2)

Confirmation that these, and others were part of the modelling process appeared to provide some level of reassurance. The sergeant did not offer a straight rejection but advocated to contributing to the process in keeping with the findings of Ratcliffe et al. (2020).

"The lack of a human element to the software, combined with its inherent black box nature, concerned many officers. But some, rather than rejecting the entire enterprise, advocated for allowing in the human element, opening up the black box so that the experienced officers' knowledge base could contribute." (Ratcliffe et al., 2020:10)

In contrast, a neighbourhood inspector who had been involved throughout the research and with experience of analytical products and the analyst researcher, summed up his attitude with the following;

"*for me you've done your research. You're telling me it's high, it's high. I believe you." (N Insp B phase 2)*

One of the aspects of this research study was to understand the context in which analytical results were more likely to be accepted by officers. These points demonstrate one area with potential to

make a positive difference. Both viewpoints highlight the need for inclusion of officers in the research and analytical process, (Heyer, 2022) alongside good working relationships to build up the trust between those who are providing knowledge and those expected to make practical use of it as Lum et al. highlight:

"The professional experience of officers should not be ignored in undertaking evaluation research not only because officers likely have valuable insights that will improve the overall project, but also because officers will likely be more willing to cooperate with researchers who recognize and appreciate the value of officer knowledge and experience." (Lum et al., 2012:79)

There are several parallels between research and analysis in that both are considering the issue from an academic, non-practical perspective in antithesis to police officers, and those considerations highlighted by Lum et al. (2012) above should be considered equally relevant when conducting analysis. If, and when, evidence-based policing becomes ingrained into practice, the use of analysis more akin to academic research will increase the importance of these principles of inclusion.

Hunter et al. (2019:251) reflect that the 'credibility and reputation of the research producer in the eyes of the potential user' influences which analysis and evidence is utilised. Analysts are in a unique position in that they can provide guidance to steer officers towards appropriate research to meet their needs. The analysts' position within the organisation facilitates an ongoing relationship allowing the ability and availability to meet, discuss, review, and incorporate officer opinions and expertise throughout the life cycle of a research and analytical tasking. Consequently, the resulting research 'is more likely to be successful' (Heyer, 2022:8) when officers can see their knowledge is a valued part within it.

Approximately two years ago Qlik was launched within Lincolnshire Police. Qlik is a data visualisation and business intelligence software, which through a series of visual dashboards allows users to self-service their basic research needs through filtering and searching the data

held within the system. It enables officers to search crime data by crime type, area, and temporal parameters, but as these inspectors explain, they have their reservations:

"The expectations are now that will have a quick look on Qlik, and go "OK, what's the, what's the problem?" Erm I'm not a big fan of it, if I'm, honest, because it depends how you play with the data as to what the outcome is. Yeah, so you see you know, none of us are analysts we were just using kind of a bit of tool that we've been given, and just the slightest change of one thing changes the most prolific day from you know from Wednesday to Sunday or something." (N Insp B phase 2)

"[It] worries me a little bit because I think there has been such a push on Qlik…You know, we're not using analytical skills enough already. And then to push something up and sell it as that, that's what it really isn't, is a danger". (N Insp A phase 2)

Both these neighbourhood inspectors, with several years in the role, are showing an underlying appreciation for human expertise via the analysts' skill set. Weston et al. (2020:541) propose that 'software has not reduced the need for analysts to possess solid understanding of relational data, automation techniques and the affordances and limitations of different analytic tools'. Brown and Ballucci (2022:2) refer to the 'discretion, experience and personal knowledge' that 'shape the products that analysts produce', the value of which is implied by the neighbourhood inspectors. They also echoed the sentiments of Weston et al. (2020) when they discuss the value an analyst can bring over software, in this case Qlik:

"for me personally, always the human element, you know, because it comes with it often comes with a level of understanding of the topic beforehand. Erm, a history of knowledge that can't be understood, I don't think, by a program that you know on the topic and the area." (N Insp A phase 2)

This was further supported by another neighbourhood inspector,

"But well just, it's not as good as a proper product, is it? Erm no, 'cause in the daylight with Qlik all it's doing is looking at the location where the crimes occurred, isn't it? It's not looking at any of the

background information and you know giving you where something might happen. It's just like' this happened here'." (N Insp B phase 2)

Qlik provides instant readily accessible crime maps and hotspot maps. These types of mapping are long established tools seen as successful in informing where crime issues occur, and research has determined that hotspot policing can reduce crime (Braga et al., 2014). However, these types of crime maps are often viewed as analysis, when the interpretation or analysis is often lacking, resulting in the visual display of the 'symptoms of criminal acts' and unable to provide 'the root causes of crime' (Brown & Ballucci, 2022:5). When an analytical contribution is made alongside the map this adds value, and in the words of *N Insp B phase 2*, becomes more of a '*proper product'*.

One of the barriers and frustrations identified by officers, particularly those with greater experience and understanding of data analysis, was the low standard of quality in the force's own data. This related specifically to police data captured within crime and incident reports being inaccurate or incomplete.

"Yeah, I mean I have a real issue that MOs are really aren't great. Anyway, they don't actually really add value lot of time but. No. Uh, I mean there's your problem is the data quality going in isn't great, be 'cause it not data minded. Yeah. As a force, I don't think we particularly data minded, I've know is is my opinion. If we were more data minded then I think we'd see improvements in the data going in" (R Insp A phase 1)

It was seen as a wider failure to appreciate the value of data and data analysis by the Force, that had become entrenched over many years. There was a clear understanding demonstrated, that if poor information or no information was contained within crime, incident, and intelligence reports, then this had an adverse impact on the quality, accuracy, reliability, and relevance of analytical products. This reveals the officer's personal awareness of data quality on analytical output which Drawre et al. (2019) argue is dependent not only on an understanding of data

biases, limitations, and strengths, and by implication the analyst's capability, but also on the data input.

Researchers have long identified the poor quality of data provided by police officers (Boba Santos & Taylor, 2014; Brown & Ballucci, 2022; Burcher & Whelan, 2019; Cope, 2004; Ratcliffe, 2005) and stored on police systems (Bullock, 2013) as a barrier to the acceptance of analytical products, and almost twenty years from Cope's (2004) research the ability of officers to provide quality information on which to base analysis, is still an issue. An obvious observation would be that the 'street cop' culture failed to acknowledge the value and relevance of data within the organisation used for crime analysis as they focus on crime fighting and immediate aspects of the job (Chan, 2001; Paoline, 2003). Alternatively, it could be, as organisation theory suggests, subordinates exerting power over management by retaining information (Reuss-Ianni, 1983). It also illustrates how 'the product of police practices and subjective decision-making on the ground' (Sanders & Condor, 2017:239) are determined by 'street cops' day-to-day practices (Reuss-Ianni, 1983) within the Force, resulting in poor information stored and available for analysis. Despite individual 'management cops' understanding the detrimental problems of data quality, this has not permeated into an organisation culture. 'Culture shapes an organisation's response to problems' (Westrum, 2004:ii22), and in the case of data quality, successive leadership have failed to communicate through 'symbolic actions' or 'rewards and punishment' (Westrum, 2004:ii23) that data and data quality is a valuable and important asset.

However, the reason behind this enduring issue is likely more complex, particularly in Lincolnshire. Since the implementation of the National Intelligence Model, the Force has moved away from a paper-based system resulting in the direct entry of intelligence and crime reports, austerity cuts have led to reduced capacity, and several crime management functions had been outsourced to a private company. The implications of this have been the removal of direct quality assurance, overly streamlining processes to combat capacity issues, and a failure to acknowledge,

that short cutting front end data input adversely affects the timeliness and validity of management information, performance measures and ultimately analysis of demand and risk.

7.6.3 Understanding analysis and analytical limitations

Despite acknowledgement by some of the interviewees that data quality was an issue, analysis using it was considered better than no analysis, the reasoning behind this was unclear, and could be one or more of the following potential reasons: cultural conditioning, experience of prior benefits or lack of time. Through the NIM and organisational tasking processes, inspectors, particularly neighbourhood inspectors, are culturally conditioned to use analysis to understand and solve problems, it is also possible that they have previously benefitted from analytical support, or aware of peers supported in this way. The final reason could be as simple as a lack of time, but ultimately the research identified that those interviewed did want analysis to support them in their roles.

One of the key limitations of analysis, which all the inspectors and chief inspectors interviewed commented upon, was the availability of analysts, and the demand on their time. This was overtly expressed by a response inspector when asked about the barriers to utilising analysis and mirrored by a neighbourhood inspector:

'I think money and by that I mean the amount of capacity that analysts have." (R Insp A phase 1)

"Everybody's got an opinion. The analyst is the person who uses the, who helps you to use the evidence effectively, Uhm. So my answer to your question is capacity that we don't have enough."
(N Insp B phase 1)

Officers of any rank, but typically inspectors, who wish to have analytical support make a request, known as "putting in a bid". This can be done directly to the analysts' line manager or via the monthly management meetings. The bids are then assessed and allocated out, based on the capacity of the analysts and organisational priorities. Bids are also made by inspectors for other resources to support planned operations or tactical responses to analysis.

Linked to the availability of analysts was the analytical capacity. This was reflected in the inspectors' acknowledgement of the bidding process, and the belief that they would be unsuccessful in obtaining analytical services if their request was up against departments perceived to have more sway, when balanced against the potential threat and harm of an issue. It was also raised that obtaining analysis would be pointless in some cases, as there was not the capacity to deploy police resources in a proactive problem-solving plan.

"But if you don't know, it's quite a daunting thing in this organisation to even ask for things in the first place, so you don't really know what's available. Especially if you get knocked back a couple of times, you're really aware that if you're going for, for an analyst to look at whatever, you're going to be competing against other bids from other departments, and especially if you're kind of just a lowly neighbourhood or police officer, to try and go up against, because what you think of is going to be big bids from kind of more major crime. For that type of people its daunting. It isn't, it doesn't seem to be straightforward process." (R Insp B)

"I find it a bit bureaucratic…And sometimes you think that, I, by the time you've done all that, you could just do some research on NICHE and NSPIS, and I need the answer, kind of there and then when the problem's happening. And not to go through the whole bureaucratic process just to get it, so, but I do understand." (N Insp B phase 1)

NICHE and NSPIS are software applications used by Lincolnshire Police to manage crime and incident reports. They can be interrogated by users with simple queries to identify the quantity, date/time, type and location, and as the neighbourhood inspector above acknowledges, sometimes the timeliness of the historical information is enough to deal with what is happening there and then. This same inspector also commented on their distrust of Qlik, the management tool which utilises the data held within NICHE and his preference for an analytical product. In phase two of the interviews the same inspector shows they are both mindful of the time and

effort that goes into analytical products, and if the RTMdx results can help reduce time or focus into a problem that really needs it, then this was an advantage as this quote demonstrates:

"*So I think it gives us the ability to be smarter with your time" (N Insp B phase 2)*

Fleming and Rhodes (2018:15) demonstrated that police officers are 'keenly aware of the political and organisational context in which they worked' which the comments on capacity of both analysts and operational police support units substantiate. This was also implicit in the comments made by the same neighbourhood inspector when asked which of the risk terrain models they preferred, the one produced by the RTMdx software, or the manual model generated by the analyst.

"So if you got an emerging problem, then we didn't want somebody to sit there for hours and hours and hours, sort of trying to go through all the data, that if for the click of a few buttons you could magic something up like that. That's amazing, because quite often by the time you got an analytical product, no disrespect erm, it's just the way the system is. The problem's quite often stopped hasn't it?...If it persists, then you still not getting anywhere, then it might be time to come and say "Hayley you know you did us this map can you drill into a bit more and give us your professional opinion as to what you think is happening" so that we can sort of tweak it, does that make sense?" (N Insp B phase 2).

So, although the comments show limited understanding of the modelling process, there is evidence that they understand analytical processes are time consuming, and the nature of some crime problems are short lived. They see value in the risk terrain model, but the speed and automation of the software, and what they perceive as less human analytical input is reconciled by the reduced burden on the analyst and a much quicker turnaround. They imply that if a problem warrants it, (in their opinion) then ultimately, they will want the professional expertise of an analyst.

Boba Santos and Taylor (2014) commented that officers of lower ranks were more routinely exposed to short-term action orientated analysis in contrast to higher ranks who were more exposed to addressing long-term issues. There is an indication of support for this in the officer interviews, all be it further research would be required as only one constable was interviewed. However, when considering the value of the risk terrain analysis those of inspector and chief inspector ranks were able to see the potential the analysis had for crime prevention, patrol plans, evaluation of interventions and transference to other crime types as exemplified in section 7.6.6. Their management cop perspective provided them with the experiential understanding of how the information could be used to target and prioritise locations. In contrast the constable interviewed clearly had some reservations on how he could respond to the analysis, as the areas identified were greater than one officer on the ground could address:

"Yeah, no, I think. Yeah, I I. Yeah I mean I think it certainly could be, but I don't know what how, how would we because obviously a lot of these there's a lot of properties here and what would you do with that information….What am I realistically gonna do with that?" (PC phase 2)

The risk terrain analysis would be more in keeping with that provided to managers and outside of the constables expected 'recipe' knowledge of expected responses. The next section discusses how the model challenged officers' knowledge on the distribution of county lines cuckooing victims and hare coursing incidents.

7.6.4 Is it what we already know?

The officer interviews found no supporting evidence that those officers interviewed, predominantly inspectors or above, believed analytical products intrinsically lacked credibility, in line with the finding of Bullock (2013). However, it was clear that the mapped results of those areas of high risk for both hare coursing and county lines identified locations that officers were familiar with. This was evident in the areas chosen by officers on a blank map of Lincoln and

Lincolnshire at the start of the phase 2 interviews (appendices five to nine), but also in comments made as this community beat officer demonstrates:

"it's targeting the right areas in't it cause if you know Lincoln, if we like we do and you just come to look at Lincoln now and say "ohh, where's your problems, problem areas" erm it's pretty much ringing truths in err my eyes" and *"I think it's just confirming what I already know if that makes sense?" (PC phase 2)*

When referring to the hare coursing results and what they would expect to see the chief inspector commented:

"Yes, that makes sense. Yeah, that all makes perfect sense to me" (Ch Insp phase 2)

An inspector in charge of a Lincoln neighbourhood commented,

"Erm, so I'd like to hope that, you giving me a map, wouldn't say well, have you thought about this? Yeah, because it should already be on the radar and being looked at" (N Insp B phase 2)

another neighbourhood inspector supported this when discussing hotspots,

"Erm but it probably isn't much more than I already know. Having, you know drawn on a map myself, something very similar, so, to me, the better information is the why." (N Insp A phase 2)

These comments reflect a concern that predictive software reproduces existing knowledge (Sandhu & Fussey 2021), but also the importance of understanding why these areas are at risk, the importance of which is discussed later in the interviews. Researchers have identified that there is officer resistance towards research and analysis when it appears to contradict their specialised knowledge (Belur & Johnson, 2018; Brown & Ballucci, 2022). The advantage of the analysis identifying locations that all the officers expected to see, emphasised through the process of drawing on a map and then comparing it with the analysis results, facilitated a willingness to explore the analysis further. All officers in the second round of interviews practiced their craft and built experiential knowledge of the area and crimes under discussion. If the model failed to

identify locations, the majority of which they were aware of, would indicate that the officers or the model or both lacked competencies.

Lum et al. (2012) found that analysis is viewed with suspicion, whilst Sandhu and Fussey (2021) asserted that scepticism was particularly common in officers with expertise in a crime type. This was demonstrated in the questions officers asked, in the phase 2 interviews, in relation to why particular risk factors were relevant:

"How do woody areas become relevant? I mean it's intuitively, I'm kind of thinking if it's wooded, it's of no interest to them." (Ch Insp phase 2)

The chief Inspector was questioning why wooded areas were relevant, when through their experiential knowledge hare coursing took place in open areas of land. Other officers dismissed some of the results which were not in line with their own expectations, as these quotes from a community beat officer and rural team sergeant demonstrate:

"So it is of use to highlight, I think, the problem areas. Obviously, I'll take an issue with all of that, but it's in that radius, isn't it" (PC phase 2)

"It's got the risk factors but it's not accurate enough, so that's that's not actually the areas we see the hare coursers interested in". (Sgt B phase 2)

Both officers are making a direct comparison between the mapped results of the analysis, and their own identified problem areas, formed through direct contact with victims and offenders. The constable was reflecting on the model's accuracy based on their own experience of dealing with county lines, but logistically could never include all victims and all areas of the city. The following comment from the same officer highlights that the model provoked some thought around areas at risk which the constable was not aware of:

"Yeah, I think at the end of the day looking at this map is highlighting the right areas, isn't it? I mean, Burton Road it was a little bit of a shocker to me, especially all that red in there. Cause it's

not exactly a socially deprived area, is it? Burton Road. So that it's interesting how that',s how that's come up there that's that's a little bit of the shock to me". (PC phase 2)

This quote shows that the officer was considering comparing these locations against their current understanding of previous locations and perceived contributing factors. It was not an outright dismissal that the model was incorrect, and the other areas which mirrored their sense of accurate, supported the need for them to consider these 'shocking' new areas. As previously discussed, dictionary knowledge (Sackmann, 1991), for street level cops, include the categories of people and types of areas which 'stood out in the police mind as relevant to the contingencies of policing' (Loftus, 2010:14) such as council estates, problematic populations and run down areas. As the interviewee raises, he was 'shocked' as an identified area did not meet with this cultural notion and experiential understanding of who might be, or where county lines might be targeting.

Similarly, the sergeant is comparing their known truth with the analysis results. Lincolnshire is a big county, it is not possible to have experience of every possible location, so the experiential truth is restricted to, and impacted by, their limited exposure to hare coursing incidents. Consequently, there will be higher levels of officer understanding in those areas where policing activity is greatest. In the case of hare coursing, the highest number of incidents and greatest concentration is in the south of the county.

"it's sticking to the roads, which probably isn't that accurate, whereas the accuracy of the spread down south is accurate" (Sgt B phase 2),

Areas where hare coursing incidents are less prolific are likely to experience less police activity, and as such officer knowledge and understanding will be reflective of this.

The attitude of the officer in discussing the locations determined by the analysis as high risk was that only those areas they felt were accurate would be considered for use, as found by Belur and Johnson:

‘evidence indicates that there was a sub-cultural resistance to accepting analytical expertise when it might contradict operational experience or organisational priorities’ (Belur & Johnson, 2018:783)

The contemporary research of Brown and Ballucci also identified how contradictions in analytical results and officers’ experiential knowledge lead to redundant analytical products:

‘analysts view officers as willing, perhaps even eager, to use their products if it provides information on new or unfamiliar offenders; otherwise, analysts see their products as underutilized and overlooked as secondary information to police knowledge. Thus, the analysts reported resistance against their specialized knowledge when it contradicts an officer’s gut instinct.’ (Brown & Ballucci, 2022:11)

Officer experiential knowledge and its influence on research and analysis is discussed further in the following section.

7.6.5 Police craft and experiential knowledge

It was clear from the discussions around the analysis and the officer’s interpretation of the results that they brought considerable contextual knowledge to the understanding of the spatial distribution of the two crime types. For hare coursing the chief inspector added context to why a particular area had an absence of risk:

“I know there’s a lot more wooded area. It’s a lot less flat here. So the geography doesn’t lend itself to hare coursing and it’s deer, as well deer.” (Ch Insp phase 2)

The rural sergeant spoke of why certain areas would be more at risk:

“They want flat land and ditches ‘cause they like to see the dogs leap” (Sgt B phase 2)

and in relation to county borders, where traditionally policing response is complicated by multiple controlling police forces (Cambridgeshire Constabulary, 2022), which can delay police response,

or hare coursers offending in neighbouring police force areas where they perceive their vehicles are likely to be less well known:

"people think, they know you'll have problems with borders so they do want to border hop a lot" (Sgt B phase 2).

In this sense, one of the strengths of the RTM analysis is that it highlighted these areas, and the local context can be, and was in many respects included in the modelling process. In their interview Sgt B highlighted what they believed were crucial aspects to location selection, such as ditches and flat fields. It was explained to them how these factors from their experiential knowledge were incorporated into the analysis. The hare coursing models generated for each of the districts highlighted how the local topography impacted on the risk factors. In areas of the county which were predominantly flat, flat fields were not a significant factor as this was the norm. In contrast areas in the north of the county containing, the Lincolnshire Wolds, the model identifies flat fields as significant. The model facilitates taking their contextual knowledge and understanding and applying it to areas they are less familiar with and may not have been a focus of attention previously.

According to Fleming and Rhodes (2018:19) police officers 'draw on any source of information available to them and use their experience to determine the information they will act on'. Heyer (2022:8), postulates that officers do value 'the expertise of researchers, but they value their own policing experience and knowledge more' which researchers should be cognisant of when designing and evaluating analysis products. As demonstrated earlier by the Neighbourhood PC, the RTM analysis provided a middle ground, both confirming their own experiential knowledge and by raising other areas of concern, facilitated the development and acceptance of new ideas.

Brown and Ballucci (2022) acknowledge that there is value in the information gathered from data sources and police officers being combined to generate the best results. However, valuing officer experiential knowledge and explicitly including it in analytical and research products will more

likely lead to successful use (Heyer, 2022). Analysts are in a fortunate position when they are provided with, or coproduce terms of reference for new analysis; they have access to those who wish to use the analysis, to question them, understand their expertise in the subject and determine if, how and to what extent this is used in the analysis.

Officers in Lincoln also brought their own contextual knowledge to understanding the distribution of county lines cuckooing risk. Homer House is supported accommodation run by the local charity LEAP to support homeless persons and was identified as a proximity risk factor for county lines cuckooing. A community beat officer commented about the LEAP charitable housing supported accommodation:

"2020, Homer House would have been prevalent because of the contract that LEAP had for under eighteens. They don't have that anymore". (PC phase 2)

A neighbourhood inspector was able to link broader issues around the high-risk areas,

"Equally, that is Portland Street, isn't it? Which is something we all know about, and, but in terms of incident reporting it doesn't always come through strongly, which is the nature of what we're dealing with, isn't it. Incidents don't get reported. So, it gives a better picture than comes through than we can get potentially from crime data or incident data". (N Insp A phase 2)

Here the inspector was able to add context to an area highlighted at risk, but also appreciated the benefit of the analysis, in that it had flagged an area, which (anecdotally) was a problem for other crime types, but not necessarily county lines. Cuckooing is often a hidden crime, compounded by victims failing to see their victimisation (Coomber & Moyle, 2018; Moyle, 2019; Spicer et al., 2020), with offenders commonly 'manipulating the drug user to believe that they are getting a good deal' (Robinson et al., 2019:705). It is frequently the associated anti-social behaviour linked to drug dealing or a victim reaching breaking point that leads to the identification of cuckooing, and the implication is that underreporting is highly probable. The officer implies that the model can bring evidence of risk not only to the local inspector but also to partner agencies to support a

more wholistic approach to that area. Through the RTM methodology used in this research, previously identified locations were used to identify at risk areas in the preceding year, as detailed in chapter 5.2. This provided two years of analysis which demonstrated the value of the analysis when the results were compared to the actual incident locations.

Officers interviewed with experience of hare coursing provided contextual knowledge centred on the generalised topography of the county, while those involved in county lines had a more focused geographical context on neighbourhoods of Lincoln, but also a strong sense of the people involved. They recognised the influence certain individuals posed in terms of their criminality and or their vulnerability to victimisation. The connection was not made by all those interviewed, in terms of the coming together of the social and topographical factors of why these persons might be residing in these locations which the model was utilising to identify risk.

"But it's obviously it's gonna be just, yeah. I mean the general rule of thumb I've found it's the same individuals. Generally same individuals and obviously some of these people move around quite a bit. And they could be in Council property one minute and could be in another housing association property another, and some properties have had more than one, erm one county line based there." *(PC phase 2*)

This community beat officer exemplifies where officer experiential knowledge is pushed to the fore at the expense of analytical findings. The officer's point is valid but represents only part of the picture. Combining this contextual knowledge, with the findings of the model will bring about a better understanding of the problem, and how it might be tackled.

Researchers have identified the differing perspectives officers bring in comparison to analysts and researchers (Cope, 2004; Brown & Ballucci, 2022). For a successful transition to action from analysis, co-production is crucial between contextual knowledge officers bring, and the data of analysis (Brown & Ballucci, 2022; Cope, 2004; Hunter et al., 2019; Tilley & Laycock, 2012). All ranks interviewed during phase 2 provided contextual knowledge which enhanced not only the

analysis but also the interpretation. It was also inferred by those that took part in both phase 1 and phase 2, that they were more readily accepting of the results than those interviewees who only took part in phase 2. As already highlighted, analysts are in the perfect position to channel the expertise and knowledge of officers through frequent interaction, collaboration, and the demonstrable valuing of officers input in shaping and interpreting analysis and communicating results.

7.6.6 Risk terrain analysis adding value

A key factor of successful analysis is that it provides actionable intelligence. In terms of RTM analysis, potential actions can be focused around areas identified as high risk and the relative risk factors contributing to this, and how these can be negated. Highlighting hidden areas was one of the ways that officers identified that the analysis could add value or benefit their role or the organisation. Within this theme of added value there were specific strands which appeared. These were understanding why some areas were targeted and others weren't, focused prevention activities, support patrol plans, recognising the potential the analysis had to evaluate interventions and bringing a legitimacy to police response of the problems analysed.

All officers interviewed in phase 2 conveyed that they found the analysis useful, and one inspector could see the utility of the analysis for other crimes *"I guess you could apply this kind of system to knife crime as well". (N Insp B phase 2)*

In 2009 Lum argued that information-based decision making could provide legitimacy, transparency, and a structure to police-citizen communications and interactions. The transferability of this to partner organisations and subordinates was remarked upon by those in management roles as the following quotes demonstrate*:*

"I mean to me, the the, you know, the gold-plated thing that we could do with this, would be go to the local authority and go, "what you gonna do about this?"" (N Insp A phase 2)

"But this adds that layer of evidential relevance to say, "Okay. And now the reason that we're going to focus on here, the reason that I ask you to do this particular work in this particular area is these identified factors". So, I think that right, absolutely. And we'll use it, definitely." (Ch Insp phase 2).

This evidence of legitimacy and support for action plays a part in all forms of problem solving and intelligence-based policing (Maguire & John, 2006; Ratcliffe, 2003a). In many respects it is what the College of Policing has been endorsing for years in, the 'What works' approach (Keay & Kirby, 2018; Lumsden & Goode, 2018; Sherman, 2003 & 2013; Sherman & Murray, 2015) and not only legitimises to colleagues, but victims, partners, and other interested parties (Ratcliffe, 2003b). It also demonstrates that, when considering 'what works', officers do value a broader spectrum of evidence than what is seen to be 'legitimate' (Bullock & Tilley, 2009; Lumsden & Goode, 2018), such as systematic reviews and randomised control trials.

Reflecting the management cop cultural characteristics (Chan, 1996; Demirkol & Nalla, 2020; Paoline, 2003) of organisational efficiency, rational decision-making and accountability, the inspectors and chief inspector also saw the potential that the analysis had on evaluating interventions, an area that is lacking in crime analysis and policing in general (Belur & Johnson, 2018; Boba Santos & Taylor, 2014; Evans & Kebbell, 2012; Tilley, 2010).

"And it's so difficult to measure if you're had any impact. So if you've got something that you can have an impact on, that's measurable, than that's a massive" (N Insp A phase 2)

"I suppose the only thing that occurs to me would be recognising where the relative risk score has changed and then asking the question why? Why has that happened? Yeah. You kind of hope either it would be an intervention, or it would be something identifiable because if the relative risk score reduced, then you'd say, well, is there something we could learn from that area, that location?" (Ch Insp phase 2).

The risk terrain analysis has an advantage over other crime mapping analysis techniques such as hotspot mapping. Policing a hotspot has the issue of two-way criticism. If police intervention at a hotspot deters criminal activity there is the potential to argue the hotspot was wrong. If police activity focused on a highlighted area identifies further criminality, this reinforces the hotspot in future analysis (Brown & Ballucci, 2022; Egbert & Krasman, 2020; Sandhu & Fussey, 2021). Greene argues that typical police tactics applied to hotpots 'yield little information on the array of policing interventions 'that worked' in these hotspots. Not knowing 'what works' is a large shortcoming.' (Greene, 2014a:386). The predictive accuracy of the analysis therefore needs to be considered separately to the intervention (Bennet Moses & Chan, 2018). The predictive accuracy detailed in sections 5.3 and 6.5 show the value in the RTM analysis and using the relative risk scores of the analysis to determine what aspect to focus intervention on, can then be used for post intervention analysis.

In contrast to hotspots, risk terrain analysis is based on the relative risk scores calculated through a range of risk factors. Tackling one aspect of the risk, or one geographical area, and assessing whether these have changed, provides improved understanding of whether any intervention has had an impact. The process required for this evaluation highlights the ongoing need for collaboration between officer and analyst, firstly to interpret the results of the analysis, and then to determine the appropriate response and evaluating the success, or otherwise of the interventions. Ideally this becomes a continuous process, (akin to the SARA model) which could both strengthen the working relationship and that of the RTM analysis.

The success of the intervention does not detract from the success or otherwise of the model. Officers identified that the analysis could focus prevention activities, the chief inspector gave the following example:

"So if I want to put signs out, just put some signs out that said 'covert police cameras in use, hare coursing, Operation Galileo', I might use those that have got the highest relevant risk factors". (Ch Insp phase 2)

Additionally in terms of patrol planning and resource allocation, the chief inspector continues:

"So that would help identify where, would most likely to get a greatest success from with patrol or from putting technology". (Ch Insp phase 2)

Neighbourhood inspectors highlighted the additional information the analysis provided in terms of the risk factors, and that these provided insights into where action might be focused or why a location should be a focus of activity:

"'cause there might be something hidden in the system that we're not particularly seeing. This is picking up that, it's saying, "hello! There's a risk over here"." (N Insp R phase 2)

"Having, you know, drawn on a map myself, something very similar, so, to me, the better information is the why." (N Insp A phase 2)

Information on why an area may be at increased risk, which cannot be determined through the craft of policing, experience, or observations, is highlighted, and seen as a positive contribution. This is particularly important for inspectors in management cop roles, as are these inspectors, who require information on large areas to plan appropriate responses and be accountable not only to the community, but police senior management too. They also need to legitimise decisions to those street cops who will have observed these areas on the ground.

The same neighbourhood inspector also saw the positives in terms of hotspot patrolling or determining a patrol plan:

"So, I think in terms of hotspot patrolling, erm this is far better" (N Insp A phase 2)

"So, if it's preventative patrol, where do we want them, well that that makes it very obvious doesn't it." (Ch Insp phase 2)

Ratcliffe et al. (2020) argued that officers showed more scepticism for technology which determined patrol plans. They comment that officers perceived that technology utilising generalist algorithms was unable to distinguish the social context which made locations more crime prone, which experienced officers could through their street craft. This was not evident in the officer interviews, but whereas Ratcliffe at al. (2020) had focused their research on patrol officers in the United States, this research was based in England and was biased towards inspectors. In addition, officers in this research who interpreted the analysis as a tool for decision making was likely to make it more acceptable (Ratcliffe et al., 2020). Another significant difference between Ratcliffe et al.'s (2020) research and this study was that it focused on tactical analysis, determining patrol areas based on predicted areas of crime. The RTM takes a more strategic approach, it identifies locations that will be at future risk of offences in the longer term, with the intention of devising interventions to counter the risk, in contrast to the predictive analysis used in Ratcliffe et al.'s (2020) research which specified when and where to patrol. The officers making use of the RTM are still in control of the when and the where, and there is still an opportunity to interpret the results of the analysis from the street craft perspective.

The 'key to understanding technology's organisational effect is how it is appropriated by users in the context of existing work practices and its compatibility with existing norms or codes of conduct that govern the workplace' (Egbert & Krasman, 2020:492). Interviewees referred to hotspot analysis, and the use of hotspot policing is well defined in the cultural 'directory' and 'recipe' (Sackmann, 1991 in Chan, 1996) knowledge of officers. It lends itself towards proactive patrolling which Loftus (2010:14) notes 'is accorded high value within the culture because it closely resembled traditional images of the police as crime fighters and investigators'.

Thus, the apparent acceptance of the risk terrain analysis is likely due to the assimilation and compatibility with current working practices in utilising hotspot analysis and identifying crime prevention opportunities (Willis et al., 2020), whilst allowing officers to assimilate their own knowledge to interpret and react to the analysis findings.

7.6.7 Analytical presentation

This research has two clear aims. Firstly, the aim was to determine if RTM can provide a valid methodology for determining areas of high risk for future events of hare coursing and county lines. The results in chapters five and six provide evidence that this is the case. Secondly, the research was to determine whether there was 'practical application' for RTM use in Lincolnshire, by police officers, and early sections of this chapter would indicate that this is also the case, at least for those in management roles. However, establishing and demonstrating that the concept of RTM works needs to be complimented with appropriate presentation of the analysis results to maximise officer understanding and utilisation of the findings, and as this section shows, should be tailored to the relevant audience of 'management' or 'street' cops.

The first phase of interviews asked officers about the presentation of analysis in general terms, and the second phase asked how they would prefer the risk terrain results presented to them. The basic output of risk terrain analysis is in the form of a map, with areas differently coloured to show locations of significant high risk to future analysed events. In many respects the analytical product is not that dissimilar to a hotspot map, which most, if not all officers had previously encountered. Where risk terrain analysis differs from hotspot analysis is that it identifies potential contributing factors. These factors appear in the analysis results as a relative risk value, identifying the extent to which the factor is influential. To understand officers' preferences, they were shown the risk terrain analysis results with different levels of risk, and different levels of information ranging from a map showing only those at the highest risk, to one showing a graduated map of all risk. Some maps also detailed the contributing risk factors and the relative risk values for each risk factor. Examples of the maps used in phase two of the interviews are shown in figures 15 to 19.

Two clear messages came from those interviewed. The first was that the content of the analytical product, the results should vary depending on the audience and the purpose to which the results would be used, as the following quotes illustrate:

"It depends on who it was being presented to? For example, I would like to know what features, what parameters you've set Yeah, and so that that would be really useful [inaudible] Yeah. But for this one, to support the ANPR deployment I can say these are the areas we've identified Yeah. wouldn't need that. But I think, Yeah, so depending on what, what you know my audience was that I would like to present to basically." (Sgt B phase 2)

"Errm, don't need War and Peace, particularly at the low-level end. Erm your, such like your Op Parker type of stuff, where you're talking a much bigger problem then they're clearly gonna want more information aren't they." (N Insp B phase 2)

"But I am interested, and I do want to understand what sits behind it because any of the strands of data, or any of the presumptions that have been made in, as part of that analysis, I need to understand if something undermines them further down the line." (Ch Insp phase 2)

A response inspector also articulated that they wanted to understand the analysis, but that this did not necessarily mean they needed a complicated and detailed report. Their requirements were affected by the level of trust in the analyst, the level of complexity and their familiarity with the analysis and what their next step would be in utilising the analytical product.

"I think it depends what I'm intending to do with it. How much scrutiny there is likely to be from whoever I'm presenting it to, and I'll be completely honest, how much faith I have in the analyst and my understanding of whatever it is. 'Cause if it's something that if I sat down with you and you provided something because I trust you and I said right, this is how I explained it, and by the time I walked away from the conversation I had a good grasp of it in my head, so I felt I could describe whatever I needed to, but I wouldn't necessarily expect to walk away with all that in depth stuff in my head" (R Insp B phase 1)

This aspect of trust impacting on the level of detail was also commented on by a neighbourhood inspector:

“But the actual scores and stuff, for me you’ve done your research. You’re telling me it’s high, it’s high. I believe you” (N Insp B phase 2)

Both inspectors explicitly express the importance of trust effecting the level of detail they need, but the subtle difference here is that the neighbourhood inspector is considering the RTM output and more specifically what he needs to make use of an analytical product where they are the targeted audience. In contrast to the response inspector, who is speaking about analytical products in general.

In the earlier quote by Sgt B in phase two of the interviews, they imply that operational officers would only need the map of identified locations, and this was a similar view of a neighbourhood inspector in relation to information needed for a PCSO:

“*They wouldn't benefit from like the numbers. They just need to know where to go.” (N Insp B phase 2)*

The opinions of the inspector and sergeant when referring to subordinates, reflect that they not only believe those of lower rank, those personnel out patrolling, need different information and presentation of analytical results, but that these ‘street cops’ do not need to understand the analysis, the reasoning behind why they are being asked to police specific areas. It is unclear as to whether this reflects the hierarchy of policing, and that lower ranks should respond to senior officer requests without question, or that the lower ranks may not understand the analysis, so there is no need to provide the detail.

These opinions of those officers quoted above are in keeping with the results Boba Santos and Taylor (2014) found, in that different ranks use different analytical products in different ways, and the importance put on research and the presentation of results to reflect the intended audience (Lum et al., 2012; Tilley & Laycock, 2000). It was an identified criticism by researchers that this was either lacking or required improving (Tilley & Laycock, 2000) and why operational officers

tended to find analytical products unhelpful (Cope, 2004). A response inspector experienced with analysis and analytical products made the following comments:

'If the analytical product has been designed for a superintendent to receive at the strategic level, that's probably different from what I need at the tactical level or the PC's need at the operational level…We just use whatever product we've been given, which probably doesn't fit the aims of what we're trying to achieve at that tactical or operational level, and again, that's a lack of literacy to understand what's in front of them, and to understand that it's not what they need.' (R Insp A)

Targeting of analytical products to 'management cops' and 'street cops' in a manner that meets their specific needs and use of the information is extremely important. Fox et al. (2019) demonstrated this with a 'flash sheet', a field level RTM product used to direct and inform preventative patrols. The sheet included reported offences, open warrants, local events, and contacts for referral agencies. Sergeants were encouraged to feedback and evolve the flash sheets improving officer buy in.

The second message that came through from officers was that there should be an explanation of *why* areas were at high risk. Some wished to see this included on the map:

"I guess I would want to have a map, a scheme, a system that helped me to understand first of all there is a higher risk area, so where are the high-risk areas that are identified, and then within that breakdown, what is it that that is the most significant one or two contributors to it being a high-risk area." (Ch Insp phase 2)

"But it's not just the where, it's the why. What is it that makes it that high risk? So yeah, so map and what is it that, you know, your kind of model? Yeah, the map and the model together." (Ch Insp phase 2)

while others articulated that they wanted an explanation of the model,

"but I really would like the theory behind the computers as to where it's going" (Sgt B phase 2).

The wants and needs of those interviewed can be summarised in a requirement for analysed crime information as opposed to descriptive information as summarised by Swope below, if 'police' is interpreted as 'management cops':

'Police need more than just a pretty map. What should analysis of criminal activity tell practitioners? First, they should have a clear, logical structure, that is X leads to Y because of Z. It is the 'because of Z' that is the most important part of the equation; too often, practitioners stop with X leads to Y.' Swope (2001:42)

In the hierarchical policing world, some of those interviewed felt that subordinates, 'street cops' did not need this level of information, and literally only needed to know where and when to go to a location, and what to do when they got there.

In essence the research methodology, stemming from Pawson's (2000 & 2002) pragmatic realism approach, has been about determining those different contextual risk factors 'x' and the 'mechanisms' of their interactions to produce the visible 'outcomes' of increased risk of y. It is therefore paramount that the results of any analysis using this methodology be focused on communicating the mechanisms and contexts, (the 'Z') to the intended audience. In terms of the RTM, the mechanisms can be seen as the specific combinations of factors working together to increase risk, and the differing parameters of proximity or density and the extent of the spatial influence of the risk factors.

It was also clear that officers wanted simple and succinct documents.

'I suppose everyone is different. I like something basic that tells me this is where the bad guys are, go get em! …..Simplistic document. I hate longwinded things erm like those high harm documents. Do not like. I'm sorry if you write one. I hate them err it's too much information compared with everything else that you gotta try and digest.' (N Insp B phase 1)

'Maps and diagrams are always good because people lose interest when they're reading things, particularly long documents' (R Insp B phase 1)

Swope (2001) states that a good descriptive map may be proficient to communicate information, but for the development of effective interventions analysis is essential (Swope, 2001). What is missing is the understanding of the target audience. The good descriptive map is likely to be proficient to instruct officers on when and where to go, but for 'management cops' analysis needs to be included. Risk terrain analysis can go a long way to understanding geographic trends and to test hypothesis around the underlying relationships associated with crime at place. It provides an opportunity for the analyst to provide actionable intelligence, to those in a position to instigate action, which is at the heart of intelligence led policing but only if the 'Z' is included in the results presented.

An inspector provided their opinion on how they thought constables approached analysis, when asked whether constables take on board the analytical products on briefings or just give passing attention.

"I think if it's on a page, visual, has a map with some bubbles on it. I think that is pitched right for cops, especially those that have got a local interest"... "I think those sort of 60 second briefs, officers do take on board, and then they're so easy to share with Uh, you know roads policing or other resources that might be in the area. And I do think cops generally want stuff to be looking for." (N Insp A phase 1)

Meijer and Wessels (2019) identified that often the message of analysis and expected action by officers, and in particular hotspot maps, can be lost without an analyst's input or explanation, which this response inspector agreed with:

"I think there is always a danger that unless it is presented to them, so the analyst can really explain it, I find, I find officers will take what they want to get out of it, than, rather than, necessarily what it shows." (R Insp A phase 1)

This inspector, quoted above, points out that they feel this is down to a lack of understanding, and training, of senior officers commissioning analysis. He argues that not only are they unable to

task analysts appropriately, they fail to understand the finished results and (as discussed in section 7.6.3) this has been a long standing finding of researchers. It is also clear by comments made by other response and neighbourhood inspectors who have prior experience of working with analysts, that the best way to overcome this is to be involved in discussions, from the start, of any analytical requests. That not only should it inform the terms of references but will enable an effective working partnership which results in analysis tailored for the specific purpose it has been commissioned, but also the continued dialogue will enable correct interpretation and understanding of results to generate actionable intelligence.

7.7 General Findings And Broader Implications Of The Officer Interviews

Chapter 7.4 started with the quote 'Analysis represents the antithesis of traditional action-orientated police work' (Cope, 2004:197) and this section will discuss whether twenty years on analysis remains the antithesis of traditional policing for those working in Lincolnshire. Specific reference to the findings of Cope (2004) in relation to issues impacting on the effective use of analytical products, and if, and how, cop culture impacts on the use of analysis will be discussed. This section will also consider the broader implications of officers' response to analysis.

7.7.1 'Cop' culture, acceptance and the valuing of analysis

Cope (2004) identified culture as a strong contributing factor as to why police officers held analysts and their products in low regard. It was argued that officers did not see the value in skills that were not formed through the experiential development of craft knowledge (Ratcliffe et al., 2020) and this has been discussed in section 7.4.

The small number of officers interviewed in this research showed no evidence of a cultural reluctance to use analysis, undervaluing analytical products or lack of acceptance of civilians in these roles, unlike the intelligence managers and superintendents in Cope's (2004) research. On the contrary, the officer interviews indicated that there appeared to be an acceptance and general valuing of analysts and their products by management level officers. Neighbourhood inspectors referred to the *'professional opinion' (N Insp B, phase 2*) of the analyst and the *'skills of an analyst' (N Insp A, phase 1).* One of the neighbourhood inspectors went as far as stating a preference for analysts when discussing police constables on restricted duties used to understand crime problems. They commented:

'*but in my mind he doesn't have the right skill set' and 'he hasn't got that trained analytical mind to think why' (N Insp B, phase 1).*

This is a cultural shift from the finding of Cope (2004) who argued that analysts were undervalued and underappreciated due to their lack of policing craft and experience. In contrast, officers interviewed did not comment on the lack of traditional policing skills of an analyst, but appreciated their skills and knowledge in crime science and data analytics which lead officers to view them as professionals.

It is important to note that the analysts involved in the original research by Cope (2004) included some ex-police officers and only a small number of all the analysts were reported to have degrees. In contrast, the analysts within Lincolnshire, with whom the participants of the research are discussing all have a minimum of an undergraduate degree and there are no former police officers working as an analyst. It would therefore be misleading to state that this apparent cultural change is solely due to a change in attitudes as it is also likely a consequence of those persons and their skills employed as analysts. This research has considered the views of a small number of officers on analysis and analytical products, future research could consider the analysts perceptions of products and their use by officers for a deeper understanding of the changes which appear to have occurred in the last twenty years.

It can, however, still be argued that cultural change has occurred within management cops. A neighbourhood inspector referred to '*normally*' requesting an analyst to complete work on crime spikes in order that they can then '*target resources appropriately' (N Insp B, phase 1).* The chief inspector (Ch Insp, phase 1) talked of the analyst being at the '*heart*' of sensible decision making and use of resources and the response inspector (R Insp A, phase 1) on being '*really keen*' to engage with analysts as they moved to a new role. These comments from officers working in three different roles and representing two ranks, illustrate how analysts have become integrated into the culture of policing, and demonstrated through the descriptive comments deemed to make a positive contribution.

However, as already stated, a limitation of this research is the limited number of officers interviewed and the bias towards management ranks, and as previously discussed (section 7.4.2) it would have been expected that those in such roles would be more open to the analysis (Belur & Johnson, 2018; Hunter et al., 2019; Phillips, 2012).

7.7.2 Capacity issues

The inspectors and chief inspector interviewed acknowledged the benefit analysis could bring, and that for long term or complex issues they were happy to put effort in to obtain the services of an analyst as this comment from a neighbourhood inspector illustrates:

'if something is quite complex, then you know I could understand that and then be more than happy to, you know submit a terms of reference and whatever else' (N Insp B, phase 1)

Officers identified time pressures as negatively influencing the use of analysis. These include the pressure to have analysis completed and respond to a problem from senior management, and the constraints inherent in the process of requesting and obtaining an analytical product because of limited capacity. For issues they saw as reactive or short-term this could deter them from making an analytical request as they appreciated the time taken for a quality in depth piece of analysis and that for some issues, the necessity to respond or react may have abated or been resolved prior to the completion of the analytical product.

In phase two of the interviews the neighbourhood inspector talked about if a problem '*persists*' getting the analyst to '*drill into it a bit more*' and give their '*professional opinion' (N Insp B, phase 2)*. The implications of the inspector's comments centre around wanting to understand the issues to effectively tackle the problem, but also to balance the problem against analyst efficacy. The value of technology in increasing the efficient and effective use of analysts was also acknowledged, in that it '*saves your valuable time'* and '*it gives us the ability to be smarter with your time' (N Insp B, phase 2)* when discussing the RTMdx software.

Additionally, they saw the benefit of analysis to negate issues caused by lack of capacity and resources for deployment as this neighbourhood inspector notes:

'you're just dealing with such a vast geographical area. Uhm, and the hope of having your resources in the right places is extremely slim. So again, it can only I suggest be with the help of some kind of analytical product' (N Insp A, phase 1).

Capacity issues were raised by most of the officers interviewed in one aspect or another. For some it was the assistance that analysts could provide to make the most of the limited resources available, as in the comments by the neighbourhood inspector above, or that they would not envisage having resources to respond proactively to analysis:

'and as for doing things in advance you know problem solving based on any product that might come out. I just don't know how to staff it. Yeah, its like, just not enough staff' (R Insp B, phase 1)

For others it was the drawbacks of the limited analytical capacity within the Force which was raised.

'There's only so many analysts and so much work that can be done…'cause just like in frontline policing, there is always far much more demand than there is capacity' (R Insp A, Phase 1)

Some officer responses indicated a realist approach to the use of analysts, for example limiting requests for analytical assistance to those longer term or problematic jobs, others saw technology as a way to increase analytical efficiency and thus capacity:

'the more we can use the technology to increase your ability as analysts to add your magic to different areas of data, to recognise and to develop, the better' (Ch Insp, phase 1)

Showing a similar sentiment, a neighbourhood inspector discusses the benefit of the RTMdx software, compared to the manual models for risk terrain analysis:

'then it can be a fairly quick win without the need for hours and hours of work by the likes of yourselves to ultimately come up with the same result.' (N Insp B, phase 2)

Linked to limited capacity, is limited resources and the analysts were valued as an asset which can help those in management positions make best use of the policing tactics and officers available to them. The Chief Inspector (Phase 1) describes it as the '*magic*' that the analyst brings and talks about ensuring they task the analyst with clear terms of reference and parameters so that an understanding of the issue is achieved. They talk about the '*goals we want to achieve'*, '*data that would have been useful if we could get it*' and '*tactics that we might want to employ or explore'*.

It could be argued that this integration of analysis to direct resources and help plan operational response is an improvement on the use of analysts and analytical products described by analysts in the research of Cope (2004) which were described as 'window dressing' and 'wallpaper' and used to summarise operations or justify already planned operations. There is an implied sense of collaboration between the analyst and the Chief Inspector, the 'we' in working together to understand problems and find solutions, and inherent sense of value in the analytical product which contributes towards this.

Cope (2004) raises the distinction between analysts making recommendations 'based on research and analysis' and 'decisions about adopting recommendations and directing action' (Cope, 2004:191). They argue that operational plans should be developed in collaboration, and this is consistent with the current research, which presents evidence to support collaborative working from the onset of the analysis, not just in the final recommendation stage.

The current realities of policing which have reduced resources in all areas has strengthened the need to make best and better use of what is available. Consequently, these cuts appear to have led to a cultural reliance on analysts, but at the same time technology and capacity of analysts has also been curtailed which in turn limits the extent to which they can provide actionable intelligence, add value and be of assistance to all those officers and departments which could benefit from analytical expertise.

7.7.3 Easy to digest

Analytical presentation and how the content of analytical products should be tailored to the needs of different officers and roles, and influenced by the relationship between the officer and analyst is discussed in section 7.6.7. This section focuses on a common theme identified when discussing the analytical products provided to officers, which was that they wanted documents that were simple, short and quick and easy to digest. The neighbourhood inspector described their dislike for certain analytical products because they *'contain too much information compared with everything else that you gotta try and digest' (N Insp B, phase 2).* This inspector and the others interviewed did want to understand the concept and how the information had been interpreted, but where there was a trust and a valuing of the analysts' opinion, and a trust and understanding of the analytical process the documents provided could be more concise.

As detailed in section 7.6.7 and summarised by these quotes from a chief inspector and inspector there is a desire for straightforward concise analytical products which highlight the issues:

'the standard format that that comes in, and a consistent approach to the analysis means that it's a relatively easy read' (Ch Insp, phase 1)

'I like to be able to take a glance at it, see what the issue is' (N Insp B, phase 1)

It could be suggested that there are two main reasons for an abridged and concise analytical product. The first relates to the issues of capacity and the demands that officers have on their time. The time to read long documents is limited, added to this is the requirement to digest and understand the analysis, to decide on appropriate responses, and the immediacy of problems pressurising for a quick response could lead to lengthy documents being ignored, or at best skimmed over for selected highlights.

The second consideration is the analytical knowledge of officers reading analytical documents. Long complicated documents which require mental effort to understand are going to be

ineffective in a challenging and fast paced environment where the time to think is a luxury. Belur and Johnson commentated that the way analytical results were disseminated 'undermined their contribution' (2018:769) and Ratcliffe (2010) shared a similar opinion when describing lengthy documents as a distraction. Couple this with the lack of analytical understanding identified by Cope (2004) and Ratcliffe (2004), that many officers in the current research are indicating persists, and the effort and time required to fully appreciate and respond to analysis might not always be considered worth the benefits. In this respect analysts should be cognisant of the individuals they are providing analysis for and tailor their analysis product accordingly to maximise understanding and influence decision making. To reiterate the point made in section 7.4.5, analytical reports should be clear, relevant, useful and user friendly (Bullock, 2013; Fyfe & Wilson, 2012; Lum et al., 2012).

7.7.4 Lack of evaluation

Another issue which was raised previously by researchers was the lack of evaluation of analysis and the response to analysis (Boba & Santos, 2014; Cope 2004; Tilley 2009 & 2010). Officers interviewed also raised evaluation or lack of, as something which could be improved as these comments illustrate:

'well-meaning people that try and be evidence based but then never do the review' (R Insp A, phase 1)

'it's just a danger of current times, isn't it, that we don't have a chance to reflect as much on, you know, and it really is the long-term planning and who's doing it and who's leading it…we just flit around…do something here one day and something there one day and who's thinking, this is what our city looks like. How are we going to change our city moving forward?' (N Insp A, phase 2)

In relation to evidence-based policing the response inspector (R Insp A) notes that the review is never completed, they are implying that the result is not evaluated and consequently not evidence based. The neighbourhood inspector (N Insp A) is also implying that there is a lack of

evaluation which is limiting the understanding and success of interventions. A subtle difference between the two is that R Insp A implies that these are isolated attempts at being evidence based, whereas N Insp A suggests that this is common practice, not only for short-term tactical responses but also for strategic change. N Insp A comments that this is due to '*current times*' referring to the impact of austerity measures on resourcing, resources and capacity and the scrutiny from inside and outside of the organisation that problems are dealt with immediately.

The same neighbourhood inspector talks of the importance of knowing what intervention has worked or if it has had a positive or negative impact:

'it's what impact did we have? It's like with all, it's almost crime prevention, isn't it? Across the board. And it's so difficult to measure if you've had any impact. So if you've got something that you can impact on, that's measurable, then that's a massive' (N Insp A, phase 2)

Likewise, the chief inspector is expressing their need to understand if, when and why an intervention has been successful.

'I suppose the only thing that occurs to me would be recognising where the relative risk score has changed and then asking why? Why has that happened? You kind of hope either it would be an intervention or it would be something identifiable because if the relative risk score reduced, then you'd say, well, is there something we need to learn from that area, that location?' (Ch Insp, phase 2).

Both officers, of different management rank and role are wanting the knowledge that analysis through evaluation can bring. The inspectors and chief inspector interviewed commented on the positives that evaluation of analysis and interventions could have, but the general feeling was that time pressures, capacity and resources often meant there was little appetite to look back, as current issues were more pressing.

7.7.5 Reactive policing

Another cultural aspect of policing which researchers have argued persists is the desire to catch criminals, and it has been argued that prevention and protection from crime is undervalued in favour of pursuing offenders (Fen & Bullock, 2022; Loftus, 2010). Several inspectors interviewed indicated that they saw value in preventative and proactive policing supported and informed by analysis, but a lack of time and resources, or both, hindered this non-traditional policing approach.

'cause is we can prevent crime, that's better than catching them.' (R Insp A, phase 1)

The response inspectors (quoted below) are indicating a willingness to use analysis, but that their ability to respond to analysis in a proactive way is restricted because of the continued reactive use of resources:

'it's frustrating sometimes that when we have information provided for it as well, not necessarily able to make the best use of that' (R Insp B, phase 1)

'even if I had the best product in the world, I can't do anything about it, so I don't want to waste an analyst's time (R Insp A, phase 1)

The chief inspector discusses the strategy for reducing hare coursing and how the prioritisation of analysts is aimed at criminality with a higher threat and harm level than hare coursing. There is an understanding of the limited analytical capacity, but there is also a desire to work around priority and resource restrictions through tangential targeting of offenders.

'Hare crossing is such a low-level offense in law that proportionately it is not proportionate to get that level of data from the phones and when it comes to prioritising the analysis work, erm. Then, you know, in any detective is going to say, well, you know things that directly harm people, so whether that's drugs or violence or, or whatever, he's always going to be a higher priority on phone analysis. So we really don't get anywhere close, and what we're trying to do is to better

map and understand the OCG [organised crime group] linked activity of our hare courses and be over criminality of our hare courses so that we can we can focus on investigation of those higher level, more serious offenses, and in doing so we tackle hare coursing. So, you know if you're locked up for burglary, if you're locked up for drug supply, well, you're not hare coursing. So, we've achieved our hare coursing goal.' (Ch Insp, phase 1)

They argue that hare coursing is linked to organised crime and by targeting through the linked high harm offending of drug supply, a positive result will also be a positive achievement towards the goal of reducing hare coursing.

There was evidence in the officer interviews that there has been a cultural shift in policing. The traditional emphasis on catching offenders is still present but alongside this is a desire to problem solve, and be proactive in preventing further offences and victims, as these comments from a chief inspector and neighbourhood inspector demonstrate:

'We do have a responsibility to our community and to say actually we do need to do things that prevent them from being repeat victims' (Ch Insp, phase 2).

'If we can identify what that vulnerability is, and we might be able to put the relevant agency in touch with them too' (N Insp B, phase 1).

In discussing the high-risk area in the results of the risk terrain modelling the same inspector comments:

'there's a risk of them flashing up based on what's on the system that you know that if we did some dedicated patrols where that particular red spot is and did some leaflet drops and things like that, or actually just spent more time patrolling that area, it might get you some more information or actually more stop searches' (N Insp B, phase 2).

A sergeant interviewed in phase two regarding the model's use for hare coursing risk also intimated that the proactive aspect of the model was appealing and a quality that they

appreciated. They identified that the *'map would help us unlock [inaudible] and the technology that we can help try and prevent it' (R sergeant, phase 2)* by being proactive in areas highlighted by the RTM analysis as high-risk using deterrents and covert evidence gathering. The potential of the analysis to allow the policing response to hare coursing to be more proactive, and to increase understanding of the issue was also indicated when the same sergeant expressed that *'I think it is interesting that we're going forward' (R sergeant, phase 2).*

One of the elements of concern which arose in the officer interviews was that of repeat offenders and repeat victims, '*a common denominator' (N Insp B, phase 1)* and '*individuals being more of a hook than the actual locations' (N Insp A, phase 2)* and the need and desire to provide a more rounded approach including partner agencies (*N Insp A & B, phase 2*).

*'In my opinion it tends to be the same properties…They are properties provided by an organisation that provides supported accommodation to those that are obviously vulnerable' (*Pc phase 2)

This constable later goes on to say '*it's not just location, it's person*'.

The comments from all those that took part show an appreciation of the broader aspects of policing, particularly safeguarding and indicate a willingness to undertake this aspect of policing, but the impression from the interviews was that despite a willingness of individuals there were obstacles in the way, which prevented successful safeguarding of individuals, or long-term solutions.

7.7.6 Lack of management understanding: still a need for training

An issue raised by Cope (2004) and Ratcliffe (2004 & 2005), and subsequently Belur & Johnson (2018) among others, was the lack of understanding that officers had of analysis and analytical techniques. A need for training on analytical products and how to respond and interpret analysis, particularly for senior officers was also identified by researchers (Belur & Johnson, 2018; Ratcliffe, 2004; Willis et al., 2007). Typically, officers interviewed were aware of hotspot analysis and crime

pattern analysis *(R Insp B, N Insp A, N Insp B phase 1)*, but anything beyond this was very much reliant on the experience of individual officers and the work that analysts had completed for them as the following comments illustrate:

'senior management managers that have had a background in neighbourhood policing, they tend to think more about analysis' (N Insp A, phase 2).

'but I also know some of my peer group do get it and similarly get frustrated by senior leaders not getting what the analyst is trying to say (R Insp A, phase 1)

'I think a lot of the analysis gets lost, and I think that's a lack of literacy of officers around data and around analysis and understanding what analysis is, what it does and what it can be used for' (R Insp A, Phase 1)

'I'm not sure what else is out there if I'm honest' (N Insp B, phase 1)

'I'd be willing to try anything to be fair…the more sort of data and things I can get to assist with that, the better' (N Insp B, phase 1).

Even those officers with experience and appreciation of analysis openly acknowledged that they do not know enough about it, but are open to suggestions led by the analyst's professional judgement.

'without having the skills of an analyst it's quite difficult at times to know what to ask for, what you want' (N Insp A, phase 1)

This is a cultural shift from the finding of Cope (2004) who argued that analysts were undervalued and underappreciated due to their lack of policing craft and experience. In contrast, officers interviewed did not comment on the lack of traditional policing skills of an analyst, but appreciated their skills and knowledge in crime science and data analytics which lead officers to view them as professionals. It is important to note that the majority of those interviewed were inspectors and above, and as Palmer et al. (2019) proport these ranks are more likely to be open

and appreciative to analysis. Another interpretation on the apparent cultural shift from Cope's (2004) findings is that offered by O'Connor et al. (2022) in that there has been an erosion of street craft which has enabled analysis to fill the gap in knowledge that this loss has left.

7.7.7 Collaboration

In the wider policing environment, there is a drive towards pracademics in policing to help improve policing practices. At the heart of this is the collaboration between those conducting research and officers. In realistic terms many officers do not have access to academic researchers but do have limited access to analysts who typically have some, if variable levels of research experience in the academic sense. Collaboration between officers and analysts is seen as positive by officers, and as others have suggested (Braga, 2016; Keay & Kirby, 2018; Piza et al., 2021), I would advocate the analyst take on that pracademic role as part of their remit. This is despite the comments of Braga who argues analysts 'do not exert direct influence on police department decision-making' (Brage 2016: 311) to have enough impact but need to work with ranking officers acting as pracademics.

One inspector raised concern in relation to collaboration, but this was not a failure to appreciate the value of working in partnership:

'but would they [analysts] feel empowered to challenge that first stage, saying actually this is really generic. Are you sure this is what you want? Before I start putting all this work in to do it?' (Res Insp A, Phase 1)

In a similar implicit inference to Braga (2016) the response inspector is alluding to the potential difficulties of an analyst influencing and challenging the requests of ill-informed senior ranking police officers. However, I do not see this as a consequence of the analyst being a civilian and the lack of respect towards civilians by officers raised by Cope (2004), but the need for confidence and self-assurance by analysts, stemming from sound analysis and good working relationships built on trust to articulate and convey their professional knowledge.

A response inspector summed up how their limited analytical knowledge could be overcome through collaboration with analysts:

'for me it's more important that I've got the opportunity to have a conversation with the analyst to see what they suggest might be best in the circumstances and then agree it between us' (R Insp B, phase 1).

The response inspector's comments also highlight that there is an unconscious appreciation of the skills of the analyst that is outside that of their own, which they both value and appreciate. The neighbourhood inspector also refers to the '*skills of the analyst' (N Insp A, phase 1)* and the benefit that they find in discussing with analysts to ask '*what is the best way of getting it, or what can you provide or how can we present it' (N Insp A, phase 1).*

Collaboration has the advantages of improving officer and analyst relationships and overcoming the limited knowledge of analysis and analytical products that officers have. It also bridges the gap between analytical theoretical knowledge and experiential policing craft knowledge, and the feasibility of policing responses to a problem. Ultimately collaboration enriches the process and the outcome resulting in improved actionable intelligence for decision-making. In the early years of the National Intelligence Model, problem profiles were a common analytical product requested by officers. These documents combining information about a problem, analysis and inference testing, culminating in recommendations and intelligence gaps, were enriched by the discussions between analyst and officers to determine the best response to the actionable intelligence and gaps identified. Twenty-years later, my experience is that these requests are rare, and likely a victim of changing crime types (Loveday, 2017; Sylvester & Thomson, 2016), but also capacity and resource constraints when competing against other priorities, preventing focused attention by analysts and officers.

7.8 Summary

The objective of the interviews was to understand whether officers could see a value in the risk terrain analytical approach and in the results provided, that would lead to them seeing how they could use and benefit from the results in the future. In general terms the analysis was viewed positively by those interviewed, and in line with previous research, different cultural aspects of individuals' roles influenced not only their perception of the analysis, but also their utilisation of analysts. For inspectors and above this was part of their working practice, especially for those in a neighbourhood policing role where problem solving formed part of their remit and something which should be expected considering the findings of Palmer et al. (2019). For response inspectors they articulated the value in it, but in their opinion, in their reactive role it was not typically required.

A key theme which permeated the interviews was communication and relationships with analysts, from an acknowledgement that there were insufficient numbers of analysts to the importance of discussing analytical requirements and analytical results; Communication could resolve many of the issues that were limiting the effective use of analysis including lack of organisation knowledge in the use and commissioning of analysis (Belur & Johnson, 2018).

Most officers involved in the research were inspectors or above, and reflecting on this, this bias may be due to my subconscious knowledge that the RTM analysis is a product for this target audience and these managerial ranks are likely have greater experience and appreciation of analysis (Belur & Johnson, 2018; Hunter et al., 2019; Phillips, 2012). Tailoring analysis to not only the target audience, but also to target the issue, was raised in the interviews, with issues identified by officers of how the lack of analytical knowledge and understanding by officers impacted on both. This has been an issue raised from the early researchers on the subject intelligence analysts (Cope, 2004; Ratcliffe, 2004) and has been an enduring finding of researchers during the last twenty years (Belur & Johnson, 2018; Burcher & Whelan, 2019; Chainey, 2012;

Ratcliffe, 2010; Ratcliffe & Guidetti, 2008; Willis et al., 2007). All inspectors interviewed commented that they benefitted from the relationship(s) that they had developed with analysts, they acknowledge that they did not know what the best analytical approach was to a problem, but also that they didn't need to know. They just needed to have a conversation, a discussion with the analyst about the problem, what they were hoping to achieve and to allow the analyst to determine the best analytical approach, highlighting the importance of trust between the analyst and officer (Belur & Johnson, 2018; Cope, 2004).

A common criticism over the last twenty-years, by researchers and officers, is that analysis tells you what you already know. This is another area where communication is key. Working in partnership as analyst and commissioning officer, through discussions it can be determined what is already known and what is important to know. This could be the identification of why things are happening at a particular place or identifying where there are intelligence gaps that need to be addressed to move beyond what is currently known. The understanding of 'why', a key element of analysis, was valued by officers, particularly by those with good knowledge of crime hotspots in their geographical areas of responsibility. In 2004, Cope criticised analysis because it failed to integrate theory and move beyond the descriptive, negatively influencing the levels of mistrust, information sharing and valuing of analysis by officers. This research shows it remains as relevant to analysts today as it did in 2004.

The clash of experiential craft knowledge of an officer against the more theoretical research of the analyst has historically been raised as an issue which prevents the full exploitation of analysis. Again, the relationship between analysts and officers, working together from the onset co-producing research and analysis can not only overcome issues which may lead to the dismissal of analytical results, but enrich the analysis. The officers also demonstrated a respect for the professional skills of the analyst and even went as far as rating the analyst expertise above that of an officer. There has, to my mind, been a cultural shift of acceptance of the role and benefits that

analysts can bring to understanding crime and community safety issues and determining how to respond.

The phase two interviews highlighted the contextual knowledge that operational officers of different levels can bring to the interpretation of analysis, but also aspects that need including in analytical research. The rural sergeants were able to offer factors for inclusion in the hare coursing analysis that could be tested in the RTM; the community police officer was able to provide details of locations to be included for testing in subsequent analyses, improving the overall model. Others provided context which aided the interpretation of the results, which would have otherwise been unknown to the analyst. The research demonstrated the value of experiential craft, but also that there are pockets of a culture of collaboration, but that this needs expansion.

Communication and collaboration were also influential in the officers' requirements in analytical presentation. When this had been consistent, or a long-standing relationship between officer and analyst existed, officers were more readily accepting of results, and typically required less analytical information. This was also true if they were familiar with the technique. When this was not the case, or the analysis was unfamiliar, they wanted greater information and input form the analyst. Likewise, the use of the analysis was also an important feature on how or what information officers wanted presenting. If they were going to use it directly themselves, or if they were going to direct subordinates operationally, then typically simple succinct documents were called for. If they were to present the findings or explain why they were responding in a particular way to the analytical results then inspectors wanted more depth, to gain a greater understanding of the analysis. How this was achieved could be through further discussions with the analyst or a detailed report. Time, capacity and operational demands also played a part in the desire and need for simple concise analytical documents. This was reinforced by limited understanding of analysis, and I would suggest the intellectual effort and time required to understand complex analytical reports when time is at a premium.

This research highlights that many of the shortcomings identified by Cope (2004) and Ratcliffe (2005) almost twenty years ago regarding the inability to task analysts appropriately, and a lack of understanding of analytical results remain. But encouragingly this is not wholesale. There are pockets where relationships between analysts and officers have developed and flourished which facilitate an understanding and an acceptance that working together these shortcomings can successfully be addressed. How the analysis is subsequently used and whether the implemented responses are successful is an area for future research.

The interviews with officers indicate that in contrast to previous research (Belur & Johnson, 2018; Cope, 2004) police officers, particularly at inspector and above are supportive of analysts. Not only is this a positive attitude towards analysts but what I would argue is a cultural reliance on analytical products, particularly in roles where there is a requirement and flexibility to determine what issues they will respond to, and how, such as neighbourhood inspectors.

An issue which runs through the interviews with officers is the issue of resourcing, resources and capacity. One of the hinderances officers raised to the use of analysis was a lack of resources to respond. This was particularly noted by those working in response roles, with the day to day demands negating any capacity to address non-essential tasking. Neighbourhood inspectors raised the need to prioritise problems, locations and resources and the accepted method for this prioritisation was the use of analysis. Evidence provided from analysis to support the request for additional resources against competing priorities is a standard requirement through the local and Force tasking process.

Those of inspector rank and above, who had greater experience of using and requesting analytical support, also commented that analytical capacity was an issue. They acknowledged and accepted the need to bid for analytical support and that this would be competing against other priorities. For those working in neighbourhoods they spoke of ‘maximising’ the use of an analyst, allowing technology to take away some of the burden of basic analytical problems which did not go

beyond a descriptive overview, and allowing them the time to focus on long term or particularly problematic issues. These same inspectors demonstrated an understanding of balancing the need for quick and basic analysis to address immediate, short-term issues with time consuming analysis to understand the drivers, causes and trends of long-standing crime issues, crime series or victims and suspects with extensive police contact.

Austerity measures and the drive for efficiency over the last ten years have impacted on resources and capacity across police forces (Caveney et al., 2020). The effects of reduced funding have been seen in many areas which interconnect and influence the successful use of analysis. Financial support for officer and analyst training has been lacking, and just as Cope (2004) and Ratcliffe (2005) raised, management level officers interviewed in this research commented that the lack of training was still an issue which limited appropriate requests, interpretation and the actioning of analytical products. Also impacted by available finances are the procurement of appropriate technology to improve the efficiency of data cleansing and analysis which would aid the analyst to test hypotheses, understand persistent crime issues and provide actionable intelligence.

Training opportunities and the purchase of equipment is directly impacted when there are limited or no finances available, but there are several actions which are indirectly impacted due to limited resources and capacity. The quality of data captured on police systems falls as those responsible are pressurised for time as they deal with allocated tasks and recording deadlines and quality assurance becomes less of a priority.

As discussed earlier in the chapter, long-term planning and lack of evaluation were noted by inspectors as areas of concern as the demands for reactive policing overshadowed the time and space to understand the consequences of interventions. Inspectors also raised the value of liaison and collaboration with analysts to ensure the most appropriate analytical product was being produced, and the importance of the relationships which they had developed with analysts. The trust built between analysts and inspectors helped them overcome issues in the lack of

understanding of analysis when requesting analytical products, and neighbourhood inspectors acknowledged the change from geographically based to thematically based analysts had reduced their access to analysts. Further research would be required to understand whether this was a real change or a perception of change.

Another aspect influenced by perception were the requests for analysis made by officers who discussed the lack of analysts available to provide analysis. Inspectors implied how they would make their own judgement on the likelihood of being allocated an analyst and thus worth requesting analysis based on the extent of a problem, the level of threat and risk it presented and the perceived competition by other inspectors and departments for analysis. Response inspectors spoke of the inability to respond to analysis due to the demands from incidents and the number of available officers to do so.

Figure 21 diagrammatically represents the impact that limited resources and capacity has on reducing actions which contribute to the quality production and informed use of analysis. It highlights that a reduction in resources and capacity across different operational and support departments within a police force result in a reduction in data quality, officer training, available technology and the training of officers. These in turn influence the quality of analytical products, capacity of analysts and the ability to respond to analytical requests and provide evaluation of police interventions, the time and space for collaboration, long-term planning and ultimately provide a policing response to analytical documents.

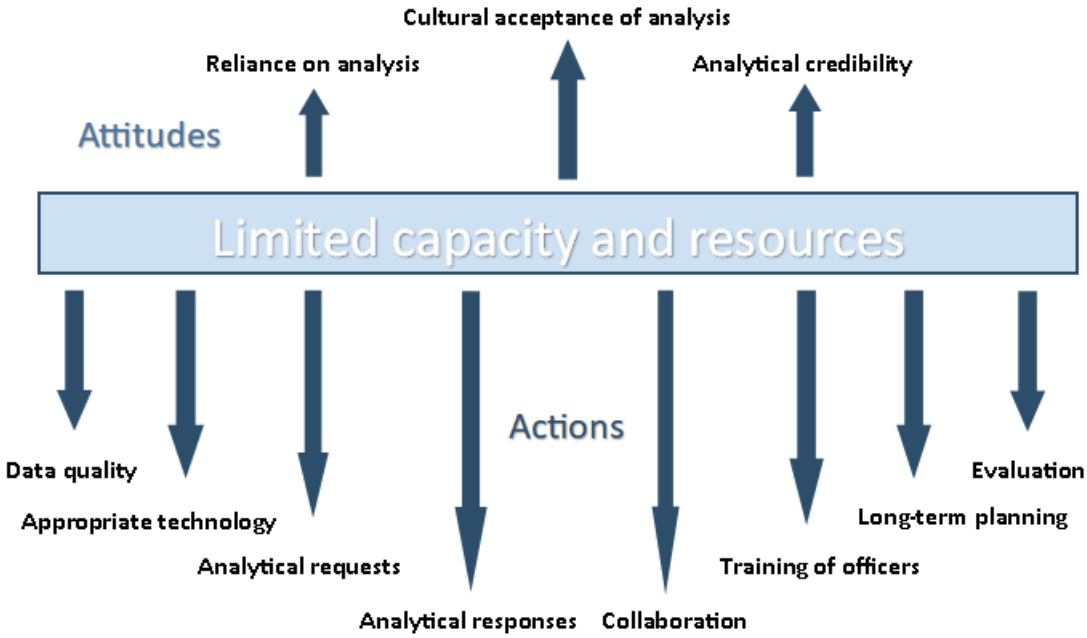


Figure 21: The impact of limited capacity and resources on actions and attitudes.

It could be argued that the limited capacity and resources which have characterised the last ten years have had a positive impact on the attitudes of officers to analysis. The interviews have shown that there is a cultural acceptance of analysis, particularly amongst those of management ranks. This is demonstrated through an expectation, which stems from senior managers, that requests by officers and departments for additional police resources, to address ongoing crime and community problems, will be supported by analysis. Intertwined with this cultural acceptance is the increase in analytical credibility as more officers are exposed to analytical products and can see the benefit that analysis can have in determining where and when to best respond to a problem. As the availability of resources with which a sergeant, inspector or chief inspector can respond is restricted, a need for analysis to determine the most efficient use of staff is required. Justification for additional resources, as already stated becomes an increasing necessity and cultural norm which instils a reliance on analysis.

The officers interviewed within this research indicate that the officer analyst divide has shrunk since the research of Cope (2004), but there are important observations made then that are still

relevant today. The two most important that filter through all aspects of successful analysis are the quality and range of information which products are based on, and the training of officers to task, manage and respond to analysis. Whilst individual and teams of analysts can improve their analytical products through self-learning and continuous professional development, improvements in range and quality of data, and the training of officers, requires commitment from the organisation's leadership team, and to some extent the national organisations with influence over politics and policy.

More positively, Cope stated there was a 'structural difficulty' involving the 'integration of analysis into existing working principles that are embedded in police culture' (Cope, 2004:202), and all officers interviewed demonstrated or implied that analysis was now an integral part of policing.

8 Conclusions and Implications For Practice

This research has examined the value that risk terrain modelling can have in understanding the factors which contribute to locations being at an increased risk to hare coursing and county lines cuckooing, and whether the results of risk terrain analysis are accepted and found to be of use to police officers in Lincolnshire. This closing chapter will summarise the key findings, firstly of the risk terrain analysis for the two crime types and then whether officers perceived it to have value and a practical application. Following from this, will be a review of how this research contributes to academic knowledge and how it can be used to improve professional practice. A summary of limitations and recommendations for future research will follow and the chapter will conclude with recommendations for practice.

The research aimed to answer a series of questions which, when combined, would identify the success or otherwise of the risk terrain modelling approach at identifying areas at significant risk to county lines cuckooing, or to hare coursing in Lincoln and Lincolnshire respectively. Firstly, the locations of hare coursing events and identified addresses of persons previously cuckooed were mapped, and it was determined that both crime types were not randomly distributed and worthy of further investigation to understand what aspects of the geography were influential, positively, or negatively on the locations of these offences.

8.1 Selection Of Risk Factors For Consideration In The Analysis For County Lines Cuckooing

County lines cuckooing offences were considered first. Comparative case analysis of towns in Lincolnshire identified key features of towns which typically facilitated county lines activity. These were a railway station, needle exchange facilities, and most importantly a population greater than 15,000 people. Although railway stations are a strong indicator of county lines activity, the town requires a population of at least 15,000, otherwise, it is unlikely to have county lines activity based in the town. A less dominant indicator was the presence of a homeless shelter.

Further analysis of the information contained within the literature review then identified demographic characteristics which were common in towns nationwide which had county lines activity. T-tests were conducted to determine, which if any of these characteristics were significant for Lincolnshire. The results were combined with officer opinions on contributing factors to the locations of cuckooed properties provided during phase one of the interviews. This was further enhanced by Lincolnshire Police data collected on previously exploited victims of cuckooing. Key characteristics of victims were that they, typically lived alone, and this was probably in a rented flat. Vulnerability factors included mental health issues, drug and alcohol addiction, previous police contact and periods of homelessness. These were all characteristics that were incorporated into the risk terrain analysis.

Census data provided the relevant information on tenure, household size and accommodation type. Support services and their locations were represented by the locations of the services within Lincoln and considered as single entities and as a group. The proximity to the railway station, as the main transport facilitator of young people to work on the county lines was included, and to represent the social network and routine activity of victims' lives, an area which included the main support services, bus station and shops in the city was generated.

Aspects of deprivation were apparent as risk factors in both the manual model and the RTMdx models which was articulated as the Census category ‘constrained city dwellers’ in the RTMdx analysis and as the 10% most deprived output areas in the manual model. Routine activities also feature in both model types, with the generic routine activity area a focus in the manual model, and specific support service locations in the RTMdx results. Finally, the relevance of previous exposure as a risk factor is evident in the manual model, but also in improving the RTMdx analysis results.

8.2 Selection Of Risk Factors For Consideration In The Analysis For Incidents Of Hare Coursing

A similar process of determining which risk factors should be considered for inclusion in the risk terrain analysis for hare coursing was taken as for the county lines cuckooing. During the first phase of interviews, officers, were asked for their opinions on where offences were most likely to take place, and this was supported by an extensive literature review on European brown hares and hare coursing. The literature review combined with officer opinions identified factors which would impact on the habitat of the hares, particularly food preferences, but also the elements of the environment which not only enable hare coursers, but that they actively seek or avoid when committing an offence.

These included proximity to different road types, woodlands, water courses and ditches, the type of crop grown in the field and the level of isolation of the location. Six geographical areas were used to generate models, from county wide to individual districts. The county of Lincolnshire covers a large geographical area and except for Lincoln the analysis covered all the county's districts, and was run at a countywide, and area and district level. This identified the importance of focusing the analysis on specific areas to determine the most appropriate risk factors. Two risk factors were significant at all levels of the analysis, and these were the proximity to junctions and winter wheat fields.

Limiting the geographical extent of the analysis to specific districts allowed the modelling to be more precise and took into consideration the underlying nature of the topography. For example, flat fields were a significant risk factor in the results for the county and for the combined district areas of East and West Lindsey and North and South Kesteven. They were not significant in the resulting models for Boston or South Holland, or the combined area of the two districts. The exclusion of flat fields in the models for Boston and South Holland reflected the nature of the topography of those two areas, which are characterised by wide expanses of flat open farmland

which are ideal for hare coursing. In contrast the more varied topography in the remainder of the county required the specific selection of a flat field, and so it became significant. The districts of Boston and South Holland are the worst affected in terms of annual offences of hare coursing, and the analysis identified proximity to junctions and winter wheat fields, and the density of A roads as significant risk factors for the district of Boston, and this was consistent over the two years the analysis was tested. For South Holland the significant risk factors were identified as proximity to junctions and winter wheat fields, and the density of residential areas, classified roads, and B roads. In the following year this changed slightly, proximity to farms became a significant factor replacing B roads and winter wheat fields.

8.3 Lessons Learnt From Conducting The Risk Terrain Analysis

8.3.1 County lines and hare coursing

The risk terrain analysis identified several points for use in the policing of county lines cuckooing and hare coursing, but also in the wider context of research analysis. Firstly, it identified the importance of threshold population for towns in Lincolnshire to likely experience occurrences of county lines cuckooing, and that if this threshold level was combined with the presence of a railway station this becomes more likely. It also identified the importance of needle exchanges within a town, likely indicative of an active drug market, whilst the presence of homeless shelters, again a key feature in towns with cuckooing, of a likely cohort of vulnerable people for exploitation. Important factors for the location of hare coursing incidents were the proximity to winter wheat crop fields and the high density of road junctions. Winter wheat fields had the ideal topology for hare coursing, whilst the density of junctions represented the accessibility to and from a targeted field. The identification of these characteristics helps to better inform understanding around county lines cuckooing and hare coursing.

8.3.2 Inclusion of a broad spectrum of risk factors, informed by literature and experience

The second point, relevant to the wider aspect of analysis and research in a policing context is the essential requirement for all manner of partnership and third-party data. This was raised by officers from their limited experience of crime analysis, but also from the literature reviews of the crime issues and criminology. It is discussed below the importance of determining all potential contributing factors, but the analysis will fail to meet its potential if data is unavailable to convert the identified factors into data which can be included in the analytical process.

The use of the risk terrain modelling was a new technique to both myself as a researcher, analyst and to the officers involved in the interview process. Developing an understanding of potential

contributing factors involved practitioner knowledge and an extensive literature review but was enriched by the officers who had experience of policing the offence types. Some officers found it easier to consider the situational contexts which could influence the location of offences, but for some this was more difficult and focused on those locations they would police. Combining officer knowledge with that obtained from the literature review allowed for a more rounded list of potential risk factors for use in the analysis. For example, officers ignored some of the risk factors which contributed to a good habitat for hares, as they focused on hare coursing being in large flat fields.

8.3.3 Crime theory and analytical content

Another important area for consideration is the use of crime theory in analysis and in the case of risk terrain modelling environmental criminology as a basis for understanding how the environment and the use of it, by victims and offenders can be incorporated in the analysis. A good basic understanding of the relevant crime theory which is relevant to the crime issue being analysed enables the analyst to identify a broader list of risk factors or interpret what features of an environment should be considered as part of the modelling process. In this research the identification of routine activity areas was important in understanding the locations at risk to cuckooing, whilst road junctions reflected the permeability of a road network and consequently the accessibility of areas for hare coursing.

In 2004 Cope noted that analytical products lacked explanatory content, which Chainey (2012) agreed with, and which Ratcliffe (2008) stated was a reason for analytical products failing to influence decision-making. Chainey also comments that 'if a problem is poorly understood, it makes it difficult to determine which responses will have the most impact' (Chainey, 2012:118), and grounding analysis in criminological theory can help to identify and explain the issues impacting on crime problems. Cope argues that 'recommendations for action logically follow' (Cope, 2004:191) when crime problems are properly understood, but as there remains no

national training requirement for analysts to have knowledge on criminological theory it should be expected that explanatory analysis which provides actionable intelligence will be aspirational and ad hoc in most analysis departments. This stems from a broader issue within police forces and analyst departments, as roles and expectations vary across organisations, therefore the essential skills will also vary (Cope, 2004; Weston et al., 2020) and so the generation of a national skill set, and training program would be problematic.

8.3.4 Improving communication and collaboration

The second phase of interviews identified the blank map as an enabling factor for discussion. Officers interviewed for both crime types, when given a blank map to highlight what they perceived as high-risk areas, better articulated their reasons for selecting or excluding particular locations. This simple request facilitated officers in articulating their opinions, and reasoning, in a far more informative manner than the more abstract act of asking 'what do you think contributes to a location being more at risk? Or why do you think offenders choose these locations? Questioning officers to understand their analytical requirements, background information and what they hope to achieve should be seen as an essential part of all analysis. The use of a visual prompt, in this case a map, was found to be an effective method of accessing officer knowledge.

The importance of initial, followed by ongoing collaboration throughout an analytical task can aid greater understanding of the issues by both the analyst and the officer, but also helps officers to trust and act upon the results of the analysis (Belur & Johnson, 2018; Cope, 2004; Hunter et al., 2019). The significance of collaboration raises the importance of good interpersonal skills required to be an effective analyst (Evens & Kebbell, 2012; Weston et al., 2020).

8.4 Does RTM Have The Capability To Predict Areas At Increased Risk Of Hare Coursing Or County Lines Cuckooing?

The RTMdx analysis was able, when compared with manual analytical models, to successfully identify locations at high risk to future offences of county lines, and incidents of hare coursing. The modelling process, using data from a three-year period allowed for the generation of models with year one and year two data, which were subsequently compared with the actual offence and incident data for year's two and three respectively. This process, generating different models for consecutive years enabled the predictability of the models to be assessed using the PAI scores (Chainey et al. 2008). The manual alternative for county lines was also successful in identifying risks, and, due to the location being considerably smaller, (town compared to districts), was easier to manage and generate manual analysis. In contrast the area covered by the hare coursing incidents was extremely large, and the manual models which were generated were inferior at identifying areas at high risk to future incidents of hare coursing.

The exception to this was the high PAI score of the manual grid model used as an alternative model for hare coursing. It identified areas 300 metres by 300 metres which had had at least one hare coursing incident in the last year. The PAI was particularly high at 52.5 compared to a PAI scores for the most successful RTMdx models, Boston and South Holland of 21.72 and 30.65 respectively. The advantage of the RTMdx was that it not only identified focused areas for police intervention, but also identified those features influencing the locations. The grid model identified areas across wide expanses of countryside, meaning focused intervention would be difficult and some other method of determining intervention locations would be needed to manage the fragmented areas at risk.

A second type of manual model was also generated for comparison with the hare coursing RTMdx analysis, and this considered the risk factors and different combinations of overlapping risk factors which were in proximity to one another. These models were unsuccessful as they

identified too large an overall area for focused activity, and still only produced a maximum PAI score of 2.5.

The RTMdx analysis for residential properties in Lincoln at risk of cuckooing, based on a grid of 150 metres produced a PAI of 4.88. This was improved to a score of 17.83 when filtered by locations within 100 metres of previously cuckooed addresses. Combining the RTMdx with prior exposure resulted in identification of an area of less than 5% of residential properties which were at significant risk at the 95% level to future cuckooing by county lines drug dealers. The RTMdx results were combined with a 150 metres exposure layer but was not as successful. Likewise, RTMdx models were created using 50 metres and 100 metres grids and these were also less successful at determining locations at significant risk to future incidents, based on the PAI scores. The RTMdx model determined to be the most appropriate was based on a 150-metre grid and identified two risk factors, both of which were based on proximity. The most influential was the proximity to areas of the Census category of 'constrained city dweller' effective to 300 metres for the relevant output areas and contributed a relative risk score of 23.03. The other influential factor was the location of the Probation Service offices, at up to 1200 metres and had a relative risk value of 7.43.

The manual model results for cuckooing identified those areas at an increased risk, which were the co-located areas of 10% most deprived census output areas, within 400 metres of the routine activity area and areas with mean plus one standard deviation from the mean of socially rented properties, flats or single households, all of which were also within 150 metres of previous incidents. This identified an area of less than 1% of residential properties which were at high risk of future cuckooing and a PAI of 26.27 for 2021.

8.5 Officers Understanding Of The Analysis, And Identification Of Practical Value In The Results.

When compared with the manual models for determining areas at future risk of offences of both hare coursing and county lines, the RTMdx can be seen as an improved alternative to the manual models in terms of the overall PAI score, the extent of geographic area identified as at risk, and the identification of contributory risk factors. However, the second aspect of the research question concerned whether police officers, whose area the analysis had been conducted in, saw value in the results, and not only that, but could see how they could or would make practical use of them.

Through the interview process an understanding of the participants perception of analysts and analysis was found to be positive, and those of higher rank and greater experience, particularly in neighbourhood policing had a greater understanding of analysis and products. All officers were accepting of the RTMdx results but were challenged, and challenging, regarding the inclusion of some aspects of the risk factors. Through discussions relating to the generation of the models, officers were accepting of the results, more so for the officers in management roles (N Insp A, N Insp B and Ch Insp). Regardless of the suspicion shown by a small number of the participants (PC and Sgt B) this did not detract from them identifying how they could put the analysis into practical use.

An obvious benefit was to aid the planning of officer patrols, hot spot policing or the identification of pinch points for the positioning of roads policing units. One inspector identified that it had the benefit of identifying at risk areas which were otherwise unknown and could be subject of underreporting. Others saw how the analysis could be replicated for other crime types. The analysis was also seen as a method to demonstrate the legitimacy for police action or intervention, to both colleagues and partner agencies, and the potential benefit it could give in evaluating interventions was also acknowledge by inspectors.

The most important aspect of the analysis appeared to be that the RTMdx confirmed their existing knowledge and challenged them to see how their own reasoning as to why an area was at risk, was reflected in the RTMdx. This in turn facilitated the acceptance of the other locations that the analysis had determined as at significant risk to future offences and linked in with an understanding of why areas were at risk. The RTMdx, through the identified risk factors and the corresponding relative risk values went a long way towards this, but it was also the contextual knowledge that officers had regarding these areas, that enriched the understanding of 'why' in relation to the risk factors. For example, officers could understand from the RTMdx model that a location was more at risk to being cuckooed if it was in a location with high levels of single occupant, rented flats. But their contextual knowledge, and that of the analyst researching this issue, contributes in part to understanding the underlying factors of *why* a single person living in rented accommodation would be more suspectable to cuckooing victimisation. The understanding of why a location is at risk identified by the model provides the basis for prioritisation of intervention, whilst the contextual knowledge of officers and analysts from research and professional knowledge provide the insight for determining the appropriate intervention.

The RTMdx modelling is a process akin to the 'Scan, Analyse, Respond, Assess' model. First a problem is identified and researched to identify potentially contributing risk factors, second comes the RTMdx analysis which identifies those significant areas at future risk, and those contributing risk factors. A response is determined considering the significant locations identified, the significant risk factors and the context from the scanning phase, which determined their inclusion within the analysis phase. Finally, the assessment or evaluation of the intervention completes the cycle by repeating the RTMdx analysis phase to identify if risk levels have been reduced, eliminated, or replaced.

The research demonstrated that officers valued the RTMdx approach and its advantages over other spatial analysis to understand 'why'- the contextual influences of why crime was

concentrating at places. It also highlighted the importance of communication, and strong working relationships with analysts. The opinions of officers demonstrated that a trusting relationship between officers and analysts, and continued positive communication, could overcome many of the identified factors (identified in the extant literature) limiting the effective use of analysis. This relationship was something that many of the inspectors interviewed had experienced, and valued, and had found led to improved tasking, which in turn facilitated tailored analysis and results to address specific crime or community safety issues. Through collaboration and mutual understanding, for the duration of the analytical process, commissioning officers and analysts can be enabled to jointly identify and co-produce actionable intelligence, which should be the goal of all analysts.

8.6 Contribution To Research

8.6.1 Risk terrain analysis as an evidence-based tool

In concluding their systematic review, Marchment and Gill (2021) acknowledge that RTM is still an emerging method and further research is required to understand the specific crimes and contexts in which the method should be applied. This research provides some evidence that the technique can be used for two very different crimes, and in the rural contexts of a small city in a rural county, and within a distinctly rural area to determine risk of a very rural crime type, hare coursing.

Although this research did not use the kernel density method for incorporating exposure areas advocated by Caplan et al. (2020), it does provide further evidence for the inclusion of exposure and vulnerability when considering areas most at risk to future offences.

Officers, where possible, were interviewed via a two-stage process. The first interview focused on understanding their experience of analysis and gleaning information about the two crime types which they believed were relevant in where the offences occurred. The second phase commenced by showing the officers a blank map of the analysed area and asked them to mark on where they believed offences took place. I feel that this approach had two benefits and was not an approach that I had come across during the lead up to the interviews. The first benefit was that all the officers were more articulate about the crime type, describing why they were identifying locations as vulnerable, or previously targeted. The information gained was both more descriptive and beneficial for determining risk factors that should be considered in the RTM analysis.

The second benefit was that it focused their attention on why areas were vulnerable and, when presented directly after with a map of the RTMdx analysis, could make direct comparisons with their current knowledge, allowing their assumptions to be challenged in a non-confrontational manner which was led by the interviewee. They were open to discussing why areas were at risk

and others were not. This two-stage approach provided a process for inclusion and valuing of officer opinions, and those involved in both stages appeared to be more receptive to the analytical results than those who only took part in phase two.

8.6.2 The two-stage interview approach and the benefit of a map as a visual prompt for discussion

This two-stage method of interviewing could have great potential for both academic researchers and practitioners, if the visual prompt of a map used for identifying areas is utilised on the first round of interviews, or during the development of a terms of reference for practitioners, and then referred to in the second stage, or when considering the analytical results. I feel this will lead to more successful co-operation between analysts or researchers and commissioning officers, a clearer understanding of the experiential knowledge officers bring, and consequently greater understanding and acceptance of the results. These expectations are also an area which future research could test using a larger and more varied officer sample.

8.6.3 Analytical practice

As discussed above the research identified two clear practical contributions to analytical practice:

1. the success of the risk terrain model with a lower crime concentration than previously tested, in a larger non-urban environment and unique crime types.
2. The use of a map, or other visual cue to facilitate officers to articulate their knowledge and understanding and aid the officer-analyst interaction.

A third practical implication of the research was that officers required concise and simple documents when being presented with analysis, and in support of previous research (Belur & Johnson, 2018; Cope, 2004) the greater the trust in the analyst and the analytical techniques used, the more accepting of the analysis, and the less detail was required in analytical documents. In agreement with the findings of Ratcliffe (2010) the officers interviewed (predominantly

inspectors) found lengthy documents detracted from the message they were trying to convey. Overall, analytical documents should portray findings in a clear, user-friendly manner, with relevant and useful information (Bullock, 2013; Fyfe & Wilson, 2012; Lum et al., 2012), and as most analysis has a geographical element include the visual and contextual prompt of a map.

But the research also supported the findings of previous researchers in that problems remain around the understanding of analysis and analytical products (Belur & Johnson, 2018, Cope, 2004; Chainey, 2010; Ratcliffe, 2004 & 2005; Willis et al., 2007) with those most likely to be using analysis, management cops and first line supervisors (Boba Santos & Taylor, 2014) requiring training for organisations to see maximum benefits from analysis and analytical products (Burcher & Wheelan, 2018).

8.6.4 An end to cultural resistance?

Earlier research on the acceptance of analysts and analysts' products identified a cultural resistance from officers in preference of experiential knowledge and street craft (Brown & Ballucci, 2022; Bullock, 2013; Cope, 2004; Lum at al., 2012; Palmer et al., 2019; Willis et al., 2007) to research and analysis. This research has provided some evidence, predominantly from management cops that analysis is not only accepted, but welcomed by officers to support resource allocation, evidence the need for additional resources and understand crime issues. One of the arguments put forward within this research is that one of the contributing factors to this cultural shift has been the impact of austerity measures on police forces. Chapter seven presents that argument from the perspective of limited capacity and resources hindering the tangible actions which can improve analytical quality, including data quality, training of officers, evaluation and the number of requests for analysis. In contrast the less tangible attitudes and opinions towards analysis have been improving, as officers interviewed demonstrated reliance on analysis, a cultural acceptance as part of normal policing, and that to those interviewed it provided credible information that they trusted to aid decision making. Another contributing factor to this

cultural shift has been raised in the contemporary research of Bacon et al., 2023 and O' Connor et al., 2022. They propose that this cultural shift is due to the lack of experiential street craft of officers. In the case of the officers who were interviewed for the research, all were experienced officers, and only one was a police constable, consequently no supporting evidence was found in this research to support a lack of street craft in officers. However, during this research I have become more aware of the use of street craft in colleagues who are police constables, and the difference in attitudes of experienced constables versus those with only a few years' experience, and this would certainly be a valuable area for future research.

8.7 Limitations

Police recorded crime is not a true representation of actual crime (Maguire & McVie, 2017; Torrente et al., 2017) and rural crime is no exception. Inaccurate numbers of officially recorded crimes underestimate both the type and extent of rural crime (Morris et al., 2019) and reinforce the perception of a crime free rural, additionally they undermine the quality of data for use in analytical products. Underreporting crime has several practical consequences. Legislation, policies, and practice are informed by the experiences and reports of victims and witnesses; budget decisions are influenced by crime trends, severity, and public perception (Hardy, 2019; Torrente et al., 2017). Underreporting crime has an impact on the ability of analysts to understand the issues facing communities and challenges the factual nature of crime hotspots. The ability to understand the variety of criminal threats to the countryside and its residents is also vastly diminished, along with expectations of prevention and prosecution opportunities.

An important limitation and consideration in interpreting these results is the under reporting of crime, or the potential for bias in reporting of incidents or offences. MacDonald (1998) concluded from his research using the British Crime Survey that 'incidents involving loss have a much higher probability of being reported' and that there is a 'significant negative association between drug use and reporting crimes' (MacDonald 1998:14). Despite his research focus on burglary offences the implications are likely transferable to this research context. Hare coursing activity in which the farmer avoids loss or damage would be less likely to come to police attention. Likewise, those persons subjected to cuckooing activities of out-of-town dealers are typically vulnerable. This vulnerability is often linked to substance abuse. Consequently, the identification of individuals subject to cuckooing is likely to be underreported and reliant on policing activities or concerns raised by third parties not directly involved. Hardy (2019) supports these assertions by MacDonald (1998) and argues that underreporting of crime is a significant issue across society, with victims' decision's not to report crime as 'multifaceted and fluid' (Hardy, 2019:316). Torrente et al. (2017)

also support Hardy (2019) and add that geographical variations also add to this complexity. They found community drug problems can influence the level of reporting; community cohesion and confidence in police effectiveness can incentivise crime reporting as can community policing models (Schneby 2008 in Torrente et al. 2017). Lincolnshire Police's response to hare coursing is Operation Galileo. Officers interviewed perceived that hare coursing was most problematic in the south of the county, it is therefore possible that residents have a greater sense of police effectiveness in the south as they see firsthand, and via media reports the effectiveness of the Galileo team and consequently report more incidents.

Data limitations also occur across the research due to the availability of reliable and up to date demographic information and point level data. The research relies on Census 2011 data as the most consistent robust data for demographic information, all be it now over ten years out of date. The data is also only available at an aggregated level with the implications of potential ecological fallacy arising from modified areal unit problems (Weisburd et al., 2009) or to change the outcome of the analysis (Fotheringham & Wong, 1991; Openshaw, 1977). Research has been undertaken to identify the most reliable and time appropriate data for the research, including the level of aggregation based on the issues under analysis. It is acknowledged that the models would likely be improved with point level data particularly in terms of property type, tenure, ownership, and occupancy in the county lines research. Within the hare coursing models the confirmation of actual location of incidents and crop type at the time of the incident would also assist in improving the model.

Despite these limitations, the police are under an obligation to prevent and detect crime utilising the data, information and intelligence which is available. In many respects the data availability in this research reflects day-to-day data availability for the majority of crime analysts, me included.

8.8 Future Research

This research considered the views of police officers, with a bias towards those of management level. Further research could consider whether there is a distinct difference between 'management cops' and 'street cops'. The literature on police culture highlights that there is a distinction, and there is still a dominant theory that street cops are reliant on their experience and craft when determining what or who to listen to (Brown & Ballucci, 2022; Flemming & Rhodes, 2018; Heyer, 2022).

During this research I have become mindful of the differing cultural approaches of the officers I work with. Alongside this has grown an awareness of experienced 'street cops' voicing opinions on lesser experienced officers, lacking or afraid to use, 'street craft skills'. Future research can not only consider whether this is the case, but also whether this is a significant factor in determining officers use of analysis such as risk terrain modelling. If officers do not have the experience of street craft, or policing demands are leading to a reactive force which only goes to where they are told to respond, are they reliant on analysis in a way officers patrolling the street five- or ten-years prior were not? I feel it would also be beneficial in identifying whether those with greater levels of street craft, are better at determining those risk factors for consideration in risk terrain analysis.

An unexpected finding encountered in the hare coursing analysis was the impact of large changes in the number of target offences. The research identified that when the number of offences dramatically increased from the data used to generate the RTMdx then the PAI scores would be negatively influenced. It is recommended that further research be conducted to specifically understand the impact that large variations in the number of target offences has on the PAI scores and whether this also impacts on the relative risk values of those significant risk factors.

A final consideration for future research would be to develop a method of incorporating social networks within a risk terrain analysis. Officers raised the notion of a facilitator type person, a

member of the local drug using community who helped county lines to locate addresses to cuckoo. This person was a common link between groups of users and differing county lines or out of town dealers which could mean those connected to this individual are more likely to be cuckooed.

8.9 Recommendations For Practice

The process of conducting this research, and the results of the analysis, have raised several areas for enhancement in analytical practice, which can be implemented by individuals. However, for greater and sustained improvement, issues require institutional investment of finances and attitude in analysis and analysts to drive and improve tactical, strategic, and operational requirements and responses through actionable analysis. The remainder of this section details key recommendations arising from this research.

8.9.1 Increased analytical capacity

The literature review and the officer interviews identified and confirmed the importance of interaction of analysts with police officers, particularly those requiring analytical products. The availability and capacity of analysts was an issue raised, particularly by inspectors, who wanted to engage with the analysts but cited the limited numbers as something which often made this difficult. They commented on the importance of building professional relationships with analysts and how this facilitated appropriate requests for support. Inspectors, during the interviews, acknowledged the benefits of analytical insight but that capacity, and time required for detailed analysis, led to comprises on the types of analytical products or support they would request. Increasing the capacity of analysts, whether through an increase in numbers, or freeing up time to focus on analytical products and tasks, has the potential to improve relationships, leading to better tasking, and more effective analytical products which then generate actionable intelligence.

8.9.2 Training on crime theory and the development of interpersonal skills for analysts

The importance of crime theory in understanding crime distribution and crime issues is fundamental to examining and testing inferences in order that analytical products are explanatory and move beyond the descriptive, an enduring criticism of analytical products. This research has

highlighted the importance officers utilising analysis place on understanding the 'why': why does it occur at this location, why are these people victimised, why does it occur at this time as opposed to another? The research has also demonstrated how the integration of crime theory into the design, data gathering, inference testing and analysis of the risk terrain analysis has enabled a more thorough generation and assessment of potential risk factors for each of the risk terrain models. The result of which enabled the identification of risk factors which significantly contribute to why offences were occurring where they were.

Unfortunately, crime and intelligence analyst training and recruitment are variable, depending on organisation and perceived role of the analyst. There is no standard prerequisite knowledge on crime science or criminology for appointed analysts and no specific standard training on employment. As the move towards developing pracademics in policing, analysts are in an ideal position from their insider status to develop into this role and embrace a greater level of evidence-based and inference testing analysis. However, this will require a commitment and support from the College of Policing to devise or promote training programs and for police forces to utilise the expertise of analysts.

Collaboration between officers and analysts has been shown to have multiple benefits. Collaboration builds trust and knowledge and provides officers with improved knowledge on analytical products, an awareness of the potential array of analytical options and the empowerment to discuss their requirements with analysts. Consequently, the tasking provided to analysts allows the analyst to target the analysis and presentation of the results to meet the needs of the commissioning officer. This improved tasking becomes an iterative process, officers are provided with products they can make use of, meets their needs in terms of content and presentation and leads to further requests and discussions.

Collaboration, as an ongoing aspect of the analytical process has been shown to enrich research in general and more specifically within this research identify potential risk factors to test in the

modelling process and aid the interpretation of the results. There was also some indication that those officers who were involved in both phases of the interviews had a greater level of acceptance to the analysis, which is as expected from previous academic research. The implication of the need for collaboration is that analysts need to develop good interpersonal skills with a range of officers, of all ranks. They need to build and maintain trust, convey confidence in their ability and the analytical processes they use whilst being open and approachable.

It is recommended that analysts are provided with training and support to develop and maintain interpersonal skills to build lasting, productive professional relationships with all ranks of officers. It is also recommended that analysts be provided with training to develop knowledge and understanding of crime theory in both a theoretical and practical sense in order that they can provide greater explanatory insights within the analysis they produce. Finally, it is recommended that the College of Policing under the remit of professionalising the police service identify and promote nationally recognised training and qualifications that can provide the knowledge and professional legitimacy for analysts to become the pracademics which the evidence-based rhetoric advocates.

8.9.3 Training on analytical products to 'management cops'

Officers receive training on the policing skills, but there is very little evidence of training in relation to analysis and analytical products. The officers which featured in this research had gained their knowledge through experience and interaction with analysts. It is recommended that as part of continued professional development of officers of inspector rank and above, they be given training on the most common analytical products in order that they can understand the types of analysis which are available, and the most appropriate scenarios for analytical products. Educating officers in management roles, and those likely to require analysis to support problem solving, should include local practices and policies for requesting and commissioning analysis, various types of analytical products and the types of results which could be expected. There

should be an emphasis on the two-way communication process between requesting officer and analyst for the generation of a terms of reference for analysis, a focus on the questions to be answered by the analysis and ultimately what the officer aims to achieve because of the analysis. Finally, officers should be given support to understand how the analysis answers their specific questions and how they then interpret and utilise the results.

8.9.4 Integrate analysts within problem solving hubs

Analysis has the potential to support a range of policing practices, particularly problem orientated policing, the SARA model and in evidence-based practice. A key area of analysis is the problem profile, and the frequency of requests for problem profiles (from personal experience), has diminished over the years. Integrating analysts with problem solving hubs will allow a rounded approach to tackling medium to long term issues, analytical techniques can aid the understanding of issues, such as the examples of hare coursing and county lines cuckooing in this research. Analysis can also provide opportunities to understand the extent or change in problems to assess whether an intervention has been successful.

8.9.5 Promote the importance of data quality and availability

The use of quality data within analysis is paramount to maximise the benefit and ensure the results are based on accurate information. It is vital that organisations demonstrate the value of accurate and complete data through their cultural expressions of what is valued and important. Resourcing, tactical and operational decisions are made on the information and data collected, stored and analysed within forces. Data quality should be promoted by senior leaders, and its value understood and permeated to all officers and staff.

The literature review and officer opinions highlighted that the wider the range of data incorporated into analysis, the better a problem could be understood. Problems encountered by police or put forward for analysis are not the sole responsibility of the police service to resolve. Many issues require an understanding, or an interpretation of a complex range of social,

demographic, economic, health, crime, and geographical influences that only a partnership approach can solve. It is recommended that there are mandatory data sharing agreements between government agencies and bodies to ensure all aspects of situational and demographic factors can be considered in analytical hypotheses and testing. Additionally, specialised data sets should be more readily available including, but not exclusively mapping data, social demographics, health, education, and environmental data.

8.9.6 Investment in specialist technology

This research utilised the RTMdx software. The software is not currently widely used in the United Kingdom, despite the systematic review of Marchment and Gill (2021) confirming the value of the technique in several policing contexts. This research has demonstrated the positive value it can have in less traditional contexts. The literature review raised that analysts can often be limited in their work by available technology which not only constrains their ability to provide actionable intelligence, but also, to go beyond the descriptive. Inspectors interviewed valued the interpretation analysts could provide to understanding the 'why' of a crime issue and providing appropriate analytical tools for analysts should be as important as providing the correct radios or tasers for operational officers. If analysis is at the heart of intelligence led policing, determining priorities, directing on resource allocation, as designated twenty-years ago in the National Intelligence Model, then it should follow that the analytical tools should be fit for this demanding and challenging purpose.

It is recommended that specialist software, such as RTMdx which has been identified as beneficial, is made available for analysts and that the necessary training and ongoing continuous professional development is provided to ensure that analysts can keep pace with changing technology, research, and crime issues to provide the most appropriate analytical products to drive operational, tactical, and strategic decision making.

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Accommodation type - Households [GeoPackage geospatial data], Scale 1:2500, Tiles: GB, Updated: 27 March 2011, ONS, Using: EDINA Society Digimap Service, <https://digimap.edina.ac.uk>, Downloaded: 2021-08-26 21:18:15.904

Boundary-Line™ [SHAPE geospatial data], Scale 1:10000, Tiles: GB, Updated: 9 April 2021, Ordnance Survey (GB), Using: EDINA Digimap Ordnance Survey Service, <https://digimap.edina.ac.uk>, Downloaded: 2021-08-26 21:10:15.14

Census 2011 English and Welsh census data sourced from: https://www.ons.gov.uk/ under OGL v3. https://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/

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England Agricultural Census 2010 [SHAPE geospatial data], Scale 1:10000, Tiles: GB, Updated: 30 June 2010, DEFRA, Using: EDINA Agcensus Digimap Service, <https://digimap.edina.ac.uk>, Downloaded: 2021-08-26 21:14:22.314

GB Woody Linear Features Framework [FileGeoDatabase geospatial data], Scale 1:50000, Tiles: GB, Updated: 7 November 2016, CEH, Using: EDINA Environment Digimap Service, <https://digimap.edina.ac.uk>, Downloaded: 2021-08-26 20:35:07.667

GB Woody Linear Features Framework [FileGeoDatabase geospatial data], Scale 1:50000, Tiles: GB, Updated: 7 November 2016, CEH, Using: EDINA Environment Digimap Service, <https://digimap.edina.ac.uk>, Downloaded: 2021-12-04 16:21:48.498

Household composition [GeoPackage geospatial data], Scale 1:2500, Tiles: GB, Updated: 27 March 2011, ONS, Using: EDINA Society Digimap Service, <https://digimap.edina.ac.uk>, Downloaded: 2021-08-26 21:18:15.904

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Occupancy rating [GeoPackage geospatial data], Scale 1:2500, Tiles: GB, Updated: 27 March 2011, ONS, Using: EDINA Society Digimap Service, <https://digimap.edina.ac.uk>, Downloaded: 2021-08-26 21:18:15.904

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OS MasterMap Highways Network [FileGeoDatabase geospatial data], Scale 1:2500, Tiles: GB, Updated: 26 March 2019, Ordnance Survey (GB), Using: EDINA Digimap Ordnance Survey Service, <https://digimap.edina.ac.uk>, Downloaded: 2021-08-27 18:32:15.655

OS MasterMap® Topography Layer [GeoPackage geospatial data], Scale 1:1250, Tiles: GB, Updated: 6 August 2020, Ordnance Survey (GB), Using: EDINA Digimap Ordnance Survey Service, <https://digimap.edina.ac.uk>, Downloaded: 2021-08-27 17:52:00.959

OS Terrain 5 [SHAPE geospatial data], Scale 1:10000, Tiles: se70ne,se70se,se71ne,se71se,se72ne,se72se,se80ne,se80nw,se80se,se80sw,se81ne,se81nw,se81se,se81sw,se82ne,se82nw,se82se,se82sw,se90ne,se90nw,se90se,se90sw,se91ne,se91nw,se91se,se91sw,se92ne,se92nw,se92se,se92sw,sk73ne,sk73se,sk74ne,sk74se,sk75ne,sk75nw,sk75se,sk75sw,sk76ne,sk76nw,sk76se,sk76sw,sk77ne,sk77nw,sk77se,sk77sw,sk78ne,sk78nw,sk78se,sk78sw,sk79ne,sk79nw,sk79se,sk79sw,sk80ne,sk81ne,sk81nw,sk81se,sk81sw,sk82ne,sk82nw,sk82se,sk82sw,sk83ne,sk83nw,sk83se,sk83sw,sk84ne,sk84nw,sk84se,sk84sw,sk85ne,sk85nw,sk85se,sk85sw,sk86ne,sk86nw,sk86se,sk86sw,sk87ne,sk87nw,sk87se,sk87sw,sk88ne,sk88nw,sk88se,sk88sw,sk89ne,sk89nw,sk89se,sk89sw,sk90ne,sk90nw,sk90se,sk90sw,sk91ne,sk91nw,sk91se,sk91sw,sk92ne,sk92nw,sk92se,sk92sw,sk93ne,sk93nw,sk93se,sk93sw,sk94ne,sk94nw,sk94se,sk94sw,sk95ne,sk95nw,sk95se,sk95sw,sk96ne,sk96nw,sk96se,sk96sw,sk97ne,sk97nw,sk97se,sk97sw,sk98ne,sk98nw,sk98se,sk98sw,sk99ne,sk99nw,sk99se,sk99sw,ta00ne,ta00nw,ta00se,ta00sw,ta01ne,ta01nw,ta01se,ta01sw,ta02ne,ta02nw,ta02se,ta02sw,ta10ne,ta10nw,ta10se,ta10sw,ta11ne,ta11nw,ta11se,ta11sw,ta12se,ta12sw,ta20ne,ta20nw,ta20se,ta20sw,ta21nw,ta21se,ta21sw,ta30ne,ta30nw,ta30se,ta30sw,ta31sw,ta40sw,tf00ne,tf00nw,tf00se,tf00sw,tf01ne,tf01nw,tf01se,tf01sw,tf02ne,tf02nw,tf02se,tf02sw,tf03ne,tf03nw,tf03se,tf03sw,tf04ne,tf04nw,tf04se,tf04sw,tf05ne,tf05nw,tf05se,tf05sw,tf06ne,tf06nw,tf06se,tf06sw,tf07ne,tf07nw,tf07se,tf07sw,tf08ne,tf08nw,tf08se,tf08sw,tf09ne,tf09nw,tf09se,tf09sw,tf10ne,tf10nw,tf10se,tf10sw,tf11ne,tf11nw,tf11se,tf11sw,tf12ne,tf12nw,tf12se,tf12sw,tf13ne,tf13nw,tf13se,tf13sw,tf14ne,tf14nw,tf14se,tf14sw,tf15ne,tf15nw,tf15se,tf15sw,tf16ne,tf16nw,tf16se,tf16sw,tf17ne,tf17nw,tf17se,tf17sw,tf18ne,tf18nw,tf18se,tf18sw,tf19ne,tf19nw,tf19se,tf19sw,tf20ne,tf20nw,tf20se,tf20sw,tf21ne,tf21nw,tf21se,tf21sw,tf22ne,tf22nw,tf22se,tf22sw,tf23ne,tf23nw,tf23se,tf23sw,tf24ne,tf24nw,tf24se,tf24sw,tf25ne,tf25nw,tf25se,tf25sw,tf26ne,tf26nw,tf26se,tf26sw,tf27ne,tf27nw,tf27se,tf27sw,tf28ne,tf28nw,tf28se,tf28sw,tf2

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OS Terrain 5 [ASC geospatial data], Scale 1:10000, Tiles: se80se,se80sw,se90ne,se90nw,se90se,se90sw,sk74ne,sk75ne,sk75se,sk76ne,sk76se,sk77ne,sk77se,sk78ne,sk78se,sk79ne,sk79se,sk81ne,sk82ne,sk82se,sk83ne,sk83nw,sk83se,sk83sw,sk84ne,sk84nw,sk84se,sk84sw,sk85ne,sk85nw,sk85se,sk85sw,sk86ne,sk86nw,sk86se,sk86sw,sk87ne,sk87nw,sk87se,sk87sw,sk88ne,sk88nw,sk88se,sk88sw,sk89ne,sk89nw,sk89se,sk89sw,sk90ne,sk90nw,sk90se,sk91ne,sk91nw,sk91se,sk91sw,sk92ne,sk92nw,sk92se,sk92sw,sk93ne,sk93nw,sk93se,sk93sw,sk94ne,sk94nw,sk94se,sk94sw,sk95ne,sk95nw,sk95se,sk95sw,sk96ne,sk96nw,sk96se,sk96sw,sk97ne,sk97nw,sk97se,sk97sw,sk98ne,sk98nw,sk98se,sk98sw,sk99ne,sk99nw,sk99se,sk99sw,ta00ne,ta00nw,ta00se,ta00sw,ta10ne,ta10nw,ta10se,ta10sw,ta11se,ta11sw,ta20ne,ta20nw,ta20se,ta20sw,ta21se,ta21sw,ta30ne,ta30nw,ta30se,ta30sw,ta31sw,ta40sw,tf00ne,tf00nw,tf00se,tf00sw,tf01ne,tf01nw,tf01se,tf01sw,tf02ne,tf02nw,tf02se,tf02sw,tf03ne,tf03nw,tf03se,tf03sw,tf04ne,tf04nw,tf04se,tf04sw,tf05ne,tf05nw,tf05se,tf05sw,tf06ne,tf06nw,tf06se,tf06sw,tf07ne,tf07nw,tf07se,tf07sw,tf08ne,tf08nw,tf08se,tf08sw,tf09ne,tf09nw,tf09se,tf09sw,tf10ne,tf10nw,tf10se,tf10sw,tf11ne,tf11nw,tf11se,tf11sw,tf12ne,tf12nw,tf12se,tf12sw,tf13ne,tf13nw,tf13se,tf13sw,tf14ne,tf14nw,tf14se,tf14sw,tf15ne,tf15nw,tf15se,tf15sw,tf16ne,tf16nw,tf16se,tf16sw,tf17ne,tf17nw,tf17se,tf17sw,tf18ne,tf18nw,tf18se,tf18sw,tf19ne,tf19nw,tf19se,tf19sw,tf20ne,tf20nw,tf20se,tf20sw,tf21ne,

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Output Area Classification [GeoPackage geospatial data], Scale 1:2500, Tiles: GB, Updated: 27 March 2011, ONS, Using: EDINA Society Digimap Service, <https://digimap.edina.ac.uk>, Downloaded: 2021-08-26 21:18:15.904

Social grade - Household reference person [GeoPackage geospatial data], Scale 1:2500, Tiles: GB, Updated: 27 March 2011, ONS, Using: EDINA Society Digimap Service, <https://digimap.edina.ac.uk>, Downloaded: 2021-08-26 21:18:15.904

Tenure [GeoPackage geospatial data], Scale 1:2500, Tiles: GB, Updated: 27 March 2011, ONS, Using: EDINA Society Digimap Service, <https://digimap.edina.ac.uk>, Downloaded: 2021-08-26 21:18:15.904

UKBuildings [SHAPE geospatial data], Scale 1:5000, Tiles: GB, Updated: 1 March 2021, Verisk/Geomni, Using: EDINA Geomni Digimap Service, <https://digimap.edina.ac.uk>, Downloaded: 2021-08-27 18:29:43.954

UKBuildings [SHAPE geospatial data], Scale 1:5000, Tiles: GB, Updated: 1 September 2021, Verisk/Geomni, Using: EDINA Geomni Digimap Service, <https://digimap.edina.ac.uk>, Downloaded: 2022-01-23 14:08:00.136

UKLand [GeoPackage geospatial data], Scale 1:10000, Tiles: GB, Updated: 6 October 2020, Verisk/Geomni, Using: EDINA Geomni Digimap Service, <https://digimap.edina.ac.uk>, Downloaded: 2021-08-26 21:23:48.527

Associated Digital Object Identifiers:

DOI for Land Cover Map 2019 (land parcels, GB): Morton, R. D.; Marston, C. G,; O'Neil, A. W.; Rowland, C. S. (2020). Land Cover Map 2019 (land parcels, GB). NERC Environmental Information Data Centre. https://doi.org/10.5285/44c23778-4a73-4a8f-875f-89b23b91ecf8

11 Appendices

11.1 Appendix 1: Ethics approval.

Keele UNIVERSITY

Keele University HumSS Faculty Research Ethics Committee
humss.ethics@keele.ac.uk

8 April 2021

Dear Hayley Fox,

Project Title:	Is there value in a "risk terrain" analytical approach and can it have a practical application in reducing rural crime in Lincolnshire?
REC Project Reference:	HU-210110
Type of Application	Main application

Keele University's Faculty of Humanities and Social Sciences Research Ethics Committee reviewed the above project application.

Provisional Opinion
The Committee is unable to give an ethical opinion on the basis of the information and documentation received so far. Before confirming its opinion, the Committee requests that you provide the further information set out below.

Authority to consider your response and to confirm the Committee's final opinion has been delegated to the Chair.

Further information or clarification required

Your application is fine - I don't foresee any ethical problems; however, I do need a bit more information.

I'm also checking whether there is any requirement to store Keele research data on Keele servers - because of annual leaves I won't have a response on this until next week (when I myself will be on annual leave). While we're waiting on that please can you update the following:

What about the transcripts – where are you holding those?

What is the relevance of the number plate recognition software – how are you using this (it's not clear from the application form if you are pursuing this at all, as all the information seems to be about interviewing officers).

If you are using this, could you explain for what purpose, and do you have or need consent?

On the consent form – it's not the Student Ethics Committee, please update this.

Do you want to ask for consent for using quotes?

And perhaps you need something on the consent form about anonymity to make clear they understand they are being anonymised. Your call.

I'll be able to respond to you as soon as I get back from leave.

Please submit revised documentation in accordance with ***Applying for Faculty Research Ethics Committee Review (HumSS-FREC)*** (UREC-SOP20). Revised documentation should include, where appropriate, tracked changes, underlining or otherwise highlighting changes which have been made, including revised version numbers and dates. You do not have to make any changes to the HumSS-FREC Application Form unless you have been specifically requested to do so by the HumSS-FREC.

The revised application should be submitted as soon as possible.

Documents reviewed
The documents reviewed were:

Document	Version	Date
Ethics particpant form V5 Student 18019453 - Hayley Fox	1	08/04/2021
humss-frec-application-form v5 student 18019453 - Hayley Fox	1	08/04/2021

Yours sincerely,

Professor Helen Parr
Chair

Fw: Hayley Fox ethics application

Philip Catney <p.j.j.catney@keele.ac.uk>
Fri 07/05/2021 11:09
To:Hayley Fox <h.y.fox@keele.ac.uk>
Cc:Helen Wells <h.m.wells@keele.ac.uk>

Hi both,

FYI.

Best wishes

Phil

From: Helen Parr <h.parr@keele.ac.uk>
Sent: 07 May 2021 11:08
To: Philip Catney <p.j.j.catney@keele.ac.uk>
Cc: Tracey Wood <t.wood@keele.ac.uk>
Subject: Re: Hayley Fox ethics application

Hi Phil,
Thanks - I am sure I okayed Hayley's application after she clarified a couple of details. Perhaps this got lost in communication. She's fine to proceed.
Best wishes,
Helen

From: Philip Catney <p.j.j.catney@keele.ac.uk>
Sent: 07 May 2021 10:23
To: Helen Parr <h.parr@keele.ac.uk>
Subject: Hayley Fox ethics application

Hi Helen,

I hope you are okay. The election news is a bit grim this morning!

I have just had a supervisory meeting with Hayley Fox (I'm on the team supporting her project) and she was telling me about her ethics application. I think she's not been as clear as she could have been to help you make a decision. Her project is essentially bifurcated in data storage: 1) the risk modelling data is Lincolnshire Police's and stay's on its servers (it has agreed to its use in the project), 2) the data she generates through interviews will be on Keele's storage because it is recognised that this might be problematic to have on Lincolnshire's server if the officers are not being complimentary about their seniors!

Best wishes

Phil

11.2 Appendix 2: Interview question plan.

Phase 1 Initial round of interviews

How would they normally go about policing these crimes?
Would you obtain data or do any analysis yourself?
Do they trust information from other sources, or do they prefer to trust instinct, or experience, or other officers for example?
Do you feel that you are expected by senior management to incorporate analysis?

How do you feel about acting based on analytical products?
Are they 'using' analysis because it is expected and ticks a box or, do they get meaningful insights from it?
What type of analysis do you currently use?

What is your preferred type of analysis?

Are you aware of any of the following types of analysis and would you or have you used them?

Crime pattern analysis

Comparative conjunctive case analysis

Predictive analysis

“Risk terrain” analysis

Hotspot analysis

“Risk terrain” modelling

Choropleth mapping

present

Any others you are aware of or used?

What have you used the analysis types for?

Which did you find worked best for you? Have you had any specific analysts products that worked really well/had good results?

What information do you want from analysis?

What is your preferred method of presentation?

Summary- bullet points

Report

Table

Map

Combination of map and summary

In terms of hare coursing, county line drug dealing, or plant/farm machinery theft are there any points you have identified that should be included when considering where these offences are likely to occur?

e.g., do farmers mention vulnerabilities, types of fields targeted, location of machinery when targeted.

Phase 2: Follow-up Interview Guide

Looking at the example of the “risk terrain” analysis results – what is the map telling you?

Is there any additional information that you would want in order to use the “risk terrain” analysis?

Would you want this presented on the map or separately?

Could this analysis assist you in your role?

How do you see this analysis assisting you in your role (resource allocation, crime prevention, community engagement, partnership engagement)?

Would you be able to access this via a mobile terminal, laptop/PC or would you want a printable copy via e-mail?

Are there any issues you can see in making use of the analysis?

How could these be overcome?

Do they trust information from other sources, or do they prefer to trust instinct, or experience, or other officers for example?
Do you feel that you are expected by senior management to incorporate analysis?

How do you feel about acting on the basis of analytical products?

11.3 Appendix 3: RTMdx results output for county lines in Lincoln city with a place size of 150 metres.

County lines Lincoln

Produced by: Hayley Fox

Dated: 03/13/2022

Notes

Risk Terrain Modeling (RTM) identifies how certain qualities of geographic space interact and overlap to influence behaviors and outcomes pertaining to your study topic: CL. This diagnosis of spatial vulnerabilities throughout the study area is used for forecasting, resource deployments, risk mitigation, problem solving, and other highly actionable decision-making efforts

RTM Results MAPS:

Risk terrain maps show vulnerable places within the study area. These are places where the spatial influence of risk factors in the risk terrain model (see "RTM Results TABLE") exist with varying levels of intensity. Highly vulnerable places are more likely to experience future events pertaining to your study topic than elsewhere. Consider allocating resources accordingly.

A Relative Risk Score (RRS) was assigned to each place in your study area, ranging from 1 for the lowest risk to 171.104 for the highest risk place. These scores allow for easy comparison among places in the risk terrain map. For instance, a place with an RRS of 10 has an expected rate of events pertaining to your study topic that is 10 times higher than a place with a score of 1.

Analysis units of forecast = 300 m places
Total number of places: 1716
RRS Statistics:
Range = 1 to 171.104
Mean = 18.738; Standard Deviation = 40.699
Number of Places greater than 2 Standard Deviations from the Mean: 108 (6.29% of the study area)

APPENDIX to
County lines Lincoln
Produced by: Hayley Fox
Dated: 03/13/2022

Summary of Analysis Paremeters:

Boundary File: SA - Lincoln district.shp
Study Area Name: SA - Lincoln district.shp

Topic Issue Data File: 2020 - Lincoln 2020.shp
Topic Issue Name: CL

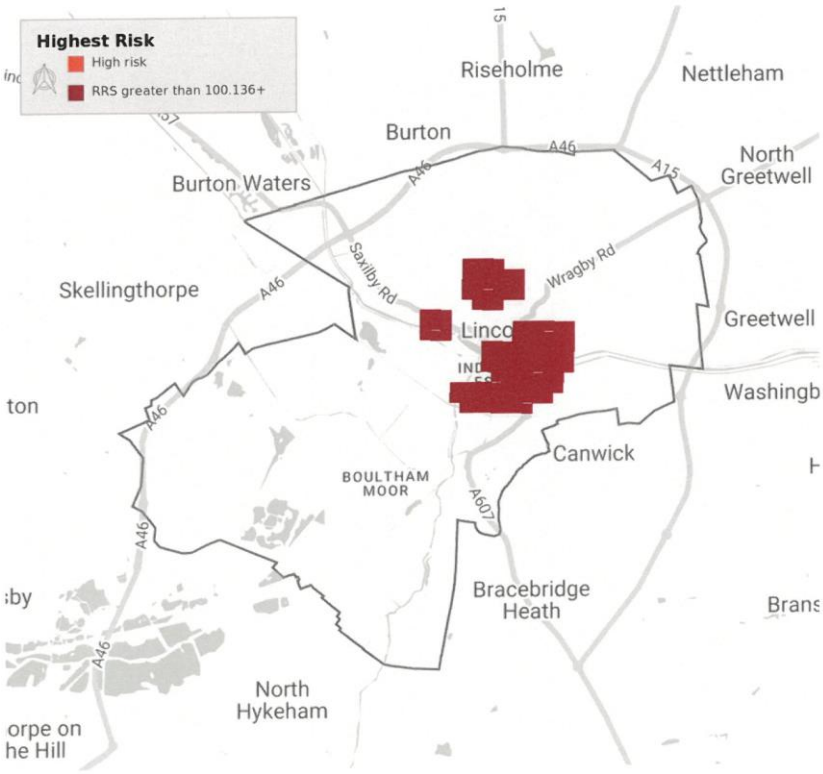
Model Type: Aggravating

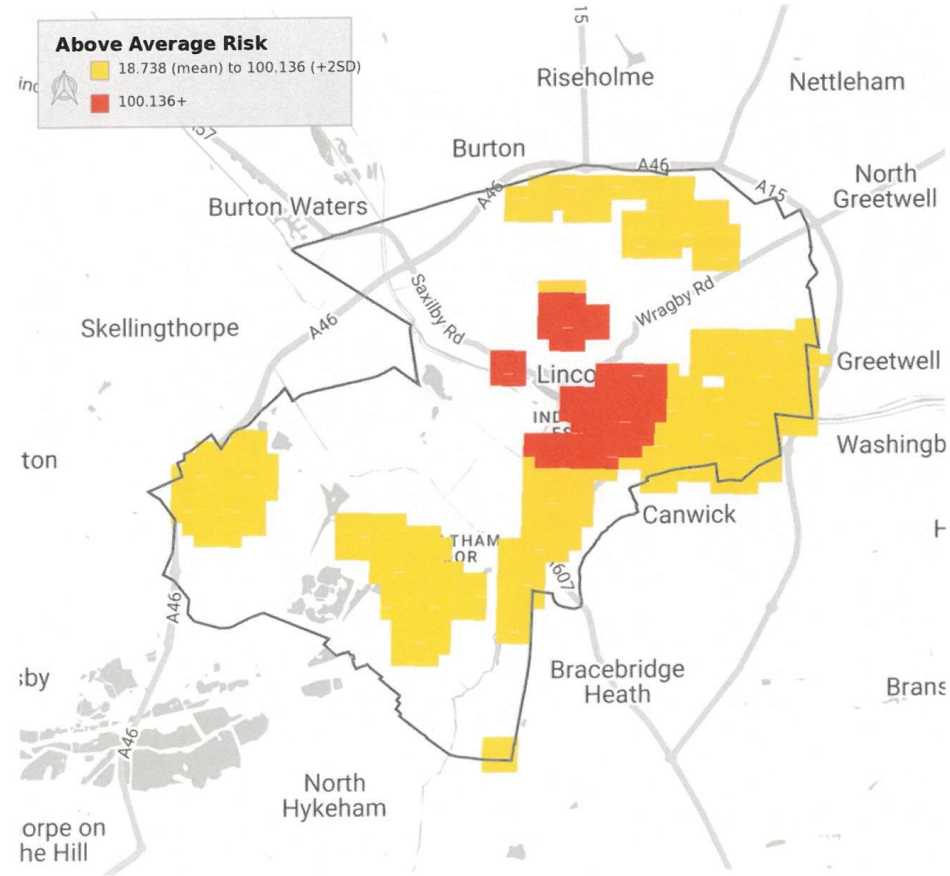
Standard Value: 300 m
Place Size: 150 m

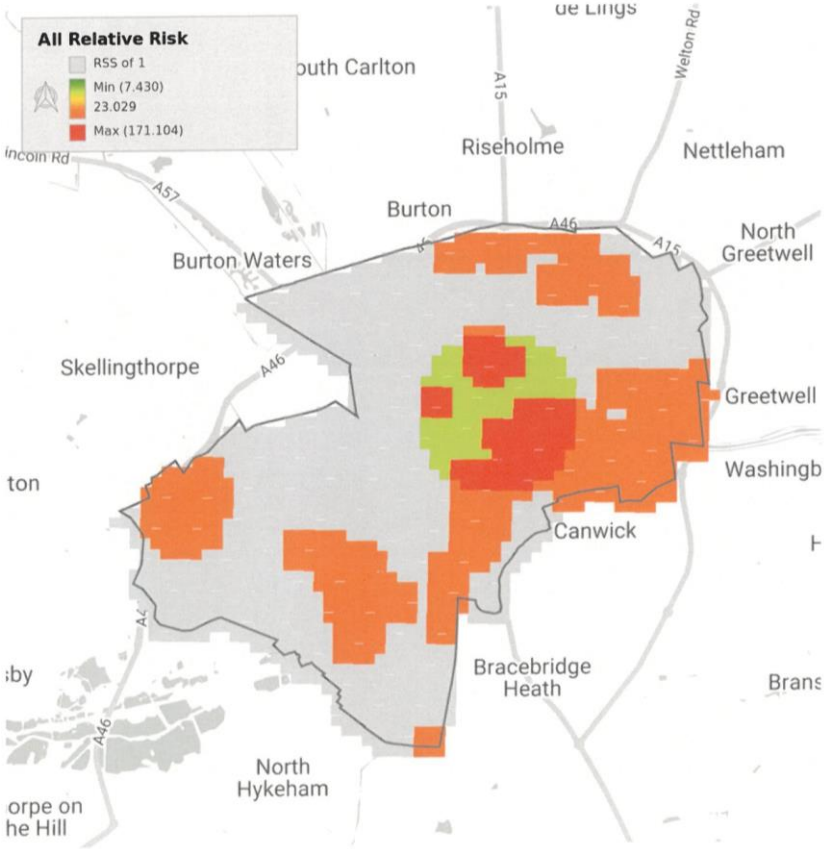
All Risk Factors Tested:

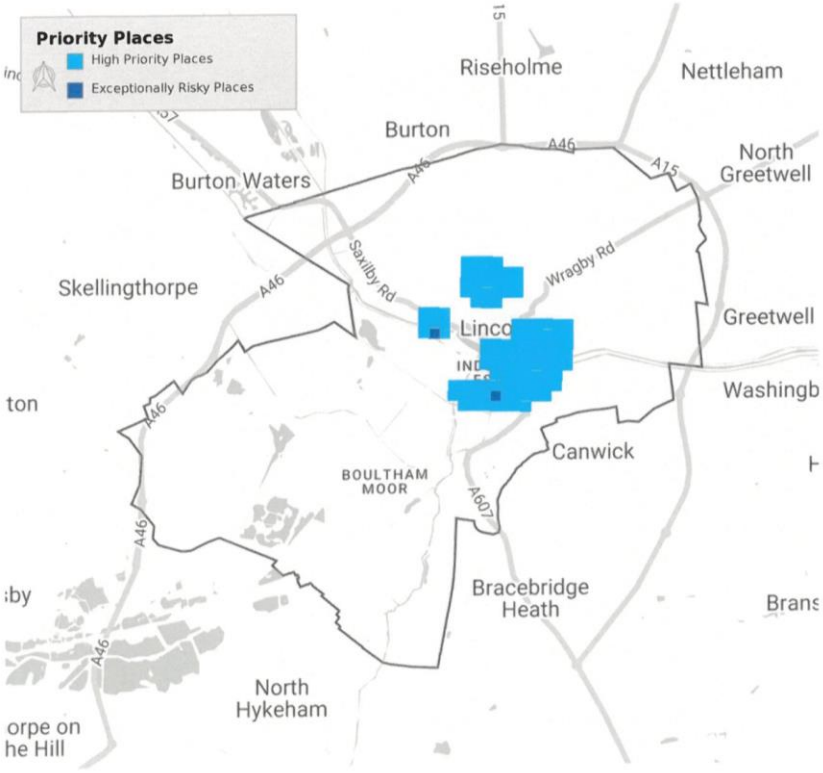
Risk Factor	Operationalization	SVM	Increments
P poly - Flats OA mean and 1sd.shp	Proximity	4	Half
P - Bala House.shp	Proximity	4	Half
P - Nacro services.shp	Proximity	4	Half
P - Probation.shp	Proximity	4	Half
B - Support services.shp	Proximity or Density	4	Half
P poly - RTA area.shp	Proximity	4	Half
P - Addaction.shp	Proximity	4	Half
P - Homer House.shp	Proximity	4	Half
P - Nomad.shp	Proximity	4	Half
P - Railway station.shp	Proximity	4	Half
B - Supported accommodation.shp	Proximity or Density	4	Half
P LCC - Lincoln city council.shp	Proximity	4	Half
P poly - Single houshold OA greater mean and 1sd.shp	Proximity	4	Half

Risk Factor	Operationalization	SVM	Increments
P - Needle exchange.shp	Proximity	4	Half
P - YMCA.shp	Proximity	4	Half
P poly - Constrained city dwellers OA.shp	Proximity	4	Half
P poly - Tenure OA greater mean and 1sd.shp	Proximity	4	Half
P - Framework.shp	Proximity	4	Half
P - Jobcentre.shp	Proximity	4	Half
P - Pathways.shp	Proximity	4	Half
P - Supported accommodation.shp	Proximity	4	Half


Highest Risk
High risk
RRS greater than 100.136+
Riseholme
Nettleham
Burton
Burton Waters
North Greetwell
Skellingthorpe
Saxilby Rd
Wragby Rd
Greetwell
Washingb
Canwick
BOULTHAM MOOR
Bracebridge Heath
North Hykeham
A46
A15
A607


Above Average Risk
18.738 (mean) to 100.136 (+2SD)
100.136+
Riseholme
Nettleham
Burton
Burton Waters
North Greetwell
Skellingthorpe
Saxilby Rd
Wragby Rd
Greetwell
Washingb
Canwick
Bracebridge Heath
North Hykeham
A46
A15
A607


All Relative Risk
RSS of 1
Min (7.430)
23.029
Max (171.104)
Riseholme
Nettleham
Burton
Burton Waters
North Greetwell
Skellingthorpe
Greetwell
Washingb
Canwick
Bracebridge Heath
North Hykeham
A15
A46
A57


Priority Places
High Priority Places
Exceptionally Risky Places
Riseholme
Nettleham
Burton
Burton Waters
North Greetwell
Skellingthorpe
Saxilby Rd
Wragby Rd
Greetwell
Washingb
Canwick
BOULTHAM MOOR
Bracebridge Heath
North Hykeham
A15
A46
A607

County lines Lincoln

Produced by: Hayley Fox

Dated: 03/13/2022

RTM Results TABLE:

Understand risk factors in the risk terrain model according to the operationalization, spatial influence, and relative risk value (RRV). Interpret RRVs as risk factor weights; places affected by a risk factor with a RRV of 6 are twice as risky compared to places affected by risk factor with a RRV of 3. Develop risk narratives for the study topic based on the RTM Results Table. You may choose to prioritize the risk factors for mitigation based on the RRVs and/or your risk narratives.

Risk Factor	Operationalization	Spatial Influence	RRV
P poly - Constrained city dwellers OA. shp	Proximity	300	23.030
P - Probation.shp	Proximity	1200	7.430

APPENDIX to
County lines Lincoln
Produced by: Hayley Fox
Dated: 03/13/2022

Summary of Analysis Paremeters:

Boundary File: SA - Lincoln district.shp
Study Area Name: SA - Lincoln district.shp

Topic Issue Data File: 2020 - Lincoln 2020.shp
Topic Issue Name: CL

Model Type: Aggravating

Standard Value: 300 m
Place Size: 150 m

All Risk Factors Tested:

Risk Factor	Operationalization	SVM	Increments
P poly - Flats OA mean and 1sd.shp	Proximity	4	Half
P - Bala House.shp	Proximity	4	Half
P - Nacro services.shp	Proximity	4	Half
P - Probation.shp	Proximity	4	Half
B - Support services.shp	Proximity or Density	4	Half
P poly - RTA area.shp	Proximity	4	Half
P - Addaction.shp	Proximity	4	Half
P - Homer House.shp	Proximity	4	Half
P - Nomad.shp	Proximity	4	Half
P - Railway station.shp	Proximity	4	Half
B - Supported accommodation.shp	Proximity or Density	4	Half
P LCC - Lincoln city council.shp	Proximity	4	Half
P poly - Single houshold OA greater mean an d 1sd.shp	Proximity	4	Half

Risk Factor	Operationalization	SVM	Increments
P - Needle exchange.shp	Proximity	4	Half
P - YMCA.shp	Proximity	4	Half
P poly - Constrained city dwellers OA.shp	Proximity	4	Half
P poly - Tenure OA greater mean and 1sd.shp	Proximity	4	Half
P - Framework.shp	Proximity	4	Half
P - Jobcentre.shp	Proximity	4	Half
P - Pathways.shp	Proximity	4	Half
P - Supported accommodation.shp	Proximity	4	Half

APPENDIX to

County lines Lincoln

Produced by: Hayley Fox

Dated: 03/13/2022

Analysis ran on March 13th 2022 at 4:33 pm
Analysis Duration: 0 min 36 sec
GIS Duration: 0 min 3 sec
Image Duration: 0 min 4 sec
Total Duration: 0 min 44 sec

R Script Results:

```
Family: c("NBII", "Negative Binomial type II")

Call:
gamlss(formula = crime_count ~ r17p04_P_poly_._Constrained_city_dwellers_OA.shp_proximity_300 +
    r12p02_P_._Probation.shp_proximity_1200, sigma.formula = ~1,
    family = NBII, data = raster.data, method = mixed(3, 10))

Fitting method: mixed(3, 10)

------------------------------------------------------------------
Mu link function: log
Mu Coefficients:
                                                                 Estimate Std. Error t value
(Intercept)                                                       -7.158     1.0238  -6.991
r17p04_P_poly_._Constrained_city_dwellers_OA.shp_proximity_300     3.137     1.0311   3.042
r12p02_P_._Probation.shp_proximity_1200                            2.006     0.4664   4.300
                                                                  Pr(>|t|)
(Intercept)                                                     3.884e-12
r17p04_P_poly_._Constrained_city_dwellers_OA.shp_proximity_300 2.384e-03
r12p02_P_._Probation.shp_proximity_1200                        1.803e-05

------------------------------------------------------------------
Sigma link function: log
Sigma Coefficients:
  Estimate Std. Error    t value   Pr(>|t|)
   -0.5429     0.6084    -0.8924     0.3723

------------------------------------------------------------------
No. of observations in the fit: 1716
Degrees of Freedom for the fit: 4
      Residual Deg. of Freedom: 1712
                      at cycle: 1

Global Deviance:    187.8458
            AIC:    195.8458
            SBC:    217.6368
```

11.4 Appendix 4: RTMdx results output for hare coursing in South Holland with a place size of 600 metres.

Hare coursing South Holland district

Produced by: Hayley Fox

Dated: 02/13/2022

Notes

2019-2020 September to March inclusive

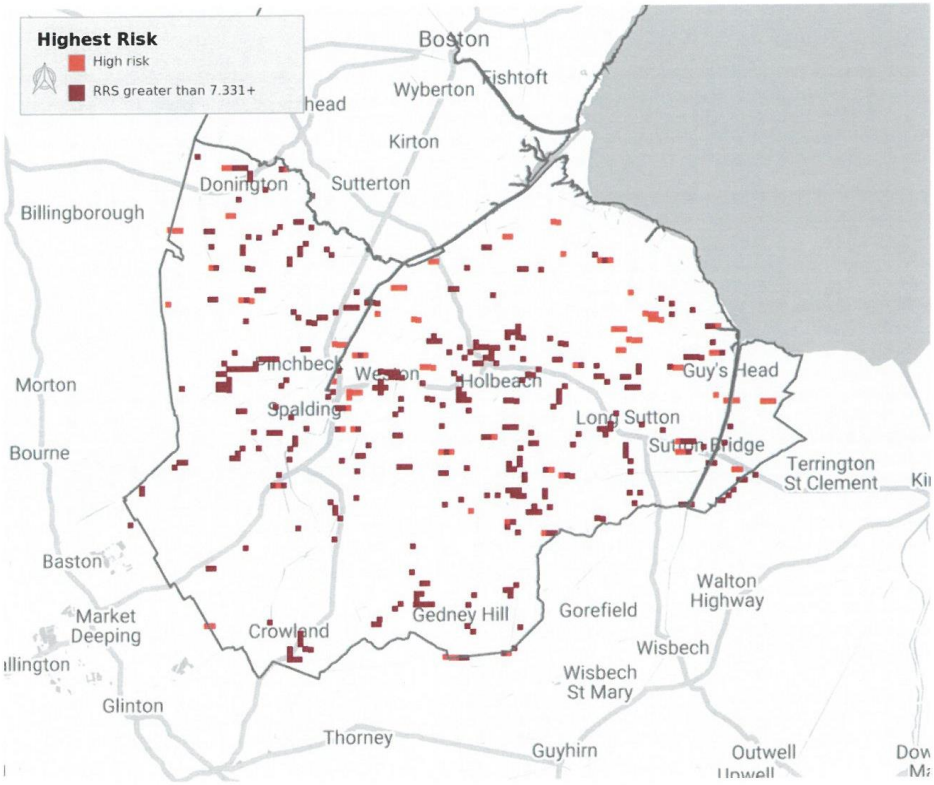
Risk Terrain Modeling (RTM) identifies how certain qualities of geographic space interact and overlap to influence behaviors and outcomes pertaining to your study topic: Hare coursing. This diagnosis of spatial vulnerabilities throughout the study area is used for forecasting, resource deployments, risk mitigation, problem solving, and other highly actionable decision-making efforts

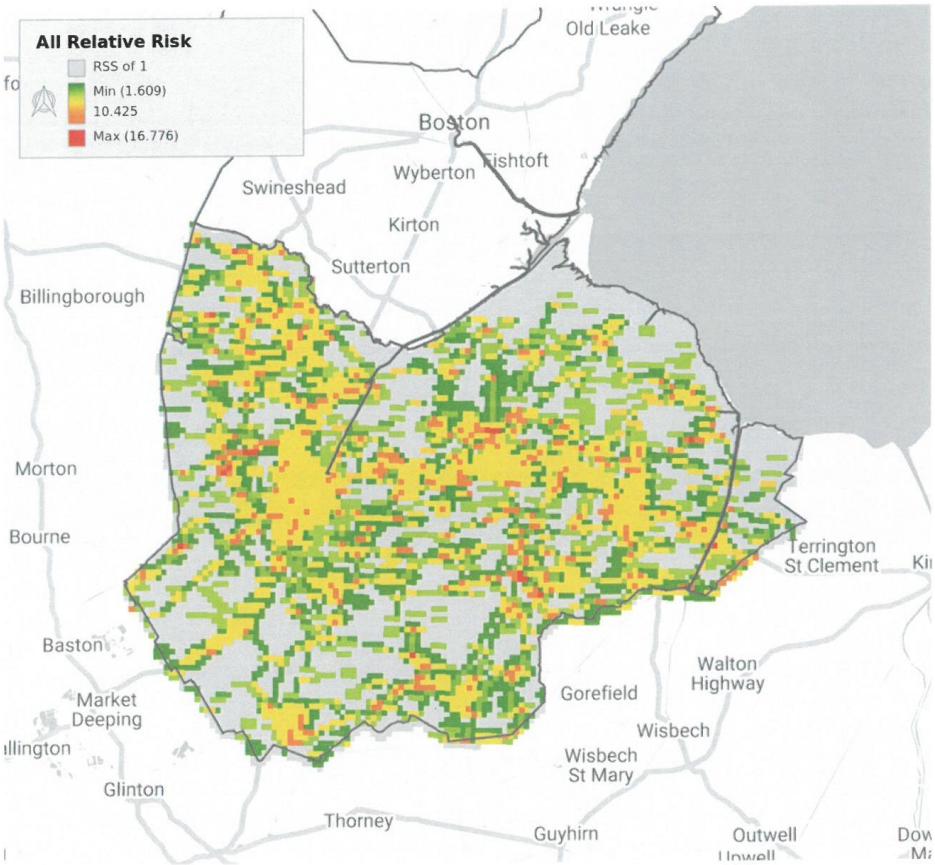
RTM Results MAPS:

Risk terrain maps show vulnerable places within the study area. These are places where the spatial influence of risk factors in the risk terrain model (see "RTM Results TABLE") exist with varying levels of intensity. Highly vulnerable places are more likely to experience future events pertaining to your study topic than elsewhere. Consider allocating resources accordingly.

A Relative Risk Score (RRS) was assigned to each place in your study area, ranging from 1 for the lowest risk to 16.776 for the highest risk place. These scores allow for easy comparison among places in the risk terrain map. For instance, a place with an RRS of 10 has an expected rate of events pertaining to your study topic that is 10 times higher than a place with a score of 1.

Analysis units of forecast = 600 m places
Total number of places: 8644
RRS Statistics:
Range = 1 to 16.776
Mean = 2.756; Standard Deviation = 2.288
Number of Places greater than 2 Standard Deviations from the Mean: 369 (4.27% of the study area)


Highest Risk
High risk
RRS greater than 7.331+
Boston
Fishtoft
Wyberton
Kirton
Donington
Sutterton
Billingborough
Morton
Bourne
Pinchbeck
Holbeach
Guy's Head
Spalding
Long Sutton
Terrington St Clement
Baston
Walton Highway
Market Deeping
Crowland
Gedney Hill
Gorefield
Wisbech
Wisbech St Mary
Glinton
Thorney
Guyhirn
Outwell


All Relative Risk
RSS of 1
Min (1.609)
10.425
Max (16.776)
Old Leake
Boston
Fishtoft
Wyberton
Swineshead
Kirton
Sutterton
Billingborough
Morton
Bourne
Terrington St Clement
Baston
Walton Highway
Market Deeping
Gorefield
Wisbech
Wisbech St Mary
Glinton
Thorney
Guyhirn
Outwell

Hare coursing South Holland district

Produced by: Hayley Fox

Dated: 02/13/2022

RTM Results TABLE:

Understand risk factors in the risk terrain model according to the operationalization, spatial influence, and relative risk value (RRV). Interpret RRVs as risk factor weights; places affected by a risk factor with a RRV of 6 are twice as risky compared to places affected by risk factor with a RRV of 3. Develop risk narratives for the study topic based on the RTM Results Table. You may choose to prioritize the risk factors for mitigation based on the RRVs and/or your risk narratives.

Risk Factor	Operationalization	Spatial Influence	RRV
B - Junctions.shp	Proximity	300	3.303
B - Farms.shp	Proximity	300	1.826
B - Classified roads.shp	Density	300	1.728
B - Residential areas.shp	Proximity	600	1.609

APPENDIX to

Hare coursing South Holland district

Produced by: Hayley Fox

Dated: 02/13/2022

Summary of Analysis Paremeters:

Boundary File: A - Boston South Holland.shp
Study Area Name: Boston

Topic Issue Data File: E - HC 2018-2020.shp
Topic Issue Name: Hare coursing

Model Type: Aggravating

Standard Value: 600 m
Place Size: 300 m

Filters:

Study Area Filtered to Subarea Polygon ("area_name"): South Holland
By Date ("Date"): 9/1/2019 - 4/1/2020

All Risk Factors Tested:

Risk Factor	Operationalization	SVM	Increments
B - B roads.shp	Proximity or Density	4	Half
B - Farms.shp	Proximity or Density	4	Half
B - Inland water.shp	Proximity or Density	4	Half
B - A roads.shp	Proximity or Density	4	Half
B - Classified roads.shp	Proximity or Density	4	Half
B - Junctions.shp	Proximity or Density	4	Half
B - Water course.shp	Proximity or Density	4	Half
B - Wetlands.shp	Proximity or Density	4	Half
B - Other crop fields.shp	Proximity or Density	4	Half
B - Fields no contours.shp	Proximity or Density	4	Half

Risk Factor	Operationalization	SVM	Increments
B - Winter wheat and other crop fields.shp	Proximity or Density	4	Half
B - Not and unclassified roads.shp	Proximity or Density	4	Half
B - Residential areas.shp	Proximity or Density	4	Half
B - Winter wheat fields.shp	Proximity or Density	4	Half
B - Woody linear features.shp	Proximity or Density	4	Half
B - Woods.shp	Proximity or Density	4	Half

APPENDIX to

Hare coursing South Holland district

Produced by: Hayley Fox

Dated: 02/13/2022

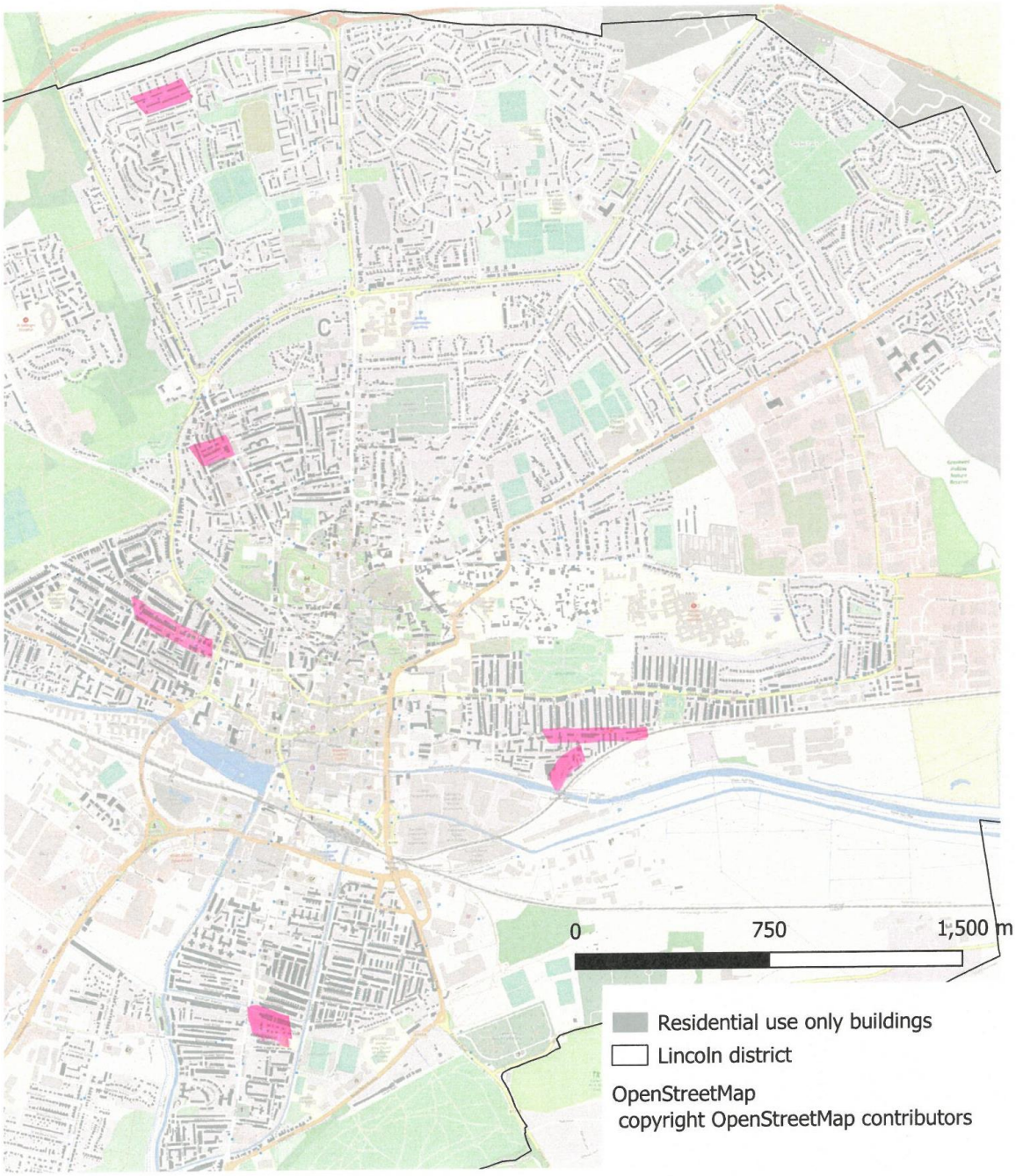
Analysis ran on February 13th 2022 at 6:26 pm
Analysis Duration: 9 min 22 sec
GIS Duration: 0 min 20 sec
Image Duration: 3 min 42 sec
Total Duration: 13 min 25 sec

R Script Results:

```
Family: c("NBII", "Negative Binomial type II")

Call: gamlss(formula = crime_count ~ r07p06_B_._Junctions.shp_proximity_300 +
    r03d06_B_._Classified_roads.shp_density_300 + r10p07_B_._Residential_areas.shp_proximity_600 +
    r04p06_B_._Farms.shp_proximity_300, sigma.formula = ~1, family = NBII,
    data = raster.data, method = mixed(3, 10))

Fitting method: mixed(3, 10)

------------------------------------------------------------------
Mu link function: log
Mu Coefficients:
                                          Estimate Std. Error t value   Pr(>|t|)
(Intercept)                               -3.6055     0.1252 -28.798 3.184e-174
r07p06_B_._Junctions.shp_proximity_300     1.1949     0.1283   9.312  1.563e-20
r03d06_B_._Classified_roads.shp_density_300  0.5471     0.1365   4.007  6.191e-05
r10p07_B_._Residential_areas.shp_proximity_600  0.4758     0.1196   3.978  7.009e-05
r04p06_B_._Farms.shp_proximity_300         0.6021     0.1844   3.265  1.098e-03

------------------------------------------------------------------
Sigma link function: log
Sigma Coefficients:
  Estimate Std. Error    t value   Pr(>|t|)
 9.183e-01  1.146e-01  8.013e+00  1.262e-15

------------------------------------------------------------------
No. of observations in the fit: 8644
Degrees of Freedom for the fit: 6
      Residual Deg. of Freedom: 8638
                      at cycle: 2

Global Deviance:    3390.046
            AIC:    3402.046
            SBC:    3444.434
```

11.5 Appendix 5: Areas of risk to county lines cuckooing identified by N Insp B.

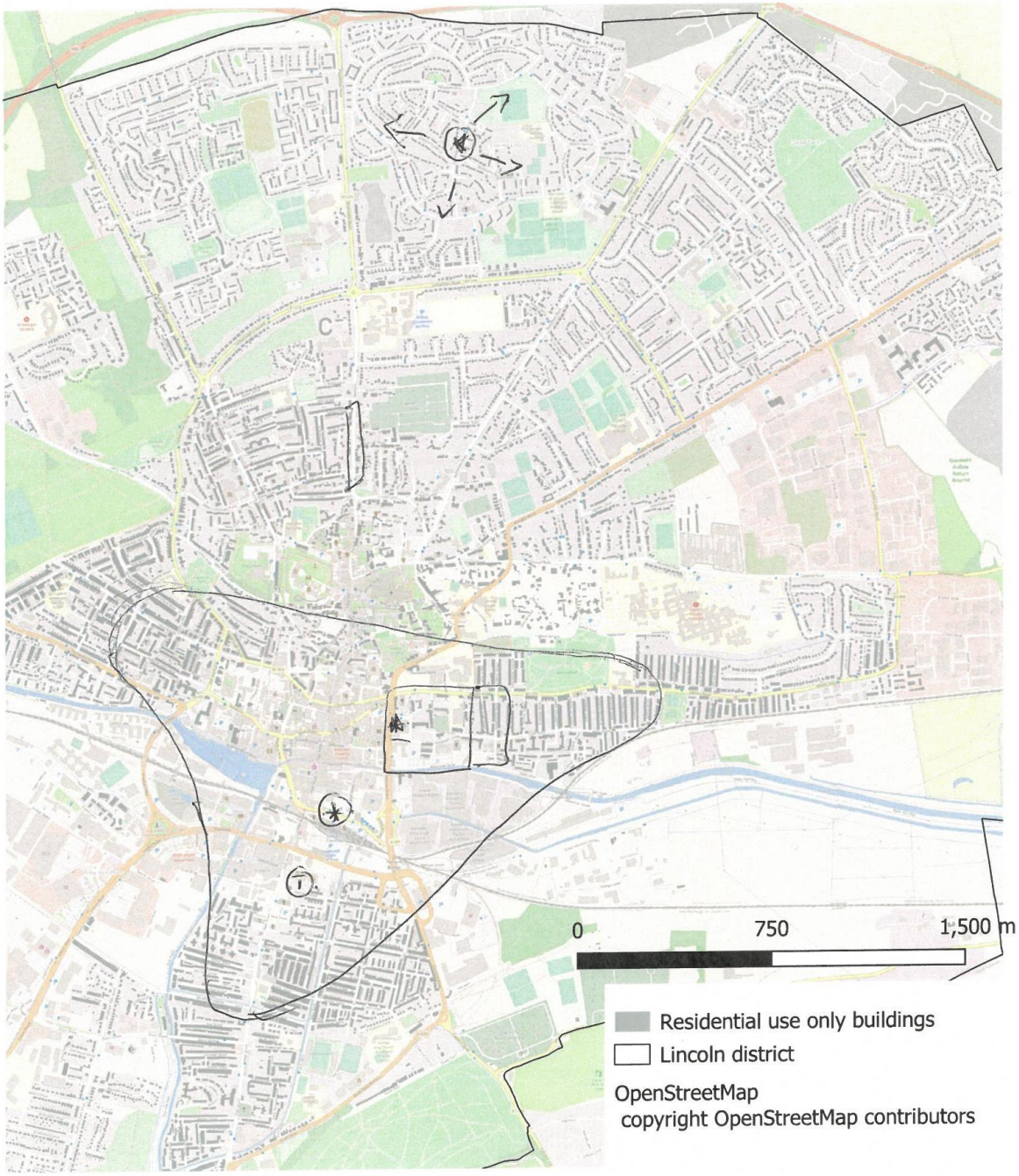
Map showing residential properties at high risk to county line cuckooing in Lincoln city.



Areas highlighted in pink were identified by N Insp B during the second phase of interviews as those areas they believed to be at risk to county lines cuckooing.

11.6 Appendix 6: Areas of risk to county lines cuckooing identified by N Insp A.

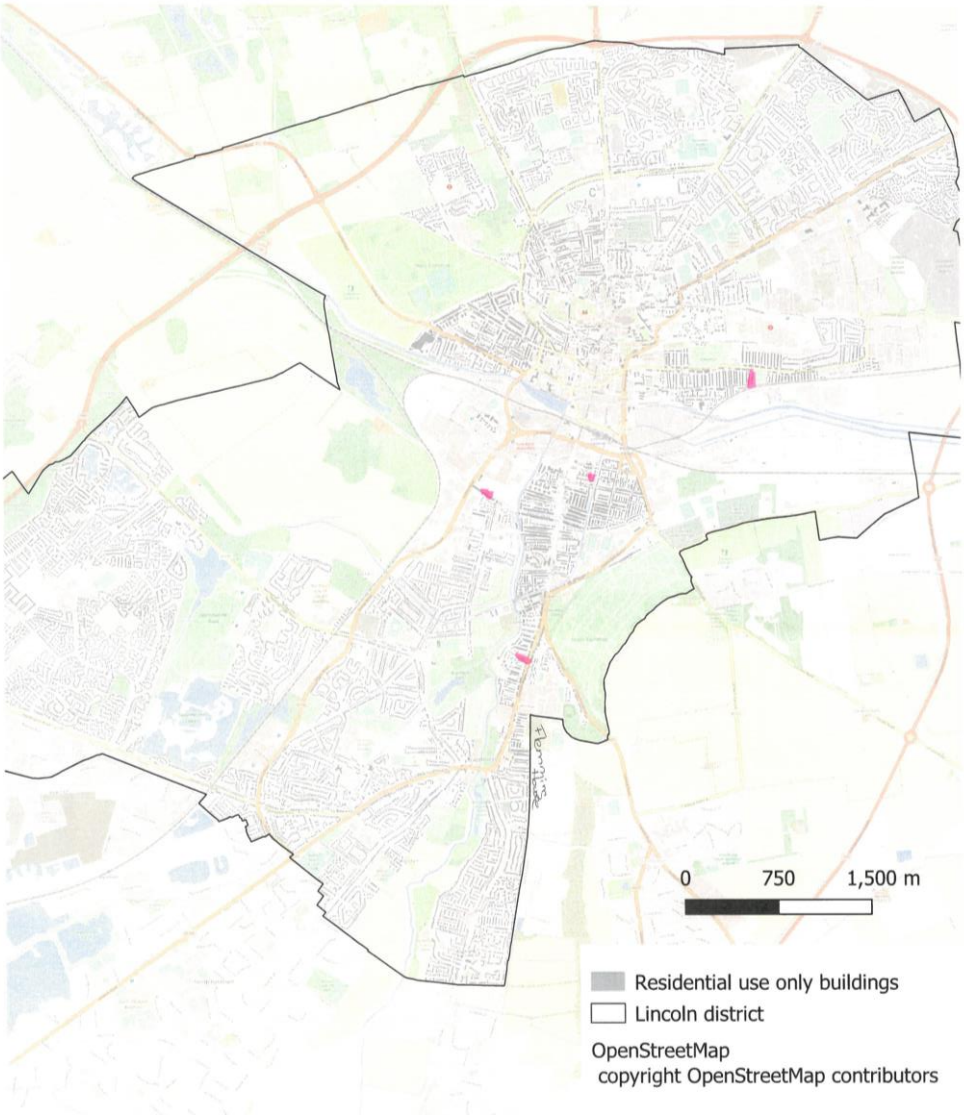
Map showing residential properties at high risk to county line cuckooing in Lincoln city.



Areas highlighted in black pen were identified by N Insp A during the second phase of interviews as those areas they believed to be at risk to county lines cuckooing.

11.7 Appendix 7: Areas of risk to county lines identified by the PC.

Map showing residential properties at high risk to county line cuckooing in Lincoln city.

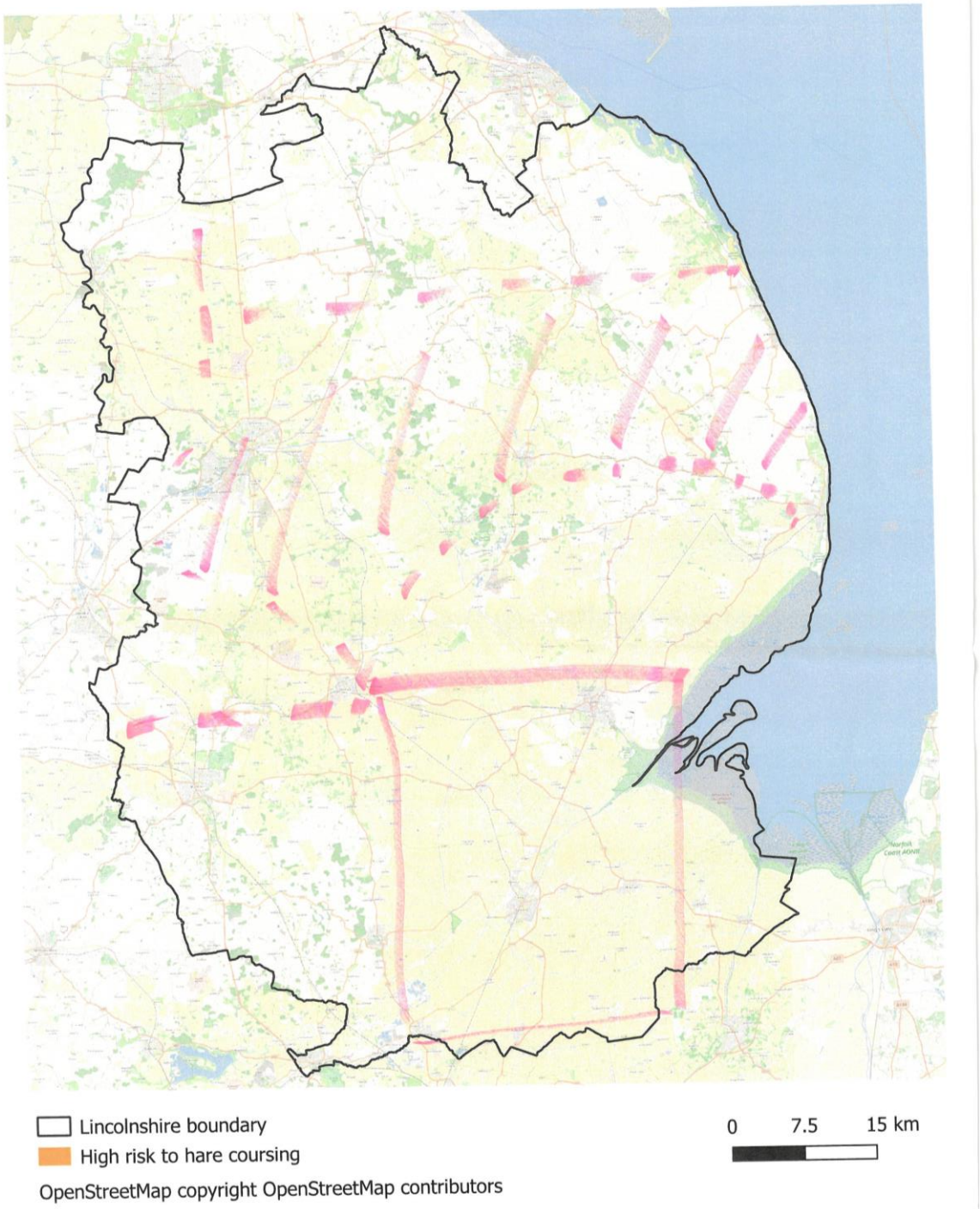


Areas highlighted in pink were identified by the PC during the second phase of interviews as those areas they believed to be at risk to county lines cuckooing.

11.8 Appendix 8: Areas of risk identified by CI Insp to hare coursing.

The areas bounded by the blue line was identified by CI Insp during the second phase of interviews as the area they believed to be at highest risk to hare coursing.

11.9 Appendix 9: Areas of high risk identified by Sgt B to hare coursing.



The area bounded by the pink line was identified by Sgt B during the second phase of interviews as the area they believed to be at highest risk to hare coursing, those areas bounded by the dashed lines were identified as at risk to hare coursing, and the area in the centre of the map containing vertical stripes was identified as not at risk to hare coursing.

11.10 Appendix 10: Officer interview coding.

The officer interviews were analysed to determine themes and broad codes during the familiarisation process. Subsequently these were sub-divided into more specific sub-codes. The following table is split into sections showing the broad codes, under which are the sub-codes and an example of a relevant officer quote taken from the interviews.

Sub-codes	Example Quote
Presentation and format of analysis	
Content varies depending on audience and purpose	It depends on who it was being presented to? For example, I would like to know what features, what parameters you've set Yeah, and so that that would be really useful [inaudible] Yeah. But for this one, to support the ANPR deployment I can say these are the areas we've identified Yeah. wouldn't need that. But I think, Yeah, so depending on what, what you know my audience was that I would like to present to basically
Explanation of why	But it's not just the where, it's the why. What is it that makes it that high risk? So yeah, so map and what is it that, you know, you kind of model? Yeah, the map and the model together.
Simple and short	I suppose everyone is different. I like something basic that tells me this is where the bad guys are go get em! …..Simplistic document. I hate longwinded things erm like those high harm documents. Do not like. I'm sorry if you write one. I hate them err it's too much information compared with everything else that you gotta try and digest.
Value of analysis	
Impacted by data quality	I mean there's your problem is the data quality going in isn't great, be 'cause it not data minded
Impacted by range of available data	It might apply to all of these, but I think essentially an, it's often the case that we hold the least data as an agency to analyse, so I think going wider, mmm with the data request.' … 'And, and sharing all that kind of original data, and children services and getting all of that in one place for analysis. Uhm, I think is one of the most helpful things.
Different between ranks	I think if it's on a page, visual, has a map with some bubbles on it. I think that is pitched right for cops, especially those that have got a local interest".. "I think those sort of 60 second briefs, officers do take on board, and then they're so easy to share with Uh, you know roads policing or other resources that might be in the area. And I do think cops generally want stuff to be looking for.

Lack of management understanding	Rather than come, say honestly and say, right I want, I want 20 minutes with you so I can talk through what my problem is, this is what I need to do?...But they [referring to other senior officers] don't, they will say, oh can I just have a problem profile
Pointless if no resources available to act on it	I, the only sort of downside for me, really are more, the practical aspects in terms of, it's all very well if we can predict things if we can't, if we don't, don't have the resources to deal with that information. It almost feels a little bit pointless doing the background work because we're not going to be able to use the product when it's finished.
What I already know	In relation to a hotspot map and Qlik: 'Erm but it probably isn't much more than I already know. Having, you know, drawn on a map myself, something very similar, so, to me, the better information is the why.
Access to analysis and analysts	
Limited capacity of analysts	I think money and by that I mean the amount of capacity that analysts have.
Limited number of analysts	Everybody's got an opinion. The analyst is the person who uses the, who helps you to use the evidence effectively, Uhm. So my answer to your question is capacity that we don't have enough.
Value of personal working relationship	From experience I learned very early on that rather than me ever trying to say this is definitively what I want, I'm better off having conversation with said analysts say this is what I have. And I want you to look at or what's available to you. This is what I want to do with it as an end result, or this is where I'm heading with it. What have you got? You know, what are my options? What can you provide?
Force 'bidding' process	But if you don't know, it's quite a daunting thing in this organisation to even ask for things in the first place, so you don't really know what's available. Especially if you get knocked back a couple of times, you're really aware that if you're going for, for an analyst to look at whatever, you're going to be competing against other bids from other departments, and especially if you're kind of just a lowly neighbourhood or police officer, to try and go up against, because what you think of is going to be big bids from kind of more major crime. For that type of people its daunting. It isn't, it doesn't seem to be straightforward process.
Joint working between analyst and officer	
Brings local context	But the relevance here is that you're close to a populates are, you're more likely to be seen, you're more likely caught, witnessed or whatever. So, kind of that that intensity could continue right out here.

Greater acceptance	Would you feel more reassured if you were involved at an earlier stage Yes and putting in Yes suggesting those parameters? Yes, yes.
Increased understanding of the problem by the analysts and focused results for the officer	From experience I learned very early on that rather than me ever trying to say this is definitively what I want, I'm better off having conversation with said analysts say this is what I have. And I want you to look at or what's available to you. This is what I want to do with it as an end result, or this is where I'm heading with it. What have you got? You know, what are my options? What can you provide?
Acceptance of analysis	
Meeting expectations or perceptions	it's targeting the right areas in't it cause if you know Lincoln, if we like we do and you just came to look at Lincoln now and say ohh, where's your where's your problems, problem areas erm it's pretty much ringing truths in there in my eyes.
Dismissive is not mirroring officer perception	So it is of use to highlight, I think, the problem areas. Obviously I'll take an issue with all of that, but it's in that radius, isn't it?
Officer involvement	
Analyst officer relationship/trust	But the actual scores and stuff, for me you've done your research. Your telling me its high its high. I believe you.
Data quality and availability	It might apply to all of these, but I think essentially an, it's often the case that we hold the least data as an agency to analyse, so I think going wider, mmm with the data request.' … 'And, and sharing all that kind of original data, and children services and getting all of that in one place for analysis. Uhm, I think is one of the most helpful things.
Benefits of RTM analysis	
Focus patrol plans	So I think in terms of hot spot patrolling, erm this is far better
Focus prevention/intervention	So if I want to put some signs out, just put some signs out that said covert police cameras in use, hare coursing, Operation Galileo, I might use those in those that have got the highest relevant risk factors.
Brings legitimacy- for staff and external partners	But this adds that layer of evidential relevance to say, okay. And now the reason that we're going to focus on here, the reason that I ask you to do this particular work in this particular area is these identified factors. So, I think that right, absolutely. And we'll use it, definitely.
	I think, I mean to me, the the you know the gold plated thing that we could do with this would be to go to the local authority and go, what you gonna do about this?

Identifies 'hidden' areas	Erm I think where it does come in particularly handy is more for the the residential properties. Whether it be Council or otherwise, erm 'cause there might be something hidden in the system that we're not particularly seeing. This is picking up that, it's saying, hello. There's a risk over here.
Method to evaluate actions	And it's so difficult to measure if you've had any impact. So if you've got something that you can have an impact on, that's measurable, then that's a massive. Yeah. Otherwise, it feels like you're going very much round around the houses doing the same things and having unknown impact.
Aids understanding of why an area is targeted	But you know, being able to put in context, it's not just why is it happening there, it's why is it not happening here?