Exploring the Behaviour of Foraging Burglary Offenders and Predictive Police Interventions to Prevent and Reduce their Offending

by

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ABSTRACT

Drawn from ecology, the optimal forager predictive policing methodology has been identified as the primary tasking tool used by police services to tackle domestic burglary. Built upon established findings that the target selection behaviour of foraging domestic burglary offenders can be predicted, this thesis examines the physical offending and geographical characteristics of foraging offenders in greater detail. This study evolves established research evidence by drawing upon criminological methods that have potential to increase the approaches effectiveness before testing their applicability in respect of foraging criminals. Ecological research evidence relating to assumptions of foraging behaviour are used to devise theoretical manifestations within criminal behaviour which are subsequently tested for and used to build a theoretical model to combat them.

The study achieves all of this through a number of key research chapters, these include (1) identifying predictive thresholds for linking burglary offences committed by foraging criminals (2) drawing on existing assumptions within ecology the study then seeks to identify their presence within foraging criminals, including the presence of significant crime displacement, and (3) geographical profiling is identified and tested as a potential solution to combat the evasive behaviour of foraging offenders as a response to the increased police presence that the optimal forager model is designed to co-ordinate. Underpinning the study throughout is an examination of the enablers and blockers present that impact upon the effectiveness of such transitions of theory into practice. Overall, the thesis provides new theoretical material by creating a framework of foraging offender typologies. The key practical implications for policing include a model for tackling the identified theoretical foraging typologies to increase the crime prevention and reduction efforts in respect of domestic burglary.

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List of Acronyms   **Acronym**

Association of Chief Police Officers…………….……	ACPO
Burglary in a Dwelling………………………………….	BIAD
Burglary Other Than in a Dwelling…………………….	BOTIAD
Cambridge Harm Index………………………………….	CHI
Closed Circuit Television………………………..……	CCTV
College of Policing …………………………………….	CoP
Geographical Information System…………………….	GIS
Her Majestie's Inspectorate of Constabularies and Fire and Rescue Services…………………………….	HMICFRS
High Risk Area……………………………………………	HRA
Intelligence Led Policing……………………………...	ILP
Journey to Crime…………………………………………	JTC
National Policing Improvement Agency ………………	NPIA
National Intelligence Model…………………………..	NIM
National Criminal Intelligence Service………………	NCIS
Problem Orientated Policing……………………………	POP
Scanning Analysis Research Assessment……………	SARA
Stealing From Motor Vehicles………………………..	SFMV
Theft From Motor Vehicles……………………………	TFMV
United Kingdom………………………………………...	UK

ACKNOWLEDGEMENTS

CHAPTER 1
INTRODUCTION

This chapter will begin to explain how the project came to life and outline what the core foundations of the study are based upon. It will also outline the aims and objectives of the study as well as its contribution to knowledge. An outline of the chapters will then be provided, which will give the reader an idea of the overarching journey within the thesis.

1.1 Research Context

In 2015 the National Policing Improvement Agency (NPIA) commissioned a scoping review of all predictive policing methods and systems currently available for use within policing. This review defined predictive policing as;

> "*Techniques used to forecast where future crime is most likely to occur over a specified period in a defined geographical area*" (NPIA, 2015, pp 3)

Of note, the review identified a total of 25 various methods of predictive policing but very few of these models were actively being utilised (NPIA, 2015, pp 3) The report split the various models into sections based upon the theoretic model being used to conduct the prediction. The report identified that within the United Kingdom the most common method being used was what was described as a temporal univariate model. The report outlined this as using a single variable to examine previous crimes to identify areas at increased risk of future crime (NPIA, 2015, pp 2). Table 1 on page 21 illustrates the description provided for the method being used most frequently which it outlined as being based upon the near-repeat theory (NPIA, 205, pp 3). It is commonly accepted that the theoretic framework that underpins the near repeat phenomena is that of the optimal forager theory drawn from ecology. Johnson and Bowers (2004a) have strongly argued that offenders are seen as optimal foragers who are a typology of predator that seeks to maximise gains whilst minimizing risks during foraging (Johnson and Bowers, 2004a). As a result they argue that it is possible to predict with some accuracy their nearest offending location and their offending pattern by applying risk levels to areas closest to the offender's most recent victim

(Johnson and Bowers, 2004a). The primary motive for use of the optimal forager theory as a methodology is to prevent and reduce domestic burglaries. The methodology achieves this by predicting future high-risk areas through a process that involves first identifying 3 or more linked crimes that form a series of offending. The geographical areas identified are then overlayed producing a zone were the two overlap which are then outlined as being at risk of victimisation in respect of domestic burglary. The police then use these predictions as a basis around which they co-ordinate their resources which are deployed into the identified zones to act as a capable guardian. A capable guardian is any person present within a place likely to be victimised, whose presence is likely to deter an offender, the most effective of which is accepted to be the presence of the police (Felson, 2017). The combination of the optimal forager and capable guardianship theories will form the major theoretical frameworks that the predictive policing element of this study will be based upon.

Temporal Univariate models					
use only one variable, previous criminality, to identify areas at increased risk of future criminality					
Near-Repeat Analysis	**Crime type:**	**Skills;**	**Use;**	**Capability;**	**Pilots;**
Based on near-repeat phenomenon, where properties close to those that have been victimised are deemed to be at higher risk for future crime than targets further away. Models identify patterns of near repeat crimes in the area under study to determine areas with elevated levels of risk over a specified (short) time period	Strongest with property crime, particularly burglary **Data:** historic point data; better when data is available for a long time period e.g. one to two years	Minimal skills required to use the analytical packages; an understanding of statistical significance useful in interpreting the output	Most noticeably effective in areas with high burglary rates or in areas experiencing a sudden rise in burglary	Does not predict time of specific future crimes, but does help to identify areas with elevated levels of risk over a specified period; model should be focused on one type of crime at a time	Tested in the East Midlands and West Yorkshire Police. Currently being tested by West Midlands Police and is also being used by Greater Manchester Police

Table 1. NPIA 2015 – Table Describing The Method of Near-Repeat Analysis

The necessity for the police to prevent and reduce domestic burglary is multifaceted. Firstly, they have a duty to protect people and communities from being victimised. Secondly, the reduction and prevention of crime are identified pillars through which all Her Majesty's Inspectorate of Constabularies (HMIC) assessments are considered against in terms of their effectiveness (HMIC,

2016). If police services can show they are effective at reducing or preventing crime then they are more likely to be graded as outstanding in this area. This provides further incentive, not only politically, but in terms of increasing the confidence of the communities that they service and their legitimacy to police those communities.

In chapter two, a review of literature (which includes an examination of research of current crime reduction and prevention theories) is conducted. This demonstrates that research into existing crime prevention approaches has stalled. However, the new concept of predictive policing is emerging which may offer an avenue for reinvigorating the criminological study of crime reduction and prevention. Whilst this study identifies that there has been some research and a small number of articles written about predictive policing, there is still a significant absence of literature on the subject and a complete absence of any comprehensive analysis of its efficiency and effectiveness, particularly in relation to its use within the United Kingdom and for volume crime. Furthermore, there is even less literature that has examined the success or otherwise, of implementing such theoretical approaches to crime control. It is imperative that such research is conducted so that any policing organisation that chooses to undertake this approach to crime reduction and prevention do so on an evidence-based footing.

Furthermore, if police services do opt to use such methods, then they are able to implement these in a manner that maximises the effectiveness of police resources through their efficient management and coordination. There are also important theoretical questions that remain unanswered about the existence, impact and extent of crime displacement and other unintended consequences that may arise as a result of tactical responses based upon the aforementioned predictive policing. Research in this area will go a significant way to establishing what these consequences are and seek methods to combine victim and crime location predictions with offender-based predictions and in doing so help provide a model for combating such issues or improving the effectiveness of current predictive approaches.

1.2   Aims and Objectives

The overall aim of this thesis was originally to conduct an evidenced-based study of the implementation of predictive policing methodologies within the United Kingdom (UK). It was quickly established that predictive policing within the UK focused primarily on a single form of prediction within a specified crime area. As such, any evidence-based examination required an in-depth study of optimal foraging theory. As a result, the study's primary aim became a more in depth study that explored the behaviour of foraging burglary offenders and predictive police interventions to prevent and reduce their offending.

In order to achieve the primary aim of this thesis, a number of specific research questions were developed that are addressed within the subsequent chapters. A case study approach, recorded crime data and qualitative interviews were used to answer these questions which included;

1. What impact (if any) does the optimal foraging implementations have on recorded crime rates (assessing effectiveness)?
2. How were the implementations conducted and what lessons can be learned?
3. Do key behavioural, physical and spatial offending characteristics exist within foraging criminals and, if so, what are they?
4. How much do the findings from within the research chapters relate to general ecological foraging assumptions?
5. How effective are geographical profiling techniques when attempting to profile foraging burglary criminals?
6. How has geographical profiling been implemented within the UK and what lessons can be learned?
7. Do the findings support the development of a new predictive policing model to reduce the number of domestic burglaries and maximise crime prevention strategies to combat foraging offending?

The aformentioned questions are key to reaching the study's primary aim because of several reasons. Firstly, they focus the study to assess the effectiveness of the predictive approaches examined, ultimately enabling an

assessment of their success or otherwise, in their current form. Secondly, answering these key objectives enables a deep exploration of foraging offender behaviour, which can be used to improve future scientific crime control efforts. Finally, they enable exploration of how the predictive solutions are implemented so that future efforts to integrate the new knowledge can be conducted in a manner that maximises their potential for success.

1.3   Thesis Sequencing

To ensure the aims and objectives of this study are reached effectively it is important for the study to follow a very structured format that creates a clear narrative. Creating this narrative involved ten clear stages within the study that are laid out within the sequence of chapters and are outlined here:

(1) The first stage sought to understand whether or not use of the optimal forager methodology had been effective as an approach to prevent and reduce crime, most notably domestic burglary (Objective 1);

(2) Having established if the approach was successful or not, there then existed a requirement to understand what the blockers and enablers within the implementation were. This is achieved through structured interviews with practitioners involved in the methodologies use as an evidence based policing methodology;

(3) The study then sought to understand if the approach could be maximized and if so, how? This stage used knowledge gathered from within the examination of research literature to establish methods (i.e. crime linking) to improve the accuracy of the optimal forager predictions used to identify areas at high risk of victimisation;

(4) Having identified crime linking as the first step in improving the effectiveness of the optimal forager predictions, it was then necessary to assess if this could be successfully conducted against foraging crimes and identify what decision making thresholds this can provide to underpin the linking procedures used by police analysts;

(5) Similarly to stage 3, this stage of the study sought to build upon the findings from the literature further by examining what underpinning assumptions exist

within ecology regarding the optimal forager that could be drawn upon to maximise the effectiveness of the police response.

(6) The next step was to form a number of hypotheses that outlined the likely manifestation of the identified ecological assumptions within recorded crime data. These were then used to apply analytical methods against that sought to enable an assessment of the assumptions presence.

(7) Having successfully identified the presence of the hypothesised ecological assumptions within crime data, the study then again called upon research evidence of other methodologies to outline potential approaches to how these behavioural assumptions, particularly the anti-predator ones could be combatted;

(8) The eighth stage of the study then sought to test the identified potential solution of geographical profiling by examining a number of crime series linked to suspected optimal foraging offenders. Doing so also enabled further conclusions to be discussed about the geographical behaviors of foraging offenders;

(9) Having established the potential for geographical profiling to combat anti-predator behaviours that foraging criminals display, the final research element of the study seeks to understand the practical implications of applying geographical profiling within the UK before the final stage by examining its operational application within the united Kingdom;

(10) Finally, the thesis synthesised all results generated during previous stages to create a theoretical model for fully realising the potential of geographically focused, predictive policing approaches to crime reduction and prevention.

For ease of understanding a visualisation of the sequencing of the thesis is outlined in the diagram on page 26 which shows how these steps were considered in the generation of the thesis and constructed together in the various chapters.

START

Is the Optimal Forager Approach Effective?
Chapter 4:
A quantitative study of optimal forager within the United Kingdom

If it is, or is not, why?

Chapter 5:
A practitioner perspective of the implementation effectiveness of the optimal foraging predictive policing methodology within the United Kingdom

How can the methods effectiveness be increased?

Could more accurately identification of linked crimes increase identification of foraging offenders through improved prediction of foraging areas?

END

Can the individual marginal gains identified be amassed to create a more effective combined predictive model?

First, can we accurately link forging crimes?
Chapter 6:
A case linkage examination of the behavioural and physical characteristics of foraging offenders

THESIS SEQUENCING

This diagram is designed to show the 'thought process' of the researcher to enable them to better understand the evolution of the study

Geographical profiling is effective, but operationally how well can it be utilised?
Chapter 9:
Assessing the effectiveness of geographical profiling as a predictive policing methodology

Do foragers behave in any other ways?

What wider assumptions are established within existing literature? Could these be used in a way to increase effectiveness?

Is geographical profiling an effective way to predict a foragers home or base?
Chapter 8:
Examining the geographical behaviour of foraging offenders

How can 'anti-predator' behaviour by offenders be combated to further improve the policing response?

Do the identified foraging assumptions exist within offender behaviour?
Chapter 7:
Testing the assumptions of ecological behaviour within foraging burglary

Figure 1: Thesis Sequencing Diagram

1.4 Contribution To The Knowledge

When exploring implemented methods of predictive policing, it transpires that most use a method based on the optimal forager theory (NPIA, 2015 pp 3). The success of this method relies exclusively on the tactic of tasking and co-ordination of police resources to produce the presence of a capable guardian, which is a fundamental criminological approach to crime prevention and reduction (Felson, 2017). However, the use of this approach and its impact on the behaviour of foraging burglary offenders has not been studied in any detail. The outcomes of this study include significant findings that contribute to a number of research gaps within criminology, psychology and ecology and these are outlined in the discussion chapter within this thesis.

1.5 Chapter Outlines

In order to fulfil the key aims and objectives this thesis will examine the evidence based policing implementation of predictive policing methods of optimal forager theory and geographical profiling within the United Kingdom using the following structure:

Chapter 2: Literature Review

The aim of this chapter is to provide the reader with an understanding of the underpinning literature that the thesis is based upon. This includes an overview of literature regarding the implementation of evidence based policing approaches to help illustrate how such models should be embedded operationally. Situational crime prevention theories are explored to provide the theoretical context of how and why such approaches are effective. The chapter will also provide an outline of literature regarding the applied crime prevention and reduction concepts within policing such as problem orientated and intelligence led policing. Traditional hotspot methodologies and the issues of crime displacement are also reviewed before outlining in more detail the concept of predictive policing. These areas are examined as they outline both the effectiveness of previous police crime control methods and also highlight implementation factors that contribute to their ultimate success. Finally, the chapter provides an outline of published literature in respect of the key areas being investigated within this study, namely the theories of optimal foraging, geographical profiling and crime linkage. Particular

attention is paid to literature that focuses on the offence type of domestic burglary.

Chapter 3: Methodology

In this chapter, the mixed methods approach is explained. It outlines the use of primary data from recorded crimes and practitioner interviews, supported by data from police evaluation reports. The chapter outlines the statistical inferential analysis techniques that have been used to conduct the research as paired one-way T-tests to analyse pre, and post intervention data, linear regression and receiver operating characteristics to assess crime linkage thresholds, chi-square tests to test identified assumptions and distance decay to underpin geographical profiles. The chapter also outlines the qualitative use of semi-structured interviews to add further richness in respect of the predictive methodologies implementations. This is done to provide the reader with a deeper understanding of the optimal forager and geographical profiling theoretical methods and their application to this research.

Chapter 4: A Quantitative Study of Optimal Forager Within the United Kingdom

This chapter's primary objective is to assess the optimal forager method's effectiveness as a crime control method. It does this by analysing recorded crime data. The data is obtained from examining electronically written, tasking and co-ordination briefings (n=50) which are used to direct police resources in a capable guardianship capacity by predicting the future location of domestic burglaries. Recorded crimes (n=2916) were then examined both before and after publication of the tasking and co-ordination briefings to identify the overall impact of increased police presence on the offending of foraging criminals. The chapter then concludes by outlining the presence, or otherwise, of ecological foraging assumptions.

Chapter 5: A Practitioner's Perspective of the Implementation Effectiveness of the Optimal Foraging Predictive Policing Methodology Within the United Kingdom

The aim of this chapter is to provide greater richness to the underlying operational conditions present within the organisations implementing the predictive policing, optimal foraging approach to burglary reduction and prevention. Doing so provides a better understanding of the efficiency of the processes and how they impact upon its overall effectiveness. This helps establish possible operational causes that relate to the methods implementation, providing possible explanations for conclusions drawn from within chapter 4. Key practitioners (n=11) involved in the implementation, co-ordination and operational delivery of the intervention were interviewed. In doing so, implementation issues such as leadership, buy in and offending behaviour were discussed. Personal perspectives are also obtained that further enable assessment of the method's effectiveness and efficiency along with the interviewees advice on improvement developments.

Chapter 6: A Case Linkage Examination of the Behavioural and Physical Characteristics of Foraging Offenders

The aim of this chapter is to explore further the behaviour of foraging offenders to enable new scientific knowledge to be absorbed into future evidence based policing responses. The chapter first briefly reviews the level of actionable intelligence available to practitioners to underpin traditional policing tactics to combat domestic burglary to articulate the necessity for more evidence-based approaches. This is also done to put into context the current difficulties with offender-based targeting methods. Crime linkage analysis is then examined in the context of optimal foraging offenders by examining pairs of linked crimes (n=200) that fall within predicted domestic burglary high risk areas. The chapter then outlines the results of regression and ROC curve analysis of behavioural and physical characteristics of the linked burglary offences. Conclusions are drawn in respect of predictive indicators for foraging burglary offenders and these are considered against the known ecological assumptions.

Chapter 7: Testing the Assumptions of Ecological Behaviour Within Foraging Burglary

Progressing findings from chapters 4-6, data from recorded crimes (n=2916) are examined both before and after intervention using the same statistical inferential analysis techniques within chapter 4. However, within this chapter the primary purpose of this was to examine the data to assess for the presence of hypothesised ecological foraging assumptions within burglary offending recorded crime data. This continues the exploration of foraging burglary offenders and the move to uncovering new evidence for enhancing future police optimal forager implementations. Existing evidence-based characteristics of crime displacement are used to help compare the hypothesised assumptions against those identified within the underpinning ecology foraging literature. The chapter then discusses the presence or otherwise of ecological assumptions within the context of foraging domestic burglary offenders. Conclusions are then drawn regarding the implications of the findings for burglary prevention and reduction.

Chapter 8: Exploring the Geographical Behaviour and Physical Characteristics of Foraging Burglary Offenders

This chapter continues to pursue new knowledge in respect of the behaviour of foraging offenders. It does this by examining examples of crime displacement (n=3) identified within the optimal forager predictive products and creating geographical profiles (n=7) of foraging domestic burglary offenders. Doing so adds further knowledge that can be used by police practitioners to create more effective geographical based crime control methods. The chapter then conducts a qualitative analysis of the domestic burglary foraging offenders responsible for the crime series conducted to better understand the makeup of the offenders responsible for this form of criminality.

Chapter 9: Assessing the Effectiveness of Geographical Profiling as A Predictive Policing Methodology

Chapter 8 identified geographical profiling as a potential predictive solution to the issue of crime displacement and another anti-predator behaviour. Chapter 8 also explored the method's accuracy and effectiveness. This chapter extends these

findings by conducting interviews with practitioners (n=5) in an effort to understand the operational effectiveness and efficiency of geographical profiling as it continues to be assessed as a predictive solution to identifying the home or base of foraging burglary offenders. Perceptions of front line practitioners (n=11) involved in tackling domestic burglary are now considered in the context of geographical profiling. This enables conclusions to then be drawn in respect of the methodology as a predictive solution to combating foraging induced displacement. Furthermore, it allows the study to further analyse the implementation of this predictive theoretical approach and continue to provide insights into how the police can better implement scientific approaches to crime control.

Chapter 10: General Discussion and Conclusions

By bringing together the observations and findings from the research conducted, this chapter discusses the conclusions in greater detail. The effectiveness and efficiency of the optimal foraging approach to predictive policing is discussed. Key themes that have had significant impact throughout are outlined and the implications for predictive crime prevention and reduction of domestic burglary are discussed. Key behavioural, physical, spatial and offending characteristics of foraging criminals are collated, and a potential combined predictive model is outlined to maximise the prevention and reduction of domestic burglary. Finally, organisational execution and evaluation recommendations are also outlined that combat identified implementation issues discussed throughout the research.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter provides a comprehensive review of the literature in existence that relates to this study. The chapter is split into two distinct sections. Section 1 provides contextual information regarding the policy and practice that surrounds the police service within the UK. This serves to contextualise the importance of the study by outlining what the current policing landscape looks like, focusing on the reduction of resources and the increasing recorded crime levels. The inspection framework is also outlined followed by a description of policing's professional practice and traditional policing methods that are used to help prevent and reduce crime such as intelligence led policing, problem orientated policing (POP) and most recently introduced, the concept of predictive policing. The second section of the chapter focuses upon the academic influences that have driven the motivation of the study and briefly explores their key contributions before outlining the drive for further research, and in what areas. The section then delves into the operational application of theory within policing and specifically focuses on material that relates to evidence-based policing and the relevant enablers and blockers. Finally, the section then outlines the specific research evidence that relates to the study including material relating to hotspot policing, predictive policing, geographical profiling and also a review of relevant criminological literature that relates both to the environmental influences within crime and the predictive aspects of human development.

2.2 Method

The search strategy for this study was very organic. As a serving police officer whose role specifically involved the subject area being studied, a high degree of familiarity already existed with the concepts within the literature and evidence. To a large degree this familiarity underpinned the initial search terms which are highlighted in the full literature search strategy within appendix 5. After beginning the examination of material identified through the initial literature search the identification of further material then naturally followed. From this material the remaining search terms were identified and completed. Importantly, the literature chosen was not restricted by that solely drawn from the search terms which would likely have been too restrictive.

Further material was sourced by a method of following literature from one study to another. For example, if the literature outlined or referenced material within it and this material was perceived to have potential value then it was examined in further detail. This was done through a brief examination of the abstract and introduction to ascertain if it met the inclusion criteria outlined in the search strategy before examining it in more detail. In an effort to provide the reader with a 'head start' in contextualising the literature review and enabling an early understanding of how it begins to shape the study, a diagram is shown below that provides an overview.

2.3   Policing Landscape

It has been suggested that there is a lack of a clear definition of 'police' (Benyon et al, 1994) but several scholars have outlined the authorised use of force to maintain or establish control as a characteristic for defining the police (Goldstein, 1977). Others have suggested a more overarching definition and described police as those that investigate and control crime as well as maintaining order (Reiner, 2000). Further to this description it has been suggested that ultimately it is not simply the presence of police that maintain order but the presence of effective and active 'policing' through many different approaches (Bowling and Foster, 2002). Viewed in this context it is entirely understandable that the methods, styles and tactics used to carry out policing can have varied results, as simply being omnipresent is not enough to maintain order. This is why identifying effective evidence-based approaches to the tasking and coordination of police resources is important to the success of 'policing' as it offers a framework to increase the effectiveness of the police.

It has been suggested that the international economic crisis experienced post 2008 has heaped further pressure on UK police services with their operational budgets being reduced significantly (BBC, 2018). The vast majority of police services have had to reduce expenditure by up to 20 percent and further budgeting cuts are being proposed as far ahead as 2020. As a result, there is revitalised pressure on UK police services to find further ways of increasing their effectiveness and this pressure of austerity has forced tentative steps into what has been termed 'predictive policing' to enable the police to better protect communities before they are victimised (NPIA, 2015).

However, such developments are easily hampered within the current policing landscape surrounding UK police services. It could be argued that this is in large due to reduced resources; however, austerity has also placed upon services an emphasis on cost reduction and it could be argued that some police forces have responded with *'carte blanche'* reductions in staff and officers across all business areas within policing with little regard for anything other than hitting designated budgetary reduction targets. The conservative government that has largely overseen the scaling down of the policing budget have been resolute in their stance to police services and repeatedly argued that there is much waste to be cut and effectiveness to be increased without jeopardising the service they deliver. Much of this effectiveness it is argued can be attained by investing in smarter ways of policing, drawing on evidence-based practice and theoretical concepts that provide a greater '*bang for your buck'.* However, unfortunately, in many police services this form of cost saving has created an absence of the appropriate people and skills within the service to make evidence-based practice successful which it has been argued has reduced an already slim number of relationships between academics and the police service (Goldstein, 2003; 25-34).

2.3.2 Policing Inspection and Policy Framework

To fully understand the landscape within the modern police service and some of their motivation behind attempts to integrate evidence-based practice it is necessary to articulate the drive for effective methods for enhancing policing performance. This drive is in large fueled by an inspection regime, which is not uncommon within public services, especially within the United Kingdom. By briefly outlining the evolution of how the police have historically managed their performance and how they are now inspected and monitored adds context that underlines the importance of this study. In doing so the value of the research can be fully appreciated as it seeks to maximise the crime reduction and prevention effectiveness of ever decreasing resources.

The emergence of focus on the performance of police services within the UK originated from concepts utilised within the private business sector in the late 1980's (Crawford 1997:88). Police services became under increasing scrutiny

and political pressure to offer transparency to their communities through the publication of crime statistics which underpinned publications such as the British Crime Survey (BCS). Although many surveys showed a general decrease in crime within the UK in the preceding decades, police services were under ever increasing pressure to offer greater value for money (Ratcliffe 2008: 19).

Within the United Kingdom all police services are inspected by Her Majesty's Inspectorate of Constabularies and Fire and Rescue Services (HMICFRS). Police services are graded between inadequate to outstanding on a range of thematic areas and on their overall Policing Effectiveness, Efficiency and Legitimacy, or PEEL as it is known. Furthermore, the police are governed by the National Police Chiefs Council (NPCC) who are responsible for setting national best practice, guidance and policies. The NPCC was formerly known as the Association of Chief Police Officers (ACPO). The professional body for the police service is the College of Policing (CoP) who set the approved professional practice for areas within policing and manage the 'what works centre' of evidence-based practice, an archive of studies that have been systematically shown to increase the effectiveness of the police to prevent, reduce and control crime and anti-social behaviour. The power and influence of these bodies is great within policing and collectively they carry a large responsibility for the continuous professional development of the service.

This study is in large driven by the need to increase the police service's effectiveness and in doing so, evidence this to the inspectorate in an empirical fashion. This is not the first time that these agents of power within policing have been a catalyst for change. There is a steady trend of the policing inspection and policy framework influencing practice (Loveday, 2006).

What can be described as the instigator of modern day intelligence led policing was the 1975 Association of Chief Police Officers (ACPO) subcommittee commissioned report on Criminal Intelligence. This report is more commonly known as the Baumber report (1975). The report was an assessment of the state of the United Kingdom's intelligence structure and produced a total of 79 recommendations to redirect the UK's policing model (Baumber: 1975). That said, the report was not widely utilised or acted upon. Shortly after, ACPO

produced a second paper in 1978 entitled 'The ACPO Working Party on a Structure of Criminal Intelligence Officers' which was a further attempt to offer avenues for change in modern Policing structures (ACPO, 1978). Again, in 1986 ACPO produced the 'report of the ACPO Working Party on Operational Intelligence' which was more commonly known as the Ratcliffe report (1986). This report again reiterated many of the key issues raised in the Baumber report and the 1978 report and also outlined the fact that ultimately nothing had changed, which it cited was due a total lack of comprehension of the fundamental directions in the Baumber report (ACPO, 1986:14). Along with numerous further recommendations the Ratcliffe reports key directive was the introduction of an intelligence grading system (ACPO, 1986) which came to be one of the key elements of the National Intelligence Model (NIM). These reports all shared the drive to become more efficient in using intelligence to direct policing activities in an effort to increase effectiveness. These reports also highlighted resource constraints and the negative perception of criminal intelligence, but these issues were not acted upon at the time of commission. This was because at that time there was simply no impetus or catalyst to change current policing methods.

Such an impetus only began to emerge during the late 1980s when recorded crime rates began to soar; it is at this stage we began to see the influence of the HMICFRS, NPCC and the Home Office in driving change within policing. As early academic literature studying policing began to flourish in the late 1980s and early 1990s, reports were commissioned by these agents of policy and inspection. One of the first of these reports was the Audit Commission's 'Helping With Enquiries: Tackling Crime Effectively' which provided strategies for integrated approaches to dealing with crime and methods of targeting the offender as opposed to responding to the crime (Audit Commission, 1993). Along with other reports (Audit Commission, 1993), HMIC produced in 1997 'Policing With Intelligence' which advocated the use of intelligence gathering techniques to further focus the use of Police resources into more proactive methods of crime control. HMIC as it was then known, also produced 'Closing the Gap' in 2005 which highlighted, that despite the advances in policing in the late 20th century changes were still required. This report by HMIC placed a high value on the gathering of intelligence and the expertise used to analyse it and identified that changes in the police

services approach were still required to meet the demands of volume crime (HMIC, 2005: 6) and provided a number of options for change.

It was at this time that the HMIC adapted their inspection framework to account for the use of the NIM within their operational activity. Due to the rising public interest in the performance of police services and now readily available data by which to assess them, the NIM was widely adopted and is now recognised as the primary policing model by most police forces within the United Kingdom.

It could also be argued that the NIM has been responsible for defining intelligence-led policing as we see it within the UK. The NIM has been successful in standardising intelligence processes through advocating analysis of problems and intelligence to achieve outcomes such as reductions in crime and the control of disorder through a process of strategically and tactically tasking resources to maximise their effectiveness (NCIS, 2004).

There were three key factors which served to influence its wide adoption and evolution. Firstly, was the rise in crime rates and lack of resource increases to match, combined with the failure of traditional policing models to address the issue, resulting in what has been described as 'The Demand Gap' (Ratcliffe, 2007:2). Second was the need for a more professional, business minded approach to policing (Ratcliffe, 2007:2) brought about through the realisation of a requirement for value for money and greater efficiency, both concepts advocated by governmental assessments such as the Audit Commission and HMIC. Finally, we see the influence created by the emergence of organised crime and geographic restrictions on the police, creating a greater necessity for collaboration and consistency within law enforcement. The combination of all of these factors ensured the adoption of intelligence-led policing as the most strategic, future orientated and targeted (Ratcliffe, 2008:11) of all the emerging Policing models whilst also offering the most efficient use of resources and the value for money so greatly required and the focus of the inspectorate framework.

2.3.3 Professional Practice Within Policing

Having outlined the inspection and policy framework that surrounds modern policing, important additional context can be provided by articulating the working practices that police services conduct in an effort to achieve efficient and effective crime prevention and reduction. The professional practice of crime control within policing has evolved over the past several decades. Clarke (1997) outlines that crime reduction and its prevention is commonly conducted in four ways. Firstly, this can be done by target hardening potential victims by increasing the effort it takes to commit a crime, for instance, by improving security measures. Secondly, by reducing the rewards of criminal behaviour, for example by placing identifying markings on property to reduce its value. Thirdly, by rule setting through clear legal restrictions on behaviour and increasing awareness of the consequences, for example domestic violence or drink driving. Finally, increasing the risk of crime for the criminal by improving the likelihood of apprehension or detection. In the main it is the use of the final method of crime prevention outlined by Clarke that this study seeks to maximize. Increased risk for the offender is most commonly achieved by increasing the policing presence within areas of high crime, areas which the literature has identified as commonly being referred to as 'hotspots' (College of Policing, 2018). High levels of crime are most generally experienced in relatively small geographical areas referred to as hotspots and as such the increase of policing presence in a crime fighting capacity in these areas can have a significant positive impact on crime reduction (Braga 2002; Eck 1997, 2002; Skogan and Frydl 2004; Weisburd and Eck 2004). This study will evolve to suggest improved models for achieving such an environment.

2.3.4 Traditional Policing

In the past several decades policing has undergone a number of major changes in the way in which senior policy makers and decision makers approach the business of crime reduction and prevention. The traditional approach to policing has historically focused on being reactive rather than pro-active and can be brought together under several key strands consisting of investigation and detection, random patrol and response and finally, stop and search (Karn, 2013).

The investigation and detection approach to policing is based around the accumulation of evidence in reaction to a crime. Once an offence has taken place resources are deployed to gather witness accounts, CCTV or forensic evidence such as fingerprints and more recently DNA, all for the purpose of identifying a suspect. Once the suspect is identified they can be arrested with a view to a successful prosecution and in the best-case scenario a conviction and prison sentence (Karn, 2013) It is entirely appropriate and proper that the police use this technique to investigate crime and the fact that many crimes cannot be predicted or prevented means that it shall and always will remain a key part of policing. However, this approach is often lengthy and with a large number of crimes remaining unsolved it is not entirely effective as a stand-alone policing approach (Telep & Weisburd, 2012).

Police patrolling has been a part of policing since its inception and will likely always remain so in one form or another. At its inception, the traditional approach to police patrolling was heavily concentrated towards officer foot patrolling (Karn, 2013). Such patrolling had a highly positive impact on public confidence and is widely believed to prevent crime and ensure community safety (British Crime Survey, 2003; Noaks, 2000). However, early research has shown that it is highly ineffective unless it is very focused and targeted (Koper, 1995), and early reserch has suggested that it is in fact more about reassurance rather than crime prevention (Clarke & Hough, 1984; Kelling, 1981). Even when such patrols were targeted they were done so based on what Ratcliffe defines as *'old intelligence'*, being information obtained from traditional sources such as police informants (2002:3) as opposed to new intelligence, being that retrieved from open sources such as the internet and social networks (Ratcliffe, 2006: 4-5).

Finally, the use of stop and search is also a traditional technique used by the police service, especially within the UK where its use is a highly controversial issue. The police use this tactic as a method of detecting drugs, weapons and stolen property and although the law relies upon the techniques used to be based on facts, it is widely used to disrupt criminal behaviour. Empirical analysis of the effectiveness of this approach has shown it to be highly ineffective with some research suggesting it's disruption ratio to be as low as 0.2% (Miller et al., 2000).

Rossmo (2000) has outlined that firstly, the occurrence of a crime or crime series is necessary to begin the process and generate police activity. Once a crime has occurred the second stage of the policing process best described as the policing response begins. An investigation is conducted to identify the person responsible and the police utilise an array of what have been described as 'traditional' response and investigative techniques (Rossmo, 2000) to identify, apprehend and prosecute offenders. Such techniques are a key part of the crime fighting function and through rehabilitation and incarceration do have an impact on crime reduction and prevention. Currently there is nothing that can be described as a theory of investigation, this is quite simply because there are so many variables within criminal investigation that it would be a practical impossibility. Instead, within the United Kingdom this stage of the policing process operates in line with guidance produced by the ACPO. The guidance is utilised across all 43 Police services in England and Wales and is outlined in a number of pieces of literature. These include the Manual of Gun Crime Investigation (ACPO, 2005), The Murder Investigation Manual (ACPO, 2005), The Journal of Homicide and Major Investigation (ACPO, 2005), The Major Incident Room Standardised Admin Procedures (ACPO, 2005) and the Core Investigation Doctrine (ACPO, 2005).

The most overarching of these guidance manuals is the Core Investigation Doctrine. This manual sets out the guidance to front line investigators on how to investigate an array of crimes. The doctrine outlines key considerations for investigators such as the use of CCTV, exploiting forensic opportunities, telephony investigation, obtaining of witness evidence and the interviewing of suspects (ACPO, 2005). In essence the manuals provide a 'tick box' for officers conducting investigations into crime however the practicalities of conducting such investigations changes from jurisdiction to jurisdiction. Other traditional investigative techniques include the gathering of intelligence and information or research on police databases for modus operandi matches to generate suspects or postal code prioritisation if for example a vehicle make, and model is known (Rossmo, 1995).

Thirdly, whilst an investigation is underway the police will simultaneously seek to prevent or reduce the reoccurrence of further crimes. Traditional approaches to the response process are undertaken and these are outlined by Rossmo (2005)

as effectively being 'patrol saturation'. This is the identification of a crime hotspot and the subsequent police response which often manifests itself in increased patrolling, leaflet drops and canvassing to identify an offender or prevent further crimes (Rossmo, 1995) and on occasion a problem-solving approach. Problem orientated approaches are also outlined later in this chapter on page 43 where it outlines how they seek to address the underlying causes which may contribute to the crimes.

An examination of the CoP crime reduction toolkit which can be located on their website (CoP, 2018) is the policing professional bodies own assessment of 'what works' in respect of crime prevention, reduction and investigation. A review of this helps to illustrate the limitations of the polices responses with an examination of interventions for acquisitive crimes including burglary, robbery, theft and vehicle crime outlining only 9 potential intervention responses. Further examination highlighting traditional responses that are assessed as working or having promise to do so, outlines just 8 approaches. This includes the use of environmental design preventions including the use of closed circuit television, alley gating and street lighting, along with the POP approach, neighbourhood watch schemes and tagging of items within retail stores.

It is clear from this brief overview of the policing process that present responses only very rarely and in the most serious cases go beyond the traditional response and investigative techniques stage and focus predominately on long established and traditional methods of crime control.

2.3.5 Intelligence Led Policing

Intelligence led policing emerged as a framework for professional practice within policing in the late 1980s and was an early effort to ensure that the police adopted an evidence-based approach to the pro-active and re-active responses. The very foundations of intelligence led policing were however founded in the formation of the early British police service and the emphasis has changed very little ever since;

"*The primary object of an efficient police is the prevention of crime: the next that of detection and punishment of offenders if crime is committed. To these ends all the efforts of police must be directed*" (Mayne: 1829)

It has been identified that in recent years the gathering and analysis of information to create intelligence has become an activity that is central to modern day policing and is a formidable tool within crime prevention (Bayley and Shearing, 1996:591) and no longer an activity conducted solely by national security agencies. It is the analysis of the intelligence obtained that underpins the core concept of intelligence-led policing by providing those involved in policing the means to formulate priorities based on information with tested provenance and not "experience" (Flood, 2004:43). Because of its continually evolving nature it is hard to define intelligence-led policing, but Sheptycki describes it as:

"The technological efforts to manage information about threats and risks in order to strategically manage the policing mission" (Sheptycki, 2005:3)

Ratcliffe goes further by offering a broader definition of intelligence-led Policing, describing it as:

"A business model and managerial philosophy where data analysis and crime intelligence are pivotal to an objective, decision making framework that facilitates crime and problem reduction, disruption and prevention through both strategic management and effective enforcement strategies that target prolific and serious offenders" (2008:89)

It is clear that central to both definitions is the management or analysis of information or intelligence to assist in strategic decision making. Although there are certain sceptics of intelligence-led policing who believe that it is simply traditional random patrol policing with a makeover (Ratcliffe, 2008:10; Tilley, 2003), it could be suggested that the basic concept is flexible enough to be used to address most policing problems. Be it criminal offender orientated targeting or anti-social community-based problems, intelligence-led policing and other modern methods such as the problem orientated approach are closely linked and

could all benefit from an intelligence approach that focuses on multiple information sources (Ratcliffe, 2008:10, Tilley, 2003).

Although the basics of intelligence-led policing have been present for many years, dating back as far as the 1880s (John and Maguire, 2007:193), it was not until the late 1970s and early 80s when policing intelligence was fully examined during a number of reports commissioned by the Association of Chief Police Officers (ACPO, 1975, 78, 86). As a result of these reports a governmental drive to adopt the intelligence-led policing (ILP) approach began and the National Criminal Intelligence Service (NCIS) produced the NIM which they first referred to in its most basic form in their annual report in 1995-1996. NCIS subsequently formally published the NIM in 2004.

The NIM advocates a joined up professional practice to tackling policing issues and set out three operating levels of policing, level 1 being local, level 2 regional and level 3 national and international (NCIS: 2004). Described as a business model the NIM places the gathering, analysis and use of intelligence at its core and provides a three-tier structure to grade the reliability and dissemination instructions of the intelligence (NCIS: 2004). The NIM also outlines a structure for police forces to set priorities at strategic and tactical levels and finally outlines an approach to identifying crime hot spot areas, setting problem profiles to address these issues and also how to target prolific offenders proactively (NCIS: 2004). This is in line with the academic theory which believes there should be four key principles of any crime strategy and outlines these as the victim, volume crime, criminal specialists and criminal leaders (Flood, 2004: 57-59).

2.3.6 Problem Orientated Policing

Emerging at roughly the same time as the move towards a more intelligence led police service within the UK, the concept of (POP) was devised. This form of professional practice cites the necessity for partnership working whereby the police service and local authorities work together to identify and address underlying issues and causes of crime. Tilley has published extensively on the subject of POP and outlines that the theory examines pinch-points in information, acknowledges repeat victims as a key issue, uses concentrated 'crackdowns' to tackle policing problems and requires the use of information analysis (2003:2).

Extensive research has shown that the POP approach is successful at reducing crime and disorder, especially in intervetions that have combined the approach with environmental criminology such as placing CCTV within targeted car parks or on homes and businesses (Braga 2007; Clarke, 1997; Clarke and Goldstein: 2002 and 2003; Curtin and Tilley et al: 2001; Fisher: 1993 and 2004; Goldstein and Susmilch: 1982, Leigh and Read et al: 1996; Payne and Gallagher et al, 2013; Rossmo and Fisher: 2004 and Saville and Rossmo: 1995) It is also now universally accepted the involvement of partner agencies and the community is key to identifying and implementing long term solutions (Goldstein & Susmilch: 1982, Zanin & Clarke: 2004, Clarke & Goldstein: 2002).

Early case studies of its implementation quickly identified that POP in many circumstances increased police efficiency, reduced costs and increased partnership working. The success of these studies went on to drive the early uptake of POP. Sidebottom and Tilley conducted two major reviews of UK police services use of the POP model (2010; 2011). Both these studies identified partnerships as being key to the success of POP (2010) and recent research has continued to support this (Payne et al, 2013). These early studies have also played a major part in the development of the SARA model of scanning, analysis, response and assessment which went on to be the standard process of professional practice when developing POP solutions and was used by the vast majority of subsequent POP related literature. The centre for problem oriented policing (2018) outlines that the scanning element of SARA involves the examination of information, crime trends and patterns to identify problems. The analysis phase then examines the finer grain detail to concentrate solutions by identifying for instance specific times, dates and proximity to environmental or geographical points of interests. The response element of SARA is the operational phase which concentrates on identifying solutions to the identified problem, the success of which can finally be assessed.

It has been suggested that the professional frameworks for the use of POP should be adopted in conjunction with ILP. In reviewing the NIM, Tilley identified that although ILP is a system of professional practice primarily devised to handle criminal intelligence it can be used to underpin both POP and ILP. Tilley suggests that a POP orientated NIM process would examine a range of issues and would

direct analysis to consider an equally large array of solutions (2004:4). Most significantly, Tilley suggests the contrast to an ILP orientated NIM would be its absence of traditional enforcement tactics and evaluation through analysis of POP effectiveness using holistic indicators such as crime reduction rates, increase in public confidence and decrease in harm to the community (2004). This is a direct contrast to ILPs focus on enforcement and the use of arrest, detection and prosecution as indicators of success but shows how the NIM process could be adapted to direct, control and resolve a wide number of community-based issues (2004:4). In reality, within the current UK policing landscape both professional practices are used in conjunction but on an ad hoc and often ill co-ordinated fashion.

2.3.7 Hotspot Policing

Broadly speaking, the aim of hotspot policing is to concentrate the professional practice of police patrolling on identified areas of high crime using usually small numbers of both high visibility and plain clothed, covert police resources (Bragga, 2007). It was suggested early within its inception that resource increases of 50% into the affected areas can have a similarly large effect on the reduction of crime and demand placed on police resources, in some examples reducing disorder by as much as half with its highest impact being in areas of high levels of drug associated social problems (Sherman and Weisburd, 1995). However, research evidence since that time suggests that more often hotspot policing approaches provide modest decreases in recorded crime (Braga, Papachristos, Hureau, 2012). It has been suggested that this is because its impact is dependant on the situations the hotspot approach is used in and that it is most effective when combined with heavily resourced, high visibility and zero tolerance methods of crime control (1999). Conversely, evidence suggests that the issue regarding which tactics are most effective within a hotspot has not been fully examined and required more robust investigation (Taylor, Koper and Woods, 2010). This has been attempted previously, most significantly in a 1995 (Koper) study which tested three concepts: (1) that controlling disorderly behaviour can reduce fear and more serious crime; (2) that police can reduce disorder and crime by increasing their presence at hot spots where such behaviour is concentrated; and (3) that the presence of an officer in a hot spot has the effect of deterring

disorderly and criminal behaviour even after police depart (Koper, 1995). The conclusion of the study was that the deterrence impact of police presence within an identified hotspot had maximum effectiveness after 10 minutes, peaking at 15 minutes and then diminishing as police presence increased (Koper, 1995). In discussing the Koper Curve the Police Foundation have stated;

"When combined with situational and problem-oriented policing strategies implemented by patrol officers and other units or officers, hot spots policing using the Koper Curve Principle can enhance policing effectiveness, thereby substantially reducing crime" (Police Foundation, 2018)

As alluded to above, hotspot policing is most commonly underpinned by and combined with other methods of professional practice that drive crime control which have been covered in this chapter such as POP, and adoption of the NIM. Limited empirical evidence has supported the claim that the makeup of its combined approach and the type of crime it is targeting for reduction does impact its effectiveness. For instance, it has been argued that it is most effective at tackling issues of violent crime and disorder when combined with a problem orientated approach (Sherman et al 1989, Sherman & Weisburd 1995, Criminal Justice Commission 1998). This is because such crimes are most often associated to an environmental factor such as the presence of a problem nightclub or drug dealers home for example which more easily lend themselves to tactical approaches that can address these issues head on. In contrast, the combined hotspot and POP approach is least effective in tackling volume acquisitive crime types such as burglary and vehicle crimes (Caeti, 1999: 319-322). This correlation is understandable considering the difficulties of tackling at source some of the main causes of these forms of crime, for instance, how does one prevent home and vehicle owners from leaving their doors and windows open? That said, a multitude of empirical studies (Caeti, 1999; Eck 1997; Lum, Koper and Talep, 2011; Ratcliffe and Taniguchi et al, 2011; Sherman & Weisburd, 1995; Skogan & Frydl 2004; Weisburd & Eck 2004) have shown that this combined approach does have a positive effect on the reduction of crime in the identified hotspot area, albeit less that when combined with environmental interventions. Singular studies have had their conclusions corroborated by much more up to date, larger meta analytical systematic reviews which ultimately show

that the method has significant, albeit modest crime reductions but importantly, that the reductions go beyond the targeted area, diffusing into surrounding locations (Braga, Papachristos and Hureau, 2012).

Newer research also includes the potential to impact upon harm caused to victims as opposed to simply recorded crime rates when using the hotspot approach. In theorising this the Cambridge Harm Index (CHI), which is an assessment of harm to the victim based upon the length of custodial sentence on conviction, is used to illustrate concentration is within extremely definable areas (Weinborn et al., 2017). Recorded offence hotspot methods have shown that half of all crimes can be concentrated in just a 3% geographical area, but this study showed that when using the CHI as the measurement, this concentration is reduced to just 1% (Weinborn et al., 2017). This finding suggests that if policy can be adapted to direct police resources based upon harm, there is also potential to prevent and reduce the impact to victims of serious harm crime.

Regardless of the level of impact or form of its use, this approach does have efficiency and effectiveness benefits and for this reason has become a mainstay of the modern professional practice within policing in their efforts to prevent and reduce crime and is recognised as such by the CoP (CoP: What Works Network, 2018).

2.3.8 Predictive Policing

Predictive policing is the newest professional practice within policing and is viewed by many as the next stage of evolution within law enforcement. Its ethos is centred around using data and information to predict issues before they arise so that measures can be taken to prevent their occurrence (Beck and McCue, 2009). The practice moves beyond simply using historical crime information to identify areas of high crime which is how the method of hotspot policing is conducted. Essentially predictive policing aims to predict where crime is going to occur before it has even happened. As with the previous policing models discussed in this chapter, there is no universally accepted definition of what predictive policing is but Uchida (2009) has defined it as:

"Any policing strategy or tactic that develops and uses information and advanced analysis to inform forward thinking crime prevention".

The complexity of the predictive approach can differ and could be as simple as analysis of historical crime data in conjunction with time and spatial patterns to predict where future crimes are most likely to occur (Kennedy et al., 2011). In contrast, a more complex method might also take into consideration criminological theories such as routine activity and include the home addresses of known offenders, under the assumption that they are most likely to commit crime close to their home or base (Kennedy et al., 2011). It may also even include topographical and environmental factors that can help identify areas of heightened vulnerability (Kennedy et al., 2011). Academics have studied the correlation between crime and place for some time and predictive policing advances this research by building upon the existing academic and theoretical insights.

Within the current policing landscape of austerity and finite resources, combined with an inspection and policy framework that praises efficiency and effectiveness of resources in pursuing crime prevention and reduction, it is easy to see why this practice would be enticing to police services. Furthermore, early academic research, although extremely limited, shows some genuine potential for success, especially when used to target volume acquisitive crimes such as theft and burglary offences (Baxter, 2012 & Addis, 2013). However, there is a significant lack of research examining the approaches effectiveness and absence of theories on how to improve and refine the practice. As such, this is primarily the research and literature gap that this study seeks to fill.

2.4   Academic and Research Literature

The previous section of this chapter examined the current policing landscape, the inspection and policy framework within the United Kingdom and the place based professional practices within the UK to prevent and reduce crime. In doing so it has been possible to articulate the motivation and necessity of this study. This section now seeks to outline the academic influencers and influences, current research evidence and issues regarding operational application of theories and methods of crime control and prevention that have all underpinned the research conducted.

2.4.1 Academic Influences

Rossmo's Policing Framework

Rossmo has been a key influencer within predictive methodologies of criminology and as such emerged as a key academic influencer for this study. Rossmo's professional framework of policing (2000) outlined that the occurrence of a crime, its investigation, patrol saturation and problem solving are the primary practices police services focus on. However, he has argued that other practices exist that can further increase their efficiency and effectiveness. Rossmo (2000) suggests that crime linkage analysis provides investigators with a clearer picture of the criminality being addressed and also multiplies opportunities for traditional investigative techniques to identify offenders. Rossmo (2000) further argues that criminal profiling provides further benefits and can be utilised to narrow long lists of potential suspects are identified within a profiled area. Rossmo (1995) also suggests that the use of a criminal offender profile assisting to reduce the list of suspects and also help produce a priority list, identifying those most likely to have committed the offence (Rossmo, 1995; 159) can further enhance a response. Geographical profiling is further advocated which enables the policing response to increase its effectiveness and likelihood of preventing or reducing further crimes through earlier apprehension or disruption of the offender than standard patrol saturation (Rossmo, 1995).

Harcourt provided one of the first efforts to implement a scientific approach to crime prevention and reduction. His approach was made famous as a result of the apparent success of the New York Police Department during the administration of Mayor Rudolph Giuliani in the early 1990's. The approach was called the broken windows theory. In its simplest form the theory argues that the most minor of crimes or disorder infringements such as drinking in public, low level graffiti and criminal damage, if left un-tackled evolves into more serious crime types such as robbery, burglary and serious violence and disorder (Harcourt, 1998). The theory emerged mainly as a result of a single study by Wilson and Kelling in 1982. The theory was adopted by Former New York City Police Commissioner Bratton who cited the theory as his inspiration for all of his crime prevention initiatives and lauded it as responsible for the crime reductions experienced in New York during his office (Harcourt, 1998). During this time, the NYPD concentrated on prosecutions for the aforementioned minor crimes and as such a drop in more serious crime types was experienced (Harcourt and Ludwig, 2005).
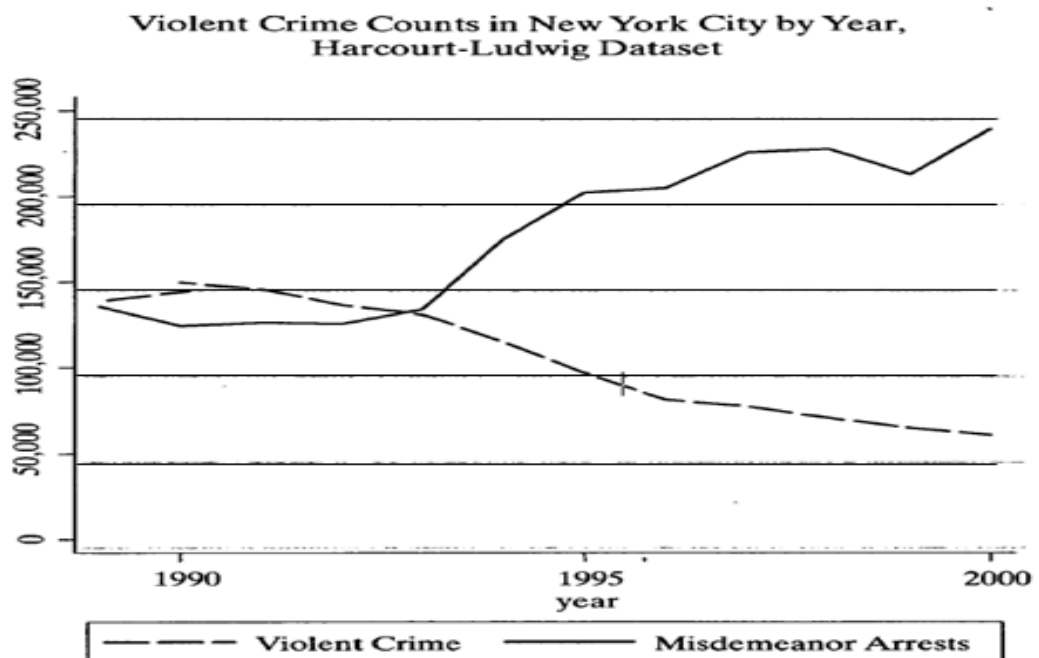
Figure 2. The Harcourt-Ludwig Dataset of Violent Crime Counts in New York 1990-2000 (Harcourt and Ludwig, 2005)

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This can be seen in the above chart produced by Harcourt and is cited as the main basis of the broken windows 'empirical' stance. However, research has shown that ithe broken windows phenomena is simply a form of hotspot policing and that contrary to the claims, very little empirical evidence exists to support it (Howell, 2012). Also, research has shown that such an approach to the prosecution of low-level offending can actually have a very negative impact, particularly on public confidence and that the costs associated with the prosecutions of such high levels of minor offending outweigh the benefits (Howell, 2012). It has also been suggested that there is no actual empirical link between low level disorder, incivility and offending and its evolution into more serious crime types (Magdalena et al, 2009; Mathews, 1992). Despite these criticisms the influence of the approach in raising the profile of scientific crime control methods cannot be overlooked.

Herman Goldstein and Problem Orientated Policing

The concept of POP emerged in the late 1970s and is universally accredited to the early work of Goldstein. Because of the extensive use of POP within the UK and the depth of research and literature within the field, both Goldstein and POP became significant influences on crime prevention and reduction within policing, and as such have rightly influenced this study heavily. Goldstein defines POP as;

> "A*n approach to Policing in which each discrete piece of Police business that the public expects the Police to handle (referred to as a 'problem') is subject to careful, in-depth study in hopes that what is learned about each problem will lead to discovering a new and more effective strategy for dealing with it"* (Scott, 2016)

Goldstein believes that the current methods of policing are generic and essentially follow a standard pattern of patrol, investigate, arrest and prosecute with little examination of the problem they are confronting or what they seek to achieve (2003; 21). He goes on to suggest that as and when an emerging threat arises, all too often, law enforcement agencies simply 'knee jerk' in their response through increased patrols or target hardening with no long-term plan to address, reduce or prevent the underlying causes (2003; 21). As outlined

earlier in this chapter, in contrast to this traditional approach, Goldstein's theory relies on solutions that encourage the involvement of non-law enforcement agencies (partners), provides solutions which concentrate on prevention and importantly identify the use of the criminal justice system as a key tool (2003; 14).

Since Goldstein's original theory was outlined a relatively small number of key authors have sought to develop his work and have emerged as key influencers within policing literature. Their research can be broadly split into two distinct areas. Firstly, there is the extensive list of case studies which have reviewed operational attempts to utilise POP to develop solutions (Braga 2007, Clarke: 1997, Clarke & Goldstein: 2002 & 2003, Curtin & Tilley et al: 2001, Goldstein & Susmilch, 1982; Leigh & Read et al: 1996; Payne, Gallagher, Ecak & Frank, 2013, Rossmo & Fisher, 2004, Saville and Rossmo: 1995). Many of these case studies have either been produced directly or commissioned by government agencies (Harocops & Hough: 2007, Leigh and Tilley, 1996 and Scott: 2016). The second category is the numerous publications by authors from both academic and law enforcement backgrounds who have aimed to conduct reviews of the subject (Bullock & Tilley: 2009, Eck, 2014, Goldstein: 2003, Payne and Gallagher, 2014, Scott: 2016, Sidebottom & Tilley: 2011; Tilley: 1996, 2003, Weisburd & Eck: 2004). These are further complemented by a number of systematic reviews that conducted detailed meta-analysis of such implementations (Braga, Papachristos and Hureau, 2014).

To ease the transition to a POP culture, Tilley (2002) produced a guide on the implementation of POP solutions. In 2003 Tilley built on this piece of work and produced a structured step by step guide on how to analyse and identify the issues underlying street crime problems, and on how to implement solutions and review their success.

Doing so helped police services address common crime issues such as vehicle crime within city centre car parks, commercial burglaries in retail developments and drug supply in suburban residences (Tilley, 2003). Furthermore, they have shown that the changes put in place often had minimal impact on the day to day demands of police departments if incorporated effectively. They were also cited

as having significant impact on reducing offending and as such evidenced the fact that crime reduction and prevention approaches could be utilised with minimal financial support to produce reductions in crime and disorder (Scott, 2016). In addition, that implementation of such solutions created long term reductions in crimes committed (Scott, 2016).

2.4.2 Academic Drive for Research

One of the most significant influences on this study has been the recurring call from academics within criminology and policing studies for the provision of further high-quality research regarding crime prevention and reduction. Scholars have cited a multitude of reasons as to why continued research is required. For example, a 2008 review of the POP model conducted by Weisburd et al cautiously concluded that POP is a successful method to reduce crime but there were however, caveats attached to this conclusion. One of the initial objectives of the review was to delve deeper than previous studies in reviewing and analysing POP literature using a meta-analysis approach. However, their review identified that there was simply insufficient literature in this field to produce such an analysis (2008:9). This is a worrying conclusion and as Weisburd et al stated:

> "*The absence of a wide body of evidence in the area of problem-orientated Policing is particularly concerning*" (2008:10)

The ultimate objective of the study by Weisburd and Eck was to assess if the police process of identifying and implementing tactical solutions to crime and disorder had been successful (2008:9). The conclusion of their study produced some surprising results. Firstly, Weisburd et al argued that the effectiveness of the POP approach, although possessing benefits, provides far less impact than many academics profess (2008:31). They identified an aggregate reduction in crime and disorder of between just 0.10-0.20 (2008:31). Weisburd et al also outlined that although the benefits are consistent and its level of impact and frequency statistically significant, it is difficult to describe these results as comprehensive (2008:33). This is due to the 'case study' approach to the examination of POP which has produced a lack of studies conducted in conditions suitable for legitimate comparisons (2008:33). Weisburd & Eck et al also concluded, most notably, that due to the lack of studies in this field they

cannot identify statistical conclusions regarding the effectiveness of specific tactics for specific problems (2008:33). Weisburd et al are in fact extremely damming in their assessment of this issue and assert;

> "*We think it a major public policy failure that the government and the police have not invested greater effort and resources in identifying the specific approaches and tactics that work best in combating specific types of crime problems. The portfolio of studies that exists is at best serendipitous, and does not represent any concerted public effort to either assess the effectiveness of problem-orientated Policing as an approach, or understand the mechanisms that would make it more successful*"
> (2008:33)

Goldstein goes on to outline that he believes further development within policing is still required (2003; 23). He believes that if advances are achieved that the benefits would include identifying new strategies for resolving problems, reduce reliance on the criminal justice system, increase relationships with non-law enforcement agencies and also build new partnerships (2003; 25). To achieve this, Goldstein believes that each police service has to 'experiment' to devise how to implement such prevention and reduction strategies at a local level (2002: 64). Ratcliffe has also identified that there is an absence of empirical research into emerging policing models stating;

> "*There is an absence of theoretically informed, empirical studies into the effectiveness of policing strategies, not least of all due to a lack of theory informing the strategy itself............Policing in turn may need to be more open to academic involvement and would appear to be in need of guidance to turn more tracts of the new paradigm's rhetoric into practice*"
> (2002: 65)

This literature review has shown that it is evidently clear that the evolution of policing approaches to crime control have significantly waned in their momentum. This study seeks to capture the drive for further research cited by key academics to reinvigorate the field.

2.4.3 Operational Application of Research

As Foster and Bowling (2002) have suggested, policing is multi-faceted and involves a number of key responsibilities. The literature in this area outlines a number of police functions which Rozee (2012) has encompassed under several key themes. These include social functions, order maintenance, service tasks, transnational policing and finally, crime fighting (Rozee, 2012, p108-p111). As Reiner (2000) has outlined a major function of the police is their responsibility to investigate and control crime, a role which Rozee (2012) outlines as crime fighting, which is accepted by criminologists as a fundamental aspect of police work and involves the reduction and prevention of crime (Kaunert and Rozee, 2013).

Crime fighting can relate to all manner of criminal behaviour ranging from serious and complex crimes such as terrorism, murder and rape which are relatively low in number, to less severe crimes which are often greater in volume (Edwards, 2005). This is where the term 'volume crime' originates from and includes crime categories such as, shoplifting, burglary, criminal damage or thefts from motor vehicles. We have seen earlier in this chapter how the prevailing theories evolved into professional practices that formed approaches to enhance the polices crime fighting capability by increasing their efficiency and effectiveness in controlling such volume crimes. In doing so, these studies have identified both blockers and enablers of applying research evidence into practice.

In 1995, Maguire and John qualitatively examined the use of pro-active policing and intelligence gathering methods in an effort to assess their effectiveness via interviews, reviews of case files and observations of policing structures and practices. They concluded that a complete 'buy in' is required from senior managers to achieve best value from ILP and that clarity in focus is key to ensure effective intelligence gathering. Furthermore, that ingrained cultural stances need to change to allow ILP to flourish, that systems and processes should be continually reviewed to maintain them in a productive form and true to ILPs core and finally, that systems thinking should react to outcomes of academic research to ensure its evolution and effectiveness against changing policing backdrops (1995: 54-55).

Introduction of the NIM, as with ILP as a whole, continued to experience implementation problems, failing to achieve full operational applicability. The NIM faced resistance at a senior police officer level as many chief constables were suspicious of NCIS's intentions and viewed their academic idea as the nationalisation of policing (Stelfox, 1998:397). In the interest of self-preservation many resisted the early work surrounding the NIM conducted by NCIS, affecting its credibility and resulting in some police forces abandoning their product all together (Gill, 2000).

It has been argued that one of the fundamental failures of the NIM and one of the issues holding it back is that it provides no definition of what the intelligence within 'intelligence' led policing actually is, resulting in various interpretations across police services and amongst academia (Kleiven, 2007:264). Kleivens research also identified a cultural deficiency within the police service regarding intelligence: fundamentally the police are not intelligence practitioners and Kleiven suggests this creates numerous issues with the implementation of ILP (2007:260). Kleiven argues that ILP and ergo, the NIM process, concentrates on highly defined and traditional intelligence sources such as informants and police officers which makes it unfit as a policing model for the threat posed within the 21st century (2007:271). Ratcliffe supports this stance and suggests the meaning of ILP has been distorted by a misconception of what the term 'intelligence' actually means (2007:1). Ratcliffe (2007) underpins this by pointing out that Wardlaw & Boughton (2006) argue that the concept of intelligence-led policing is now widely espoused by police services as a fundamental part of the way they do business. However, for such a widely talked about concept, there is remarkably little clarity about its definition and fundamental concepts (2006: 134). These findings emphasise the necessity for clearly defining future crime reduction and prevention approaches, a factor this study must remain acutely aware of.

One blocker to the uptake of the ILP theoretical framework and the NIM is continually cited as senior officer 'buy in'. John and Maguire (2004) have highlighted that the NIM model has continually lacked the support of senior police officers, resulting in huge knowledge gaps throughout all ranks regarding the concepts of the process and importance of intelligence analysis (2004:8).

Ratcliffe furthers this assessment by identifying that in the infancy of an organisation shifting towards the use of ILP, this 'buy in' of senior officers was essential (2002: 62). This factor was so key because, he believes, there is a huge difference between becoming a police service being led intelligently to one that is truly intelligence led (2002: 64). Analysis of material within the field of intelligence led policing has identified that the key reason that this lack of buy in exists is because of a failure by police services and senior leaders to recognise the importance of intelligence analysis (Ratcliffe, 2007). Unsurprisingly, the increase in use of intelligence gathering tactics to underpin ILP has increased a need for greater analysis (Gill, 2000). However, the climate of austerity has seen the capacity for this function reduce dramatically, despite its disproportionate importance hilighting a necessity for future crime reduction and prevention approaches to be clearly understood and supported by senior officers.

Further operational application has also been stifled by police services failing to fully embrace the underpinning theoretical concept of intelligence led policing. Research has identified a huge gap between the academic theory of ILP and the operational implementation (Cope, 2004:201). Cope has identified that the current standard of analytical products produced by police services are below par and as such do not possess the positive impact on policing as originally anticipated (2004:201). Cope cites a number of reasons for this but identifies them as predominately a fundamental misunderstanding between analysts and police decision makers causing a breakdown of the theoretical foundations, stating:

> *"Officers fail to ask the right questions and analysts produce a descriptive product which offers no direct answers....which in turn makes officers less willing to share information. The misunderstanding creates a depressing self-fulfilling prophecy" (*Cope, 2004, pp 36*)*

Secondly, Cope outlines that analysts are not currently utilised effectively in policing boroughs and as such, add little value as they are not afforded sufficient overview of strategic issues and are often tasked in too bespoke a manner and often on non-crime related corporate projects (2004:202). This issue is magnified when we take into consideration that crime statistics and intelligence analysis

influences most heavily those at the patrol officer level (Gul and Cemil, 2009). As a result, it could be argued that a negative cycle occurs whereby officers input inadequate information which analysts then interpret and produce poor quality products which subsequently influence the activity of those on the frontline, then the cycle repeats itself, whilst each time moving further away from the actual true cause and solution to the problem.

The lack of accuracy of such analytical products has also been recognised by officers and as a result it has been identified that detectives are no longer heavily influenced by any products resulting from crime analysis (Gul and Cemil, 2009). which is worrying considering a fundamental reason for modern Police forces adopting ILP is to increase crime detection rates. The effectiveness of crime analysis is further diluted when it is also taken into consideration that at a more strategic level, senior decision makers are most heavily influenced on non-statistical information such as public surveys and the needs and wishes of other partner agencies and politicians (Gul and Cemil, 2009). As a result of this lack of understanding of the analyst's importance by senior managers, they remain relatively low paid and undervalued and efforts to standardise processes are proving difficult as police commanders remain accustomed to traditional policing models (John and Maguire, 2004:9). These issues of buy-in, accuracy and adherence to theoretical underpinnings will all require careful consideration as this study progresses.

To address these issues, it is suggested that police services increase training to analysts to offer a greater insight into policing and training to police officers and managers, so they can more fully understand the potential of analysts (Cope, 2004). It is also suggested that analysts need to be given more scope to produce products offering 'theoretical insights' and 'critical overviews' so that their potential can be fully realised (Cope, 2004:202). Gill has supported this stance and also suggests that there remains a need for increased training of both analysts, to produce better products and police officers to enlighten them on the full benefits of ILP and how to implement and interpret analytical products (Gill, 2000). Despite academics identifying this necessity, increased investment in training in this area has so far not materialised (Ratcliffe, 2008).

If the theoretical philosophies can be fully bought into from a 'top down' strategic perspective by senior police managers who are prepared to adopt theory then concepts still have potential (Ratcliffe, 2008). If this was to take place, it is argued that the theories would be most effective in circumstances when innovative thinking, ingenious problem solving, partner agency teamwork and finally, collaboration and information sharing among police services can flourish (Ratcliffe, 2006: 63-71). Until that time Ratcliffe argues that implementations will not reach a stage where they are a major influence on a police decision maker's strategic thinking (Ratcliffe, 2006) due to the inefficient structures in place to offer an informative product (Ratcliffe, 2006: 13). Further more, the emergence of 'new' intelligence creates an environment whereby intelligence handlers are information rich but knowledge poor (Ratcliffe, 2006). Change and increased use of more advanced information systems is also required to provide a more detailed overview and advancement into what has been described as 'knowledge based' policing as opposed to intelligence led (Kleiven, 2007:271). Worryingly though it has been suggested by Ratcliffe that ILP and future theoretical frameworks may fall by the wayside as other policing 'fads' have done (2006: 15).

There is also a need to counter misconceptions regarding new working practices. Initially police services were apprehensive regarding the POP approach because of the cultural misconceptions of the field, for instance that it was too difficult to do; the police had insufficient time and it was not cost effective etc. (Leigh and Tilley, 1996). This initial lack of investment in the theory from senior police leaders (Goldstein, 2003; 25-34) resulted in a lack of support at a senior management level and stopped the theories uptake being as wide as was anticipated which has been a major impediment to its success (2003; 20).

Other more overarching hurdles exist as Goldstein and Susmilch (1981) identify. They were among the first to produce a series of case studies on the subject of POP and they identified a number of factors that they argue stifled the early uptake which included: the very nature of policing itself; a blinded concentration of immediate needs and results, and confusion of responsibilities both internally and externally (Goldstein and Susmilch, 1982:10-15). Goldstein and Susmilch also provided a wide array of reasons why new solutions were required, such as

a lack of clarity in direction of current policing models, increasing financial costs and a need to develop policing tactics that provide more consistent outcomes (1981:16-18).

Tilley (2003) provided several key denominators that needed to be present for success such as the access and use of partner agency held data being key to the analysis stage (2003). They also indicated that research by agencies into similar problems addressed elsewhere increased a project's success rate and most obvious was the requirement for stringent analysis of empirical data (2003). Tilley highlighted that weaknesses in these areas negatively impacted on the successful identification of key problems (2003). From their case study analysis, Tilley and Read also identified the fundamentals of successful problem analysis which they outlined as concentration on the identification of the weakest link in the problem; identification of responses relevant to the local issue; that early identification of the intended result of solutions is required to maintain clarity and most importantly the inclusion of communities and partner agencies through multi-agency teams and the identification or creation of incentives for each organisation (2003). Tilley has also suggested that the POP approach is best suited to tackling issues such as: repeat victims; crime hotspot areas; serial and prolific offenders; seasonality of crime and finally what he called 'hot' targets, meaning items or areas attractive to criminals (Tilley, 2003). As a whole, Tilley's work clearly suggests that for evidence-based practice to be successful it must be used appropriately and in the areas and fields it is best suited to addressing.

Similarly to blockers in operational application experienced within the implementation of ILP, key to the formation and success of these partnership approaches is the 'buy in' of senior police managers (Goldstein, 2003; Weisburd et al, 2008). Without this, it could be suggested that solutions may lack the financial or resourcing support required for success. Also, key is the training of the staff conducting the work (Goldstein: 2003 & Tilley: 2003) as without proper analysis and identification of the problem and solution, again, success will be significantly reduced.

Scott has suggested that he believes the major challenges ahead that face the the future of POP are mainly centred around if and how the police seek to train

their staff in POP, how successful studies are circulated and how they are accumulated and stored for future examination (2003:109-120). This is an opinion shared by Goldstein who optimistically calls for an increase of appropriate analytically trained and 'ring fenced staff' and in the best-case scenario, a specialised centre for POP with the overall responsibility of pursuing the true objectives of the theory (Goldstein, 2003; 35-38). Although such a centre is unlikely a smaller approach could still be beneficial as other studies have also identified that POP solutions were most effective when dealt with by dedicated teams but with the caveat that such teams should only be given manageable workloads, or this hugely impacted on the success of any POP implementations (Tilley et al., 2008:33). Such a small team approach would enable the time and energy that is needed to be spent by Police forces investing in more detailed research (Goldstein, 2003; 21).

2.4.4 Evidence Based Policing Implementations

The previous section outlined issues that have historically been encountered during evidence based policing implementations and have impacted the operational application of previous these implementations. This section explores the literature that studies this area specifically, known as 'implemenation failure'. This provides context to enable the study to fully understand the implementation environment required for success. Furthermore, any implementation of scientific principles should be conducted with care as there are a multitude of factors that can impact on its success. Taking time to outline these now, later enables the study to better understand the causal factors which may contribute to the success of the implementation of the optimal forager methodology or any proposed potential model. This will help achieve the primary aim of the study by framing how the new knowledge acquired through exploring the behaviour of foraging offenders can be used to influence police interventions to help reduce and prevent their future offending.

Rosenbaum et al, 1986 (Cited in Kirby, 2013) has suggested that there are several factors that impact on the effectiveness of evidence-based implementations within policing. These are theory failure, implementation failure and measurement failure. Wanderman has suggested that resources are also a

distinct implementation factor (2009). Theory failure broadly relates to the situation when the theoretical framework of the scientific concept is incorrect, as a result, the desired and anticipated outcome is not manifested (Kirby, 2013). As the previous sections have outlined, most previously utilised approaches, with the exception of the broken windows theory have been shown to have sound theoretical underpinnings, indicating any failure may lie elsewhere.

it has been outlined that implementation failure relates to more tangible or identifiable aspects of an approach such as the leadership driving it, ineffective co-ordination, poor supervision, technical factors, training, lack of skills or cost factors and interestingly, cultural influences (Hope & Murphy, & Dalton et al, 2007). This literature review identified that examples of such implementation failures have been identified within both intelligence led policing and problem orientated policing, where ineffective leadership has reduced the anticipated positive outcomes (John & Maguire, 2004 & Ratcliffe, 2002 & 2008). John and Maguire have outlined that several studies have highlighted that a complete 'buy in' is required from senior managers to achieve the potential of any attempts at changing or implementing a theoretical framework within policing (John and Maguire, 1995: 54-55). Previous research has shown that without such top down direction that in the infancy of an organisation shifting towards the use of a new policing model the 'buy in' of senior officers is essential (2002: 62) as it can be the difference between becoming a police service being led intelligently or not (2002: 64).

Furthermore, implementation failure has also been identified in technical failures in the production of analytical products (Cope, 2004; Gill, 2009) in the previous use of prevention and reduction evidence-based methodologies. Skills and training have also been identified as underpinning the chapters theoretical implementations success (Ratcliffe, 2004:6). John and Maguire (2004) highlighted that previous theoretical implementations when first introduced had huge knowledge gaps throughout all ranks regarding the concepts of the process and importance of intelligence analysis (2004:8) which it suggests impacts on success.

Finally, evaluation failure is an issue that it can be argued fuels the cycle of poor implementation. Kirby (2013) has suggested that poor evaluations are conducted because the culture of performance management within the police breeds poor evaluations which are'doomed to succeed and are rarely objective in their scrutiny. To combat evaluation failures Sherman (1998) has advised using the Maryland scale of measurement which it is advised is embedded in the planning stage when possible and considers four levels of evaluation. These range from less reliable, simple correlations of causation to highly controlled randomised control trials.

2.4.5 Research Evidence

In this section the research evidence that underpins the study is examined. This is distinct to the previous sections which provided an overview of the concepts and theories being discussed i.e. optimal forager and geographical profiling. This section now seeks to provide an analysis of the empirical research evidence as it relates to these areas and others relevant to the study. All of the aforementioned share commonalities which relate to areas of criminology, that at their most fundamental, draw upon the three basic criminological concepts of rational choice (Cornish and Clarke, 1987), routine activity theory (Eck, 1994) and environmental criminology (Brantingham and Brantingham, 1991).

Capable Guardianship

The routine activity theory of crime is a central theory that underpins the behaviour of foraging burglary offenders (Johnson and Bowers, 2004a) and the concept of hot spot policing. This form of crime is best combatted by policing places in which a motivated offender encounters a suitable target (Reynald, 2011). Doing so ensures that the target is is effectively guarded.

Historically there have been several distinct subtypes of guardians within the literature referred to as handlers, managers, and guardians (Eck, 1994; Felson, 1995; Felson & Boba, 2010; Sampson, Et al, 2010 and Tilyer & Eck, 2010). The guardian has been defined as;

"*the physical or symbolic presence of an individual (or group of individuals) that acts (either intentionally or unintentionally) to deter a potential criminal event*" (Hollis-Peel et al, 2011, pp 5)

Felson (2006) has suggested that a guardian need not be a member of authority and can in fact be any ordinary citizen, so long as they are in position to look after any place or property. This definition would include neighbourhood watch schemes which the CoP 'what works network' outlines as an intervention that is effective and with a high impact level (2018). More recently Felson has updated his definition of the theory to include "*someone whose mere presence serves as a gentle reminder that someone is looking*" (2010, pp 28). As can be seen, there are multiple potential descriptions of guardianship and all have been examined using various methods allowing a reasonable assessment of the research evidence regardings its effectiveness. Examination of this research evidence has identified that there are five accepted forms; place managers such as the police, security guards, citizen patrols, neighbourhood watch and the use of CCTV (Hollis-Peel et al 2011).

Early research by Cohen and Felson showed that increased presence of a capable guardian through the above approaches did reduce levels of crime. However, research since that time has shown that similarly to the wider concept of hotspot policing, it is not unconditional with research showing the time of day impacted upon its effectiveness (Coupe & Blake, 2006) with daytime use of the theory being most effective. This finding has been further supported by research that examined home occupancy levels and showed that higher daytime rates positively impacted upon burglary offences but night time occupancy rates did not (Lynch and Cantor, 1992). More recently, newer positive effects of capable guardianship have been identified including the impact of police response times to reported crimes where research (Kirchmaier and Vidal, 2015) has identified that a faster response creates an increased likelihood of detection.

Approaching the hotspot as both a temporal and spatial phenomenon Ratcliffe has produced what has been defined as a 'policing hotspot matrix' which identifies the most appropriate combination of tactics for deploying capable

guardian tactics within crime hotspots which can be seen in Figure 3, however the strict implementation of this matrix has not been operationally tested.
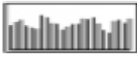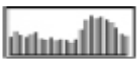
Policing Hotspot Matrix		Spatial		
		Dispersed	Clustered	Hotpoint
Temporal	Diffused	Uniform vehicle patrols, architectural changes, public education campaign	Random breath tests, foot patrols, architectural changes, publicity campaign	Roadblocks, plain clothes patrols, random breath tests, private security, CCTV
	Focused	Uniform vehicle and foot patrols, improved lighting, public education campaign	Vehicle and foot patrols, random breath tests, private security, improved lighting	Surveillance units, plain clothes foot patrols, CCTV, surveillance of entry/exit points
	Acute	Unmarked vehicle patrols, private security, improved lighting	Surveillance and plain clothes patrols, CCTV	Surveillance, arrest squads, CCTV, unmarked police units

Figure 3. Ratcliffe's Matrix of Hotspot Policing Methodologies'.

Despite the many evidenced benefits to the capable guardian theory to crime control, it has been identified that in line with other methods such as situational crime prevention, the method does produce a level of crime displacement (Braga, Papachristos, Hureau, 2012 and Repetto 1976). Crime displacement occurs when the offenders simply adapt their offending behaviour and target less highly guarded areas or change the time or method of operation. Research has indicated that this occurs least in relation to violent crime types associated to alcohol related premises (Braga, Weisburd, Waring, Green Mazerolle, Spelman and Gajewski, 1999), however this has been recorded as occurring in other research and as such is recognised as a by-product of approaches that rely upon the guardianship approach to policing (Taylor, Koper and Woods, 2010). Crime displacement is at its most prevalent when targeting issues such as drug dealing (Weisburd and Green 1995: 730-731; Hope, 1994). It is suggested that the reason for this displacement is simply because as one 'drug den' is closed down another opens up in its place to meet the existing demand (Hope, 1983).

As information technology has advanced and data analysis methods have increased in their effectiveness how guardians are deployed has also evolved.

Police services and criminologists are now beginning to make tentative steps into a move away from mapping what has occurred and predicting what will occur, coining the term predictive Policing (Beck and McCue, 2009). Literature on this new theory will be reviewed later in the chapter.

2.4.6 Predicting Future Victims and Crimes Locations

In essence there are several aspects to the theory of predictive policing and these include; methods for predicting crimes; methods for predicting offenders and methods for predicting victims (Walter et al., 2013). The theories used for both predicting future crimes and victims are intrinsically linked but the theories surrounding the predicting of offenders is an entirely different science altogether and involves criminological theories of both geographical and offender profiling (Walter et al., 2013) which is covered in greater detail later in the study.

Having outlined the research evidence as it relates to the study of geographical evidence-based approaches to police crime reduction and prevention and factors impacting upon their success, the objective of this section is now to provide a review of the literature as it relates to the prediction of future crimes and victims. This section is distinct from the previous methods as they are at present much more theoretical in their nature. As such the aim of this section is to enable the reader to understand the scientific principles that underpin the main *'predictive'* policing methodologies identified by the NPIA (2015) in their table of temporal univariate models which was outlined within the introduction of the thesis. Doing so also helps to articulate the limited volume of empirical literature that underpins the most common method, the optimal forager theory, adding weight to the necessity of the research.

Risk Terrain Modelling and Epidemic-type Aftershock Sequencing

Risk terrain modelling (RTM) is a further method of predicting future events that has been used within the policing environment. However, it has only ever been utilised to address the issue of violence and shooting related incidents and in very limited circumstances, with the exception of a small initiative aimed at predicting residential burglaries (Kennedy et al., 2011) although it was done with reported success. In contrast to the near repeat theory which examines previous

data to predict future events, RTM analyses 'risk factors' to predict where events are most likely to occur. After identifying the requisite risk factors which are themselves subjective, they are assigned a value and mapped using a geographical information system (GIS). The GIS map will then provide a product which identifies the areas in which the greatest level of overlap and thus risk is present (Kennedy et al., 2011). As previously outlined, the identified risk factors are entirely subjective and will change dependant on the issue attempting to be predicted. So, for example an attempt to predict violent offences may include licensed premises and closing times in their analysis and in contrast a prediction of future burglaries may wish to include the homes of known burglars for instance (Kennedy et al., 2011).

The use of epidemic-type aftershock sequencing (ETAS) is another form of predictive modelling that has been used to identify areas most likely to be subject to criminality. The primary research that underpins its proven effectiveness is based upon two key studies, one conducted within the Los Angeles police department in the USA and one with Kent Constabulary within the UK (Mohler et al, 2015). In these studies Mohler et al (2015) used an ETAS model to predict risk areas with an improvement of 1.4-2.2 times better accuracy compared to traditional hotspots created by police analysts. When police resources provided capable guardianship through tasked patrolling in these areas they produced an average reduction of 7.4% in overall crime volume (Mohler et al, 2015). A weakness of this study is that it has not yet been compared to any other form of predictive hotpots such as those produced on the near repeat or optimal forager theory, both of which are discussed in the following sections.

Near Repeat Theory

The theory that those who live nearest to a recent victim of crime are at the highest risk of becoming a target is now commonly accepted and is referred to as the 'Near Repeat Theory' (Ratcliffe and George, 2008). This theory has been shown to be consistently relevant when analysed in the context of volume acquisitive crimes such as burglary and vehicle thefts (Pitcher and Johnson, 2011). However, it has not been tested to predict the accuracy of future crimes

until very recently (Chainey and Silva, 2016; Farrell and Pease, 2017; Johnson and Bowers, 2004a; Wang, 2018).

The near repeat effect can effectively be split into two distinct theories namely the 'flag theory' and the 'boost theory' (Farrell and Pease, 2017; Johnson, 2008; Ferguson, 2014 and Sagovsky and Johnson, 2007). Flag theory has been outlined as the fact that targets of the highest vulnerability which are the easiest prey are advertised to potential offenders because of factors such as their ease of access and lack of security or guardianship (Ferguson, 2014). Johnson (2008, pp 216) outlines the process as "different offenders independently target attractive locations for which risk is *flagged*". It is also argued that these areas are commonly clustered together in estates or housing developments and as such provide a fruitful ground for offenders to work within which is why the near repeat phenomena arises (Ferguson, 2014). The concept that an offender will target victims based on their perceived low level of risk or cost is an approach to crime predication which is very similar to the optimal forager theory which will be outlined in the next section.

Boost theory on the other hand suggests that criminals and crime gangs will share information about victims (Farrell and Pease, 2017). As a result, if they have previously been successful in committing offences against a particular victim or area without apprehension or consequence then they will return to the same area or pass this information on, resulting in further crime against the same victim or those close by (Ferguson, 2014). This means that "each burglary increases the risk to nearby locations for a short period" (Ornstein & Hammond, 2017). Research has been conducted that supports this assumption indicating that as many as 76% of burglary offenders will return to the area of previously successful crimes (Ferguson, 2014).

Regardless of what draws the offenders to the locality, both underlying theories offer a method for the Police to analyse this spatial information to actively predict future crimes and it has the potential to be especially successful when both time and spatial data are combined. For instance, previous research has indicated that the near repeat phenomenon is at its peak within the first week of the

commission of an offence and that the risk steadily decreases over time (Ferguson, 2014). Furthermore, it is also more effective when examining offences committed during the working week between Monday to Friday (Glasner & Leitner, 2017). By analysing this data, the police are provided with the potential to predict both a geographic area and subsequent time span in which crimes are likely to occur.

Optimal Forager Theory

A further approach to crime prediction has been the use of theories of animal foraging behaviour. Known as 'optimal forger' this theoretical concept argues that offenders will act much the same way as a predator (Johnson and Bowers, 2004). It is believed that as an animal does when hunting for prey an offender will balance the costs and benefits of committing an offence and target their victims to maximise their return (Johnson, 2014). For example, an animal will weigh the level of energy expenditure and risk i.e. being preyed upon them-selves vs. the likelihood of sourcing food. A criminal will consider the same issues when searching for a victim by calculating the risk of detection or apprehension vs. the potential for criminal reward (Johnson and Summers, 2014). When making these calculations Johnson (2008) theorised that both the animal and criminal will display similar foraging behaviour as they search for their prey or victim. It is suggested that the two foraging principles that they will adopt are the central place foraging approach or the optimal patch choice (Johnson, 2014). The central place theory argues that the forager will conduct their searching based around a specific base or home and as such their prey will fall within their routine activity node (Orians and Pearson, 1979). The theory of central place foraging is one that is already known to be mirrored within criminology in studies of routine activity theory and geographical profiling. The optimal patch theory argues that the foraging behaviour will be dictated by the amount of time available to forage combined with their knowledge and previous success of a certain area (Pyke, 1984). It is also suggested that areas that are closer together are more likely to be similar in their abundance of prey or victims and as such a clustering effect emerges which is in essence the same underpinning theory to

the near repeat approach and what provides the potential to predict future victims (Fortin and Dale, 2005).

However, the review of literature conducted in this study has identified that although it can provide a methodology that helps achieve a certain level of effective crime reduction and prevention it is overly simplistic in its approach. This observation is made by researching the literature within ecology that the optimal forager theory is based upon. By doing so it can be identified that a number of fundamental issues have been overlooked and not considered in any depth within the research or case studies implemented. By comparing the behaviour of a criminal to a foraging animal, one should naturally take into consideration of other behavioural factors in this scenario, however, as yet no identifiable criminological approach to optimal forager has done this. For instance, the current use of the optimal forager method of predictive policing adopts the assumption the criminal is the predator and the victim are the prey. However, ecology literature identifies that this is not correct. Research using game theory has argued the relationship is a three tier one involving the predator, prey and the prey's resource (Hugie, 1994 and Sih, 1998). This means that within criminology the relationship can be more likened to police (predator), criminal (prey) and victim (resource).

Another major factor, possibly the most vital, is that current adoption of optimal forager theory within policing has failed to take into consideration the impact of nonlethal interaction between the predator and the prey which Lima (2002, p70) argues is an important issue in respect of this relationship. The literature review in this study could find no literature within any of the researched criminological areas that addresses or even considered these issues. The ecology literature within this area however argues that increased predation, which in this scenario would be in the form of a raised police presence providing capable guardianship in the identified forager area, forces the prey (criminal) to alter their behaviour in a number of ways (Lima, 2002). One of the most obvious being movement to alternate patches to seek out new resources or to avoid the increased predation (Lima, 2002). Lima (2002) argues that the movement of the predator (police) and prey (criminal) can occur simultaneously as predators seek out areas where the prey is at their most active, but the prey purposefully responds by avoiding the

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areas showing an increased number of predators. Therefore, in the policing world this would manifest itself in the criminals simply staying clear of the identified patrol areas and seeking victims elsewhere. This issue has been identified within the criminology and policing literature where it is referred to as crime displacement.

As such, in line with research into traditional hotspot displacement outlined earlier in the chapter, when considering the implementation of predictive policing methods, it is strongly suggested that organisations also need to be cautious and consider how to address the issue of crime-displacement or any experienced benefits will be minimal and short lived (Ferguson, 2014). Some have argued against this and suggest that the issue of crime displacement is a myth. However, this stance is built upon very limited literature which has been tested against only a small amount of crime types. For instance, one of the only studies cited as underpinning the argument against crime displacement does evidence that it can and does occur and on occasion at a 100% level (Eck, 1994). Other studies cited as evidence against the issue of crime displacement have also only been tested against violent crime and prostitution which are both heavily influenced by environmental factors such as the positioning of licensed premises for example (NCJRS) or have adopted a mathematical approach to explain ecological behaviours (Short et al, 2009). The issue requires much further research to conclude firstly if it does occur as it has been identified within traditional hotspots and secondly how to address it.

Despite the issue of very limited research into crime displacement as a result of predictive approaches (Mohler, 2011 & Fielding & Jones, 2011), early evidence has shown that when used to analyse volume acquisitive crimes these predictive approaches can be more effective than traditional techniques and hot spotting approaches at reducing crime. It achieves this by using the information to more effectively direct and control the deployment of police resources into the predicated crime areas. These areas are most commonly identified as small 500 feet by 500 feet zones which are subjected to increase police attention (Mohler, 2011). This is one of the main reasons that the concept of predictive policing is causing so much excitement as it has the potential to provide the proverbial crime fighting 'golden egg'. The ability to predict where crime is going to occur before

it does has obvious benefits and can potentially create great financial savings in an environment of increasing austerity (Beck and McCue, 2009). However, the theory is currently disjointed and very under researched with as yet no identifiable theoretical framework or accepted definition but regardless; several academics have espoused the approaches 'potential' success since its emergence (Chainey & Ratcliffe, 2005; Harries, 1999 & Paulsen & Robinson, 2009). Gascón has suggested that predictive policing is the perfect tool to help services increase efficiency as austerity measures continue to take hold;

> "*With predictive Policing, we have the tools to put cops at the right place at the right time or bring other services to impact crime, and we can do so with less*" (2010, pp 3).

Regardless of its potential there are still obstacles to be overcome before the theory can be regarded as complete and much more research is required before it can be considered evidentially based

A detailed review of the literature as it relates to the predictive policing of crimes and victims shows that predicting the future crime location is only one side of the coin. All aspects of a crime need to be addressed if a truly predictive policing theoretical framework is to be created. It is universally acknowledged that for every crime there must be a perpetrator. As such the other side to the geographical element of predictive policing is the predictive identification of offenders which it is suggested is best done through scientific geographical profiling (Walter et al, 2013). Such a combined approach is also unknowingly identified as a solution within the ecology literature (Werner & Gilliam, 1984). Again, through studies of the predator and prey interaction it has been identified that when a predator can move between the area of the prey's resource and natural habitat that it directly impacts on the prey's mortality and negates any antipredator benefits of moving beyond their habitat (Werner & Gilliam, 1984). From a policing perspective this in essence suggests that if the police (predator) can operate in both the criminal's area of their home or base (natural habitat) and the area the criminal commits crime and seeks their victims (resource) they stand a greater chance of apprehending or deterring them completely (mortality). This review has shown that at present there is a complete absence of literature

available that has researched such a combined predictive approach. Researchers identified within the previous sections have only ever tended to focus their work on narrow and isolated silos that investigate the crime, the victim or the offender. This study postulates that only when both offender and crime are research and predicted together can an approach truly be considered to be entirely predictive and potentially any approach that operates in silo will not reach its full predictive effectiveness and impact on crime prevention and reduction.

Current methods to pro-actively target offenders are in operation within policing and to some degree are useful. However, as this chapter has demonstrated the IPL approach which underpins such targeting is controlled through the NIM process whose effectiveness over the past decade has been significantly reduced due to a lack of useable crime intelligence, information and the analysts to interpret it (Ratcliffe, 2008 & Cope, 2004). This study will show later on that in some police forces the level of useable intelligence has decreased by as much as 75% between 2010 and 2015. Without useable intelligence and information, it is argued that the NIM approach is little better than effectively putting a finger in the air to predict offenders of crime which results in a culture of 'rounding up the usual suspects' (Gill, 2000). It can be argued that such a narrow approach to predictive policing also does little to counter the problems created through crime displacement and as such will only have a small-scale geo-specific impact as opposed to providing overall crime prevention and reduction.

2.4.7 Identifying Offenders

This chapter has shown much work is still to be done in relation to predictive policing methods. However, even at this early stage in the field it can be effectively argued that the greatest avenue for potential is through a combined model that incorporates scientific approaches to predicting both the crime and offender. An examination of literature suggests that geographical profiling provides the most obvious scientific approach in respect of offender prediction and if done correctly by first accurately linking crimes, one can then use existing and accepted empirical methods to identify potential offender's natural habitats and then introduce traditional police interventions to maximise the effectiveness of tasking and co-ordination (Walter et al., 2013). As such the chapter now briefly introduces the concept of crime linkage before outlining the theory of geographical profiling in detail.

Crime Linkage

One of the fundamentals of geographical profiling is the analysis of crimes which can be attributed to the same offender. This process is often referred to as crime linkage (Bennell & Canter, 2002; Davies et al, 2012; Tonkin et al, 2008). Although it is not individually recognised as a specific method for law enforcers to reduce crime on its own it is becoming increasingly necessary for more accurate methods of crime linkage to be formulated to underpin other predictive approaches. For example, accurate crime linkage will help analysts and decision makers produce more accurate profiles or predictions and as a result, in theory, can be more effective at preventing and reducing offending. A more detailed examination of the literature in this area is completed within chapter 6.

Geographical Profiling

The use of offender profiling is an established practice within criminal investigation and has been for some time. As a result a large number of authors have contributed to the available literature. However, the concept of geographical profiling is a relatively new development. Its birth can be traced back to early academic studies (Turner, 1969) examining the correlation between age and journey to crime (JTC). In this early research, Turner utilised data from

property and violent crimes and using what he described as a 'taxi cab' measurement he plotted the offender's homes and crime scenes (Turner, 1969). The study found that there was a clear decay in offences committed as the distance increased from the offender's homes (Turner, 1969). Rossmo subsequently spearheaded the early concept and his publication in 2000, 'Geographical Profiling', was the first identifiable theoritcal framework regarding the subject. This book was based upon Rossmo's PhD thesis which introduced a formula for calculating the likely home or base of an offender within a grid square and thus was born the field of geographical profiling (Rossmo, 2000).

Rossmo's theory worked on the principle that a buffer zone exists immediately around the offender's home or base (1987). His theory argued that within the buffer zone crime will increase as the distance from the offender's home increased and conversely, outside the buffer zone, the frequency of crime decreases with distance (1987). Working on this theory and applying it to a crime series a boundary is created around the crime scenes and every square in the boundary is rated according to how much it matches the principle (1987). Rossmo's formula for geographical profiling was subsequently incorporated into the geographical information system (GIS) Rigel and is routinely utilised by the Royal Canadian Mounted Police (1997), National Crime and Operations Faculty, UK (1999), the Bureau of Alcohol, Tobacco and Firearms, US (2000) and the Bundeskriminalamt, Germany (2000).

Since Rossmo's publication a number of notable academics have advanced the theory (Beauregard & Rossmo, 2007; Block & Bernasco, 2009; Canter, 2004; Canter & Hammond, 2006; Emeno, 2008; Hammond & Youngs, 2011; Rattner & Portnov, 2007; Snook et al, 2002) Through their research a number of techniques have been established in the discipline such as the circle hypothesis, uniformed pattern and bulls eye pattern to name a few (Block and Bernasco, 2009; Canter and Hammond, 2006; Emeno, 2008; Rattner and Portnov, 2007) but all are fundamentally underpinned by the distance decay theory.

The distance decay theory within crime has a history dating back several decades. In the mid 1990's, Brantingham and Brantingham produced a number of studies on rational choice theory. Although not specific to geographical

profiling as this field had yet to been fully defined they commonly referred to the subjects of spatial pattern analysis, rational choice and crime pattern analysis. The Brantinghams' argued that the vast majority of offenders committed their offences within a definable range of their home or base (1996: 223-225) which is a theory that Canter has also identified (1996: 218).

In the late 1990's a number of academics began to conduct studies testing the basic principles of geographic profiling although at this time the field was not widely referred to by that name. In 1997, Kocsis and Irwin conducted a study using a basic circle theory of geographic profiling (1997). By utilising data of serial offenders from 24 rapists, 22 arsonists and 27 burglars Kocsis and Irwin plotted the crimes and encompassed them by using the basic circle theory to examine the principle that serial offenders lived within a defined geographical area and their offending radiated from their home or base (1997). Although basic these early studies confirmed further the key principles of the method but against varying crime forms. The studies also identified several issues that have been subsequently underpinned or debated by a large number of subsequent authors in the field.

In 2000, Canter et al., conducted a study on the behavioural patterns of serial murderers using the Dragnet GIS to corroborate the body deposition sites and predict prioritised offender search areas. The results indicated that the highest level of predictive accuracy was gained with the absence of a buffer zone parameter (2000). Canter et al (2000) highlighted even at this early stage in the field that further studies on other forms of serial crimes had huge potential for both academia and as a support tool for law enforcement.

Over the past decade or so, Rossmo, arguably the founder of geographical profiling has drawn the subject back to its core principles and has taken to analysing the theory in non-crime related, ecological scenarios such as shark predation (2009), bee foraging (2009) and infectious diseases (2011). These studies of geographical profiling have further underpinned the argument for the case that spatial behaviour of criminals is associated to the natural instincts of other animals and predators. This further adds weight to the necessity of this

study to continue to advance and contribute to this area of literature that investigates links between ecology and criminology.

In 2009, Rossmo collaborated with Raine and Le Comber to test geographical profiling information system algorithms on the foraging behaviour of bumble-bees and were successful in identifying animal foraging patterns based on varying food sources and densities (2009). Although a very early test of the use of geographical profiling in this context, Rossmo outlined how the examination of animal behaviour in this way could help further develop accuracy in traditional geographical profiling and also assist in analysing animal spatial behaviour (2009; 317). Other research has analysed the predatory patterns of white shark hunts as they engaged with cape fur seals (Rossmo and Hammerschlag; 2009). Using geographical profiling techniques, it was identified that the predator utilised a base or anchor point, similar to serial offenders (2009; 115). The study also identified that the hunting area was not the area that offered the greatest access to prey, as one would expect but in fact seemed to show some cost benefit analysis by the sharks in identifying a zone which offered the highest balance of prey availability, capture rate and level of competition (2009; 116-7).

One could argue that this is behaviour also exhibited by serial criminals in their own rationale choice when conducting target selection. In 2011, the use of geographical profiling was also tested further by analysing its effectiveness in the management of disease control. In this study, Rossmo et al., (2011) utilised two infectious breakouts as their data sources. Using disease sites as the data source as opposed to crime locations, Rossmo et al., (2011) were successful in utilising a geographical information system to identify a geo-profile identifying the highest likely location of the outbreak to 0.2% of the profile which contained the outbreak water source, as opposed to the highest likely residence area of the criminal. In a further case, the team utilised disease locations to rank 59 water sources and were again successful in ranking the top 6 outbreak locations in the top 2% of their geo-profile (2011). On both occasions the use of geographical profiling outperformed other techniques being used and as such, Rossmo et al., rightly conclude that geo-profiling could potentially be successfully utilised to target resources to more effectively manage any number of infectious outbreaks (2011).

The research conducted within geographical profiling has shown that various factors can have an impact on the profile produced and conversely that the geographic profile and journey to crime distances can also suggest characteristics of the offender. For instance, Snook (2004) has identified that it appears the younger the offender the less distance they are prepared to travel: those under 15 years will travel significantly less distance, just 1km to commit their crimes as opposed to the distance travelled by offenders aged over 30 years who travelled on average in excess of 2 km. This argument has been corroborated by further research that indicated that the age of the offender had a negative impact on their journey to crime distance meaning younger offenders were likely to travel a shorter distance to commit crime (Snook et al, 2005; 156-160: 198 & Levine, 2009: 170).

It has also been suggested that information such as IQ and access to transportation impacted on the straight-line distance to crime measurement (Snook et al, 2005; 147), specifically that the use of transport was directly linked to potential for higher monetary reward and increases in distance to crime (2004; 61-62). The accuracy of a geographic profile can be further increased when the aforementioned factors are introduced into the equation. By adding considerations such as the offender's age, gender, number, access to transportation, and crime location (rural or urban) and value of the property stolen, researchers are able to make broader assessments (Cullen et al, 2006: 195).

The inclusion of these factors has identified a number of conclusions. For example, Cullen et al., argue that the number of offenders appears to have a positive impact on JTC distance which increased significantly, peaking at three offenders, although examples examined only reached up to five offenders (2006: 198). When the issue of dual offenders was studied further it has also been shown that in over 25% of cases, serial offences are committed with a second offender who routinely lived within a short distance of their co-accused (2009:172). In furtherance of the factors impacting on the journey to crime distance, Levine has concluded that overall, female offenders tended to travel shorter distances to their crimes than males and that their crimes most commonly occurred in town centre retail areas (2009: 172).

However, there are certain pieces of information that do not appear to impact on an offender's spatial decision making. For example, Snook et al., highlight that the duration of the crime series or whether it was a commercial or dwelling burglary committed do not impact on the journey to crime distance taken by the offender (2004; 59-62). It has also been suggested that contrary to previous research (Snook, 2004), the value of the property stolen does not impact on the distance travelled to offend, presumably because this is factor that cannot always be identified by an offender and again, unsurprisingly and in line with previous studies on other offence types, the use of a mode of transportation significantly increased the JTC distance (Cullen et al, 2006: 199).

Having identified what demographic factors make an impact on the journey to crime distance many researchers have focused their attention on the methods used to analyse the distance decay function to improve profiling accuracy. The distance decay theory is the most commonly accepted method of measuring the journey to crime distance to produce a geographic profile (Cullen et al., 2006: 197) with some studies showing as much as 63% of offenders live within 10km of their crime location (Cullen et al., 2006: 197). However, most commonly offenders are identified as living within just 1km of the place of the offence (Cullen et al., 2006: 197). Phillip's research corroborates this by identifying that linear journey to crime tests show that offending behaviour follows the distance decay theory (1980). This study also indicated that different crime types had varying journey to crime distances which broadly correlated to the severity of the crime committed (Phillips, 1980).

Research has also tested the accuracy of the distance decay principle by combining it with other approaches (Block and Bernasco, 2009). By examining profiles obtained from serial burglars, Block utilised the Comp-Stat 3.1 system which is a GIS similar to other products including Dragnet and Rigel, to measure a combined approaches predictive accuracy in relation to what has been defined as commuters, which are offenders who travel larger distances and marauders, who are offenders who live very localised to their crimes (2005;2).

Similar to risk terrain modelling techniques used within predictive policing, Block identified a total of five risk surfaces, as opposed to the usual three used within

a GIS (2005; 4). By doing so, Block identified that a combination of 'conditional' and distance decay approaches obtained the most optimal accuracy (2005; 10). Furthermore, that all of the tested approaches were most successful in predictive accuracy for marauding offenders (2005; 11). The argument that a combined theory approach does significantly increase the accuracy of the offender's base location and future crime predictions has also had weight added to it by more recent work. In 2009, O'Leary identified that this can be achieved by combining the theory of distance decay geographical profiling with what he describes as a 'hot-spotting' approach which is defined as a blanket area encompassing the most recent crimes of the offender (2009; 13). O'Leary has suggested that the combined model offers greater accuracy than both of aforementioned models in silo but that further work is required to solidify this conclusion (2009; 15).

Geographical Information Systems (GIS)

As a result of the emergence of geographical profiling, several key authors on the subject have devised computerised systems based on mathematical algorithms to conduct the process (Dragnet, Rigel and CrimeStat). Rossmo's theory was first incorporated into the system Rigel. Following that David Canter produced the GIS system, Dragnet. Finally, Levine produced Crime-Stat, one of the most popular and widely utilised geographical information mapping systems. Crime-Stat is a standalone system which is able to interface with the records of most large Police forces and produces geographical profiles hotspot data based on the location data that is input into the system (Levine, 2005: 43). Levine describes his system as being a tool to assist law enforcement agencies in the mapping of crimes and their analysis and as an aid for decision makers (2005: 43). Levine describes how the system can utilise the spatial theories that underpin journey to crime distance analysis (2005: 47-50).

Some researchers have also compared the varying mathematical foundations that are used to underpin geographical profiling in an effort to try and understand further the thought process of offenders when deciding their crime locations but to also increase efficiency of the geographical information systems (O'Leary, 2009). Unsurprisingly they have broadly concluded that the distance to the offence location plays an important part in the offender's decision-making

process (O'Leary, 2009). It has also been identified that when examined using a GIS to produce a geographical profile, that no statistically significant differences between any of the underpinning mathematical approaches have been identified (Canter and Hammond, 2006: 104).

The use of a GIS to create geographical profiles has, helped form the assumption that complexity, as defined as either a higher number of crimes or use of more complicated methods (such as the use of a GIS algorithmic approach) increases accuracy with respect to the prediction of an offender's base (Rossmo, 2000; Snook et al., 2005). To underpin this assumption, Snook et al., have also identified the use of geographical information systems and the algorithms underpinning them as evidence of complexity, before suggesting that simple heuristics may yield equally accurate results (2005). In an effort to prove this Snook et al have tested two hypotheses (i) that the more complex a strategy the greater the predictive accuracy, and (ii) the more complex the strategy the greater the predictive accuracy of more complex tasks (Snook et al, 2005). This research provided an interesting conclusion suggesting that regardless of the complexity of the profile, comparable results could be obtained using much simpler heuristic approaches without the need for a geographical information system (Snook et al, 2002; 2005).

As this chapter has outlined, the use of geographical profiling, although extremely helpful, can have some drawbacks and there are a number of issues which need to be considered. It also identified that some believe that current theories on geographical profiling are too simple (Levine, 2009:178), whereas others argue that simplicity is not a blocker to predictive accuracy (Snook et al., 2005). It has also been suggested that the theory may prove most useful if it is viewed as a method of underpinning a psychological profile and having identified the demographic factors that have been identified from analysing geographic profiles it is easy to see why Young's assessment has gathered some support (Canter, Young's, Hammond & Juszczak, 2012).

Some authors (Levine, 2009) have rightly argued there is still significant work to be done on the theory of geographical profiling and down a number of potential avenues. Canter has suggested that much of the previous research has been

hampered by their data being analysed on an aggregate basis and there may be merit to studying single ideographic cases in more comprehensive detail (2012). Young argues that because of this, although geographical profiling is viewed as a valuable tool in criminal investigation, it is fraught with downfalls and doubt because it has only been robustly examined in scenarios were the offender is known which clearly makes its use limited in operational environments (2006: 24).

It has also been suggested that further emphasis needs to be placed on studies including outside contributory factors such as the topography and more research on other crime types as current research is mainly concentrated on serious crime forms with the most minor being that of burglary (Levine, 2009:178). Young also argues that the field of geographical profiling is ultimately flawed as it fails to take into account any behavioural or physical characteristics of the offender when used in silo (2006). For example, using information obtained from previous research and conclusions relating to the number of offenders, their age and gender and its impact on the distance decay and journey to crime to further increase accuracy. As we have seen, Snook et al, 2005) argue that complexity does not necessarily equate to accuracy and that heuristic approaches can be competitive, but can their effectiveness be further increased by combining the aforementioned offender characteristics? Or as O'Leary has argued (2009), can we create more effective predictions when combining approaches? For instance, what would complement a geographic profile to make predictions more effective, intelligence led operations, hotspot policing, optimal forager, risk terrain modelling? It has been suggested that the highest performing GIS geographical profile predictions all included information regarding the origin points of the offenders and others who had committed previous offences in the same locality (Snook et al, 2006;79) which is a basic principle of risk terrain modelling, as such, is their merit in approaches that can include such offender data? Also, Snook et al (2005) argue that the heuristics versus GIS debate still requires further research to exhaust all comparative angles. For instance, comparing police officers to non-law-enforcement participants is one method to ascertain if professional experience was a factor in their average accuracy exceeding the GIS average predictions. Ultimately, what can be concluded from this review and

is succinctly argued by Canter is that a real need for further research is needed on how such criminal behaviour studies can assist operational policing (2005; 667-8).

Predictive Human Development, Behavioural and Physical Characteristics

Having outlined the research evidence as it related to geographical methods of predicting offenders to fully understand where this study fits within existing research it is necessary to outline literature regarding predictive human and physical characteristics. As such this section now gives an overview of criminological research regarding known human development, behavioural and physical characteristics that affect the criminal career.

Farrington (1994, pp 64) has described a criminal career as *"the longitudinal sequence of offences committed by an individual".* Edelstein (2015) defines criminal careers as being the activity conducted by "habitual offenders," "professional criminals," and "serial offenders." By examining their career path it is possible to identify behaviours and characteristics that precede offending which is often indicative of other causal disorders, with crime often the symptom or an indicator of the disorders presence. These behaviours include things such as risk-taking behaviour, unreliability, being absent from school, intimidation and bullying of others, cruelty to animals, excessive gambling and alcohol consumption and early sexual behaviour (Farrington, 1994 and Moffitt, 2017). Such behaviours are often described as callous-unemotional traits.

Research examining anti-social syndrome and adolescence-limited antisocial behaviour (Moffitt, 2017) has shown that such behaviours are often present within a juvenile offending history. Early research on the subject suggested that as many as 67% of offenders aged 18 or under possess at least four of these factors (West and Farrington, 1977). Furthermore, there are multiple other studies that have identified the presence of such behaviours as potential indicators preceding criminal offending (Robins & Ratcliff, 1980; Donovan et al., 1988 & Farrington, 1991a). Such syndromes often develop into or are indicators of other disorders such as conduct disorder (Robins, 1991 and Matthys &

Lochman, 2017), anti-social personality disorder (Robins, 1979 and Storebo and Simonsen, 2013) or even an indicator of psychopathy (Hare, 1980 and Klingzell et al, 2016). One condition that is repeatedly cited within the research evidence as a potential cause or predictive link to offending is that of impulsivity.

Research evidence has shown that hyperactivity-impulsivity-attention-deficit is strongly linked to career offending (Gittleman et al, 1985; Loeber, 1987 and Morgan et al, 2016). Whether such impulsivity disorders are a cause remains debatable, but studies have shown that its developmental evolution is predictive of future behaviour and conduct problems (Morgan et al, 2016). For instance, Richman et al., (1983) showed that its presence at the age of 3 was a significant indicator of future impulsivity related disorder at the age of 8. Furthermore, there have been multiple studies that have shown that the presence of this disorder at as young as 8-10 is a predictor of future juvenile convictions (Farrington, Loeber, and van Kammen, 1990 and Taylor, 1986 and Wojciechowski, 2018). As such, it seems the link between impulsivity and offending is well established and it has been further argued through several studies that the disorder and related behaviours lead to criminality because of the individuals lack of or lower than normal self-control (Gottfredson & Hirschi, 1990; White et al, 1985 and Chen et al, 2017). A number of studies (Magnusson, 1988 and Chen et al, 2017) have shown that these disorders create somewhat of a higher adrenalin threshold with children who possessed low adrenalin levels at ages as young as 13 committing more offences than those with standard measures. This suggests that the combination of low self-control and low adrenalin levels are strong compound behavioural factors both predictive of future offending.

As well as disorder related influences or predictors for offending there also exist some biological ones. Although a very controversial subject some biological traits do predict the future likelihood of offending and link to other areas already outlined. For instance, Farrington (1992c, 1993a and 1993b) has shown that low intelligence levels as evidenced through school attainment does predict the future likelihood of committing both juvenile and adult offences. Since this early study this hypotheses has been investigated a number of times and recent meta-analysis of research suggests that intelligence levels are a factor which is linked

to levels of offending (Farrington et al, 2016). It is suggested that this is because of such individuals inability to see the beyond the short-term consequences of their actions (Farrington, 1994 and Farrington, 2016). Moffitt (1989 and 2017) and Henry (1989) have shown that low intelligence is in fact caused by low functioning within the frontal lobes of the brain. This is the area that controls reasoning, self-monitoring and behaviour and their research has shown that low measures of activity in this area is linked to people responsible for offences and those who possess disorders linked to impulsivity (Moffitt 2017 and Moffitt & Henry, 1989).

In addition to psychological and biological predictors, there are also physical ones that can be used to predict future offending. One of the most significant is the issue of age. Studies using a criminal career approach have outlined that when comparing offenders at an aggregate level there are significant differences which may aid in informing predictive profiles of offenders. For instance, examining offender careers at this level has identified that offending is most likely to begin between the ages of 13-15 years (Fry, 1985; Farrington, 1992b and McCuish et al, 2016).

Research has shown that the age of onset can be predicted by the presence of certain familial conditions such as a lack of, and low levels of time spent with a fatherly role model, or overly autocratic parenting styles (Farrington and Hawkins, 1991 and Piquero et al, 2016). A further finding from research examining offending onset is that the earlier the offending begins, the longer their offending lasts in their criminal career and the overall number of offences is greater (Gottfredson and Hirschi, 1986). After initial onset, frequency of offending then increases and is at its height during the juvenile phase of development and it has been identified that the peak age within the teenage years ranges from 14 to 17 (Farrington, 1989; McCuish et al, 2016 and Wolfgang et al, 1987). Once peaked, offending then continues at a stable frequency (Farrington, 1986a and McCuish et al, 2016).

Studies that have examined age as a characteristic of offenders throughout their offending lifespan have established that as offenders continue to age, their criminal behaviour also changes. Research examining frequency of offending

has established that as an offender becomes older, their offending begins to desist which is manifested in a declining frequency of offending which decreases fastest after the age of 30 (Blumstein et al., 1982 and Farrell, 2017). Early research by Blumstein suggests that as the majority of juvenile offenders cease criminal behaviour before the age of 30 that career criminals above that age are, in fact, a subset of persistent offenders (1982). More recent research has shown that this finding has changed little in the subsequent years with only minor deviations based on crime types and life circumstances (Farrell, 2017). An exception to this offending desistance and frequency is seen in those criminals suffering drug addiction who research has identified as conducting higher rates of non-drug related crimes during their addiction periods (Mazhnaya, 2016). A final factor for consideration when reviewing research relating to offending frequency is the interval period between crimes. Several studies have shown that the longer a crime series continues, the shorter the time period between the offending becomes (Farrington et al, 2016; Hamparian et al., 1978 and Tracy et al., 1985). However, when examined at the career aggregate level, this is not the case, and in fact the interval remains relatively constant over time (Barnett and Lofaso, 1985).

Fortunately, most offenders eventually desist in their criminal behaviour and there have been multiple studies examining when (Blumstein et al, 1985; Farrington, 1992b, Farrington, et al, 2016; Wolfgang et al, 1972; & Farrington & Wikstrom, 1993) and also why (Osborn, 1980; West, 1982 & Shover, 1985). From research of offender data it has been identified that 'normal' criminal careers last only approximately 5-6 years (Farrington et al, 2017), ending at roughly the age of 23 (Farrington, 1992b). The maturity of the offenders, emergence of personal marital type relationships and a heightened awareness of the consequences though previous experience of imprisonment for instance, all contribute greatly to the desistance of offending (Osborn, 1980; West, 1982 & Shover, 1985). Desistance however does have exceptions and those who continue are often described as 'chronic' offenders. Research has shown that such chronic offenders are relatively rare and account for only between 1% (Wikstrom, 1987) and 6% (Farrington, 1983a and Farrington et al, 2017) of offenders. Chronic offenders account for vast proportions of recorded crime with

some studies showing that they committed over 80% of robberies, over 70% of rapes and murders (Farrington, 1983a).

Having examined some of the factors that are potential predictors in the psychological and behavioural characteristics of offenders it is now important to touch upon the characteristics of offending behaviour. This allows us to place the examination of foraging offenders in greater context.

There have been a number of research studies that examine such issues as specialisation of offending, motive and intention and the issue of co-offending. In respect of specialisation, research evidence has shown that offenders who possess a propensity for violence do not develop specialised methods for conducting offences as their careers develop (Elliott & Francis, 2018 and Farrington, 1991b). In fact, Farrington's research suggests that the methodology effectively remains random (1991b). In contrast, research (Elliott & Francis, 2018 and Stander et al, 1989) has shown that sex offenders and criminals who commit fraud can become extremely specialised and this specialisation becomes increasingly specific with age. Some research also suggests that the seriousness and harm caused by specialised offenders increases as they age (Elliott & Francis, 2018 and Tracy et al, 1985) but this suggestion still requires further examination.

In respect of co-offending the research evidence shows that this is most prevalent in certain offending types including acquisitive crimes such as burglary (Reiss and Farrington, 1991 and Waring 2018). When offenders conduct offences with associates research evidence also indicates that significant similarities will exist between them (Waring, 2018). This includes the fact that they are likely to be of a similar background in terms of class but also that they will most likely be of similar age, the same ethnicity and importantly for this study, reside in the same geographical proximity (Farrington, 1994 and Waring, 2018). Significantly however, some research has shown that these similarities between co-offenders fade as the criminal career extends (Farrington, 1994 and Waring, 2018). As can be seen from the research evidence outlined in this section, age is a significant factor that impacts upon multiple offending behaviours as criminals grow older. The impact of age is also a prevalent factor in the motives

of offenders. Older research has intimated that younger offenders commited crimes for less rationale reasons such as excitement and enjoyment whereas older offenders did so for material gain (Farrington, 1994; West and Farrington, 1977 and Waring, 2018)). In the main, such material gain was sought to support their families or to fund some form of substance abuse such as alcohol or drugs (Petersilia, 1978). Recent research has continued to support these early findings.

2.5   Conclusion

This chapter outlined the emergence of the performance culture within UK policing that occurred during the 1980's and 1990's. As a result of this culture, it was established that there was a necessity for forces to become better at crime prevention and reduction and this helped the uptake of several policing models. These included the 'zero tolerance' broken windows approach, intelligence led policing, problem orientated policing and also the hotspot methodology. Most recently, Police services have begun to operate using what is defined as predictive policing. The chapter established that several forms of predictive policing exist but that it was the optimal forager model that is drawn from within ecology, that has had the widest uptake but only for a small area of crime, namely domestic burglary. The chapter also identified factors that affected the successful implementation of evidence-based crime reduction and prevention efforts.

The chapter went on to explore literature and empirical research that underpins the optimal foraging approach to predictive policing by reviewing the limited studies available and identifying their key ecological foundations. By doing this the chapter identified that the existing literature had failed to take into consideration key ecological assumptions and their impact, most notably that of patch movement which occurred as a result of increased predation, which it was postulated was the equivalent of the criminological issue of crime displacement. Geographical profiling also established as a further potential predictive methodology that complemented the optimal foraging model by combating anti-predatory behaviour. This included a review of crime linkage literature which is a key foundation to geographical profiling, along with the emergence of algorithmic based geographical information systems. Finally, the review found that despite

the wide implementation of a number of the identified Policing theories, there has been little empirical research to underpin them.

CHAPTER 3

METHODOLOGY

3.1   Introduction

In the previous chapters it was established that Policing and criminological literature focusing on theoretical concepts to reduce and prevent crime is limited. One area that had continued to advance was the concept of predictive Policing. It is also acknowledged that the term predictive policing, within the United Kingdom, effectively referred to near repeat victimisation, optimal forager theory. However, it was identified that there had been no evidence-based assessment of the theory within UK Policing, despite its implementation by a number of Police services. It was also established that a number of unanswered questions remained surrounding what ecologists call patch movement but is referred to within the predictive criminology literature as the issue of crime displacement which is caused by serial offenders as a consequence of the adoption of this theoretical model (Repetto and Braga, 1976 Anthony, Papachristos, Andrew V, Hureau and David, 2012). All of the aforementioned issues are implementation risk factors which were outlined in chapter 2, specifically those relating to theory failure. This is because previous research has failed to take into consideration all aspects that impact on foraging behaviour, particularly the predator – prey relationship and its impact on prey (offender) movement. This relationship is mirrored within policing as the tasking and co-ordination of resources into areas of increased predicted risk, providing capable guardianship to prevent and reduce crime. Some scholars within criminology (Eck and Walter et al, 2013) and also ecology (Lima, 2002) have suggested that the way to counter this is through combining crime predictions with methods to target the offenders, such as geographical profiling. To successfully combine these approaches would first require the ability to accurately link crimes. The previous chapter identified the approaches to conduct crime linking and generate predictions for both the highest risk crime areas and the offender's likely home or base.

This chapter outlines the methodological approaches to be adopted throughout the study. The chosen approach is that of a mixed methodology as this best reflects the nature of the study. This is because some data required to answer

the key questions outlined in chapter 1 already exists in quantitative formats, such as recorded crimes and the characteristics and behaviors of offenders. Other questions, particularly those relating the operational implementation, require a more exploratory qualitative approach to answer them, hence the use of case studies and interviews. The combination of both a quantitative and qualitative methodology allows a fuller exploration of the issues but probe a number of data resources to triangulate any findings extracted. No specific methodology is 'right' or 'wrong' or intrinsically better than any other (Kaplan and Duchon, 1988), however, what this section seeks to do is outline the methodologies chosen and explain why they are best equipped to address the questions being asked and to attain the objectives of the study.

3.2   Conceptual Design

Prior to outlining the aforementioned, to enable a better understanding of the methodology within the study it is important to explain the concepts of ontology and epistemology so that the philosophical perspective of the researcher can be understood. Within the field of social science these concepts help frame the social reality. Ontology refers to the question "that is", "what is out there to know about" and whether there is a "real world out there" a world that is "independent of our knowledge of it" (Grix, 2002 and Marsh et al, 2002). It is suggested that ontology is "claims and assumptions that are made about the nature of social reality, claims about what exists, what it looks like, what units make it up and how these units interact with each other" (Blaikie, 2000, p8). Ultimately, a person's ontological stance is their interpretation of the political and social reality they are investigating (Hay, 2002, p.63). The ontological stance of the researcher is one of the most important foundations for all research, once this stance is identified both the epistemological and methodological then naturally flow from this starting position (Grix, 2002, 177). Epistemology mutually supports a researcher's ontological stance and seeks to address the 'limits of human knowledge' and how we 'come to know' and 'how we can know it' (Schuh and Barab, 2007). It is essential to identify one's position as it relates to ontology and epistemology to fully comprehend how key areas of the research such as the method and methodology interrelate. Ultimately, one's ontological position naturally informs

one's epistemological position which in turn impacts on one's methodological approach (Mack, 2010; 6).

3.3   Inductive and Deductive Research Strategies

The aim of inductive strategies is to produce explanations for patterns or generalisations which are extracted from an empirical approach to gathering information from people or social situations (Blaikie, 2007; p8). Once such data has been accumulated it is possible to start to identify themes or salient points by establishing patterns which may be able to provide answers or explanations to specific questions (Blaikie, 2007; p8). This allows inductive logic to be applied and provide a contribution by making further observations. Blaikie (2007) suggests that deductive strategies work in the opposite way to inductive strategies. Where inductive strategies seek to identify patterns and generalisations, deductive strategies use them as a starting point from which to provide a theoretical explanation for a 'why' question (Blaikie, 2007; p9).

3.4   The Application of Inductive and Deductive Research Strategies in Respect of This Study

The first stage of this study consisted of a comprehensive literature review. It is deductive in the sense that it identified generalisations or patterns by studying theories or concepts that have already been established within the literature. Most notable was the links between ecology and criminology such as the pattern of patch movement, or crime displacement. This provided the question; does this occur when predictive Policing models are used? And how can it be combatted with increased effectiveness? These questions provided the opportunity to construct the theoretical concept of a combined predictive model which seeks to simultaneously predict both offending area and the likely home or base of the offender. Although partially deductive the literature review was primarily an inductive process as its purpose was to identify patterns and generalisations from pre-existing studies from which to identify opportunities for further work or as yet unanswered questions. As has been suggested these two strategies although very different can be used in a complimentary fashion which has been done in this case.

In respect of chapters 5 and 9 case studies were selected that allowed sufficient access to interview participants. The case studies focused on the operationalised application of both the optimal forager predictive Policing and geographical profiling approaches within the UK. This inductive interview method was used to obtain empirical data to help identify what the benefit of applying predictive Policing and geographical profiling was by assessing its accuracy and effectiveness. Interviews were then interpreted to produce generalisations to assess the Policing model's operational success. A deductive approach was used within the remaining chapters. Chapter 4 used quantitative recorded crime data to examine the effectiveness of an optimal forager implementation. Using alternate analysis techniques, chapter 6 used recorded crime data to underpin logistic regression and receiver operator characteristic analysis to ascertain crime linkage thresholds. Chapter 7 again used the same recorded crime data to examine the presence or otherwise of ecology and criminology assumptions. Finally, chapter 8 used geographical data and offender characteristics to interpret the spatial behaviour and characteristics

3.5   Research Strategy with an Epistemological and Ontological Perspective

The epistemological and ontological perspectives of the research are important as they help prevent confusion and misunderstanding in relation to issues of social and theoretical importance. Ultimately it allows others who examine the research to recognise the author's position and understand the defence of their stance (Grix, 2002, p. 176). This research draws together a combination of ontological and epistemological choices. This is because the differing tasks or questions cannot reconcile with one 'catch all' position. This is not unusual, and it is perfectly normal for researchers to vary on the ontological and epistemological paradigm (Cohen, Manion and Morrison, 2000). This is also a positive thing as combined research methods are increasingly being called upon as a way of improving the quality of studies but what is important in this scenario is that the differing perspectives are managed with care (Kaplan and Duchon, 1988).

Broadly speaking, the positivist approach to ontology has been adopted for this study. Such a stance believes that reality can be observed and as such interpreted if observed in the correct manner (Mack, 2010; 6). This is because the data in this study seeks conclusions and generalisations that can be drawn from knowledge based on experience and understanding which can be obtained through observation and experimentation (Mack, 2010; 6). An objective reality is also pursued as opposed to complete truth which can go a long way to producing strong probabilities or as this study seeks to do, generalisations and predictions, as opposed to 100% certainty (Mack, 2010; 7) which in a study with so many variables is a positive outcome.

In respect of the epistemological stance both an empiricist and rationalist position has been adopted. The perspective of empiricism has been adopted because by calling upon knowledge that is gained through experience of the subject matter in hand (Longworth, 1998; 1), the research is seeking to identify the source and justification of the conclusions (Longworth, 1998; 1). Conversely, the rationalist perspective is that 'intuition' or 'rational insight' is the basis of knowledge and from this position we can draw further conclusions based on deduction (Longworth, 1998). Such a combined perspective enables a more complete understanding of the social facts in play and a more in-depth analysis of the relationship between them and a fuller picture of the issues created and examined.

To summarise, the main strategy that this study has utilised is deduction. This is because the study seeks to compare data that is gathered by a variety of means which can then be analysed to inform conclusions. Strategies of induction have been used to form the basis of the thesis by identifying patterns and generalisations for the theory to be constructed, which is most evident in the literature review. It is also to a lesser degree found within the interviews conducted that also highlighted further or corroborated existing patterns and generalisations. It is accepted that the epistemological and ontological stance adopted by the author does have an impact on the study's findings and as such any conclusions should be viewed in the context of their position as opposed to being accepted as fact.

3.6   Mixed Methodology

The previous section outlined the ontological and epistemological perspective of the researcher, which has dictated heavily the mixed methodological approach pursued. The documentary data and information will be drawn from the three most commonly accepted forms, primary, secondary and tertiary sources (Burnham, 2004). Such triangulation of data collection provides the study with a wider array of sources and as such a greater understanding of the subject being examined.

Quantitative Data Extraction

Within chapters 4, 6, 7 and 8 quantitative data was extracted from police systems in the form of recorded crimes. This data was then subjected to various forms of inferential and descriptive analysis to identify patterns, characteristics and behaviours and also inform conclusions and generalisations that are made.

The collection and interpretation of quantitative data within chapter 4 is extracted from recorded crime records within a provincial police force, Lancashire Constabulary. This was then analysed to assess the impact on offending rates both pre and post increased tasking and co-ordination of police resources. This is done to assess the overall effectiveness of the implementation of the optimal forager theory of predictive policing. Within chapter 4, to assess the effectiveness of the optimal forager implementation the extracted data was analysed using SPSS software. This enabled the research to analyse large historical data sets using advanced equations such as Cox & Snell, Nagelkerk, Chi Square and Jaccard's co-efficient.

The objective of chapter 6 is to attempt to better understand the behaviour of foraging domestic burglary offenders. The chapter seeks to do this by using the same quantitative data to examine linked behavioural and physical characteristics of foraging burglary offenders. This is then used to provide knowledge which can be used to create more effective decision-making thresholds for prevention and reduction. This section focused on three different themes; (1) targeting selection behaviour; (2) temporal and spatial offender behaviour; (3) property selection behaviours. The data within chapter 6 was

analysed using the B-Link software supplied by Dr Craig Bennell. This software was also used to produce ROC curves to identify the most accurate predictive indicators.

Advancing the understanding of foraging burglary offenders further chapter 7 also used the quantitative data extraction method to underpin further analysis of the same recorded crime data. In this chapter, it is done to examine the presence of otherwise of optimal foraging behavioural assumptions from within ecology against those from within traditional criminology literature. Similarly to chapter 5 the extracted data was analysed using SPSS software. This enabled the research to analyse large historical data sets using advanced equations such as Cox & Snell, Nagelkerk, Chi Square and Jaccards co-efficient.

The final data chapter is underpinned by the theory that geographical profiling may provide a criminological solution to combating predictive tasking and co-ordination induced crime displacement. Chapter 8 explores this potential by using crime mapping and geographical information systems to further examine quantitative data extracted from Lancashire Constabulary's recorded crime data. This is done to help further understand the spatial behaviour of foraging offenders, and the effectiveness of geographical profiling as a potential methodology to combat foraging burglary offenders. To explore this solution geographic profiles of optimal foraging burglary offenders are created to provide new knowledge in respect of the spatial behaviour of the offenders and the methods predictive effectiveness. To produce geographical profiles the GIS mapping system MapBrix was used which uses a distance decay algorithm to predict the likely offenders home or base. Simple forms of data calculation were then used to produce a descriptive analysis which included the mean and medians of the data, percentages and standard deviations which were then illustrated in tables and chart formats.

These quantitative methods followed a distinct process of enquiry with its aim being the testing of a theory which is an accepted approach (Abawi, 2008). The goal of this quantitative method was to determine whether the predicted end results of theories specified within each chapter held true. It is suggested that

such research focuses on deductive forms of logic with theories and hypotheses being tested in a cause-effect order (Abawi, 2008).

Case Studies

Using a case study methodology, three police services are chosen to examine the implementation of the optimal forager theory of predictive policing as a tactic of domestic burglary prevention and reduction. Within chapters 4, 6 and 7 and 8 the primary case study within Lancashire police is used to underpin the data extraction and quantitative analysis. Within chapters 5 and 9 the case study selections are used to underpin the participant interviews within Lancashire, West Yorkshire and Greater Manchester. Table 2 on page 98 provides the reader with an understanding of the options available for the study.

A case study approach to selecting the environments to be studied was chosen because they are different to other positivist methods as they do not seek to 'control' the phenomena being studied (Yin, 2003). Instead they seek to use a range of data sources to examine the subject of the investigation. In this thesis this was the behaviour of foraging burglary offenders and predictive police interventions to prevent and reduce their offending. Adopting a case study approach also enabled the ability to draw one's own conclusions and generalisations (Yin, 2003). Such an approach is particularly useful where the case study is seeking to understand something as it is the process of the case study itself which is a means to an end not an end in itself. This is different from other research methods such as experiments or surveys which more commonly simply aim to provide an end conclusion (Yin, 2003). The focus of a case study should be on the broader issues being investigated to achieve a better comprehension of the phenomena before generalisations can be drawn (Yin, 2003).

Case Study	Advantages	Disadvantages
Greater Manchester Police: Near Repeat Prediction	Limited key participants are available to provide additional insights and key information.	No access to quantitative recorded crime data No access to quantitative predictive products used
Kent Police:		No access to quantitative recorded crime data No access to quantitative predictive products used No access to key participants are available to provide additional insights and key information.
West Yorkshire Police: Operation Optimal	Limited key participants are available to provide additional insights and key information.	No access to quantitative recorded crime data No access to quantitative predictive products used
Lancashire Police: Operation Optimal Forager	Full access to quantitative recorded crime data Full access to quantitative predictive products used Full access to key participants are available to provide additional insights and key information	
West Midlands Police: Operation Swordfish		No access to quantitative recorded crime data No access to quantitative predictive products used No access to key participants are available to provide additional insights and key information
Lincolnshire Police, East Midlands Police, Metropolitan police		

Table 2. Case Study Selection Strengths and Weaknesses

For the case study selection to be credible it was important that a number of conditions be considered. It is argued (Silverman, 2000:175-88 and Yin, 2003: 34-39) that to provide a case study that can withstand scrutiny that certain tests need to be met relating to construct validity, internal validity, external validity and reliability. Construct validity relates to forming the correct operational measures for the concepts being studied (Silverman, 2000:175-88 and Yin, 2003: 34-39). Yin suggests achieving this by using a number of data sources or articulating exactly what is to be studied and providing sufficient explanation about how it is to be measured to justify one's approach (2003:35). In respect of explanatory and causal studies internal validity is defined by Silverman (2000) and Yin (2003) as the establishment of a causal relationship in which circumstances are shown to lead to subsequent conditions. The test of external validity involves establishing the arena within which generalisations can be made from the study's findings (Silverman, 2000:175-88 and Yin, 2003: 34-39). This can be achieved by conducting research that involves a coordinated set of case studies within a field investigating the phenomena (Yin, 2003; Stake, 2006). Finally, according to Silverman (2000) and Yin (2003) reliability is the demonstration that the methods by which data was collected could be repeated and reach the same conclusions (Yin, 2003:37). This study considered all of these conditions and meets all of the aforementioned criteria. The explanation as to how they are met will be fully explained in the operationalisation section of this chapter.

Strengths and Weaknesses of the Case Study Approach

There are a number of reasons why this research strategy fits so well with this study, but it is acknowledged that they have both strengths and weaknesses. Advocates of case studies will argue that they can produce a greater detail of information than through analytical approaches (Writing Centre, 2004) and are particularly more equipped in describing the context of a phenomena. This is especially true when investigating people, groups, social, political and organisational situations. This is because they offer researchers the ability to examine issues in their real-life environment (Yin, 2003) in a much more flexible way and remain organic and able to adapt to questions, issues or opportunities as they arise (Writing Centre, 2004). This approach also allows the researcher to gain face to face access to people who can 'bridge the gap' between evidence

such as policy or guidelines and get first-hand observations of what the reality of a situation is, allowing greater comparison with other forms of data. As such, a case study approach is very well suited to assessing the effectiveness of predictive Policing and geographical profiling within the UK. In pursuit of the research objectives the study has to examine how efficient, effective and accurate optimal forager predictive Policing and geographical profiling are. This approach allows the primary research question to be answered within a real-world context by taking into account organisational and cultural phenomena within which the question is based. In pursuit of answering the primary research question, this approach also provides insights and information to enable generalisations and conclusions be drawn in pursuit of several of the underpinning objectives. It does this by taking into consideration a wide array of factors to form generalised conclusions in respect of this aim and adopting a case study approach in several police forces provides a wider context. .

Despite the advantages it is accepted that there are a number of potential issues and prejudices against the use of case studies as a methodology. The first main issue cited against the use of case studies is the belief that they are inherently subjective because they are more generally based on qualitative data (Yin, 2003) which creates potential for bias when drawing conclusions and generalisations. However, other approaches such as survey questionnaires can also be open to bias, but it is the duty of the researcher to take steps to maintain their integrity and present their results accurately. Secondly, according to Yin (1989) the case study has been ridiculed for being a lesser form of research strategy because it creates to much potential for inaccuracy because of its lack of scientific basis. Yin states, *"investigators who do case studies are often regarded as having deviated from their academic disciplines, and their investigations as having insufficient precision (that is, quantification), objectivity and rigour"* (Yin 1989). However, this criticism is commonly accepted as being mainly in respect of single case studies and as such would still be an issue for other more quantitative based experiments if conducted just once (Yin, 2003). In response to these criticisms Yin (2003) argues that the purpose of case studies is not to produce hard facts supported by statistical analysis but to provide generalised theories for comparison with empirical findings or other theories. In order to provide

information of sufficient quality and validity this study utilises a multiple case study approach which provides significant advantages by studying more than one case. Each study collects data from interviews, documentary evidence and other sources. According to Johnson & Christensen (2008, p. 408) the conduct of several case studies regarding the same phenomena allows comparisons to be made in order to explore similarities and differences. It also allows the researcher to test a theory but ultimately simply examining more cases provides greater reliability and validity and greater weight for any claims for generalisability (Johnson & Christensen, 2008, p. 408).

Interviews with Practitioners

A qualitative approach using semi-structured interviews was conducted within chapter 5 which used participants involved in optimal forager implementations, and chapter 9 which interviewed operational geographical profilers. Each of these interviews was recorded using a Dictaphone. This allowed for the interviews to be transcribed at a later date and analysed in detail. The conduct of the interviews was directed by the questionnaires within appendix 1 and 2. On average they lasted approximately 45 minutes to 1 hour and were conducted by myself, with only the participant present. These interviews were conducted in a range of locations but due to the profession of the participants they were all within the police premises where the participant was based (which I travelled to in an effort to ease the burden on the interviewee). After the interviews were completed they were then transcribed by myself, verbatim using Microsoft word.

Interviews were structured in format and through the adoption of an deductive analysis, themes were identified prior to the interviews. These themes were based upon key areas of discussion that were identified from within the literature reviews of evidence based policing, operational applications of research and implementation failure. The interview questions template was built upon these coded themes and also allowed sufficient freedom for the interviewee to provide unsolicited information towards the conclusion of the interview. The subsequent analysis process was completed manually but with the aide of Microsft word and excel. This was done by firstly assigning a colour code to each coded theme that is described within the distinct sections of the interview chapters, which was

drawn from the literature as described. The transcripts were then reviewed and content was then highlighted in colour, within the Microsoft word transcripts. Upon completion content from each interview transcript was then copied into specified boxes within a Microsoft excel document whose titles and assigned colour code matched the deductive themes identified. Untitled boxes were left free to populate with content that had not been previously coded from the inductive analysis of the literature. For example, the issue of cost was not identified during the inductive analysis process but was mentioned during several interviews and as such any transcribed data relating to this theme was placed together in an untitled box which was labelled 'cost' at the conclusion of the analysis. This iterative process was able to satisfactorily capture words or short phrases during the analysis stage and code them appropriately.

This method was adopted because it provides a deeper context of information than quantitative approaches alone which enabled the research to identify both negative and positive impact factors which have an effect on the operational use of both methodologies and their successful implementation. Conducting such qualitative research provides a way of understanding the holistic picture of the issues being investigated (Abawi, 2008). The approach enables a deeper truth to be uncovered by peeling away layers to reveal underlying issues or causes. They achieve this by understanding situations in terms of the meaning people bring to them with their goal being to obtain an interpretation of a social or human problem from multiple perspectives (Abawi, 2008). However, it must be acknowledged that use of such a structure or predetermined framework does possess flaws. Most significantly, there is a distinct possibility of researcher bias heavily dictating the process from as early as the literature review stage (Hoyos and Barnes, 2014). It is also suggested that it can limit the analysis of the data and potentially the quality of the research drawn from it (Hoyos and Barnes, 2014). These negative issues are somewhat counter-balanced through the increased ease of analysis and Hoyos and Barnes have suggested that this approach is least precarious when the area studied is well understood by the researcher and the likely responses themes of response can be anticipated (2014). Due to the extensive background of the researcher in the area being

studied and the extent of literature examined it is felt by the author that any negative impact is counterbalanced sufficiently.

3.7   Methodology Sequencing

As outlined, this study uses a mixed methodology approach and combines the analysis of quantitative data, practitioner interviews, statistical analysis and geo spatial analysis, all underpinned through a case study selection process. During the introduction chapter, the sequencing of the thesis was outlined to provide context in figure 1 located on page 26 in which the methodologies are illustrated as being practically interwoven to enable a fuller understanding of the methods used.

As can be seen from figure 1. the thesis sequencing the study follows is a very practical narrative and the methodologies selected flow accordingly. A more formal illustration of the chapter sequencing is outlined in table 3. overleaf. This table describes the objective of the chapter and the analysis method used to achieve it.

Chapter	Objective	Analysis
Literature Review	Establish and analyse the findings from the existing research literature	Strategised literature search combined with further deductive identification of literature from within the examined material.
Chpater 4	Ascertain what impact (if any) does the optimal foraging implementations have on recorded crime rates (assessing effectiveness)?	Statistical analysis of the effectiveness of the optimal forager intervention
Chapter 5	How were the implementations conducted and what lessons can be learned? What impact (if any) did the optimal foraging implementations have on its effectiveness?	Structured interviews of practitioners involved within the interventions implementation
Chapter 6	Do key behavioural, physical and spatial offending characteristics exist within the serial crimes of foraging criminals and, if so, what are they?	Case linkage analysis of crimes committed by foraging offenders
Chapter 7	Do identified assumptions from ecology exist within the behaviour of foraging criminals? Can the assumptions be identified from examining recorded crime data?	Statistical analysis for the hypothesised presence of foraging assumptions within crimes committed by foraging offenders
Chapter 8	How effective are geographical profiling techniques when attempting to profile foraging burglary criminals?	Geographical profiling of crimes committed by foraging offenders and a descriptive analysis of their personal characteristics
Chapter 9	How has geographical profiling been implemented within the UK and what lessons can be learned?	Structured interviews of practitioners involved within the interventions implementation
Chapter 10	Do the findings support the development of a new predictive policing model to reduce the number of domestic burglaries and maximise crime prevention strategies to combat foraging offending?	

Table 3. An overview of chapter objectives and associated analysis methodology

Chapter 4 begins with the assessment of the effectiveness of the optimal forager implementation within Lancashire. Quantitative methods, namely the use of a paired T-test analysis, are utilised to conduct this assessment. Doing so enables some conclusions to be made regarding its effectiveness and also enables the first truly empirical evaluation of an optimal foraging implementation, both of which are objectives of the thesis.

The purpose of chapter 5 is to then add further richness to the conclusions within chapter 4 and generally seeks to understand the 'why' in respect of its effectiveness or otherwise. This can only be achieved by speaking to practitioners at the coal face of its implementation to identify blockers or enablers of the practical application of the forager theoretical framework. This is achieved in chapter 5 through structured practitioner interviews which were recorded and subsequently analysed for thematic trends. A full description of the method used to conduct the interviews is outlined on page 139 within the research chapter.

The purpose of these subsequent chapters is to develop the predictive theories identified in the literature review and use these to test methodologies that if applied, have potential for improving the effectiveness of predictive policing approaches and the tasking and co-ordination that is directed by them. Chapter 6 begins this process by examining the first stage of any predictive process, the linking of crimes. This is an essential stage as to identify a foraging offender requires serial offending. This chapter seeks to establish linkage decision making thresholds for foraging crimes using existing techniques (receiver operator characteristic and regression analysis), this is in contrast to professional judgement which is the dominant existing method. A full description of the method used to conduct the crime linkage is outlined on page 192 within the research chapter.

Chapter 7 seeks to further improve the predictive approach and does this by exploring the theory that other ecological assumptions may be present within the behaviour of foraging offenders. Identifying these behaviours may further improve understanding and as a result the accuracy of predictions and effectiveness of interventions. By examining categories of crime types and characteristics of those crimes such as the size and value of property stolen, a

number of hypothesised manifestations of the ecological assumptions are outlined. The chapter then examines the impact of the optimal forager intervention on these and achieves this by replicating the methodology used in chapter 4.

The ecology literature had also outlined that the best method to maximise the apprehension of a forager was to operate in both their chosen patch and natural habitat. Having established the presence of other ecological assumptions within chapter 7 and establishing geographical profiling within the literature chapter as a predictive approach capable of identifying an offender's home or base, the next natural step is to test its ability in a forager context. Chapter 8 seeks to do this by using the method of geographical profiling through the use of a geographical information system (GIS) to assess its effectiveness in predicting the home or base of a foraging offender. A full description of the method used to conduct the geographical profiling is outlined on page 247 within the research chapter.Once geographical profiling is established as an effective method, similarly to chapter 5 there exists a necessity to establish the operational practicality of the method to assess if it is applicable as part of a combined predictive model. This chapter also achieves this through the use of structured qualitative interviews.

3.7 Ethical Considerations

At the time of conducting the research the author was enrolled at Dundee University and as such all ethical approval refers to this organisation's policy. Ethical approval was gained from the University's ethics committee for the completion of the studies interviews and this can be viewed in appendix 3. (Dundee University, Policy ref: REHP/V1/04.11). As such, the study has received rigorous scrutiny, and this assures both the researcher and readers that the research conducted was done so in an ethical manner thus supporting the validity of the findings.

It is essential when conducting any form of research that those taking part do so with fully informed consent. This means that all participants are fully aware of the full details of any research procedure they are consenting to so that they can make a valid choice. There are specific issues that must be taken into consideration when considering ethics that are distinct to the methodologies

chosen. In respect of interviewing participant's consideration in relation to the participant's competency to provide such consent as confidentiality, position, age or mental condition were considered (Dundee University, Policy ref: REHP/V1/04.11). Respect has also been outlined as an ethical consideration to be taken into account, in particular their personal dignity (Dundee University, Policy ref: REHP/V1/04.11).

Each of these areas provided some practical and cultural hurdles to be addressed to ensure that participants contributed to the study willingly. This was in the main because of the issues of rank. At the time of the author was the rank of Detective Inspector. Within policing this is a mid-managerial role and as such carries a certain degree of authority. This is compounded by the fact that policing, like the military, is an incredibly hierarchical service and this is underpinned further by legislation which essentially outlines that it is a criminal offence to fail to comply to a lawful order and doing so can mean an officer is potentially committing misconduct in a public office. This scenario creates obvious issues in relation to trust that related to the willingness of the participants. It was essential that I was content that practitioners were engaging with the research for their own reasons and not because they were influenced by my rank and felt compelled. This was achieved through some simple steps; (1) Firstly, when communicating with participants I made sure this was done using my private university email address and academic status, as opposed to my organisational identifiers which may have influenced the behaviour of participants (2) I ensured all interviews were conducted in plain clothes and that I was not wearing uniform which would have displayed my rank (3) I also ensured that I wore no identifying insignia when conducting interviews as this clearly displays my rank and position (4) I always ensured I used my first name only in correspondence in an effort to further put participant's at ease (5) I conducted all interviews whilst off duty and as such the hierarchical influence was not present, or at worst, it was reduced (6) finally, if rank or managerial status was ever mentioned or brought to the surface I provided reassurance to participants regarding the impartiality of research from my professional position and used the ethical authorisation process as a further example of such impartiality.

Documentary evidence and access to primary sources of information such as police records was also key to this study. Many of the documents used were in the form of analytical reports not openly available to the public. As such, it was key that the relevant legal authority was gained from the document owner. In line with other research, areas of this study this was achieved by seeking fully informed consent. By doing so the owners of the information were fully aware of its intended use and referral. However, obtaining such information also experienced similar hurdles to that of securing interview participants with informed consent. The concerns anticipated and planned for in this ethical process tended to be less related to rank or hierarchy and more related to the fear of impact upon organisational reputation, confidence and legitimacy. In respect of organisational reputation, it was anticipated that if the results of the analysis upon the optimal forager implementation was not entirely positive, this may negatively reflect upon that police service's ability to prevent and reduce crime. As was outlined in the literature review chapter, the police inspectorate, the HMICFRS, assess police services on their efficiency and effectiveness to prevent and reduce crime. As such, any unfavourable findings on their ability to do this would not be welcomed. Furthermore, this would have potential impact upon the confidence of the communities served in their area. In its worst manifestation the result of this could be a reduction or complete loss of legitimacy of the affected police service which can potentially incite reaction or intervention from communities, victims or social action groups which can often create its own consequences. So called 'paedophile hunters' are an excellent example of this where the police have lost the confidence of the public to tackle an issue and as such lost its legitimacy, resulting in the rise of such groups, often with negative consequences. To address these concerns all of the aforementioned mitigative actions taken in facilitating interviews were also utilised when appropriate in securing documentary and primary source evidence with the addition of some additional reassurance. This addition was in the form of an outline of the intentions of the author in respect of circulation and publication. Unfortunately, some police services were not sufficiently reassured by these assurances and information and this is a major reason behind why a number would not allow the release of primary data or the interviewing of their staff.

This was evidenced in the fact that case studies could not be conducted in several organisations as they did not wish their documents and the information within to be publicised and as such these studies were ruled as unsuitable for this research project. In respect of accessing Police records full consent was received from the owner of the systems and data accessed and again, this was done so with fully informed consent. To obtain this consent it was agreed that all personal information that could lead to the identification of any person was fully redacted if referred to within any stage of the research or completion of the study.

Chapter 4

A Quantitative Study of Optimal Forager within the United Kingdom

4.1 Introduction

This chapter's primary objective is to examine the implementation of the predictive policing optimal forager theory as a methodology to prevent and reduce domestic burglaries. This chapter seeks to establish the success or otherwise of this approach. Not only will this provide a conclusion to be reached in terms of impact but as outlined within the introduction, it is an identified pillar through which all Her Majesty's Inspectorate of Constabularies (HMIC) assessments are viewed in terms of reducing crime (HMIC, 2016). If Police services can show they are effective at reducing or preventing crime, then they are more likely to be graded as outstanding in this area.

Doing so also provides the first empirical assessment of the effectiveness of the method within an operational, real world, context, something that has not been done empirically. Ultimately this chapter should allow for further understanding regarding whether or not a heightened Police presence positively impacts on the behaviour of foraging burglary offenders and enable identification of any other unintended consequences that may be present. To help assess such unintended impact, the diffusion of benefit of the implementation was also assessed, as was the presence of any forms of crime displacement before examining the impact on overall recorded crime rates detections and other outcomes. Findings are then discussed in respect of targeting behavioural changes, functional crime displacement, increased vigilance, violent offending behaviour, impulsivity as a causation, foraging departure rules and rational choice theory.

4.2 Literature Review

Ecological General Foraging Theory

In its simplest form the ecological theory of the optimal forager simply suggests that when animals search for food, an act known as foraging, that their feeding behavior is although complex, fundamentally driven by a basic cost-benefit analysis (Juliana et al, 2017 and Pyke et al, 1977). What this actually means is that when searching for food, whether that be by scavenging, hunting or any other method that the animal will take into consideration key factors such as the level of energy expanded or handling time vs. the potential reward (Garay et al, 2015; Juliana et al, 2017 and Pyke et al, 1977). Pyke et al argue that these foraging strategies have been developed over many thousands of years stating;

"If animals survive and die as a function of variation in their foraging strategies then natural selection has run its course. Animals that survive are able to contribute genes to the next generation, while the genes from animals that die are eliminated, and along with it unsuccessful foraging behaviors" (Pyke et al, 1977, p1)

Pyke at al further argue that such a behavioral assessment of the potential reward increases the likelihood for the animal to survive, reproduce and be successful (1977). This behavioural decision making can be visualized in a simple formula;

$$\text{Profitability of Prey or Resource} = \frac{\text{Energy gained per item - Costs to acquire}}{\text{Time taken to acquire prey and handle/consume}}$$

Depending on the overall cost or risk by the forager it may not choose to feed on every item that it comes across because it may not believe the benefit of that item offsets the cost or risk. For example, whilst foraging an animal may encounter a low reward item that is very abundant. When considering this resource, the forager will take into consideration the fact that it has to spend time handling it, consuming it and then due to its low reward, repeat the process. All factors that use further time and thus increased energy. As such the forager may

make a different decision based on its interpretation of the cost – benefit analysis. The animal may choose to continue its search for prey or resources which are less abundant and take greater energy to obtain. However, in doing so its reward is greater, for instance, in calorific intake or by virtue of only requiring one item thus reducing handling and eating time and as such less energy expenditure.

In respect of the spatial behaviours displayed by foraging animals there has been significant research which has identified a few distinct behavioural patterns, and this will be outlined in the following section.

Central Place Foraging

The concept of central place foraging is similar in its assumptions to that of the criminological theory of geographical profiling which is discussed in further detail in chapter 8. Central place foraging is a very simple theory which suggests that the forager operates within its natural habit which radiates around their home providing a safe, quick and easy opportunity to remove themselves from risk but also keeps energy expenditure low (Boyd et al, 2016; Orians and Pearson, 1979 and Rozen-Rechels, 2015). Animals that tend to favour this strategy are those for whom an abundance of resources may be available, and they can position their home within this area with minimal risk, rabbits for instance can create a relatively low risk, high safety home in the form of a burrow and quite easily position this within a grassy plain thus surrounding themselves with their natural resource.

Optimal Patch Choice

Unfortunately, not all animals are as lucky as the rabbit and can adequately adopt the central place strategy. For these animals the optimal patch choice is adopted which is much more complicated than the central place foraging strategy. Animals adopting the optimal patch choice will make a number of behavioural decisions when foraging, taking into consideration the factors outlined at the beginning of this section which included time taken, distance travelled and abundance of resources (Bettinger and Grote, 2016 and Charnov, 1976). When making these decisions the animal will move between what are called within ecology, 'patches', which simply refers to areas where the animal knows that it

can or is likely to acquire its resources or prey (Bettinger and Grote, 2016 Charnov, 1974).
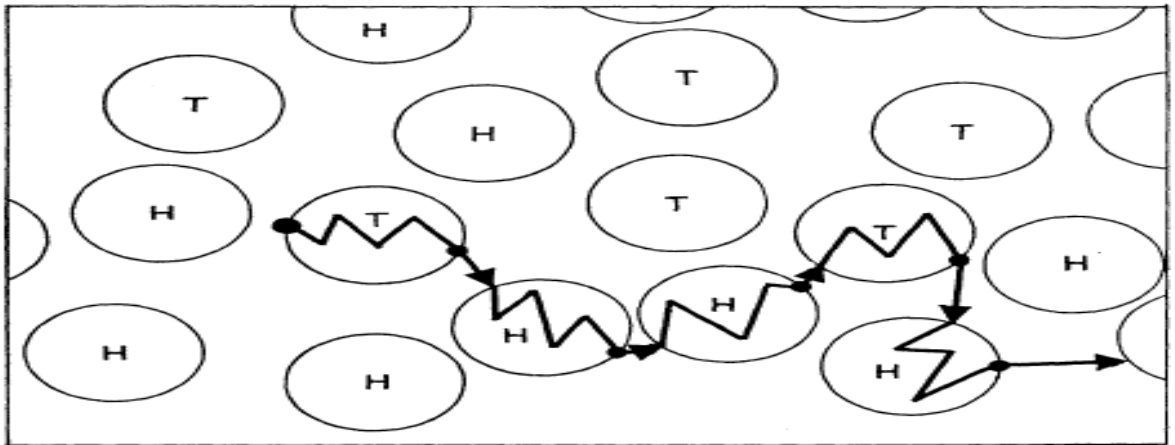
Figure. 4. A hypothetical environment of two patch types. The predator encounters prey only within a patch but spends time in travelling between patches. H= High T=Threshold (Charnov, 1974).

If time is not a factor in need of consideration or the forager is not fully aware of what is available within each patch, then the forager may choose to wander between patches as they observe what is on offer, continuously weighing up if what is seen is above or below their average expectation, a level known as the marginal value theorem (Bettinger and Grote, 2016 and Charnov, 1976). This is the value used to describe the level at which reward drops to the average level across known patches based on their past experience. However, if the forager is already aware of a patch that can provide sufficient reward with what they deem an acceptable level of energy expenditure, then they may reduce outlay even further by eliminating travelling between patches and make straight for this previously fruitful area (Charnov, 1976). The optimal patch forager will also move between patches based on a number of factors which may be due to over foraging, where little of the resource or prey remains or due to previous levels of foraging the level of predation now is too high (Charnov, 1976). These factors are known as patch departure rules (Charnov, 1976). As the diagram above shows, the forager will move from patch to patch as they seek out patches which offer the highest level of reward vs. their energy expenditure. As can also be seen from this diagram the forager will seek to, although not always successfully, choose a route which minimises the time spent travelling between patches to further reduce unnecessary energy expenditure (Bettinger and Grote, 2016 and

Charnov, 1976). The travelling between patches has been shown to follow two distinct strategies (Johnson and Summers, 2015) and these will be outlined in the next section. This thesis does not propose to utilise the underpinning algebraic framework that these walks are calculated but more the overarching principles, as such only an overview of their fundamental assumptions is required.

Brownian Motion

Firstly, the Brownian motion walk. This type of walk was drawn from research into the behaviour of particles which showed that their behaviour is effectively random (Athreya, 2010). In the context of walking, each time the forager steps it does so in a random direction, however, research of such walks has shown that despite its 'randomness' a regularity can be identified because of the finite number of choices at each step (Athreya, 2010). Analysis of such walks has shown that foragers adopting the Brownian walk return to previous locations of choice on a more regular basis (Johnson, 2015), most likely because the abundance of prey is at high levels (Viswanathan et al, 1999).

Levy Walk

A lot of research has shown that foragers utilise the Levy strategy of walk which is shown to be more frequent in foragers whose prey or resource is sparser (Viswanathan, et al). This form of forager behaviour is also shown to be favoured as a strategy when resources or prey and their locations are unknown to the forager (Plank et al, 2013). In reality what this strategy shows, is that although the foragers step distribution in principle remains random it is not finite, and a probability distribution can be generated using the Pareto power law (Plank et al, 2013).

The Optimal Forager as a Criminal

Despite its current use by as many as nine Police services within England and Wales, just like ILP and POP Policing before it, the optimal forager approach has not been subjected to any rigorous empirical testing. What has been conducted is a number of pilot case studies as the literature review chapter has outlined. As such the theoretical link or leap to its use within criminology is quite blurred and

unclear. However, what is clear is that one of, if not its earliest citings is in the work of near repeat theory conducted by Bower and Johnson in 2004 where the model is used to help predict domestic burglary. Within their work Bower and Johnson argue that criminals, in particular, burglars operate in a manner which is likened to a foraging animal and by doing so generate patterns of behaviour. It is suggested that when subjected to both spatial and temporal analysis evidence arises that indicates that the offender repeats their behaviour, which suggests that they are serial offenders or communicating their method of success, and that previous victims in that same area are at an increased risk of victimisation. It is suggested that this repeated behavior and predictive localised targeting is conducted as the criminal identifies opportunities as they go about their normal everyday activities, a concept known as routine activity theory which will be outlined in greater detail later within this chapter. Bower and Johnson (2004) argue that burglary offenders use this information to underpin their targeting behavior which is done so in a foraging manner, akin to that within ecology.

The link that is made between humans and the offender as a forager does have credibility. Research has been conducted that shows the link between the Brownian and Levy walk strategies of humans and animals (Brockman et al, 2006). More direct links between foragers and criminals has been identified in research conducted by Johnson and Summers (2015) who outlines that both animals and criminals share some common goals, for instance both seek to maximize the cost – benefit ratio of energy expenditure vs. reward, the fundamental difference being that a criminal's resource is stolen property. Further, both forms of foraging behaviour involve having to search for their chosen resource and expend energy during the subsequent handling or realisation of the resource, whether that be by its consumption as an animal or onward sale for a criminal (Johnson and Summers, 2015). Both of these activities pose similar risks, whether that be being preyed upon as an animal or caught by the Police as a criminal. Also, Johnson outlines that both have to take into considerations their limitations in respect of what can be carried, how fast and for how long as each increases energy expenditure and may increase risk of being preyed upon or apprehended (2015). Finally, Johnson outlines that both,

for similar reasons, most notably their historic knowledge of resource availability and associated energy expenditure or risk level, operate within repeating spatial areas (2015). This point has clear prevalence when one considers the optimal patch choice behaviour of an animal and the near repeat behaviour of a foraging criminal.

Finally, as this section alluded to at the beginning, humans have been shown to display foraging walk strategies and this has been researched in the context of criminology (Johnson and Summers, 2015). However, links have been identified with both the Brownian motion and Levy walks (2015) with both strategies being identified as present in the movement and patch choice of criminals but neither providing an unequivocally greater fit (Johnson and Summers, 2015). The reasons for this as yet remain untested but it is suggested that this may be down to a combination of geography, demographics and knowledge of the locations and a key reason which will be outlined later in the section, increased predation (Summers et al, 2010).

The Optimal Forager Framework

Previous research that has been conducted in relation to the offence of burglary which has shown that patterns in respect of both time and space occur over a period after the originating crime (Johnson & Bowers, 2004b; Johnson et al., 2007a; Johnson & Pease, 2007). This research has shown that properties within an area of 400 metres from the originating offence are at a heightened risk of victimisation for a period of up to six weeks as the foraging criminal moves within the chosen patch, but that the risk decreases over that period (Bernasco, 2008; Johnson, Summers, & Pease, 2009).

The optimal forager approach to predicting areas for heightened Police patrol uses a basic algorithm. The algorithm scores areas by examining the inter crime distance between offences that have occurred within the past 21 days with higher scores being attributed to offences within 400meters of the originating offence. Scoring of the inter crime distance is split into groupings, based on spatial parameters. The 400-meter zones are then placed on a map which creates a visual representation of areas being subject to repeat victimisation, as the section

has outlined, most likely as a result of serial offenders. Once placed on a map it is then possible to identify any zones where the 400m high risk repeat victimised areas overlap. By applying various levels of translucency of the identified areas based on the scoring system outlined, it is then possible for an intelligence analyst to manually examine the maps and identify areas at the greatest risk of repeat victimisation. A sample of the visual representing of this analysis is shown below;

Figure 5. An Example of The Overlaying of Optimal Forager Zones to Identify A Prioritised Area.

As can be seen from this diagram, areas that are of the highest risk of repeat victimisation are the least translucent with red being the area with the greatest risk. The blue area is an overlapping zone that has a lower risk level. These maps are then provided as a product to Police decision makers to aid in the tasking and coordinating of Police resources in an effort to prevent or reduce crime in the identified areas. This allows the Police a more efficient and evidence-based tool to increase focus on only the highest risk areas, as opposed to the information that usually larger more and generic crime hot spots known as 'super critical' hotspots, can provide.

4.3 Aims and Objectives

The aim of this chapter is to assess the effectiveness of the implementation of the optimal forager predictive policing approach to burglary prevention and reduction. The chapter examines recorded crime and police data obtained through case studies of three burglary initiatives that have used the methodology to task and co-ordinate police resources to combat burglary offending.

4.4 Method

In the previous chapter we identified how the case studies selected for this project were heavily dictated by the availability of suitable pilot exercises available for study and the level of access that could be facilitated to primary data, documentary evidence and also to interview participants. After identifying a total of nine potential case studies in respect of predictive Policing, three were selected for detailed examination. This was as a result of contact made through email to the police services direct, outlining the study and the access required to conduct the research. Responses varied in respect of the depth of access that could be permitted and this reduced the number of suitable forces to just three. However, it has to be accepted that none of the potential case studies offered a 'perfect' scenario with all possessing their individual strengths and weaknesses, what was important was their ability to address the research question by providing sufficient information to assess the aforementioned criteria.

Quantitative Data Extraction

Of the three case studies selected to be included in this study the Lancashire Constabulary Optimal Forager pilot provided the greatest level of freedom. This included unlimited access to primary data and as such was selected to be used to provide the main source of quantitative data for this chapter. The data was extracted directly by the researcher from the Lancashire Constabulary system called Sleuth. This was done by taking the date perameters from the 50 optimal forager briefing products supplied. These were then used to input the dates within the recorded crime search section of sleuth. The crime types being investigated were then selected. The specific crime types searched are outlined in the results sections of this chapter. In addition, the geographical area to be searched was also selected and again, this was dictated by the optimal forager

briefing products. Finally, a search was conducted on the inputted criteria. This produced a list of every crime that met the perameters in the form of a CSV. data table outlining all the crimes committed within the area, dates and of the designated crime types. To ready the data for examination the crime statistics for each crime type, before and after were then grouped into the categories outlined in the results section and the frequencies were counted and recorded in two distinct columns, 'before' and 'after'.

Date Parameters

All data used within this chapter was obtained from crime records between July 2014 to July 2016. As was outlined in the previous section, the optimal forager briefings which direct the police resources are compiled using data extracted over a two-week cycle, prior to their publication. As such this time frame is used to underpin the analysis in this chapter with data extracted from 14 days prior to the briefing being circulated and 14 days after which enables a pre and post tasking and co-ordination comparison to be drawn, with the crimes drawn from the previous 14 days acting as the control group.

Optimal Forager Products

Within Lancashire, optimal forager burglary tasking and co-ordination briefing reports are produced on a fortnightly basis. These reports are cascaded to frontline supervisors who then use the information to deploy resources at their disposal to provide capable guardianship as a burglary prevention and reduction tactic. These analytical products are compiled using recorded crime data from the 2 weeks prior. In total 312 briefing products were produced within the date parameters outlined in this chapter and 50 were supplied for examination. This equated to 16% of all briefings produced. A list of these products is provided in appendix 4.

SLEUTH Crime System

In total 2916 recorded crimes fell within the pre and post tasking and co-ordination periods of the 50 products provided. This primary data, in the form of crime records was drawn from a computer system called the 'SLEUTH' intelligence system which is used by Lancashire Constabulary. The intelligence system records a huge array of information which includes arrest records, stop searches, intelligence entries, 999 call information and most importantly for this study, crime records. Access to this system was authorised by Lancashire Constabulary to support this study.

Data Analysis

To analyse the data that was extracted a paired t-test was used to compare the data of recorded crimes from before and after the optimal forager intervention. This approach was used as it is outlined that the best method to compare two population means when you have two samples in which observations in one sample can be paired with observations in the other sample (Corder and Foreman, 2014 and Kim, 2014). The purpose of the test is to determine whether the mean difference between two sets of observations is zero (Kim, 2014). To conduct the test the software SPSS was used. This was conducted using the transform, compute function within SPSS. The recorded crime data that had been previously readied for examination was subjected to the test by selecting the one-sample t-test criteria; analyse and then compare means. This then produced a results table for further examination and comparison.

4.5 Results

This section illustrates the level of offending that has taken place within 50 predicted high-risk forager areas. The results outline the level of criminality before burglary forager offending was identified and any increased police presence, referred to as 'pre-increased predation'. Comparison is enabled by also outlining the level of burglary forager offending after publication of the predictive tasking and co-ordination briefing document used to underpin an increased police presence through resource deployment. This is referred to as 'post-increased predation'. A descriptive table of these definitions is also outlined. Initially results are shown individually with a descriptive overview before

Policing Terminology	Ecological Terminology
Prior to Any Increased Police Presence	Pre-increased Predation
After an Increased Police Presence	Post Increased Predation
Enhanced Capable Guardianship as a Result of Increased Police Resources	Increased Predation

Table 4. Description of Ecological Terminology

Results Overview

Offence Type	M	SD	T	Df	Sig. (2 tailed)
Violent Behaviour	-3	2.95	-2.03	19	.015*
Overall Offending	-6.4	18.3	-2.4	49	.017*
Robbery	-8.3	2.5	5.7	2	.029*
Functional Displacement	-9.3	10.8	-2.44	12	.030*
Possession Offences	-10	6.9	-2.9	3	.062
Public Order	-5.8	5.1	-2.5	4	.064
Other Thefts	-13.8	23	-1.9	10	.074
Criminal Damage	-32	33.3	-2.1	4	.099
BIAD	14.8	25.7	1.285	4	0.26
Sexual Offences	0.6	1.1	1.1	4	0.30
Vehicle Offences	-11	21	-1.06	3	0.38
BOTIAD	-8	14.1	-8	1	0.57
Violent Offences	-1.1	8.7	-0.3	6	0.74

Table 5. Overall Comparison of Pre, and Post Increased Predation
*df = Degrees of Freedom; *p <0.05; **p <0.1; ***p <0.001.*

Domestic Burglary Offences

Prior to any increased police presence, offences (N=181) in respect of domestic burglary were analysed. This included offences of burglary within a dwelling, theft in a dwelling, attempted burglary within a dwelling, aggravated burglary in a dwelling and distraction burglary within a dwelling which were associated with M=36.2 (SD=52) number of offences per crime type. By comparison, offences after an increased police presence (N=107) was associated with a numerically lower mean number of offences M=21.4 (SD=29). To test whether pre, and post offending were significantly different a paired sample t-test was performed. The paired samples t-test did not show a statistically significant effect, $t(4) = 1.285$ $p > .05$. As such, although lower, the reduction in offending was not statistically significant, producing a significance score of 0.26 ($p > .05$).

Burglary Other Than in a Dwelling

Prior to any increased police presence, offences (N=76) were analysed in respect of burglary 'other than' offences. This is a police term which is used to describe non domestic burglary and includes burglary other than within a dwelling (BOTIAD) and attempted burglary other than within a dwelling. These were associated with M=38 (SD=26) number of offences per crime type. By comparison, offences after an increased police presence (N=92) were associated with a numerically higher number of offences M=46 (SD=36). To test the whether pre, and post increased offending was significantly different a paired sample t-test was performed. The t-test did not show a statistically significant effect, $t(1) = -8$ $p > .05$. Although higher, the result did not show that the increase in offending was statistically significant, producing a significance score of 0.57 ($p > .05$).

Vehicle Related Offences

Prior to any increased police presence, offences (N=114) in respect of vehicle crimes were associated with M=28.5 (SD=27.9) number of offences. By comparison, offences after an increased police presence (N=158) were associated with a numerically higher number of offences M=39.5 (SD = 48). A paired samples t-test indicated that the post, increased predation offending rate was not significantly different, t (3) = -1.0, p >.05. Although higher the increase in offending was not statistically significant, producing a significance score of 0.38 (p > .05).

Other Theft Related Offences

Prior to any increased police presence, offences (N=112) in respect of other theft related offences were examined. This included theft by employee, forgery, blackmail, theft from machines, dishonest use of electricity, fraud, making off without payment, theft of pedal cycle, and other unauthorised taking which was associated with M=27.4 (SD=44.2) number of offences per crime type. By comparison, offences after an increased police presence (N=145) was associated with a numerically higher number of offences M=35 (SD = 53.3), but was non-signficant, t (10) = -1.9, p >.05. Although higher, the increase in offending was not statistically significant, producing a significance score of .074 (p > .05).

Robbery Offences

Prior to any increased police presence, offences (N=18) in respect of the class of offences under the robbery designation were considered. This included robbery, theft from the person and robbery of business property which was associated with M=7.3 (SD=7.7) number of offence. By comparison, offences after an increased police presence (N=29) recorded a higher number of mean offences M=15.6 (SD=9.7). On this occasion the paired sample t-test analysis did show that the increase in offending was statistically significant, producing a significance score of .029 (p < .05).

Criminal Damage Offences

Prior to any increased police presence, offences (N=180) in respect of criminal damage were examined. This included criminal damage to a dwelling, arson not endangering life, criminal damage other, criminal damage to other buildings and criminal damage to vehicles which was associated with M=36 (SD=26.5) number of offences per crime type. By comparison, offences after an increased police presence (N=339) was associated with a numerically higher number of offences M=67.8 (SD=44.9), This was a very large increase in numerical offences however, the paired sample t-test analysis did not show that the increase in offending was statistically significant, producing a significance score of .099 (p > .05).

Violent Crime

Prior to any increased police presence, the total offences (N=329) in respect of violent crime were examined. This included assault without injury, threats to murder, kidnapping, racially aggravated common assault, assault without injury on a constable, assault with injury and wounding and was associated with M=47 (SD=67.5) number of offence per crime type. By comparison, offences after an increased police presence (N=334) was associated with a numerically higher number of offences M=48.1 (SD=70) per crime category, This was a very low increase in numerical offences and the paired sample t-test analysis, as expected, did not show that the increase in offending was statistically significant, producing a significance score of 0.74 (p > .05).

Sexual Offences

Prior to any increased police presence, offences (N=18) in respect of sexual offending were analysed. This included rape of a female over 16, rape of a female under 16, exposure and voyeurism, sexual assault on a female aged 13 and over and possession of indecent publications and was associated with M=3.6 (SD=5.3) number of offences per crime type. No other forms of sexual offending were recorded in the periods examined. By comparison, offences after an Increased police presence (N=15) was associated with a numerically lower number of offences M=3 (SD=6.5) per crime category, This was again a very low increase in numerical offences and the paired sample t-test analysis did not show

that the increase in offending was statistically significant, producing a significance score of 0.30 (p > .05).

Possession Offences

Prior to any increased police presence, offences (N=36) in respect of possession related offences were analysed. This included going equipped to steal, possession of bladed articles or offensive weapons, possession of controlled drugs and possession of other weapons and was associated with M=9 (SD=9.9) number of offences per crime category. By comparison, offences after an Increased police presence (N=74) recorded a higher number of offences M=19 (SD=15.8) per crime category. This was a high increase and the paired sample t-test analysis showed that the increase in offending was marginally above the level of statistical significance at .062 (p > .05).

Public order Offences

Prior to any increased police presence, offences (N=72) in respect of public order offences were examined. This included homophobic incidents, public fear alarm or distress, other public order offences, racist incidents and harassment, and was associated with M=14.4 (SD=8.6). By comparison, offences after an increased police presence (N=101) was higher at M=20.2 (SD=11.1) number of offences per crime category. This difference was non-signficant, t (4) = -2.5, p >.05 (.064). This was a moderate increase however the paired sample t-test analysis showed that the increase in offending was not of statistical significance at .064 (p > .05).

Violent Offending Behaviour

Prior to any increased police presence, offences (N=112) in respect of crime types examined associated with violent behaviour were examined. This included violent offences, robbery, theft from the person, public order offences and sexual offences, and was associated with M=22 (SD=44.4) number of offences per crime type. By comparison, offences after an increased police presence (N=163) was associated with a numerically higher number of offences M=25 (SD=45.7) per crime category. A paired samples t-test produced a statistically significant

effect, t (12) =-2.82, p <.05 (.015). This was a large increase and of the greatest statistical significance at .015 (p < .05).

Functional Displacement

Prior to any increased police presence, offences that could be interpreted as the presence of functional displacement was analysed (N=388). This included offences relating to vehicles and other thefts and was associated with M=29.6 (SD=39.5) number of offences per crime type. By comparison, offences after an increased police presence (N=508) had a higher number of offences M=38.9 (SD=50.3) per crime category. The paired samples t-test indicated post, increased predation functional displacement showed significantly different levels of offending, t (12) =-2.44, p <.05 (.030). This was a very large increase and the result was statistically significant at .030 (p < .05).

Overall Offending

Prior to any increased police presence, offences (N=1302) in respect of all the crime types examined and was associated with M=26 (SD=40.7) number of offences per crime type. By comparison, offences after an Increased police presence (N=1622) was associated with a numerically higher number of offences M=32.4 (SD=45.7) per crime category, Overall, this was again a very large increase and the paired sample t-test analysis also showed that this was statistically significant at .017 (p < .05). Table 4. Provides a visual comparison of these findings.

4.6   Discussion

The key aim of this chapter was to explore the implementation of the optimal forager method of predictive policing and understand its impact. The chapter sought to do this by examining the levels of recorded crime both pre and post an enhanced capable guardianship which was provided by an increased police presence in predicted high risk areas. The study refers to this as the increasing of predation risk. The results of the research within this chapter indicated that the approach did reduce the intended crime type, but that this effect was non-significant across most crime types. However, it had a negative impact on overall

recorded crime, offences involving violent behaviour and robbery related offending, and also caused significant levels of functional crime displacement. This section will discuss the implications and possible causations in detail.

Previous research has shown that high levels of crime are most generally experienced in relatively small geographical areas (Weinborn et al, 2017) Traditionally these are referred to as hotspots and are routinely combatted by increasing the level of police resources within the identified environment. Existing literature suggests the increases of Policing presence in a crime fighting capacity in these areas can have a significant positive impact on crime reduction and prevention (Braga 2007; Eck 1997, 2002; Skogan and Frydl 2004; Weisburd and Eck 2004). This section will discuss the results of examining the impact of such interventions as a result of tasking and co-ordination of police resources into predicted high risk areas of domestic burglary and examine its position in relation to existing knowledge. The section will also discuss these results in an ecological context, most significantly the theory that increased tasking and co-ordination is akin to an increased predation risk. In doing so we can begin to discuss if foraging offenders, who the optimal forager predictive policing approach is directed to combat, display other behavioural and physical characteristics identified within the ecology literature. This will then be investigated further in the study. Finally, the section will also review the results within a criminological context to consider any correlations between these findings and existing knowledge which again will be analysed in greater detail in future chapters.

Overall Crime Reduction

As this study in part aims to assess the overall effectiveness of the optimal forager methodology one of the greatest indicators of this is its impact on overall crime levels and as such will be discussed first. With police officer numbers having been significantly reduced over the past several years there has been a committed drive to more efficiently use the finite resources available. Tasking of resources based on the predicted forager high risk areas was seen as a potential tool to achieve this. As such, producers of the predictive product also layered in other key information relating to vulnerabilities within the predicted zones to

maximise the preventative impact (LC2, 2015) and in essence maximise the potential for positive crime diffusion benefits.

Previous research on traditional hotspot methodologies has outlined that increased policing in high crime areas can and does often have a positive impact on reducing and preventing certain offending forms (Braga, Anthony A.; Papachristos, Andrew V.; Hureau, David M, 2012). This study is in contrast to these findings and suggests that it has not reduced overall offending. In fact, there is a significant increase in recorded crimes, underpinned by an acceptable effect level. Such a finding is more in line with very limited research on hotspot and POP approaches which suggests the tactic is least effective in tackling volume acquisitive crime types such as burglary and vehicle crimes (Caeti 1999: 319-322).

The Impact on Domestic Burglary

What is immediately evident from the results of this study is that there is a strong positive impact on the number of recorded burglary dwelling offences which, although non-significant, did reduce, although the effect size indicates that the difference is medium which is a relatively strong indicator of impact. This is in line with previous research (Braga 2007; Eck 1997, 2002; Skogan and Frydl 2004; Weisburd and Eck 2004) into traditional non-predictive hotspot approaches and cements previous studies (Bowers and Johnson, 2004) that have suggested that the optimal forager theory provides a methodology to prevent and reduce burglary dwelling offences. However, it must be accepted that despite the reductions appearing strong, they are not statistically significant. As such, they are not great enough to be able to reject the null hypothesis which is that the optimal forager interventions had no impact. The exact reasons for the lack of effectiveness of the optimal forager implementation are complex and this section will now discuss these further

Targeting Behavioural Changes

This chapter also identified that burglary other than against a dwelling increased as a result of the implementation. Literature examining crime displacement has previously identified this unintended effect which is called target crime displacement (Repetto, 1976). This is the commission of the intended offence but when it is committed against a different target (Repetto, 1976). Although moderate and statistically insignificant, an identifiable increase in the offence of burglary other than in a dwelling suggests that target displacement has occurred to some degree. This was reflected in the medium-large effect size identified which suggests the impact is noticeable, despite its insignificance. The potential presence of crime displacement as a result of a hotspot approach to crime reduction, although a predictive approach and previously unidentified within the literature, is not unexpected. It has been identified that in line with other methods of crime control and situational crime prevention, the methods can produce a level of crime displacement (Repetto 1976 and Braga, Anthony A.; Papachristos, Andrew V.; Hureau, David M, 2012) if it is not countered appropriately and as such corroborates the existing literature in this area.

Functional Crime Displacement

When other areas of offending such as vehicle related and other theft offences are considered further evidence that foraging offenders may alter their targeting behaviour emerges. Both of these crime types experienced increases in recorded crime, with other theft offences being at the margin of significance, post increased predation risk through tasking and co-ordination of resources into the high-risk forager areas. Again, this is a finding that has previously been identified as a result of traditional hotspot policing tactics but is the first identification of it within predictive approaches and is referred to as functional crime displacement (Repetto, 1976) which will be studied in much more detail later in the study. However, again the increases are not individually statistically significant but are of an effect size sufficient to be noticeable to the naked eye. When the two are combined and examined under the banner of functional crime displacement they produce a more profound finding which showed that there was a significant change in these offending rates which rose as a result of increased predation. Furthermore, the effect was of sufficient size to be beyond trivial, adding further

weight to the finding that functional crime displacement was a by-product of the implementation.

Increased Vigilance

In addition to the increases in theft related offending there was also an increase in criminal damage related offences, but this was non-significant. The underlying reason for this increase is difficult to identify without a more in-depth analysis of these crimes which this study has not conducted. One potential causation is identified within the ecological literature that underpins the optimal forager theory. Within this literature it is suggested that the forager may not cease its foraging behavior, but it will increase its vigilance in response to increased predation levels (Kelley et al, 2001) which in this scenario is manifested as increased police presence through predicted tasking and co-ordination. The result experienced is what is referred to as a higher *'giving up'* rate, which is when an offender abandons their attack on a target and is a characteristic displayed by the forager before ultimately abandoning the area entirely and seeking a new foraging patch (Kelly, 2001). Criminal damage to a target is often a precursor to the commission of a substantive offence, resulting as part of the offender entry behavior. As such a rise in criminal damage offences particularly against properties and vehicles may be representative of the foraging burglary offender altering their behavioUr and displaying a heightened awareness. It can be postulated that tactical crime displacement may also impact on the increase in criminal damage offences. Tactical crime displacement is the commission of the intended offence but by a different method (Repetto, 1976). This would manifest itself in a different entry behaviour. A causation for the increase of criminal damage offences could be as a result of a combination of behavioural changes such as a new tactical approach to offending, and a heightened awareness manifesting itself in increased criminal damage offences, providing an explanation to the statistical increases of this form of offending.

Violent Offending Behaviour

From examining offending such as sexual offences and violent crime it is possible to begin to investigate whether there is any evidence of increased predation risk through tasking and co-ordination of resources, impacting on the

behaviour of other forms of offenders. In certain circumstances, it may also be possible to use this information to draw generalisations regarding whether, or not, it may have negatively altered or escalated the behaviour of foraging burglary offenders. Answering this question helps the study begin to assess whether any displacement that may occur is benign or malign. In this study, it was outlined that there has been an identifiable increase in several forms of violent offences against people. Although not significant, an increase in sexual offending behaviour was identified, along with an increase in violent crime which was again, not of statistical significance. Interestingly a rise in public order offences was identified that was on the margins of significance. Furthermore, robbery and theft from the person increased statistically significantly with a large effect size, which indicates that this increased behaviour would be noticeable to the naked eye when viewing recorded crime records. Existing research has identified that displacement of violence related offences can occur as a result of hotspot methodologies (Taylor, Koper and Woods, 2010) but of all the crime forms displacement should affect, violent offending is the one that it should impact on the least (Braga, Weisburd, Waring, Green Mazerolle, Spelman, and Gajewski 1999). When the offences within these identified categories which include violent behaviour were examined as a group, it was identified that the overall impact in this area was statistically significant and with a credible effect size. As such, we can say with some confidence that increased predation risk contributed to the escalated behaviour of offenders in the predicted high-risk areas. This is a result that is contrary to previous literature.

Impulsivity as a Causation of Increased Offending Types

Having established that there are significant increases in certain types of offences, post increased tasking and co-ordination there is a necessity to try and understand why this has occurred. Statistically significant increases were identified in the offence categories of robbery, violent behaviour, functional crime displacement and overall offending. Foraging offenders are by definition serial criminals, and the personality trait of Impulsivity has been shown to be an underpinning psychological cause of recidivistic behaviour (White et al, 1994, p. 192). This section explores the possibility that foraging offenders have a high level of impulsivity which accounts for the increases in certain offending types.

Impulsive offenders have been shown to have a higher association to substance abuse dependence (Farrington, Loeber and Van Kammen, 1990) which may explain the increase in any drug related possession offences. It is also argued that they are more inclined to violent behavioural characteristics such as anger and violence (Fossati et al, 2004) which offers a potential understanding for the increase in violence related theft offences such as robbery and the rise in violent behaviour. It is further argued that the reason for the heightened levels of these behaviours within impulsive offenders is because of their Low self-control (Critchfield, Levy and Clarkin, 2004 p. 556; White et al, 1994, p. 93). The policing application of targeting areas of heightened risk of attack from foraging burglary offenders relies on the theory that they are rational individuals who make their decisions to offend on whether the risk of being apprehended is outweighed by the benefit of offending. However, although burglary offending has been shown to reduce, increases in other crime types within the predicted high-risk areas suggests that this theory is not made out. It has been suggested that impulsive offenders have low levels of inhibition (1980 and Schalling, 1978) and are also less able to delay levels of inhibition (Newman, 1987) which is why overall offending increased significantly. Furthermore, if the increased predation through tasking and co-ordination is ineffective or does not provide an immediate consequence, impulsive offenders will continue to succumb to temptation. This is because they are less likely to be inhibited by a delayed or uncertain consequence (Wilson and Hernstein, 1985, Zimmerman, 2009). Such as arrest after the offence at a later date or time. The links to characteristics outlined within the impulsivity literature suggest that foraging burglary offenders have a high level of impulsiveness. As such, they may have higher levels of substance abuse which drives their offending. These links also suggest that foraging burglary offenders may have low self-control, urges to seek immediate gratification and higher levels of aggression and tendencies of violence. These personality traits provide a possible causation for the reason why, when a foraging burglars ability to commit their chosen offence type is reduced, they continue to offend to receive gratification and succumb to immediate temptation (Zimmerman, 2009) by committing other forms of offending, including ones which involve violence.

Unintended Consequences

Often ill thought out implementations that lack an evidence-based foundation can have unintended consequences (Kirby, 2013). In this context it can be argued that a reduction in burglary but an increase in possession related offences indicates that the increased predation risk within the predicted forager high risk areas may be having successful preventative impact but with potential unintended consequences. This is because there is danger that identifying an area as being at high risk of offending may bias capable guardians responsible for increasing the predation risk. This may inadvertently cause innocent people to be penalised who may not otherwise have been so and provides a possible causation for the increase of possession related offences. Although not significant this area is worthy of discussion because of the potential for impact on trust and confidence of the police which could negatively impact on their legitimacy (Bradford and Quinton, 2014).

If this is the case, then there is potential that otherwise innocent citizens may be unfairly criminalised. For instance, increased police resources within a predicted high-risk burglary area may cause an increase in stop and search powers being used. If this is the case a person innocently in possession of a rucksack which contains a pair of gloves, in certain circumstances could be responsible for an offence of going equipped to steal (Theft Act, 1968). However, such items could also be held completely innocently, all that must be proven for an offence to be complete is that the person had knowledge of the existence of the item at the time and that it was to hand for use (Theft Act, 1968). It is outlined that the circumstances in which the person is found can also be provided as circumstantial evidence to support a prosecution (Theft Act, 1968), posing the question, does the presence within a predicted high-risk area constitute circumstantial evidence? Furthermore, there is no requirement for it to be proven the items were to be used to commit a specific burglary (R v. Ellames; CACD, 1974). With these factors in mind there is a genuine possibility that Police officers may form an unconscious bias towards innocent citizens within a predicted high-risk area to underpin their stop and search powers, resulting in increased arrests and prosecution of people innocently in possession of mundane items. As the study has earlier outlined, stop and search has been shown to have a negative impact on crime reduction unless it is used in a very sparingly and targeted

fashion with some studies indicating that after its use it has been shown to increase violence and disorder (Weisburd and Eck, 2004 and Miller et al, 2000). This may be a further causality for increases in violent behaviour that have been identified. The correlation of increased possession offences, which by definition require interaction between a police officer and an offender, and the increase of public order offences which also require the presence of an officer to witness, underpin these previous findings (Weisburd and Eck, 2004 and Miller et al, 2000). Because of the aforementioned observations, this issue in itself is worthy of detailed investigation, which this study does not seek to do. However, what it does illustrate is that what may on the surface appear a positive outcome may not be such when considered in greater detail.

Crime Displacement

From examining the apparent changes in offending patterns both pre, and post increased predation it is evidently clear that there are a number of distinct changes. The most obvious of which are changes in the offences committed which it is believed evidence several forms of crime displacement. These include target, functional and tactical displacement. The degree to which these are evidenced is however limited at this time with only functional crime displacement being sufficiently evidenced. This is because although some offending changes do show positive indications towards other forms of displacement such as target displacement and tactical displacement, the lack of significant results to a degree that provides confidence to conclude that each are present is absent, and as such requires further investigation which is completed later in the study.

Forager Departure Rules

The identification of displacement identified within this chapter also supports the fact that some of the ecological manifestations of increased predation are also present. A reduction in domestic burglary and increase in other offending forms support this observation. As earlier identified, Charnov (1976) has shown that these behavioural characteristics displayed by the prey of a forager relate to them effectively 'weighing up the cost-benefit' of their search for prey in that particular area, and at a specific time, a process identified as the marginal value theorem (Charnov, 1976). This is the value used to describe the level at which

reward drops to the average level or below that of known patches based on their past-experience taking into account; over foraging, reduction in resources or increased predation. The evidence that increased vigilance of the forager is present indicates that the marginal value theorem is in play and is a result of the departure rule in relation to increased predation which is the only one that could be effectively measured within this chapter.

Rational Choice Theory

The theory of rational choice is well documented within economics and more recently criminology. The examination of foraging behaviour of animals from within ecology and the likeness to patterns of offending behaviour by foraging offenders within this chapter has highlighted several potentially mirrored behaviours. These include the marginal value theorem and rational choice, as is outlined here, along with potentially several forms of crime displacement and their likeness to departure rules and behavioural changes as a result of increased predation. What we can see from the discussion within this chapter is that there is enough 'food for thought' to begin to start questioning whether or not there exists a more basic foundation that underpins the rational choice within offenders. However, it is accepted that the discussion and findings in this chapter are in no way substantive enough to support this claim at this time and may be nothing more than singular similarities of characteristics. To substantiate such a bold claim would require significant evidence and although not initially outlined as an objective of this study, its potential value in exploring this is clear and as such future chapters will continue to examine and discuss this area.

4.7   Conclusion

This chapter sought to explore the implementation of the optimal forager method of predictive policing and ultimately assess its overall effectiveness. In doing so, a positive but non-significant impact on the reduction and prevention of burglary dwelling was identified, which is the primary aim of the outlined tactics. However, small increases were identified in relation to sexual offences, violent offending and non-dwelling burglary offences. Larger increases in offences relating to other forms of theft, and vehicle theft related offences, and criminal damage were identified. Most notably it was established that overall recorded crime increased

significantly within the predicted burglary high risk areas. A significant conclusion of the results was that the optimal forager approach does suggest functional crime displacement and may be responsible for several other forms of crime displacement, namely tactical and target displacement. The chapter also suggests that the presence of such displacement can be considered as confirmation of ecological departure rules such as the marginal value theorem and increased vigilance.

Similarities were identified between an escalation of violent behaviour and offences such as robbery. The chapter suggested a reason for this being the fact that foraging burglary offenders have higher levels of impulsivity and as such are prone to violent behaviour, seek immediate gratification and are more prone to substance dependence which when combined provides a possible explanation for rises in other theft offences, particularly those involving violence or the threat of violence. To conclude; the chapter highlights the potential for a more basal foundation for criminal offending behaviour drawn from predatory behaviour within ecology, as opposed to that provided by traditional criminological views such as rational choice theory. However, these possible links require further research, and a number of areas for further work were identified which sought to address the limitations of the generalisations made.

Chapter 5

A Practitioner's Perspective of the Implementation Effectiveness of the Optimal Foraging Predictive Policing Methodology Within the United Kingdom

5.1 Introduction

In the previous chapter a rise in overall recorded crime rates after increased tasking and co-ordination into predicted high risk burglary areas was established. The aim of this chapter is to provide greater richness to the underlying conditions present regarding the implementation of the optimal foraging approach to burglary reduction and prevention. In doing so the chapter aims to better understand the causation factors that underlie the recorded crime changes seen in Chapter 4 and add further information to the conclusions and generalisations made. This will enable an assessment of the scientific theories ability to prevent and reduce crime, and also indicate if any implementation factors have influenced the findings. Key practitioners (n=11) from across three police forces, involved in the implementation, co-ordination and operational delivery of optimal forager based predictive tasking and co-ordination were interviewed. Issues such as leadership, buy in and offending behaviour are discussed with the participants. Personal perspectives are also obtained that further enable assessment of the methods effectiveness, efficiency and accuracy along with the interviewees perspectives on improvement developments.

5.2   Aims and Objectives

The previous chapter gave a quantitative 'official' insight into 'what' has happened as a result of using the optimal forager approach to predictive policing as a burglary prevention and reduction tactic. This showed it reduced the intended crime type but to a non-signifying level. The aim of this chapter is to establish how were the implementations conducted and what lessons can be learned? Doing so enables the study to understand why the identified outcomes may have occurred by providing greater richness through practitioner interviews to the underlying conditions present regarding the implementation of the optimal foraging approach to burglary reduction and prevention. The chapter will

complete this by conducting case study examinations of examples of optimal foraging implementations to provide contextual information regarding its application and impact.

5.3   Method

This data chapter now draws upon participant interviews from Lancashire Constabulary, West Yorkshire and Greater Manchester Police services. Due to the use of participants from several implementations further information on the case study selection process is outlined to justify their selection.

Case Study Selection

Chapter 4 used quantitative data extracted from the criminal intelligence system of Lancashire Constabulary. This was because it was the only implementation identified within the UK that allowed access to this data at the requisite level. This chapter draws upon practitioners from a wider base and will outline why this was done and how these participants were selected. The process of selection is illustrated in figure 6 overleaf. The first step in identifying suitable case studies was a full review of predictive Policing pilot programs conducted within the UK to ascertain the exact number of opportunities. In June 2015 a technical review of the various models in use within the UK was conducted by the National Policing Improvement Agency (NPIA, 2015). This review was solely to map the current uptake of predictive Policing and nothing more. This review identified that within the UK only four pilot programs were in existence or had been conducted and that all had used the optimal forager methodology, underpinned by near repeat analysis as their method of prediction. Through liaison with the College of Policing, open source research and onward referral within the predictive Policing community, five further Police services were identified that had not been recorded in the NPIA technical review, providing a total of nine potential case studies in respect of predictive Policing. These are shown in table 2 on page 98. Figure 6 overleaf illustrates the case study selection process visually in an effort to further articulate the thought process of the author.

Step 1	→	Identify All Predictive Policing Implementations within the United Kingdom		

| Step 2 | → | Is Access to Quantitative Record Crime Data Provided? | → Lancashire Constabulary: Full Access | → Primary Data Source: Chapters 4, 6, 7 and 8 |

| Step 3 | → | Is Access to Interview Participants Provided? | → Lancashire Constabulary: Full Access | → Primary Data Source: Chapter 5 |

West Yorkshire Police: Limited Access

Greater Manchester Police: Limited Access

→ Supplementary Data Sources: Chapter 5

North Yorkshire Police and Durham Constabulary

→ Single Respondents: Supplementary Data Sources: Chapter 5

Figure 6.   Case Study Selection Process

To further assist the decision making regarding the case study selection each option was considered in respect of its potential to be able to provide sufficient information to assess them in respect of their efficiency and effectiveness. To enable this each implementation needed to be able to provide a broad range of information which included a number of criteria; (1) access to quantitative recorded crime data (2) access to primary documentary evidence including the predictive products generated by the analysts (3) access to frontline practitioners for interview who could provide information regarding the real life operational environment that the study seeks to judge. Of the nine identified potential pilot programs for examination, only 3 met these criteria. Lancashire Constabulary met all of the specified criteria and, as such, was the primary implementation studied within the research. It was the sole implementation studied within chapter 4, 6, 7 and 8 as it was the only one that could provide access to the required quantitative data. It was also the only one able to provide unlimited access to interview participants and as such was the primary source for interview participants within chapter 5. Implementations within West Yorkshire and Greater Manchester provided limited access to interview participants and as such were both accessed to provide supplementary insight.

Semi Structured Interviews

The reason for using semi structured interviews is to increase the understanding and assess the effectiveness of the optimal forager predictive Policing approach in an operational Policing environment. Quantitative information only provides one aspect of information. To ascertain if other factors have played a part, it is necessary to speak to those conducting the work on the front line. Interviews are the best way to do this because they offer the best method of obtaining an individual's subjective experience and any meaning they attached to the relevant outcomes (Devine, 2002; 199). Interviews properly constructed around open questions also allow the interviewee opportunity to express their views and opinions (Devine, 2002; 198), in this case around the efficiency and effectiveness of both predictive Policing and geographical profiling.

However, there is number of potential issues to be mindful of when using semi structured interviews. Opendakker (2006) suggests that structured interviews,

particularly those conducted face to face can impact on the responses of the interviewee through the body language and social cues displayed by the interviewer inadvertently guiding the participant down a certain avenue. This is an issue that the interviewer has to be particularly careful to manage through recognition of their own behaviour and its potential impact. According to Wengraf (2001) there is also the possibility of what is referred to as "double attention" which is the situation where the interviewer is simultaneously trying to absorb and sometimes record the subject's responses. They may also be doing this whilst trying to maintain focus and direction on the relevant questions and other issues such as time parameters that may be in place. As a result, the interviewer may miss opportunities to ask other questions or probe important issues that are identified (Wengraf, 2001). Other logistical issues are created by the choice of interviews such as whether to record them or not or simply take notes.

Both create different issues, for instance if recorded there is always the possibility of technological failure which will interrupt the flow of the interview or in the worst-case scenario, fail completely thus losing all of the information (Wengraf, 2001). Taking notes further adds to the issue of double attention and has a big impact on the attention of the interviewer as their concentration levels are directed towards multiple factors (Wengraf, 2001). One of the most important concerns in respect of qualitative interviews is that of the interpretation of the information obtained. It is suggested (Devine, 1995, Mason, 2002) that doubt can be present as to whether any generalisations or patterns drawn from such a technique are accurate. The researcher may also misinterpret or in the worst-case scenario draw their own assumptions from the accounts provided to support their hypothesis. However, if care in participant selection is taken it is very rare that an adequate sample of interviews will fail to produce themes or generalisations (Devine, 1995). Measures can also be taken to further corroborate generalisations drawn from qualitative interviews, most notably the use of additional data sources to compare them with.

Sample

In total 15 interviews were conducted for this part of the study. A breakdown of the participants is outlined in table 6. The interviews were conducted between March and September 2015. Of the three case studies selected to be included in this study the Lancashire Constabulary Optimal Forager pilot provided the greatest level of freedom including unlimited access to primary data and documentary evidence as well as complete freedom to select and interview staff who had been involved in the program. As such, the majority of interview participants (n=7) are from this organisation.

Police Force	Role	Reference ID
Lancashire Constabulary	Crime Co-ordinator	LC1
	Community Safety Partnership Analyst	LC2
	Operational Immediate Response	LC3
	Divisional Operations	LC4
	Pro-active Burglary Team	LC5
	Policing Operations	LC7
	High Impact Acquisitive Crime	LC8
West Yorkshire Police	Senior Intelligence Analyst	WY1
	Head of Performance and Analysis	WY2
	Operational Policing	WY4
Greater Manchester Police	Intelligence Bureau	GMP1
	Intelligence Bureau	GMP2
	Hub Manager	GMP3
North Yorkshire Police	Research and Analysis Branch	NY2
Durham Constabulary	Intelligence Bureau	DC1

Table 6. Interview Participants

However, as alluded to earlier, the chapter also takes into consideration interview results (n=3) obtained from the case study of the Trafford Park experiment conducted by Greater Manchester Police. The Trafford Park experiment was conducted over the longest period of time and was by far the most comprehensive in respect of the depth of theoretical consideration applied to it before its implementation and continued development throughout. In addition, practitioners involved in the West Yorkshire Police Operation Optimal (n=3) were also interviewed to add further richness. Finally, as a result of a request for

further interview participants with knowledge of the use of optimal forager implementations placed on POLKA, the Police knowledge forum, two further interviewees volunteered, one from North Yorkshire Police and Durham Constabulary respectively but as they were only one from each police service and these were not supported with any accompanying documentary evidence, they are not considered as a *'full case study'.* To initially identify suitable participants two criteria were used to select interviewee audiences. Participants were targeted due to their position within a Police service or organisation where they were involved directly within the predictive Policing case studies identified earlier in the section or could provide a frontline practitioner perspective on either of these areas. The roles in which the interviewees fulfilled within their organisation ranged from intelligence analysts and various ranks of Police officers ranging from constables to middle managers and chief officers. This provided a wide array of perspectives and expertise, but the criteria ensured that the interviews were sufficiently experienced to provide relevant and insightful information.

The use of probability sampling was considered to aid in the selection of participants and provide a more representative sample. However, each implementation was conducted using certain types of staff and as such was not appropriate. For instance, firearms officers and detectives were not used during any of the implementations. As such a subjective purposive sample was selected from the practitioners directly involved in the tasking and co-ordination process. Within Lancashire Constabulary there are 3 burglary teams, one per borough command unit, each with 12 officers. In respect of immediate response constables, there are 1370 within Lancashire Constabulary and a single analyst was responsible for producing the forager products. As such, the potential number of participants was significant at 1407. Within Lancashire, officer's and staff were invited to participate via an advertisement on the forces internal intranet and a force wide global email. In total 26 officers responded, displaying a general lack of willingness to participate in the study. During the facilitation period a further 15 retracted their participation prior to interview for a multitude of reasons unrelated to the study itself. Within both Greater Manchester Police and West Yorkshire Police access to participants was heavily restricted. The

approach was via a single point of contact who selected specific staff based on the aforementioned criteria. As a result, it is not possible to accurately identify the level of potential participants available. In total, 4 interview volunteers came forward from Greater Manchester with one subsequently being unable to maintain the commitment. Of the 3 that came forward from West Yorkshire, all completed their interviews. As a result, it is accepted that the results may not be a generalisation of views of the wider workforces involved (Palinkas et al, 2015) and this is highlighted within the limitations section of this chapter.

Equipment

Interviews were audio recorded and then transcribed. This allowed the interview to be conducted in a conversational manner that allowed the participant to feel at ease and provide the best information possible. An aide memoire of key questions was used to guide the interviewer and maintain structure and comparison between all participants.

Design

The interviews followed a four-step process as suggested by Burnham (2004); Step one consisted of identification of participants. Step two was the conduct of the interview. Step three was the completion of the semi structured interviews in which a number of key open questions were asked to keep the subject focused but also provide freedom for the interviewee to elaborate. This semi structured approached enabled the same key questions to be asked as it related to the subject specific to the interviewee. This approach also enabled the interview to produce comparable information but also provided sufficient flexibility for areas of interest to be probed further. Finally, step four consisted of anonymising and recording the interviews formally and transcribing them.

Procedure

Facilitation of the interviews was done primarily face to face. Interviews were conducted at the place of work of the participant. On occasions, due to the geographical restraints faced, interviews were conducted using face to face (n=11), internet-based media such as Skype, Face Time or telephone (n=4). A small number of supplementary questions and clarifications were conducted

using email when diary restrictions prevented other options. The semi structured interviews were conducted in a manner in which a number of key open questions were asked to keep the subject focused but also provide freedom for the interviewee to elaborate. An interview question schedule is attached within appendix 1. This semi structured approached enabled the same key questions to be asked as it related to the subject specific to the interviewee. This approach also enabled the interview to produce comparable information but also provided sufficient flexibility for areas of interest to be probed further. Prior to referencing within the study all interviews were anonymised. The necessity for anonymity of the interviewees was because many of them held important roles within law enforcement and had previously worked within the arenas of organized crime, covert Policing and counter terrorism or had aspirations to do so in the future. As such a coded system adopted by Rozee (2012) was followed. Interviews were referenced using the initials of their organisation and a number. This number was sequential when more than one interview was conducted in an organisation. For example, an interview from The Metropolitan Police would be referenced as MP/1 and subsequent interviewees from the Metropolitan Police would be referred to as MP/2 and so on.

Ethical Considerations

It is important for the researcher to ensure their behaviour is appropriate during interviews. Secondly the researcher must also pay particular attention to the way in which they ask the questions when conducting their interviews. For instance, they should avoid deceiving participants in any way (Burham et al, 2004) and avoid an oppressive interview style (Mason, 2002). This places both researcher and interviewee in a difficult ethical position and as such it is good ethical practice for the researcher to inform the participant of the boundaries of the interview, so all are clear about what will be done with the material (Mason, 2002). Confidentiality is an essential part of interview research and it should be made clear from the outset what level of confidentiality the interviewee will be afforded (Dundee University, Policy ref: REHP/V1/04.11). This was especially relevant when conducting the interviews and case studies to protect the personal information of participants who did not wish to be named. All of the interviewees requested that their identity remain anonymous because of their employment

status and as such this was fully adhered to. Ethical approval was gained from Dundee university's ethics committee for the completion of the studies interviews as this was the establishment enrolled within at the time of the completion of interviews. This can be viewed in appendix 3.

Analysis

The interviews in this study were subject to deductive and inductive thematic analysis. Full details of the process for analysing these interviews is outlined within the method section on page 139. Many of the themes were identified through the quantitative assessment conducted in chapter 4. Further themes were also identified during the conduct of the literature review and were also included. The remaining themes that were not identified previously were inductively identified by the author through the analysis of the interviews.

5.4   Results

Knowledge and Understanding

It has been suggested (Maguire, 2005 and Ratcliffe, 2004) that gaps in knowledge regarding the theoretical foundations of policing implementations is a contributory factor in their success. To help gauge their understanding interview participants were asked to define predictive policing. This is in an attempt to conclude whether Police services implementing predictive Policing methodologies fully understand the aims of the theory that they believe they are implementing. Such an assessment enables a deeper understanding of fundamental factors that may impact on the implementation. There have been several attempts by academics and scholars to define what predictive Policing actually is (NIJ, 2016 and Perry and McInnis et al, 2013). Worryingly participants interviewed were either unable to define what predictive policing was (NY2) or were only able to provide a degree of understanding. Participants understood what the generic objective of applying predictive methodologies was but did not describe any process of predictive analysis, in essence simply describing what are best described as traditional hotspot methodologies (LC1, GMP2 and LC2, 2015). For example, the following definitions provided show how interviewees were unable to provide any predictive element within their understanding;

> "*Predictive Policing means applying intelligence led information and analysing recent crime types and patterns to develop the most appropriate method of utilising limited Policing resource*" (LC1, 2015)

As can be seen from the following definition outlined, very little distinction can be made between what the interviewee defines as predictive Policing and a traditional hotspot definition.

> "*Predictive Policing is using an intelligence led and research led approach to provide effective patrolling for Police and partner resources*" (GMP2, 2015)

Taking into consideration the previous definitions provided and the one outlined below we can see that there is also a fundamental difference in opinion in respect of the actors whom the methodology seeks to direct. These definitions outline the strategic difference in understanding with the key actors being identified primarily as the Police or partnership agencies.

> "*The aim is to combine Police data with other partnership data such as fire and rescue, health, accident and emergency etc. in order to identify community safety threats and direct partnership resources accordingly*" (LC2, 2015)

In contrast however, others interviewed showed a clear understanding of the concept of predictive Policing and were able to provide very comprehensive definition (LC3, LC4, GMP3, WY2 and LC5, 2015), examples of which are outlined below;

> "*The application of predictive analytics to drive operational or strategic activity in order to improve operational and organisational outcomes*" (WY2, 2015)

"It is about using an evidence base to identify as far as possible…the greatest likelihood of future risk….and…is about directing resources where the risk is likely to occur" (LC2, 2015)

What can also be identified from examining the definitions provided by participants is that their understanding of the concept is heavily weighted towards the prediction of risk associated to the commission of crime (LC4 and GMP3, 2015). Very little impetus was placed on the prediction of information relating to the origin of the cause of the crimes, the offenders.

"The ability to successfully predict the occurrence and location of future crimes and have the effective ability to take appropriate action to prevent or reduce that occurrence" (GMP3, 2015)

"Evidence based approaches to using data sets to make predictions about the patterns and likelihood of future offending" (LC4, 2015)

One interviewee made reference to the potential of predictive Policing as a methodology for identifying information in relation to the offender;

"The analysis of data to predict likely vulnerable crime areas and demographic of offenders committing crime" (LC3, 2015)

Training

It is essential that those generating predictive products and the decision makers and practitioners utilising them can analyse, interpret and understand their meaning. One of the key methods that can ensure that this is achieved is through appropriate training of key stakeholders. Such training will have a direct impact on the efficiency of those producing the predictive products by reducing the production time. Appropriate training to increase the ability of decision makers to interpret a product should increase their efficiency by enabling them to make faster and better-informed decisions, ultimately impacting on the effectiveness of a predictive product. Raising the knowledge of the practitioners would likely increase their buy in and as such their efficiency would be greater through

reduction of unproductive patrolling which has minimal crime reduction or prevention effectiveness.

Participants were asked to explain the frequency, standard and quality of training supplied to those involved in the predictive process and it was evidently clear that approaches to this area were incredibly inconsistent throughout the United Kingdom. At one end of the spectrum were the analysts who had responsibility for conducting the complex procedure of generating a predictive Policing product. Almost all analysts interviewed identified that, as a prerequisite, that they possessed qualifications obtained from the National Intel Analyst Training (NIAT) course (LC2 and GMP2, 2015). In addition, some analysts also benefited from additional training through training delivered through problem solving analysis courses, strategic analysis courses and inferential statistics training (LC2). However, it was highlighted that there was no training in production of algorithms, a fact that would hamper analysts in the further development of predictive approaches should they wish to enhance their analytical ability (LC2).

In contrast to the high level of skill and training possessed by analysts conducting predictive Policing it was identified that practitioners who had responsibility for acting on the product received very little training, if any (LC5, 2015);

> "*No training impeded because it was clear that there were many interpretations of 'predictive Policing' which influenced expectation*" (DC1, 2015)

The delivery method of training also varied and ranged from a single email explaining the introduction of predictive Policing (LC3, 2015) to detailed face to face lessons on the subject (DC1, 2015) but with the majority of staff receiving a short briefing from a senior officer (LC4, 2015). Furthermore, the quality of what training was delivered varied significantly. The best examples of the quality of training included the theory of the predictive approach;

"Training was achieved by extensive team briefings to every member of staff who might undertake this activity to explain the science, what was required of officers and the results 'buy in' may bring" (DC1, 2015)

However, despite the depth or quality of training it was clear that not all officers found it useful suggesting that they learnt very little new information from it (LC4, 2015). Ultimately, what was clear from examining the training delivered to front line practitioners was that it had a direct impact on the level of 'buy in';

"Had we implemented it again I would have had a roll out where the science was explained to officers and the data shown to them to get them on board". (GMP2, 2015)

"More time should have been given over to training and convincing stakeholders and practitioners" (WY2, 2015)

Buy in will be discussed in greater detail later in this chapter but what has been established at this stage is that the training to front line staff is absolutely essential to the success of any predictive Policing approach. This is a fact that was also identified by staff involved in managing the introduction of predictive Policing.

Process of Prediction

In the previous section it was identified that analysts received a high level of training to support them in their roles. A major reason for this is the complexity of the analytical function that they conduct and the ability to provide an expert interpretation of quantitative information at their disposal. In this section the processes conducted by the analysts involved in producing predictive Policing products are examined. In doing so the study identifies the data collection tactics, sources and the analysis process, particularly in respect of the methodologies used to produce optimal foraging predictions to enable an assessment of the efficiency of generating a tasking product.

In examining the analytical process, it was identified that the Forager response is considered part of a 'two-tiered' approach which considers both offender and location-based tactics, with the forager prediction forming the locality-based element (LC6, 2015). In each case study it was established that there were embedded processes in place to deal with the targeting of offenders, although this study argues that these are ineffective, thus the primary focus for analysts producing optimal forager predictions was to identify areas of increased vulnerability and high risk, predominately in terms of dwelling burglary offences (LC6). However, as part of their own internal research, some analysts did make efforts to predict other offences type localities such as those for commercial burglary and theft from motor vehicles (WY3, 2015). However, these are not considered in this study which relates entirely to the offence of domestic burglary. To maximise the accuracy of the predictive products each of the pilots examined conducted prior in-depth testing to ascertain the predictive accuracy of various methodologies before settling on their chosen approach (LC6, GMP2 and WY3, 2015).

> *"Prior to embarking on any form of implementation a 12-month historical crime data comparison was carried out which illustrated that if these predictive techniques had been used 12 months prior the Trafford division could have successfully predicted 61% of our burglary dwelling offences"* (GMP2, 2015)

On occasions data drawn from as far back as three years was used to complete this testing process (GMP3, 2015). For tactical predictions in general most Police services opted to use historical data from between 14-21 days (NY1, LC1, WY3 and GMP2, 2015) on which to base their predictions.

> *"When looking at the where the next offence was going to take place we used a rolling three-week period. This data was and still is used to create the risk maps. These are pictorial patrol plans"* (GMP2, 2015)
> *"Two weeks, again this is based on the original research and the work carried out by Trafford Police"* (LC1, 2015)

However, it was established during the pilot period that this frequency was too low and as a result the data source was checked every 24 hours and as required, adaptations to the predictive product were made (LC1, 2015). Changing the prediction so regularly may have provided a more up to date product but does risk impacting on the overall predictive accuracy which is generated from a longer temporal data set. This was a danger identified by the analyst responsible for producing the product who stated;

> *"This fluid approach was essential but effectively bastardised the integrity of the initial data"* (LC1, 2015)

Once the requisite data had been extracted an analytical process was undertaken to produce the predicted optimal foraging product. For a fully trained analyst this process became a relatively simple task (LC2, 2015). Regardless of its simplicity it was a time-consuming process because of the level of underpinning information required to inform a prediction. For instance, an overall assessment of the identified areas was made taking into consideration threats above and beyond the committed domestic burglary offences (LC2, 2015).

> *"Traditional intelligence and also information from offender management units in relation to the recent behaviour and circumstances of known criminals within the predicted areas was taken into account when identifying the highest risk foraging predictions"* (LC1 and LC2, 2015).

Also, information in relation to suspects wanted for more serious offences such as robbery or assault formed part of this decision-making process (LC1, 2015). Once the analyst had collated all relevant information, the predicted foraging areas were then categorised into high and lower risk areas, identified in red and blue 400 metre zones respectively (WY2, GMP2 and LC6, 2015). Red areas were considered of higher risk and they included offences which had occurred within the preceding 7 days whereas the lower risk, blue areas included older offences (LC6, 2015). Quite often the product produced could include multiple areas of predicted foraging offending but due to the restraints of the capability of front line resources it was impractical for every high and lower risk area to be

highlighted (LC6, 2015). As such, in an effort to maximise the effectiveness of limited resources, the crossover zones between two red areas were identified as the priority predicted forager areas for the purpose of targeting and resourcing decision making (LC6, 2015).

> *"The briefing product has been designed so that the highest risk areas are highlighted (i.e. those that occurred most recently), if an offence occurred in the first week of the period, the risk is still present but based on the research is lower than the risk relating to more recent offences"* (LC1, 2015).

Within the product produced, the exact offence locations were also included. This served to underpin the activity of neighbourhood level resources who could use this information to conduct cocooning activity such as leaflet drops or face to face contact with homeowners residing closest to the victims (LC6, 2015).

Frequency

Essential to underpinning the tasking and co-ordination of resources from both within the Police and partner agencies was key to the predictive Policing approach and an integral part of this was the generation of the predicted high-risk forager areas. Once produced the frequency in which the product was published and used to co-ordinate taskings was identified as being a factor in the effectiveness of the process.

The level of frequency differed with some producing them on a weekly basis (NY1 and GMP3, 2015) and others opting for a more fluid approach (LC1, 2015). However, the most common frequency was identified as being 3 times per week (GMP3, GMP2, DC1 and WY3, 2015).

> *"Initially the analysis was conducted twice a week – once on a Monday to direct taskings for the week, and secondly on Friday to direct taskings for the weekend"* (LC1, 2015)

"Initially one a week, but flowing liaison with JDI, it moved to three times per week, which it still is at present" (GMP2, 2015)

Regardless of the final frequency what was identified was that a process of trial and error was required before finally settling on a frequency that they felt met their needs best. As a result, there are conflicting frequencies in place with different rationales for each. For example, some co-ordinators opted to produce a predictive product twice weekly with the first being published on the Monday for the week ahead and a second product on the Friday to drive tasking and co-ordinating over the weekend (LC2, 2015). However, as time passed it was felt that altering the product twice a week, which often resulted in new high-risk areas being predicted, reduced the effectiveness of the tasking and co-ordination as the tactics had insufficient time to make impact (LC1, 2015). As a result, the frequency was reduced to a single product that was produced on the Monday before being discussed at a governance meeting on the Tuesday (LC1, 2015).

A Forager meeting is held every Tuesday after the daily Risk & Threat meeting, and the product is used to identify actions and task resources accordingly. The meeting is chaired by the risk and threat Det Inspector, and attended by the geographic Inspectors, partnership representation (CSP teams), and any other relevant parties (e.g. Neighbourhood Watch, Intel). Both police and partnership actions are identified and reviewed at each meeting (LC1, 2015)

It has been further suggested that although theoretically a new predictive product could be published every day and provide close to 'real time' predictions, this would fail to provide sufficient time for the interventions to be put in place effectively and their success to be properly evaluated (LC2, 2015). This was a particular issue in terms of the tasking of partner agencies as it was not possible for them to respond as quickly as the Police, they required time to digest and plan their activities so anything more frequent than once a week caused them problems (LC2, 2015). Not only did the potentially reduced effectiveness have a bearing on the frequency of the product, the crime rates also played a major role. For example, in certain areas the levels of criminality were greater than in others

and as such there was insufficient data to make predictions at a frequency higher than one each week (LC2, 2015). However, not all stakeholders shared this opinion with practitioners of burglary investigations raising concern that if their function was to be removed due to austerity driven resource changes, then once a week would be insufficient to ensure necessary resources were kept suitably informed (LC5, 2015).

Other co-ordinators felt that producing the predicted forager high risk areas only once a week was too infrequent and reduced the capability to respond effectively to emerging threats (GMP3, 2015). As a result, the frequency was increased from once per week to three times a week on a Monday, Wednesday and Friday (GMP2, 2015). In doing so it was also identified that there was a reduction in internal demand for further information and analysis from staff within the geographic areas analysed (GMP2, 2015). It has been suggested that a solution to bridging the variances in frequency could be achieved by adopting a two-tier approach (LC1, 2015). A strategic predictive product could be produced on a weekly basis that fed the overall decision-making process, but also be underpinned by a more regular product that concentrated on identifying emerging threats such as intelligence on active burglars or crime spikes as it is argued that such a two-tier approach could potentially increase the effectiveness of the tasking and co-ordinating (LC1, 2015).

Cost Effectiveness

The issue of cost is often an overlooked area in criminological study and criminal justice policy. Previously it has been argued that decision makers have not always paid sufficient attention to the issue of cost when considering efficiency or the wider implications that arise from the introduction of new approaches (Domiguez and Raphael, 2015). The UK Police services have historically been well funded public service providers but, as this funding has diminished in the face of increasing economic restraint in all public services the issue of cost has become increasingly relevant. No longer can the 'cost' element of the cost-benefit analysis be one of the last considerations when evaluating the application of a methodology.

Manageable costs can be identified for systems and suppliers that the UK Police service have an existing relationship with. For example, the MapInfo system was identified as costing between £1500 per annum with only a £225 recurring annual fee (LC2).

> *"MapInfo has been the primary mapping software used by Lancashire Constabulary intelligence analysts for a number of years, its initial cost is £1500 per licence then 15% annual upkeep and upgrade cost"* (LC2, 2015)

The variations in cost is stark and is a consideration that Police decision makers should pay careful attention to. As was the case for two of the case studies conducted who both cited cost as one of the primary reasons for using existing analysis software to make their predictions (GMP2, WY2 and LC2, 2015).

> *"Cost could have been prohibitive if we had turned to a commercial supplier. Support from the College of Policing has allowed us to continue with this approach"* (WY2, 2015).

However, although a distinction between cost can be made it is right to acknowledge that this study has not sought to make any comparison between such systems and as a result a conclusion cannot be made as to which provides the greatest 'value for money'. As has been identified by analysts involved in applying predictive policing the systems do not necessarily provide all the answers, it is not simply a case of plugging them in and a predicted hotspot being identified, the pre-analysis is essential to ensure an accurate product (GMP2). However, after taking all of the above factors into consideration practitioners of predictive Policing have identified that cheaper forms of software or internally generated system-based practices, for instance, Microsoft Excel, provide a greater level of predictive accuracy than most private suppliers (WY2).

A further cost that has to be taken into consideration is that of time. Although the outlay is not as visible or immediate as when purchasing a new piece of software, the cost incurred through time can be a significant one. This is especially true if

the process of producing a predictive product is inefficient and time consuming. In an effort to identify this cost some simple calculations were conducted and the mean cost was identified as £43 per predictive product. This cost equates to an average annual cost of £2236 to produce 1 predictive product per week for one year.

However, as this chapter will outline later, many Police services have opted to produce more than one predictive product per week and as such this cost could increase further still. As a result, we can identify that even if costs can be maintained at a minimal level by utilising existing software or by exploiting relationships with suppliers, that the cost of production can still be significant in terms of analytical time.

Governance

Production of a predictive Policing product is only a small part of the overall methodology with tasking and co-ordination forming an essential phase which is key to achieving effectiveness. The direction and control of potentially large numbers of resources requires a structure of governance. Such governance affords key decision makers an opportunity to interpret predictions, apply their professional judgement if necessary but most importantly to ensure that the appropriate resources are tasked effectively to achieve the desired outcome which in this context is the prevention and reduction of crime.

The optimal forager predictive product was a core agenda item which was discussed within what are called the risk and threat or national intelligence meetings which are held on a daily basis (LC1 and LC2, 2015). Such meetings form part of the tactical tasking of Police resources as outlined by the national intelligence model (Home Office, 2003). Underpinning the daily tasking meetings were weekly meetings that discussed the predictive products in greater detail, it was within these meetings that the specific taskings were ratified (LC1 and LC2, 2015). Governance within this setting was almost always provided by a senior officer such as a Chief Inspector, Inspector or Detective Inspector whose core position was to provide oversight for the predictive Policing tasking and co-ordination within the relevant area (LC2 and LC4, 2015). Often in attendance

within the governance meetings were other key stake-holders. These included officers from neighbourhood Policing teams, pro-active burglary teams and also external partners (LC1, LC2 and LC4 and LC6, 2015).

> "*The partnership element of the response has been key, especially in a time of diminishing resources across the public sector. The Forager response encourages shared responsibility to target risk areas*" (LC2, 2015)

At the weekly meetings the specifics of actions that related to predictions for both locations and offenders were discussed (LC2). A major part of these meetings was to identify how each department or agency in attendance could have a positive influence over the identified issues or share resources to maximise the impact of independent taskings (LC1 and LC6, 2015).

> "*Police uniform high visibility has been a key response, with Neighbourhood Policing Teams playing a key role. Partners have also been tasked to provide visibility using street cleaners, fire and rescue conducting Home Fire Safety Checks within risk areas, Trading Standards conducting activity*" (LC1, 2015).

Despite being provided with a detailed product and being exposed to such high levels of joint governance, individual people of influence or rank were able to overrule both the product and key stakeholders to make key decisions and direct action (LC1, 2015).

Involvement of Partners

Police partners such as local councils or other agencies such as fire and rescue and ambulance were also involved in the governance team of predictive Policing approaches;

> "*This would allow for the most effective tasking of wider Police resources, maximise opportunities for partnership working, and build on the community-focussed element of Forager*" (LC6, 2015)

One reason that the involvement of partners was such a key element has been cited as the level of reducing Police resources available to conduct traditional pro-active or problem-solving work but also the ability to provide a more fluid response to identified threats (LC1, 2015).

> *"Some identified risk areas may require a robust Policing response to focus on active offenders, whereas other risk areas may only require more focus on issues such as security and target hardening. This is where shared responsibility between Police and partners is most important – in theory the Police could provide a robust response in one area, while relevant partner agencies provide visibility and crime prevention advice in another area".* (LC6, 2015)

It was suggested that by involving partners to such a close degree it ensured that all agencies could provide a truly joined up approach to identified issues and also avoid duplication of effort (LC1, LC2 and LC4 2015). To begin with the pilot exercises quoted great success in rejuvenating previously disparate relations with partners;

> *"The Forager product has refocused partnership tasking by bolstering channels of communication between partner agencies"* (LC6, 2015)

Strong examples of joint working included the flagging up of multiple occupancy homes as a high-risk burglary issue resulting in visits from council landlord teams which helped reduce the number of offences (LC6, 2015). Partners were also identified as being particularly helpful in terms of preventing repeat offences by assisting with the super cocooning of attacked properties (GMP2, 2015).

> *"We developed a complimentary strategic approach with local housing providers in relation to residual risk hot spots"* (GMP2, 2015)

> *"The local authority was extremely receptive and used the risk maps to task their own Community Safety Patrol Teams and implemented their*

own system of performance management based on these deployments. Trafford Housing Trust, the largest social housing provider in Trafford has been similarly receptive" (GMP2, 2015)

Successes like this were in large achieved by partners assisting the Police efforts through providing crime prevention advice and handing out leaflets to residents as part of the normal day to day business of agencies such as fire and rescue who co-ordinated their Home Fire Safety Checks plans with the predicted forager areas (LC2, 2015). Agencies such as fire and ambulance and even the Police driving school also used the forager predictions to co-ordinate their routes to and from non-emergency deployments, so they navigated through the high-risk areas (GMP2, 2015).

"Force Driving School who were asked to conduct driving lesson within risk areas" (GMP2, 2015)

Other positive contributions included the deployment of high visibility guardians in the form of street wardens, parking attendants and street cleaners into predicted areas during the threat time periods (LC6, 2015). Local charities were also used to target harden properties in predicted high risk areas by improving locks, supplying window stickers and further free crime prevention advice to residents (LC6, 2015). Communities were also empowered with information regarding the predicted forager areas and conducted 'community stands' and 'days of action' in the high-risk areas to also prevent offending (GMP2, 2015).

It was established that the greatest success in relation to joint working with partners was achieved through a greater understanding of what motivated the agency and what their performance indicators were (GMP2, 2016). Areas where these objectives could be aligned with the forager predictions resulted in greater levels of partnership working (GMP2, 2015). However, as with many Policing initiatives, over time the predictive Policing optimal forager approach become heavily Police orientated (LC1, 2015) as partner agencies withdrew or reduced their level of involvement. This was, in part as a result of confusion amongst partners such as councils over responsibility for geographic areas (LC1, 2015). Also, the type of agency was an important factor, particularly in relation to

councils where unitary areas were highlighted as being much more attune to the predictive forager approach than areas where a two-tier council system was in operation (LC4, 2015). A potential reason for this was identified as the fact that unitary councils in general have more deprived areas within their boundaries and as such have access to greater funds and resources than county councils (LC4, 2015). It was also highlighted that as time progressed, despite the positive rhetoric there was a significant reduction in tangible work conducted by the partners involved who began to cite issues in resourcing or budgets as their main blockers (LC1, 2015).

Tasking and Co-ordinating

One of the primary functions of producing a predictive Policing product based on the optimal forager theory is to maximise the impact of location-based crime prevention and reduction tactics. One of the main tactics used to achieve this is through providing a capable guardian through effective patrolling by high visibility resources, whether that be from a law enforcement agency or a partner as the previous section has highlighted. This concept is expertly outlined by an interviewee in the study;

> "*The tactical use of the predictive risk maps as a guide to patrolling resources is not a panacea. It is an effective means to direct resources to operate at a particular location at a particular time. It coordinates and maximises what can be obtained from high profile uniformed resources in delivering capable guardianship*" (GMP2, 2015)

By providing staff with greater clarity in terms of their patrolling it removes the professional judgement which was so often used without a sound evidence base (GMP2, 2015). The importance of the efficiency and effectiveness of such tasking and co-ordinating has been identified as becoming increasingly relevant as the level of time and resources that can be attributed to such work decreases as numbers of front line officers are also reduced (LC2, GMP2 and WY2, 2015). Furthermore, rather than creating additional burden on staff the aim of producing a predictive product for tasking and co-ordination is to allow staff to "*do what they normally do*" (LC2, 2015) but in a more effective manner.

To create the tasking actions predominately location-based patrol strategies are raised within the governance meetings outlined in previous sections which are then provided to the relevant teams and departments through briefings and 'tasking documents' (LC6, 2015). The generated actions and who they are allocated to were however not identified purely based on the predicted high-risk forager areas but also took into consideration the 'professional judgment and local knowledge' (LC6, 2015) of the decision makers. The professional judgement-based decision-making process took into consideration factors such as the temporal risk, whether the predicted area was a short and emerging or long term, established problem and also what resources were available to tackle the identified high-risk area, for instance, whether they were Police or partnership staff and also whether they were uniformed or plain clothes Police officers (LC3, 2015).

The identified tasking was often subjected to a quality assurance process within the wider daily BCU risk and threat meetings to ensure they remained relevant (LC2, 2015). The predicted forager high risk areas are also outlined on software based 'problem profile' sections of electronic briefings delivered to staff which are specific to the time of day their shift relates to (LC6 and GMP3, 2015). The format of these briefings was in the form of a map displaying the patrol plan which were key to gaining buy in (GMP2, 2015).

> *"The maps would be placed on the electronic briefing site and supervisors on both Response Policing Teams and Neighbourhood Policing Teams would task patrols to patrol certain areas at certain time as dictated via the risk maps" (GMP2, 2015)*

The tasking documents were provided to supervisors and also to the partner agencies involved in the weekly governance meetings and included a section for results of patrols and work conducted in relation to the predicted high-risk areas (LC6, 2015). The purpose of the tasking documents was identified as being threefold, to record activity for the purpose of effectiveness evaluation, to avoid duplication of action by the tasked parties (LC1 and GMP3, 2015) and also to

provide information for senior officers to direct thanks to staff who had conducted the tasking's as a tactic to maintain 'buy in' and co-operation from the staff tasked (GMP3, 2015).

The staff tasked by the predictive product varied with some interviewed focusing on uniformed front-line Police resources (DC1, 2015) or staff from within criminal investigation departments (NY1, 2015). Others chose to use a wider pool of resources (LC2, 2015) and drew from non-front-line staff including Police driver training school, neighbourhood Policing teams and an array of plain clothed officers as well as creating specific roles in the form of a dedicated unit to target only the predicted forager high risk areas (GMP2, 2015).

> *"Each RPT shift would nominate a dedicated vehicle which by default would be given the freedom to patrol the hotspot areas as indicated by the most recent maps and not allocated to an incident. At the end of the tour of duty this patrol would complete an end of shift template which would be submitted to the Divisional Intelligence Hub" (GMP2, 2015)*

> *"One of the key 'selling points' of Forager is that it should not create any additional work in the response – we should just 'do what we normally do', but do it in specific defined areas" (LC2, 2015)*

> *"Uniform and CID, although the product was available to all officers" (NY1, 2015)*

The responses to the taskings to staff and partners varied. Some officers felt that they provided them with much more focus in terms of their patrolling so that they could maximise their time (LC3, 2015);

> *"...It provided increased efficiency in terms of 'maximum bang for your buck' from preventative patrol…" (WY2, 2015)*

On the other-hand some staff, particularly from specialist teams whose core role was the investigation of burglary offences felt that they provided very little benefit and at best were just a confirmation of their existing knowledge (LC5, 2015).

> *"We were already scanning crime patterns and the forager document did not affect how we did our work, also the previously mentioned issue about it being 'behind' or out of date"* (LC5, 2015)

Although a well-established process was in place around the tasking and co-ordinating of staff, it is questionable whether that process was adhered to. Evidence was identified that some supervisors rarely even identified or briefed their staff on the predicted forager high risk areas (LC3, 2015). Further information indicated that the predicted high-risk areas were given little more than lip service with supervisors only instructing their staff to patrol the forager areas *"if and when they had free time available"* (LC3, 2015) as opposed to factoring it into their shift planning. There was also little consistency across shifts or departments in their approaches to tasking evidenced by occasions where only a single member of staff would be tasked to patrol the areas at the same time as responding to emergencies or other activities (LC3, 2015) meaning the attention given was ad hoc at best. Other members of staff, particularly those from specialist pro-active departments simply rejected the predictive tasking's on the basis that they were designed to "*direct immediate response patrols to current or future crime hotspots*" and had little relevance to their role (LC4 and LC5, 2015), ironically, this is despite such members of staff owning thematic responsibility for the investigation of domestic burglary.

> *"It might help in briefing staff who are not regularly scanning crime patterns but for me I found no real benefit"* (LC5, 2015)
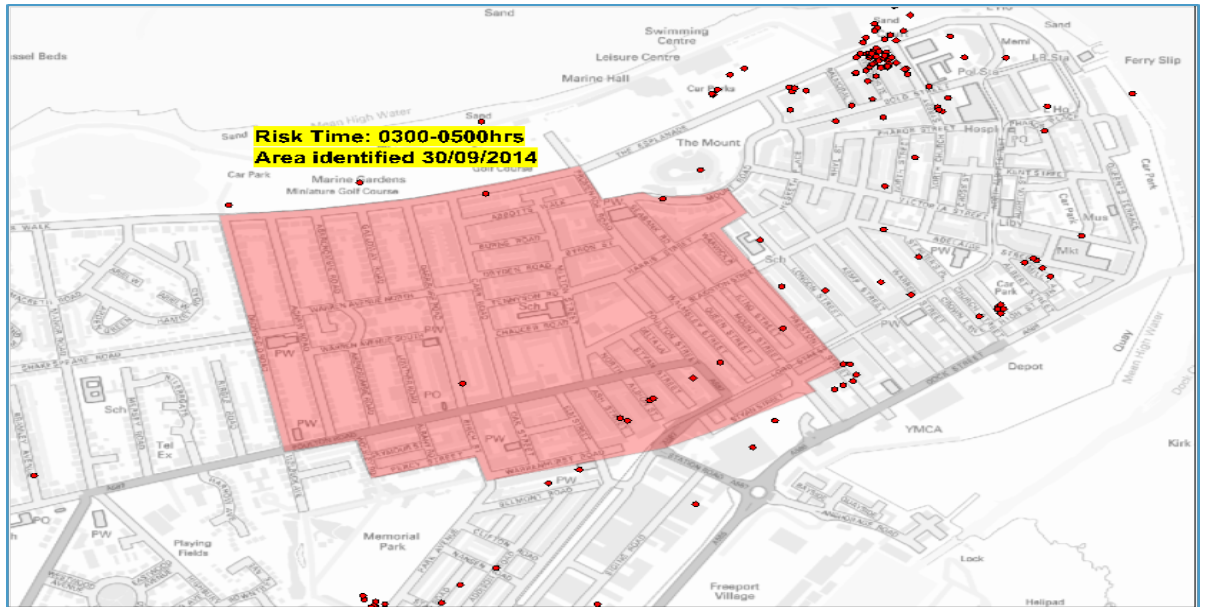
Figure 7. Predicted Forager Risk Area 30/09/2014, overlaid with ARLS GPS data 0300-0500hrs

The issues articulated by the interview participants can be seen in figure 7. This shows a visual representation of the tasking failures. The aforementioned map shows a predicted high-risk forager area overlaid with GPS data which is drawn from Police officers radios. As can be seen from this example, during the two-hour period identified as a high risk optimal forager burglary area, very few officers are present within the identified risk zone, instead choosing to radiate towards other zones. Examination of crime and incident records identifies no major incidents in the locality of the clustered resources (LC6, 2015). A further example of this problem is highlighted overleaf in figure 8 and is drawn from a daytime tasking and over a greater time period, again showing the resources overwhelmingly patrolling outside of the predicted high-risk forager areas.
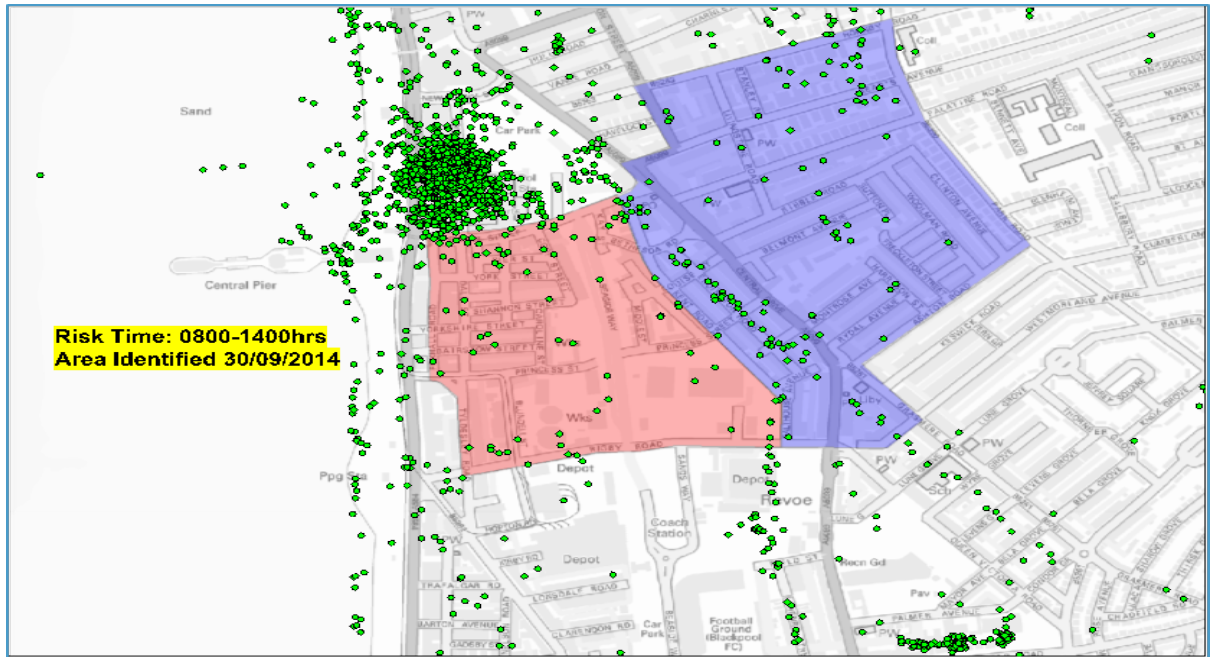
Figure 8: Predicted Forager Risk Area 30/09/2014, overlaid with ARLS GPS data 0800-1400hrs 01/10/2014

Such issues did not escape the attention of senior officers and those involved in driving the predictive Policing approaches;

> *"The current set up does not allow us to fully monitor exactly how the risk areas are being targeted, and my suspicion is that resources are still being tasked 'generally' rather than in accordance with the specific streets, time periods provided by the Forager product"* (LC2, 2015)

The data gleaned from maps such as those highlighted on the previous page were utilised as part of the daily evaluation process with feedback being provided by senior officers and supervisors to staff who did not adhere to the taskings and conversely, praise to those who did to increase and maintain buy in from front line staff (GMP3, 2015).

It is suggested that the result of such reduced levels of targeting in the predicted forager high risk areas is likely to have a negative impact on the effectiveness of the predictive Policing approach (LC3, 2015). In an effort to combat this it is argued that there is a necessity for the drive behind the predictive Policing approach to be the responsibility of a key individual or team to ensure that

taskings and actions are conducted to maximise their crime reduction and prevention effectiveness (LC2, 2015). Alternatively, by authorising the command and control communications team, who answer all calls for service, to co-ordinate the deployment of resources into the high risk predicted areas, up to a 95% compliance rate can be achieved (DC1, 2015) which would further maximise the capable guardian presence.

'Them and Us' Culture

An integral part of making any new initiative a success is the buy in of key stakeholders. In this context this includes the practitioners responsible for conducting the tasking and co-ordinating and providing the presence of the capable guardian, both within the Police service and partner agencies. It also includes the supervisors of the practitioners who are key to driving the activity and motivating their staff. Finally, the senior officers who ultimately make the decisions in terms of ratifying the predictive product and the layering in, or not as the case may be, of professional judgment. A key factor that impacts on obtaining this buy in, particularly within the Police service, is that of culture.

It has been suggested that a major cultural hurdle was caused as the practitioners from different departments had very opposing opinions of roles and responsibilities (DC1 and LC2, 2015). This was also a problem highlighted within the partner agencies as well;

> "*It became increasingly Police led as even partners within the same council bickered over involvement and responsibilities*" (LC1, 2015)

This was a factor further supported throughout the study as interviews of staff from within the different departments such as uniformed front-line staff, known as response, the criminal investigation department also referred to as the CID and pro-active target team staff from within burglary teams all displayed a clear 'them and us' attitude. Interviews from those involved in producing the predicted forager high risk products identified that the feedback they had received from front line response officers was that they did not give much consideration to the predictive products;

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"Burglary is for the target teams to deal with" (LC3, 2015).

However, worryingly, it was also suggested that the target team staff did not pay much attention to the predictive product (LC5, 2015). This was a fact that was confirmed through interviews with officers from the pro-active target teams;

"My duties were not directed as a result of optimal forager but as a team we did bear it in mind. I think the information was used to direct immediate response patrols to current or future crime hotspots…. It might help in the briefing of staff who are not regularly scanning crime patterns but for me I found no real benefit" (LC5, 2015)

Senior Manager 'Buy In'

As this section has begun to identify, the culture has a large part to play in whether key stakeholders bought into the predictive Policing approach or not. It has been argued that the potential negative impact of a failure to secure buy in from senior managers was one of the biggest factors in terms of the success or failure of the predictive Policing approach (GMP2 and GMP3, 2015). It is suggested that this is because ultimately, making a success of any new initiative within the Police service requires an element of rule of law;

"Making people do what they probably don't want to do" (GMP2, 2015).

Culturally, one of the key tactics within the Police service for ensuring this is achieved is through effectively ordering staff to comply and if senior managers do not buy into the concept they are less inclined to enforce it (GMP2 and GMP3, 2015).

"Implementing a new or different way of working within the Police is never easy and if people can avoid it they will. I benefitted enormously from strong personal support and a regime of total compliance" (GMP3, 2015)

Rightly or wrongly a tactic of enforced compliance can be a method to ensure success, but it is suggested that obtaining this level of support is no easy task as there is a general perception that managers within the Police service are not of a high quality (GMP2, 2015). As such the support provided by senior managers was often varied and wavering, ranging from complete buy in (LC1 and GMP2, 2015) to a stance of suspicion (WY2, 2015). It could be argued that a potential factor for this was because the approach did not provide the 'silver bullet' that senior officers wanted;

> "*They want an off the shelf product that they can plug into their computers, press one button and their problems are solved*" (GMP2, 2015)

This was further compounded by a misunderstanding of how to use the predictive products effectively by combining them into daily business and as part of a partnership orientated, problem solving approach (DC1, 2015). However, there were successful methods of gaining senior management buy in and support identified by interviewees. If it was felt to be, or could be portrayed as the "*the next thing*" (DC1, 2015) or if it could help them achieve a positive impact on performance indicators (LC3 and WY2, 2015) then senior managers displayed a higher degree of enthusiasm towards the predictive Policing approach. It has been suggested that this was because at the time of the pilot exercises there was still a culture of performance and targets within the Police service (LC3, 2015).

Conversely, it was argued once the culture within the Police service began to shift away from performance targets, the motivation to support the predictive Policing approaches significantly reduced as senior officers failed to grasp the wider potential benefits of the methodology (NY1 and DC1, 2015). Furthermore, it has been outlined that as the support from senior officers was very person specific, as soon as that manager moved on or was replaced, the new person had little motivation to support it (GMP2, 2015). It was argued that this was because new managers want to generate their own plans and make their own legacy by adopting different tactics to try and "*stand out from the crowd*" (GMP2, 2015).

Local 'Buy In'

It is essential to understand blockers and enablers to achieving buy in from key demographics which was identified as a continuous challenge (LC6, 2015).

"*For forager to be successful, it is clear that the staff and officers who are physically implementing the approach are fully on board with the theory and what is trying to be achieved*" (LC6, 2015)

One of the main reasons that was cited as a blocker to gaining successful practitioner buy in was the feeling that staff were having their own experience overlooked and that the predictive Policing products reduced the use of their professional judgement (WY2, 2015). Others however felt that staff preferred simply to choose the easiest option arguing that in essence it was easier to maintain the status quo then to change what they did (GMP2, 2015). These issues were further compounded *by "too little impetus being placed on winning the 'hearts and minds' of the staff"* (WY2, 2015). It is argued that this could be achieved by paying as much attention to the training of the practitioners and providing them with the evidence base, as is given to the analytical processes (GMP2 and DC1, 2015).

"*When people read the research and were shown the data and patterns, they were more receptive*" (GMP2, 2015)

"*By pursuing a process of engagement with front line practitioners a higher level of buy in could be achieved and there was a greater chance of success as every person knew how their role featured in the bigger picture and overall effectiveness of the predictive approach*". (DC1, 2015)

Unfortunately, despite efforts to convince some of the potential benefits it was suggested that there were a hard-core group who were much more difficult to reach (GMP2, 2015). This hard to reach group often viewed the move towards a predictive Policing approach as simply the latest trend in Policing and had little

faith in its longevity so had little motivation to embrace it (GMP2, 2015). It was also argued that this group more often consisted of officers longer in service or age and also those who placed a greater emphasis on their own personal experience (GMP, 2015). As the previous section has outlined, the only sure method to gain buy in from the hard to reach demographic was through a process or accountability and enforcement (GMP2, 2015). For the middle managers responsible for maintaining accountability and enforcement it was a difficult position. A great deal of motivation and belief in the predictive Policing approach was required;

> "*It was also my role to cajole and chivvy people to comply. I did not win any popularity contests, but was more than content in the knowledge that what I was doing was right and justified*" (GMP3, 2015)

Furthermore, the personality of the middle managers conducting this work was also key (LC6, 2015). It was identified that if the wrong person was in that role then there was a risk that the drive and motivation of staff to conduct the taskings in the predicted high-risk forager areas would subside;

> "*Local drive is very much dependant on the personalities involved. For example, the crime and tasking co-ordinator has a very keen interest in the idea of optimal forager and has therefore worked hard to drive the approach; he has actively sought to co-ordinate a robust response, involving multiple departments and partner agencies. However, if another person were to take the role, would they?*"

Diffusion of Benefit

In order to fully understand the effectiveness of the optimal forager approach as a predictive Policing methodology this section seeks to examine the practitioner's perception of the extent and nature of crime diffusion. The potential benefits of crime diffusion were a positive consequence that was identified by the co-ordinators of the case studies very early on (LC2, 2015).

> *"Initial underpinning analysis of the predicted high-risk forager areas identified that in certain areas as few as 5 predicted zones accounted for as much as 80% of all offences"* (LC2, 2015)

Other non-crime related diffusion benefits were also identified. For instance, although less quantifiable as an effect, confidence and trust within the Police was identified as having significantly improved in the predicted high-risk areas as a result of an increased capable guardian presence (GMP3 and LC2, 2015);

> *"Confidence in the Police doing a good job increased to place us as best in Force" (*GMP3, 2015)

> *"This positive benefit was attributed to the number of face to face interactions between the Police and members of the public which was identified as being 8,902 which were achieved through personal visits to addresses in the predicted high risk areas"* (GMP3, 2015)

It was also suggested that other non-crime potential threats to the community were identified as a direct result of patrolling predicted forager high risk areas. These included the identification of health and safety and fire risks and also tenancy issues which were all referred to the relevant service to resolve (LC4, 2015). Positive benefits were also identified in relation to the apprehension of wanted offenders. Although not a primary objective of the predicted forager high risk areas it was identified that the presence of a capable guardian in areas regularly led to the arrest of other offenders wanted for various crimes (LC2, 2015).

Crime Displacement

This section provides both participant perceptions of crime displacement and geographical examples that were highlighted to the author and also identified from crime recorded data within the 50 optimal forager tasking and co-ordination briefings examined.

Participants identified that the issue of potential crime displacement was considered and expected (WY2, LC6 and GMP2, 2015). For some it was even seen as a positive sign that patrolling the predicted forager high risk areas was having a beneficial impact (LC6, 2015), despite having not completed any form of overall analysis before reaching such a conclusion;

> "*Again, it is worth re-iterating that area displacement is seen as a positive, it indicates that forager is identifying the correct areas to target, burglary offenders are being disrupted in their activity, and in the longer term this 'should' lead to an increase in positive outcomes".* (LC6, 2015)

Although some were more comfortable with the presence of crime displacement others remained concerned, highlighting its debatable context (WY2, 2015). What was also clear was that the issue of crime displacement was also an area of contention between the practitioners responsible for the predictive Policing implementation and their advisors, further confirming cultural blockers experienced in the introduction of other evidence-based approaches;

> "*There was anecdotal evidence of this, this was a tension between the academics and practitioners*" (WY2, 2015)

The presence of crime displacement was identified as being present in varying degrees and in one form or another, in each of the case studies. Such examples consisted of evidence that indicated once a predicted forager high risk area was identified and the capable guardian presence was increased, that the enhanced risk of predation of the foraging criminal resulted in a shift of offending to areas within close proximity but outside the predicted forager boundaries (LC6, 2015). Due to the fact on many of these occasions no offenders were apprehended the conclusion that the displacement was caused by the same serial motivated offenders was predominately made on the basis that the offence modus operandi contained a high degree of similarity, underpinned by close inter crime distances (LC6, 2015).

"The weekly nature of the product meant that it was relatively fluid to react to any reported displacement. We would not simply follow their pattern but would look to ensure the offenders could not retreat to a previous comfort zone". (LC1, 2015)

Participant evidence has been identified that supported this presumption (LC2, 2015) identifying what was effectively a cyclical process of prediction, response and displacement.

"Near repeat offending patterns would occur in the 'new' area which would allow for continued targeting" (LC2, 2015)

"The indications are that while offending behaviours are being disrupted in areas, offenders are not becoming erratic in their activities and are continuing to commit near repeats in other locations" (LC6, 2015)

A further interesting insight obtained during this study also established that the identification of displacement or patch movement as it is referred to in the ecology literature, is much harder to identify in areas of greater resource availability i.e. victims or opportunities (LC6, 2015).

"The risk areas identified within east, through Forager, tend to be slightly bigger geographically because of the volume of offending. This also means that area displacement is subtler and less easy to identify, however, again there are numerous examples where this has occurred" (LC6, 2015)

Organised Travelling Criminality

Evidence of the ineffectiveness of the predicted forager methodology in this criminal context was identified throughout the study (LC1, GMP2, GMP3 and LC6 2015). The organised and co-ordinated nature of travelling criminals was identified as being the main factor as to why predicting high risk forager areas was not effective against this criminality (GMP3, 2015)

"It would not be as successful in deterring the criminal activity of an organised crime group who would present a more determined mind set to commit an intended crime" (GMP3, 2015)

It was suggested that such organised criminality could be identified by their common modus operandi which often involved the theft of high powered vehicles whilst concealing their identity with facial coverings (GMP2, 2015). Such crimes were more difficult to tackle using the optimal forager methodology due to their use of motor vehicles in the commission of offences meaning that they could cover large distances and swiftly move between patches (LC1 and LC6, 2015) and managers needed to 'manage their own expectation's;

"There needs to be an acceptance of what such a methodology can and cannot do" (GMP3, 2015)

It was further argued that although it may be an ineffective method to control organised criminality, by enhancing Police services capability to tackle the local level foraging criminals, specialist investigative resources increase their capacity to conduct reactive investigations into organised crime groups (GMP2 and GMP3, 2015)

It is suggested that the majority of organised travelling criminals come from outside of the jurisdictional boundaries of the researched Police services (LC6, 2015). However, there was also an inefficiency identified in tackling organised crime groups from within the pilot areas themselves (LC6, 2015). As a result, it was argued that the effectiveness of the predictive forager methodology is not consistent across the board (LC6, 2015). For example, it was identified that in west Lancashire due to its geographical location, it suffered from lower levels of organised travelling criminality and as such was more effective when implemented to tackle locally based offenders (LC6, 2015). Conversely, the east area of Lancashire shared borders with several other Police services and a large internal border with another division and as such suffered greatly from cross border organised criminality (LC6, 2015). It is argued that the result was that the optimal forager methodology had little identifiable impact in preventing or

reducing such crime (LC1, 2015) which may have an adverse effect on evaluation of the approaches impact on overall burglary prevention and reduction (LC6, 2015).

Crime Reduction and Prevention Effectiveness

Despite the time and effort spent on implementing the optimal forager approach to domestic burglary prevention and reduction, participants interviewed expressed low levels of confidence in its impact;

> *"The effectiveness in combating Burglary, or Theft from Motor Vehicle is negligible. It is recommended that this type of predictive mapping is not used to combat these crime types, and further efforts are put into the development of more nominal focused methodologies"* (WY3, 2015)
> *"I believe that predictive policing has impacted on crime figures in that without it, our burglary dwelling figures would have been much higher"* (LC1, 2015)

Furthermore, it was highlighted that during the implementation periods that there was a significant change to the way in which Police services recorded crimes. This change meant that crimes were now immediately recorded at the first contact point as opposed to within a 72-hour period, which previously afforded time to investigate offences and on occasion negate the necessity to record an offence.

> *"Overall crime reduction was minimal, but this could be explained by a change in approach to crime recording. The fact that there hasn't been a huge increase would suggest that predictive Policing has softened the blow"* (LC1, 2015)

Conversely, steadfast believers, particularly amongst front line practitioners responsible for investigating burglary offences, believed that the implementation of the predicted forager method had not had any impact on any reductions that may have been identified. This was a stance that was supported by the fact that reductions were also identified in some areas where the predicted forager approach had not been adopted (NY1, 2015);

"No reductions in crime were related to forager, the arrest and remand of suspects is the main thing that influenced falls in crime in my opinion" (LC5, 2015)

"It did not highlight any positive results in relation to crime reduction which could be directly attributable to the predictive mapping" (NY1, 2015)

Despite these views others involved in the implementation of the predicted forager method offered reassurances that despite efforts to identify factors that may have contributed to the recorded decreases in crime that none could be identified beyond doubt (GMP3, 2015);

"Alternative explanations for the decrease in the specific crime types of burglary dwelling and vehicle crime during the period of maximum application have been sought, however it has not been possible to identify additional contributing factors with any degree of certainty" (GMP3, 2015)

5.5   Discussion

The main aim of this chapter was to continue to explore the evidence-based implementation of the predictive policing forager methodology. It did this by furthering findings from chapter 4 by adding underpinning qualitative information in an effort to help understand the quantitative findings. Findings which emerged within this chapter consisted of multiple implementation failures which include; the impact of knowledge, understanding and training of those involved in the implementations, the necessity for effective tasking and co-ordination to impact on the rational choice of offenders, the lack of intelligence within intelligence led policing, the role of bi-lateral relationships, the importance of 'buy in' from frontline staff and how leadership is key to this, the impact of the prediction frequency and other issues impacting cost effectiveness, the hold of 'professional judgement' and the inability of the methodology to tackle organised criminality.

5.5.1 Theory and Implementation Failures

Prediction, Frequency and Cost Effectiveness

Overall, the Police services examined have become highly efficient in their methodological processes. For instance, it was established that through their own research of external software suppliers many Police services had reached the conclusion that they could just as easily produce equally, if not more accurate processes of prediction based on the theory of optimal forager. As such, many had reached a very cost-effective approach to prediction. However, it was established that the process was not cost neutral as staff time, system purchase and licensing costs all cumulated to several thousand pounds per year. Despite these costs the methodology for implementing a predictive solution was identified as being very cost effective. This is in contrast to previous literature that argued that implementing a predictive framework would be costly and required complicated and expensive software and investment in analysts (Walter et al, 2013). As a result of these findings the generalisation that any failure of the optimal forager implementation cannot be attributed to factors relating to cost or efficiency of producing the predictions and conclusions must lie elsewhere.

The Impact of Knowledge, Understanding and Training

It was clear from the research conducted within this chapter that tested the understanding of key decision makers regarding predictive Policing, that many practitioners responsible for implementing the optimal forager approach had a fundamental misunderstanding of it. There was also evidence to suggest that many presumed it was simply another version of hotspot Policing and showed no understanding of its predictive nature and preventative potential. With the exception of analysts there was also a lack of training amongst practitioners involved in the optimal forager predictive policing implementation. It was also evident that expectations of what could be achieved by adopting a predictive Policing approach was an issue of contention. It could be suggested that many senior officers expected a 'silver bullet' that would solve all their crime prevention and reduction problems by simply 'going where it told them to'. In reality a greater level of understanding was required to comprehend the approaches constraints which may have impacted on assessments of its effectiveness and underpinned

other identified consequences. This lack of knowledge and understanding is a clear theory failure as described by Kirby (2013). In fact, Kirby explicitly states;

"The practitioner to first explain why the intervention should work, for if there is no theory underpinning the process, then experience shows it is likely to fail" (Kirby, 2013, p79)

The lack of understanding was likely as a result of a further failure, specifically, implementation failure as it relates to the training of staff. Recent literature has further directly linked the lack of an effective learning and development strategy to evidence-based implementation failures within policing (Clough, Adams and Halford, 2017). Such findings within this study continue to evidence concerns that have previously been raised and argues that there is a continued reduction in the standard of training within UK Police services.

Further evidence arose within the chapter that the lack of knowledge and understanding had a negative impact on the effectiveness of the implementation as a result of decreasing partnership co-operation. Hope and Murphy (YR) have outlined an inability to co-ordinate partner agencies as a specific factor within implementation failure. This was evidenced multiple times as it was outlined on several occasions that the lack of continued joint working was disappointing, and it was identified that there was a feeling that partner agencies had not fully grasped the potential for fully '*buying in*' to the predictive forager approach (LC1, 2015). As with law enforcement personnel, greater training to partners could enhance co-operation of key stakeholders within the implementation, and, as a by-product increase the crime prevention and reduction effectiveness. As alluded to, the finding that relevant and practical learning and development is an essential part of increasing practitioner co-operation and understanding of evidence-based practice (Clough, Adams and Halford, 2017). However, it is not possible to quantify the exact impact on buy in from practitioners from this study I believe that other factors, such as the capable guardianship provided through tasking and co-ordination have been negatively impacted upon and it is these failings of the implementation that have contributed to its effectiveness, or lack of. Furthermore, another way to address this issue was highlighted as writing

such joint working into strategic plans between the Police and other agencies and partners (GMP, 2015).

Routine Activity Theory

The study identified that the effectiveness of tasking and co-ordination was an essential part of the predictive policing approaches success. This conclusion is not a new finding and is a position that is strongly supported in existing literature in respect of problem orientated policing (Goldstein, 1977 and 2003) and other hotspot related studies (Cohen and Felson, 1979), which suggests that other than the methodology used to direct resources, the implementations are far from revolutionary in their fundamentals. In essence, one of the main conclusions that can be reached from this study is simply that a capable guardianship impact cannot be achieved if the principles of routine activity theory are not adhered to. It has been argued that an effective crime control strategy is best achieved through supervision of targets by guardians, effective supervision of offenders by police handlers and effective protection of places by managers (Felson, 1986; Eck, 1994).

Supervision of	Target	Offender	Place
Directly Supervised by	Guardian	Handler	Manager

Table 7. The Capable Guardianship Framework: Adapted from Ecks Triplets Model (1994)

In the context of a crime prevention and reduction strategy aimed at foraging burglary offenders this would manifest itself in the following model; supervision of victims who are the source of resource sought by foraging offenders (targets) by increasing the predation risk (police as predators) for offenders within the predicted high-risk areas (place) through tasking and co-ordination of resources by police managers, underpinned by effective supervision of foraging offenders. However, this study has identified that again, the theme of theory failure was present. This occurred as the optimal forager predictive policing approach created an over reliance on prediction of place and targets, highlighting potential failures within the implementations in several other ways; firstly, the management of resources into the identified place was weak, a clear

implementation failure, secondly; the handling of foraging offenders was also very weak causing a theory failure as the model described by Cohen and Felson was not properly fulfilled.

Professional Judgement Over Empirical Evidence

The adaptation to the theoretical framework based upon professional judgement was identified throughout as being consistent with the least effective implementations and was further underpinned by evidence that this also impacted on the tasking and co-ordinating process. This causes another direct deviation from the theory, this time from the foraging methodology specifically which the whole implementation was underpinned by. Unsurprisingly it was established that the least successful implementation included a large degree of flexibility to allow such professional judgement to impact on practitioner decision making, with examples of officers choosing to effectively ignore the predictive products. It was established that this had a negative impact on the overall effectiveness of the predictive approach which further reduced its effectiveness and ability to provide capable guardianship in areas that would maximise its impact. Conversely, it was argued that allowing the use of professional judgement increased practitioner buy in to the approach but there is little identified evidence to substantiate this position.

Organised Travelling Criminality

Although the method of predicting optimal forager high risk areas to underpin the tasking and co-ordinating of resources may be useful to help tackle certain serial offending behaviour, if the aforementioned discussion areas can be achieved, it has been identified that it is less effective in other contexts. One of the least successful areas of the optimal forager predictive policing approach was in tackling organised travelling criminals. This is likely as a result of a clear theory failure, specifically because the solution has been used to try and address an issue which it is inappropriate for (Kirby, 2013). It was suggested that this was because of two main reasons, firstly the organised and co-ordinated nature of their offending making it harder to predict patterns and secondly the long commuting distances they travelled. Often organised crime groups travelled from neighbouring Police services meaning that their offending territory was much

higher. That said, it may theoretically possible to use the method at an aggregate level. In the context of this study the form of organised crime was identified as mirroring the definition provided by the national crime agency in that it was '*serious crime planned, co-ordinated and conducted by people working together on a continuing basis*' (NCA, 2016). In this study their offending took the form of high value domestic burglary and their motivation appears to be for financial gain. As existing literature has identified, organised crime often takes advantage of environmental factors, most notably, borders, whether they be jurisdictional or national (Spapens, 2010). This study corroborates such literature and identifies that in the mind of the professionals, organised crime groups have exploited a lack of co-ordination between bordering police forces to maximise their own success. Although it is highly likely that an increased predation risk will similarly affect organised crime groups as it theorises it does foraging offenders, the direct observation and confirmation of this is extremely difficult to corroborate. However, what this finding does begin to outline and is possibly the first to do so, is that there are possibly some distinctly different forms of burglary offending and that they require equally distinct crime prevention responses.

The Lack of Intelligence within 'Intelligence' Led

As alluded to in the previous discussion section the implementation examined appears to have multiple failures, one of which was the management of foraging offenders. An interesting finding from this chapter is that it was established that there was little emphasis on identifying scientific approaches to provide useable information that could underpin the prediction of foraging offenders. The structures around offender management were heavily constructed around the philosophy of intelligence led policing and the national intelligence model methodology for identifying offenders. It could be argued from this research that this structure is no longer fit for purpose. This is due to the fact that when information in relation to potential offenders was considered it was established that there was a complete reliance on traditional intelligence sources or information supplied by offender management units. Offender management units are the officers responsible for the traditional handling of offenders as outlined by Eck (1994). However, as this chapter has outlined there has been a significant reduction in useable intelligence in respect of acquisitive offenders such as those

responsible for committing foraging burglary offences. Any policing model based upon limited information is potentially flawed. Existing literature argues that in such circumstances law enforcement agencies are likely to display a considerable bias towards the *'usual suspects'* (Gill, 2000). The limited availability, reliability and use of such intelligence, and absence of any empirical evidence base could very well have negatively impacted on the effectiveness of the implementations through the ineffective handling of the wrong suspects, thus leaving unidentified foraging offenders to continue offending.

Ineffective Tasking and Co-ordination

It is further argued that another failing of the optimal forager predictive policing implementation is the lack of effective management of places. Previous research has argued that both the management of place through effective tasking and co-ordination and the guardianship within that place are both key to an effective crime control strategy (Felson, 1986 and Eck, 1994). Furthermore, the ecological literature in respect of foraging behaviour clearly outlines that an increased predation risk is required to impact on the behaviour of foragers (Lima, 1994). Despite these key assumptions existing within the underpinning research this study has outlined systematic failures in achieving this simple objective. As such, there can be little surprise at the failures to prevent or reduce crime that were evidenced in chapter 4. When examined in greater detail there appears to be several key issues that underpin the ineffective tasking and co-ordination which include communication, buy in, motivation and leadership. All of these failures are classed as clear implementation failures, as opposed to theoretical ones as they were caused by practitioner failings, specifically inadequate supervision, a factor outlined by Kirby (2013) and to some degree, failures in respect of resources, a factor outlined by Durlak and Du Pre (2008).

Bi-Lateral Communication

This study has identified that there are distinct communication difficulties that have weakened the effectiveness of the optimal foraging predictive implementation and prevented maximising the management of place. Wandersman (2009) would identify this as an implementation failure in an enabling factor. In its worst manifestation, the breakdown of internal communication created confusion over who was responsible for the tactical responses that were primarily orientated towards increasing guardianship of areas at risk of further crime. Culture was also established as a significant communication blocker in the effectiveness of the least successful predictive approaches. This issue was prevalent in the form of what is described as a departmental 'silo' culture, with operational departments strictly adhering to perceived responsibilities. For example, front line response officers paying little attention to the predictive products because '*burglary is for the target teams to deal with*' (LC3, 2015). Ironically, it was established that in contrast to popular belief the specialist teams with responsibility for burglary failed to take into account the predictions and preferred to refer to their own professional judgement. Similar communication issues were identified with partner agencies who despite initial enthusiasm over time reduced their co-operation. This finding mirrors that within existing literature that has examined crime reduction implementations but illustrates how over time the lessons of 'what work's' are not retained within 'organisational memory'. It was argued throughout the study that a way to counter this is to make efforts to foster a greater 'one team' approach to the issue both within the Police service and with partner agencies so that there is less division between teams and departments (LC1, 2015).

A potential causation of the breakdown of communication is decreasing trust levels. Communication increases trust which has also been shown to increase co-operation. It has been suggested that to form trust through effective communication is particularly important in areas of higher risk such as that within policing (Langbein and Jorstad, 2004) and that actors within the relationship need to aspire to reach a position whereby they can pre-empt the adopted position of one another (Langbein and Jorstad, 2004 and Schotter, 1998). By doing so a position of mutual pursuit of identified objectives can be achieved

(Langbein and Jorstad, 2004). As such, future evidence based policing implementations must ensure that they seek to establish close bi-lateral relationships which it is suggested can prove valuable in further leveraging co-operation and 'buy in' (Langbein and Jorstad, 2004) which would likely increase effectiveness of the management of the predicted high-risk areas. Such co-operative working relationships are best created through face to face communication at a practitioner level (Miller and Whitford, 2002; Sholz, 1991; Schneider, Teske and Marshall, 1991; Ostrom and Ahn, 2001) and as such police services should carefully consider the makeup and frequency of implementation meetings with high frequency, practitioner-based forums potentially being more effective than periodic, management level co-ordination as was most frequent within the pilots examined.

5.5.2 Solutions to Implementation Failures

The previous discussion sections have identified failures from both a theoretical and implementation perspective. The following discussion section offers potential solutions to prevent or minimise such failures in the future.

Social Capital, Co-operation and Implementation 'Buy In'

It was established earlier in this discussion that the quality and depth of the training delivered to front line practitioners was a factor affecting the success of the forager implementation. The interviews identified further that this was not purely because it created a lack of knowledge but that directly impacted on the level of buy in experienced during implementations. In essence, it can be argued that those who received the highest quality training had a greater desire to engage with the new approaches. Over the past decade there has been a considerable effort by Police services within the United Kingdom to adopt more evidenced based approaches to their response to crime and reduction policies (Clough, Adams and Halford, 2017). The research within this study corroborates recent literature which suggests that 'early adopters' of such evidences-based approaches have experienced significant cultural resistance (Sherman, 2015). Such cultural implementation blockers are not experienced only with policing and the findings within this study corroborates other research identifying similar resistance within medicine (Altman, 1996; Fairhurst & Dowrick, 1996; Murphy

and Adams, 2005), management (Adams & Sasse, 1999; Rousseau, 2012), and teaching (Beista, 2007, Perry & Smart, 2007; Adams & Clough, 2015).

Research within the social sciences indicates that the concept of social capital can be used to leverage co-operation (Woolcock and Narayan, 2000) which would likely lead to increased implementation buy in, which, it is theorised would manifest in increased capable guardianship within the predicted high-risk areas. Further research has outlined that establishing social networks within an organisation enables a greater co-operative culture that is better equipped at not only responding to major issues (Moser 1996; Narayan 1995), but also adopting a more rational approach to conflict (Schafft 1998; Varshney 1999) and responds quicker to shifting environments (Isham et al, 1999). Such characteristics, experiences and responses are required within modern policing and as such it is logical to deduce that increasing the social capital within an implementation zone and at a wider level, the organisation, will increase the likelihood of success of evidence-based implementations such as the one examined in this study. Existing literature outlines that such social capital can be maximised through positive staff engagement and communication (Langbein and Jorstad, 2004). As a result of establishing a basic level of social capital, it is then theorised that the pool of early adopters will increase until a critical mass is established (Langbein and Jorstad, 2004). Success can then be achieved as motivation to co-operate with new crime prevention and reduction strategies is heightened (Langbein and Jorstad, 2004). As a long-term solution to maximise the success of future evidence-based implementations Langbein and Jorstad (2004) suggest that fundamental changes to recruitment, focusing on intrinsic, as opposed to extrinsic values would likely maximise an organisations co-operative culture.

Leadership - Turning Buy in Into Effort

The previous section discussed how to maximise the buy in to an evidence-based implementation through increasing co-operation through focusing on enhancing the social capital within an organisation. A further way to maximise the likelihood of success of the tasking and co-ordination element of the researched implementation is through effective leadership. This study established that the police governance of the predicted optimal forager was consistent across each case study and formed an integral part of a national intelligence model orientated tactical tasking approach. However, there were minor deviations between rank in respect of the individuals with operational responsibility for the tasking and co-ordinating with a correlation identified between the rank of inspector and higher levels of crime reduction. It was suggested that the lower rank ensured that there was a more intrusive approach because of reduced disjoin between the officer and its tactical implementation and as such, greater accountability of resources providing capable guardianship. Other forms of accountability such as allowing communications operators to control resource deployment were also identified as increasing the levels of capable guardianship. In contrast to these intrusive approaches it was suggested that winning the 'hearts and minds' (GMP2, 2015) through greater engagement and training of staff is a potential way to ensure taskings are adhered to.

As outlined above, interviewees within this study said that on many occasions compliance was required to be enforced, but they accepted that this was not a pathway to long term success. This finding is in line with research showing that intrusive micromanagement by first and second line managers actually has a negative impact on the motivation and co-operation of practitioners within crime reduction and prevention implementations (Langbein and Jorstad, 2004). Due to the identified ineffectiveness of this particular implementation, and, the identification of transactional methods of leadership, it can further be argued that the study provides further support for existing literature (Peak and Glensor, 1996 and Hesketh, 2011) that evidences that transformational leadership styles are much more successful at embedding change within policing. As well as using leadership to establish co-operation it can also be used to enhance motivation. Evidence based research within a policing context has identified that people

focused policies raise staff performance and productivity through increased 'buy in' to an organisational vision, increasing motivation and discretionary effort (Hesketh, 2016).

Evaluation Failure - Establishing Crime Reduction and Prevention Success

Ultimately any crime prevention and reduction strategy are measured by its success, regardless of what may or may not have underpinned the measured outcomes. However, this study has shown that the police forces examined failed to properly consider the implementation and its impact on effective evaluation and committed several potentially fatal mistakes. Firstly, it has been strongly argued that police implementation plans should be conducted in an evidence-based manner. Sherman et al cite the use of the Maryland scale as the best way to measure this and randomised control trials are frequently cited as the highest standard of test (Sherman,1998, 2006 and 2007). The implementation of optimal forager could have achieved this, but this study has identified that fairness to communities and not wishing to provide 'postcode' orientated service levels prevented fully controlled implementations. Secondly, evidence was identified throughout that the evaluations conducted by the forces were flawed. This conclusion is reached through the view that there was an Omni-present tendency to cite only the successes of the implementations and to also frame any potential flaws as sugar coated victories, for instance, the identification of crime displacement and its impact. The likely cause of this is that in each of the implementations reviewed those implementing them were also heavily involved in the evaluation process. It has been argued that this restricts the openness and objectivity of any measurement of success (Tilley, 2002 and Tilley, 2003). In its worst manifestation, such lack of independence creates evaluations that are in effect '*doomed to succeed*' (Tilley, 2002). Thirdly, not only was lack of independence an issue within some forces reviews of their work, the Implementations examined were able to do little more than 'evaluate' their own approaches. It has been argued such evaluations are not an objective method of assessing the operationalisation of a criminological theory (Sherman, 2006 and 2007) as this study has sought to do, in part because of the lack of proven statistical or scientific evaluation methods. From establishing the implementation

and evaluation errors the forces made it has been possible to establish that a number of these mistakes were avoidable as they are already grounded in criminological literature, highlighting that there is still much to do to properly embed the fundamentals of evidence-based policing.

5.6   Conclusion

Using semi-structured interviews to underpin the case study examination of the implementation of several optimal forager crime prevention and reduction programmes, a number of key findings were established. This included confirmation of the methods successful at tackling domestic burglary. Overall, in respect of issues that impacted on the success of the implementation it was established that these were extensive and complex. They included the governance of the pilots, leadership of their implementation, partnership relations, tasking and coordinating, the frequency of product publication, their cost effectiveness, the presence of organised crime groups along with the Police silo culture and other cultural issues regarding the buy in of senior managers and practitioners. The chapter discussed the positive impact from close partnerships working, particularly in respect of delivering traditional problem-solving approaches when localised issues were identified by the forager predictions.

Conversely, there were many reasons behind sporadic evidence of ineffectiveness of the implementations. These were identified as a lack of knowledge and understanding of the theoretical framework of the pilots, which negatively impacted practitioner buy in. It was established that the lack of buy in created a breakdown of the theoretical framework in respect of routine activity theory and capable guardianship, namely in the areas of the management of place, guardianship of that place and the handling of offenders. It was outlined that potential causes for this breakdown included poor leadership styles, a lack of communication and poor intelligence levels underpinning suspect identification. Finally, it was also identified that the methodology was ineffective as a tool to tackle serial offences caused by organised travelling criminals.

Chapter 6
A Case Linkage Examination of the Behavioural and Physical Characteristics of Foraging Offenders

6.1 Introduction

Currently, prediction that a foraging criminal is operating within a policing area is identified solely on the basis that near repeat victimisation is present. Furthermore, the accuracy of predictions is identified by examining the proportion of all recorded burglary offences that were committed in the predicted forager high risk areas. This is an overly simplistic and unscientific approach to identifying the presence of a foraging burglary offender and lacks any identifiable evidence base. The literature in respectal forager (Bowers and Johnson, 2004) suggests they are serial offenders. In the absence of forensic, visual or witness evidence, the most effective way of identifying the presence of serial offending is through an accurate crime linkage process (Rossmo, 2000 and Bennell and 2005). Once serial foraging offending can be confirmed it is then possible to more accurately and effectively target the responses. To further the knowledge in this area this chapter examines the offending behavioural and physical characteristics displayed by serial foraging burglars to identify which provide the greatest accuracy in terms of crime linking with logistic regressions and receiver operating characteristic techniques used. Conclusions are then drawn in respect of predictive indicators for foraging burglary offenders.

6.2   Crime Linkage Literature Review

The limited research conducted to date on this area has solely analysed crimes that are already linked by the fact that an offender has been convicted. Traditionally the most beneficial method for linking crimes prior to conviction is linkage through forensic evidence such as DNA, fingerprints or footwear impressions and when available even CCTV evidence. However, the presence of such evidence is unfortunately rarer than one may think as criminals go to great lengths to prevent depositing any evidence which would lead to their apprehension. As Bennell and Jones astutely outline:

"Without such physical evidence, linking crime scenes may hinge solely upon behavioural information revealed through examination of crime scene characteristics and offence locations" (Bennell and Jones, 2005: 23)

In practical application what this actually means is that to link two crimes or identify a crime series an individual must examine them in detail and identify factors which contribute to the conclusion that they are linked. However, this is fraught with danger if it is done without the backing of any empirical analysis as it could lead to both false positives and missed opportunities. If this occurred in an operational environment this would mean the subsequent geographical profile or prediction produced and the tasking and co-ordination of Policing resources from that information would be unlikely to be effective. In the very worst-case scenario if too much weight was placed upon the linking of two crimes, without prior sound analysis it could potentially lead to the conviction of individuals for a crime they may not have committed. As such the importance of this area cannot be underestimated.

Despite its importance little academic research has been conducted that aims to do this. Limited research has been done that examines the effectiveness of crime linkage through non-tangible information such as behavioural characteristics, target selection and offence location (Bond and Grant et al, 2008; Bennell and Jones, 2005; Santtilla and Korpela et al, 2004; Bennel and Canter, 2002) but this is refrained in its scope and has never been tested in an operational environment, similar to the issue with geographical profiling. However, what these recent studies have suggested is that contrary to what one might expect it is actually inter-crime distance, as opposed to the modus operandi (Bennell and Jones, 2005: 23) which is the most accurate linkage feature, particularly when researching serious acquisitive crime such as burglaries and stealing from motor vehicles (Bond and Grant et al, 2008; Bennell and Jones, 2005; Santtilla and Korpela et al, 2004; Bennel and Canter, 2002). Each of the studies which reached this conclusion was conducted utilising both receiver operating characteristic (ROC) analysis and regression analysis to identify each linking factors individual optimal accuracy thresholds. The technique of regression analysis is well established and is routinely used in many fields to analyse data

and produce a dichotomous outcome (Swets, Dawes and Monahan, 2000). This technique has been shown to be effective in the smaller aforementioned studies and the method is an exceptionally strong fit for the problem being asked in the context of crime linkage. By adopting this approach, the researcher is essentially turning the linkage of behavioural characteristics into a diagnostic task (Bennell and Canter, 2002: 24). The reason this is such an effective method to use is because in fundamental terms only a very basic question is being asked, are these two crimes linked or not? As Bennell and Canter outline in their study in 2002 this question really only has a limited number of options, firstly we can predict either that they are, or they are not linked and secondly the reality of the fact i.e. whether they are confirmed as linked or are confirmed as unlinked. This scenario creates four possible outcomes with two that would be correct and two that would be incorrect. As Swets (1998) identifies, this would be the scenario for any other yes-no form of diagnostic task which is why the method is so well suited for crime linkage analysis.

6.3   Aims and Objectives

The aim of this chapter is to first briefly review the level of actionable intelligence available to practitioners to underpin traditional policing tactics to combat domestic burglary. The purpose of this is to set the landscape in terms of current linkage information available to practitioners and thus illustrating the necessity for more innovative approaches. The chapter then aims to begin the exploration of fringing burglary offender physical and behavioural characteristics. This objective is achieved by completing the crime linkage analysis of optimal foraging offenders by examining pairs of linked crimes (n=200) that fall within predicted domestic burglary high risk areas.

6.4   Method

The data used in this chapter is the same data used within chapter 4 which consisted of 2916 recorded crime records. This data was chosen by identifying pre, and post intervention dates, and location parameters dictated by the selected 50 optimal forager tasking products produced within Lancashire Constabulary. From within the 2916 crimes, 200 linked pairs (committed by the same offender) were then identified. The quantitative data, in the form of 400

crimes, is then subjected to new analysis methods within this chapter using logistic regression and receiver operator characteristics and to a lesser degree, some descriptive analysis.

Logistic Regression Analysis

Previous chapters within this study have identified the various stages of the investigation process involved in fulfilling the crime fighting function of Policing. By doing this it was identified that traditional Policing responses to crime rarely use techniques to prevent or reduce crime that are not part of their traditional approach. Crime linkage is one of the identified areas that are underutilised, an issue that this study will seek to address. As such this section will explain how regression and ROC analysis will be used to achieve the aims and objectives of this chapter.

Because of the simplicity of the main question being asked in this chapter, 'are two crimes linked or not?' and the potential multiple outcomes, crime linkage lends itself well to forms of analysis that can analyze several variables. Regression analysis has proven itself to be a valuable tool in analyzing variable data which this chapter seeks to do (Chatterjee and Price, 1991:1 and Peng, Lee and Ingersoll, 2002). This is because it offers an easy and simple method for analyzing the relationships between variables (Peng and Lee, 2002). As such, this method will be used to assist in the identification of the probability of an outcome between several variable factors. The prediction of the final dichotomous outcome being sought i.e. are these two crimes linked, is largely reliant on variables which can change dependent on the scenario (Chatterjee and Price, 1991:1, Peng, Lee and Ingersoll, 2002). Scenarios where the relationship between the dependent variable and a number of independent variables are examined are referred to as multiple regression analysis (Chatterjee and Price, 1991) and this is the depth of regression analysis that this chapter will utilise. As it pertains to this study the dependent variable or dichotomous outcome that is to be identified is simply whether or not two crimes are linked. The independent variables that will be utilised to assist in identifying the positive likelihood of this factor will be the characteristics of the crime scenes. These characteristics will be both behavioural and physical and are outlined in

detail within table 6. By adopting this technique within the study and by retrospectively examining these factors, you are able to identify the probable likelihood that two or more crimes are linked.

It is important to point out that the analysis in this part of the study will have to be retrospective. This is essential as it is the only way to ensure with a high level of certainty that two or more crimes were linked and works on the theory that historical probability forms the basis of the future likelihood that unsolved crimes are linked and can subsequently be profiled. This stance is extremely common amongst the social sciences as the data is almost always based upon variables which are used to predict future probabilities. The only way to do this with any accuracy is to examine the previous relationship between the variables in question, but of course the very nature of variables being fluid and quite simply, varying, means it can never be 100% accurate.

Logistic regression analysis centers around the concept of the logit which is an odds ratio which in its most basic form is derived from a 2 x 2 contingency table which would pit predicted outcomes versus actual outcomes (Peng, Lee and Ingersoll, 2002:3). In the scenario of linking two crimes together this would be (the prediction that the crime is linked or unlinked) (x) (the reality that it is linked or unlinked). Combining these two statements, as outlined by Bennell and Canter, provides four possible options with two being positive and two being negative (2002). Bennell and Canter outline that these positive and negative results are referred to as hits, correct rejections, false alarms and misses (2002). Firstly, the hit would indicate that two crimes have successfully been identified as being linked. The false alarm indicates that a hit has occurred when in fact it has not. A correct rejection simply means that the crimes being examined have been identified as being unlinked and finally the miss means that two crimes have incorrectly been identified as being unlinked when in fact they are.

By studying both the behavioural and physical characteristics of a crime as previously outlined the study will seek to identify what is statistically the most likely conclusion i.e. a hit and a correct rejection. Logistic regression analysis is well suited for this task as it will provide an odds ratio that the user will be able

to base their decision making upon. Having established a level of predictive accuracy for each behavioral and physical characteristic this information can then be used to underpin receiver operator characteristic analysis to assign each characteristic a level of predictive accuracy. When combined together or viewed in silo this information can then provide the decision maker with information to justify the linking or not of crimes. By completing this in the context of foraging serial burglary offenders we can establish what are the most accurate indicators of linkage to underpin future policing tactical and methodological responses.

Receiver Operator Characteristics (ROC) Analysis

Receiver operator characteristics is used to identify information thresholds that can aid in diagnostic decision making (Swets et al, 2000). It is in this context that the technique will be used within this study. Several studies have been done to date using this technique to build on the aforementioned regression analysis to predict crime linkage and calibrate the validity of crime linking features, and most importantly identify and produce decision making thresholds (Benell and Canter, 2002 and Bennell and Jones, 2005). The knowledge provided in this chapter will continue to build upon these studies by testing them in a new context, namely that of foraging burglary offenders.

Bennell and Canter (2002) outlined that a decision-making threshold is important in the absence of any categorical linking criteria such as forensic evidence. This is because it provides a 'cut off point' whereby any reading above that figure can imply a positive decision which in this study would mean that two crimes are linked (Swets, 1992). The threshold analysis is also important because although regression analysis may be able to provide us with some surety regarding the linkage likelihood of two crimes, what it can't do is put this result into context. ROC analysis can provide this context by offering an easy to understand result between 0 – 1, with 1 being 100% accurate which then allows the decision maker to apply their own level of risk (Bennell and Jones, 2005).

The next step is to then plot the identified linkage scores onto the ROC graph which is essentially made up of an x and y axis with pH situated on the y axis and pFA on the x axis (Bennell and Jones, 2005:27). After the plotting of this

data is complete it will usually provide a curved line which is known as the ROC curve and runs from left to right diagonally. The start of the curve which is situated in the bottom left hand corner indicates a strict decision-making threshold and finishes in the top right-hand corner, where a lenient threshold lies (Bennell and Jones, 2005:27 and Swets, 1998). The area underneath the ROC curve is known as the 'area under the curve' (AUC) and this is the important area that provides the decision-making threshold.

The use of ROC analysis is beneficial for identifying a decision-making threshold and in particular for this study because it provides the AUC. The AUC is independent in the sense that it evidences the entirety of the ROC curve as opposed to a single point or figure plotted on a graph or in a table. It also offers a method for examining both hit and false alarm rates with various thresholds, for example changes to inter crime distance from 1km to 2km and in doing so provides an overall measurement of predictive accuracy that is not strictly based around set thresholds (Bennell and Canter, 2002:155).

Analysis

In line with the analysis within chapter 4 the data for this element of the study was all sourced from within a set time period, namely July 2014 to July 2016. Within Lancashire, optimal forager burglary tasking and co-ordination briefing reports are produced on a fortnightly basis. These reports are cascaded to frontline supervisors who then use the information to deploy resources at their disposal to provide capable guardianship as a burglary prevention and reduction tactic. As the optimal forager briefings are conducted in a two week cycle this time frame was used to draw data to enable an effectiveness assessment. In total 312 briefing products were produced within the date parameters.

To complete the analysis, the recorded burglary dwellings within the predicted high-risk forager areas identified in the 314 briefing products were analysed in further detail to identify 200 linked pairs of burglary crimes. For a pair to be defined as linked the offender must have been convicted. By adopting this strict criteria, this study was able to make conclusions on data that has already surpassed a high burden of proof. The linked crimes were then examined, and

key behavioural and physical characteristics extracted to be analysed using the B-Link and SPSS statistics programs.

Historically law enforcers have identified the 'MO' or Modus Operandi, which simply means a method or particular way of doing something, as the main source of information to identify characteristics of a crime scene in an effort to make a decision as to whether a crime is linked or not (Bennell and Jones, 2005). As chapter two has outlined, the reason for this is because people draw on their own experience and knowledge to reach this conclusion, over time creating cognitive maps that are not based on critical and analytical thought processes (Albar and Jetter, 2009). It is in many ways a subjective decision as to what is defined as a behavioural or physical characteristic but the very limited studies which have tried to answer this question have outlined that these are broadly defined as entry behaviour, property stolen, target selection in including time of the offence, inter crime distance (Bennell and Jones, 2005; Bennell and Canter, 2002 and Tankin, Grant and Bond, 2008) with the latter two being the most accurate. This is in contradiction to the other more traditional MO characteristics. As these areas have been previously identified through a proven, although limited pool of studies these headings were used to collate the behavioural and physical characteristics of the linked burglary crime scenes. In addition to these categories a further category of offender behaviour was added to further knowledge in this area as this has never previously been examined in this context.

When broken down into individual behavioural and physical characteristics the analysis factors are outlined below. In the main these characteristics were all present within the recorded crime information and during the crime input process are selected as the reporting officer completes the recording process. As such there was little to no requirement for further coding as this was dictated by the recording process itself. There was additional information provided by the officers in a free text area, but this was not analysed within this study.

Variable Examined	Criteria of the Variable
Entry Behaviour	Entered via the Front, Side or Rear
	Entered via Insecure Window, Patio Doors, Door
	Forced Entry via Window, Door
	Entered by climbing
	Smashed a Window, Door
	Used Tools, Lock snapping
	Distraction
	Entered via Garage, Entered via Attic,
	Removed Beading or Window Entered via a cat flap
Offender Behaviour	Conduct a Tidy Search
	Conduct an Untidy Search
	Committed Criminal Damage
	Used a Motor Vehicle
	Wore Gloves, Used Violence or Weapons
	Multiple Offenders
Property Selection	Cash, Jewellery, Precious Metals, Electronics, Motor
	Vehicles or Keys, Identification and Copper
Target Selection	Occupied Caravans
	Bungalow, Apartment or Flat
	End Terrace, Mid Terrace
	Semi-Detached, Detached
	Rural, Suburban
	Overlooked, Secluded
	Old (Pre-1940)
	New Build (Less Than 10 Years) Contemporary (1940-2006)
	Monday – Sunday
	24HRS (4-hour Intervals)
Inter crime distance	0-6KMs (250m Intervals)

Table 8. Physical and Behavioural linkage Indicators

To conduct the analysis process, close guidance was sought by the leading academic in this field, Dr Craig Bennell. Under Dr Bennell's tuition each set of linked crimes were recorded in a binary format where 1-1 refers to the first crime committed by offender 1 and 1-2 refers to the second, for example; 1-1, 1-2, 2-1, 2-2, 3-1, 3-2, 4-1, 4-2 and so on for each of the 200 identified crime pairs. Each pair of linked crimes then had the behavioural and physical characteristics present recorded against them as 0s and 1s, with 0 indicating absent and 1 indicating presence.

This data was then analysed using a bespoke crime linkage software programme called B-Link provided by Dr Bennell which has been used to conduct such crime linkage in other published studies. The B-LINK system completes the following

functions; (a) creates all possible crime pairs, (b) indicates whether the pairs that are constructed are linked (1) or not (0), and (c) calculates a variety of different across crime similarity scores for each crime pair based on the data that was coded for example; property stolen, in the input file. In total 79,800 possible permutations were analysed. On completion, the B-Link system then provides data based on a variety of statistical analysis that measure relationships between variables including simple matching, Jaccard's coefficient[1], Yule's Q[2], Pearson's phi[3] and Sorensen-dice[4] co-efficient.

To then assess how accurately you can discriminate between the linked and unlinked crime pairs provided in the B-Link output file, the data is analysed using the software SPSS. This analysis shows how good each behavioural and physical characteristic is at distinguishing between linked and unlinked crime pairs. To complete this process, the Jaccard's coefficient was selected as it was identified as the most useful tool for statistically assessing the similarity between binary attributes, in this case physical and behavioural characteristic of linked dwelling burglary offences committed by serial foraging offenders. Then, just with this data, logistic regression was completed within SPSS providing an output of that analysis informing how useful each indicator is as a linking variable. To conclude the analysis, the logistic regression data was then re-analysed again using SPSS to conduct the receiver operator characteristic analysis resulting in production of charts displaying the AUC and accompanying confidence data for each behavioural and physical category.

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[1] Jaccard's co-efficient is a measurement of asymmetric information on binary and non-binary variables.
[2] Yule's Q also produces a relational assessment but utilises a -1 to 1 scale to indicate the strength of a relationship between dichotomous variables.
[3] Pearson's phi is a measure of association between two binary variables produced from 2x2 contingency tables.
[4] Sorensen-dice equals twice the number of elements common to both sets divided by the sum of the number of elements in each set.

Descriptive Analysis

A further aim of this chapter is to identify the levels of intelligence and information that currently exists within police systems to aid them in their tasking and co-ordination processes to combat crime. This data is person specific and is entered onto the SELUTH intelligence system for other police employees to review and analyse. It is often used to identify suspects in crime and to underpin the selection of 'subject profiles' for increased disruption and offender management interventions. To understand the current state of the intelligence foundations upon which the police response to crime, particularly acquisitive crime is built, some simple quantitative data extraction was completed. Using the Lancashire Constabulary SELUTH intelligence system free word searches were conducted on the following key terms; burglary, burgs, BIAD, BOTIAD, SFMV, theft, TFMV and auto crime with 5-year intervals of 2000, 2005, 2010 and 2015. The data is then subjected to descriptive analysis to underpin generalisations and conclusions.

6.5   Results

Intelligence Levels

Examination of intelligence records regarding acquisitive crime which includes domestic burglary is out lined in table 9 below.

Keyword	2005	2010	2015
Burglary	3591	2633	1076
Burgs	2065	732	401
BIAD	5098	3487	1589
BOTIAD	4801	2877	1265
SFMV	5336	3209	1703
Theft	8098	5355	2094
TFMV	1307	770	105
Auto crime	1663	1059	543
Total	**31959**	**20122**	**8776**

Table 9. Intelligence Keywords 2005, 2010, 2015

Entry Behaviour

As outlined in the previous section, entry behaviour was categorised as accessing the property via the front, side, rear and the method of entry behaviours which including insecure windows, patio doors, insecure doors or whether they forced a door or window, whether the offender entered by climbing, smashed a window, smashed a door, used tools, lock snapping, distraction, via garage, via attic, removed beading or window or finally via a cat flap.

Table 10. Entry Behaviour Logistic Regression Analysis Result

Linkage Predictor	Logit (SE[a])	Wald's (df[b])	R^2
Entry Behaviours	2.30(0.20)	126.02(1***)	0.38

. SE[a] = Standard Error; df[b] = Degrees of Freedom; *p <0.05; **p <0.01; ***p <0.001.

As can be seen from table 12, the Wald's statistic indicates a high degree of predictive accuracy in respect of the regression analysis. Furthermore, the R^2 indicates a satisfactory fit with the analysed data. When the ROC curve analysis is completed a strong AUC of 0.66 is achieved. This can be seen in figure 9 overleaf, which indicates a moderately strong predictive accuracy. However, the confidence interval displayed a wide range between of between 0.61-0.70. In an operational setting this could be interpreted as saying that 66% of the time crimes with the same entry behaviours are likely to be linked, however, the moderate confidence rating suggests that the decision maker should take caution in using this prediction to support their lines of enquiry and may wish to seek further supportive indicators.

Table 11. Entry Behaviour Area Under the Curve.

Linkage Predictor	AUC[a]	SE[b]	95% Confidence Interval	
			Lower Bound	Upper Bound
Entry Behaviour	.66***	0.02	.61	.70

AUC = Area under the curve; SE[b] = Standard Error; *p < 0.05; **p < 0.01; ***p < 0.001.
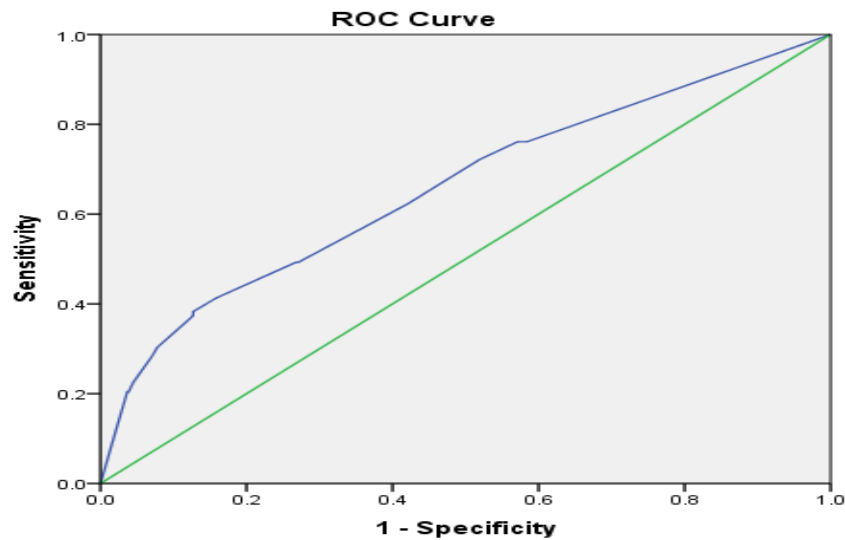
Figure 9. Entry Behaviour ROC Curve.

Inter Crime Distance

Inter crime distance was identified as 250-metre intervals between zero to 6 kilometres. Again, the regression analysis as displayed by the Wald's statistic indicated a high degree of predictive accuracy and the R^2 indicated a satisfactory fit with the data and a high logit was also produced.

Table 12. Inter Crime Distance Logistic Regression Analysis Result

Linkage Predictor	Logit (SEᵃ)	Wald's (dfᵇ)	R²
Inter Crime Distance	4.16(0.25)	265.19(1***)	0.21

. SEᵃ ⁼ Standard Error; dfᵇ = Degrees of Freedom; *p <0.05; **p <0.01; ***p <0.001.

The ROC analysis produced a very high decision-making threshold of 0.89 with a low standard error. It was also supported by a very low range in respect of the confidence intervals, between 0.87-0.91. Figure 10 overleaf shows the area under the curve which was identified as .89. In an operational setting this could essentially be interpreted as saying that 89% of the time such crimes are linked, and furthermore, that the decision maker can have a high confidence level in using this prediction for including such crimes in subsequent geographic profiling, establishing lines of enquiry or tasking and co-ordination.

Table 13. Inter Crime Distance Area Under the Curve.

Linkage Predictor	AUC[a]	SE[b]	95% Confidence Interval	
			Lower Bound	Upper Bound
Inter Crime Distance Overall	.89***	0.01	.87	.91

AUC = Area under the curve; SE[b] = Standard Error; *p < 0.05; **p < 0.01; ***p < 0.001.
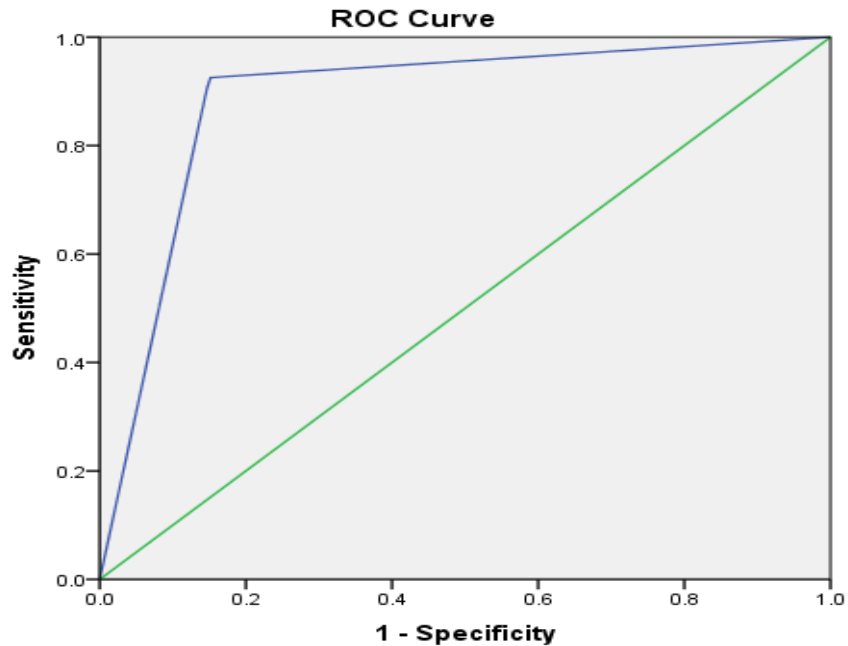
Figure 10. Inter Crime Distance ROC Curve

Offender Behaviour

Offender behaviour has been categorised as conduct of a tidy search, untidy search, committing criminal damage, using implements at the scene, multiple offenders, using a motor vehicle during the commission of the offence, wearing of gloves and using violence or weapons. Offender behaviour displayed a strong fit with the data but there was a lower level of predictive accuracy than inter-crime distance and entry behaviour.

Table 14. Offender Behaviour Logistic Regression Analysis.

Linkage Predictor	Logit (SE[a])	Wald's (df[b])	R^2
Offender Behaviour	0.73(0.14)	26.15(1***)	0.019

SE[a] = Standard Error; df[b] = Degrees of Freedom; *p <0.05; **p <0.01; ***p <0.001.

In line with the lower levels identified through the regression analysis the ROC analysis resulted in a moderate decision-making threshold, a higher standard error and an increased range in respect of the confidence intervals. Figure 11 below shows the area under the curve which was identified as .58. In an operational setting this can be interpreted as saying that 58% of the time crimes displaying the same entry behaviours could be linked, however, low to moderate confidence rating suggests that the decision maker should take caution in using this prediction to support their inclusion in subsequent geographic profiling, lines of enquiry or tasking and co-ordination.

Table 15. Offender Behaviour Area Under the Curve.

Linkage Predictor	AUC[a]	SE[b]	95% Confidence Interval	
			Lower Bound	Upper Bound
Offender Behaviour	.58***	0.02	.54	.62

AUC = Area under the curve; SE[b] = Standard Error; *p < 0.05; **p < 0.01; ***p < 0.001.
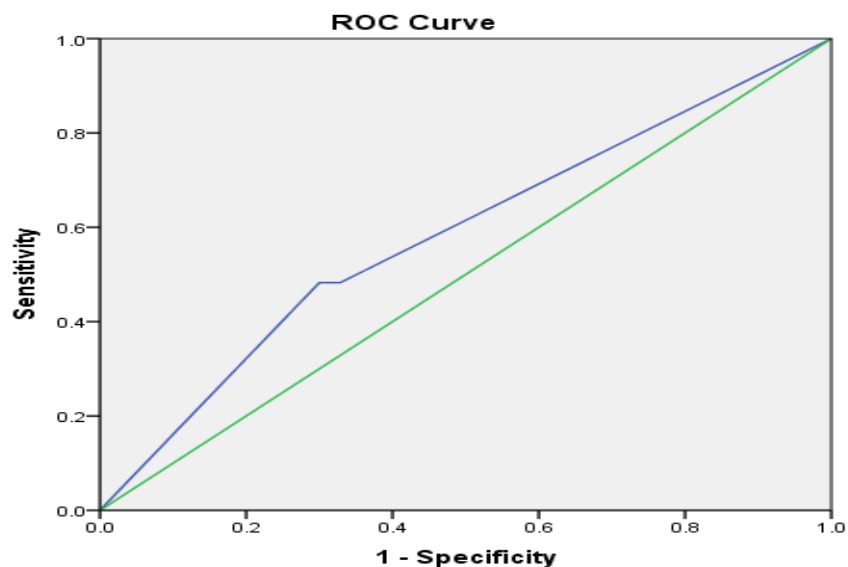
Figure 11. Offender Behaviour ROC Curve.

Property Selection

Property selection was split into the categories of cash, jewellery, precious metals, electronics, motor vehicles or keys, identification and copper. Although the data was satisfactory, similarly to offender behaviour, a lower logit was produced and with a low predictive accuracy as identified by the Wald's statistic.

Table 16. Property Selection Regression Analysis.

Linkage Predictor	Logit (SE[a])	Wald's (df[b])	R^2
Property Selection	0.87 (0.18)	24.28(1***)	0.08

SE[a] = Standard Error; df[b] = Degrees of Freedom; *p <0.05; **p <0.01; ***p <0.001.

As experienced in relation to offender behaviour, the ROC analysis for property selection also produced a moderate decision-making threshold, slightly higher standard error and again, a wider range in confidence intervals of between 0.54 - 0.63. Figure 12 below shows the area under the curve which was identified as .59. In reality this means that similarly to offender behaviour, approximately 59% of the time crimes in which the same property was stolen could be linked, however, there are again low to moderate confidence ratings, so the decision maker should take caution in using this prediction to support their inclusion in subsequent geographic profiling, lines of enquiry or tasking and co-ordination.

Table 17. Property Selection area Under the Curve.

Linkage Predictor	AUC[a]	SE[b]	95% Confidence Interval	
			Lower Bound	Upper Bound
Property Selection	.59***	0.02	.54	.63

AUC = Area under the curve; SE[b] = Standard Error; *p < 0.05; **p < 0.01; ***p < 0.001.
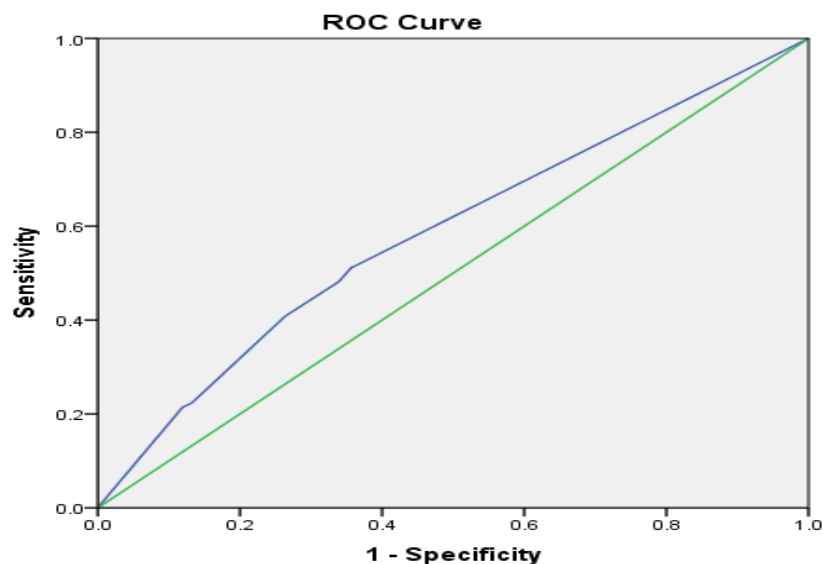
Figure 12. Property Selection ROC Curve

Target Selection

The categories of target selection were identified as occupied caravan, bungalow, apartment, end terrace, mid terrace, semi-detached, detached, rural, suburban, overlooked, secluded, old (pre-1940) new build (less than 10 years), contemporary (1940-2006), along with time of the day split into four-hour intervals and finally, the day of the week. In line with all other behavioural and physical characteristics analysed; the regression analysis provided a good fit with the data analysed. It also provided the highest level of predictive accuracy and the largest logit.

Table 18. Target Selection Logistic Regression

Linkage Predictor	Logit (SE[a])	Wald's (df[b])	R^2
Target Selection	4.36(0.27)	265.5(1***)	0.77

AnalysisSE[a] = Standard Error; df[b] = Degrees of Freedom; *p <0.05; **p <0.01; ***p <0.001.

The ROC analysis of target selection behaviours also produced a high decision-making threshold with an AUC of 0.76, with a standard error of 0.02 and a high confidence level and moderate interval range of 0.07. Figure 13 overleaf shows the area under the curve which was identified as .76. For operational decision makers this indicates that 76% of the time attacked properties that share the same characteristics are likely to be linked and committed by the same offender, furthermore, that they can have a strong degree of confidence in this prediction and their inclusion in subsequent geographic profiling, lines of enquiry or tasking and co-ordination.

Table 19. Target Selection Area Under the Curve.

Linkage Predictor	AUC[a]	SE[b]	95% Confidence Interval	
			Lower Bound	Upper Bound
Target Selection	.76***	0.02	.72	.79

AUC = Area under the curve; SE[b] = Standard Error; *p < 0.05; **p < 0.01; ***p < 0.001.
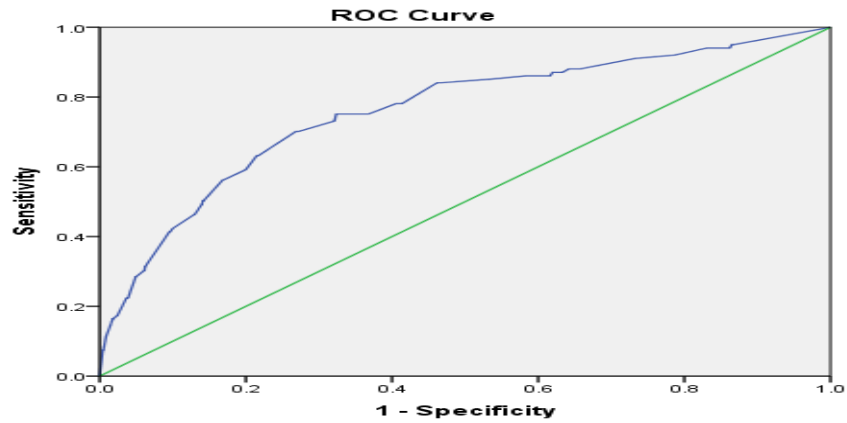
Figure 13. Target Selection ROC Curve

Behavioural and Physical Characteristics Comparison

In this section, we compare each of the characteristics to ascertain which provides the greatest indication of serial foraging burglary offences being linked. In relation to the logistic regression analysis Table 22. below shows that all of the examined behavioural and physical characteristics examined were found to have a high degree of predictive accuracy (as measured by Wald's statistic) and a satisfactory fit with the data (as measured by R2). However, it was target selection that produced the highest logit and predictive accuracy, closely followed by that of inter crime distance.

Table 20. Behavioural and Physical Characteristics Logistic Regression Analysis Comparison.

Linkage Predictor	Logit (SE[a])	Wald's (df[b])	R^2
Target Selection	4.36(0.27)	265.5(1***)	0.77
Inter Crime Distance	4.16(0.25)	265.19(1***)	0.21
Entry Behaviours	2.30(0.20)	126.02(1***)	0.38
Property Selection	0.87 (0.18)	24.28(1***)	0.08
Offender Behaviour	0.73(0.14)	26.15(1***)	0.019

SE[a] = Standard Error; df[b] = Degrees of Freedom; *p <0.05; **p <0.01; ***p <0.001.

When a comparison is made of the ROC curves produced it was inter crime distance that provided the largest AUC and as such, strongest decision-making threshold. For operational decision makers table 21 provides them with new knowledge that can aid them in linking their crimes prior to making geographical predictions such as the optimal forager taskings and geographic profiles. This

new information shows that geographical and structural characteristics are most likely to provide them with high accuracy predictions that they can rely on with confidence.

Table 21.   Behavioural and Physical Characteristics Area Under the Curve Comparison

Linkage Predictor	AUC[a]	SE[b]	95% Confidence Interval	
			Lower Bound	Upper Bound
Inter Crime Distance Overall	.89***	0.01	.87	.91
Target Selection	.76***	0.02	.72	.79
Entry Behaviour	.66***	0.02	.61	.70
Property Selection	.59***	0.02	.54	.63
Offender Behaviour	.58***	0.02	.54	.62

AUC = Area under the curve; SE[b] = Standard Error; *p < 0.05; **p < 0.01; ***p < 0.001.

*Combined Optimal*

In an effort to optimise the predictive accuracy and increase the decision-making threshold, the two optimal characteristics were combined. Target Selection produced the highest logit and predictive accuracy and Inter Crime Distance produced the greatest AUC and greatest decision-making threshold and as such were selected for combining in an effort to further increase value.

Table 22. Combined Optimal Logistic Regression Analysis Result

Linkage Predictor	Logit (SE[a])	Wald's (DF[b])	R[^2]
Optimal	5.82(0.25)	557.03(1***)	0.14

. SE[a] = Standard Error; df[b] = Degrees of Freedom; *p <0.05; **p <0.01; ***p <0.001.

The combined characteristics produced a satisfactory goodness of fit and an increased predictive accuracy, suggesting that crimes committed can be more accurately predicted as linked when the inter crime distance and target selection characteristics are considered together. However, when ROC analysis was also conducted although a reduced standard of error was also achieved than that of target selection alone, the confidence interval range although improved, was still

below that of inter crime distance alone. As was the strength of the AUC and as such the decision-making threshold. Figure 14 below shows the area under the curve which was identified as .84. For operational decision makers this indicates that combining these two characteristics does provide a high predictive accuracy of 84%. Furthermore, that they can have a strong degree of confidence in this prediction and their inclusion in subsequent geographic profiling, lines of enquiry or tasking and co-ordination. However, it is still a less accurate prediction than inter crime distance alone.

Table 23. Combined Optimal Area Under the Curve

Linkage Predictor	Roc Curve	SE[b]	95% Confidence Interval	
			Lower Bound	Upper Bound
Optimal	.84***	0.01	.81	.87

AUC = Area under the curve; SE[b] = Standard Error; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.
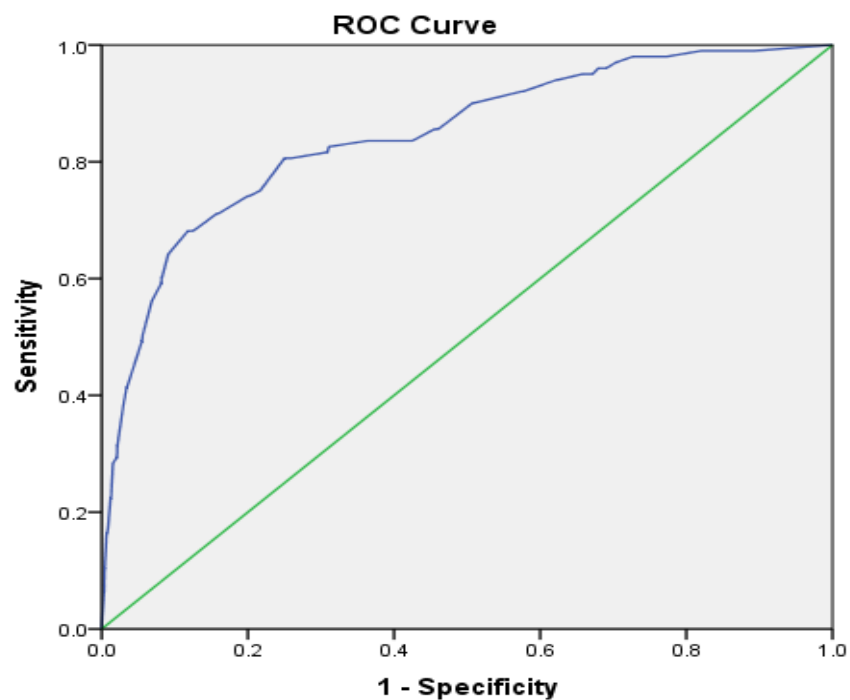
Figure 14. Combined Optimal ROC Curve

6.6   Discussion

The aim of this chapter was to firstly conduct an analysis of burglary crimes committed by foraging domestic burglary offenders and identify the linkage thresholds between a defined set of behavioural and physical criteria. Secondly, to ascertain levels of acquisitive crime intelligence available to the police to underpin the national intelligence model of tasking and co-ordination. The key findings of this chapter indicate that inter crime distance provides the highest linkage accuracy, followed by target selection, entry behaviour, property selection and finally, offender behaviour. Furthermore, it was established that crime intelligence has decreased continually since 2005. The conclusions and generalisations that can be drawn from these findings are discussed in more detail within this section.

Offender Behaviour

The behaviour of foraging burglary offenders has not previously been researched in isolation in respect of its ability to predict linkage between either foraging or traditional burglary offences. Previous studies have categorised these behaviours with that of entry behaviour to define what is commonly referred to as a modus operandi or MO (Bennell and Canter, 2002; Tonkin and Grant et al, 2008 and Davies and Tonkin et al, 2012). This study disconnects the physical entry characteristics from other behaviours displayed by the offenders and as such provides new insights. Only one other study has attempted to do this by examining the internal search behaviour of offenders (Tonkin and Santtila, 2011) in which discriminatory prediction accuracy was identified (AUC = 0.66). However, the results from this study suggest that out of all potential behavioural and physical characteristics researched that it provides the lowest level of discriminatory predication (AUC = 0.56). This is an interesting finding as other studies suggest that it is the characteristics the offender has greatest control over which provide the highest predictive linkage accuracy (Bennell and Canter, 2002). Naturally one would expect that the offender can control behaviours such as the way they search, number of offenders, use of a motor vehicle or wearing of gloves and using violence or weapons at the scene and as such a higher predictive accuracy would have been expected.

However, this result was not entirely unexpected as multiple other studies (Bennell and Canter, 2002; Tonkin and Grant et al, 2008 and Davies and Tonkin et al, 2012) have concluded that traditional MO characteristics, which the offender behaviours are drawn from, provide the lowest levels of prediction accuracy. One possible explanation for this result is that all but one of the offender behaviours in this study are reliant on being identified by either eye witness evidence i.e. multiple offenders and use of a motor vehicle or being identified through a thorough forensic examination of the scene i.e. the wearing of gloves to mask the presence of finger prints. As such it is not possible to generalise as to whether these characteristics are unreliable linkage factors solely displayed by foraging burglary offenders or all burglary offenders alike. Although this finding was in respect of foraging burglary offenders it has potential implications for non-predicted burglary linkage and also linking other forms of acquisitive crime and further research of this issue would identify whether or not this is unique to foraging burglars or not.

Property Selection

The type of stolen property that a foraging burglar aims for provided a relatively low level of discriminatory accuracy (AUC = 0.59). This is not a surprising result and is in line with other studies into randomly selected linked dwelling burglaries and commercial burglaries (Bennell and Jones, 2005; and Tonkin and Santtila, 2011) who predicted AUCs of 0.59 and 0.58 respectively. It is highly likely that as Bennell and Canter have previously argued (2002) that indicators that offenders have least control over provide the lowest accuracy in terms of linkage prediction. Property stolen is one of these indicators as ultimately what is stolen is controlled by the property available, which is highly likely to be incredibly similar between homes. Furthermore, they are often intrinsically linked together. For instance, cash, vehicle keys and identification are all property items that are frequently located together within a handbag, purse or wallet and as such, difficult to distinguish as a behavioural characteristic for prediction.

Entry Behaviour

As has been outlined earlier in this chapter, other studies (Bennell and Jones, 2005) have suggested that traditional entry MO characteristics are one of the lowest (AUC = 0.59) in terms of predicting linkage of dwelling burglaries. However, this study places it quite significantly above property selection (AUC = 0.59) and offender behaviour (AUC = 0.58) with an AUC of 0.66, this is a discriminatory decision-making threshold of 0.07-0.08 above these indicators respectively and greater than other similar studies on randomly selected linked dwelling burglaries. Previous studies have also suggested that using traditional entry MO indicators may create false positives for law enforcement and reduce their effectiveness at preventing and reducing crime (Bennell and Canter, 2002). In contrast, this study's finding make an important discovery that suggests that the form of burglary offending may have an impact on the linkage accuracy of behavioural and physical characteristics. In a policing and investigation context, this means that by applying greater scrutiny to identifying the form of offending i.e. foraging, random or organised criminality will better inform the linking process and increase predictive capability of behavioural and physical characteristics.

Target Selection

Previous studies (Bennell and Jones, 2005; and Tonkin, Santtila and Bull, 2011) examining randomly selected linked burglary dwellings have identified wide varying degrees of discriminatory prediction accuracy in respect of target, with AUCs of 0.58 and 0.73 respectively, however both were below the results identified within this study (AUC = 0.76). This further underpins the finding suggested in respect of entry behaviour, namely that case linkage accuracy is potentially offending behaviour specific i.e. forager, random or organised.

Inter Crime Distance

Inter crime distance was shown to be the most effective predictor of crime linkage of foraging dwelling burglary offenders and provided the greatest AUC and the strongest discriminatory decision-making threshold. This was in line with previous studies conducted in respect of randomly selected linked burglaries (Bennell and Canter, 2002 and Bennell and Jones, 2005). However, the link in respect of predicted foraging offenders was insignificantly slightly less (AUC =

0.89) with that that identified in previous studies (Bennell and Jones, 2005) of linked dwelling burglaries (AUC = 0.90). A strong insight that this result provides is confidence that foraging dwelling burglary offenders do not commit their burglary offences in geographical areas that overlay one-another. If they did then much lower scores of predictive accuracies would have been seen but this was not the case. This result is supported by the findings in chapter 4 which indicated that the predicted tasking and co-ordination of Police resources into forager high risk areas reduces and prevents dwelling burglaries. This chapter's results suggest that the increased capable guardianship forces foraging offenders to commit other offences or completely displaces them, forcing them to switch patch before restarting their burglary offending resulting in close inter crime distances between offences.

Behavioural and Physical Characteristics Comparisons

A continuous thread throughout this discussion section is the theoretical potential that the form of burglary offender identified has a potential impact on the predictive accuracy of linking characteristics. Potential forms of burglary offender can be identified as the forager, who moves between patches seeking to maximise the cost-benefit return of offences, as outlined by Bowers and Johnson (2004), the commuter, who travels extensively from outside of the attacked area, as identified by Rossmo (2000), the marauder, who moves uncoordinatedly and selects targets randomly, also identified by Rossmo (2000) and the organised burglary criminal who often operates within a group, committing very distinct forms of offending. It may of course be possible for an offender to possess characteristics of more than one type of offender, an organised foraging burglar. Table 9 overleaf shows the results from the very few studies that have examined the predictive potential of indicators of burglary offenders. From comparing these results, we can see that study 1 (Bennell and Canter, 2005) and Study 2 (Tonkin and Santtila, 2011) are distinctly different in terms of predictive accuracy with the exception of property selection. In contrast study 2 and study 3 (this study) display very similar levels of predictive accuracy with the exception of offender behaviour, which is explained as a result of different indicators within this category. This finding is significant because of the forms of offending studied, albeit in study 2, unintentionally. Study 1 by definition, analysed random

offending and study 2 which was conducted within Finland, it can be argued, unintentionally analysed the behaviour of foraging burglars which is evidenced by the description of offending behaviour by the researchers;

> *"The geographical area studied here was relatively large and…….*
> *offenders seek to minimize the efforts and risks involved in offending by*
> *returning to the same places that are familiar to them" (Tonkin and*
> *Senttila, 2011)*

Linkage Predictor	Study 1 Bennell and Canter, 2005	Study 2 Tonkin and Senttila, 2011	Study 3
Inter Crime Distance Overall	.90	.84	.89
Target Selection	.58	.73	.76
Entry Behaviour	.59	.66	.66
Property Selection	.59	.58	.59
Offender Behaviour	N/A	.66	.58

Table 24. AUC = cross comparison of the area under the curve

It was suggested in study 2 (Tonkin and Senttila, 2011) that the distinction between results between studies was explained by the cultural and structural differences of the property types between Finland and the United Kingdom. However, the striking similarities between this study which is entirely focused on foraging offenders, and the results of study 2, adds weight to the theory that the primary distinguishing feature is in-fact the type of burglar i.e. forager vs. random.

6.7   Conclusion

This chapter provided the first detailed study of linkage indicators of dwelling burglary offences believed to be committed by optimal foraging offenders. It has achieved this by first identifying the offences most likely to have been committed by a foraging offender by selecting them from areas of predicted forager related, burglary high risk areas. By conducting logistic regression and receiver operator characteristic analysis of the 200 identified linked crimes, a number of new findings were made, specifically in relation to linkage indicators of foraging

burglars. Firstly, it was identified that in line with other research of randomly identified dwelling burglaries, that the inter crime distance of offences committed by foraging criminals remained the highest predictor of crime linkage. Secondly, it was also established that the target selection behaviour of foraging burglars also provides a strong likelihood that crimes are linked. This is in contrast to previous randomised studies which found that it was only inter crime distance that provided a strong degree of predictive accuracy, with all other indicators being moderate. Furthermore, it was identified that the entry behaviour, the indicator that is traditionally referred to as the MO, of foraging burglars, in contrast to previous studies, does provide a strong indicator that offences are linked. In line with previous studies, the property selection of foraging burglars was the lowest linkage predictor.

These results indicate that foraging burglars display repeating behaviours that are based on geography, target selection and entry behaviour. In essence, they are creatures of habit that repeat behaviours that have previously been successful, in all likelihood to reduce the perceived risk, as other studies have suggested. The increased clarity in identifying the predictive indicators of foraging burglary offenders has wider implications for the profiling of burglary offenders as it suggests that the accumulation of the characteristics of these behaviours may produce distinct offending patterns that can be attributable to individuals, or groups of individuals. The practical implications of this for practitioners could include the recording and categorising of burglary offender types to underpin intelligence and investigative enquiries and aid in suspect identification and prioritisation. From a theoretical perspective, it is argued that these findings also show that foraging offenders display distinctive behaviour from other forms of burglary offenders which creates the potential to categorise offender types. This would theoretically increase the accuracy of crime linkage for each category of burglary offender and could maximise the potential of crime reduction strategies to combat distinct types of burglary offenders.

Chapter 7

Testing the Assumptions of Ecological Behaviour Within Foraging Burglary

7.1 Introduction

From examining predictive policing crime prevention and reduction strategies within the United Kingdom it was established that current methods focused on co-ordination of resources to provide capable guardianship of high risk crime areas, through a predictive approach using the optimal forager theory, a principle drawn from ecology. The previous chapters outlined how foraging burglars display inherently predictable geographic, target and entry behaviours. Progressing findings from these chapters, data from recorded crimes (n=2916) were again examined both pre, and post tasking and co-ordination, but now with the purpose of examining if foraging burglars display other characteristics that are present within foraging animals. Existing evidence-based characteristics of crime displacement, which is one of the earlier behavioural findings of foraging criminals, are discussed alongside assumptions identified from within the underpinning ecology foraging literature. The chapter discusses the presence or otherwise of these assumptions within the context of foraging domestic burglary offenders.

7.2 Literature Review

Earlier in this study it was established that a limited amount of research has identified that serial burglary offenders display the behavioural characteristics of foraging animals (Bowers and Johnson, 2004). As a result, a predictive methodology had been devised to predict the future areas at the highest risk of being targeted by foraging criminals. Examination of the ecology literature that this assumption was based upon identified that until recently, little consideration had been given to the impact of increased predation on foraging animals within ecology and none within a criminal behavioural context. Within ecology literature a number of responses by the forager to increased predation were identified and this section will outline these.

The principle of foraging is that the animal seeks to maximize efficiency by selecting patches that provide the biggest return in terms of energy expenditure vs. reward. However, one of the key assumptions that underpins this theory is that this cost – benefit analysis of energy used vs. reward gained is the only factor that has significant influence over the forager's behavior (Charnov 1976; Stephens and Krebs 1988). However, it has been highlighted that a flaw to this model is failing to consider the impact of predation risk (Sih, 1980, 1982, 1992 and Verdolin, 2005). It is further suggested that the evidence that foragers adapt their behavior significantly in response to predation factors is the reason why previous research has shown inconsistencies among their respective results (John, 1999). Ecology literature has outlined that the major behavioUral change made by a foraging animal is patch movement (Lima, 2002). This study postulates that this is the equivalent to what is referred to within criminology as spatial crime displacement but most significantly, but that it is not the only ecology based behavioral change conducted by the offenders.

Established Ecological Assumptions Present Within Criminology
Earlier in this study it has been outlined that there are direct links between foragers and criminals (Bowers and Johnson, 2004a and Johnson, 2015). The links established so far within existing literature highlight that both animals and criminals share some common goals and operate in pursuit of a resource, one being food the other criminal property (Johnson and Summers, 2015). Both operate similar foraging search behavior in pursuit of their resource (Bowers and Johnson, 2004a and Johnson and Summers, 2015). It was also further outlined that both criminal and animal foraging experience similar risks, whether that be being preyed upon as an animal or caught by the Police as a criminal. Also, Johnson outlines that both take into consideration their limitations in respect of what can be carried, how fast and for how long as each increases energy expenditure and may increase risk of being preyed upon or apprehended (2015).

Although the transfer of the optimal forager theory into criminology has identified significant positive correlations, its study has only been completed on a selective basis. It is a key argument of this thesis that failing to consider all aspects of foraging behavior means that any predictions drawn from it will fail to maximize

its potential impact on crime. It was established in chapter three that the major aspect of the transfer of the theory that has been completely overlooked is the impact of increased predation on the forager. It was earlier evidenced in this study that increased predation does not prevent or reduce foraging offending behavioUr. Such a conclusion supports the ecological assumption that it does not reduce or stop the animals foraging (Verdolin, 2005). However, these are only two ecological assumptions that occur as a result of increased predation and this section will outline in more detail other manifestations.

Theoretical Criminological Manifestations of Ecological Behavior

The ecology literature that underpins the optimal forager theory of predictive Policing firmly suggests that patch movement will occur as a result of increased predation (Lima, 2002). This assumption is only highlighted at this stage as it will be explored in much more detail in the next chapter. What is significant about the evidence in relation to the impact of increased predation on foraging animals is that it does not reduce or stop the animals foraging (Verdolin, 2005). However, it does have an impact on their behavioUr which has been shown to manifest itself in the forager altering their selected resource, reducing the handling time or switching the foraging patch (Engelhart and Muller-Schwarze 1995; Epple et al. 1993; Sullivan and Crump 1984). It is also suggested that although the forager may not cease its foraging it will increase its vigilance in response to increased predation levels (Kelly, 2001). This was a response that is most evident on the periphery of previously foraged areas now subject to increased predation which results in a higher 'giving up' rate by the forager before ultimately seeking a new foraging patch (Kelly, 2001). It is further suggested that in response to an increased risk of predation that the forager may also choose to begin searching in groups which provides additional security and early detection of predators (Berkley, 2000).

In respect of behavioural transfer between animals and criminals, drawing on the existing assumptions within ecology as outlined above this study hypothesises that several offending behaviours should exist and that these can be tested for using certain forms of statistical analysis. These are illustrated in table 25.

Ecological Assumption	Criminal Manifestation	Analysis
Alters the Selected Resource to Reduce Handling Time	Changes in Value of Stolen Property	Paired T- Test
	Changes in Size of Stolen Property	Chi-Square
	Reduction in Domestic Burglary and Increase in Other Theft and Non-Domestic Burglary (Substantive Offences Only)	Paired T-Test
Increased Giving Up Rate	Increased Attempted Burglaries	Paired T-Test
	Increased Criminal Damage Offences	
Increased Vigilance	Increased Offenders/Suspects Per Crime	Chi-Square

Table 25. Outline of Ecological Assumptions, There Criminological Manifestations and Analysis Method

Firstly, in respect of the ecological assumption that the forager will alter their selected resource or reduce its handling time it is theorized that the criminal may change the type of target or items that they seek to steal. It is argued that they will target property that has a lower handling time, which in a criminal context means items that are easier and faster to sell on to realize their value. In Policing this may be seen in a reduction in the size or value of stolen property. The literature examined as part of this study supports this assumption. Research identified that between 1981 to 2013/14, criminals have been consistent in the property selection of stolen items with money being the highest item, followed by vehicles and their component parts (Crime survey of England and Wales, 2015). Of the items stolen that would feasibly be resold by a thief, vehicle parts and accessories, cars, vans and bicycles, stereo and hi fi equipment, clothes, jewellery, tools, garden furniture and mobile phones, account for the most stolen items every year. Value is clearly a factor in determining which goods are stolen, but is not the only factor (Shaw et al, 2015). It has been identified that there are six main factors that influence why acquisitive criminals select the items of property they do when committing theft related offences, these include their ease of concealment, removal and accessibility, underpinned by its value, ease of disposability and to a lesser degree their own enjoyment (Clarke, 1999)

Research has shown that the value of goods is the strongest motivator for acquisitive criminals targeting items of property (Shaw et al, 2015). Second only to value is the resale potential of the items stolen (Shaw et al, 2015). This is best articulated by considering mobile phones who use the operating system IOS7 or newer which is significantly more secure than previous operating systems, as such, makes the resale potential of such phones considerably less (Shaw et al, 2015).

Item	% of Burglaries in a Dwelling
Cash	40.5
Jewellery and Watches	34.6
Computer Equipment and Laptops	28.2
Mobile Phones	17.5
Plastic Cards	13.7
Purse and Wallet	13
House Keys	9.1
Games Consoles	8.7
Camera	8.7

Table 26. Percentage of Items Stolen within Dwelling Burglaries: Crime Survey for England and Wales 2013/2014

Once stolen, the goods are most frequently sold through what are referred to as handlers or fences, through friends and associates or in exchange for drugs (Schneider, p134, 2005). All of the aforementioned information underpins the theory that certain assumptions regarding the targeting and realisation of criminal property exist, which as alluded to are that items of property stolen that are smaller in size or value have a reduced handling time as they are easier and quicker to sell on after they are stolen. This assumption underpins the theory that if it can be established that increased tasking and co-ordination to combat predicted burglary offences alters the size and value of property stolen that this may indicate the presence and behaviour of a foraging offender.

The hypothesized manifestation of increased vigilance through an increased giving up rate is that the criminal will become more aware of increased predation risks in the form of increased Police presence and the rate may increase. It is theorised that this may be seen in crime records as a reduction in the predicted crime, for instance burglary but an increase in attempted burglaries as their threshold for risk decreases to prevent apprehension. The giving up rate may

also be manifested by an increase in criminal damage offences which is often recorded instead of the substantive burglary offence (Hallam, 2009). Finally, it is argued that increased vigilance will be identifiable within criminal offender behaviour through the increased number of suspects per crime as a method to increase early detection of Police presence and reduce the chance of apprehension.

7.3   Aims and Objectives

The overall aim of this thesis is to explore the behaviour of foraging burglary offenders and predictive police interventions to prevent and reduce their offending. To achieve this aim, a deep understanding of the subject is required. This chapter seeks to add to this knowledge by examining if foraging burglars display other characteristics that are present within foraging animals. As a result, this examination of behavioural and physical offending characteristics of foraging criminals will increase understanding of their predictive indicators.

7.4   Method

To contribute to the overall aim of this thesis this chapter needs to ascertain if foraging burglars display the same characteristics as foraging animals. To test for these behaviours the data extracted from the Lancashire Constabulary crime recording system SLEUTH is again revisited. Previously identified recorded crimes (n=2916) are examined in further detail to test for new information to assess if the theoretical behavioural indicators outlined in table 25 are present. A detailed explanation of the methodology used within this chapter is repeating that within chapter 4. Broadly speaking, information from crimes committed before increased tasking and co-ordination is put in place, acts as the control sample. This data was then subjected to three forms of analysis as outlined in table 25. This section will now outline the rational for the analysis selection and the process conducted.

T-Test Analysis

A paired T-Test will be utilised to analyse the extracted quantitative recorded crime data to test a number of the theorised crime manifestations. The rationale and process for analysing the data within this chapter is outlined in detail within chapter 4 on page 118. Firstly, this included changes in the value of property stolen which was analysed by comparing the values stolen per crime both pre- and post-intervention. Secondly, changes are examined in respect of any reduction in domestic burglary combined with increases in other theft and non-domestic burglary, an increased in attempted burglaries and increased criminal damage. The purpose of this analysis is to test the null hypothesis that there is no significant effect caused in the aforementioned areas as a result of the optimal forager crime reduction and prevention strategy.

Unless otherwise specified, only substantive offences are analysed within this chapter. This is because by definition an attempt does not include the theft of property and, as such, no assessment of the forager altering a resource can be deduced. Attempts are subject to a specific test themselves as outlined in table 25.

Chi-Square Test of Independence

The methodology to assess whether the size of items or number of suspects has altered will be the use of a chi-square test of independence. The chi-square test of independence is the most suitable analysis in this circumstance because this section seeks to identify if the two categorical variables, pre, and post increased predation are either independent from, or associated with each other (Frank, Ho and Christie, 2012). It has been outlined that the test of independence is most appropriate when the information is collected from one data sample (Frank, Ho and Christie, 2012), which in this case is recorded crime, over a set period. This test is used to test the null hypothesis that there is no association between the size of individual items stolen per crime and the crime reduction and prevention strategy. Both the size of stolen property and number of suspects will be examined in the same pre, and post context as the paired T tests within this chapter and chapter 4.

Assessing changes in size is problematic due to there being no recording method for the size of items stolen. There is, however, a property classification field which provides keywords for a variety of items which are selected by the officers when inputting the crime report. This section of the study will use these keywords as outlined in table 27 and splits them into five size categories which are based on a professional judgement in regard to their size; *Very Small, Small, Medium, Large and Very Large.* These categories are then given a numerical coding between 1 (V small) and 5 (V Large) to enable size of each item from each crime to be empirically examined.

Size Classification	Property Keywords
V small	Alcohol, Books, Cheque, Document, Drugs, Food, Jewellery, Keys, Money, Telecom, Tobacco, Toiletries, Watch
Small	Audio, Bag, Clothing, Computer, Firearm, Fuel, Sat Nav, Mobile Phones, Toys, Number Plates
Medium	Animals, Car parts, Cycle, Electric, Garden, Metal, Sports Equipment, Tools, TVs, Videos, DVDs
Large	Motor car, Trailer
V Large	Building, Caravan

Table 27. Property Size Categorisation Table.

The numbers of suspects per crime both pre-and post the optimal forager intervention was ascertained by extracting the quantitative data from record crimes regarding the known or suspected number of offenders. This was completed by extracting data from the SLEUTH system from three areas of the crime data. Firstly, the officer's MO to look for any indication of the number of offenders; secondly by examining the suspects field which lists the details of people 'suspected' of the crime but not charged or convicted. Finally, for offences which are detected, the number of offenders charged is used as the indicator.

Chi-Square Goodness of Fit Test

To finally help understand if the overall amount of stolen property is affected a chi-square goodness of fit test is used. This test has been chosen because it has been identified that this is the most appropriate method when a sample is compared on a variable of interest, such as the total number of items stolen, against a population with known parameters, in this case how many items of each size category were stolen before and after intervention (Frank, Ho and Christie, 2012). In this scenario, the null hypothesis is that the data follow a specified distribution. The interpretation upon rejection is that the sample differs significantly which in this case would mean it differs because the post intervention level is lower or higher (Frank, Ho and Christie, 2012). The quantitative figures being examined were ascertained by identifying the total sum of all property stolen from the crimes committed before the optimal forager intervention (n=1302) and after (n=1622).

7.5 Results

Altering the Selected Resource to Reduce Handling Time

Within ecology it has been shown that an increased predation risk causes the prey to alter its selected resource or reduce its handling time. It is theorised that this change will manifest itself in a number of ways. This section will outline the results of tests to assess the presence or otherwise of evidence to support this theory.

Reduction in the Value of Items Stolen

The pre, increased police presence offending was analysed (n=1302). The value of stolen property was associated with M=263.76 (SD=822) value per item. By comparison, the post, police intervention offending (n=1622) was associated with a numerically lower value M=156.99 (SD=265) per item. The paired samples t-test was associated with a statistically significant effect, t (277) = 2.061 p <.05 (.040). This means that the post, police intervention offending is associated with significantly lower levels of property value stolen, per crime, identifying that the reduction on value of property stolen was statistically significant producing a significance score of .040 (p < .05).

Reduction in the Size of Items Stolen

A chi-square test of independence was performed to examine the relation between the size of individual items stolen per crime and the crime reduction and prevention strategy, namely increased predation risk through tasking and co-ordinating of police resources into predicted high risk areas. The relation between these variables is not significant (X^2 *(12) N=189, p > .05. (.156).* This result indicates that the size of items stolen remains the same both prior to and after the police presence in a predicted high-risk area is increased.

A chi-square goodness of fit test was then performed to examine the relation between the overall number of items stolen pre (n=1071), and post (n=175) the crime reduction and prevention strategy, namely increased predation risk through tasking and co-ordinating of police resources into predicted high risk areas. The result of this test identified that the variable associated with post increased predation did not follow a specified distribution. The difference in distribution was significant (X^2 *(2) N=2, p < .05. (.004).* This result is significant and indicates that the overall number of items stolen was significantly less after the increased police presence was placed into predicted high risk areas.

Decreased Levels of Domestic Burglary, Increased Levels of Commercial Burglary and Other Theft Related Offences

Pre, police intervention offending considered (n=166) in respect of substantive domestic burglary offences only which included theft within a dwelling, aggravated burglary within a dwelling and distraction burglary within a dwelling, was associated w ith M=41.5 (SD=57) number of offences per crime category. By comparison, the post, police intervention offending (n=97) was associated with a numerically lower number of offences M=24.2 (SD=32) per crime category. The paired samples t-test was not associated with a statistically significant effect, t (3) = 1.187 p >.05 (.320). This was a high increase however the paired sample t-test analysis showed that the increase in offending was not of statistical significance at .320 (p > .05).

To further the analysis within this section pre, police intervention was considered (n=338) in respect of substantive burglary other than domestic burglary, and theft

offences which included theft by employee, forgery, blackmail, theft from machine, dishonest use of electricity, fraud, making off without payment, theft of pedal cycle, other theft or unauthorised taking and shoplifting. This analysis was associated with M=31 (SD=43) number of offences per crime category prior to increased police presence By comparison, the post, intervention offending (n=432) was associated with a numerically higher number of offences M=39 (SD=53) per crime category. The paired samples t-test was associated with a statistically significant effect, t (10) = -2.655 p <.05 (.024). This means that there were significantly higher levels of substantive burglary other and theft offences after an increased police presence was put in place.

Increased Vigilance

Within ecology it has been identified that a result of increased predation is that foragers begin to alter their behaviour to display increased vigilance and reduce the likelihood of their mortality, which in this context is their apprehension by police. This section will outline the results of tests to assess the presence or otherwise of evidence to support this theory.

Increased Levels of Offenders

A chi-square test of independence was performed to examine the relation between the number of offenders per crime and the crime reduction and prevention strategy, namely increased predation risk through tasking and co-ordinating of police resources into predicted high risk areas. The relation between these variables is not significant (X^2 (2) N=4, p > .05. (.578). This result indicates that the number of offenders remains independent to the optimal forager intervention and is not affected by the increased police presence in a predicted high-risk area.

By-Proxy Indicators of 'Giving Up'

Pre, police intervention offending was considered (n=198) in respect of attempted only burglary offences and criminal damage offences which included criminal damage to dwellings, criminal damage other, criminal damage to other buildings, criminal damage to vehicles, attempted burglary in a dwelling and attempted burglary other than in a dwelling. These offences where associated

with M=33 (SD=25) number of offences per crime category. By comparison, the post, police intervention offending (n=350) was associated with a numerically higher number of offences M=58 (SD=46) per crime category. The paired samples t-test was not associated with a statistically significant effect, t (5) = -1.842 p <.05 (.124). This was almost an increase of double but despite this increase the paired sample t-test analysis showed that the increase in offending was not of statistical significance at .124 (p > .05).

Comparative Analysis

In this section, the results of the T-test analysis conducted is compared. Doing so illustrates which ecological indicators are present and to what significance.

Table 28. Pre, and Post Increased Predation and the Presence of Ecological Assumptions

Offence Type Behaviour	Ecological Assumption	Pre		Post		Sig.
		M	SD	M	SD	
Increased BOTIAD and Other Theft	Altering the selected resource	30.72	43	39.27	53	.024*
Property Value	Altering the selected resource	263.76	822	156.99	265	.040*
Increased Attempts and Criminal Damage	Increased vigilance	33	25	58.3	46	.124
Reduced BIAD	Altering the selected resource	41.5	57	24.25	32	.320

*p <0.05; **p <0.1; ***p <0.001.

7.6   Discussion

The purpose of this chapter was to explore if foraging criminals do display other behavioural characteristics observed within foraging animals. If the Police and criminal relationship does in fact operate in-line with the forager theory and it is to be viewed in a predator – prey context, then evidence of ecological behavioural changes should be present. Having identified a number of significant

effects on the crimes within the high-risk areas including a reduction in the overall amount and value of property stolen, and increases in other thefts and non-domestic burglaries, this section now discusses the findings.

Altering the Selected Resource to Reduce Handling Time

This chapter of the study examined several key areas that it is theorised would be manifested in the behaviour of foraging burglary offenders as a response to increased predation through tasking and co-ordination. The presence of these characteristics would add further support to existing literature (Bowers and Johnson, 2004a) that has outlined the link between burglary offenders and foraging animals. The ecological assumptions being tested were the altering of the selected resource and increased vigilance.

Firstly, it was theorised that the value of the items stolen would reduce as a response to increased predation and doing so would enable the offender to increase the likelihood of the realisation of the stolen property's criminal value. This study supported this theory as it was established that there was a significant difference in the individual value of the items stolen at each offence. Furthermore, the study theorised that the size of the items would reduce. This result was not of significance and as such it was established that the size of property stolen does not appear to be a behaviour that changes in response to increased predation risk. Examination of the overall level of property stolen was significantly reduced and it then follows suit that the overall value of items stolen after the predation risk is increased also reduced, and not just the individual value.

When considered in their totality, it can be concluded that foraging burglary offenders respond to an increased predation risk by altering their selected resources and stealing fewer items, that are of a lower value. These results are in contrast to previous research that identified value as one of the highest priorities for acquisitive criminals (Social Welfare, p7, 2013). Furthermore, it was anticipated that the size would reduce but this is not the case, providing new insight into the decision making of burglary offenders and their perspective on what increases apprehension risk or affects the potential resale of the resources

stolen. This finding is in contrast to; and builds on, a limited body of literature that has examined this area, suggesting that offenders do consciously consider whether property can be easily carried and concealed when selecting their resource (Hearnden and Magill, 2004). This study furthers this knowledge by evidencing the fact that crime reduction and prevention interventions directly impact on the number of items stolen. Examinations of burglary offender characteristics has focused almost entirely on target selection and method of entry. As such the quantitative impact upon the property selection choice of burglary offenders has never been examined in any detail and is completely absent in respect of predictive methodologies meaning that these findings are the first of their kind.

The fact that both the individual value of items stolen and the overall number of stolen articles both reduce establishes that the overall financial loss to victims of crime can be significantly reduced through an intervention based on increased capable guardianship in areas of high risk. This is a new finding as previous research that examines hotspot policing has only previously served to outline the interventions effectiveness in respect of overall offence reduction and prevention.

Furthermore, it is the first to go beyond the scope of rational choice theory by providing evidence to support the ecological decision-making foundations behind offender's property selections. In respect of ecology literature these findings can be considered to corroborate the lesser established ecological assumption that the forager will reduce its 'feeding rate' when increased predation risk occurs (Fraser and Gilliam, 1987). Most significantly, the results corroborate ecological assumptions outlined in this chapter by evidencing the extensive wider literature that has identified that foraging animals alter their selected resource as a response to increased predation to reduce the likelihood of apprehension (Werner and Hall 1974, Lima and Valone, 1986, Lima and Dill, 1990, Lima 1992, 1998a and 1998b and Lima and Bednekoff, 1999), but goes further by being the first study to examine this from a human dimension.

Decreased substantive BIAD but increased BOTIAD and other theft

As well as alterations to the property selection behaviour at their chosen crime type, this study theorises that the forager will also make adaptations to their target selection. It is theorised that this will take place to both avoid increased apprehension risk when conducting their chosen crime type but also to provide access to alternate forms of stolen property. It is argued that both behavioural changes afford increased or maintained ability to realise the value of the stolen property. A similar analysis was conducted in chapter 4 but the restricted criteria examined in this section is designed to analyse the access to resources and as such only substantive offences where property had successfully been stolen were considered. The results within this section support the theory with domestic burglary decreasing, although not significantly, and other thefts and non-domestic burglary increasing significantly. This result raises several interesting discussion points.

The first and possibly most significant is that the findings do corroborate the plethora of studies (Braga, Anthony A.; Papachristos, Andrew V.; Hureau, David M, 2012) into hotspot policing that already evidence the effectiveness of these methodologies as crime reduction and prevention strategies for specified crime types. However, this finding continues to support the results from chapter 4 which evidenced the fact that, as a by-product, the intervention actually increased the offending levels of in other crime types.

Secondly, traditional criminological theory suggests that functional crime displacement may occur, and again, was alluded to within this study in chapter 4. In that chapter, the examination of a much wider scope of theft related offences significantly proved the presence of this form of displacement. These findings continue to support this conclusion and provider further evidence still that the offender is altering their resource. These findings add further weight to existing research corroborating published literature within criminology that suggests reducing opportunities does not impact overall offender behaviour as they possess the ability to counter the prevention methods (Repetto, 1976), and other ecological literature (Lima, 1990) that identifies the same within foraging animals.

Traditional criminology would simply argue that this finding corroborates the long existing awareness of rational choice theory which is cited in this field (Clark and Weisburd, 1994 and Barr and Pease, 1990), and confirms the fact that the foraging offender has simply calculated risk and benefit and desisted or changed their criminal behaviour to reduce risk. As the review of literature outlined in this chapter, this argument also has basis within ecology where it is referred to as the marginal value theorem (Charnov, 1976). As a result, an incredibly provocative argument begins to take form around the key questions of how to differentiate between rational choice and the marginal value theorem, or at a fundamental level, whether there is even a necessity to do so, as both are effectively one and the same. As earlier chapters have alluded to this direct comparison between theories within ecology and criminology literature adds further weight to the argument that the causation of certain criminal offending behaviour may in fact be founded within ecology rather than criminology or psychology.

A final consideration in respect of this issue is that the identified reduction in the substantive burglary offences identified within this section may in fact also provide evidence of another in the form of increased vigilance. As this section will further explain, this is a well-established ecological assumption and it stands to reason that a foraging criminal whose vigilance is heightened may well reduce their offending of a certain crime type or behaviour to avoid apprehension.

Increased vigilance

Within ecology, increased vigilance is a by-product of increased predation risk within a foraging patch (Lima, 1988a). This study suggests that in the policing context examined in this research this this is the equivalent of increasing capable guardianship through increased tasking and co-ordinating of resources into a predicted high-risk burglary area. Within ecology the prey responds to increased risk in a number of ways. This section examines the behavioural characteristic whereby the forager displays a higher giving up rate which it is theorised will be manifested in recorded crimes through increased levels of by proxy indicators of 'giving up' and increased attempted offences. The results from examining attempted offences and criminal damage offences does lean towards supporting

this theory as these crime types did increase, but it was not significant. This finding offers very limited corroboration of the single qualitative study that could be identified regarding behavioural changes of burglary offenders in such circumstances (Hearnden and Magill, 2004). This study of interviews with burglary offenders outlined that a large majority of offenders do change their behaviour as a result of increased tasking and co-ordination of police resources and became increasingly *'cautious'* (Hearnden and Magill, 2004).

It is suggested that a further indicator of increased vigilance is that the foraging burglary offenders will begin to offend in groups. This is based in the ecological assumption the forager may choose to begin searching in groups which provides additional security and early detection of predators (Berkley, 2000). The results within this chapter failed to evidence this as it was established that the offender levels identified per crime were not affected by the optimal forager crime prevention intervention. Not only does this finding contradict the ecological assumption it was assessed against but also the criminological comparator. Boost theory suggests that criminals and crime gangs will share information about victims and a by-product of this is increased numbers of offenders targeting repeat burglary victims (Ferguson, 2014). Several explanations may underpin this finding including the possibility that foraging offenders may prefer to offend alone. It is also possible that the levels of offenders identified, which were primarily just 1 or 2 offenders per crime, is the optimal number to increase vigilance without also heightening the apprehension risk, which is also a consideration identified within studies of animal foraging behaviour (Bertram, 1978; Pulliam et al,1982; Dehn, 1990; McNamara and Houston, 1992).

A possible overarching explanation for the by-proxy, offender level findings, impact on property levels stolen and reduced substantive offences is again found within ecology literature. Brown (1999) has outlined that as the encounter rate with predators, which in this context is the police, increases giving up rate, vigilance level and patch movement are all further heightened. It is argued that the vigilance level is directly linked to the predator encounter rate, so the higher the frequency of contact, the greater the vigilance (Brown, 1999). The result of this is that as vigilance increases, available foraging time decreases and the time

remaining for harvesting (obtaining stolen property) is significantly reduced. In such a heightened state of vigilance this would mean that a foraging burglary offender would have less available foraging time to commit offences so reduced recorded crimes should be present. They would also have less time available to obtain stolen property, meaning fewer items would be stolen per crime, and higher levels of giving up rate would be seen, all factors which this chapter has identified. As such, it can be strongly argued that these findings indicate that the optimal forager crime prevention and reduction strategy has been effective because of the high degree of police encounter rates. Furthermore, these findings continue to add evidence to the argument that foraging burglary offenders display more forager characteristics then those relating solely to geographical target selection.

7.7   Conclusion

The aim of this chapter was to establish if behavioural characteristics identified within foraging animals existed within the behaviour of foraging criminals. The chapter specifically examined behaviours that occur as a result of increased predation which within a policing context was the increase of police resources into a high-risk burglary area. Three ecological assumptions were identified for examination which included the giving up rate, alteration of the selected resource and increased vigilance. It was suggested that these assumptions would manifest themselves in seven distinct patterns of criminal offending behaviour. The research conducted in this chapter did in large confirm the theory by firstly showing how it altered the selected resources supporting another ecological assumption that the forager reduces the feeding rate as a result of increased predation. The research, however, did not support the theory that the size of items stolen would also reduce.

The research also showed that foraging burglary offenders altered their target selection as the offences examined decreased and increased as predicted. A trend indicating the presence of giving up was also established, but this was non-significant, however, there was no increase in offenders per crime to increase vigilance and detection rate of predators, namely the police, and thus reduce the risk of apprehension. Finally, it was suggested that the findings that ecological

assumptions are present within foraging burglary offenders raises interesting questions regarding the psychological, criminological or ecological basis for offender decision making that need further attention.

Chapter 8
Examining the Geographical Behaviour of Foraging Offenders

8.1 Introduction

The previous chapters examined in detail the implementation of the optimal forager theory of predictive policing as a methodology to prevent and reduce burglary dwelling offences. The strategy was shown to be of limited success for a number of reasons the predominately related to implementation failures. Some were tangible implementation failures such as cultural blockers that may have impacted on the effectiveness of the approach, others it is argued are a direct result of theory failure. This is effectively failing to consider an evidence based tactical response based upon the ecology literature which underpins the evidence of foraging behaviour.

To enhance crime prevention strategies to combat domestic burglary subsequent chapters examined the behavioural and physical behaviour of foraging burglary offenders. This research provided new knowledge to identify and link offences committed by foraging burglary offenders. The study evolved to provide evidence that foraging burglars also display other characteristics evidenced within ecology literature and as a result we are beginning to see how the implementation of an optimal forager based predictive policing model within the United Kingdom was fundamentally limited in its potential for success. This is because it was doomed to experience "theory failure'' as it was unaware of these findings and as such failed to take them into account, along with the unintended consequences of the increased tasking and-ordination. As a result, it was not possible to maximise the effective of the increased capable guardianship provided by heightened police resources into areas identified as high-risk forager burglary zones. These chapters also began to underpin the argument that there are distinct 'types' of burglar and that each requires a specific tactical response, and finally, that a discussion is emerging between the basal foundation of burglary offender behaviour between ecology, psychology and criminology.

This chapter seeks to continue to examine the behaviour of foraging burglary offenders by considering their geographical behaviour. In doing so the chapter is able to assess the behaviour of foraging burglary offenders against the final and most significant ecological assumption that has been identified as a response to increased predation; patch movement.

8.2   Literature Review

Crime Displacement and Patch Movement

Previous research that has examined the impact of the capable guardian principle provided by police tasking and co-ordination of resources has done so in the context of classical approaches to criminology such as routine activity theory, rational choice, and deterrence theory**.** In doing so, it has been identified that six forms of crime displacement occur as a result of prevention and reduction initiatives that focus on these theories. These are identified as temporal, tactical, target, spatial and functional (Repetto, 1976) with further research building on this and suggesting a further form as perpetrator (Barr and Pease, 1990). To date no research has examined the issue of capable guardianship and its impact on crime prevention and reduction and the existence and form of displacement from an ecological perspective, or as a result of 'predictive' forms of hot spot targeting. Johnson has outlined that both foraging animals and criminals, for similar reasons operate within repeating spatial areas (2015). Ecology literature has outlined that the major behavioral change made by a foraging animal is patch movement (Lima, 2002). This study postulates that this is the equivalent to what is referred to within criminology as spatial crime displacement.

Crime displacement is a contentious issue within criminology with some arguing against its existence (Brantingham, 2014) and suggesting that the issue of crime displacement is a myth, is very rare and that criminals will behave in line with traditional assumptions born out of routine activity and rational choice theory. It was originally suggested that there are two inaccurate underlying assumptions behind the issue of crime displacement which were that the commission of a crime was a necessity for the offender, due to their circumstances, for instance a dependence on drugs (Repetto, 1976). Secondly, that by reducing

opportunities for offenders to commit crimes does not impact on their behaviour as they possess the ability to counter the prevention methods (Repetto, 1976). Others go on to suggest that the opposite of crime displacement, which is referred to as diffusion of benefit, is a positive by-product, which is essentially whereby other forms of offending also reduce as a result of the implemented reduction and prevention tactic (Clark and Weisburd, 1994), and outweigh any negative displacement. It has also been argued that displacement is not a forgone conclusion and that offenders will naturally consider whether or not the risk of offending is outweighed by the potential reward (Barr and Pease, 1990).

The arguments against crime displacement appear to be based on very limited literature which has been tested against only a small amount of crime types. For instance, one of the only studies cited as underpinning the argument against crime displacement does infact evidence that it can and does occur and on occasion at a 100% level (Eck, 1994). Other studies cited as evidence against the issue of crime displacement have also only been tested against violent crime and prostitution which are both heavily influenced by environmental factors such as the positioning of licensed premises for example (NCJRS) or have adopted a mathematical approach to explain ecological behaviours (Short and Brantingham et al, 2009). Existing literature suggests that there are six forms of crime displacement (Barr and Pease, 1990 and Repetto, 1976). It is also suggested that not all types of displacement are the same, one potential form is that of benign displacement whereby the offenders switch to committing crimes of a less serious nature (Barr and Pease, 1990). In contrast, Barr and Pease (1990) outline that malign displacement is the escalation of offending to more serious crimes.

Other studies of crime displacement have shown that in as much as 63.16% of studies, crime displacement was clearly identified (Phillips, 2011) which clearly goes against the accepted assumption that displacement is a myth or an erroneous assumption. Further analysis outlines that studies that have included offender focused research including interviews and behavioural analysis shows an even higher proportion (84.6%) of evidence supporting the fact that displacement does occur (Phillips, 2011). When the offence of burglary is

assessed, the proportion is 100% with each study identifying displacement in respect of crime type (Letkemann, 1973), temporal and spatial (Bennet and Wright, 1984, Cromwell et al, 1991 and Van Burik and Overbeeke et al, 1991) and tactical displacement (Van Burik and Overbeeke et al, 1991). Previous research (Repetto, 1976) has further strengthened this argument, particularly in respect of foraging burglary offending where it is argued that offenders prevented from committing crimes in one 'familiar' patch will switch offending to other areas known to the offender. This further underpins the routine activity of foraging offenders which makes their behaviour much more predictable than other types of burglary offenders.

As this overview of crime displacement literature has shown. It's presence, form, causes, and even existence is a bone of contention, with research showing that it can and does take place, often as an unintended consequence of crime reduction interventions. This is particularly the case if such interventions are not thoroughly considered before implementation. Some remain convinced however that crime diffusion can potentially offset these issues (Clarke and Weisburd, 1994 and Guerette and Bowers, 2009).

Patch Movement, Identified Through Spatial Crime Displacement

It is suggested that although the forager may not cease its foraging it will increase its vigilance in response to increased predation levels (Kelly, 2001). This was a response that is most evident on the periphery of previously foraged areas now subject to increased predation which results in a higher 'giving up' rate by the forager before ultimately seeking a new foraging patch (Kelly, 2001). In the previous chapters, the presence of patch movement in the form of crime displacement caused by increased predation was alluded to within implementations of the optimal forager theory, as is present within the ecology literature (Charnov et al 1976 and Charnov, 1976). The ecology literature that underpins the optimal forager theory of predictive Policing firmly suggests that patch movement will occur as a result of increased predation (Lima, 2002) and as such its presence should not come as a surprise. If the criminal forager's behaviour mirrors that seen in animals then this would be particularly prevalent at the edge of patches or in this context, the predicted 400m prediction zones.

Most significantly, the criminal will simply change patch and switch their activity from one area to another where there is less Police presence and as the ecology literature indicates, predation will result in doing little to curtail overall foraging behaviour, or in this context crime levels.

The Link Between Ecology and Geographical Profiling

Earlier in the study it was established that the inter crime distance is the most accurate indicator of a linked crime but when other research was analysed in the context of a central place foraging patch choice, it was identified as the least accurate (Johnson and Summers, 2015). It could be argued that the reason for this is because of the theory of the buffer zone, a concept within geographical profiling that shows that an offender is unlikely to operate in the immediate vicinity of their home or base because it raises the perceived likelihood of apprehension (Rossmo, 2000). The presence of foraging animals displaying behaviour previously only attributable to geographically profiled criminals is a very recent link. In 2007 Rossmo collaborated with Raine and Le Comber to produce the publication 'Geographical Profiling Applied to Testing Models of Bumble-Bee Foraging'. In this study Rossmo et al tested geographical profiling information system algorithms on the foraging behaviour of bumble-bees and were successful in identifying animal foraging patterns based on varying food sources and densities (2007). Although a very early test of the use of geographical profiling in this context Rossmo outlined how the examination of animal behaviour in this way could help further develop accuracy in traditional geographical profiling and also assist in analysing animal spatial behaviour (2007; 317).

Other research has analysed the predatory patterns of white shark hunts as they engaged with cape fur seals (Rossmo and Hammerschlag; 2009). Using geographical profiling techniques, it was identified that the predator utilised a base or anchor point, similar to serial offenders (2009; 115). The study also identified that the hunting area was not the area that offered the greatest access to prey, as one would expect but in fact seemed to show some cost benefit analysis by the sharks in identifying a zone which offered the highest balance of prey availability, capture rate and level of competition (2009; 116-7).

It has been argued that the theoretical stance in respect of the cause of the crime displacement dictates the crime prevention reaction (Eck, 1994). This is a similar stance to the theoretical suggestion from chapter 6 which concluded that there may be distinct types of burglary offenders, and, that each type requires a distinct response. As this study theorises an ecological cause of crime displacement a response that is based upon ecology theory is a natural reaction and this chapter examines the validity of this theory by advancing the strong links between ecology and geographical profiling, and in doing so, assess the potential for geographical profiling as an ecological response to maximise the impact of predictive policing. Such methodology-based approach to combating displacement is in contrast to current literature which it could be argued advocates an overly simplistic approach. This is most evident in literature that argues for the use of super critical hotspots, which are in effect extremely large hotspots that cover wide areas encompassing multiple smaller hotspots called 'sub critical hotspots' (Brantingham, 2013). In current financial times, such responses are not possible and a bespoke problem orientated response, combining theories with strong theoretical foundations provides a potentially more palatable approach during times of austere resource levels.

Theories of Geographical Profiling

Identifying a universally accepted definition of what geographical profiling is has proven somewhat more difficult than was originally expected. It appears that although most in the field know what geographical profiling actually is and what it means, very few have taken the time to actually offer a formal definition. Dr Kim Rossmo is accepted as the 'father' of the term geographical profiling which developed by building on work by Brantingham and Brantingham in 1981. In their work, the Brantinghams suggested that the crime site location could be interpreted to identify the most likely home or base of the offender (Rossmo, 1995, pp. 149). What was essentially identified here was that the geographical importance of the crime site location was being overlooked by more traditional areas in relation to the crime, such as the psychology of the offender, their behavioural characteristics and victim selection. What Rossmo astutely pointed out was that for any crime to occur there is a specific time and moment when

and where the victim and offender cross paths and that this has the potential to offer important information (Rossmo, 1995, pp. 149). Brantingham and Brantingham described the combination of crime and place as 'the fourth dimension of crime' (1981:21). Rossmo elaborates by suggesting that detecting any crime whereby the link between the victim and offender is unknown is problematic as we traditionally work outwards from the victim. In the absence of this as a tactic the secondary option is to work inward towards the offender (Rossmo, 1995). To do this it was required to invert environmental criminology research and reverse the logic of this theory to begin to predict an offender's likely home or base (Rossmo, 1995). Rossmo went on to argue that crime site locations are not random, although they may appear to be, they are in fact influenced by geography as it pertains to the offender (Rossmo, 1995). Drawing from routine activity theory, Rossmo outlined that offenders would commit crimes at locations that were identified within their activity space i.e. within the area of their day to day activities and as such it stood to reason that their home or base would be situated within the area of their offending (Rossmo, 1995). Drawing all of this together into a simple definition, Wiesenthal defined geographical profiling as;

> *"An investigative technique used to determine the most likely location of a criminal's residence based upon the geographic location of crime sites"*
>
> (Prof. David L. Wiesenthal, 2012)

This definition covers the key objective of geographical profiling entirely and it seems a simple observation, which may go a long way to explain why very few have taken the time to formally define what is essentially the obvious. By following the definition and identifying a probability that an offender lives in a specific area, allows the Police to maximise their Policing response and increase their chances of apprehending or preventing an offender or reduce their number of crimes. By more scientifically and theoretically more accurately concentrating on the most likely home or base of the offender, traditional investigative techniques as previously outlined have a greater chance of a successful outcome (Rossmo, 1995). The next major question is the 'how'. How is a geographical profile actually produced? Rossmo suggests the most effective method to do this is by amalgamating principles from environmental criminology and journey to

crime data with the basic principles of Centro graphic analysis (Rossmo, 1995). The most effective manner to conduct this is through what Rossmo described as criminal geographic targeting (CGT) which is effectively what we have come to know as geographical profiling (Rossmo, 1993). The easiest and most accurate way to do this is by use of a geographical information system which would analySe the spatial data regarding the crime sites to produce a three-dimensional product that would offer a probability ratio for each square section of the grid to identify the most likely area of the home or base of the offender (Rossmo, 1993). Brantingham and Brantingham (1981) formaliSed the model for CGT by using the distance decay function $f(d)$ to replicate the journey to crime behavioUr of an offender. To do this the Brantinghams assigned a probability value of $f(d)$ to each point (x,y) which was located at distance d from crime site i. They then established the final probability for a location (x,y) of the offender's home or base by combining with this the n values at the location from the n various crime locations (Brantingham and Brantingham,1981).

To actually produce the profile, Rossmo (1995) supplies a four step theoretical process as follows; mapping boundaries delineating the offenders hunting area are first established using the locations of the crimes and standard procedures for addressing edge effects; Manhattan distances (i.e. orthogonal distances measured along the street grid) from every "point" on the map, the number of which is determined by the measurement resolution of the x and y scales to each crime location are then calculated; next, these Manhattan distances are used as independent variable values in a function that provides a number that: (a) if the point lies outside the buffer zone, becomes smaller the longer the distance, following some form of distance decay; or (b) if the point lies inside the buffer zone, becomes larger the longer the distance. Numbers are computed from this function for each of the crime locations. For example, if there are 12 crime scenes then the map will have 12 numbers associated with it. Finally, these multiple numbers are multiplied together to produce a single score for each map point. The higher the resultant score the greater the probability that the point contains the offender's residence (Rossmo, 1993).

To interpret the data produced Rossmo then outlines how it is required for the information to be plotted on a curve graph or other similar model which allows a comparative analysis of each "point" score. It can then be ascertained what percentage of the total mapped area the offender's residence is located within, with a lower percentile indicating a higher probability accuracy (Rossmo, 1995). Rossmo argues that there is a direct correlation between predictive accuracy and the number of crime scene locations mapped with the higher the number of scenes, the more accurate the resultant profile (Rossmo, 1995).

Spatial Theories of Geographical Profiling

Moving on from the definition of geographical profiling and Rossmo's theory on the subject, it is important to outline that there are several underpinning spatial theories that underpin the theory. Although psychological theories offer an underpinning explanation as to why an offender chooses a crime location, they fall short of providing the profiler a tried and tested scientific theory of identifying the offender's home or base, which is the fundamental objective of a geographical profile. This task is completed by utiliSing a number of spatial theories which are known to effectively predict an offender's home or base and as outlined above, provided the basis of Rossmo's overarching theory. Although not all of the following theories will be utilized in this study they are worthy of a brief description as follows;

Distance Decay Theory

The origins of distance decay theory lie in the concept of gravity models which was first outlined by Sir Isaac Newton in his 'law of attraction' (Kent, Leitner and Curtis, 2006). The essence of the theory is that the attraction between two elements 'decays' or reduces as the relationship between them, in this case distance, increases (Kent, Leitner and Curtis, 2006). In respect of this study this would refer to the location of a crime and the home or base of an offender. The concept has been heavily utilized in urban and economic geography and has been used to explain the movement of people in such areas as commuting in transportation and migration and in short, the theory suggests that individuals when provided with a choice will select to travel short distances rather than prolonged journeys in their routine activity (Harries, 1999). There are a large

number of both theoretical and mathematical modelling functions used within these industries which have used a variety of different approaches such as a linear curve, lognormal, negative exponential and truncated negative exponential distance decay models (Harries, 1999). Of all of these models it is the truncated negative exponential function that is most effective for analyzing the distance decay characteristics of criminals (Kent, Leitner and Curtis, 2006). In respect of its use within crime, the theory has been used to explain the choices made by criminals in their target selection and goes beyond examining just the behavioUral characteristics of their crime and analyses their journey-to- crime decision making process (Nichols, 1975). By examining the use of distance decay within the crime environment it has been established that a 'buffer zone' exists (Rossmo, 2000 and Brantingham and Brantingham, 1981). This is essentially an area where the criminal does not commit crime and is located immediately between the offender's home or base and the area in which their criminality begins. It is suggested that this buffer exists as the offender is reluctant to commit crime close to their home or base through a perceived fear of the increased likelihood of detection (Brantingham and Brantingham, 1981).

It is only within the last decade or so that the concept of distance decay has been developed and the various models tested so that it can used to estimate the home or base location of a serial criminal (Canter et al, 2000, Levine, 2002; Snook et al, 2002). By analySing the clues provided by the offence locations such as the rate of decay and factoring in of a buffer zone, that an analysis can provide a probability surface, indicating the offender's most likely home or residence. It is directly from examination and testing of distance decay theory that the emerging field of geographical profiling has arisen. It is now commonly accepted that the distance travelled by offenders is directly linked to their base and that their offending decreases as the distance form their base increases (Block and Bernasco, 2009; Canter and Hammond, 2006; Emeno, 2008; Phillips, 1980; Rattner and Portnov, 2007; Rengert, Piquero and Jones, 1999, Rhodes and Conly, 1981 and Turner, 1969). As such it is this spatial theory will form the centre of the geographical profiling theoretical framework.

Circle Hypothesis

Based on research of violent serial offenders, this theory indicates that an offender's base will be within parameters set by encircling their two most distant offences (Canter and Larkin, 1996; Kocsis and Irwin, 1997; Tamura and Suzuki, 1997). The theory is very similar to distance decay but in many ways, is much more rudimentary and because of this reason it will not be utilized within the study. Rengert (1996) has also proposed several further spatial theories, namely uniform pattern with no distance-decay; a bull's-eye pattern with spatial clustering, exhibiting distance-decay centered round the offender's primary anchor point; a bimodal pattern with crime clusters centered around two anchor points; and finally, a teardrop pattern with a directional tendency toward a secondary anchor point. It is not my intention at this time to utilise these theories in the study as in my own opinion, as with circle hypothesis they heavily lean towards distance decay and the evidence base for them is limited only to the study by Rengert.

Identification of Geographical Profiling Assumptions

Emerging from the extensive research conducted in this field there have been a number of assumptions generated which it is suggested are required to maximise the predictive accuracy of this theory. It is important to outline these as any deviation from the assumptions may impact on the result of any profiles produced and the overall credibility of any research. Firstly, several studies have led to the assumption that complexity equals accuracy and a minimum of 5 linked crimes for an effective analysis is commonly suggested (Brehner, 1994; Hammond, 1990; Hogarth, 1980; Kahneman and Tversky, 1973). Secondly, the commonly held assumption within geographical profiling is that it is most successful in serious and serial complex crimes (Kocsis and Irwin, 1997; Tamura and Suzuki, 1997; Warren et al, 1998 and Canter et al). Furthermore, the identified crime scenes must be able to be attributed to the same offender for the profile to be accurate (Rossmo, 2000); It is also assumed that a marauder's offending behaviour remains localised, geographically stable, that they commit crime within a confined area and are likely to have an anchor point (Stevens, 1961; Canter and Hammond, 2006; Canter 2004 and Phillips, 1980, p136). Commuters on the other hand, are assumed to be more mobile, dispersed and commit their crimes

over large areas. It is also assumed that they utilise complex hunting strategies with no reliance on a definable anchor point (Cornish and Clarke, 1986; Hammond and Youngs, 2011, p95). There is a well-established assumption that offending behaviour 'decays' as the distance from their home increases (Block and Bernasco, 2009; Canter and Hammond, 2006; Emeno, 2008; Phillips, 1980; Rattner and Portnov, 2007; Rengert, Piquero and Jones, 1999, Rhodes and Conly, 1981 and Turner, 1969). It is also believed that the distribution of the crime scenes is required to be evenly distributed around the offender's home or base to enable a more accurate prediction (Rossmo, 2000). Finally, the most accurate profile is generated if the offender does not move anchor points or operate from multiple bases during the commission of their offences (Bennell and Corey, 2007).

Ethnicity, Gender and Age and Experience

There have been a variety of studies that have investigated suspect characteristics in respect of burglary offending (Vaughn et al, 2008; Snook 2004; Baldwin and Bottoms 1976; Costello & Wiles, 2001). A systematic review of studies in respect of these factors identified that burglary offenders are significantly more likely to be white males (Vaughn et al,2008). They also possess on average a criminal history that on average consists of 4 burglary convictions, a 20 year criminal career, and have committed 50 offences in their lifetime (Vaughn et al, 2008). In respect of age, research shows that there is a correlation, specifically that younger offenders target properties closer to their home or base (Snook, 2004). However, there has never been a study that has solely examined these factors in respect of foraging burglary offenders and as such this will be the first of its kind.

8.3   Aims and Objectives

The aim of this chapter is to examine the geographical behavioural characteristics of foraging criminals to increase understanding of predictive indicators. The chapter also examines the physical characteristics of foraging offenders to add greater insight into their personal and offending history.

8.4   Method

In this chapter recorded crime data extracted from the SLEUTH intelligence system forms the primary source to be analysed. Using the original 50 optimal forager briefing products provided which were used to control the tasking and co-ordination of police resources, they are examined specifically for examples of crime displacement and serial offending. The identified crime displacement examples are then subjected to further analysis of a descriptive nature to identify patterns and trends of spatial behaviour. Geographical profiles are then conducted (n=7) to examine the effectiveness of this method against foraging offenders. Finally, the physical characteristics of the foraging offenders responsible for the crime series profiled are then subjected to descriptive analysis. This section will now explain in greater detail how this will be achieved.

Patch Movement

Spatial crime displacement or 'patch movement' as it is referred to within the ecology literature will be examined in this chapter. This is achieved by using the aforementioned examples of spatial crime displacement (n=3) from within the 50 forager products. These are then mapped by plotting the areas of high risk identified within the products on a geographical information system (GIS), namely Google Maps. Pins are then placed onto the maps to identify crime scene locations. Domestic burglaries often referred to as burglary in a dwelling (BIAD) are displayed using green pins, violent behaviour is black, functional displacement offences defined as non-domestic burglaries, often referred to by police as burglary other than in a dwelling (BOTIAD), vehicle related and other theft offences are in yellow. By-proxy indictors, defined as attempted burglary and criminal damage offences against both buildings and vehicles, are in blue and other unrelated offences are grey.

This visualisation allows a wider view of the behaviour in its full context and will enable a generalisation to be reached in respect of whether the behaviours are committed on the periphery of foraging patches, and, if they correlate with any other information, for instance the trajectory between patches. Key distance measurements are also taken to provide insight into the inter crime relationships and journey to crime behaviour of the foraging offenders. These measurements

include the distance between the centre of each high risk area (HRA), the distance between the last and first burglary with the HRA, the distance between the last burglary within the initial HRA and the 1st evidence of functional crime displacement as categorised within chapter 4 and was selected due to its significance result, the last burglary within the initial HRA and the first by proxy indicator then to concluded, the mean inter crime distance between functional displacement offences and by proxy indicators.

Geographical Distribution

To add further depth to the aforementioned analysis a two-month window selected at random covering September 2014 to October 2014 which was examined in further detail. Situated in the borough command unit of 'west', every identified and predicted high risk forager area was identified and overlaid on the GIS system Google Maps thus providing a strategic overview of a large time window and the geographic distribution of the forager areas.

Geographical Profiles

Geographical profiles (n=7) of foraging domestic burglary offenders are conducted to better understand their geo-spatial behaviour. This examination will also help assess the effectiveness of geographical profiling as a predictive policing methodology to identify the natural habitat of the foraging offender, defined as their likely home or base. The linked crimes were identified by virtue of offenders being charged or convicted with the identified offences. In line with previous chapters, offences were identified from crimes within a set time period, namely July 2014 to July 2016. The profiles were completed using geographical profiling software called MapBrix. This GIS package MapBrix was chosen for a very specific reason. In order for the study to be as close to real life operational procedures as possible it needed to be conducted using the tools that were readily available to the Police. Research with the National Crime Agency and the College of Policing identified that within England there were only two people trained specifically to create geographical profiles, all others are classed as Geographic Profiling analysts and are trained to a lesser standard. The profilers identified confirmed that two systems were available to them, MapBrix and

MapInfo, both of which are free packages available to them and due to ease of access and use, MapBrix was selected for use within the study.

Descriptive Analysis

To complement the geographical profiling of foraging behaviour an assessment of offender characteristics is also conducted. The offenders examined are those responsible for the 7-crime series identified. Characteristics examined include ethnicity of the offender, their criminal offending history, their relationship to substance abuse and violence. These characteristics are identified by using the SLEUTH intelligence system and analysing the offenders subject profile which contains a full breakdown of their personal history obtained during arrests and their criminal record. This analysis enables deeper look into the possibility that foraging burglary offenders have impulsive personality traits, as suggested earlier in the study.

8.5   Results

Patch Movement, Identified Through Spatial Crime Displacement

In total, only 3 distinct examples of crime displacement were identified within the 50 optimal forager tasking and co-ordination briefings subject to analysis. The result include visualised examples of displacement. In all examples burglaries are displayed using green pins, violent behaviour is black, functional displacement offences are in yellow, by proxy indictors are in blue and other unrelated offences are grey. The first high risk area (HRA) is the original optimal forager locality identified by the police analyst and cordenned by a green square. The second HRA is the locality within which optimal foraging burglary offending was displaced to when analysed two weeks later and is cordonned by a red square.

The section also includes tables that display a number of key distances. These include a description of the trajectory between the original high risk area (HRA) and the area the crimes were displaced to; the distance between the two HRAs; the distance between the last BIAD within the original HRA and the first BIAD in the new HRA; the distance between the last BIAD within the first HRA and the first offence that is covered by the functional displacement definition within the

second HRA; the distance between the last BIAD within the first HRA and the 1st offence defined as a by-proxy offence within the new HRA; the mean distance between the first and second HRA of all offences covered by the functional displacement and by-proxy definitions.

Patch displacement Example 1

The following example highlights an instance of displacement which was confirmed as a result of the apprehension and subsequent conviction of the offenders for the offences during the pilot period (LC6, 2015). In this example, a series of burglary offences were identified through an analysis process on the 4th of November. Figure 15 below shows the two areas highlighted in this example prior to the area being raised for increased tasking and co-ordination of police resources. The area highlighted in green is the identified optimal forager high risk area. The area highlighted in red is the area that offending was displaced to. As can be seen from this visualisation there appears no obvious distribution of offending.
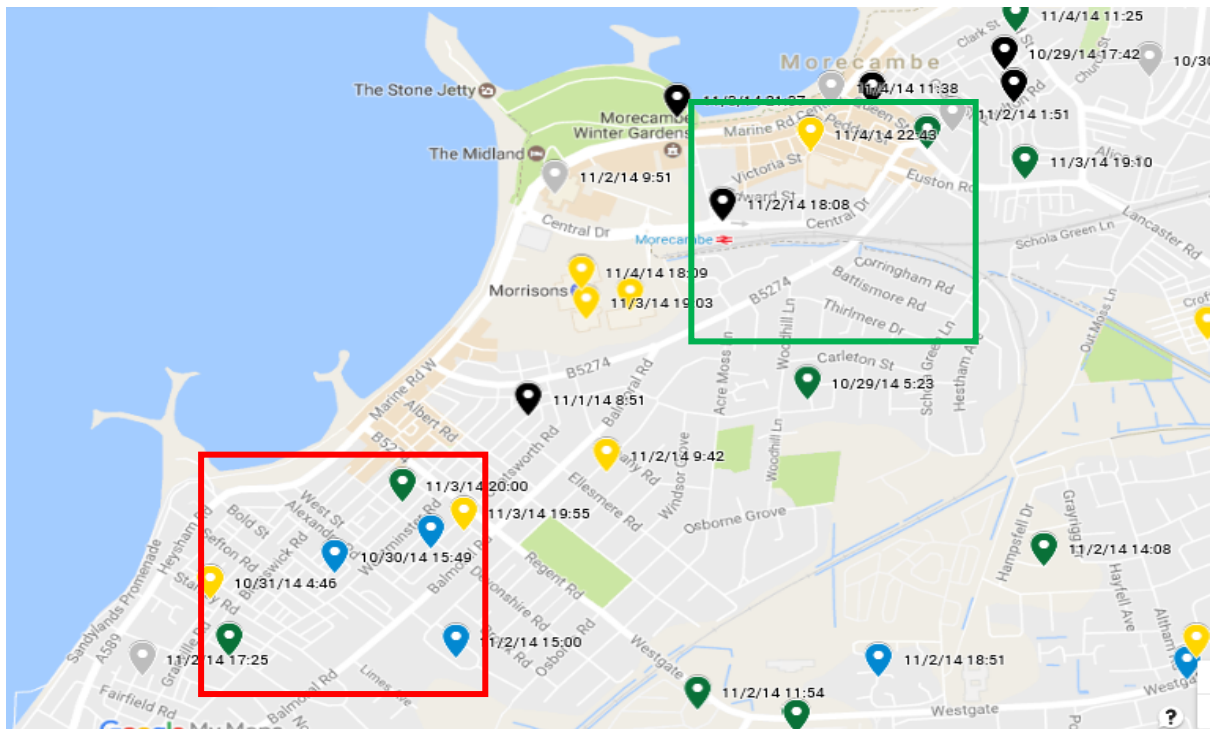
Figure 15. Recorded crimes prior to increased predation, example 1.

As a result of this analysis, a predicted forager product was generated, and a response was put in place in line with that outlined earlier in the study. When analysis was completed the following week on November 10th it was established

that the offence locations had shifted (LC6, 2015). These changes are illustrated in figure 16. below. As can be seen in this example the spatial dimension of the offences has been displaced to the location, or patch, as it is referred to in the ecology literature and is cordonned by the red box. This area remains within close proximity but outside of the original predicted forager high risk area. Most noticeable is the fact that there are now very few offences in the area originally cordonned in green. Furthermore, the distribution of offending appears less randomised and appears to follow a clear directional trajectory to the south west of the original high risk area.
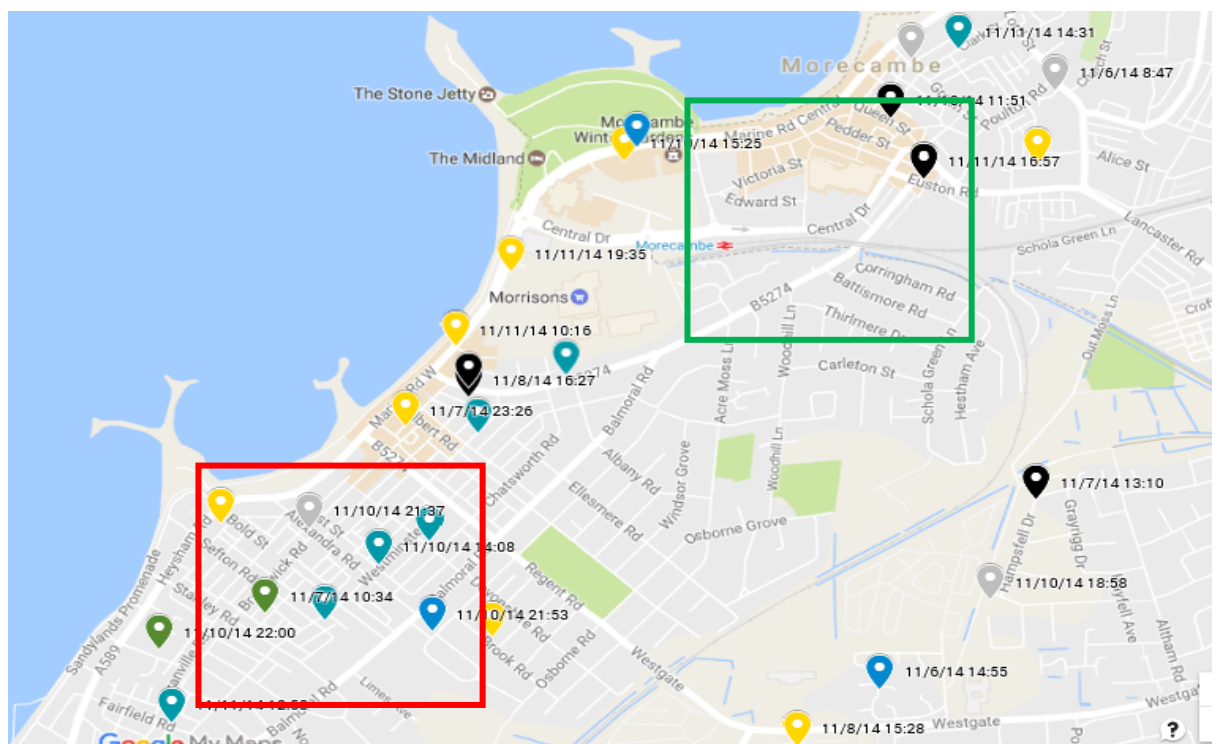
Figure 16. Recorded crimes after increased predation, example 1.

Patch displacement Example 2

The following is an example of displacement identified within a large geographical area, with high density victim resource availability. In a predictive product produced on the 3rd November 2014 a high-risk area was identified. All offences were within close proximity and a clear modus operandi of the offender was identified, namely, the targeting of insecure properties with entry being gained through the rear of the home. Figure 17. illustrates the crime distribution prior to increased predation within the originally identified foraging high risk area which is again highlighted in green and the displacement high risk area highlighted in red.
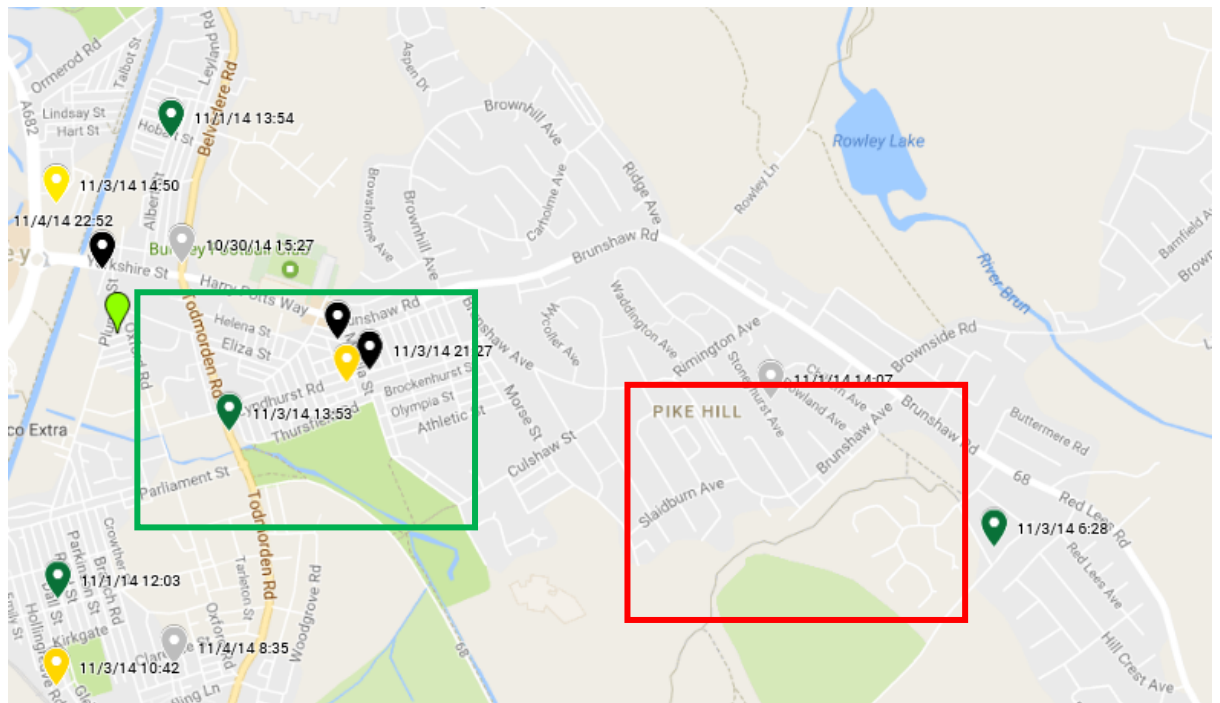
Figure 17. Recorded crimes prior to increased predation, example 2.

On this occasion predation risk was again increased for the foraging criminal through increased capable guardian presence by enhancing police patrols in the origainal high risk area. As a direct result the offending was displaced a short distance away but as in the previous example, outside of the identified foraging high-risk area. As shown in figure 18 overleaf, the following week on the 10th November the new area of offending was identified through the presence of the same behavioural characteristics of the offenders (LC6, 2015). What is distinctly

clear from this example is that prior to the increased presence in high risk area one, there had been no crimes within high risk area two.
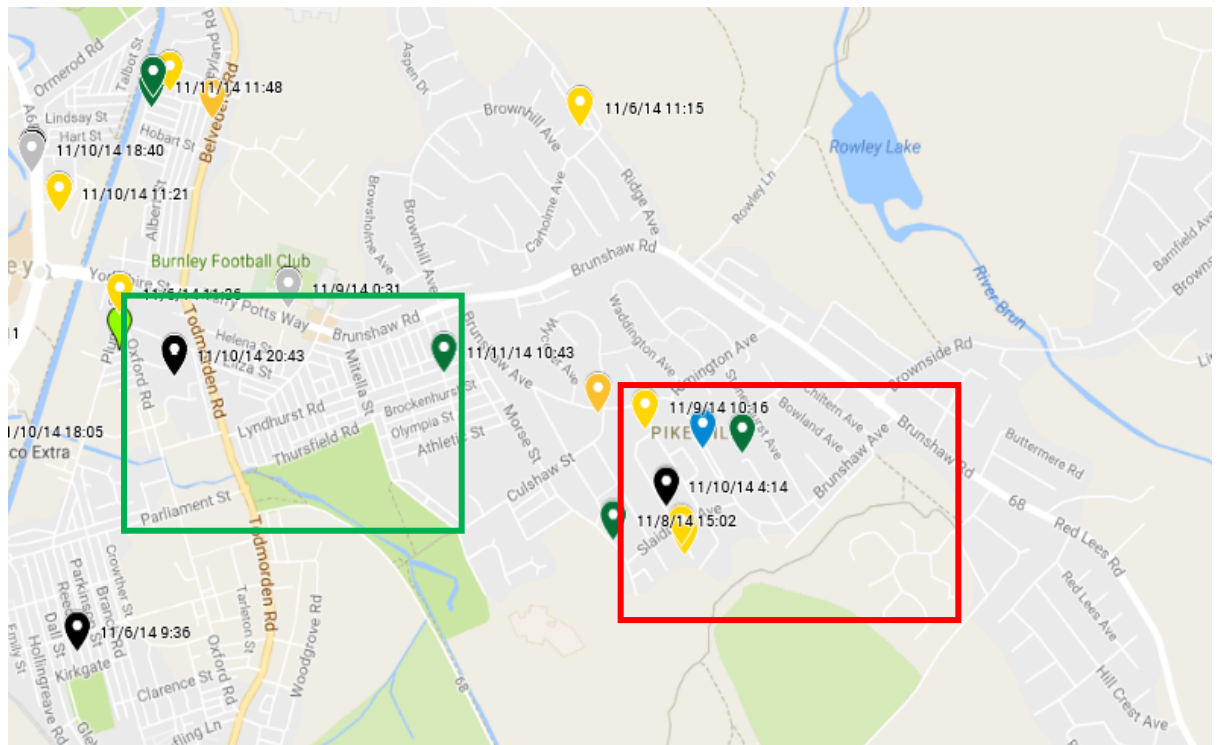
Figure 18. Recorded crimes after increased predation, example 2.

However, once increased police patrols entered high risk area one, offending was immediately displaced into high risk area two shown in the red cordon.

Patch displacement Example 3

A further example of the optimal foraging criminal being displaced within an area of high density victim resources occurred in December 2014. Identical to the previous examples, a predictive product used to task and co-ordinate staff was created on the 1st of December 2014. This product highlighted a high-risk area being targeted to the left of the map shown in the green box within figure 19.

Figure 19. Recorded crimes prior to increased predation, example 3.

Again, on this occasion the serial foraging criminal was identified as a result of their apprehension and conviction. On this occasion, the offender targeted unoccupied homes during the night and removed copper piping. As a result, the predation risk was increased through enhanced patrols and again the offending in that area diminished. However, the same issue was highlighted again several weeks later but on this occasion in a different area very close by, indicating the offender had been displaced (LC6, 2015) which can be seen in figure 20 overleaf.

Figure 20. Recorded crimes after increased predation, example 3.

The resuls of the analysis of the significant distances between high risk areas one and two for each example is now set out in comparison table 29 on page 255 overleaf.

Geographical Analysis	Example 1	Example 2	Example 3	Mean Distances
Trajectory Between Hras	South West	South East	North East	N/A
Inter HRA Distance	1300	971	1080	1117
Inter BIAD Distance Within Hras	1750	674	507	977
Last HRA BIAD And 1st Functional Displacement	642	811	102	518
Last HRA BIAD And 1st By-Proxy	606	1030	709	2345
Mean Inter Crime Distance Functional	293	178	593	1064
Mean Inter Crime Distance By-Proxy	175	N/A	10	92.5

Table 29. Significant Distances Between High Risk Area 1 and High Risk Area 2

Geographical Profiling

In this section of results the study outlines the findings from conducting a total of 7 geographical profiles of foraging serial burglary offenders. The original geographic profiles are illustrated in this chapter and the examination of the offender responsible for these crimes.The offender analysis process examined the number of crimes committed in the series, the age of the offender, the mean distance they travelled to commit their offences, number of previous convictions, and the total number of offences they committed in respect of burglaries in a dwelling (BIAD), attempted BIAD, burglary other than in a dwelling (BOTIAD), other theft, criminal damage, violence and vehicle related offences.

Table 30 overleaf illustrates the collation of these findings as they relate to the number of linked crimes that have been profiled. Table 31 illustrates the mean, median and standard deviation of the findings from the 7 profiles.

No. of Linked Crimes	Age	Distance (m)	No. of Previous Convictions	BIAD	BOTIAD	Attempted BIAD	Other Theft	Criminal Damage	Violence	Vehicle Related
11	18	791	22	18	0	0	1	0	2	1
9	32	1304	140	100	6	10	3	7	4	10
8	38	5411	29	14	10	3	3	0	0	0
7	24	1585	16	8	0	0	8	0	0	0
5	43	231	228	127	3	14	1	0	1	82
4	38	1930	5	4	0	0	0	0	1	0
3	29	5685	19	15	0	1	1	2	0	0
Total	N/A	N/A	459	286	19	28	17	9	8	93

Table 30. Comparison table of foraging burglary offender criminal history prioritised by no. of linked crimes

Measure	Age	Distance (m)	No. of Previous Convictions	BIAD	BOTIAD	Attempted BIAD	Other Theft	Criminal Damage	Violence	Vehicle Related
M	31.7	2419	65.5	40.8	2.7	4	2.4	1.2	1.1	13.2
Mdn	32	1585	22	15	0	1	1	0	1	0
SD	25	5454	223	123	10	13	8	7	4	82

Table 31. Measurement table of foraging burglary offender behavioural characteristics and criminal hist

Geographical Profiling - 3 Linked Crimes

When examining three linked crimes the error distance between the predicted home or base of the foraging burglary offender and the actual location recorded on police systems was 5954 metres. The geographical profile of the 3 linked crimes can be seen in figure 21. below. As can be seen in table 31 on page 257 the mean distance of the offence locations to the foraging offender's actual home or base was identified as 5685 meters.
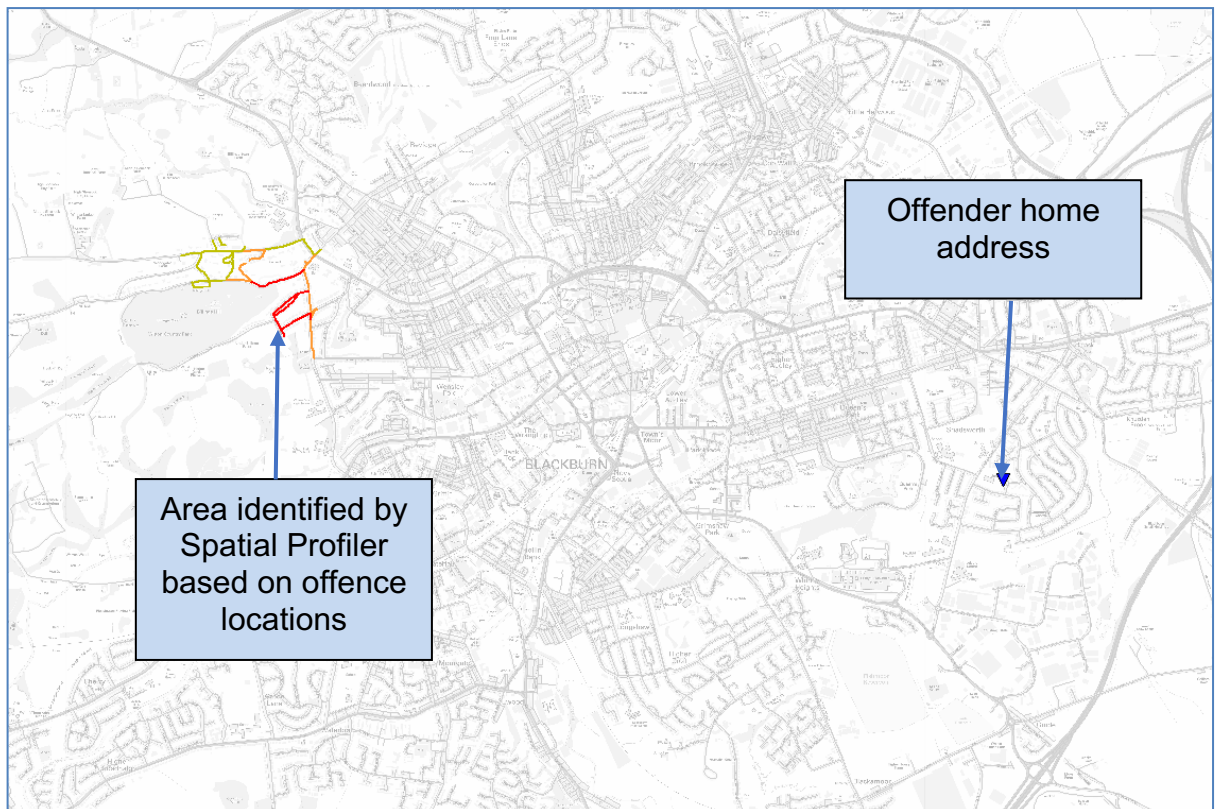
Figure 21. Geographical profile of 3 linked crimes associated to a foraging burglary offender.

4 Linked Crimes

When examining four linked crimes the error distance between the predicted home or base of the foraging burglary offender and the actual location recorded on Police systems was 1609 metres. The geographical profile can be seen in figure 22 below. Outlined in table 30, the mean distance of the offence locations to the foraging offender's actual home or base was identified as 1930 meters.
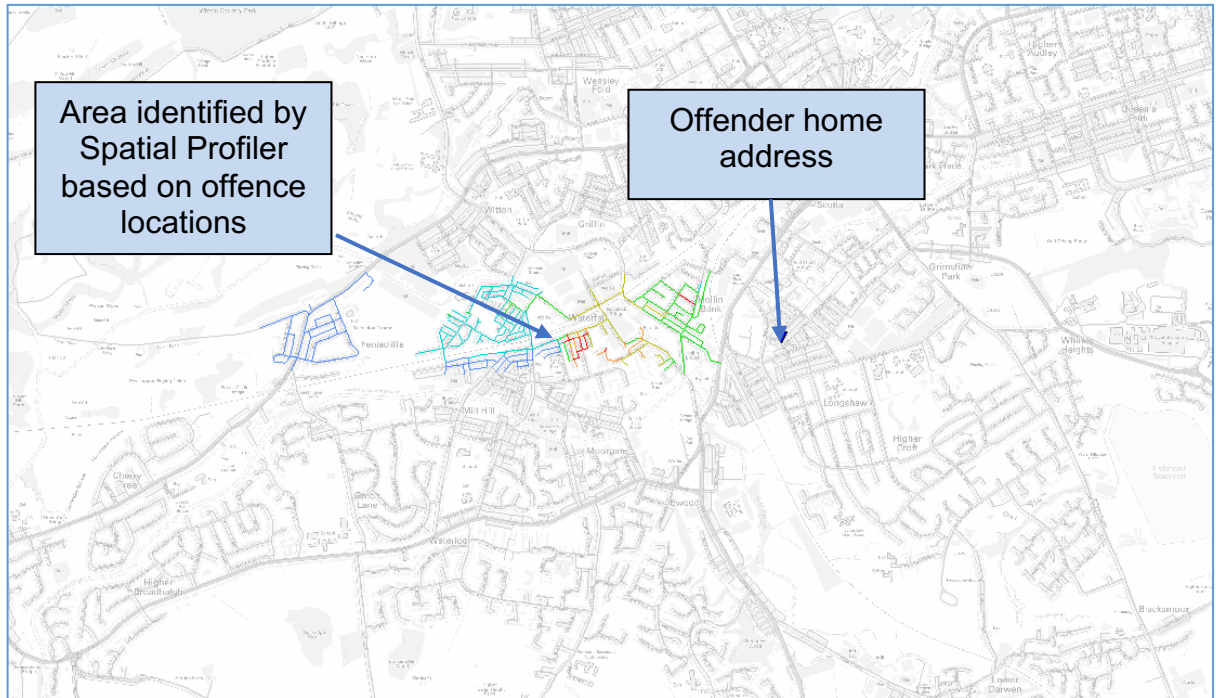
Figure 22. Geographical profile of 4 linked crimes associated to a foraging burglary offender.

5 Linked Crimes

When examining five linked crimes the error distance between the predicted home or base of the foraging burglary offender and the actual location recorded on Police systems was 321 metres. The geographical profile can be seen in figure 23 below. Again, in table 31 the mean distance of the offence locations to the foraging offender's actual home or base is identified as 231 meters.
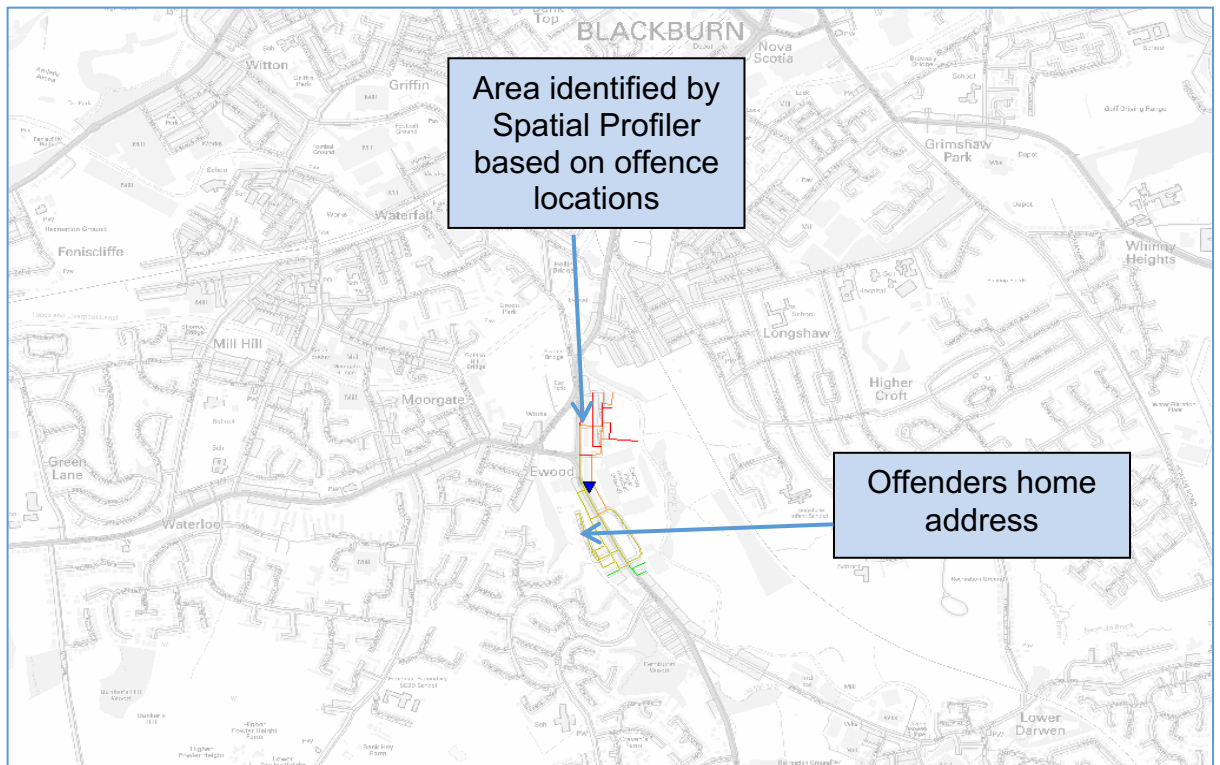
Figure 23. Geographical profile of 5 linked crimes associated to a foraging burglary offender.

7 Linked Crimes

When examining seven linked crimes the error distance between the predicted home or base of the foraging burglary offender and the actual location recorded on Police systems was 804 metres. The geographical profile can be seen in figure 24 below. The mean distance of the offence locations to the foraging offender's actual home or base was identified as 1585 meters and is outlined in table 31.
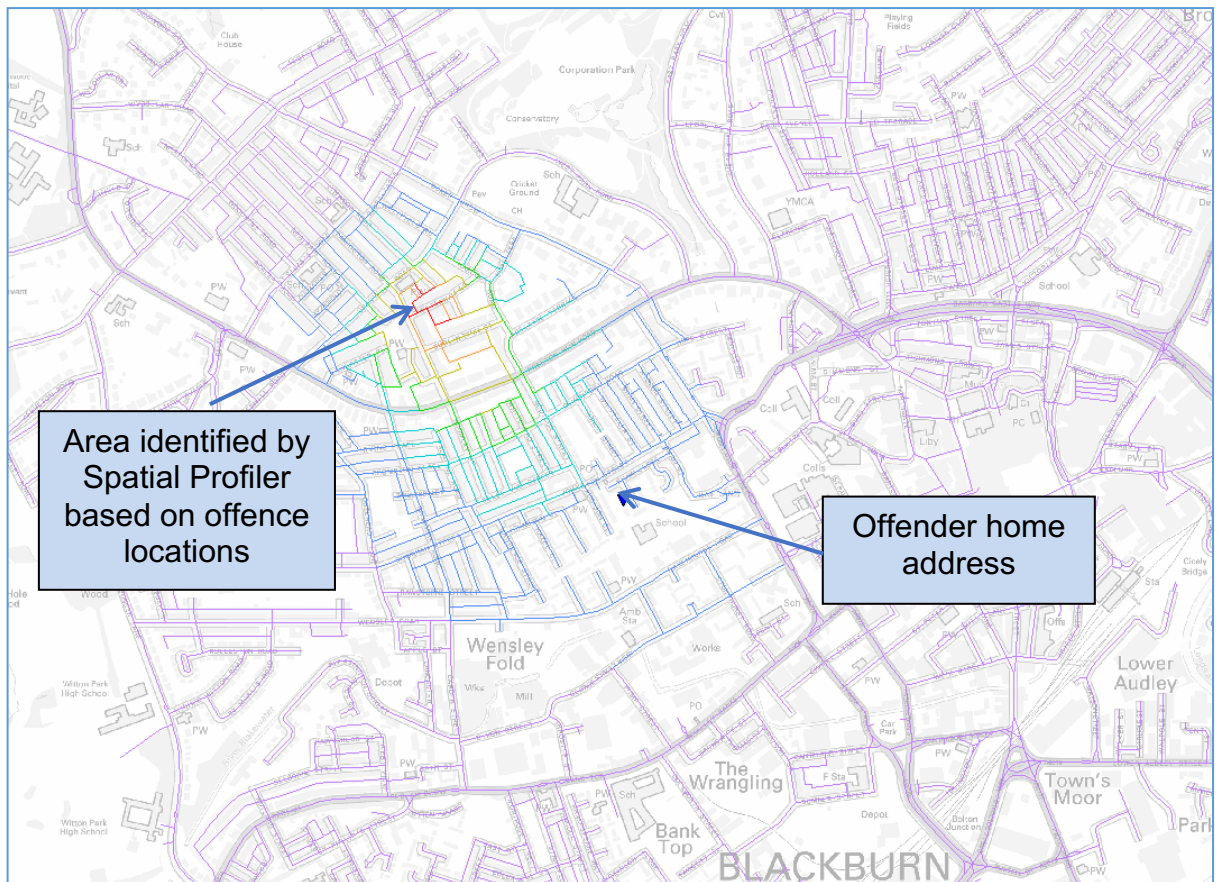
Figure 24. Geographical profile of 7 linked crimes associated to a foraging burglary offender.

8 Linked Crimes

When examining eight linked crimes the error distance between the predicted home or base of the foraging burglary offender and the actual location recorded on Police systems was identified as 4667 metres. The geographical profile can be seen in figure 25 below. The mean distance of the offence locations to the foraging offender's actual home or base was identified as 5411 metres and is outlined in table 31.
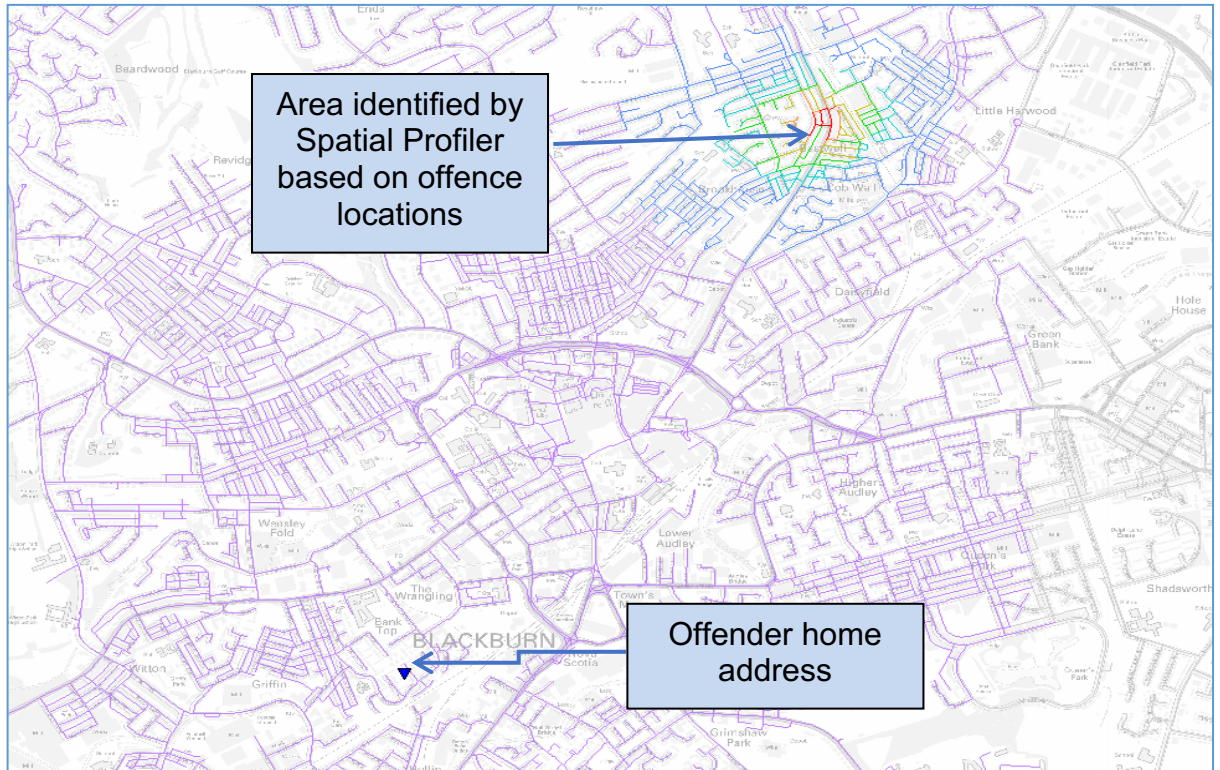
Figure 25. Geographical profile of 8 linked crimes associated to a foraging burglary offender.

9 Linked Offences

Nine linked crimes resulted in an error distance between the predicted home or base of the foraging burglary offender and the actual location recorded on Police systems of 2092 metres. The geographical profile can be seen in figure 26 below. The mean distance of the offence locations to the foraging offender's actual home or base was identified as 1304 meters and is outlined in table 31.
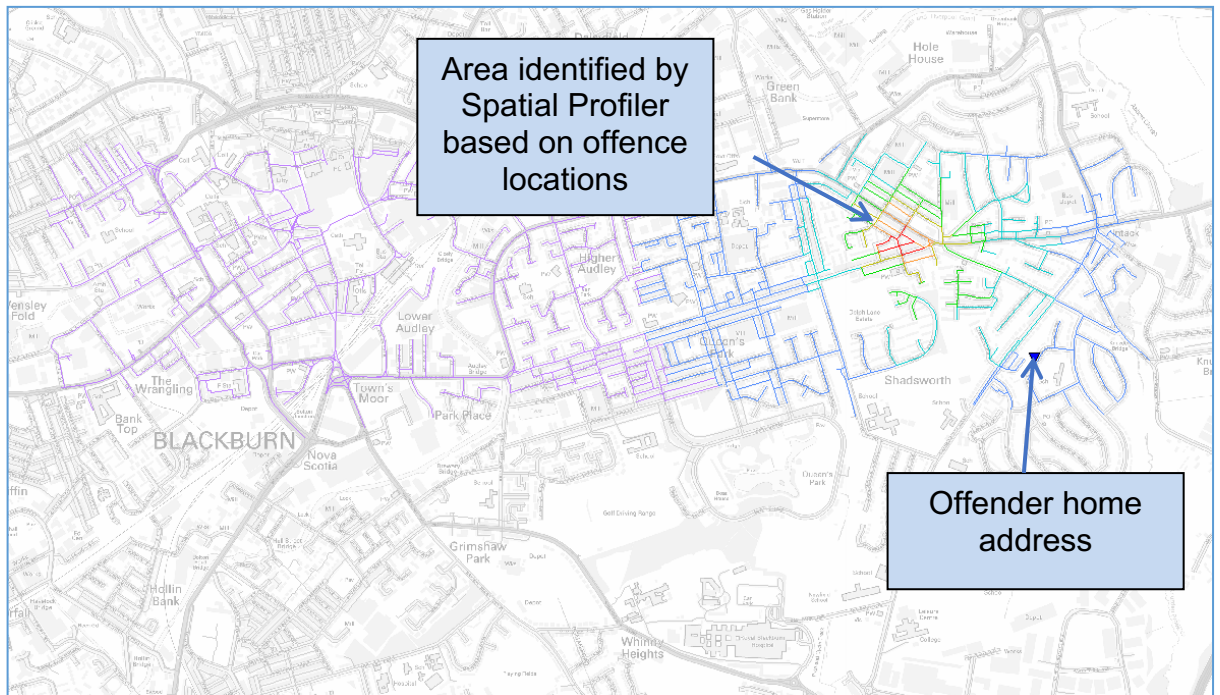
Figure 26. Geographical profile of 9 linked crimes associated to a foraging burglary offender.

11 Linked Offences

Eleven linked crimes resulted in an error distance between the predicted home or base of the foraging burglary offender and the actual location recorded on Police systems of 321 metres. The geographical profile can be seen in figure 27 below. The mean distance of the offence locations to the foraging offenders actual home or base was identified as 791 metres and is outlined in table 31.
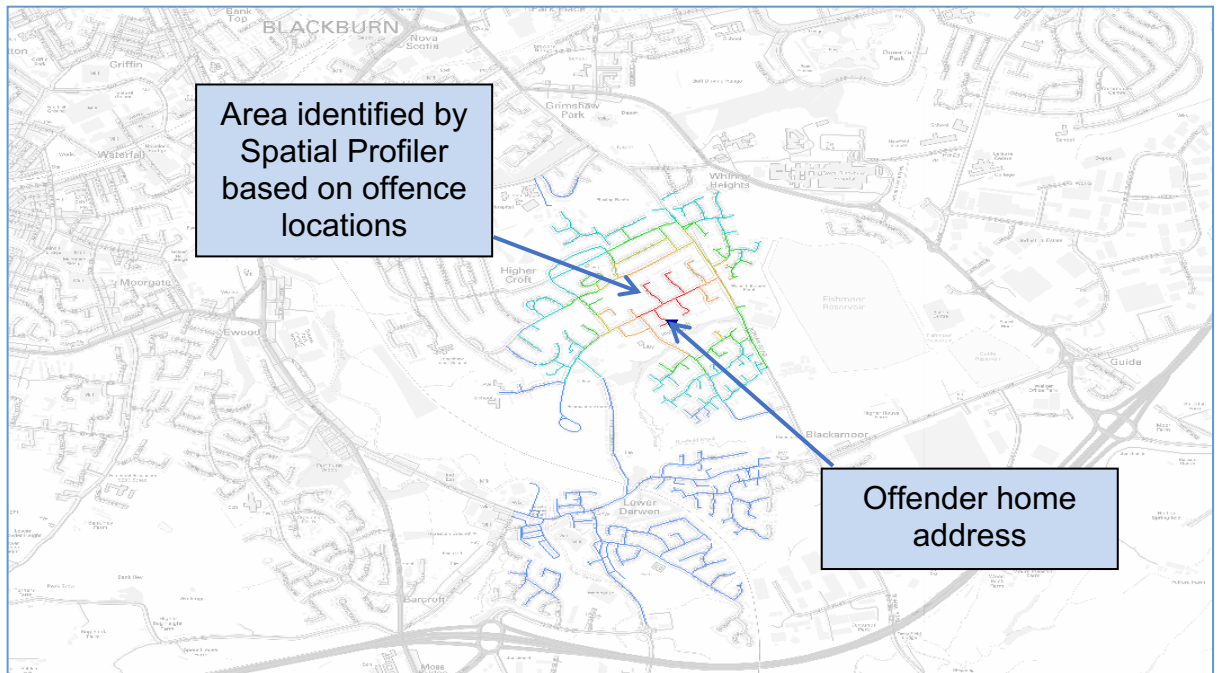
Figure 27. Geographical profile of 11 linked crimes associated to a foraging burglary offender.

The key distances measured in respect of the geographical profiles are outlined in table 32 on page 267. Mean distances between the offence locations and the home or base of the foraging offender varied from just 231 metres to 5685. The error distance also differed significantly from between 321 metres to 5954.

No. of Linked Crimes	Mean Distance from Crimes to Home/Base (m)	Geographic Profile Error Distance (m)
5	231	321
11	791	321
7	1585	804
4	1930	1609
9	1304	2092
8	5411	4667
3	5685	5954
Mean Distance	2419	2252

Table 32. Geographic Profile Error Distance from Lowest to Highest.

Geographical Distribution

In figure 28. below the jurisdictional boundaries are outlined for a section known as 'West' Borough command unit from within Lancashire. Within the boundaries are the red predicted high risk forager zones. This image shows the cumulative area for all predicted forager zones within an examined two-month period
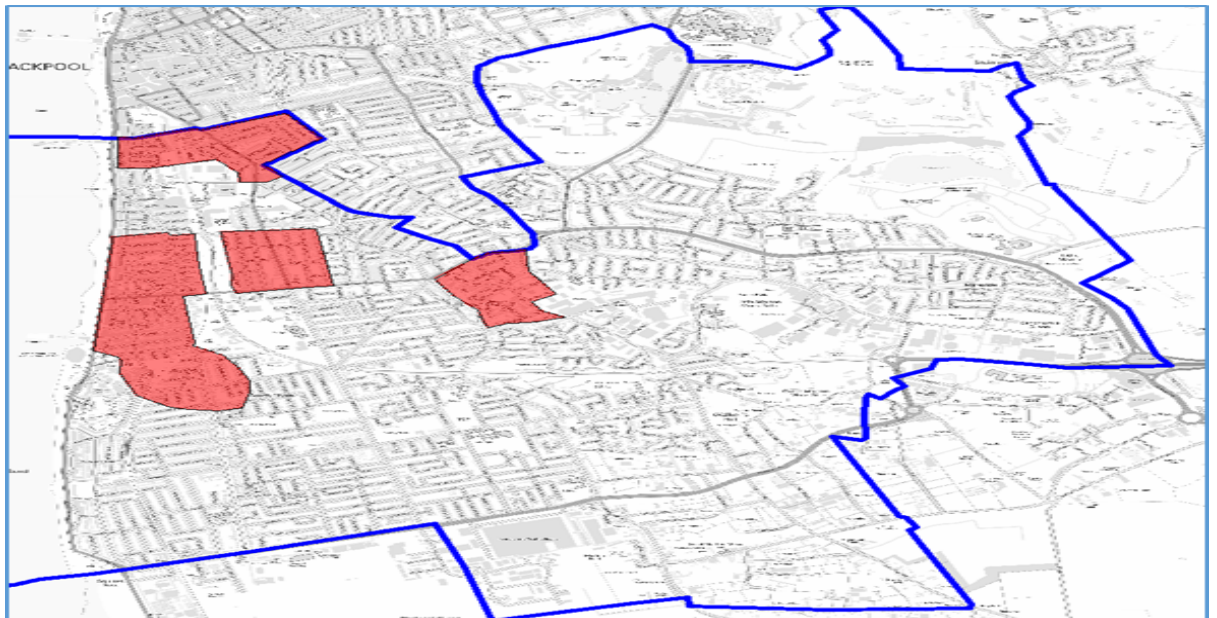
Figure 28. West BCU Optimal Forager High Risk Areas Between September 2014 to October 2014.

The journey to crime distance (JTC) and its correlation to the home or base of the foraging offender was also analysed and shown in figure 29 below.
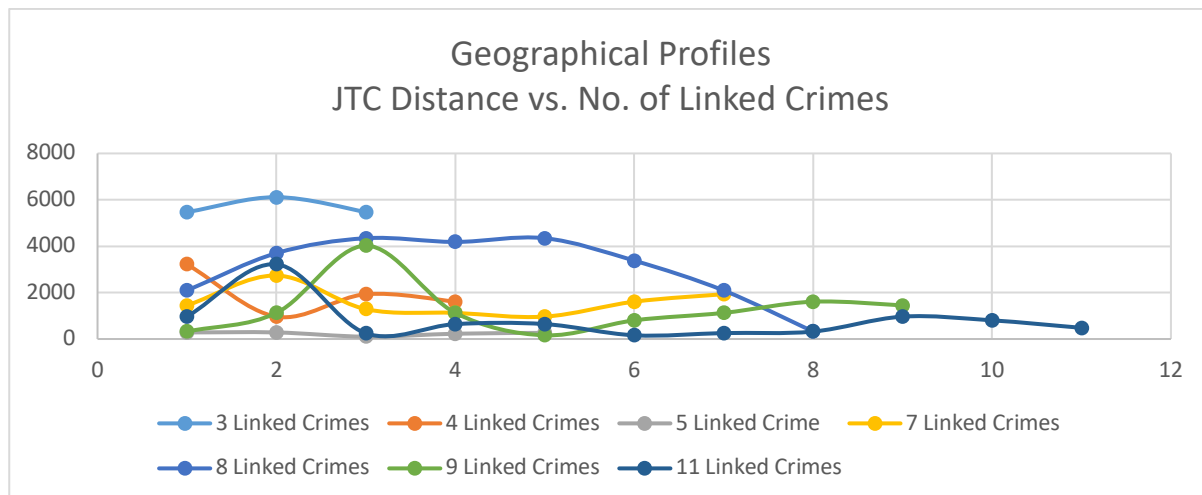
Figure 29. Journey to crime distance vs. No. of Linked Crimes

Descriptive Analysis

Gender

Of the 3 cases of crime displacement examined it was identified that all three were committed by male offenders. Of the 7 geographical profiling cases examined, all were committed by male offenders. As such it has been established that all geographical behaviours examined in this chapter were conducted by male offenders.

History of Violence

Of the seven geographical profiles examined it was established that 71.4% (N=5) of the male offenders had a history of violent offending within their recorded criminal history.

Mental Health

No history of mental health was found on the police national computer records or local sleuth intelligence system for any of the offenders examined in this chapter.

Substance Abuse

It was further established that of the seven offender geographical profiles examined that 71.4% (N=5) had a history of drug dependence, specifically class A drugs abuse.

Age

The mean age of the offenders geographically profiled was 31.7 years. In respect of age distribution 14% (N=1) of offenders were below the age of 20 and above the age of 40 years. 28% (N=2) of offenders were aged between 20-30 years. The age range with the highest proportion of foraging offenders was between 30-40 years and accounted 43% (N=3) of offenders. There appears to be no direct correlation between age and other factors such as number of previous convictions. The results of these observations are also displayed in table 30.

Offending History

A detailed breakdown of offending history can be seen in tables 30 and 31 on page 257. From this analysis, it has been established that just 7 foraging offenders amassed a total of 459 offences over their criminal lifetime. 62% of these offences were domestic burglary which accounted for the highest proportion of offending. Vehicle related theft offences accounted for 20.2% meaning that combined, just two offence types make up 82.4% of all offences committed by the foraging offenders examined. These offences were then followed by attempted burglary offences (6.1%), burglary other than in a dwelling (4.1%), other theft (3.7%), criminal damage (1.9%) and violent related offences accounting for just 1.7%.

8.6   Discussion

The aim of this chapter was to deepen the understanding of foraging domestic burglary offenders by examining the geographical behavioural characteristics of foraging criminals to increase understanding of predictive indicators. The chapter also examined the physical characteristics of foraging offenders to add greater insight into their personal characteristics and offending history. This examination identified a number of key characteristics including the dominance of male offenders, with long histories of violence and drug addiction. The results also confirmed geographical profiling as an effective tool to predict the home or base of foraging offender's, and that they strictly adhere to the buffer zone concept. Furthermore, the presence of ecological behavioural assumptions is also identified through the examined displacement examples. These findings are now discussed in greater detail.

Offender Characteristics - Gender

The research in this chapter that examined the offender demographics identified that every offender was male. This is in line with previous research which has indicated that burglary offenders are almost exclusively male (Haginoya, 2014 and Snook, 2004) with previous studies identifying that as much as 97% of burglary offenders are male (Haginoya, 2014). The fact that 100% of subjects in this study are male may be an indication that foraging burglary offenders are even more likely to be male.

Violence

A surprising revelation within this chapter is the high propensity for violent offending displayed by foraging burglary offenders. Over 70% had a history for violent related behaviour within police records. Previous research has shown that only sexually predatory burglary offenders possess high levels of this characteristic (Vaughn et al, 2008) with other studies identifying burglars as traditionally being non-violent offenders (Fox and Harrington, 2012). Sexually predatory offenders possess higher levels of previous convictions for offences such as aggravated assault, burglary and robbery offending (Vaughn et al, 2008). Such violent offending was also evidenced in the offending history of foraging burglars who also had a history of robbery related crimes. A possible causation

for this finding is the predatory behaviour displayed by foraging burglars who, by definition, are effectively a form of predator, seeking out prey which in this context is a burglary victim with the only distinction being that a sexually motivated burglar does this for gratification and not to locate a resource such as stolen property.

Mental Health

Research indicates that burglary offenders do not possess a history of mental health illness (Haginoya, 2014). This chapter further evidence this finding with none of the profiled offenders having any history of mental health illness on their police intelligence records. One possible anecdotal reason for this is the high level of cognitive functionality required to commit an offence of burglary. Burglary is an offence which often requires planning and as the criminology literature suggests, requires a careful consideration of costs vs. benefits and rational choice or as Charnov has suggested from an ecological perspective, a careful consideration of the marginal value theorem (1976). All of these may be traits that are difficult to maintain without a consistent and stable mental state.

Substance abuse

Extensive research has shown that a high proportion of acquisitive criminals, including burglary offenders, are drug dependant (Cromwell et al, 1991). More recent research has continued to underpin this finding (Hearnden and Magill, 2004) and this chapter continues to corroborate this factor. However, with over 70% of the profiled offenders being 'class A' drug dependant it appears that foraging offenders are much more likely to be drug dependant greater than previous studies have suggested (Vaughn et al, 2008 and Fox and Harrington, 2012) The reason for this finding is difficult to pinpoint and raises a 'chicken and egg' scenario whereby it is difficult to deduce whether the offenders were drug dependant to begin with or developed this dependency post offending, as some research has shown (Hearnden and Magill, 2004). If this is the case for foraging offenders, then early action interventions and diversion plans to support foraging burglary offenders may prove successful as a complementary approach to reducing their offending.

Offending History

This study adds further insight to this research by beginning to identify the characteristics of foraging burglary offenders. In doing so it begins to show that in comparison to previously identified burglary offender typologies (Vaughn et al, 2008 and Maguire and Bennett, 1982), foraging offenders have a much higher mean number of previous convictions (M=40.8). Previous research has shown that burglary offenders do tend to have a varied history of criminal behaviour (Hearnden and Magill, 2004; Snook, 2004; Vaughn et al, 2008 and Haginoya, 2014). This study further underpins these findings with 100% of the offenders having previous convictions for a multitude of offences. Despite this similarity distinctions in offending do exist. This research suggests that foraging offenders have a greater likelihood of having a criminal history of domestic burglary (100%) than other identified offender typologies (Fox and Harrington, 2012; Vaughn et al, 2008 and Hearnden and Magill, 2004) It was also established that they have a higher likelihood (43%) of possessing more previous convictions for other theft offences than other studies have suggested (Fox and Harrington, 2012 and Hearnden and Magill, 2004). Conversely, foraging offenders were identified as having a lower propensity for vehicle related offending than other identified studies and a lower mean average of violent offending convictions (Vaughn et al, 2008). However, when considered as a proportionate representation (57%), and in conjunction with the section that established the presence of violent behaviour within foraging offenders police records, as opposed to their actual violent convictions, as being 70%, there is a strong argument for foraging offenders being more likely display violent behaviour than both sexual predator burglars (Vaughn et al, 2008) and chronic offenders (Fox and Harrington, 2012). However, conversely, on an individual basis appear to be less prone to a prolonged history of violent behaviour.

Impulsivity as a Causation

In chapter 4 it was postulated that foraging offenders may be more impulsive that other forms of offender. However, at that time the study had not analysed any actual foraging offenders, only the statistically manifestation of their behaviour in recorded offence rates. This chapter has been able to significantly move this idea forward. From examining the offender profiles of foragers, we now know they

have a high ratio of drug dependency, they also have extensive records for other theft related offending and a high proportion have a history of violent behaviour. These findings mirror those from within chapter 4 when we discovered statistically significant increases in the offence categories of robbery, violent behaviour, functional crime displacement and overall offending. Research outlines that impulsive offenders have a higher association to substance abuse dependence (Farrington, Loeber and Van Kammen, 1990), that they are more inclined to violent behavioural characteristics such as anger and violence (Fossati et al, 2004) and often suffer from a low level of self-control (Critchfield, Levy and Clarkin, 2004 p. 556; White et al, 1994, p. 93). In my opinion, the accumulation of these findings begins to paint a very strong argument to suggest that foraging burglary offenders are impulsive individuals. Furthermore, it begins to help paint a picture of the lifestyle and potential pathway to becoming a foraging offender. This consists of a lifestyle that involves drug addiction. Drug dependency can be very costly and requires consistent and stable funding streams to support such a habit. To support this, foraging offenders resort to acquisitive crime to steal and support their addiction. When potential blockers to their violence free offending arise, they appear less able to control their response. This is likely because of the combination of a developed impulsive personality reducing their assessment of the cost of being apprehended and the benefit of securing a resource. This lack of clarity is further worsened by a necessity to fund their drug addiction. As a result, they may be more likely to resort to violent offending such as aggravated burglary, robbery or theft from the person, all offences which use violence as a means to secure their resource.

This finding provides new awareness in respect of foraging offenders that can be used to help monitor their risk. Practically, for law enforcement organisations monitoring such offenders can use this knowledge to identify foraging offenders, understand their drives, what is likely to escalate their behaviour and how this can be avoided through lawful offender and drug support programmes.

Age

Previous research has established that the mean average age for a burglar is around 27 years of age (Bache, Crestani, Canter, & Young's, 2010; Santtila et al., 2004), with some studies suggesting that this is even younger and ranges between 20-22 (Snook, 2004). The mean average of the foraging burglary offenders within this study is 31.7 (Mdn=32 and SD=25) which is notably higher than other studies. This research also suggests that there is a much higher likelihood (43%) than previous studies (Haginoya, 2014) for the offender to be aged between 30 and 39. Although it is hard to read too much into these differences due to the low number of offenders examined it suggests that in general, foraging offenders are older than other types of burglary offenders studied. One reason for this could be that foraging offenders require a greater depth of experience to calculate the costs and benefits of regular, sustained criminality without apprehension which would support the idea that they are adopting a rational choice approach as opposed to the ecological marginal value theorem. This is argued because if the offenders were calling on their basal ecological nature then one may expect them to instinctively possess this ability. Conversely, this could be viewed in the same manner as any animal simply learning as they grow and becoming increasingly efficient at foraging for their resources.

Age and the Journey to Crime

Multiple studies have shown that the younger the burglary offender, the less distance they will travel from their home or base to offend (Baldwin & Bottoms, 1976; Costello & Wiles, 2001; Gabor & Gottheil, 1984 and Haginoya, 2014). Some have even shown the average distances that certain age groups undertake to offend, for instance, over 30s have been shown to routinely travel over 2km (Snook, 2004). Furthermore, that the younger the offender was, the more likely they were to commit their offences on foot (Snook, 2004 and Haginoya, 2014). Conversely, the older an offender is the more likely they are to travel further and use a motor vehicle to assist their offending (Kocsis, 2007). Studies have even shown that the distance the offender travels can be correlated to a mode of transport in an escalating fashion i.e. walk, bicycle, motor bicycle and motor car (Snook, 2004). What this illustrates is that the age and journey to crime distance

can provide a great deal of useful information about an offender's profile. This study continued to add to this existing knowledge base by identifying that as a mean average, foraging burglary offenders travelled 1.5 miles. As a mean, this is greater than other studies who have examined random burglary typologies (Snook, 2004).

This study ascertained that in general the correlation between age and journey to crime distance remains apparent. It was established that on average younger offenders aged 18-25 travelled just 0.73 miles, offenders aged 26-35 travelled 2.17 miles and offenders aged 34-40 travelled the furthest distance on average at 2.28 miles. In general, there is a distinct difference between the JTC for offenders aged under 25 and those over. This is most likely to be as a result of the previously identified cause within other studies (Snook, 2004) that identified that this was due to the correlation between age and access to transportation. Although this section of the study provides less startling findings to others, the identification that foraging burglary offender's travel similar JTC distances as other studies and that it remains consistent with age correlations still provides value.

Displacement and Patch Movement
Within the ecology literature this is evidenced by an increase of 'giving up rate' as the forager's level of risk taking is reduced due to the perceived increased predation risks. In the case of a criminal forager this would for instance, likely manifest itself in a reduction in substantive burglary offences but an increase in attempted burglary offences, caused by the offenders decreased level of risk taking. This should be particularly evident in areas close to the periphery of a foraging patch, as is found within ecology. Finally, and most significantly for this study once the predation risk increases does the foraging criminal switch patches and begin offending in another area.

The chapter identified that an apparent westerly trajectory in offending is visible in example 1 but examples 2 and 3 both shift easterly, as evidenced by further functional crime displacement in the period between the increased predation risk and identification of the new foraging high risk area the following week. These

trajectories are also mirrored through the presence of by-proxy indicators such as criminal damage offences which is what was theorised was evidence of an offender 'giving up'. Furthermore, the trajectories continue for some distance until the commission of new burglary offences are conducted prior to the new high-risk area within which the forager is now operating being identified. This is particularly evident within example 1 and 2 where the offending can be seen following obvious arterial routes. When these offending behaviours are considered in terms of mean distances it can be seen that once displaced the forager is most likely to commit a functional offence first, with results indicating this is within approximately 500m. After continuing their displacement and increasing the distance from their previous high-risk area by a mean distance of approximately 800m, the offender's confidence appears to increase and 'by proxy' indicators become present. Finally, the full commission of dwelling burglaries return at a mean distance of approximately 1100m.

The three clear examples of spatial crime displacement examined in this study illustrates a clear shift in offending as a reaction to increased predation. Furthermore, the shift appears to be instantaneous in certain examples with functional displacement occurring on the exact day that the increased predation through enhanced tasking and co-ordination begins. These findings suggest that the foraging offender has displayed a number of behavioural characteristics. Firstly, the presence of functional crime displacement indicates that they appear to be altering the source of their selected resources, namely stolen property. This further supports the findings from within chapter 7 that identified that increased predation significantly increases the commission of other forms of theft and burglary other offences. Secondly, although this study failed to prove this issue categorically, it adds further weight to the suggestion within chapter 7 that criminal damage is a by-proxy indicator of foraging behaviour. This example goes further by providing new insights, most notably suggesting that both functional displacement offences and by-proxy indicators can be used to provide geographical predictors of movement of foraging burglary offenders. Finally, the finding supports ecological hypotheses (Lima, 1988a, 1988b and 1992) which suggests that once the forager believes the risk of foraging has reduced

sufficiently, they return to their primary source of resource (domestic burglary) until the risk of predation is again increased or they are apprehended.

Geographical Profiling

Although there are significant changes that a forager can make to avoid predation it is not a one-way interaction. There are also behavioural changes that the predator can make to reduce the effectiveness of the forager's efforts to evade predation. Through studies of the predator and prey interaction it has been identified that when a predator can move between the area of the prey's resource and natural habitat that it directly impacts on the prey's mortality and negates any antipredator benefits of moving beyond their habitat (Werner and Gilliam, 1984). From a Policing perspective, this in essence suggests that if the Police (predator) can operate in both the criminal's (prey) area of their home or base (natural habitat) and the area the criminal commits crime (the foragers patch) and seeks their victims (resource) they stand a greater chance of apprehending or deterring them completely (increased mortality). Literature from criminology and ecology both argue that the simultaneous increase of risk both within the area of the prey's resource or victims and their natural habitat, home or base greatly decreases the antipredator effect of patch movement and crime displacement.

This chapter examined geographical profiles of foraging criminals to ascertain if this theory could be applied operationally, and to also understand the effectiveness of geographical profiling against foraging offenders. In general, the chapter identified that the use of geographical profiling is effective against foraging burglary offenders and on some occasions had an extremely low error distance of just a few hundred metres. That said, the distance for foraging burglars between their home or base and offence locations identified within this study appears to be greater than previous studies with all but two profiled offenders committing all of their offences over a mile (1500m) away from their identified home or base. Previous research has identified that this distance is routinely below 1km (1000m) (Cullen et al, 2006: 197).

The scatter line graph displayed in figure 29 provides some interesting visual context. This illustrates that although there does not appear to be any obvious connection between the overall number of linked crimes committed in a series by a foraging burglar and the JTC distance, there does appear to be a downward trajectory after the first several offences. In general, this suggests that foraging burglars may start their initial offending a greater distance from their home or base. As the series develops the distance reduces and offences begin to be committed closer to their 'natural habitat'. This may be as a result of the increased predation risk due to tasking and co-ordination responses forcing the foraging offenders to retreat closer to their home or base to dynamically evade apprehension, should the need arise. This finding goes against the behavior of conventional burglars who it has been shown often radiate outwards in a distance decay fashion, with later offences in a series increasing in distance from their home or base before reaching a maximal point (Snook, 2004). A possible causation for this may be the mode of transport used to commit offences with foraging offenders over time committing offences nearer to their home suggesting they are most likely to be committed on foot (Haginoya, 2014).

The Buffer Zone

This chapter also identified that there appears to be the presence of a buffer zone in action within crimes series examined, with all but two profiled offenders committing all of their offences over a mile (1500m) away from their identified home or base. This is in line with the fundamentals of geographical profiling (Rossmo, 2000). Conversely, it was established that foraging offenders who did not appear to utilise a buffer zone and committed offences closest to their homes, provided the most accurate geographic profiles. As alluded to above an explanation for this could be in the argument that offenders are committing crimes close to their homes as they are likely to be on foot. Earlier in this study it was highlighted that the police relied heavily on the frequency of the forager product to counter displacement by disabling the foraging criminal's ability to 'retreat' to their natural habitat, or comfort zone as it was referred to. This was heavily debated amongst practitioners interviewed as there were many examples that failed to apprehend offenders or identify their natural habitat (LC2, 2015). The fact that foraging offenders are likely to strictly adhere to the buffer zone

theory may be the reasons why the police failed to accurately identify their home or base by adopting only a single predictive approach. As this study has theorised, supported by the ecology literature, the most likely result of failing to address the displaced foraging behaviour is that it will continue and as such the crime reduction and prevention strategy is likely to have been limited because of a lack of capability to predict an offender's home or base.

Geographical Distribution of Offending

It should be highlighted at this stage that simply proving that significant amounts of other crime and disorder fell within predicted forager high risk areas is itself not evidence that a positive impact in terms of preventing or reducing these issues occurred. However, it does evidence the potential for a positive diffusion of benefit, especially against crimes and issues that are more susceptible to a capable guardian approach. What can be seem from figure 23. is that over time, the foraging burglary offender remains within relatively small identifiable geographical areas. This further underpins other findings within this chapter which highlighted that the foraging criminal will not always switch patch entirely but on occasions will remain within the same relatively small geographic area and simply remain outside of the area where the increased predation risk has occurred. This finding supports research by Brantingham et al, 2009) who argued that concentrating efforts on a larger 'super critical hotspot' could combat offending more effectively.

Circle Hypothesis and Distance Decay

The majority of research has identified that a standard circle hypothesis is ordinarily accurate at predicting the offenders home or base. Although this study has not sought to specifically test one approach against another for accuracy, as measured by error distance, the findings provide sufficient information to discuss generalisations. Firstly, the high mean error distance of the distance decay function (2252m) indicates that this approach is only moderately effective against the sample tested. However, the error distance was at its lowest when the JTC was approximately 1500m and below, which is to be expected, but indicates that when offences are closely clustered in the proximity of the home or base, that the distance decay method is fruitful. In considering Koscis and Irwin's study

comparing methods (1997) who found that when examining burglary offences, the circle methodology was the most effective in only around 50% of cases. Considering this information as a whole suggests that each is effective when used in the right circumstance and that in the context of foraging burglary offenders, the circle model is best used when examining wider dispersed offences and the distance decay is most accurate when examining highly geographically focused offending. To identify the distinction would, of course, necessitate an effective linkage methodology to underpin it.

A Combined Predictive Model

As a result of adding further evidence to existing literature examining ecological assumptions within a criminological context, the value of a combined predictive model begins to illustrate its potential. Doing so adds increased weight to the belief that an alternate way to combat super critical hotspots is to predict the movement of the foraging criminal in a manner in line with that outlined within the ecological literature. Such literature identifies that simultaneous predatory behaviour (police tasking and co-ordination) within the patches within which foraging is present, and, also the area of their natural habitat will maximise predatory effectiveness increasing the mortality (apprehension) of the forager. This will be achieved by providing information that enables the police to operate in both the patch choice area of the offender and within their natural habitat, which as the ecology literature suggests, should negate or reduce the anti-predator behavioral changes of the forager. This provides the police with a much more scientific and focused predictive response that can be effective with fewer resources and underpin pro-active disruption and investigation methods.

Ecological Links

This chapter examined geographical behaviour through both a criminological and ecological lens. Doing so identified traits of behaviour relating to foraging burglary offenders that supported findings in both fields. For example, the criminological assumptions of crime displacement and geographical profiling, particularly the buffer zone element of profiling, were all present. It did however establish that foraging offenders displayed some distinctly ecological traits such as the presence of what appears to be the 'giving up rate' and its geographical

link to the patch movement. Finally, it was clear that a high degree of cognitive functioning was taking place that underpinned the decision making of foraging offenders. However, what is less clear is whether this was evidence of rational choice or the ecological theory of marginal value theorem. For instance, was it rational choice that caused the offenders to cease their burglary offending and switch to other offence types to evade apprehension? Or, was it a causation of the offender being displaced into a less resource rich foraging area before identifying one that returned them to their optimal foraging level from their favored resource?

The presence of behaviours present in both fields returns the study back to the conflicting debate between criminology and ecology. It is clear they possess traits for both but what this study has tried to provocatively weave throughout is whether or not at a more basal level it is animalistic traits within offenders that is driving their behaviour and decision making?

Offender Typology

There are few previous studies that have sought to specify typologies for burglary offenders but those that exist are predominately based upon the offending history of the subjects. A number of typologies have been suggested within these studies which include; young versatile, vagrant, drug dependant, sexual predators (Vaughn et al, 2008) and Maguire and Bennett (1982) identified a three-tier typology of low-level amateurs, mid-level professionals, and high-level professionals. Others have put forward a similar four class offender typology (Starters, low rate, high rate and chronic) based on their offending rate (Fox and Farrington, 2012). This study has furthered this area of knowledge by clearly establishing that foraging burglary offenders are a distinct type of criminal, who display their own behaviours and are identifiable by their personal, offending and geographical characteristics. Doing so has great value to crime prevention and reduction efforts as when identified it enables law enforcement agencies to call upon 'what works to combat foraging behaviour specifically by for instance adding further detail to Ratcliffe's policing hotspots matrix (2004).

Foraging Burglar Typologies

Advancing the theory that there exists a distinct foraging burglary typology this study, and this chapter in particular enables the thesis to outline 6 potentially new forms of foraging behaviors. These behavior types are dictated by a multitude of factors outlined as the marginal value theorem (Charnov, 1976) and include oover foraging, where little of the resource or prey remains or, due to previous levels of foraging the level of predation now is too high (Charnov, 1976). These types include the optimally focused forager, the optimal patch forager, the central place forager, the optimal temporal forager, the marauding forager, and finally the impulsive forager. Optimally focused foraging refers to the circumstances where the forager is free to travel between patches as and when they please and has no impleading factors to consider, such as an increased risk (Sinervo, 1997). Sinervo (1997) outlines that in such circumstances the forager will almost certainly target the areas of highest gains with least energy expenditure and risk resulting in what this thesis calls an optimally focused patch, where they focus both time and space in a focused manner that maximises return for effort and risk.

Similarly, the optimal patch forager remains geographically fixed but alters the time of their offending to maintain their success at a high level. The central place forager is one that as Orians and Pearson (1979) has outlined will conduct their searching based around a specific base or home and as such their prey will fall within their routine activity node (Orians and Pearson, 1979) which Sinervo (1997) outlines as a place they can quickly retreat to. The optimal temporal forager is built upon the theory that certain types of forager have fixed time constraints that cannot be altered (Sinervo, 1997), but as a response to the marginal value theorem, when resources are scarce, or risk is heightened, the forager has the knowledge and ability to locate other patches using known landmarks and geography (Roche, and Timberlake, 2002). The marauding forager is a concept drawn from the research relating to geographical profiling which outlines two types of offenders as 'marauders' and 'commuters' (Canter and Larkin, 1993) based on the distribution of their offences, with marauders being more likely to commit offences in cyclical dispersed parameters to their home or base (Canter and Larkin, 1993). In this scenario, they do this being

cognisant of both predation and temporal restrictions. Finally, the impulsive forager is one that is both marauding and temporally distributed due to extremely high risks which has a fundamental impact on their offending behavior, as outlined in earlier chapters. This thesis is the first to suggest that an offender may operate as any, or all of these typologies, dependent on their perception of the increasing predation risk. Furthermore, that the ability to identify which foraging behavior is being utilized, enables the selection of the most effective evidence based geographical predictions to inform police tasking and co-ordination response.

8.7   Conclusion

The key aim of this chapter was to examine the geographical behaviour of foraging domestic burglary offenders and to examine their personal characteristics to provide deeper insight into their makeup. The results from the research within the chapter provided a large number (n=18) of interesting new insights that have contributed to the knowledge within the studies main areas. These included identifying that foraging burglary offenders are predominately male, possessed a long history of violence which wasn't always reflected in their convictions, did not have a history of mental health but did have a strong dependency on illegal controlled drugs. Furthermore, they had a strong history of theft in general but conversely, did not routinely possess theft convictions relating to vehicles. In respect of age, the foraging offenders appear to be older than normal burglary offenders with a mean age of 31 but in line with other burglary offender typologies, the younger you are, the less distance they travel to commit offences.

Results suggest that foraging offending is committed within tight geographical zones, which could be combated using a super critical hotspot approach if such resources permitted. The presence of crime displacement, or patch movement as the ecology literature outlined was also established. Such movement was identified in a spatial, temporal and offence context. Furthermore, it was established that the displaced behavior actually mirrored that of behaviour identified within ecology, particularly through the presence of a higher 'giving up' rate on the periphery of offending patches prior to re-offending continued and

returned to their favoured source, burglary, suggesting that their movement could potentially be tracked through crime locations. The chapter also established a strong adherence to the buffer zone theory by foraging criminals which was usually as large as 1500m, and, who in contrast to standard offending actually appears to radiate inwards towards their home or base as opposed to away, or in a stable perimeter. In this respect, it was suggested that as their crime series continued, that after 3 offences the JTC appears to reduce.

Chapter 9

Assessing the Effectiveness of Geographical Profiling as a
Predictive Policing Methodology

9.1 Introduction

In previous chapters the efficiency and effectiveness of the predictive Policing methodologies implemented by UK police services was examined by quantitatively and qualitatively. In doing so it was established that there were a number of key areas that ultimately impacted on the efficiency of the adopted optimal forager methodology and the effectiveness of its implementation and also the methodologie's accuracy. In chapter 8 geographical profiling was examined quantitatively using GIS software to ascertain its effectiveness in predicting the home or base of foraging burglary offenders. This chapter began to outline how combing two predictive models (optimal forager offence prediction and geographical profiling to predict a foragers home or base) could be combined to complement each other. It is argued that doing so could increase the effectiveness of combating foraging offender behaviour and maximising the effectiveness of what in reality are finite police resources.

In this chapter, the same qualitative process used in chapter 5 will be applied to establish the accuracy, efficiency and effectiveness of operational geographical profiling. This will again enable an assessment of the implementation issues which may impede any future combined predictive solution to tackling foraging burglary offenders. It is important to distinguish the meaning of 'operational' and why this issue is so important. Much research has been conducted into the theory of geographical profiling, however, the overwhelming majority is retrospective in nature, meaning it is completed by testing the theory against historic cases. As such the aforementioned types of study have no need to examine the logistics and practicalities experienced by front line practitioners of the theory as the suspect is already known and has been proven. However, as earlier chapters illustrated, this paints only half of a picture. To assess the effectiveness it is essential that they are examined in an operational front-line setting. Only by doing this can the intricate nature of holistic factors that may facilitate or block the efficiency and effectiveness of this theory be identified. Only once this is

achieved can the potential for combining such methodologies to maximise crime prevention and reduction be understood and in future, put into practice. In completing such an analysis the chapter examines areas such as practitioner perspectives on offender targeting, understanding of the definitions of geographical profiling, the impact of crime linkage on the theory, the training and costs of its conduct, the awareness of law enforcement agencies regarding the theory and their access, availability to the procedures before reviewing how profilers collect the required data, how timely they produce profiles and their ultimate effectiveness and accuracy.

In examining the small area of literature, it was identified that only a single piece of literature has been produced that seeks to examine geographic profiling in an operational setting, but its objectives were achieved through a questionnaire in an effort to identify how the profiles are constructed, their perceived usefulness, whether the key assumptions of geographic profiling are considered and finally the types of cases which are used (Snook, Bennell and Taylor et al, 2015). Although this chapter will cover some of these issues, due to its qualitative nature, the study adds greater richness to this almost completely absent literature base.

9.2   Aims and Objectives

By conducting interviews with geographical profilers (n=6), further richness is added to the operational effectiveness and efficiency of geographical profiling as it is assessed as a predictive policing solution to identifying the home or base of foraging burglary offenders. Perceptions of front line practitioners (n=11) involved in tackling domestic burglary are now also considered in the context of geographical profiling. This enables conclusions to then be drawn in respect of the methodology as a predictive solution to combating foraging induced displacement.

9.3   Methodology

Semi Structured Interviews

The chapter uses the same methodology as that utilised within chapter 5 on page 139 and concentrates on the use of semi-structured interviews to increase the

understanding and assess the effectiveness of the geographical profiling theory in an operational environment. This was again because they offer the best method of obtaining an individual's subjective experience and any meaning they attached to the relevant outcomes (Devine, 2002; 199) and allows the interviewee opportunity to express their views and opinions (Devine, 2002; 198). However, there a number of potential issues to be mindful of when using semi structured interviews. These relate predominately to the potential for the interviewer and interviewees behaviour, language and non-verbal communications impacting upon the bias and quality of the content and subsequent products produced (Opendakker,2006; Wengraf, 2001; Devine, 1995; Mason, 2002). All of these issues are outlined in much more detail earlier in the study.

Sample

In total only 6 interviews were conducted for this part of the study. The interviews were conducted between March and September 2015. The use of probability sampling was considered to aid in the selection of participants and provide a more representative sample. However, as this section will illustrate, restrictions heavily impacted on this method making it unable to be conducted.

In total this element of the study is drawn from interviews of 6 geographical profilers all currently operating in a law enforcement role. Within the United Kingdom there are 43 Police services and it was established that disclosure of the presence of a geographical profiler would only be achieved as part of a freedom of information request. Due to the cost of this it was not practicable to achieve in this study. However, it was established that within the UK all geographical profilers were required to be accredited by a single academic establishment. As such an agreement was reached with the accrediting authority to establish contact on the researcher's behalf with accredited profilers and profiling analysts. Furthermore, a call for volunteers was placed on the Police knowledge sharing community website, POLKA, which is operated by the College of Policing for the use of Law Enforcement practitioners. As outlined above, unfortunately only a small number of geographic profilers and analysts responded and as such the conclusions and generalisations made from this

element of the study must be considered with caution. This is because it has not been possible to establish how representative the views are of the wider geographical profiling community. In fact, due to these restrictions it was not even possible to identify the number of operational geographical profilers within the UK at all. That said, it was identified that the number of accredited professionals is incredibly small which will be outlined in greater detail later in this section. Similar access issues were identified in the most recent publication relating to geographical profiling (Snook et al, 2015) who also experienced difficulties in accessing operational law enforcement staff for completion of their questionnaire on this field. Other scholars have also experienced similar access issues in the past with response rates ranging from 25% (Burrell and Bull, 2011, cited in Snook et al, 2015) to as low as 6.3% (Jamel et al, 2008 cited in Snook et al, 2015). Each of these studies related to questionnaire responses whereas this study conducted interviews, so it could be argued that such a low participation rate is not necessarily a weakness of the research approach conducted and more a reflection of the ongoing issues experienced by researchers when examining operational law enforcement processes.

In addition to the interviewees from a geographical profiling background the participants from chapter 5 (N=11) are also revisited as many can also add value to the discussion in respect of offender identification and predicting their home or base. Finally, to identify suitable participants two criteria were used to select interviewees. Firstly, participants were chosen due to their position within a Police service or organisation where they were involved directly within geographic profiling. Secondly, they possessed frontline law enforcement experience and could provide that important operational practitioner perspective.

Equipment

Interviews were audio recorded and then transcribed. This allowed the interview to be conducted in a conversational manner that allowed the participant to feel at ease and provide the best information possible. An aide memoire of key questions was used to guide the interviewer and maintain structure and comparison between all participants.

Procedure

Facilitation of the interviews was primarily done face to face. Interviews were conducted at the place of work of the participant. On occasions due to the geographical restraints faced, interviews were conducted using face to face internet-based media such as Skype, Face Time or telephone. A small number of supplementary questions and clarifications were conducted using email when diary restrictions prevented other options. Prior to referencing within the study all interviews were anonymized and a coded system adopted by Rozee (2012) and was also used in chapter 5 was followed. Interviews were referenced using the initials of their organisation and a number. This number was sequential when more than one interview was conducted in an organisation.

Analysis

The interviews in this element of the study were subject to deductive and inductive theme analysis. Many of the themes were identified through the assessment conducted in chapter 4, 5 and 8. Further themes were also identified during the conduct of the literature review and were also included. The remaining themes that were not identified previously were inductively identified by the author through the analysis of the interviews.

9.4 Results

In this section key factors that have been identified for examination include those that have been identified earlier in the study as potentially impacting upon the implementation success. These include factors that contribute to theory failure as well as those contributing to implementation failure such as the impact of crime linkage, cost, training, awareness, access, availability and request procedures, information collection, timeliness and accuracy. These areas will each be outlined in further detail throughout this section.

The Practitioners Perspective of Offender Targeting

In this first section, we offer a brief outline of practitioner perspectives on the need for new approaches to offender prediction. These perspectives were expressed during the crime prediction qualitative studies and offer a useful

interlude to assessing the potential of geographic profiling as a complimentary theoretical framework to a combined predictive model.

During the literature review for this study the national intelligence model was identified as providing the driving force behind current offender targeting approaches. This approach relies heavily on the availability and analysis of intelligence. However, as this study has alluded to intelligence levels have reduced significantly now and in respect of acquisitive crime this is evidenced as being a reduction of as high as approximately 75%. The impact of this on the national intelligence model is not fully understood yet and requires further study, however, during participant interviews it was evident that there is currently an existing doubt in the success of the intelligence driven approach which was expressed during the participant interviews;

> *"As both pilots have progressed it has become apparent that the strength of Forager lies predominantly in the 'location based' response…. the Police have well established processes in place to effectively develop intelligence on local offenders and identify and target them accordingly. Are offender-based approaches effective though?" (LC6, 2016)*

During the analysis of participant interviews the necessity to predict offenders was identified with it being argued that predicting the crime and offender are two sides of the same coin (LC2, 2015). It was further suggested that the most effective approach to predictive Policing would be in predicting both angles to this equation (LC2, 2015) as this study seeks to try and do. During the interviews, there was also evidence of a deep understanding from some that a necessity existed to look at offender targeting in a more scientific approach;

> *"I do believe that given a large enough sample size and scale modelling, human behaviour is intrinsically predictable. We should be using demographics, crime, health and social data to inform decisions" (LC4, 2015)*

Although not expressly arguing for a combined crime and offender approach to predictive policing such statements highlight the awareness that current processes may not be operating effectively and that a better way to predict the offender is required.

Defining Geographical Profiling

In this section, we briefly look at the definition of geographical profiling. Although as with predictive Policing reaching a consensus on a definition is not an objective of this study, however, it serves as a useful barometer of the understanding of those interviewed during the research process. Geographical profiling has been most simply defined as;

> *"An investigative technique used to determine the most likely location of a criminal's residence based upon the geographic location of crime sites"*
>
> (Prof David L. Wiesenthal, 2012)

From the interviews conducted during the research into operational geographical profiling it was established that there was a high level of understanding of what the theory sought to achieve. Equally important was the participant's understanding of what could not be achieved using this methodology. As can be seen from the definitions highlighted below the participants had a strong understanding of the subject and their responses included almost all of the fundamentals of the definition;

> *"An investigative methodology used primarily to determine the most probable location of an unknown offender's key anchor point (usually their home address) by analysing spatial and temporal offence-related data"* (NCA1, 2015).

> *"An investigative methodology to find the most probably anchor point or search area of a serial offender"* (CISA1, 2015).

> *"Analysis conducted in relation to a series of, or more rarely, one off, offences where an offender has not been identified with a focus on using*

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geographic and temporal information to develop strategies to assist the investigation" (NIC1, 2015)

"It is a technique for using any available geographic information about a serial offender, and the linked offences committed to try and put any identified suspects in priority order for the investigators (GMP1, 2015).

This section established that the level of knowledge of the participants interviewed was impressively high. The reason for this high level of understanding becomes clear when the training undertaken by the participants is examined in greater detail later in the chapter.

The Impact of Crime Linkage on the Efficiency and Effectiveness of Geographical Profiling

This section seeks to establish if, and what the issues may be in this area of work. In doing so this information can be combined with other blockers and facilitators to aid in reaching a conclusion on the overall efficiency and effectiveness of the geographical profiling process.

When questioned regarding this area all of the participants were universal in their stance that one of the biggest blockers to a case ever being identified as suitable for considering a geographic profile was the absence of crime linkage (NIC1, NCA1, GMP1 and CICA1, 2015). In its simplest form the argument outlined that more accurate crime linkage leads to more accurate profiling and as such a more effective predictive product (NCA1, 2015). One of the biggest bottlenecks to an accurate linkage of crimes was identified as crime analysts (NIC1 and GMP1, 2015). In an operational environment, it is most often the crime analysts and to a lesser degree the investigators, who work in a borough command unit who are most likely to identify a linked series of crimes at an early stage. This is because they are responsible for compiling intelligence and performance products. However, it is suggested that cultural beliefs around the issue of crime linkage impact on their training which becomes ineffective at both emphasising the importance of this area or in the techniques used to conduct the linkage;

"It seems to be widely believed that it is easy and so no-one gets any useful training. Analysts have the Comparative Case Analysis technique but I'm not a big fan" (GMP1, 2015).

It is further suggested that because of both cultural and training issues these analysts are failing to identify crimes as being linked (NIC1, 2015) and as such they are not identified as a series despite its obvious potential;

"We know that a large proportion of crime is committed by a small number of offenders which means that we have a lot of series, so identifying these has the potential to have big impacts" (NIC1, 2015).

It was argued that one of the major reasons for this is that as a result of a lack of empirically underpinned training, they underestimate the complexities of linking crimes and look for more culturally acceptable yet inaccurate indicators of linkage (GMP1, 2015);

"My experience is that officers and analysts are often pretty bad at identifying linked series with a marked tendency to pick up on similarities and to ignore differences. Also, aspects of the MO which are generic, i.e. those actions which have to be done in order to commit the offence, are often given too much weight" (GMP1, 2015).

Training and Cost

When trying to assess the efficiency of the implementation of geographical profiling it is necessary to examine the training undertaken by the participants interviewed. In doing so it can be established how detailed the knowledge of the profilers and analysts is and enable conclusions to be drawn from any correlations with other factors that may arise such as time and accuracy.

In assessing the depth and standard of the training provided to geographical profilers it was identified that all of those interviewed had received training and that in their opinion the initial training that they received was of a very high standard. This has previously been identified with research suggesting as many as 77% of profilers have received training in the methodology (Snook et al, 2015).

> *"I was asked to go on the two-week Certificate in Geographic Profiling course from the JDI and Geographic Profilers from Bramshill. My understanding is that only certified Geographic Profiling Analysts who have completed this course are allowed to undertake 'official' geographic profiling"* (GMP1, 2015)

Attendance at an accredited two-week profiling course is required which provides expert tuition on the theories of environmental criminology along with role play of real life profiles and the use of geographical information systems (NCA1, 2015). However, it was highlighted that the downside to this training programme was that it focused heavily on volume crime (NIC1, 2015). As part of the certification process and because of the risk attached, the profiling of more serious crime types is restricted to more experienced profilers or is completed under their supervision (GMP1 and NIC1, 2015).

Despite the high level of training delivered to profilers at the beginning of their careers it was outlined that the field is one of regular change with new literature, research and theories (NCA1, 2015).

> *"the undertaking of a geographic profiler is constantly changing and therefore the understudy program run by the ICIAF is slightly out of date and requires some improvement"* (NCA1, 2015)

Despite such developments the profilers receive no refresher training and as such their skill level often falls behind (NCA1, 2015). A further issue which compounds this is identified in the technology used by the profilers. It was outlined that despite often being provided with the excellent software to assist their work, training in its use was minimal, severely hampering some profiler's effectiveness (GMP1, 2015). Furthermore, the actual software systems were identified as being different dependant on the organisation the profilers worked within which it was suggested hampered their effectiveness as well (GMP1, 2015).

"On the training course, we used Crimestat III (freeware) and Rigel Analyst. We were all given a time-limited copy of Rigel Analyst to complete a profile in our own Forces that was required to gain certified status" (GMP1, 2015)

For example, although the Rigel system was identified as being one of the very best available, not all profilers had access to this system because of the cost of licenses (NIC1, 2015). As a result, profilers resort to using free to download applications or basic Google street maps (NIC1 and GMP1, 2015). In respect of this issue it was suggested that the use of any specific software or associated training was not key to an effective profile as it was the science and theory behind it which was the biggest factor (GMP1, 2015).

"it was made very clear on the course that the use of any particular software is not necessary for geographic profiling because it is more a way of thinking about the analysis of crime series. Nevertheless, I think that this will be less true for less experienced geographic profilers like me" (GMP1, 2015)

However, it was argued that the less experienced profilers required the assistance provided by the software systems to help them do their job (GMP1, 2015). It was identified during this study that the most effective geographical profiling systems are extremely expensive with purchase of Rigel and ArcGIS, which are considered amongst the best examples of profiling software, costing as much as £10,000 for a single user license (NIC1 and CISA1, 2015). Cost for higher numbers of users rising closer to £12, 000 (CISA1, 2015). It was also established that the annual maintenance costs can also be significant, often reaching several thousand pounds per year (NCA1, GMP1, CISA1 and NIC1, 2015). As has already been highlighted, the cumulative cost of these systems results in profilers being unable to use what are potentially the most effective software with a potentially detrimental impact on their work (GMP1, 2015)

Awareness

After all of the training and cost that is required for a geographical profiler to be able to provide a service it would be reasonable to expect that they would be a

highly sought-after asset. However, this study identified that this was far from the case and this section sets to outline, the reasons behind the lack of awareness of the skill. It was established universally across all of the participants interviewed that there was a widespread lack of knowledge in both the existence and capability of geographical profilers (NIC1, NCA1, GMP1 and CISA1, 2015).

> *"As things stand there is no real mechanism for publicising the availability of a geographic profiling analyst or of helping colleagues to understand what it can and can't do"* (GMP1,2015)

> *"I think that hardly anyone knows that we have the capability"* (NCA1, 2015)

Sadly, it was evident that only very experienced or specialised people within the Police service had an understanding of geographical profiling as a potential investigative support tool (NIC1 and NCA1, 2015). Even those that were aware of the method did not fully understand its potential to assist in volume crime investigations such as burglary (GMP1, 2015). To further compound these issues, it was also suggested that even when awareness was present there was potentially cultural issues of parochialism between officers and profilers;

> *"A lot of investigators do not know this kind of analysis and have never heard about it. Some also do not want to work with analysts and don't want to give information about their case"* (CISA1, 2015).

> *"Investigators should be more open and provide analysts with more information of the case. There is unfortunately always the fear that an analyst is going to solve the case"* (CISA1, 2015).

Unfortunately, it was suggested that there was little that could be done to combat these issues as there was a lack of mechanisms to advertise the services available from profilers (GMP1, 2015).

Access, Availability and Request Procedures

Providing that staff are aware of the availability and capability of geographical profilers a further issue that has an impact on their efficiency and effectiveness is gaining access to this skill. As such this section will outline potential issues that impact on this process such as the lack of geographical profilers and the request process itself in more detail.

The first and most obvious and significant issue that was identified in relation to this section was simply the lack of qualified practitioners available to assist Police services;

> *"As of April 1st 2015, there will be one full time geographic profiler employed in UK law enforcement. Two former geographic profilers may be available for consultancy work as external advisors, but there will be a charge to Police forces to cover their costs. There are a few trained Geographic Profiling Analysts (GPAs) working within forces but the exact number is unknown"* (NCA1, 2015).

Worryingly the lack of geographic profilers was an issue highlighted by all participants that were interviewed (CISA1, NIC1 and GMP1, 2015), although some were lucky enough to have access to a profiling analyst (CISA1, 2015) or an apprentice within the national crime agency (NIC1, 2015). Even then it is suggested that there is a distinct lack of qualified geographical profilers who are available to assist profiling analysts and apprentices in their professional development (NIC1, 2015). It was suggested that a cause of the lack of profilers could largely be attributed to cuts in resources due to measures of austerity (GMP1, 2015). It is argued that as a result of the lack of awareness of geographical profiling and what it can do to assist investigations was a contributing factor in the level of budget cuts experienced and that there is now a genuine possibility of the tradecraft disappearing;

> *"The discipline is at risk of being lost to UK law enforcement due to under-resourcing at local and national level creating a lack of resilience"* (NCA1, 2015).

Providing that officers are aware of the concept of geographical profiling and there are sufficient profilers available to service requests a further hurdle that stands in the way of its efficiency is the request procedure itself. It was established that there is a significant lack of consistency in terms of processes for requesting a geographical profile. It can either be done at a national or international level through the national crime agency, or, for those lucky enough, there may be an internal request process to follow.

In respect of requests through the national crime agency, these can be conducted by contacting the specialist operations centre or via what is called the 'operational support team' (NCA1, 2015). However, it is accepted that how individuals go about this is not routinely publicised (NCA1, 2015). Furthermore, dependant on the organisation, the request procedure varies.

> *"We have a standard tasking process for Analysts and Researchers where requests for work for FIB Analysts and Researchers (on a form) are sent to the Senior Analyst for allocation. (GMP1, 2015)*

> *"Contact via NCA Specialist Operations Centre or direct to a member of the NCA Crime Operational Support team" (NCA1, 2015)*

Furthermore, external requests must also compete with internal requests that relate to the core business of the national crime agency which it was identified consisted predominately of investigations into homicide and serious sexual offences (NCA1, 2015). As such, only the most serious of external requests is likely to be prioritised to a sufficient degree to receive an expedient response and a volume crime case such as burglary would likely be a very low priority. However, it was further identified that the majority of external requests related to commercial robberies (GMP1, 2015) and as such it is reasonable to presume that it is rare for an external case to be satisfactorily expeditious to provide a useful investigative aid.

Should a Police service be fortunate to have an internal geographical profiling capability then investigators can request a geographic profile through arguably

more effective channels. The formal avenue is often as simple submission of a written request to the relevant department within which the profiler is based which is then recorded and allocated (GMP1, 2015). On occasions however, the formal process is completely circumnavigated;

> "*There is also the other process where senior officers (Chief Superintendent and above) just short circuit the whole process and get the bosses here to task us directly*" (GMP1, 2015).

However, not all investigators have the liberty of possessing such authority and must follow the formal methods of request. That said, even though internal request procedures may be more effective, it is still suggested that at best they are severely underutilised or at worst there is insufficient resources available to concentrate on producing profiles (NIC1, 2015);

> "*I have been approached perhaps twice or three times about producing geographic profiles for series that were not suitable*" (GMP1, 2015).

Once a request is submitted and before it can be allocated to a geographical profiler there is a distinct set of conditional criteria that must be met. The criteria outlined was established as the presence of a crime series that was linked through a strong evidence base and there must be at least five crimes. Secondly, that the suspects are local marauding offenders as opposed to commuting criminals. Furthermore, if there are more than one offenders that they originate from the same home or base and finally, that the marauding offender has not moved home or base during the crime series (GMP1, 2015). These requirements do correlate strongly to the conditions outlined by Rossmo (2000, 2005) who has repeatedly argued that the production of an accurate and effective geographical profile can only be conducted when certain conditions are met.

Information Collection

The data collection stage often starts with the initial request that is submitted and as the previous section outlined, this has to reach a very high threshold. Once a profiler is allocated a case for further investigation they will routinely ask for all of the available information in relation to that case (GMP1, CISA1 and NIC1, 2015).

This will usually consist of information from crime scene reports and witness statements (GMP1, CISA1 and NIC1, 2015). Some profilers will also request a face to face briefing from the investigating officer (CISA1, 2015) which could potentially be difficult if an investigator has had to request external assistance to provide the profile. This is also a potential issue in relation to the crime scenes themselves as some profilers also request a visit to the place of the offence (GMP1 and CISA1, 2015), whereas others request only photographs (NIC1, 2015). It was identified that certain types of information that the geographical profilers required could cause delays in the creation of a predictive product;

> *"Statements and CCTV footage are a particular issue because they are not stored in Force systems and we have to request copies from the investigators. This can be very time-consuming to say the least"* (GMP1, 2015).

It was also suggested that the production of a predictive product was most successful when the profiler had sufficient information about the offender's behavioural characteristics to enable them to draw conclusions, for instance, the direction of approach to a target and the offenders escape route (GMP1, 2015). This is of course, not always information that is known by the investigators. It has been suggested that such a wealth of information is required because a profiler does not solely rely on the geographical crime location of the crime scene (NCA1, 2015). A profiler in today's investigative world calls on knowledge and experience of scientific theories that underpin criminal behaviour such as routine activity and rational choice theory (NCA1, 2015). In doing so it is argued that the profiler is able to better understand the offender;

> *"It is used to understand the criminal event, why it happened where it did, how far the offender may have travelled, how he chose the location, victim"* (NCA1, 2015).

It is further suggested that the use of a geographical information system is only used to underpin the profiler's conclusion in respect of a prediction of a likely home or base area (NCA1, 2015).

Timeliness

The length of time that it takes to produce a geographical profile from the time a submission is authorised to a predictive product being generated can take anything between several days to several weeks (CISA1, 2015). This difference in time scales is as a result of several factors, including the personal requirements of the profiler;

> *"Provided we can get all the information we need and providing that the series meets the criteria then the process is not time-consuming. I would say a matter of days, but I would want a guided tour of the offence locations before starting, to avoid falling into any elephant traps"* (GMP1, 2015).

Other factors include the complexity of the case being investigated with it being suggested that the more complex the profile, the longer it takes to produce a predictive product but on average a useable prediction takes approximately two weeks (NCA1, 2015). It has also been suggested that the length of time it takes for a predictive profile to be generated is one of investigators main issues with the approach (GMP1, 2015). This is because often in real time operational investigations an investigator requires information to underpin their tactical decision making at an expeditious pace, however, current processes often prevent this from occurring. As a result, it has been outlined that it is a regular occurrence whereby once a profile request is submitted, they are solved during the interim period through traditional investigative approaches (GMP1, 2015).

Measuring Accuracy and Effectiveness

In pursuit of a conclusion to the accuracy of geographical profiling it was argued that there is no specific measure for assessing accuracy in an operational context (NCA1, 2015). This is in large due to the fact that often some investigated offences that form part of an offender based predictive geographical profile remain unsolved for evidential reasons (NCA1, 2015) as the theory cannot be used to support a prosecution. In reality, this means that although the geographical profile may have predicted the likely home or base of an offender with a high degree of accuracy, unless that suspect is successfully convicted using traditional evidential means it cannot be labelled as an accurate prediction as there is always the possibility that another suspect was responsible, or a conviction would likely have been secured.

Furthermore, it was established that there was no database in existence that recorded the outcomes of investigations in which a predictive product was requested. As such it is impossible to offer a quantitative level of accuracy on the methodology as was possible in relation to the predicted optimal forager product. It was outlined that the lack of cases that could be directly attributed to a success of geographical profiling was an issue that made it 'hard to sell' (NIC1, 2015). That said it was outlined that in geographical profiling cases were software was used to aid the profiler that a high degree of accuracy was experienced in identifying anchor points for suspects (CISA1, 2015) with some reporting accuracy as high as 99%;

> *"Where offences have been detected, most offenders have been shown to have an anchor point in or close to the area prioritised. Where Rigel has been used, this has been in the top 1% of the hunting area"* (NCA1, 2015).

However, it is important to outline that as already alluded to in this section, no quantitative data could be produced to underpin this fact and as such it is taken on face value but with caution. What was identified was that participants could offer numerous qualitative examples of geographical profiles that underpinned strategies that led to the apprehension of a suspect (NIC1, 2015).

"*Success is more than being able to put a pin in a map and say where the offender lives*" (NCA1, 2015).

As such, to enable a more informed conclusion the accuracy of operational geographical profiling has to be assessed as a by proxy of its investigative effectiveness. This is because it is argued that a predictive profile that was effectively used to aid an investigation by the fact that it added value in tracing or equally valid, eliminating, potential suspects, is in essence an investigative success and as such, effective (NCA1, 2015);

"*Whilst it is therefore unlikely to lead directly to the apprehension of an offender, it may accelerate this outcome by providing a focus on a geographic area. Disruption is likely to be achieved by traditional Policing methods which are given a geographic focus*" (NCA1, 2015).

For example, numerous cases were outlined in which geographical profiling was used to help investigators prioritise their traditional tactics (CISA1, 2015) such as house to house or prioritise suspects identified for DNA screening (NCA1, 2015). It was also cited as being successfully used to position CCTV in a specific area which led to the arrest of a suspect which disrupted further offending, although not resulting in a successful prosecution (CISA1, 2015). Each of the participants interviewed suggested these examples showed that the methodology was accurate as it led to an accurate and 'positive' result, underpinning its effectiveness as a predictive tactic.

This stance that geographical profiling is more than just predicting a likely home or base of a suspect is one that is repeatedly argued by operational geographic profilers (NIC1, 2015);

"*Snook et al assume that GP is just putting a dot or circle on the map to suggest 'offender lives hereabouts', but GP in practice does much more than that, using analytical techniques and considerations such as opportunity structure, directionality, target backcloth and street layout*

amongst many other things, providing potential leads and strategies for an investigation. A computer programme can't do that" (NIC1, 2015).

Future of Geographical Profiling

Interviewees were also asked about their thoughts and opinions in respect of what the future may hold for such a predictive policing approach. This was as a result of recent research that has shown that the perception exists that the use of a GIS to produce a geographical profile remains the most accurate method (Snook et al, 2015) and that such highly qualified profilers may not be required. Furthermore, there also exists some support for informed use of spatial analysis techniques without a GIS (Snook et al, 2015). The importance of trying to shift geographical profiling from a specialist function to one that can be conducted on a volume basis using either a GIS or heuristic approach is not lost on profilers themselves. Participants interviewed expressed concern that there is a legitimate potential for the approach to be abandoned due to its infrequent use (NCA1, 2015);

> *"I believe it could add immense value particularly in relation to volume crime as by linking offences and investigating as a series rather than one off offences this brings all the collective evidence to bear on the analysis and investigation with better chances of developing leads and greater efficiency of tasking investigative resources"* (NIC1, 2015)

However, this acceptance of a potentially easier way of doing things was tapered with apprehension, particularly around the ability and expertise of those who would conduct the geographical profiling;

> *"I think it's dependant on a lot of different considerations and the application of expertise and tacit knowledge to come up with various investigative strategies. It's not just a heuristic of circling a location on a map"* (NIC1, 2015).

Concern was also expressed around the suggested areas for which such an applied approach would most likely be used for (GMP1, 2015). It was suggested

that volume crimes such as burglary often do not provide sufficient case information to produce an accurate profile and as such it was suggested the simple heuristic approach would not be accurate enough to add value (GMP1, 2015). Such an argument was underpinned by the overarching suggestion that a heuristic approach was an oversimplified way of trying to reproduce a very complicated methodology (NCA1 and NIC1, 2015). However, this is not an opinion shared by practitioners involved in targeting offenders who in the light of a failing intelligence based NIM approach considered its potential value to be worthy of consideration;

> *"If a model to combine geographic and offender profiling could be developed at a cost-effective rate then we could gain some great success in the war on crime"* (LC1, 2015).

It was also outlined that in order to achieve such a position that there is a clear need to train more frontline staff in the theoretical frameworks of the approach to enable a wider understanding of its use and potential impact, but the cost of such training would be a likely blocker (NCA1, 2015). A more cost-effective solution was identified as training existing intelligence analysts in the underlying concepts as they already possess a high degree of analytical and technological awareness (GMP1, 2015). Combine this with a culture change that advocates analysts taking a more 'field work' orientated approach to crime linking and profiling and this may address the current underemployment of geographical profiling as an offender prediction methodology (GMP1, 2015).

9.5   Discussion

It was identified in the previous chapter that geographical profiling provides a complementary predictive policing methodology to combat foraging burglary offenders. The aim of this chapter was to conduct interviews with practitioners to understand the operational effectiveness and efficiency of geographical profiling as it is assessed as a predictive policing solution. Doing so enables an assessment of the approaches implementation success and future capability as part of a combined predictive solution to combating foraging burglary offenders. The key discussion areas and findings discussed in this section include the lack

of geographic profilers at a local, regional and national level. Its use and development are impacted by cost, awareness of the methodology and the stringent tasking processes combined with acceptance criteria. These issues are now discussed in more detail.

Practitioner Learning and Development

Practitioner knowledge is an important factor as it highlights a high degree of understanding of the theoretical framework underpinning the profiling process. Such a level of understanding is essential to achieving a high degree of operational effectiveness, as without a sound underpinning knowledge base it is likely that the quality of any geographical profile produced would not be maximised and 'theory failure' would be likely. This study established that the level of knowledge is extremely high amongst practitioners and this is no doubt as a result of the large investment in their initial training. However, once trained the level of continued development is almost non-existent, especially in respect of the use of the geographical information systems. This lack of training around geographical profiling principles is also present amongst analysts who, despite their important position in the process of producing information that underpins a profile, they appear to receive no formal training in that area specifically. What was clear from interviewing geographic profilers regarding this issue was that in their position they believe there is a blocker occurring at the analyst stage. This blocker is in the main a cultural misunderstanding of the theoretical foundations whereby it is suggested that analysts conform to traditional cultural beliefs within the police service that the modus operandi is the most accurate indicator of linkage, despite empirical studies identifying inter crime distance as the most accurate (Bennell et al). However, it should be accepted that this study has not incorporated the opinions and an assessment of their training in this area to understand this issue in greater detail so in effect, only one side of the story has been obtained on this issue. Despite this, it is reasonable to conclude that the theory of geographical profiling is strongly adhered to by profilers, however, the high potential for theory failure amongst analysts is high which may have a knock-on effect on the subsequent prifling accuracy.

Crime Linkage

What is clear from the literature review in relation to this area of the study is that accurate crime linkage is essential to underpinning any predictive geographical profile. However, what is not clear is how efficient or effective this area is operationally which has a large impact on the subsequent value of any predictive product. It was alluded to above that police analysts who are routinely responsible for the linkage of crimes and identification of a series are not formally trained in geographical profiling or crime linking. As outlined in the previous section, there is a suggestion from those interviewed that this has a direct impact on the quality of the profiles that operational geographical profilers can produce. Poor or inaccurate crime linkage caused as a result of inadequate knowledge or training is likely to causes both theory and implementation failure, as outlined by Wandersman (2009). Both failures could have a significant knock on effect of the subsequent profiles produced and could reduce their accuracy and as a result the tasking and co-ordination that can take part as a result of one causing significant theory failure.

Cost

As has already been highlighted in the previous chapter, no longer can cost be overlooked as a factor when assessing potential crime reduction and prevention approaches. In fact, cost is cited as a specific area of implementation failure (Kirby, 2013). When viewed in the context of this study it was established that training a geographical profiler is conducted at only one academic establishment within the United Kingdom and that the cost was very high (£1850) and that the software that underpins production of a profile is even more expensive. However, if considered against the potential savings in respect of investigation time, investment could be a sound choice. However, police forces are reluctant to invest in them heavily, most likely because at present they are not a widely used asset and their effectiveness is not widely understood and so the issue of cost therefore can be considered a blocker to efficient operational use of geographical profiling and a potential factor of implementation failure.

Awareness

System failure as described by Wandersman (2009) is a significant implementation factor. Failure of this factor was identified in the form of unconsciously unaware practitioners. This was the overwhelming opinion of profilers interviewed who believed that there is potentially a huge demand for their skills on investigations that they could assist with but because people are not fully aware of either their existence or capability, they go underutilised (NCA1, 2015). Such a lack of awareness potentially has a negative impact on the investigation of crimes which may go unsolved and develop into larger scale serial offending. It was suggested that a way to begin to resolve some of these issues is through the inclusion of geographical profiling awareness training within the teaching of analysts and practitioners (NCA1, 2015) which may serve to break down some of these barriers. That said, it was accepted that to make any real in roads to achieving this that such awareness would need to reach a 'critical mass' before it would have any real impact (GMP1, 2015). This suggestion carries weight and, from the research within this study and literature in respect of evidence-based policing, we know that engaging staff early and providing suitable awareness training on the theoretical underpinnings of a study increases the frontlines likelihood to embrace the theory. However, as a word of caution, although methods are known regarding raising awareness of geographical profiling, such enhanced knowledge could increase their use but there is a danger that if sufficient practitioners are not in place to receive the increased demand it could damage the approach further by impacting on officer and analyst's confidence in the processes.

Access, Availability and Procedure

This chapter established that due to a lack of available profilers within law enforcement it is incredibly difficult to access one. If awareness of them exists and one is identified, then the process that underpins their tasking is chaotic at best and is non-standardised with different forces operating different access channels. As a result, the use of this valuable asset diminishes even further. This knock-on effect continues if and when a profiler can be identified and successfully tasked and is compounded by the acceptance criteria placed on a tasking submission. This specific area is a potentially in-built implementation

failure in the form of what Kirby (2013) describes as an *"unanticipated technical difficulty"* but is further compounded with a potential theory failure. This was identified as it was established that some of the weeding out criteria had a very weak evidential basis and as such may prevent potentially strong cases being analysed. Some of these criteria have an obvious and strong evidence base, for example the necessity for crimes to be strongly linked is a fundamental of any geographical profile. However, it is the author's opinion that the condition that at least five crimes must be within a series has a limited empirical foundation with some scholars actively suggesting it is inaccurate (Snook et al, 2005). Furthermore, the conditions that reasonable proof can be provided that multiple offenders operate from the same base and that they have not moved during the series are both difficult if not impossible to prove. Although it has been identified that some profilers are willing to create a profile without any combination of these criteria having been met (Snook et al, 2015), by outlining these as conditions for a formal request to be accepted may build in unnecessary blockers at the very first hurdle and prevent submissions by investigators ever being completed.

Data Collection

It could be suggested that it is a reasonable conclusion to assert that the more information a geographical profiler has at their disposal, the better the product that can be produced. However, as this study theorises and as others have before (Snook et al, 2002, 2004 and 2005), this may not always be the case. As such the level and depth of information that is required for a profiler to provide a product in the current climate is a significant area to be investigated further as it has potential to greatly impact on both efficiency and effectiveness of the process.

This study suggested that very large amounts of data was required to conduct a profile and furthermore, that inexperienced profilers required the use of a GIS to aid their production. This finding was in contrast to the limited recent research that identified that trained geographical profilers were most likely to use a GIS as opposed to untrained ones who on occasion relied on what was described as 'an educated guess' (Snook et al, 2015). Furthermore, this study provided further understanding of why this may be the case as it can be argued that the trained

profilers use the systems as an evaluation tool as opposed to their primary foundation. This is again potentially in contrast to other research which identified 77% of profilers as using a GIS to generate their geographic profile (Snook et al, 2015).

With experienced profilers using a GIS purely as an evaluation tool this further underpins the argument that a GIS is not necessarily even required to effectively produce a geographic profile. This argument is also supported when the methodology of how the home or base is identified is considered with research suggesting that 67% of profilers using spatial techniques opt for the 'centre of the circle' approach and with a high degree of perceived accuracy (Snook et al, 2015). Other research exists also indicating that the geographical location of the crime scenes alone can provide an accurate geographical profile (Snook et al, 2002 and 2005). This stance has a strong support within geographical profiling (Snook, 2004, 2005 and Snook et al, 2015) and raises the potential for frontline staff or analysts to receive more cost-effective tuition in this field. This begs the question about why such levels of detailed information is requested to complete what profilers are actually being requested to do. It could be argued from the information from participants in this study that that geographical profilers are at best, unnecessarily complicating their role, embedding implementation failures themselves and are significantly reducing its efficiency, and at worst, risking venture into the area of offender profiling, one which they are ill equipped to make conclusions on.

Timeliness

A further implementation failure was identified in the form of time. Once a profiler has all the requisite information that is required for them to provide an offender based predictive product the issue of completing the geographical profile becomes central. The study identified that such profiles can take several days to produce. In a real-life investigation this may be the difference between an offender committing further crimes or not. Now understanding the depth that some profilers go to in respect of data collection it is understandable why they take so long to produce, and arguably unnecessarily so. This issue is significant in terms of efficiency and effectiveness as it has a direct bearing on the likelihood

that a predictive product can be successfully utilised to assist investigators in their duties. Changes to the level of data requested and the methods used could potentially improve their turnover significantly without reducing their effectiveness. Alternatively, a risk to resource tasking approach could increase efficiency. For example, investigations that carry less risk such as domestic burglary could be subject to a more standardised product based on indicators such as the geographic data alone. Offences such as rape or murder could continue to utilise more resource and time intensive approaches due to the enhanced risk that they carry. Such an approach would enable a 'happy medium' to be reached whereby fast-moving investigations can still gain value from the predictions.

Accuracy and Effectiveness

It can be argued that the success of any predictive product comes down to the fundamental issue of its accuracy as this is likely to have a significant impact on the methodologies implementation effectiveness. This is such a key issue because unless the answer is a positive one then it raises questions around the necessity for the particular predictive approach if the value it adds is minimal. There have been a multitude of studies that have successfully evidenced the accuracy and the value of geographical profiling and as such this study does not seek to reiterate these conclusions. However, what has been alluded to in previous chapters is that it is yet to be examined empirically in an operational setting, especially within the United Kingdom. However, assessing its effectiveness proved incredibly difficult due to the absence of record keeping. This is a significant failure and one of the major reasons that the overwhelming majority of research on this subject is done using retrospective offence analysis where it is known already, beyond reasonable doubt that the suspect was the offender. This lack of available data to effectively evaluate the outcomes is a primary evaluation failure. It is fundamentally impossible to assess an evidence-based solutions impact if not even basic records are kept as to the cases overall outcomes and accuracy of prediction.

Despite such blockers it was continually outlined by geographic profiling practitioners that it was about more than just predicting an area on a map as

close as possible to an offender's home or base. They strenuously argued that this was not the best method by which to assess the operational value of geographical profiling. Although a very underwhelming conclusion, identifying a lack of recorded metrics for successful profiles and debating what those metrics should actually is in itself a useful conclusion as it will potentially inform the operational stakeholders of a key flaw in their current recording practices. If these recording flaws can be addressed, they could lead to better empirical understanding of this area. This issue is also one that is likely to hinder any implementation or trial of less complex, heuristic based geographical profiling predictions which also in theory, simply supply a likely area, home or base of operations for a serial offender.

The Future of Geographical Profiling

This study has clearly shown that geographical profiling is in a dark place and at genuine risk of being completely lost as a predictive tool for crime prevention and reduction. In the opinion of the author and many interviewed this would be a great shame considering its potential to maximise the impact of targeted investigations (NCA1, 2015). This study supports this and provides more information on the fundamental reasons for considering a simple GIS or heuristic based approach, namely its ease and speed, making it a much more applicable approach (NIC1, 2015). Many of the previous sections outlined the significant failures in the theory's practical application yet despite this there is a reluctance from profilers to let go of the specialist function. Furthermore, what was also clear from the thoughts and opinions captured from practitioners on this area is that there is a clear belief that heuristics is too simple an approach to add any value. However, as this study theorises and some of the research to date (Snook et al; 2002, 2004 and 2015) has shown, simple can also be accurate and therefore potentially effective. So, although the evidence base and practitioners may have somewhat polar opinions there is a distinct necessity to remove blockers to its use, reconsider the methodology that underpins, or both. Otherwise a genuine risk of it fading into the ether exists.

9.6 Conclusion

The aim of this chapter was to examine the real life operational conduct of geographical profiling to assess if it could in fact provide an operationally applicable methodology to address antipredator behaviour by foraging offenders. Using semi-structured interviews participants discussed details and provided their views and opinions in respect of a number of areas. These included; practitioner perspectives on offender targeting, practitioner understanding of the definition, the area of crime linkage, training and cost, awareness, access, availability and procedures for conducting geographical profiles, the data collection process, timeliness of production, their accuracy and effectiveness and finally, the future of the field within policing.

Through examining these areas, a number of conclusions were established. It was identified that theoretical, implementation and evaluation failures persisted but in very different forms to those experienced in the forager implementations. These included failures in respect of the existing training for analysts being poor, although conversely, profiler training is excellent but is limited to a single course at a single institute. The costs of training combined with effective software can be costly which is a blocker to its up-take by certain forces. On this issue, it was established that there was a lack of profilers at a regional and national level. A lack of profilers was further compounded by an almost complete absence of their existence and capability. Furthermore, even if frontline law enforcement personnel were aware, the tasking of such specialists was incredibly bureaucratic and chaotic making it confuse for staff trying to access the system. Once a profile is accepted for commission it is further impacted by a disproportionate data request process which on occasions lacked an empirical evidence base and also required large amounts of information which impacted on timeliness of completion, a significant factor in reactive investigations. To round these issues off it was established that no formal records of accuracy or success of the field existed, making it almost impossible to fully assess its effectiveness in an operational setting. All of the above aided in establishing that they created almost a perfect storm that served only to reduce the theories operational applicability to the extent that its continued commission is at jeopardy. Finally, it was established that simpler approaches such as the use of

a GIS only, or a heuristic approach could increase its efficiency and operational value. Ironically this potential was not supported by the profilers who themselves accepted the method's pure existence was at risk.

Chapter 10
General Discussion and Conclusions

10.1 Introduction

The overall aim of this thesis was originally to conduct an evidenced-based study of the implementation of predictive policing methodologies within the United Kingdom. This subsequently evolved to expanded to become an overarching study exploring the behaviour of foraging burglary offenders and predictive police interventions to prevent and reduce their offending. The forager prediction intervention was used to identify the most high-risk area for domestic burglary offences to underpin police tasking and co-ordination of resources which were used to prevent and reduce such offending through a capable guardianship presence. To achieve the aims of the study 7 key objectives were outlined which included:

(1) establishing the impact in terms of effectiveness, of optimal foraging implementations on recorded crime rates;

(2) assessing the implementations conducted and identifying what lessons can be learned;

(3) exploring if key behavioural, physical and spatial offending characteristics exist within foraging criminals, and, if so in what form;

(4) establishing how the findings related to broader ecological assumptions;

(5) Identifying the effectiveness of geographical profiling techniques at profiling foraging burglary criminals;

(6) assessing the implementation of geographical profiling within the United Kingdom and identifying what lessons can be learned;

(7) Finally, considering if the findings support the development of a new predictive policing model to reduce the number of domestic burglaries and maximise crime prevention strategies to combat foraging offending.

10.2   Limitations of The Research

This study admittedly has various limitations beginning with the findings from chapter 4. These results originate from within a single police force and as such may not be representative of all nine implementations of the optimal forager

approach to predictive policing. A further limitation of the study is that the interviews within chapter 5 were sourced from across three pilot implementations, whereas chapter 4's data came from a single source, in an ideal situation both data types would be sourced in equal ratios from the same sources. This limitation could also be directed towards the participation of partner agencies who were not interviewed as part of this study, but had they been would have been able to provide a potentially very different perspective to that provided from the law enforcement staff interviewed. In respect of the quantitative data used it should also be outlined that within the data studied there was additional information provided by the officers recording crimes onto the SLEUTH system in a free text area, but this was not analysed within this study.

The impact of the optimal forager approach to prediction was unable to effectively tackle organised criminality but further research may identify if this can be tackled at an aggregate level by using the same theoretical approach. Furthermore, it was suggested that distinctly different offending groups require different responses and as such further research to examine the varying types of burglary offenders and their responses could prove beneficial to crime prevention and reduction literature.

This study argued that an organisation could increase its level of buy in, co-operation, and as a result, the success of their crime reduction and prevention strategies by operating a value-based recruitment strategy. Further research focused on utilising specifically selected participants based upon their values and comparison to randomly selected staff for instance would extend the understanding of this issue. Further limitations were identified within 6 as some researchers feel that the methodology used is too fraught with danger because of the complexity of the technique and that it fails to deliver a solid prediction. A limitation within 6 was also that it did not include information that related to victims of foraging burglary offenders. This may have provided important new insights in both linking serial offending and also categorising types of burglary offenders.

In respect of chapter 7 the size classification of items is subjective, and variable. Certain classifications may cover a wide range of items that differ significantly in size. A further key limitation in respect of chapter 7 was that the assumption that as well as attempted offences, criminal damage acts a by proxy indicator for the giving up rate was based on previous unethical recording practices, however, changes to the national crime recording standards now mean that reports are considered much more accurate. Finally, main limitation of the examination of geographical behaviour of foraging burglary offenders and the interviews of operation profilers was again the small number of identifiable examples analysed and interview participants.

10.3   Theoretical and Practical Implications

Throughout the previous chapters a number of theoretical areas have been examined and discussed in the context of this study. This section will advance this discussion by bringing together the main points and considering these explicitly within the boundaries of the aims and objectives of the study. It will do this by first outlining the theoretical implications and then outline the practical considerations as they are applied to policing.

10.3.1 The Impact of the Optimal Foraging Implementations on Recorded Crime Rates

The results of the research conducted within chapter 4 made it evidently clear that the use of the optimal foraging theory of predictive policing had not had the anticipated positive outcome expected. Although the intended crime type of domestic burglary reduced, albeit insignificantly, there were a host of unexpected negative consequences. This section now discusses the theoretical and practical implications of this finding taken from chapters four and five.

Effectiveness

Very early in the study it was established that there was a plethora of research that had examined the impact of hotspot crime reduction and prevention strategies (Braga 2007; Eck 1997, 2002; Skogan and Frydl 2004; Weisburd and Eck 2004). However, what none of this research had done was examine the impact of a capable guardian-based hotspot response from a 'predictive'

perspective. A number of previous studies have outlined that hotspot approaches can and do often have a positive impact on recorded crime (Braga, Papachristos and Hureau, 2012) however this study has shown that when predictive approaches are used, they appear to be less effective. This finding provides new corroboration for the only identified study (Caeti 1999: 319-322) that argued that hotspot approaches were less likely to be effective when used against acquisitive crimes such as burglary, further illuminating potential theoretical restrictions of this methodology.

Effectiveness was also impacted upon by significant theory failure, as outlined by Wandersman (2009), specifically in the application of the capable guardianship model. Historical studies have shown the importance of maintaining a guardian presence in crime reduction and prevention (Goldstein, 1977 and 2003; Cohen and Felson, 1979). The results of this study further underpin this stance and add weight to the existing research from Felson and Eck (1986) and Eck (1994) which argued that to ensure a positive impact any crime prevention and reduction plan based on guardianship required three things, supervision of offenders, targeting of offenders and the management of the place, several of which were often absent in the implementations examined and corroborate the previous studies assertion of necessity. However, this study shows that the presence of all three are not essential and that through predictive approaches you can potentially provide effective prevention and reduction through using place-based approaches alone, so long as they operated within the habitable zone of the offenders as well as their area of criminality.

Implementation Failures

Having identified that the predictive optimal forager method of crime reduction and prevention had not been as successful as early adopters had expected, this study sought to understand why. Literature outlined within chapter three of this study described the factors that contributed to theory, implementation and evaluation theory. This study identified evidence of failures of each type and in multiple forms. Firstly, there were multiple and significant theory failures, and these will be outlined in a following section. In respect of implementation failures, they began by corroborating the limited previous research that suggested that

there is a continued reduction in the standard of training within UK Police services (Davies et al, 1996). This finding further corroborated recent literature that has directly linked the lack of an effective learning and development strategy to evidence-based implementation failures within policing (Clough, Adams and Halford, 2017).

A further key implementation failure was communication. Much research has examined the impact of communication (Langbein and Jorstad, 2004; Schotter, 1998; Miller and Whitford, 2002; Sholz, 1991; Schneider, Teske and Marshall, 1991; Ostrom and Ahn, 2001) on successfully gaining trust and buy in and this study extends this knowledge to the realm of evidence based policing implementations where it was no different to other areas of research, despite a hierarchical, dictatorial culture.

The implementation factor of culture, as outlined by Mastrofski et al (1998) was also evident in the findings. Recent literature suggests that 'early adopters' of evidenced based approaches, such as those studied in this research, have experienced significant cultural resistance (Sherman, 2015). Such cultural implementation blockers are not experienced only within policing and the findings within this study corroborates other research identifying similar resistance within medicine (Altman, 1996; Fairhurst & Dowrick, 1996; Murphy and Adams, 2005), management (Adams & Sasse, 1999; Rousseau, 2012), and teaching (Beista, 2007, Perry & Smart, 2007; Adams & Clough, 2015). Research within the social sciences indicates that the theory of social capital can be used to leverage co-operation and combat negative cultural attitudes (Woolcock and Narayan, 2000). Multiple other factors of implementation failures were outlined in the study which now extends links between previous research of evidence-based practice implementations to policing and is the first to propose the theory of social capital as a method to leveraging co-operation and enhance operational effectiveness (Woolcock and Narayan, 2000). Identifying communication, buy in, leadership and culture as blockers to success this study is the first known to identify solutions to these from research (Woolcock and Narayan, 2000; Moser 1996; Narayan 1995; Schafft 1998; Varshney 1999; Langbein and Jorstad, 2004) regarding social capital theory and further studies (Peak and Glensor, 1996 and

Hesketh, 2011) that evidences that transformational leadership styles are much more successful at embedding change within policing.

Originality

There are several key original findings from this section of the study: (1) It is the first to provide a quantitative and empirical, as opposed to descriptive analysis of the impact of the use of the optimal forager methodology as a crime reduction measure (2) the study is also the first to examine the importance and impact of communication within applied science in an evidence based policing context (3) Finally, this is the first evidence based policing study to examine the literature within social capital theory and outline how this can be used to address the identified implementation problems.

Policy and Practice Implications

This section of the study carries a number of key policy and practice considerations: (1) Firstly, it outlines the necessity for evaluation of implementations to be more rigorous and consider quantitative and qualitative sources and avoid any descriptive analysis (2) organisation using the forager methodology would also be wise to properly consider its wider impact on other crime rates before considering or continuing use (3) existing and future implementations should have a well thought out staff engagement plan to ensure the buy in of staff and avoid the cultural and communication issues identified (4) finally, organisations may also wish to consider their methods of recruitment to minimise the negative life span of the aforementioned issues through recruiting more staff with strong intrinsic levels of motivation.

10.3.2 Exploring the Key Behavioural, Physical and Spatial Offending Characteristics Exist of Foraging Criminals

A primary objective of the thesis is to explore the behaviour of foraging burglary offenders which was achieved by conducting a detailed examination of crimes committed by such offenders. Due to its primary focus within the study this is by far one of the most comprehensive sections in this chapter. This has resulted in a plethora of new information that can be used to evolve the understanding of this form of offender and its implications are outlined in this section.

Theory Failure

In respect of application of the theoretical principles of the optimal forager theory this implementation study identified several flaws which contributed to what Wandersman (2009; 2) outlines as 'theory failure'. This study evidenced that theory failure was present by identifying the that functional and target crime displacement does appear to occur which corroborates previous research (Repetto 1976 and Braga, Papachristos and Hureau, 2012) on this issue but now adding the optimal forager predictive approach to the base of knowledge on circumstances that identifies its occurrence. Furthermore, existing research has shown that displacement of violence related offences can occur as a result of hotspot methodologies (Taylor, Koper and Woods, 2010) but of all the crime forms displacement should affect, violent offending is the one that it should impact on the least (Braga, Weisburd, Waring, Green Mazerolle, Spelman, and Gajewski 1999). However, this study contradicted this knowledge and showed that in response to increased risk, recorded violent offending escalated. Had the practitioners been aware of these findings they would likely have altered their tactical approaches and as such is likely to have affected its success.

Linking Foraging Offending

Previous research (Bennell and Canter, 2002; Tonkin and Grant et al, 2008 and Davies and Tonkin et al, 2012; Tonkin and Santtila, 2011) has been conducted into the crime linkage behaviors of domestic burglary offenders. Similarly, to hotspot research, this study is the first to extend this method of examination to crimes committed by foraging burglary offenders and in doing so enables increased understanding of linkage indicators. This study disconnects the physical entry characteristics from other behaviors displayed by the offenders and as such provides new insights that none of the previous research has covered. Tonkin and Santtila (2011) had previously attempted this against a random selection of offenders and identified it as providing a strong linkage predictor (AUC=0.66), which was in contrast to this study which identified it as the lowest (AUC=0.58) when examining foraging offending. Bennell and Jones (2005) and Tonkin and Santtila (2011) have both examined the property selection choice of burglars as linkage indicators and found them to provide moderate

value. This study of foraging offenders further cemented this finding providing almost identical findings adding further weight to the argument of Bennell and Canter (2002) who suggest it is an element that offenders have least control over. Bennell and Jones (2005) study looking at entry behavior as a linkage indicator identified it as having a low predictive accuracy (AUC=0.59) but in line with Tonkin and Sentilla's study (2011), this thesis found it to be much higher for foragers (0.66) reiterating that by disconnecting the physical entry behaviors from generalized offender behavior, greater accuracy can be achieved. A further key finding of this study was that previous research (Bennell and Jones, 2005; and Tonkin, Santtila and Bull, 2011) had varying degrees of prediction accuracy in respect of target selection, with AUCs of 0.58 and 0.73 respectively, however both were below the results identified within this study (AUC = 0.76) further suggesting forager offending is distinguishable from other forms of burglary offending. One consistent detailed shared across research in this area is that inter crime distance continually provides the most accurate predictor of linkage and this study was similar in this vein.

Physical Characteristics

There are a multitude of studies that have examined the physical characteristics of burglary offenders (Haginoya, 2014; Fox and Harrington, 2012; Vaughn et al, 2008; Snook 2004; Hearnden and Magill, 2004; Cromwell et al, 1991; Maguire and Bennett, 1982). The previous research by Haginoya and Snook that has examined age has shown that a large proportion of burglars are male, but this study extended these findings by specifically examining foraging burglars and as such identified that in this study 100 % are male. A further interesting finding from this study was that the mean age of the offenders was 31.7. This is a higher age than many previous studies (Bache, Crestani, Canter, & Youngs, 2010; Santtila et al., 2004 and Snook, 2004) which had identified the average age of burglars as being between 20-27 years, dependent on the study suggesting that foragers are notably older than many other types of offenders with the exception of the typologies identified by Vaughn et al (2008) who's youngest offender type was 35 suggesting that

foragers may be the *'missing typology'*. Previous research by Fox and Harrington (2012) had suggested that burglars are typically nonviolent offenders but only Vaughn et al (2008) had shown that this was specific to offence typology and used sexually predatory burglars as an example. This study furthers this finding and highlights how certain types of burglar, especially foragers, in the right circumstances can become violent to obtain their resource. This study further corroborates one of the only known studies to review the mental health of burglars (Haginoya, 2012) and further corroborates that they suffer from low levels of illness. This finding interestingly links to foraging burglars dependence on drugs which was identified as a key potential causation for their behaviour, corroborating existing studies (Cromwell et al, 1991). This study furthers this understanding though by outlining that in contrast to the general typology of a burglary offender, that foraging offenders have a higher drug dependency rate with 71.4% being addicted to drugs. This dependency, compounded by their impulsive nature fuels the mean offending rate of 40.8 crimes for foraging burglars was identified as being much higher than other studies Hearnden and Magill, 2004; Snook, 2004; Vaughn et al, 2008 and Haginoya, 2014) which was a finding not previously known.

Foragers as Impulsive Offenders

Impulsivity was examined as a potential causal factor for increased violence in the predicted high-risk areas. Much previous research has examined behavioural characteristics of impulsivity and identified that impulsive offenders have been shown to have a higher association to substance abuse dependence (Farrington, Loeber and Van Kammen, 1990), low self-control (Critchfield, Levy and Clarkin, 2004 p. 556; White et al, 1994, p. 93) low levels of inhibition (Schalling, 1978) and are less able to delay immediate gratification (Newman, 1987) and less likely to be inhibited by a delayed or uncertain consequence (Wilson and Hernstein, 1985, Zimmerman, 2009), and most significantly, continue to offend to receive gratification and succumb to immediate temptation (Zimmerman, 2009). This study was the first to examine a possible link between these characteristics and the behaviour of burglary offenders, particularly foraging ones. Importantly it was identified that these were all behaviours that this study identified within foraging offenders and is the first to make this link to a specific burglary offender typology.

The Forager as a Burglar Typology

There are multiple studies that have been examined in respect of burglary offenders outlined in this study, but these have only analysed the demographics of offenders and linked them to crime scene behaviour. Only a few have actually sought to categorize them into individual burglar typologies. Maguire and Bennett (1982) identified three types of burglar linked to their offending skill and labelled these *'low level amateurs'* and *'mid or high-level professionals'*. Vaughn et al (2008) labelled them *'Young versatile, vagrant, drug orientated, and sexual predators'* and Fox and Harrington identified four categories they labelled '*older whites, younger whites, older black males and young minorities'.* As shown in table 35 on page 324, each study identified various physical, behavioural and geographical characteristics of burglary offenders. It was Bower and Johnson (2004) who first proposed the forager typology, but this study extends this by now providing the aforementioned personal and behavioural characteristics to this offender typology. One of the most fascinating elements of this study is that it is the first to examine the burglar typology from a geographic perspective. Doing so enables 6 new theoretical foraging typologies to be considered and examined in future studies. These include the optimally focused forager, the optimal patch forager, the central place forager, the optimal temporal forager, the marauding forager, and finally the impulsive forager. These are shown alongside the above typologies overleaf. Providing theoretical typologies then enables a practical solution to be devised which has been alluded to throughout this thesis and is outlined in detail in the following section.

Responses to Foraging Burglary Typologies

It has been argued that the theoretical stance in respect of the cause of the crime should dictate the crime prevention reaction (Eck, 1994). Ratcliffe (2004) has proposed a model for tactical responses by the police that could be employed to tackle burglary offending (Ratcliffe, 2004) which was mapped over both temporal and spatial criteria but was not specific to any burglary typology. This research extends the model by focusing on the forager typology as outlined in table 33 on page 326 and advances it further again by providing evidence-based models of response. By first conducting the process outlined within the predictive crime

fighting model once a foraging offender typology is identified the most appropriate response can then be adopted. The implication of adopting such an approach is that it will provide the police with a wider range of tactical responses that are specific to the identified offending. Criminological literature (Eck, 1994) argues that this is the best way to maximise the reduction and prevention of crime and combined with the other responses outlined in this section will further compliment the polices response to this form of offending.

Study	Fox and Harrington, 2012				Vaughn Et Al, 2008			
Burglary Offender Typologies	Older White Males	Younger Whites	Older Black Males	Younger Minorities	**Young Versatile**	**Vagrants**	**Drug Oriented**	**Sexual Predators**
Physical Characteristics	Male, White, Over 25, Average Build	Male (62%), Female (38%), Under 25, Short and Thin	Male, Over 25, Average Build	Male (70%), Female (30%), Under 18, Short and Thin	Male, 35 Years, White (56%)	Male, 43 Years, White (69%)	Male, 40 Years, Assorted Ethnicity, High Numbers of Tattoos	Male, 47 Years, White (60%)
Behavioural Characteristics	Chronic Offenders, Opportunistic, Disorganised	Starter Offenders, Organised,	Chronic Offenders, Interpersonal, Disorganised	Starter Offenders, Organised and Opportunistic,	No Unique Behaviours	High Levels of Vagrancy Offences	High Levels of Drug Related Offences and High Levels of Burglary and High Overall Offending	Longest Career Spans with Presence of Rape Offences and High Levels of Burglary
Geographical Characteristics	N/K	N/K	N/K	N/K	N/K	N/K	N/K	N/K
Study	This Study							
Burglary Offender Typologies	**Impulsive Forager**	**Marauding Forager**	**Optimal Temporal Forager**	**Central Place Forager**	Optimal Patch Forager	Optimally Focused Foraging		
Physical Characteristics	Male, 31 Years,							
Behavioural Characteristics	History of Burglary and Other Theft Offences, Impulsive Nature, High Level of Drug Dependency, Low Mental Health Rates							
Geographical Characteristics	Dispersed Offences, And Extreme Temporal Movement	Moderate Temporal Vigilance and Extreme Patch Movement	Extreme Patch Movement	Extreme Temporal Vigilance and Moderate Patch Movement	Extreme Temporal Vigilance	Extremely Temporal and Patch Focused		

Table 33. Comparison of Burglary Typologies Studies
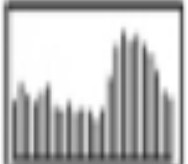
'Predictive' Foraging Behavioural Matrix			Spatial Behaviour		
		Tactical Criteria	Dispersed	Clustered	Hotpoint
Temporal Behaviour	Diffused	Forager Typology	Impulsive Foraging	Central Place Foraging	Optimal Patch Foraging
		Response to Predation Risk	Extreme Temporal Vigilance and Extreme Patch Movement	Extreme Temporal Vigilance and Moderate Patch Movement	Extreme Temporal Vigilance
		Methodical response	Super Critical Hotspot and Circle Geographical Profiling	Optimal Forager and Distance Decay Geographic Profiling	Sub Critical Hotspot and Distance Decay Geographic Profiling
	Focused	Forager Typology	Marauding Foraging	Central Place Foraging	Optimal Patch Foraging
		Response to Predation Risk	Moderate Temporal Vigilance and Extreme Patch Movement	Moderate Temporal Vigilance and Moderate Patch Movement	Moderate Temporal Vigilance
		Methodological response	Super Critical Hotspot and Circle Geographical Profiling	Optimal Forager and Distance Decay Geographic Profiling	Sub Critical Hotspot and Distance Decay Geographic Profiling
	Acute	Forager Typology	Optimal Temporal Foraging	Optimal Temporal Foraging	Optimally Focused Foraging
		Response to Predation Risk	Extreme Patch Movement	Moderate Patch Movement	No Patch Movement
		Methodical response	Super Critical Hotspot and Circle Geographical Profiling	Optimal Forager and Distance Decay Geographic Profiling	Sub Critical Hotspot and Distance Decay Geographic Profiling

Table 34. Tactical Options for Combating Foraging Burglary Typologies

Identifying Behavioural Change to Underpin Early Action

Early action is now an accepted form of response from agencies dealing with 'wicked' problems that require collaborative responses and has been shown to be effective in a number of areas. These include anti-social behaviour (Loeber et al, 2003), domestic violence (Moss and Singh, 2015) and mental health related behaviours (Richman, 2008; Duffy, 2000 and Rapee et al, 2005). In essence, early action focuses on the identification of indicating factors that are triggers to the occurrence of escalation of behaviour (Brookes, 2017), allowing a collaborative response to address or reduce the risk of escalation. This study has now extended the growing literature in this field to include the behavioural, physical and geographical indicators of foraging offenders. Doing so enables the police to now identify those that may be defined as foraging burglars and thus identify their propensity for impulsive behaviour. Doing so would enable interventions that focus on self-control of offenders or address their underlying cause which this study has illustrated is often related to drug dependency. Police services offender management units are skilled in such forms of offender management already but the only other previous study examining early action within Lancashire Constabulary (Metcalfe, 2016) has shown that when these departments do not possess the required knowledge and experience specific to offender typologies it negatively affects their ability to prevent the behaviours.

The findings from this study fills this knowledge gap in respect of foraging offenders and allows such teams to more accurately identify the escalating behaviour of foraging burglars. For instance, a known offender being managed in the community but continuing to offend may find their patch subject to increased capable guardianship forcing them to switch patches. This may result in intelligence, information or even arrests that the offender being managed is committing offences such as criminal damage, a by proxy indicator of 'giving up', and an offence not routinely committed by foragers, and also attempted offences which will further indicate their increased vigilance. Such interventions are also likely to force the foraging offender to impulsively respond with violent behaviour which may manifest itself in arrests for violent related crime such as robbery, public order or theft from the person. Ordinarily this may be an instance ruled out as a 'one off' or 'out of character', however, this study now provides the

knowledge that this may be an indicator that they are escalating their offending and more intrusive supervision, or fast-tracked drug dependency support may prove beneficial in curtailing their downward spiral. Combined with the place-based response to domestic burglary outlined in this thesis, this operational application could further reduce and prevent this form of offending.

Environmental Adaptations

This study also identified that the majority of predicted foraging high risk areas fall within a relatively small and identifiable geographic area. To compliment the crime fighting tasking and co-ordination response a place-based response underpinned by partner agencies could further prevent offending. This is not a new finding and Clarke's (1983) situational crime prevention, Ray's (1971) crime prevention through environmental design, and Newman's (1972) defensible space theories have all outlined how crime reduction and prevention strategies can be maximised by making adaptations to the environment within which criminals operate. Much of the work conducted under the problem orientated policing banner also involved changes to the environment as a method to combat offending. As such, the information provided within this study could assist the police, in particular Lancashire constabulary, by identifying the areas for them to re-invigorate this work.

Establishing the Presence of Ecological Assumptions

This research was in many ways very brave. Venturing into the potential basal causations of offending invites intense critique. However, it has successfully added further knowledge to the only previous study that had sought to do this (Bowers and Johnson, 2004) by considering ecological behavior as playing a part in burglary offending. However, this research delves much deeper and adds a large amount of new theoretical knowledge that outlines ecological behaviors within criminal offenders and is in line with existing theories used to explain criminal behavior. The first comparison is between Charnovs marginal value theorem (1976) which was defined as the value used to describe the level at which reward drops to the average level across known patches based on past experience. This thesis suggests this is akin to rational choice theory. Rational choice behaviour can also be found in Kelly (2001) who have shown that foraging

animals will increase their vigilance as a response to an increased risk (Lima, 2002) and their giving up rate will increase as a result. Sinervo has outlined that foragers also have fixed time constraints that can be altered to maximise returns (Sinervo, 1997). When the cost benefit or rational choice analysis is not in the forager's favour they adapt their behaviour accordingly. Within ecology these responses are known as patch departure rules (Charnov, 1976) which occur as a result of over foraging, where little of the resource or prey remains or level of predation risk now is too high (Charnov, 1976 and Lima, 2002). A key finding from the geographical and offending examination of foraging burglary offender's behaviour identified strikingly similar patterns for all of the aforementioned through numerous examples of crime displacement and giving up rates making this study the first time that research has made connections with such behaviours to that of criminal offenders.

Comparing Ecological Assumptions

Further examination of ecological assumptions identifies that clear comparisons can be made between routine activity theory and optimal patch choice which is a behaviour whereby Orians and Pearson (1979) have outlined the forager will conduct their searching based around a specific base or home and as such their prey will fall within their routine activity node (Orians and Pearson, 1979). The geographical profiling theory of the circle hypothesis (Canter and Larkin, 1993) is also found within ecology, it is defined as central place foraging which Sinervo (1997) outlines as a place they can quickly retreat to. Furthermore, the forager has the routine knowledge and ability to locate other patches using known landmarks and geography (Roche, and Timberlake, 2002). Canter and Larkin, (1993) describe this behaviour in their studies of geographical profiling which they call marauding, a process were offenders are more likely to commit offences in cyclical dispersed parameters to their home or base (Canter and Larkin, 1993). The geographical profiling element of this study has to one degree or another provided the presence of all of the aforementioned. The theoretical links between existing theories and their ecological link is outlined in table 35 on page 331.

Existing Criminological Assumptions	Identified Ecological Assumptions
Rational Choice Theory	Marginal Value Theorem (See Charnov, 1976 and Pyke et al, 1977)
Routine Activity Theory	Optimal Patch (See Charnov,1976, Johnson and Bowers, 2004 and Johnson,2015)
Geographical Profiling	Geographical Profiling of Animals (See Rossmo 2006,2007, 2009)
Circle Hypothesis Geographical Profiling	Central Place Foraging (See Charnov, 1976 and Orians and Pearson, 1979)
Distance Decay Theory Geographical Profiling	Increased Giving Up Rate (See Brown, 1999)
Spatial Displacement Intended Crime Type in A Different Area	Patch Movement Result of Foraging Departure Rule (See Charnov, 1976)
Temporal Displacement Intended Crime at A Different Time	Foraging Departure Rules (See Charnov, 1976 and Sinervo, 1997)
Tactical Crime Displacement Changes Offending MO	Increased Vigilance (See Kelly, 2001)
Target Displacement Intended Crime Type on A Different Target	Altering the Resource Alters Resource or Source of Resource, To Reduce Handling Time (See Pyke et al, 1977)
Perpetrator Boost Theory Offending Continues by Different Offenders	Group Foraging Searching in Groups to Decrease Mortality (See Berkely, 2001)
Functional Displacement Commits A Different Form of Crime	Altering the Selected Resource (See Pyke et al, 1977)

Table 35. Comparison Between Traditional Criminological and Ecological Assumptions.

Originality

This section of the study provides a large number of original material (1) Firstly, the study evidenced that functional and target, crime displacement does appear to occur when geographical predictive policing methodologies are utilised (2) the study also provides original knowledge regarding factors that provide the highest likelihood of foraging offences being linked (3) this section also provides new understanding of the physical characteristics of foraging serial burglars, this is

information that was not previously known and in doing so outlines foragers as a specific typology of offender and outlines 6 new theoretical foraging typologies (4) having identified new typologies of foraging offenders a further original contribution of the study is a tool box of newly identified tactical responses (5) Finally, significantly and controversially, the study is the first of its kind to specifically search for evidence of basal ecological behaviour within criminal offenders and in doing so, argues their existence and its consequences.

Policy and Practice Implications

These original findings do create a need to consider changes in policy and practice. (1) As outlined in the previous section regarding policy and practice Implications this study highlights the need to consider the wider impact of the forager methodologies implementation as it also produces several forms of displacement as unintended consequences (2) these findings also create a need for the police to reconsider how they identify linked crimes and build products and profiles based on their analysis as there are clearly more accurate and effective ways than the present methods which focus heavily on the MO of the offender and an analyst's judgement (3) similarly, these original findings provide a case for reconsidering the policies regarding how and who, are identified as subjects for early action teams, offender managers and disruptive resources such as those within burglary teams as present sections are based almost entirely on professional judgement (4) most significantly, these original findings provide an evidence based framework for tackling foraging burglary offenders and police services should consider how they currently respond, as using this framework is likely to provide a much more effective crime prevention and reduction response.

10.3.3 Identifying the Effectiveness of Geographical Profiling Techniques Against Foraging Burglary Offenders and its implementation within the UK

In respect of geographical profiling there has been much research into the effectiveness of this method to identify the home or base of serial offenders. However, limited research has been done to examine the work in respect of burglary with Snook (2002, 2004 and 2005) being the primary researcher. The majority of research has identified that a standard circle hypothesis is ordinarily accurate at predicting the offender's home or base. However, Koscis and Irwin (1997) found that this was not the case when examining burglary where only around 50% of offenders live in the circle radius of their offences. Although the circle hypothesis was not tested in this study, a key finding showed that the distance decay method provided a mean error distance of 2252m and was at its most effective for geographically focused and clustered offences, indicating that the circle approach may be most accurate for offences widely dispersed and further from the home or base of the offender.

Profiling Theoretical Foundation

Snook, and others after him (Levine, 2009) identified that younger offenders have a shorter journey to crime distance. This is also a key finding of this study which showed that on average younger offenders aged 18-25 travelled just 0.73 miles, offenders aged 26-35 travelled 2.17 miles and offenders aged 34-40 travelled the furthest distance on average at 2.28 miles. Other research (Turner, 1969) had shown that in general, offenders live within 1km of their offences, but this study has shown that the majority of foraging offenders travel much further, on average a distance of 1.5 miles.

The Impact of Age

Rossmo (1987) has shown that most offenders have a buffer zone in between their home and area of offending. A further finding in this study is that the buffer zone is adhered to by foraging offenders and that this is approximately 1.5 miles. These findings suggest that foraging burglary offenders younger in age do commit offences closer to home but that as an offender typology, that they have a tendency to travel further than others to offend and have a low risk threshold

in respect of immediate consequences, but as the literature on impulsivity has shown, a high risk threshold in respect of delayed consequences, which when makes them particularly responsive to capable guardianship interventions such as the optimal forager tasking and co-ordination tactic.

Implementation Within the United Kingdom

To begin with it was established that Rossmo (2000) has outlined the policing response to crime as covering 6 stages; (1) The occurrence of a crime or series, (2) the investigation, (3) the prevention and reduction stage, (4) crime linkage, (5) criminal offender and geographical profiling and finally, (6) the use of new investigative strategies. The literature review within this study identified that stages 4-6 are very rarely and infrequently used. This thesis is the first to provide new and novel perspectives from frontline law enforcement personnel in respect of crime linkage, and geographical profiling and have provided new and contemporary understanding in respect of these stages. All of the aforementioned also corroborate Rossmo's outline of the policing response and furthermore, provide new findings in respect of the blockers and facilitators to adopting the full range of his theoretical model.

Despite the obvious potential of crime linkage and geographical profiling to enhance the policing process a key finding in respect of predicting the offender was that at present, at an operational level within policing there are no scientific offender identification models in use. Only the national intelligence model exists but this is failing due to a lack of actionable offender-based intelligence, hi-lighting further need for science-based solutions.

Implementation Failures

Despite the aforementioned positive contribution, in line with failures within the optimal forager implementation it was also established that significant failures were present in the use of geographical profiling. Interview participants discussed a large number of key areas where failures were present, and these included; practitioner understanding of the definition, the area of crime linkage and training which all culminated in significant theory failures as outlined by Wendersman (2009). Furthermore, cost, awareness, access, availability and

procedures for conducting geographical profiles, the data collection process, and timeliness of production were identified implementation failures. In identifying these the study has added to the growing body of literature outlining implementation failures within evidence-based policing. In doing so, it highlights how embedding scientific theory is complex and as such a detailed strategy for implementation should always be in place that acknowledges the potential failures and addresses them beforehand.

Originality

The area of geographical profiling within the United Kingdom is a small field and as such this element of study had large limitations. However it did manage to identify a number of original findings (1) Firstly, the study identified that surprisingly there are no embedded and readily accessible scientific offender identification models in use in any police service (2) in respect of theoretical originality the study identified further unique traits of foraging burglary offenders and showed how the circle approach may be most accurate (3) for foraging offenders it was also established that the link between home or base and the journey to crime was very strong with a clear progression in distance related to the growing age of the offender (4) finally, it was established that foraging offenders also adhere to the buffer zone theory with foraging offenders maintaining a distinct dissection between home and base and location of offending of approximately 1.5 miles.

Police and Practice Implications

The main implications of these original findings are very clearly linked to the methods by which the police identify potential offenders. At present this is heavily professional judgement based due to the low levels of useable intelligence. These findings show that a more scientific approach can be adopted and more importantly, likely provide very tangible information regarding the identification and prioritisation of potential offenders. As such, it is strongly advised that police services should evolve their suspect targeting methods to include new techniques and the information these provide.

10.3.4 The Development of a New Predictive Policing Model

The main aim of this research was to conduct an in-depth examination of evidence-based implementations of the optimal forager predictive policing methodology. The study has achieved this and in this chapter a number of original contributions have been identified and their associated policy and practice implications. This section now outlines 'how' these new findings could be practically embedded.

Using Social Value to Embed Evidence Based Policing

Lawrence Sherman (2015) who is widely recognised as the driving force behind embedding evidence based policing has outlined a number of key factors for what he describes as a method for 'institutionalising research', these include; (1) increasing the evidence base of research available to decision makers (2) the use of the research and literature evidence base to underpin decision making (3) the effective targeting, testing and tracking of implementations (4) a move from viewing recorded crime independently towards viewing it through a lens based upon its harm (5) the use of statistical evaluations as opposed to descriptive (6) increasing police legitimacy through more effective crime reduction and prevention (7) the inclusion of such approaches within police training. There are a number of policing implications from this study that relate to embedding evidence-based policing which ultimately suggest that there were a number of failings when viewed through the lens of the optimal forager implementations. Firstly, the study identified that in the main, with the exception of factors 1 and 2, the optimal forager implementations failed to conduct any of the considerations identified by Sherman (2015) and a conclusion from this study is that this did impact on the overall success in a number of ways. These included the failure of frontline staff and specialist teams to adhere to the evidence-based tasking's provided. The cause of this was identified as serious 'buy in' problems created through bad communication, misplaced emphasis on professional judgement and leadership failures. Furthermore, when taskings were followed the evidence suggested it increased public order related incidents which this study suggests may be from increased friction between the police and the public and potential misuse of stop and search powers identifying potential ethical implications. All of

these issues are factors that this study outlined could be addressed by adoption of social value approaches to recruitment and selection. As yet this is not formally followed by any police service in England and Wales but previous evidence that outlined similar issues within the NHS (Department of Health, 2012; Berwick, 2013; Cavendish, 2013) were also addressed by adopting social value-based recruitment and selection policies. A 2013 report by Health Education England identified that to address these issues the service moved to a position where they promoted the adoption of a Values Based Recruitment approach which aimed to attract and select health care students, trainees and their employees '*on the basis that their individual values and behaviours align with the values of the NHS Constitution*' (Health Education England, 2013). Within policing there has recently been recognition of this and the College of Policing has developed the competency and values framework which will replace the Policing Professional Framework to help with the assessment of values in local and national recruitment and will also help to continue to embed the Code of Ethics (College of Policing, 2017). However, this framework is not scheduled for roll out until late 2018 and as such this study highlights a need for police services to not delay and adopt this ethos to immediately seek to address the problems identified in this study.

A Policing Model for Predicting Demand

A key policing implication from this study was outlining how the current police tasking and co-ordination framework is based heavily upon the national intelligence model and how this is impacted by the dramatic falls in intelligence identified within this study. Such falls in intelligence mean that the foundations of the national intelligence model no longer exist to effectively underpin the systems built on it. These include the identification of problem profiles based on recorded crime rates, the identification of offender targeting profiles and subsequent investigative, disruptive and prevention interventions, all are based upon intelligence and information. The national intelligence model was not based on evidence or research and this study has clearly identified that there are more evidence-based approaches for identifying all of the aforementioned policing practicalities. Doing so will move police forces towards an evidence-based model whereby they can provide more effective crime reduction and prevention

strategies at a demographic, strategic, tactical and victim and offender levels. The National Police Chiefs Council (NPCC) Demand Handbook (2017) has also identified this issue and has recommended that police services should seek to use more evidence based strategic and predictive methods to direct resources and outlined these as follows; (1) the use of deprivation data to locate 'place based' resources such as police stations within areas of high demand (Langmead-Jones and Kirchmaier) (2) the use the management of risk in law enforcement (MORiLE) risk model to prioritise demands (NPCC, 2017) and then (3) the use of crime mapping based upon a harm index as opposed to traditional recorded crime (4) the use of predictive methods such as the optimal forager model to then pro-actively combat dynamic threats (5) finally, and most significantly is the use of predictive models such as geographic and offender profiling to direct offender based interventions which is the main ethos of this study and has been able to successfully create a road map for forces to follow which is identified in this chapter.

Predictive Crime Fighting and Enforcement Model

Rossmo (2000) has outlined a policing investigation model that contains 5 stages; (1) the occurrence of a crime to instigate police activity (2) the policing investigative response (3) the policing prevention and reduction response (4) the crime linkage analysis stage (5) the generation of policing response strategies. This research has shown that this process holds true and can be followed to create a more effective crime reduction and prevention strategy. This study develops this idea further by providing policing with a framework for responding to domestic burglary that can, in theory, be used to combat other forms of criminality. This process provides a step by step model for maximising the predictive capable guardianship through applying the optimal forager and geographic profiling methodologies. Firstly, as identified by Rossmo (2000), the occurrence of a crime series is necessary to instigate a policing response. Subsequent crime analysis using non-traditional but evidence-based case linkage methods outlined in this study provides the linkage predictive indicators to increase accuracy. Decision making thresholds can be used to underpin analytical decision making in respect of crime linking. This process then enables the analyst to identify the typology of the foraging offender as outlined within

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table 37. These processes provide an enhanced accuracy which should then be utilised to maximise the predictive capability of the identification of optimal forager high risk areas. The next stage is selection of the appropriate place-based crime fighting response, which is also outlined within table 37. This stage is then followed by the creation of analytical predictive products to inform operational decision making. Effective 'in built' processes should then be designed to ensure that implementation success is not 'person based', for example, the use of dispatchers to direct resources as opposed to front line leaders. In line with Felson and Ecks (1986) situational crime prevention model, tasking and co-ordination plans are then used to direct and control police resources to maximise the effective management of place and increase the risk of apprehension of foraging offenders. In conjunction with the aforementioned criminal approach to prevention and reduction, other forms of offender management should be used in a complimentary fashion. In particular, to prevent offending escalation, which has been outlined as an unintended consequence of the optimal forager implementation, the use of behavioural predictors should be used to underpin the interventions of offender management and early intervention units. In conjunction with the available intelligence and information, their primary function should be to identify those displaying escalating indicators, whom it is theorised are the most likely foraging offenders, and use the outlined drug dependency, rehabilitation and anger management programmes to prevent their continued offending. Finally, the implementation should be evaluated periodically. This enables the re-assessment of crime characteristics such as the offender behaviour and inter crime distances that can be reviewed to adapt decision making thresholds and maintain an effective and accurate analysis.

A Heuristic Prediction Framework

This thesis has outlined a model for predicting the behaviour of foraging burglary offenders through the use of the optimal forager and geographical profiling methodologies. During the literature review it was established that there was a growing body of evidence (Snook et al, 2002 and Snook et al, 2005;21) that the use of professional judgement-based heuristics could predict geographical indicators as accurately as the use of a GIS. This study also identified that existing processes and policies in place to conduct the forager predictions and particularly the geographical profiles is incredibly bureaucratic and time consuming which is often a blocker in an operational setting. A potential solution to this is the adoption of the same predictive model outlined in this study but conducted heuristically. This findings from this study could be used by Lancashire Constabulary to underpin the future training of practitioners and analysts and outline the current crime linkage decision making thresholds. This would remove the necessity for logistic regression analysis in each affected area and reduce it to an annual function for instance. The training of staff in the theoretical foundations of both the optimal forager and geographical profiling could then be used to educate key frontline staff such as those within specialist burglary teams to conduct these predictions themselves. This would enable a faster and more fluid investigative response and as the study has hi-lighted, the enhanced engagement and subsequent empowerment would likely increase the buy in of these staff.

10.4   Next Stages For The Research

In respect of developing this specific study further the natural step would be to test the findings within an operational setting. One of the main proposals from this study is that of the Predictive Crime Fighting and Enforcement Model outlined in the previous sections. To test this would require a controlled study whereby the proposed model combining decision making thresholds of crime linking with optimal forager and geographical profiling predictions can be used to task and co-ordinate police resources. If run alongside comparative models; an assessment of the various approaches effectiveness could be measured. As a result of this thesis such a study is currently being developed in Lancashire constabulary. This controlled trial proposes a distinct predictive tasking model is

used in each of the three policing divisions as follows (1) the original optimal forager high risk zone, victim prediction approach (2) the use of only geographical profiling (3) the combined use of both methodologies. Each approach would be underpinned by the crime linkage methodology used in this study and would have improvements within the implementation stages to overcome the blockers identified within this study. This would include things such as a staff engagement plan, increased staff training on the subjects and use of police ARLS geo locating technology to direct and control patrols into the specified zones as and when required. Such a study would provide opportunity to evaluate which approach is the most effectiveness in reducing foraging criminal behaviour.

10.5   Conclusion

The aim of this study was to explore the behaviour of foraging burglary offenders and predictive police interventions to prevent and reduce their offending. The study has achieved this by conducting a comprehensive review of evidence-based implementations and their results. This chapter outlined these and then discussed the theoretical and policing implications of these findings. This included the study of criminological crime reduction and prevention methods by providing an assessment of the consequences of this approach using predictive methods. Furthermore, the thesis identified a number of implementation problems and articulated how these could be resolved through police services embedding social values within their recruitment, selection and promotion practices. One of the studY'S greatest theoretical implications was the findings in respect of foraging offenders and the presence or otherwise of ecological behavioural indicators within criminals. The thesis showed how many ecological assumptions could be identified within criminal behaviour and explored evidence based predictive solutions to further prevent and reduce their offending.

In respect of the studies practical policing implications; the thesis has produced a predictive crime fighting model that can be used by police services to better predict foraging burglary offence locations and the likely home or base of this form of offender. Critically, the thesis categorised foraging behaviour into a set of typologies and theorised a tactical response to combat this behaviour. It also

provided new evidence that outlines escalating behaviours of foraging offenders that can be used to inform decision making within early intervention and offender management settings. Ultimately, the study has provided police services with a comprehensive evidence base that they can use to underpin their decision making in respect of managing, preventing and reducing this form of offending.

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Appendix of Documents

<u>Appendix 1: Optimal Forager Interview Question Set</u>

1.   Please introduce yourself by way of brief outline of your name, rank, role or position and responsibility within your organisation.

2.   Please define what 'you' believe the term 'predictive policing' means.

3.   Please explain how you became involved in predictive policing within your organisation?

4.   Do you hold any formal qualifications or training in crime analysis and its implementation?

5.   Prior to becoming involved did you receive any specialist training on the subject of predicting crime locations or the new form of tasking i.e. what was different to previous methods/evidential background etc.

6.   If so what did the training comprise of?

7.   If not, do you believe this impeded you in any way?

8.   Specifically, what form of predictive policing did you conduct? I.e. optimal forager, near repeat, risk terrain modelling etc.

9.   How were your duties directed as a result of the 'predicted' problem i.e. a tasking process.

10.   Did you receive any briefings on the predicted crime products?

11.   If so did you find them useful, yes/no and why?

12.   What resources were tasked by this product? I.e. uniform high visibility or plain clothes pro-active etc.

13.   Do you believe the use of a predictive policing approach had any benefits? I.e. crime reductions, increased efficiency, evidence-based approach etc.

14.   Did you experience any crime displacement? I.e. The crimes simply changing time/location to avoid detection.

15.   If so, why do you believe this occurred?

16.   How did you tackle or respond to this displacement, if at all?

17.   How do you believe crime displacement could be tackled?

18.   Did you experience any reductions or increases in the predicted crime types?

19.   Do you believe other factors may have influenced any rise or fall in the specified crime types?

20.   Can you provide any advice on how to address or control these issues?

21.   To what degree were partner agencies used to tackle predicted crime locations?

22.   How receptive do you believe the tasked resources were to the predictions? I.e. did they buy into it?

23.   If not, why not?

24.   In your opinion did senior managers 'buy into' the predictive approach?

25.   What do you believe could have been done differently to make the approach more successful?

26.   Do you believe predictive policing has a future within policing in the UK? Please describe.

27.   Please provide any further information that you wish to.

Appendix 2: Geographical Profiling Interview Question Set

1. Please introduce yourself by way of brief outline of your name, rank, role or position and responsibility within your organisation.

2. Please define what you believe the term 'geographical profiling' means.

3. Do you hold any formal qualifications or training in crime analysis and its implementation?

4. Prior to becoming involved in profiling did you receive any specialist training on the subject?

5.   If so what did the training comprise of?

6. Also, how much did the training cost?

7. Do you consider the training to be adequate?

8. If not, do you believe this impeded you in any way?

9. Please specify what software programme you use to conduct your geographical profiling.

10. Do you know what costs are associated with this system? I.e. purchase, licensing etc.

11. How many geographical profilers are there within your organisation?

12. Do you know how many geographical profilers exist or are accessible within UK law enforcement, if so, how many? I.e. within other forces or specialist agencies.

13. How often do you use your expertise as a geographical profiler? Please be descriptive.

14. What forms of request do you usually receive? I.e. murders, rapes, burglary etc.

15. Do you believe you are called upon to provide profiles enough, if not why not?

16. Are your skills widely known within the policing arena? If not, why not?

17. What is the process for requesting a geographical profile?

18. Is there a cost involved, if so what is it?

19. How long does a profile take to produce for an investigation?

20. How much and what form of information do you request to create the profile?

21. Do you believe this is too much or too little information?

22. How accurate do you believe the profiling products produced are?

23. In your experience how useful do investigation teams find your product?

24. Can you cite any successful apprehensions or disruptions that have come about from the product?

25. Do you believe the process of profiling can be made simpler? If so, how?

26. How do you believe profiling could be used to underpin more day to day policing activities such as resource tasking and co-ordinating or target selection?

27. How do you believe the process could be complemented?

28. Do you believe the process of geographical profiling has any future with policing?

29. How do you believe the system or use of geographical profiling within UK police services can be improved?

30. Please provide any other information, thoughts or opinions on geographical profiling that you believe may be of relevance or interest.

Appendix 3: Dundee University Ethical Approval

6th July 2014

Dear Mr Halford,

Application Number: UREC 14080

Title: Testing the Assumptions of Geographical Profiling within Volume Crime and its Potential for Everyday use within Operational Policing.

Your application has been reviewed by the University Research Ethics Committee, and there are no ethical concerns with the proposal. The Committee makes a judgement in terms of the Guidelines issued by the British Psychology Society (Code of Conduct, 2006; Ethical Principles for Conducting Research with Human Participants, 2009), and the Medical Research Council Ethics Guide on Medical Research Involving Children, 2004). Any approval given is on the basis that you undertake to follow the relevant Guidelines.

I am pleased to confirm that the above application has been formally approved.

Yours sincerely,

A. Schloerscheidt

Dr Astrid Schloerscheidt
Chair, University of Dundee Research Ethics Committee

Appendix 4: List Restricted Documents and Reports

GMP4 (2015) Briefing Note

GMP5 (2011) Geographic Profile Analysis

GMP6 (2012) Tackling Burglary Dwelling: Disrupting the Optimal Forager, Predictive Mapping & Super Cocooning. Presentation Delivered to the UK Home Office.

NC1 (2015) Northamptonshire Police Report.

WY3 (2015) West Yorkshire Police Report.

Appendix 5: Literature Search Strategy

Search terms	The following key word searches were specifically conducted; • Predictive Policing • Crime Reduction • Crime Prevention • Burglary Reduction • Burglary Prevention • Burglary Offenders • Intelligence Led Policing • Problem Orientated Policing • Routine Activity • Rational Choice • Optimal Forager • Foraging Theory • Offender Motivation • Impulsivity • Predicting Offenders • Geographic Profiling • Distance Decay • Evidence Based Policing • Implementation Failure
Databases searched	The below systems and databases were searched in an effort to source material; • Google • Google Scholar • Directory of open access journals (DOAJ) • Journal store (JSTOR) • University of Central Lancashire Online Library • Dundee University Online Library • College of policing • Her majesty's inspectorate of constabularies and fire and rescue services • Home office
Part of journals searched	For specific journal libraries the Abstract, Title and Headings sections were selected. When using Google and Google scholar the keywords outlined above were entered. Material was then selected for further examination of the abstract or

	introduction section from the description provided in the search returns.
Years of search	In general, the data parameters for the study were large and covered approximately 1960-2017. These dates have been extended since the completion of the literature review in 2016 to include more recently published literature.
Language	English
Types of studies to be included	Peer reviewed systematic reviews, individual studies of both a quantitative, qualitative and mixed methods were all acceptable studies. On several occasions unpublished material drawn from post graduate masters level research was used if it was deemed of a high enough quality.
Inclusion criteria (why was material included?)	Did the literature or research: 1. Provide context in respect of the current policing landscape? 2. provide material that showed the evolution of police performance management? 3. Relate to methods used by the police to control, prevent and reduce crime 4. Relate to methods used by the police to predict crimes or offenders 5. Outline empirical evidence that predicted crimes or offenders 6. Relate specifically to the offence of burglary 7. Outline empirical evidence that related to optimal foraging behaviour 8. Use ecological assumptions within a crime context 9. Explain causal behaviours of offenders 10. Examine how research evidence can be put into practice 11. Examine cultural issues within policing
Exclusion criteria (why was material ruled out?)	In general, literature was very rarely ruled out if it was identified and provided value based upon the inclusion criteria. However, there was multiple occasions were research or material was identified that corroborated or repeated findings in other studies. If this was the case then an initial reference to the material was outlined but a primary piece of literature or evidence

	would be selected as the main reference study. Such primary studies were in general, selected based upon their perceived established or generally accepted nature within the area being researched.