Vandalism: A Crime of Place?

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Abstract

Vandalism is a problem for many communities across Scotland negatively affecting the lives of people who live in them. Whilst there has been recent research into the broad phenomena of anti-social behaviour, there has been little recent research into the specific phenomena of vandalism. In particular, little is understood about why vandalism often persistently re-occurs year in year out in particular locations. Wider research into crime and place suggests that, opportunities to commit crime, levels of relative deprivation, and the capacity or belief that a community can work together (collective efficacy) may be relevant factors. Other theories suggest some areas may act as crime attractors or be more criminogenic than others. There is a strong need for a better understanding of why certain places experience persistent vandalism and others do not. This thesis seeks to redress that gap by suggesting that to understand the nature of vandalism it is best understood as a crime of place rather than property. By drawing on theoretical and methodological approaches from both criminology and geography the thesis explores whether some areas experience high and low concentrations of vandalism year on year; if patterns change over time and whether areas with differing levels of vandalism share characteristics. Exploring issues related to crime and place presents specific methodological challenges. In criminology there has been much debate about whether it is best to consider crime and place processes at the micro or macro level. This thesis contributes to this debate by contending that it is necessary to employ a multi-method approach which integrates both micro and macro levels of investigation to properly understand crime and place.

The results presented here are based on secondary analysis of six years of recorded crime data on vandalism supplied by Lothian and Borders police covering the period 1 April 2004 to 31 March 2010 for a case study area within Edinburgh with a broad mix of socio-demographic contexts. The thesis investigates the value of taking an Exploratory Spatial Data Analysis approach combining GIS based Crime Mapping and LISA (Local Indicators of Spatial Autocorrelation) analysis with Group Trajectory Analysis. This is complimented by data acquired from holding focus groups with Police Officers responsible for neighbourhood policing who used shaded maps to aid discussion of characteristics of areas with high and low vandalism. Findings suggest there are distinct High, Low and Drifting areas of vandalism with particular characteristics influenced by crime attractors, routine activities, relative deprivation and collective efficacy.

By using an innovative multi-method ESDA quantitative and qualitative approach, important insights into the nature of vandalism as a place crime are gained; using a multi-spatial and temporal approach was found to be crucial. Findings are somewhat confined as they relate to a single case study area and a small number of focus groups were undertaken only with police Officers and not other community actors which may limit generalisabily. These concerns are discussed along with recommendations for future policy on vandalism and theoretical and methodological approaches for researching crime and place.

DECLARATION

I declare that this thesis is of my own composition, based on my own work, with acknowledgement of other sources, and has not been submitted for any other degree or professional qualification.

Eleanor Joanne Wilson Bates

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Introduction

It was the mid 90s and as I was leaving for work, I wondered if today, the place I was visiting would feel safe or edgy. Although this research has been conducted in Scotland, it would be fair to say that the roots of my interest in vandalism and place lie in the North East of England.

My first job after completing University was as Tenancy Relations Officer. I advised both landlords and tenants on their housing rights and also mediated in disputes between them. As part of this job I spent a lot of time walking the streets of a major Northern city. What became common was that one week I'd be visiting a tenant and would walk through a community that had no visible signs of crime or disorder and was a quiet and pleasant place to be, and then a few weeks later I'd be called to visit a tenant just a few street away and find homes that were being abandoned, there would be clear signs of disorder and I'd find myself holding tightly onto my attack alarm as I walked to a local tenants home. I began to wonder why this happened. Sometimes these areas had a very different appearance, one might have affluent large houses, another small terraced flats. However, sometimes the appearances of the places were almost identical and yet, in one location there was a reputation for major problems and I felt very uncomfortable and in others there was no apparent cause for concern. I began to wonder why these places, so similar, and so close to one another, could be so different. I remember being shown this very new computerised database and mapping software called a Geographic Information System (GIS) and after I'd got over my 'that's really cool' reaction wondering if you could use it to answer questions about why adjoining neighbourhoods could be so different.

A little later in my career, in the mid 2000s, I was using a GIS, and I worked as a Local Government Research Officer whose job was to provide reports of levels of recorded crime in local areas to Community Safety Partnerships. What became very clear was that vandalism (or criminal damage as it is known in England) was a volume crime (there was a lot of it compared to other crimes). Yet those working in local neighbourhoods to prevent crime knew very little about why vandalism was much more common in some areas than others. This was linked to a lack of understanding about why some areas, often very close to one another could be very different places. This led me to decide that I wanted to go and do some research that might provide some answers to these questions.

My first step was to review research into vandalism and crime and place. I was surprised to find that there had been a rich tradition of vandalism research until the mid 1980s. By the mid 1980s a clear research gap in understanding of where vandalism occurred and the qualities and properties of the locations it occurred at had been identified (Canter, 1984). In part at the time this was due to a lack of data and available computing power to investigate these issues. However by the mid 90s when both computing capability and available data was making research into understanding vandalism and place much more feasible, academic interest in vandalism had waned and fragmented into a research agenda concerned with broader themes of disorder, incivilities and anti-social behaviour. With the notable exception of work by Per Olof Wikström (Wikström, 1991) and later Vania Ceccato and Robert Haining (Haining and Ceccato, 2005) it appeared virtually no-one had tried to understand links between vandalism and place. Now I understood why the staff from Community Safety Partnerships had told me that people did not understand vandalism. Here was clearly an area where there was a pressing need for further research. By 2008 recent advances in both the quality of recorded crime data held by local police forces (Chainey and Ratcliffe, 2005); the increased level of high quality data being released at small area level by public websites for example Scottish Neighbourhood Statistics (www.sns.gov.uk); and software and techniques for analysing spatial distribution of crime meant that this was the ideal time to undertake research to meet this gap in understanding.

Key research questions

In view of the research gaps identified the research aimed to answer the following questions to get a better understanding of vandalism and place

- Are there areas (places) that experience high and low concentrations of vandalism year in and year out?
- Do concentrations of vandalism change over space and time, and are there any particular patterns that appear to exist?
- Do places which experience either low or high concentrations of vandalism over time appear to have any common features or shared characteristics?

The research also aims to explore the following methodological issues

- To investigate the value of using an Exploratory Spatial Data Analysis methodological approach to examining research questions related to crime and place.
- To look at how ESDA techniques and qualitative techniques including ideas from qualitative GIS might be used
- To consider the necessity of exploring multiple spatial and temporal scales in crime and place research, is it enough to just concentrate on micro or macro scales or do both need to be considered

The original contribution of this research

This research makes an original contribution by arguing that we will better understand vandalism by reconceptualising it as a crime of place, rather than a property crime. The reasons why vandalism occurs in some locations and not others across time are complex, and prior to this research, very little understood. This research has directly explored whether some places actually have consistent high or low levels of vandalism over time and the reasons why this might be. By analysing six years of recorded crime data giving locations where in which vandalism occurred, in a study area within Edinburgh, this research has found that areas where vandalism does and does not occur can be classified into three broad groups, areas with High levels of vandalism, areas with Consistently Low levels of vandalism and Drifting areas. The Drifting areas drift between, high and around average, or low and around average, levels of vandalism. This is an insight not previously found in the literature. The research has gone on to consider what characteristics are common to High, Drifting and Low areas of vandalism. As the research has been exploratory it has not been able to conclusively confirm any hypotheses about the precise nature and relative weight of these place characteristics but it has been able to show what factors are likely to be important and should now be the focus of further research. Key factors that influence whether areas have High, Consistently Low or Drifting levels of vandalism are *both* structural and situational and include:-

- the nature of routine activities in an area across all years, as well as daily and weekly patterns of behaviour;
- the use and abuse of space, in particular issues of local conflict and the presence or absence of crime generators and crime attractors;
- persistent inequality and advanced marginality in particular levels of relative inequality, and
- the nature of community interactions in an area - in particular the degree of collective efficacy in a community is likely to be important.

Since these factor go well beyond the simple concept of property it is proposed that vandalism is more usefully conceptualised as a crime of place rather than a property crime.

The second key contribution of this research is to the debate around the best methodological approach to researching crime and place. This research finds that the scale chosen for analysis of indicators of crime, and related socio-demographic factors, has a marked influence on the results observed, and the research therefore recommends that it is important to analyse data at multiple scales. The research has demonstrated that the nature of the relationship between vandalism and place is complex and changes over time, and to understand this it has been necessary to use a mixed method exploratory spatial data analysis approach. It has been suggested by some within the crime science paradigm that simple, fast response, research is sufficient for an understanding of crime and place; this research suggests simple methods such as hotspot mapping are not enough and more complex methods such as group trajectory analysis are needed. It has been suggested by those within the cultural criminology paradigm that much quantitative research of crime and place is inherently flawed, and that therefore ethnographic methods should be the primary methods for understanding issues of crime and place. This research instead argues that a mixed method approach using both focus groups and crime mapping, that approaches number in quite a qualitative and reflexive way, can be as beneficial as a more ethnographic approach, and also is highly replicable.

A final key contribution of this thesis has been to further develop innovative methods for exploring the nature of crime and place. The research has built on existing methods used by both criminologists and geographers (methods that go back as far as the work of Charles Booth in the 1890s) to develop a technique whereby responses of focus groups can be combined with map data to give useful insights into differing characteristics of places which do and do not experience vandalism. Secondly this research has expanded on methods of exploring developmental trajectories of places as recently used by David Weisburd, Elizabeth Groff and others (Weisburd et al, 2012) who use count based group trajectory models (a type of latent class modelling) of street segments to understand crime and place. This research expands on the work of Weisburd et al. by conducting both count based and category based group trajectory at two different scales. It also supplements the group trajectory analysis with qualitative data from focus groups and appears to be the first United Kingdom based research, and may be amongst the first research in the world, to do this.

Key research methods

The research uses a combination of analysis of recorded crimes of vandalism and relevant socio-economic indicators using Exploratory Spatial Data Analysis (ESDA), along with Group Trajectory Analysis and Focus Groups. Particular ESDA techniques used are Kernel Density Estimation (KDE), and the Local Indicators of Spatial Association (LISA) G_i* and Local Moran's I. It makes much use of visualisation especially in the form of maps.

Thesis Structure

Chapter 1 presents an overview of the literature on vandalism, and also considers the wider literature relating to crime and place. The first sections concentrate on understandings of vandalism. The chapter then moves on to briefly consider the meaning of place before discussing four key theoretical approaches to crime and place. The chapter ends by summarising what we know about vandalism and place and stating the key research questions relating to understanding the relationship between vandalism and place that the thesis sets out to answer. Chapter 2 discusses methodological debates around understanding crime and place and then states the methodological objectives of the research. Chapter 3 describes the methods employed in the research. It begins by explaining the analytical framework, then discusses the choice of data sources, ethical issues and choice of study area. It then considers how data, in particular sensitive data on crime, was accessed. It then details the key research methods employed in the analysis of the data. The following three Chapters, 4, 5 and 6 present the results of the research. Chapter 4 considers key findings and methodological challenges and finds evidence of the existence of high and low areas of vandalism across time, as well as presenting particular issues related to the scale at which analysis is conducted. Chapter 5 reports the results of key group trajectory models for the study area, establishing that areas tend to have either High levels of vandalism, Consistently Low levels of vandalism, or be in a Drifting state where levels of vandalism fluctuate, and using multinomial logistic regression explores some possible key characteristics of the High and Drifting areas compared to Consistently Low areas, as well as considering the characteristics of Consistently Low areas. Chapter 6 is a long chapter which considers the study area in two sections; it integrates analysis of data from focus groups with quantitative analysis of crime and socio-economic data to highlight characteristics of the High, Consistently Low and Drifting areas. Finally Chapter 7 concludes the thesis considering the methodological, theoretical and policy implications of the research.

1 Understanding Vandalism and Place

This chapter begins by defining vandalism and then explains why it is a research topic worth engaging with. It then goes on to describe the past history of vandalism research and why criminology seems to have lost interest in vandalism. Not all criminology and geography did lose interest though, so the next section discusses what is known about vandalism from current research and identifies a key research gap in the understanding of vandalism and place. In order to understand the relationship between vandalism and place it is necessary to both define place and summarise existing theories of crime and place relevant to vandalism, so this is what this chapter does next. Finally the chapter summarises how these theories of crime and place can be put into a single theoretical framework, and then sets out the key research questions this research project will ask to fill some of the gaps in our current knowledge of vandalism and place.

1.1 About Vandalism – Definitions and Why does it matter

1.1.1 Vandalism What (definitions)

Vandalism is most simply defined as damaging or defacement of a property not sanctioned by its owner. The Oxford Dictionary of English (2nd edition) definition is perhaps a more pragmatic definition:

> "action involving deliberate destruction of or damage to public or private property."[1]

Both English and Scots law are likely to term this criminal if the property belongs to another, and the action is deliberate. In Scottish criminal law:-

> "any person who, without reasonable excuse, wilfully or recklessly destroys or damages any property belonging to another shall be guilty of the offence of vandalism"
> Criminal Law Consolidation Scotland Act 1995 section 52(1)

Until 1980 there was no statutory offence of vandalism in Scotland (Gane et al, 2001), all acts of damage and defacement of property would have been classed as the common law offence of malicious mischief; now offences may be classed as vandalism or malicious mischief, with the classification of the offence effecting the criminal procedure followed.

[1] "vandalism *noun*" *The Oxford Dictionary of English* (revised edition). Ed. Catherine Soanes and Angus Stevenson. Oxford University Press, 2005. *Oxford Reference Online*. Oxford University Press. University of Edinburgh. accessed 30 April 2009 <http://www.oxfordreference.com/views/ENTRY.html?subview=Main&entry=t140.e85476>

Vandalism is a much more complex concept than just damage to property. The definitions of vandalism as damaging or defacing also comprise graffiti and street art. A proportion of local graffiti and street art is now part of a wider international cultural phenomenon[2], there are strong similarities in tackling graffiti across cities internationally and a global industry in both selling products to make graffiti and prevent it (Iveson, 2010). As Andrew Millie has commented, decisions as to whether such acts of graffiti and street art constitute crime, and or sanctioned or celebrated by public authorities are often made on an aesthetic or populist basis rather than a legal one (Millie, 2008).

Stan Cohen, the respected sociologist, whose early work around deviance and labelling theory, focused on vandalism, argued that what is understood as vandalism is socially constructed.

> "The social scientist should be aware that vandalism, like any other form of deviance, is behaviour that is perceived and categorized in many different ways. These perceptions both depend on and determine the dominant modes of understanding the phenomenon – whether in the media, public opinion, the control system or the professional theories which social scientists themselves use. All these groups are thus not just passive audiences, but active participants in the drama of vandalism: they make fateful decisions, they influence the gathering of statistics and they allocate priorities. They determine where and how vandalism is placed in the agenda of any particular society" (Cohen, 1984b, 231)

Stan Cohen's vandalism typology (Figure 1.1) is primarily concerned with behaviour and motivations and suggests vandalism should be seen as three distinct types; *institutionalised rule breaking* where vandalism occurs but is tolerated and sanctions are not applied to the rule breakers; vandalism that occurs as a result of some form of *ideological* or political protest; and, *conventional* vandalism. This typology remains very influential, although it is the ideological and conventional vandalism parts of the typology that are most commonly cited (Goldstein 1996, Wikström, 1991, Bromley and Nelson, 2002, Ceccato and Haining, 2005)

[2] As the recent Banksy film *Exit through the Gift Shop* (2010) which features interviews with a number of writers and street artists from various countries who have influenced each other's work internationally as well as worked (both legally and illegally) in a number of countries.

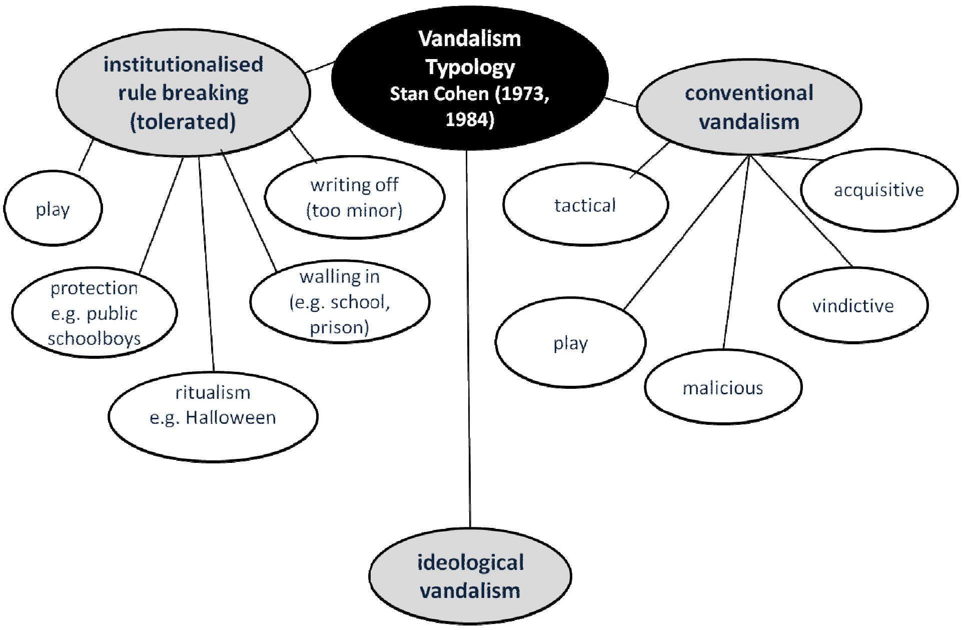

Figure 1.1 – Cohen's Vandalism Typology

The more complex definition of vandalism offered by the Oxford English Dictionary perhaps goes some way to encompass some of this complexity describing vandalism as :-

> "The conduct or spirit characteristic of, or attributed to, the Vandals in respect of culture; ruthless destruction or spoiling of anything beautiful or venerable; in weakened sense, barbarous, ignorant, or inartistic treatment." [3]

This all suggests defining of vandalism purely in terms of property damage is too narrow ignoring wider contextual and cultural elements that may be in play. The need to define vandalism as something more than just damage to property is a theme that will be returned to throughout this thesis.

1.1.2 Why does vandalism matter anyway?

Vandalism is a common crime. It matters to the police and those concerned with community safety as it has consistently made up something between around quarter and a third of all police recorded crime over the last decade (Scottish Government, 2011), and whilst there has been a significant downward trend in levels of domestic housebreaking over last decade, only in the last 3 years does there appear to be a similar trend in vandalism see Figure 1.2

[3] (accessed online at http://dictionary.oed.com.ezproxy.webfeat.lib.ed.ac.uk/ on 30 April 2009)

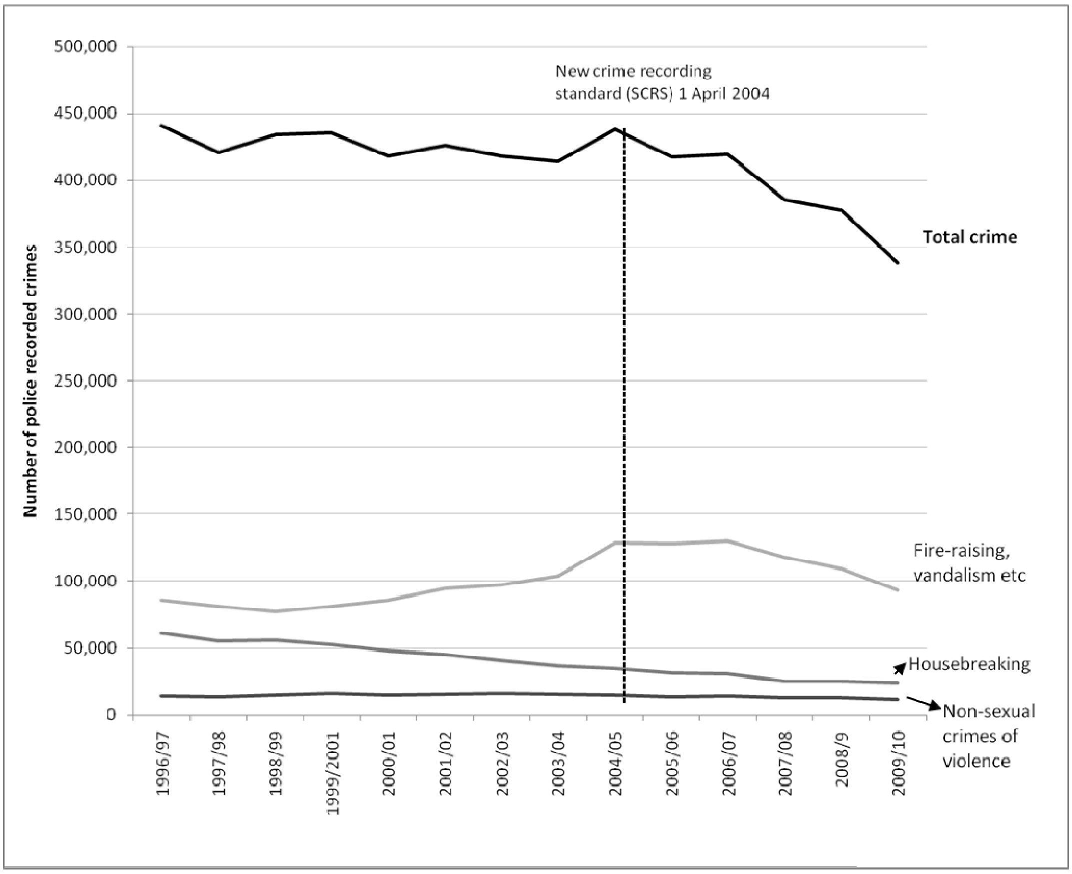

Figure 1.2: Police recorded crime in Scotland – total crime and selected crime

Vandalism and the methods used to actively prevent it can have wider perhaps sometimes unexpected or unintended consequences for communities. The highly influential Broken Windows theory argues that where a broken window goes un-mended that can lead to further disorder (Wilson & Kelling, 1982, Wagers & Kelling, 2008) although it's contention that minor incivilities if not tackled lead to serious violence is widely critiqued and contested (e.g. Taylor, 2001, Harcourt & Ludwig, 2005), and it has been recently argued so called 'broken windows policing', where minor incivilities are actively targeted, can actually increase local concerns about crime (Hinkle & Weisburd, 2008).

Perhaps one reason for this, Martin Innes has argued, is that vandalism is one of a number of signal crimes that when evidence of the offence is seen or talked about, e.g. a broken window this can signal to a local community that there is a crime problem in the local area, even if this is not actually the case (Innes, 2004). As Vania Ceccato summarises, vandalism is often high in areas where "collective resources are weak", that is to say where the community lacks shared values about the inappropriateness of vandalism in the area and are unable to self-organise to combat it; conversely in some areas high levels of vandalism may mobilise a community into social action where it was not previously present (Ceccato & Haining, 2005, p1639-1642).

Vandalism has political importance. Vandalism is commonly listed as a key component of anti-social behaviour. Whilst anti-social behaviour lacks any clear legislative definition Criminal Damage / Vandalism is in a list of behaviours defined as antisocial behaviour since 2003 by the UK Home Office (Millie, 2009, 11). Vandalism is also noted as a concern within anti-social behaviour strategy documents in Scotland (Scottish Government 2009a, 2009b). Thus understanding what vandalism is, who does it, what motivates them to do it and where and when it occurs is important. This chapter now goes on to look at the history of research into vandalism, and why research into it began to wane.

1.2 Vandalism a Research History - or Why did researchers lose interest in Vandalism?

When I first came to research vandalism when looking at the relationship between criminal damage and alcohol for my Masters Research (Bates, 2008) I was surprised to find that there appeared to be very little recent research into vandalism, as has been commented on by other researchers (Ceccato & Haining, 2005, Goldstein, 1996). The reasons why this happened are worth exploring to give a little historical context as to why vandalism has come to be ignored by many researchers despite being such an important problem as outlined in section 1.2.2 above. Albert Goldstein argued in the mid 1990s that researchers had lost interest in vandalism because researchers were “downsizing deviance” and becoming less interested in lesser forms of deviant behaviour (Goldstein, 1996, p1-2). My reviews of research shows that there has in fact been a continued interest in low-level deviance but this interest has moved away from a specific interest in vandalism to a fragmentation of research interests across a range broader research areas all in some way connected with vandalism; Figure 1.3 summarises this fragmentation.

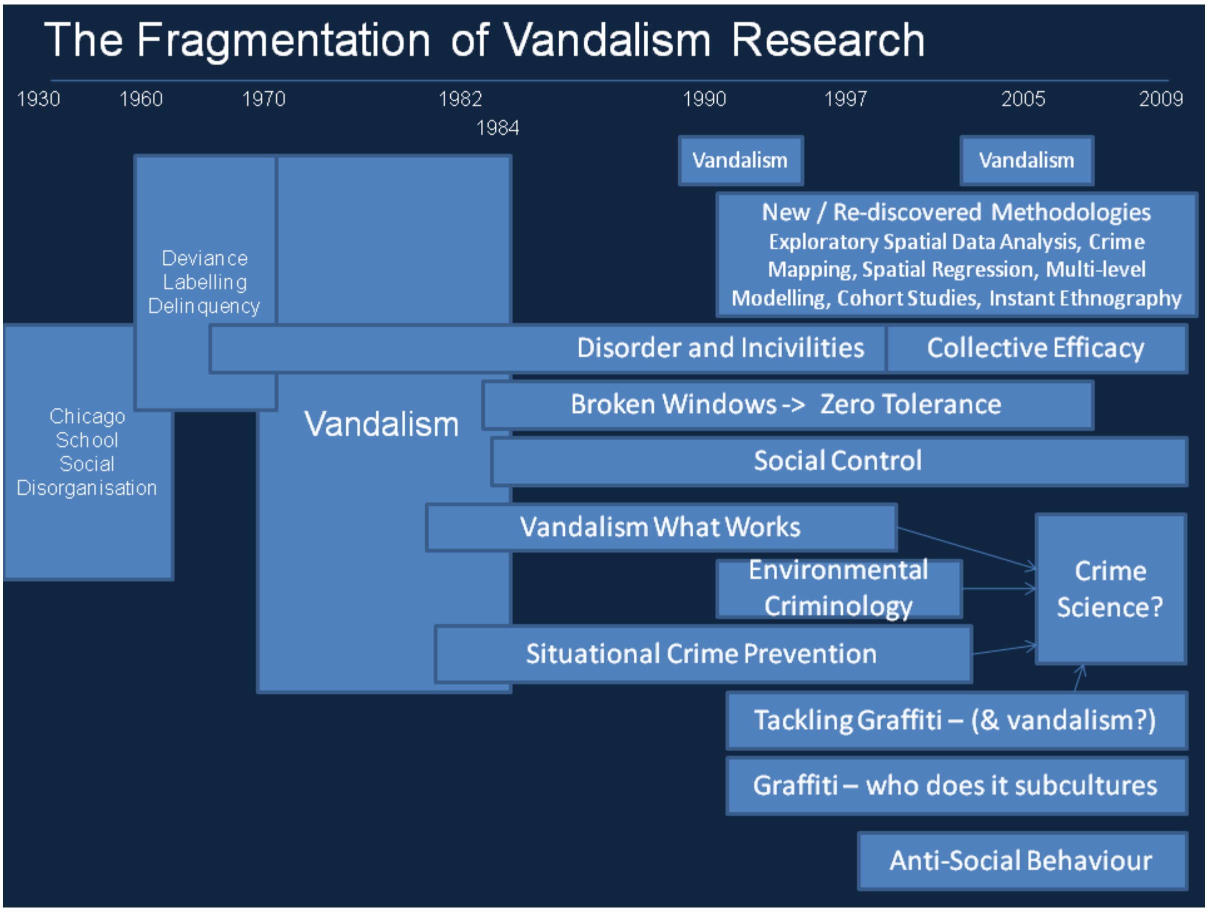

Figure 1.3 The Fragmentation of Vandalism research - Timeline

1.2.1 Vandalism research from the 1970s – 1980s and its roots from the 1960s and 1930s

There was a rich tradition of vandalism research in the 1970s. All aspects of vandalism were considered by a varied body of researchers including sociologists, psychologists, geographers and architects. This period could be said to begin with the publication of Vandalism by Colin Ward (1973) and ending with a colloquium in 1982 which led to the publication of Vandalism: Behaviour and motivations edited by Claude Levy-Leboyer (1984). This interest in vandalism in part grew out of interest in labelling theory (Cohen, 1984a) which developed in the 1960s (for example Becker, 1963, see Melossi p159-165). Early work of the Chicago School on social disorganisation (Shaw & Mackay, 1942, Park et al, 1925 and others see Melossi, 2008, p110-116) was also crucial. Finally other influential work suggested how both city planning (Jacobs, 1961 in Mayhew 1981), and how buildings were designed (Newman, 1971), could have a direct effect on crime including vandalism (Mayhew, 1981)[4].

[4] I am also very grateful to discussions I have had with Tim Hope for this insight.

At the start of the 1970s, there was a clear interest in vandalism, but limited research. Writers lament the lack of hard data, and research studies into vandalism (Ward, 1973). By 1984 van Vliet in his comprehensive review of vandalism research was able to cite numerous studies all taking place throughout the 1970s to the early 1980s. This rich review of research suggested that vandalism was primarily committed by young men aged 25 and under, was often unsolved, was fairly common among adolescents, took place in a range of environments involving both private "but particularly public" property. There was little consensus on what was defined as vandalistic behaviour, and a diverse range of strategies were in place aimed at preventing vandalism but "there is little evidence in extant literature of theoretical and methodological triangulation of the problem" (van Vliet, 1984, 24).

1.2.2 Broken Windows - The end of vandalism and the beginning of disorder

Around the early 1980s the fragmentation of vandalism research appears to begin with a growing interest in general disorder beyond the specific crime of vandalism; this is particularly the case for research based in the United States. In 1982 James Wilson and George Kelling publish their very influential Broken Windows essay in Atlantic Monthly. This essay suggested that with just one un-mended broken window a neighbourhood could change irrevocably. In such a neighbourhood Wilson and Kelling argued that serious crime was not inevitable, but residents will *think* violent crime is on the rise and crime is not being prevented. Wilson argues these areas are thus "vulnerable to criminal invasion" because residents are not confident they can regulate public behaviour through informal controls so "drugs will change hands, prostitutes will solicit, and cars will be stripped" (Wilson, 1984, 79). Interestingly some of Wilson and Kelling's argument, drew on research by Zimbardo featured in the Colin Ward 1973 volume on Vandalism (Zimbardo, 1973) but ignores Zimbardo's interest in how much fun and enjoyment could be had when being involved in vandalism. Wilson was particularly concerned with the negative effect of crime on the wider community and what practical steps might be taken to resolve this and less concerned with complex motivations; a theme that arguably became more popular through the 1980s. Zimbardo was writing in the 1970s when there was much more interest in self-expression and subcultural influences in crime.

Wilson and Kelling's vivid picture of a neighbourhood descending into chaos was hugely influential (Sampson, 2009b). Not just the actual crime of vandalism but non-criminal activities, for example rowdy children, teenagers hanging around, litter and street drinking were all labelled a problem. It is interesting that these activities continue to be used as a measure of problems in the neighbourhood for example in Scottish Crime and Victim Survey and Scottish Household Survey (Scottish Executive & Brown, 2007). In America Wilson and Kelling's controversial theory led in part to the so-called ‘zero-tolerance’ approach in New York (Melossi, 2008, 214-216). Broken windows, and some earlier work in the mid to late 1970s (see Taylor, 2001, Ch3) encouraged a growing interest in incivilities generally. Some argued strongly in support of the broken windows thesis (Skogan, 1990) while others have been equally strongly opposed (Herbert and Brown, 2006; Harcourt and Ludwig, 2005). Ralph Taylor used detailed studies of Baltimore neighbourhoods to argue that disorder alone was not the issue instead “changes in neighbourhood fabric, neighbourhood crime rates and resident’s safety concerns” were all “tangled topics” potentially affecting levels of incivility (Taylor, 2001, 20). With this move towards a focus on disorder, a consideration of the specific crime of vandalism was lost.

1.2.3 The influence of “What Works?”

In the 1980s, with the growing influences of what later became known as crime science, there was a growing demand for solutions that worked and there was a considerable amount of research which catalogued interventions that might prevent vandalism. This time can be thought of as a period when “what works” dominated the UK crime policy agenda (Garland, 1996). Over this time the Home Office research unit published two publications over a decade apart, one at the start of the ‘what works’ era (Clarke et al., 1978), and one at the end (Barker and Bridgeman, 1994). During the 'what works' era, many different types of intervention that might prevent vandalism were identified, however, there was a lack of consistent evaluation of how effective these interventions were (Goldstein, 1996, Barker and Bridgeman, 1994). This focus on solutions to vandalism does not seem to have been complemented by a corresponding interest in increasing theoretical and methodological triangulation identified as a research gap by Van Vliet in 1984 which perhaps explains why expanding understanding of why vandalism occurs and the wider contexts influencing vandalism appears to have stalled through this decade. In particular the focus on individual fairly simple single interventions of this decade did not fully appreciate the complexity of the problem. It might have been expected such a glaring research gap might have been quickly identified but before Goldstein’s or Barker and Bridgeman’s recommendations could be considered, changes in the political landscape in the UK arguably meant vandalism (already potentially lost in the broad concept of disorder in the US) became subsumed into the concept of anti-social behaviour in the UK, effectively ending the majority of independent research into the phenomena of vandalism.

1.2.4 Anti-social behaviour

Whereas disorder research could be said have it’s roots in the right wing research position of Wilson & Kelling, the roots of interest in anti-social behaviour in the United Kingdom came from the left realism school. In the early 1980s research by John Lea and Jock Young of the left realism school drew attention to the problem of disorder as being just as damaging for communities as more serious crime; they were concerned about a "continuum of disorder" where "nuisance boils over into criminal violence" and referred to this continuum as "anti-social behaviour" (Lea and Young, 1984, p55-8 quoted in Young, 1999, 138). By the time Labour came to power in 1997 there was a strong commitment to tackling anti-social behaviour. They introduced Anti-Social Behaviour Orders to deal with behaviour short of criminal, these were controversial and there was very little academic support (Burney, 2005, Hughes, 2007). The motivation for the need for these additional powers was arguably strongly political (Burney, 2005, Squires & Stephen, 2005, Squires,2006) and there remains little evidence of how effective these powers have been (Prior, 2009) with some arguing they can be counter-productive and target the most marginalised and vulnerable (Burney, 2005, Squires & Stephen, 2005).

Interest in the new anti-social behaviour powers, was also partly a reflection of a wider interest in why governments, particularly in the UK and United States since the early 1980s, and subsequently France, were (and were able) to exercise increasing levels of social control over their populations (Cohen, 1985, Body-Gendrot 2000, Garland, 2001a, Melossi, 2008, Wacquant, 2008). Researching why these new powers had come to be, and their impact, was clearly an important issue for criminologists and sociologists to tackle, but there appears to be surprisingly little research into actual levels of anti-social behaviour or the behaviours themselves (Prior, 2009). This is an issue, as whilst what constitutes anti-social behaviour and how it is tackled remains contentious, and perceptions vary between young and old, recent research in Scotland suggests of the various possible anti-social behaviours, vandalism is agreed by all to be problem (Scottish Government, 2009b – Background evidence for anti-social behaviour review).

1.2.5 Graffiti subcultures and the responses to them

The one exception to the lack of research into vandalism has been rich research into the sub-culture of graffiti writing, with much interest in who writers are and their motivations. (Ferrell 1996, Macdonald, 2001, Austin, 2001, Halsey and Young; 2001, 2006, Ferrell et al, 2008, Iveson, 2007). This research also hints that motivations to do graffiti might be quite distinct, and potentially different, from conventional vandalism involving the smashing, breaking or defacing of things. This remains a key research question to be addressed, however, whilst this research project has touched on this it will not be one of the key questions addressed here. Whilst the graffiti research is interesting and insightful, the focus on only this more obviously colourful and artistic aspect of vandalism has somehow also helped to extinguish a discussion of the phenomena as a whole – a step that is in some ways retrograde.

1.3 Vandalism – What we know already

Despite the general move away from vandalism both the research of the 1970s and more recent research has given us quite a bit of insight into vandalism. This section of the chapter summarises findings from more recent research.

1.3.1 Who is involved in vandalism

Vandalism is more likely to be committed young people; however some of those young people are not children but young adults. The peak age of offending appears to be in the early teens around 14 to 15. The Offending Crime and Justice Survey (OCJS) in 2006 found 32% of all 14-15 years olds reported they had committed a core offence, 36% of 14-15 year olds had committed an act of Anti-Social Behaviour (ASB); 9% of 14-15 year olds had committed an act of criminal damage (a core offence in the survey); 12% of 14-15 year olds said they had done graffiti (an act classified as ASB) (Figure 1.4). Figures are from tables in a recent report (Roe & Ash, 2008) on the Offending Crime and Justice Survey (OCJS) 2006, a survey of 5,353 respondents in England and Wales of whom 4,951 were aged between 10 and 25. These charts represent the proportion in each age group who say they had offended - for core offences (1) the total respondents answering the question is 4,816, for ASB (2) the total respondents 4,815.

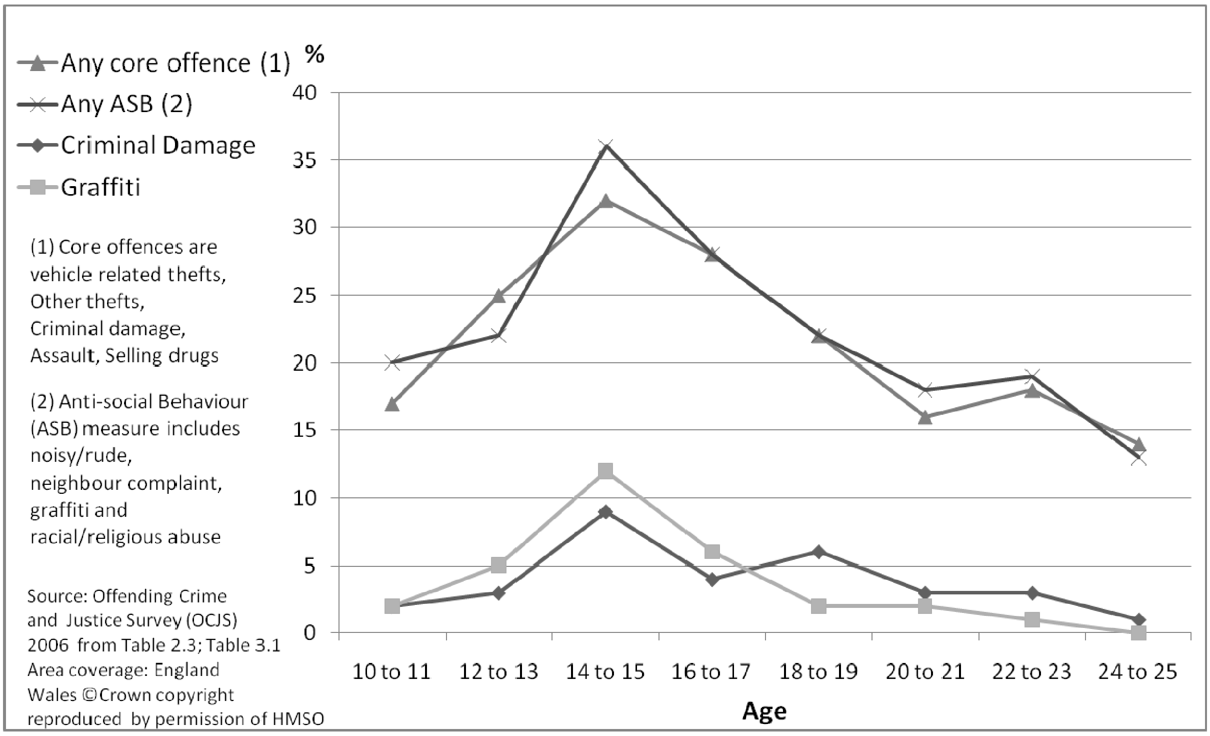

Figure 1.4 Prevalence of offences by Age – total crime and anti-social behaviour, vandalism and graffiti

Actually all crime is far more likely to be done by a younger person; the age crime curve is universally accepted across criminology although peak ages vary between different crime types and genders and criminologists remain divided as to why it looks like it does (Smith, 2007). The Edinburgh Study of Youth Transitions in Crime (ESYTC) has similar findings to the OCJS. The ESYTC is a self-report longitudinal cohort study whose data is freely available on application. The study followed a group of around 4,300 young people representing around 92% of all children in a year at secondary school across all parts of Edinburgh; as such it has greater breadth than some other similar studies of this type that limit themselves to sections of a city or only males (McVie, 2001, McVie 2003, Smith et al 2001, Smith, 2007). Young people were surveyed in 6 annual sweeps from 1998 when they were aged around 12 until aged around 17. Particularly useful for this project, in 5 out of 6 survey sweeps, separate questions were asked relating to destructive vandalism, graffiti writing and fire-raising.

Early vandalism studies in the 1970s and early 1980s suggested that vandalism was mainly an activity of young men, however that is most likely to have been due to the fact that the majority of deviancy studies at the time focused on young men (Levy Leboyer 1984, Coffield, 1991). Exploratory analysis of the ESYTC suggests both young men and women are involved in vandalism although young men are more likely to be involved in vandalism and fire-raising than young women; however there are similar proportions of young males and females involved in graffiti with slightly more women than men involved in graffiti at age around 14 (Bates & Mackaness, 2010)

1.3.2 Vandalism – Motivations and Theories of Vandalism

Research suggests vandalism isn't mindless, instead a range of complex motivations may be involved. A range of typologies have also been suggested (see Goldstein, 1996, Coffield, 1991) which taken together suggest that key factors motivating people to take part in vandalism are play, pleasure or thrill, protest, and territoriality; also that poor design invites or leads to vandalism (Goldstein, 1996). Stan Cohen's (1973, 1984a) typology of vandalism (Figure 1.2 above) is excellent. Stan Cohen's typology stresses vandalism should be seen as three distinct types; institutionalised rule breaking where vandalism occurs but is tolerated and sanctions are not applied to the rule breakers, vandalism that occurs as a result of some form of ideological or political protest and conventional vandalism. Interestingly it is the, ideological and conventional vandalism parts of the typology that are most commonly cited (Goldstein 1996, Wikström, 1991, Bromley and Nelson, 2002, Ceccato and Haining, 2005).

Goldstein is the only source I have found to detail actual theories of vandalism. He lists three theories which specifically seek to explain vandalistic behaviour, these are Enjoyment Theory, Aesthetic Theory and Equity Control Theory. *Enjoyment Theory* (Csikzentmihalyi & Larsen 1978 in Goldstein, 1996, 39-41) looks at vandalism in school settings specifically. They argue that

> "An activity seems to be enjoyable when a person perceives that his or her capacity to act(or skills) match the opportunities for action perceived in the environment (or challenges)...a peculiar dynamic experience which we have called the flow state"(Csikzentmihalyi & Larsen 1978,p13 in Goldstein,1996,p39)

Csikzentmihalyi & Larsen argue for some/many children school fails to provide such flow state opportunities so to create/manufacture them they behave in a violent, anti-social or vandalistic way. In *Aesthetic Theory* (Allen & Greenberger 1978 in Goldstein, 1996, 41-43) argues the destructive act can be aestheticallly appreciated; factors such as complexity, predictability / expectedness and novelty all contribute to the decision to destroy something, what is chosen and the appreciation of that destruction of it. Thus certain objects will be more or less enjoyable to vandalise, and therefore more or less likely to be vandalised, dependent on the joy breaking or modifying the thing will engender. Finally *Equity-Control Theory* (Fisher & Baron 1982, DeMore, Fisher and Baron, 1988) in Goldstein, 1996, 43-44) proposes

> " that the core motive underlying vandalistic behaviour is perceived inequity (i.e. perceived violations of norms of fairness in social or environmental arrangements) and that the goal of vandalism is equity restoration...The theory's central prediction is that vandalism is most likely to occur under conditions of low perceived equity and low to moderate perceived control"(Goldstein, 1996, 43-44)

Thus by this theory vandalism occurs when people perceive themselves in an unequal position and they want to restore a feeling of equality through vandalising something, this is most likely to occur where there is low control. As far as I am aware none of these theories have been widely tested in research, nor do they appear to be much discussed in recent criminological theory; this may however reflect the move away from researching vandalism to researching broader issues of disorder and anti-social behaviour discussed above. These theories also only consider motivations of offenders to do vandalism, not why some areas are affected by vandalism but others are not. This chapter now turns to this under-researched area.

1.3.3 Vandalism Where and When

The final aspect of vandalism, one that is the particular focus of this thesis is where and when it occurs, and why it occurs in certain locations more than others. This is where there has been the least research. What is known appears to be that vandalism tends to happen in public places where concentrations of people gather and where there may be an absence of appropriate guardians to prevent it (van Vliet, 1984; Wikström 1991, Ceccato and Haining, 2005). It is common to vandalise along routeways from leisure spaces, city centres and areas where people gather, in particular areas where alcohol is available (Bromley and Nelson, 2002, Roos, 1984, Ceccato and Haining, 2005). Vandalism also tends to occur where young people gather e.g. parks, street corners, in other words land-use structure affects levels of vandalism (Roos, 1984; Ceccato and Haining 2005). Vandalism also seems to occur in areas of social disadvantage especially in areas around places where people congregate in areas of social disadvantage, and there is some suggestion this may then spill out into adjoining areas (Ceccato and Haining, 2005). Existing research suggests vandalism is more common in the evening and at the weekends (Roos, 1984, Wikström 1991). Some of this is connected to this being a time that people tend to go out to socialise together and also frequently consume alcohol (Bromley & Nelson, 2002).

There is very little theory on why vandalism occurs in some places and not others. Goldstein argues it is down to a "person – environment duet" (Goldstein, 1996, 48), what he considers to be an interactionist perspective:-

> "..all acts of vandalism in my view are a combined result of qualities of the vandal and characteristics of the physical and social environment in which it occurs"(Goldstein, 1996, 47)

This he argues therefore leads to two intervention strategies – changing the physical and social environment or changing the vandal, however he feels both are needed.

> "...while some perspectives indeed capture this central interactionist quality, many others are much more full oriented toward *either* environmental solutions or person-focused (vandal-focused solutions). These latter strategies – based on environment *or* person – are in my view equally limited when enacted alone. Both are necessary; neither is sufficient" (Goldstein, 1996, 47)

In some senses in this way Goldstein was ahead of his time, criminology as a whole has been recently critiqued for being either too person or environment/situation focused rather than interactions between person and situation being seen as key (Wikström et al, 2012); it is only over fifteen years later Per Olof Wikström and others have developed Situational Action Theory to counter this perceived issue.

The other interesting commentary in this area is by Vania Ceccato and Robert Haining who present an interesting model where interactions between fear of crime, population turnover, socio-economic and geographic segregation, neighbourhood collective resources and social control all influence vandalism (Ceccato & Haining, 2005, see especially Figure 1, p1642). The focus here is particularly on social and neighbourhood factors, where interactions, are key as their paper is concentrating on the geography of vandalism. For Ceccato and Haining Neighbourhood collective resources are made up of the nature of social ties, the presence or absence of neighbourhood physical collective resources (for example community centres) and engagement between the neighbourhoods and city-wide collective resources. Ceccato and

Haining describe social ties as being comprised of involvement in the neighbourhood (where fear of crime can be a negative factor restricting this), attachment to the neighbourhood (where high population turnover can reduce levels of attachment) and identification and attainment of common goals (where high levels of segregation can act as a negative factor preventing this). However, Ceccato and Haining's research looks at only a single year of vandalism data and is unable to comment on trends of vandalism over time.

In general, there is a missing sense of place and the knowledge of the where and when is very limited. David Canter's comments summing up research gaps following a comprehensive vandalism symposium in 1982 still remain true today:-

> "Where does vandalism occur and what are the qualities and properties of these locations" (Canter, 1984, 351) "...it is essential that research looks at the various processes, development, changes over time which relate to vandalism. In other words, instead of being concerned with describing the frequency or distribution of acts of vandalism we should look more to the patterns of activity and processes involved in vandalism." (Canter, 1984, 352)

The interactions between person and place (and time) which leads to vandalism, highlighted by Goldstein and Canter, is still little understood (with the exception of the work of Ceccato and Haining). In particular, there is a need to understand processes, qualities and properties of locations affected by vandalism and change over time. Before going on to outline how this research seeks to remedy this research gap, to set research on vandalism processes across place and time in context, this chapter will now outline some key thinking and theories relating to crime and place thus providing a wider theoretical background and through this building a theoretical framework in which to site this research. Before diving into this theoretical discussion the chapter takes a very quick detour into defining place.

1.4 What is Place?

The need to ask the question what is place, may seem a strange one to anyone who is not directly interested in geography. However, a quick look to the Oxford English Dictionary demonstrates place has multiple definitions divided into four main types:

> "I. A (public or residential) square.
>
> II. Senses relating to space or location.
>
> III. Senses relating to position or situation with reference to its occupation or occupant.
>
> IV Position in some scale, order, or series." (Oxford English Dictionary, Online edition accessed 17 March 2013)

These multiple definitions suggest that place is understood as a multi-faceted complex thing.

For human geographers there are ongoing and complex debates about what constitutes place (Tita and Radil, 2010). Tim Cresswell's 'Short introduction to place' is 143 pages long (Cresswell, 2004). Cresswell summarising the work of John Agnew explains place can be a physical location, place can also be a locale where 'people conduct their lives as individuals'; there is also a 'sense of place' which concerns peoples emotional lives within a place (Cresswell, 2004, 7-8).Place "is not just a thing in the world but a way of understanding the world" (Cresswell, 2004, 11). Place can be home, history, a social construction, global, local, an ongoing process over time and an aspect of personal and group identity; place is so much more than just space or environment.

Place is thus much more than property. Property implies a (usually) physical object belonging to a person, or the quality of an object. Property is defined as:-

> "The characteristic quality of a person or thing
>
> Something belonging to a thing...
>
> A (usually material) thing belonging to a person, group of persons, etc.; a possession; (as a mass noun) that which one owns; possessions collectively; a person's goods, wealth, etc." (Oxford English Dictionary – Online edition accessed 17 March 2013)

Interestingly when criminologists have approached place some have preferred to take a more spatial and property based approach to place particularly those with an interest in routine activities

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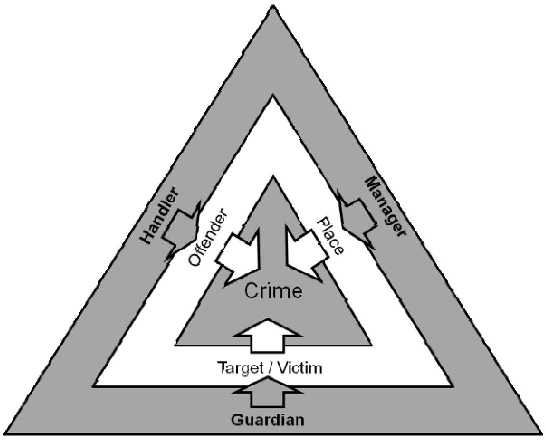
1.5 Theoretical approaches to crime and place (1)– Routine Activities

The Routine Activities approach was originally developed by Lawrence Cohen and Marcus Felson in 1979, and subsequently developed by Marcus Felson – his latest clarification of the approach is in a recent book (4^{th} edition) published in2010, *Routine* activities theory states that in order for crime to occur there needs to be "(1) motivated offenders, (2) suitable targets, and (3) the absence of capable guardians" (Cohen and Felson, 1979, 589). An important part of the theory as originally stated, was the idea that normal activity, the general tempo and pace of everyday life naturally brought people into situations which allowed crime, what Cohen and Felson referred to as "the interdependence between the structure of illegal activities and the organization of everyday sustenance activities" (Cohen & Felson, 1979, 589).

Parallel to this, Ron Clarke and others, began to look for approaches that worked. By the late 1970s in England and Wales there was growing feeling of 'nothing works' and all attempts to resolve crime focused on the offender so far had failed; a feeling that crime was impossible to eradicate (Garland, 1996, Raynor, 2007). At the same time it was also becoming apparent that crime (or at least recorded crime) was increasing rapidly (Garland, 1996, Garland, 2001). One response to this was to develop Situational Crime Prevention (SCP) techniques (Garland, 2000, Clarke, 2000, Hughes et al, 2002). The idea relied heavily on rational choice theory (Clarke and Cornish, 2008) and included the argument that offenders made deliberate choices to offend and could be dissuaded from offending if the cost of offending outweighed the benefit. If followed, whilst it might not be possible to change the offender, if the situation could be changed to make crime more difficult, then crime could be lessened. It was argued that there was less need to study motivations; instead concentration should be on understanding more about where, when and how offences occurred and reducing opportunities to commit them. This is discussed a little further in the use and abuse of space section below.

Felson subsequently allied with the rational choice theory of Ron Clarke to develop the crime triangle concept of routine activities (Felson, 2008, Clarke, 2008) figure 1.5.



After Felson, 2008, p75

Figure 1.5: The current 'crime triangle' conception of routine activities

This has led to an amount of research focused strongly around targets, locations, policing and security strategies and crime prevention policy, leading some to argue this theoretical approach has led to the 'lost offender' (Hayward, 2004, Hayward, 2007). What might be termed the crime science paradigm is discussed in more detail in chapter 2. However in its original form the Routine Activity approach considered all potential aspects of human activity that could impact on crime. Jerry Ratcliffe has recognised this should equally include temporal-spatial patterns through the day, meaning there are both temporal and spatial constraints on crime (Ratcliffe, 2006). The concept of routine activities also, as Ratcliffe has argued, strongly links to Tor Hägerstrand's concept of human activity patterns (Hägerstrand, 1970). Hägerstrand suggested that people had both life paths from birth to death, and also daily life paths through time and space. Everyday life paths included the concept of capability, how far someone could walk, or travel depending on their access to travel options (for example do they own a car?). Alongside the concept of capability, Hägerstrand's concept of authority contended that these individual life paths could be constrained by governmental and institutional barriers such as local regulations preventing certain behaviour in certain spaces. This is a much more complex picture of routine than that suggested by the more simple crime triangle version of routine in Figure 1.5.

Routine activities in the original published papers was a theory that had strong links with work of David Matza (1964, 1969) as David Garland has recognised. Although the original Cohen and Felson paper made no mention of Matza, both Felson and Matza place emphasis on the "situational character of crime and delinquency and the specific inducements and controls of particular locale" (Garland, 1999, 356). A key concept of Matza's work is the idea of drift, that young 'delinquents' do not make deliberate choices to become rule breakers for the rest of their lives, nor are large numbers of them in some way biologically pre-disposed to criminality, instead the majority of those engaged in activities considered as wrong or 'delinquent' (by particular authorities in a particular place and moment in time) drift in and out of this behaviour, most young people are only temporarily delinquent. Rather than the crime triangle approach, an alternate way in which routine activities could be further developed, would be to consider how the routine activities in places across periods of time could cause places to drift in and out of temporary delinquency.

1.6 Theoretical approaches to crime and place (2) – Use and Abuse of Space

1.6.1 Crime Pattern Theory

Brantingham and Brantingham's crime pattern theory argues (Brantingham and Brantingham, 1993, 1995), in particular the idea of how an individual's own mental maps of familiar local space impact on where they see locations of crime opportunity. Simply put, people tend to commit crimes in places they know rather than places they do not know. Where a place is known to a lot of people and has a common shared purpose, for example a school or shopping centre, it will also experience more crime. Crime will tend to cluster around different activity nodes, and clusters will vary by time of day dependent on where individuals most commonly frequent (Brantingham and Brantingham, 1993, 1995, 2008). These familiar routes include crime generators, nodal areas people are attracted too for particular activities, and crime attractors are places where people “notice and exploit criminal opportunities” (Brantingham and Brantingham, 2008, 88-90).

1.6.2 Crime Prevention Through Environmental Design (CPTED) and Situational Crime Prevention

Brantingham & Brantingham’s work has strong links to the development of CPTED. Key aspects of CPTED are: *Territorial reinforcement* -designs which aims to enforce the rights of legitimate users of a space and limit or discourage illegitimate use; *Natural surveillance* – making use of how for example neighbours overlooking each other’s properties can increase capable guardianship; and *Natural access control* - “reducing opportunities for crime using spatial definition to deny access to potential targets and create heightened perception of risk in offenders” (Cozens, 2008, 163). Later developments of CPTED include “*Activity support* the use of design and signage to encourage intended patterns of usage of public space” (Cozens, 2008, 164); *Image/space Management* – for example regular maintenance and keeping the environment in good repair so the users receive positive signals; and, *Target hardening* - taking steps to make it a greater effort for the offender to commit the crime e.g. increased used of better locks, high fences and so on. (Cozens, 2008, 164)

Cozens cites a number of key theorists and researchers who influenced the development of CPTED, particularly mentioning the work of Jane Jacobs and her book *The Death and Life of American Cities*, Oscar Newman's concept of 'defensible space' and C. Ray Jeffrey who was the “originator of the term 'crime prevention through environmental design' ” (Cozens, 2008, 154-155); these are probably the most influential early researchers in this area (see also Wortley & Mazerolle, 2008, Sampson, 2012, Bottoms 2012). Following criticism that that CPTED did not properly consider the impact of all these fences and barricades on local communities, Gerry Cleveland and Gregory Saville (Cleveland & Saville 2003a, 2003b) developed second generation CPTED in response to some of the common critique of first generation CPTED.

> “CPTED strategies must not depend on access control nor natural surveillance when those tactics reinforce the barricading of people. Much more is needed than a simple lock-it-down/light-it-up approach. CPTED strategies must aim to build communities and a sense of community. That is why 2nd Generation CPTED was developed.” (Cleveland & Saville, 2003a, 8)

Interestingly this suggests some commonality in 'second-generation CPTED' approach with how Robert Sampson has been developing collective efficacy theory as discussed below (section 1.9)

Developing alongside (and arguably partly from) CPTED and defensible space concepts is situational crime prevention (SCP). SCP “seeks to alter the situational determinants of crime so as to make crime less likely to happen” (Clark, 2008, 179). It groups its 25 techniques under five broad headings 'Increase the effort', 'Increase the risks', 'Reduce the rewards', 'Reduce provocation', and 'Remove excuses'. (Clarke, 2008, 184-185). It is a pragmatic approach, where the risks of any given situation will be carefully assessed on a case by case basis, and using the broad principles above, solutions found to make crime more difficult imposes appropriate situational based constraints. SCP is part of the same 'family' of preventive approaches, including Design against Crime (DAC) and CPTED. The "main difference between situational prevention and these approaches is that situational crime prevention seeks to eliminate *existing* problems, whereas DAC and CPTED seek to anticipate problems in new designs on the basis of past experience with similar designs" (Clarke, 2008, 182). Other than that, the concepts and theory basis (opportunity theory / rational choice / routine activities) are very similar to CPTED and DAC and arguably SCP has become an umbrella term for all three.

One notable difference is that there does not seem to have been the same enthusiasm for developing a second-generation SCP along the same lines as second generation CPTED. Clarke offers a robust defence of SCP and argues that a lot of the critique aimed at SCP is actually a concern about its implementation of SCP, not the concept itself: "criticisms are addressed to the practice of situational crime prevention, not its principles" (Clarke, 2008, 191). Secondly the critique assumes SCP is applied simplistically, Clarke argues "the criticisms generally neglect a fundamental point about the action-research *process* of situational prevention – it requires a careful assessment of possible solutions before they are implemented" (Clarke, 2008, 192).

Like CPTED and DAC, SCP involves actively studying micro-level environmental conditions that may encourage crime and then making specific changes to the environment to prevent crime. In effect SCP impacts on the nature of place, because it takes steps to fundamentally change certain aspects of places to prevent crime; it may be successful in reducing crime but may substantially change the nature of a place in the process. SCP has been divisive, critiqued by many, dismissed by some and eulogised by others, yet it still has real potential to challenge its' critics particularly if it can incorporate relevant wider criminological and social theories (Hughes et al, 2002; Hope and Sparks, 2000). Arguably one of SCP's limitations is that it pays little attention to the debates around who actually has the right to make use of and share public space. This is something that has been specifically raised by Keith Hayward (Hayward, 2007) and is now considered in an alternative paradigm to the use of space – cultural criminology.

1.6.3 Cultural Criminology – Cultural and Liminal spaces

The cultural approach to criminology builds on phenomenological approaches to criminology (Katz, 1988) emphasising the importance of wider context and as part of this approach understanding the cultural meanings and contexts of places is important for understanding crime

(Ferrell, Hayward & Young, 2008; Hayward, 2004). I would argue that much of recent research on graffiti also falls within this approach (Ferrell, 1993) although not always positioning itself as within the cultural criminology theoretical framework (Austin, 2001, Halsey and Young,2002, Halsey and Young, 2006; Macdonald, 2001).

Within this tradition Keith Hayward has talked about the concept of liminal space – a space which encourages behaviour that is on the edge, unusual, and potentially transgressive or even criminal. Along with Derek Hobbs they have considered how night-time high streets with high concentrations of bars, where people go to socialise at the weekend, can create and become these liminal environments (Hayward and Hobbs, 2007). This liminal space is not necessarily permanent – it exists *both* at a particular place *and* at a particular time – the high street on the week day may be a completely culturally different space to what it becomes on a Friday night.

1.6.4 Contested public space

Another key area of theoretical debate centres around who gets to use (or abuse) public space, and what counts as public space. Kurt Iveson has thoroughly reviewed this in *Publics and the City* (Iveson, 2007). He suggests that there are two main types of approach to public space the topographical and procedural. *Topographical* spaces are spaces that might be coloured as public on a map, shopping malls, parks, squares and so on. *Procedural* public spaces are "any space which is put to use at a given time for collective action and debate", (Iveson, 2007, 3). Iveson argues that much theorising about topographical space has one of two narratives, both of which he says can be problematic.

The first narrative about topographical space as a narrative of "loss and reclamation"; in this narrative there is one group or groups, whose use of the space deprives another more deserving group of use of the space. Who the "heroes and villains" are in each of these narratives can vary – the villains maybe teenage gangs and drug dealers and other 'anti-social' people, or they may be "corporations and developers more concerned with profit than public use; the common theme is "the erosion of public space by the actions of those who are anti-public"(Iveson, 2007, 6). Examples of the 'loss and reclamation' narrative relevant to vandalism research I would argue include actions and responses to graffiti writers, broken windows theory and also both proponents and critics of SCP and CPTED.

Iveson argues that when the 'loss and reclamation' narrative is rejected, and instead conceived as a site of struggle, a second problematic narrative emerges which he refers to as

> "the relationship between public address and the city...public address requires inclusionary and accessible urban public spaces where people can take their place as part of the public"(Iveson, 2007,7)

The principle problem for this narrative for Iveson is it assumes that

> " - public as a *context for action* ('urban public space');
> - public as *kind of action* ('public address')
> - public as a collective actor (a/the public')" (Iveson, 2007, 8)

are the same or extremely similar, whereas Iveson argues they are not, and places and people can be simultaneously both public and private depending on the context, including varying spatial and contextual factors.

An alternate approach to this is the procedural approach which sees public spaces as spaces where public actions can occur that may or may not be located in a physical space. Iveson is therefore arguing the public space has *both* topographical and procedural elements. He considers that understanding interactions in public space across time and space, and across varying political and social worlds and networks as important. This view of the use of public space has interesting parallels with theorising within sociology and criminology on the role of place and society, and how this influences levels of crime and disorder, which is discussed below in section 1.9 which considers theories around crime and disorder which relate to community based interactions.

1.7 Theoretical approaches to crime and place (3) - Advanced Marginality / Persistent Inequality

As early as the 1890s Charles Booth clearly demonstrated that poverty was concentrated in some streets and not others in London. (Booth, 1892). This has led on to a rich tradition investigating both the presence of, and reasons for concentrated disadvantage in both the United States and Europe. The fact that levels of concentrated disadvantage (often also referred to as deprivation or social exclusion in European literature) do differ by neighbourhoods across the world – "the spatial unevenness of poverty" (Milborne, 2010, 155) - is now generally accepted, but the reasons why are still hotly debated; in sociology and urban studies this debate has mainly been about whether cultural factors or structural factors are mainly at play (Flannagan, 2011, Wilson, 2010, Lobao et al, 2008, Atkinson & Kintrea, 2001).

Very simply put those who take the social structure approach assume that is mainly national to neighbourhood factors that cause concentrations of poverty in neighbourhoods (though it is more often national processes that are researched than any other (Lobao et al, 2008). Those who take the cultural approach assume that it is individual behaviours that are most responsible for poverty concentrations, as people with like behaviours, which in turn lead them to be poor, tend to live together in the same areas. Of course there are those who argue that there is a complex mix of cultural and structural factors involved, however, in the United States in much published research (and in public opinion) there has been a tendency to favour cultural factors over structural ones though views in Europe may differ (Wilson, 2010). As there has generally been less research in this area in Europe than the US recently (Atkinson & Kintrea, 2001), the cultural viewpoint can tend to dominate published research.

Someone who does not exactly fit neatly into either a cultural or structural dichotomy is the geographer Danny Dorling. His work has involved using a number of national data-sets, for example census data, and data on health outcomes and life expectancy, to look at the spread of inequality. His work has found considerable evidence of pockets of persistent inequality – often situated in neighbourhoods adjoining one another. He argues that "division between neighbourhoods" in the United Kingdom is now worse than in the past, and you need to go back to the 1890s when Charles Booth and Rowntree were involved in their research and survey work, to find social divisions as bad as they are today. (Dorling, 2011, 133)

It is against this background that I discuss the work of two theorists in particular who have recently considered specific links between concentrations of crime and disorder and concentrated poverty - Loic Wacquant and Robert Sampson. Loic Wacquant's argument is that there are areas where inequality is highly concentrated in what he calls advanced marginality – a "distinctive regime of urban poverty that diverges from the traditional American ghetto and the "European 'workers' space" (Wacquant, 2008, 232), something that goes beyond the work of Booth, Dorling and William J Wilson. These are areas of "economic penury and social destitution, ethnoracial division and public violence" accumulated in "the same distressed urban areas"; the causes of this marginalisation are not some form of "economic mismatch or backwardness" but instead, Wacquant argues, the structural workings of functioning advanced Western economies which reinforce this urban poverty (Wacquant, 2008, 232).

Wacquant argues that the causes of this advanced marginality are structural – social, economic, political and spatial. These are the four dynamics driving "the new urban poverty" (Wacquant, 2008, 263-71). These dynamics mean there is a distinct spatial dynamic to advanced marginality:

> "advanced marginality displays a distinct tendency to conglomerate and coalesce around 'hard-core', 'no-go' areas that are clearly identified – by their own residents no less than by outsiders – as urban infernos rife with the deprivation, immorality, illegality and violence, where only the discards of society would brook living" (Wacquant, 2008, 270)
>
> "..these entrenched quarters of misery have made a name for themselves as repositories for all the urban ills of the age, places to be avoided, feared and deprecated." (Wacquant, 2008, 271)

These distinct areas that experience marginality therefore have this state maintained by a feedback loop where the perception and stigmatisation of a place as marginalised can maintain or worsen actual factors that cause marginality in the community.

This description of the spatial dynamic of advanced marginality has interesting links to the recent work of Robert Sampson who has been increasingly looking at the role of concentrated inequality in the causes and perception of disorder, crime and poverty in neighbourhoods. Sampson argues that there is persistent social inequality; he links this to the work of "London epidemiologists" such as Charles Booth arguing there are

> "3 broad ideas or theses that are interlinked:
>
> The "tangle of pathology" or what today we would call social dislocations or social problems, has a deep neighbourhood structure and connection to concentrated inequality
>
> Neighbourhood social disadvantage has durable properties and tends to repeat itself...
>
> The "poverty trap" cycle can be broken only with structural interventions of the sort that government or other large organizational units (e.g. foundations) are equipped to carry out." (Sampson, 2012, 99)

Sampson's work is interesting as it is simultaneously arguing what we are looking at here is both a structural and cultural phenomena. Economic and political factors at the local and regional level are combining with very localised factors particular to certain city neighbourhoods. His work is therefore bridging the cultural structural dichotomy which Wilson suggests is needed.

After supporting his theses above with evidence from his research in Chicago over the last 12 years, Sampson then goes on to highlight the three key lessons which come out of this research:

> "The first lesson is that cities and neighborhoods are constantly changing, and in no inherent direction....The second lesson is thus that there is an enduring vulnerability to certain neighborhoods that is not simply a result of the current income of residents..the third lesson... is that upgrading (or gentrification) does not topple stability of the ecological structure" (Sampson, 2012, 119)

Sampson argues that this pattern persists across the whole of the United States and is not just a Chicago phenomenon. The common view of both Sampson and Wacquant (both of whom are influenced by the work of William Julius Wilson) is that persistent inequality is an ongoing modern phenomena in both the United States and Europe. Some neighbourhoods maintain high levels of poverty across years. Wacquant and Dorling argue that the situation is getting worse.

Sampson is less pessimistic, but is uncertain whether concentrations of poverty are being resolved by government intervention, or instead just moved around.

1.8 Theoretical Approaches to Crime and Place (4) Community Based Interactions - Social Disorganisation; Collective Efficacy; and Situational Action Theory

1.8.1 Social disorganisation / collective efficacy

From the 1920s onwards a group of theorists and researchers in Chicago began to consider in detail the links between offender, offending and the layout and nature of the city. They became known as the Chicago School. The Chicago School, in particular divided Chicago into a series of concentric semi-circular rings, the city centre (the loop) was at the diametric centre, next came a zone in transition which was frequently in a state of flux, then a zone of working men's homes, then residential homes and finally the commuter belt. This led Robert Park (Park et al 1925: 55) to produce a visualisation that has become 'probably the most famous map in the history of sociology' (Melossi, 2008, 113). Based on Park, and on other mainly ethnographic work, Shaw and Mackay came up with a "theory of gradient", as you move out from the centre, socio economic status increases and crime decreases. Over time although the composition of those living in the zone in transition and loop changes, the crime rate remains high leading the Chicago School to conclude "deviant characteristics are a property of the environment and not of given groups or individuals" (Melossi, 2008, 114) This social disorganisation could be remedied by repairing, restoring or re-organizing social relationships in an area. Later work in Sheffield amongst other areas (Bottoms, 2007, Bottoms et al, 1992) suggested concentric zones were not a good model for UK cities, but the general idea of social disorganisation persisted although it was not without its critics.

From around 1995 Robert Sampson began to revisit the issue that crime often appeared higher in disadvantaged or deprived communities whilst recognising that these phenomena were not universal. He began to develop a more nuanced approach than social disorganisation – the idea of collective efficacy. He did this by (once again) relying on research in Chicago. Since 1994, the huge research project, the Project of Human Development in Chicago Neighbourhoods (PHDCN), has been ongoing in Chicago. It has involved individual and community surveys, many interviews and independent observation of neighbourhoods (Sampson, 2012). It is probably the most comprehensive study of place ever to take place in a single city.

Sampson's position is "that we should recognise what is useful about social disorganization theory while modifying or discarding what is no longer relevant" (Sampson, 2012, 150) A particular problem is how the social disorganisation theory conceives social ties. Sampson argues that strong social ties can have both very positive and negative effects, the presence of strong social ties does not necessarily equate to high or low crime and it is important to remember that:

> "...in contemporary cities the idyllic "urban village" endures largely as a myth. Even given ample time or energy I suspect that most people do not want to be close friends with their neighhbors." (Sampson, 2012, 151)

Sampson's concept of collective efficacy builds on social disorganisation whilst recognising the realities of the modern city. It is worth presenting his explanation of the concept in full:

> "To address these conceptual issues, my colleagues and I have proposed a theory of *collective efficacy*. The concept of collective efficacy draws together two fundamental mechanisms – *social cohesion* (the "collectivity" part of the concept) and *shared expectations for control* (the efficacy part of the concept). Our premise accepts the basic idea of social disorganization theory that social control is a collective challenge not attributable to the characteristics of individuals alone and that it constitutes a major source of variation in crime rates and general well-being across neighborhoods. But we relaxed the traditional disorganization assumption that the ideal contextual setting for social control is necessarily characterised by dense, intimate, and strong neighborhood ties (e.g. through friendship and kin). This theoretical framework recognizes the transformed landscape of contemporary urban life and assumes that while collective efficacy may depend on some level of working trust and social interaction, it does not assume that neighbors or local officers be one's friend. Institutional mechanisms may be sufficient" (Sampson, 2012, 152.

What collective efficacy therefore contends is that it is communities having a shared value about what is acceptable behaviour, and *expectations* that a certain level of social control will ensure that people act in these accepted ways that matters, not strong social ties. Strong social ties alone will not lead to a community having low levels of disorder, what is needed is strong collective efficacy, and this can occur in areas that have both strong and weak social ties. Sampson's research suggests that there are clear links between high levels of crime and disorder and low levels of collective efficacy. However there is not a direct link between adolescent levels of violence and level of collective efficacy in their local neighbourhood. Sampson therefore argues that collective efficacy is "situational when it comes to crime", and suggests that "the offending PHDCN adolescents may thus still be influenced by the collective efficacy of the non-residential neighborhoods in which they hang out" (Sampson, 2012, 159) an alternative is that they choose to hang out in residential neighbourhoods with low collective efficacy.

Sampson notes the recent study by Wikström et al, 2010 has found "individual delinquency by crime-prone adolescents is significantly deterred by the collective efficacy of neighborhoods where the adolescents spend their leisure time" (Sampson, 2012, 160).; he also notes research which suggests that "neighborhood collective efficacy is significantly associated with adolescents unstructured socializing with peers"(Sampson, 2012, 160). Collective efficacy also appears to be stable across time (Sampson, 2012, 168-173) and this may in part be linked to stability of poverty over time. Sampson argues, like Ceccato and Haining above, but looking at a wider context than just vandalism, that there is an important interaction between collective efficacy and community wellbeing where community structure, local spatial processes such as concentrated disadvantage, and more macro level processes such as broader network ties, all feed into levels of collective efficacy which in turn affect levels of disorder which in turn can affect residential stability – and so the feedback loop continues (see especially Sampson, 2012, 161, Figure7.1)

1.8.2 Perceived Disorder

Interestingly Sampson's work finds that perceptions of levels of disorder, are influenced by individuals wider perceptions of a neighbourhood itself leading to feedback loops where an area can be stigmatised as being perceived as having a disorder problem. It is *perceived* levels of disorder that are particularly important, not necessarily actual levels of disorder. This links closely to issues of advanced marginality and the issue of neighbourhood stigma that Wacquant raises, as discussed above. Sampson theorises:-

> "...the grounds on which perceptions of disorder are formed are contextually shaped by social conditions that go well beyond the usual signs of observed disorder and poverty, starting a process that moulds reputations, reinforces stigma, and influences the future trajectory of an area."(Sampson, 2012, 123)

Sampson argues for a re-thinking of broken windows theory as linked to perceptions of disorder Sampson in particular argues that perceptions of minorities and race are part of local shared perceptions and social meaning feeding into overall levels of perceived disorder, and research from the PHDCN supports this. This suggests that the roots of perceived disorder as recorded in surveys such as the British Crime Survey and the community survey used in the PHDCN are in part as much about local perceptions and understanding of local places, and maybe more so, than actual levels of disorder.

This has interesting links to the work of Martin Innes who has argued that perceptions of disorder have a key effect on understandings of levels of disorder and fear of crime and harm, with certain crimes such as graffiti and vandalism acting as signal crimes which signal to the people in a community (whether resident or passing through) that the particular neighbourhood is vulnerable to crime and disorder (Innes, 2004, Bottoms, 2012). It seems to me that Sampson's theory can be applied outside of the United States to the UK. However, whereas Sampson sees a key larger context which influences local perceptions to be "US history of racial inequality and urban change, circa 1960s to present, combined with late 20th century immigration fears" (Sampson, 2012, 135, Figure 6.3), the larger context in the UK would be a history of *class* inequality and urban change coupled with a late 20th century fear of immigration -the social history expanded by Danny Dorling (Dorling, 2011, Dorling 2010).

1.8.3 Spatial Clustering of Crime and Disadvantage

Sampson also strongly argues that research from the PHDCN strongly support the suggestion that spatial clustering of crime and disadvantage at the neighbourhood level is a real and durable phenomena, and that the various interacting factors that cause this are spatially related – they are spatially interdependent, and Sampson suggests this has implications for the changing nature of Chicago and potentially cities elsewhere (Sampson, 2012, 259). Put simply spatial clustering is very important and neighbourhoods are influenced by adjoining neighbourhoods, but also retain qualities that may make the individual neighbourhood unique. A final important result Sampson notes for Chicago is that

> "extra-neighbourhood and citywide spatial dynamics create racial inequalities in a wide variety of social processes that are potentially more consequential than ones already at play within neighbourhoods" (Sampson, 2012, 260)

In other words some local areas of apparent spatial clustering may also be affected by regional factors, of a greater neighbourhood area or of the city as a whole; the influences on neighbourhoods are multi-level. The vital importance of this methodologically will be discussed further in chapter 2.

1.8.4 Situational Action Theory

Situational action theory (SAT) is an action theory which seeks to look at the interaction between people and the environment . It does this from a person rather than place perspective. The theory aims to answer the question why do people act in certain ways (at certain times and at certain places) to break rules. Wikström's SAT theory is an interesting theory in that it combines a developmental approach and an ecological (crime and place) approach to answer this question. Wikström's work is very much within the developmental criminology traditions which is interested in tracking the life courses of young people as they grow to adulthood, tracking those who do and do not offend, those who offend only once or twice and then desist, and those who continue to offend and the factor that might influence this (see McAra & McVie, 2012 for a comprehensive review of the developmental approaches to criminology).

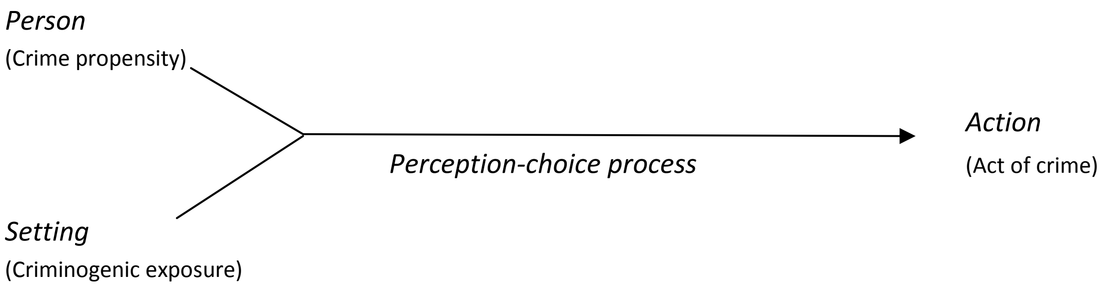
However, what makes Wikström's work particularly interesting is the way that he is seeking to develop a complete theory of crime, building on traditional developmental criminology theory including control theory, and at the same time incorporating an appreciation of aspects of the routine activity and collective efficacy approaches; it is a developmental plus ecological 'action theory'. For Wikström, the action element, the developmental, and ecological elements, are all important. Wikström defines what is meant by an action theory as follows:

> "An *action theory* is a theory that details the process (the mechanism) that produces action. Correctly specifying the process that moves people to act in one way or another (e.g. follow or breach rules of conduct) is crucial to identifying which of all the many crime correlates are causally relevant for the outcome and which are only *markers* (factors merely correlated with causally relevant factors) or *symptoms* (factors merely associated with the outcome). According to SAT this process is one of *perception of action alternative and choice*." (Wikström et al, 2012, 8-9)

The ecological element reflects both aspects of space and time and it is therefore, I would consider, aiming to be a place theory as well as a developmental theory.

> "To understand why and how particular kinds of interactions emerge at particular times and places we need an ecological approach. We need to understand how processes of *social selection* (and their interplay with self selection) introduces kinds of people to kinds of settings (and how these kind of settings emerge). This, in turn, will help explain spatial and temporal patterns and concentrations of acts of crime." (Wikström et al, 2012, 9-10)

The theory argues that crime occurs because people make a moral choice to act to commit (or not commit) a crime (break a rule) based on their propensity to commit a crime and their exposure both to various factors as they grow up and the situation they find themselves in at a given time – the theory is summarised as **P**ropensity x **E**xposure = **C**hoice. Place is important to the theory as a key part of the exposure part of the theory is that exposure to a 'criminogenic setting' can influence crime involvement based on a person's 'crime propensity' see Figure 12 (Wikström, 2006, Wikström & Treiber, 2009, Wikström et al 2010, Wikström et al 2012).



adapted from figure 1.1 "The causes of the perception-choice process in crime causation" (Wikström et al, 2012, 17)

Figure 1.6: Wikström et al.s conception of situational action theory

Wikström and his team have recently published a thorough review of research from the Peterborough Adolescent Development Study (PADS), like the ESYTC and the PHDCN, this is a longitudinal study of adolescents in Peterborough lasting nearly a decade (2003-2012) which has included yearly self report studies (2004-2008, bi-annual after this), community surveys and use of local crime data. The study is ongoing. One of the key finding of Wikström and his team is that *interactions* are crucial. In echoes of Goldstein's person-environment duet which influences levels of vandalism, their findings suggest:

> "that the person-environment interaction is critical to understanding the causes of young people's crime and patterns of young people crime in the urban environment. We have shown that acts of crime are largely an outcome of what kinds of people take part in what kinds of settings" (Wikström, 2012, 406)

Key findings are the people with 'a high crime propensity' more exposed to 'criminogenic settings' are more likely to commit crimes. Settings 'areas' (or places as I prefer) with a high presence of crime prone people at a given time, that also have high criminogenic characteristics will have high concentrations of crime. Crimes tend to occur when crime prone people converge with crime prone settings (so they will not necessarily occur at other times or without this convergence). People who have high crime propensity are more likely to commit crime (see crime as an action alternative) in highly criminogenic settings and less likely to commit crime in less criminogenic settings.

Unlike the work of Sampson and Wacquant, what Wikström's work seems to be missing (at least currently) is a broader conception of how wider structural factors, such as the presence of persistent inequality, the nature of criminal justice institutions and processes and local programmes of urban change and renewal in an area that may be effecting the criminogenic nature of a given place; his theory currently concentrates strongly on more situational (or what the inequality/poverty debate in sociology might sometimes term cultural) factors. In my view Sampson's broader conceptualisation of neighbourhood and place is to be preferred to the current simpler version in use by Wikström. However, it is very important to note that Wikström's theory is very new, still in development, and clear support for the theory has only recently been published so there is plenty of scope for a more nuanced and detailed understanding of what makes a criminogenic setting (place) to be developed. Wikström et al note their work is currently limited to situational and contemporaneous social processes, and that there may be a place for more macro interpretations of what relevant social processes are influencing the crime place dynamic

1.9 Vandalism, Crime and Place and Interactions - a Summary

In summary this chapter has presented an overview of the current state of research into vandalism. It has considered some of the history of vandalism research and how a growing interest in the broader concepts of disorder and anti-social behaviour led to less direct research into vandalism. This has meant that a key research gap, identified as long ago as 1984, the need to consider how spatial and temporal processes, particularly processes that run across a period of time was ignored. Existing research into vandalism, particularly by Vania Ceccato and Robert Haining, suggests that place influences might be very important to understanding the dynamics of vandalism, yet there has been virtually no research into this aspect of vandalism.

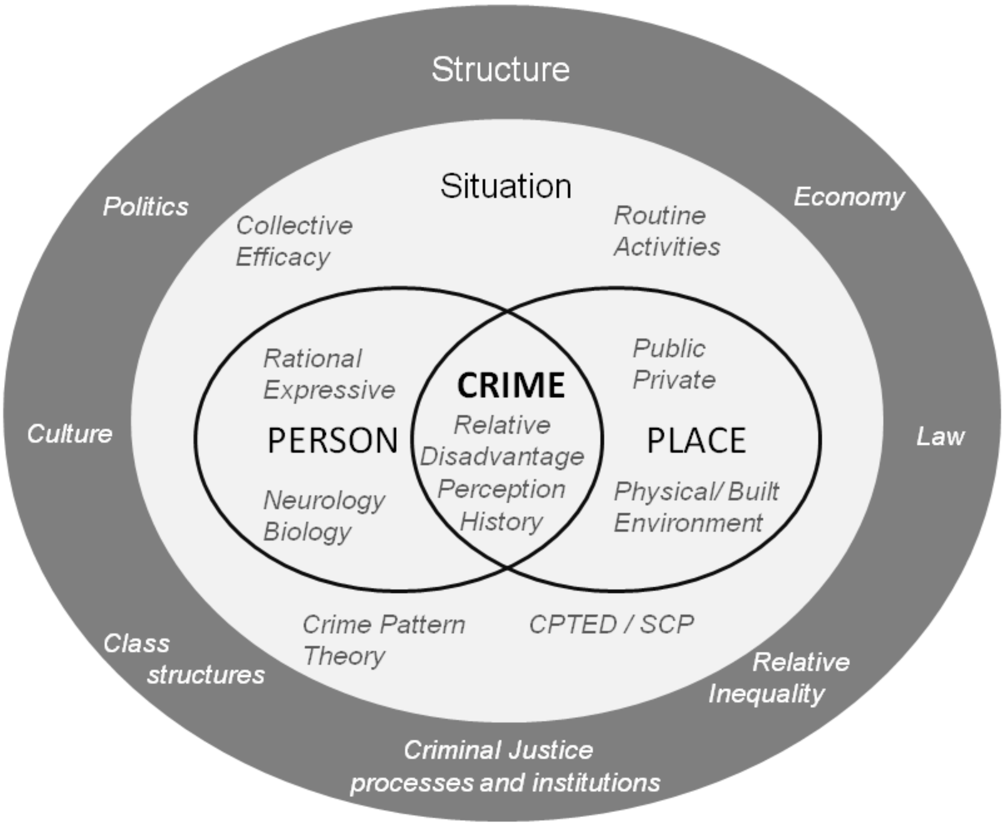


Figure 1.7: Crime as a Person Place Interaction situated in the situation and wider structure – incorporating important factors / theory

As this was a key research gap, the second half of this chapter reviewed key theories of crime and place that might provide a framework within which to understand the relationship between vandalism and place. What is immediately apparent is that there is no one coherent theory of crime and place. Theories can be grouped into four main themes: Routine Activities, Use and Abuse of Space, Persistent (Relative) Inequality, and Community Interactions. What all the theories have in common is that crime occurs as an interaction between person and place in a wider situational and structural context. What factors make up the elements of the person, place and the situation likely to experience crime are very variable, this means currently, in the absence of one overall explanatory theory, a number of current theories suggest a range of factors are relevant. What we currently have is a kind of multi-level complex theory and factor soup which I summarise in Figure 1.7.

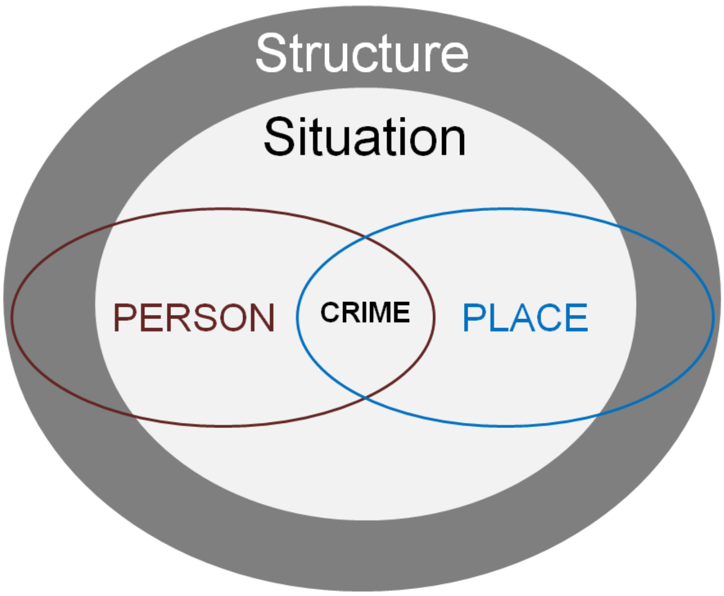


Figure 1.8 – Understanding the Person Place Crime interaction - Simplified

A simpler way to think of this, I would suggest, is given by Figure 1.8. Crime effectively occurs when a person with motivation (or crime propensity) and a place that offers crime opportunity (is criminogenic) overlap; however this always takes place in a situational and structural context, which will be time specific and influenced by the past histories and perceptions of both people and place. Figure 1.8 could be thought of as a looking at a snapshot of a moment in time when crime occurs. What is really important to note here is that this is not a static linear interaction, it is a dynamic multi-level interaction where different factors will be operating at the personal, very local (street), neighbourhood, city, region and national level. Some factors may influence a situation only briefly for example on a particular day particular group of young people may choose to gather in particular place, other factors could influence the situation and structure of many years, for example the type of local housing built in an area. This leads to particularly challenging methodological issues for understanding the relationship between vandalism and place which will be considered in chapter 2.

1.10 Vandalism and Place – the Key research questions to be addressed in this thesis

Having identified the key research gap and the theoretical framework vandalism and place research can be situated in, this left a lot of different possible avenues for research but this research project has chosen to focus on the following issues.

If vandalism is a place crime then you might expect there may be evidence of consistent high and low levels of crime over time in particular places with particular characteristics. However since the nature of places change (at different times of day and in different years) you might expect areas of high and low concentrations to move or change. Existing research into crime hotspots suggests significant temporal variation (Chainey & Ratcliffe, 2005). In the absence of a clear single theory of vandalism and place it is important that initial work should be exploratory, This approach allows how well existing theories of crime and place, and the simple theoretical framework I propose in figure 1.8 above, can assist in understanding the processes influencing levels of vandalism across different places to be considered. It is also important that the research incorporates a dynamic temporal element, to some degree, as current research on vandalism and place has so far been restricted to single year snap-shots and not looked at change over time. The aim of this research will be to concentrate on the place element of the person-place dynamic of vandalism as this is much less researched than the person perspective. As such this research will not seek to provide a complete theory of vandalism in any way, but rather seek to fill some of the research gaps on vandalism and place, and through this also contribute to the debate on the usefulness of current theories of social-spatial criminology (a term coined by Anthony Bottoms, Bottoms, 2012).

Key research questions to be considered therefore are:-

1) Are there areas (places) that experience high and low concentrations of vandalism year in and year out?
2) Do concentrations of vandalism change over space and time, and are there any particular patterns that appear to exist?
3) Do places which experience either low or high concentrations of vandalism over time appear to have any common features or shared characteristics?

To answer these questions raises particular methodological problems, and requires a more detailed consideration of the current methodological approaches to studying crime and place within sociology, criminology and geography. This will now be discussed in the next chapter.

2 Methodological Approaches to the Study of Crime and Place

In this chapter I will consider some of the important methodological issues that occur when trying to research crime and place and particularly look at approaches in use in the field of criminology, sociology and urban studies by considering various methodological approaches that have been developed to explore crime and place, highlighting their strengths and limitations.

I shall begin by looking at historical approaches. I shall then move on to consider common methodological approaches currently in use. With current methodological approaches I will begin by discussing approaches that mainly concentrate on the micro and meso level but also emphasise and valorise a scientific approach as important for the study of crime and place – concentrating on the crime science paradigms. I shall then move on to approaches that look at the meso and macro level looking at spatial econometrics (in particular the work of Robert Haining), ethnography investigating structural aspects (the work of Loic Wacquant) and ethnography around cultural aspects of crime and place. I will then consider 'cultural criminology' approaches including consideration of the cultural criminologists sometimes vociferous critique of quantitative methods. I shall then discuss approaches that take a multi-level approach and thus combine both the micro and macro elements and mixed methods highlighting the examples of the PADS+ and PHDCN studies and potentially overcome some of the limitations of methods that do not take a multi-level multi-method approach.

I will conclude that there have been similar issues faced by human geographers in researching place based phenomena and in particular consider the recent increased use of Geographical Information Science (GIS) techniques; I shall briefly consider how the critique of GIS techniques has led to the increased development of qualitative GIS methodologies and how these methodologies might be useful for the study of crime and place. I will argue that my own position is that of a pragmatic realist who has much admiration for recently developed qualitative GIS approaches which usefully bring together qualitative and quantitative techniques to bridge methodological divides.

I shall suggest that such innovative ways of combining qualitative and quantitative techniques suggest a useful way out of the growing dichotomy for, or against, quantitative or qualitative methods apparent in some current methodological debates in criminology and suggest that Exploratory Spatial Data Analysis, alongside some form of qualitative research – a mixed method approach - is a useful way of meeting some of the methodological challenges of researching crime and place.

2.1 Researching Crime and Place – Some Historical Approaches

2.1.1 Quetelet and Guerry ~ 1830s

Some of the earliest research into crime and place was done by the French speaking authors Adolphe Quetelet (a Belgian mathematician) and André Guerry. Dario Melossi explains that Quetelet and Guerry working the 1830s were amongst the first sociological positivists being:

> "among the first to develop instruments of the newly born "science of the state", *la statistique*, to phenomena of "social pathology". The name of the new scientific instrument was no misnomer. The reorganization and rationalization of the modern State...meant, that together with an array of new or renewed institutions, the new State would start also producing knowledge systems of the reality the State itself administered, controlled and sometimes had brought into being".(Melossi, 2008, 45)

Data produced included information about the administration of criminal justice, and much information about those being enlisted through conscription. Quetelet and Guerry were amongst the first to exploit this state data that continued to be a "gold-mine for sociologists and criminologists in the years to come" (Melossi, 2008, 45). They were some of the earliest quantifiers, converting pre-existing state data into aggregate tables and presenting these summaries, and analysis of them, in large folio works. Quetelet was the first to identify that statistics could be used to represent the 'average man' and recognise the "stability of social occurrences" preparing groundwork for authors such as Durkheim and Marx (Melossi, 2008, 46). He was also amongst the first to warn that official data often failed to record the full extent of crime and hence there was an amount of crime unreported and not reflected in official statistics, this is now often referred to as the 'dark number' (Young, 2004 in Melossi, 2008, Maguire, 2007). Interestingly also well ahead of his time Quetelet observed while using this state produced data:

> "that the higher rates of certain crimes seem to be connected not with higher rates of absolute poverty but with higher inequality and class distribution. He therefore anticipated the concept of "relative deprivation" and its link with crime" (Melossi, 2008, 46)

Guerry collated statistics on crime development and wealth at a department level in France and published tables and maps showing different levels and types of crime in France. He also found that "the crucial relationship was not between crime and poverty but between crime and unequal development"(Melossi, 2008, 46). Guerry was perhaps the first person to make crime maps of state recorded crime, finding crimes against property were more common in the North and crimes against person more common in the South, (Melossi, 2008, Chainey and Ratcliffe, 2005). Quetelet also noted similar patterns in his work, and also noted regional disparities in levels of convictions finding higher levels in Southern France, Southern Belgium and Southern Netherlands (Sampson, 2012, 33) .

2.1.2 *Charles Booth ~1890s*

Using scientific techniques and empiricism to understand the social world also was having influence in the United Kingdom. By the early 1890s Charles Booth had begun work on an arguably even more ambitious project to quantify early levels of poverty in London. Charles Booth's methods were a highly innovative mix of qualitative and quantitative approaches. This was an early example of what we would now call mixed methods, however, it was given no such label at the time. Booth spent a decade studying London with the aid of his assistants, finishing with a final volume in 1903. Rather than just relying on official state statistics, Charles Booth set out to quantify the state of Life and Labour in London, measuring levels of wealth and types of employment for every household by surveying as many households as possible individually. He began in East London as this was perceived to be an area with particular concentrations of poverty and he wanted to test if this was actually so, but then moved on to collect, publish and analyse data for the whole of London.

One of Booths genius ideas was to use existing 'trained observers' to collect his data for him. His trained observers were visitors for the School Boards. They already had rights to go in and quantify the number of school age children in each household and were employed to visit all households with children and maintain an up to date register of these children, updated on around an annual basis. Booth asked the visitors to systematically also make a note of who else was in the household, how many rooms they were occupying, and the main job of the head of household. He also asked them to give a brief description of each street. The School Board visitors put this information into notebooks. Booth and his team advised them how they wanted the information collected and then collected in the 46 notebooks of information amassed. (Booth, 1892). Incidentally, these 46 notebooks were for East London alone, by the end of the decade of enquiry there were more than four hundred original notebooks, now held in the Booth collection (Sampson, 2012). The notebooks contained a wealth of fascinating information and Booth’s main aim was to quantify this information, although he also later used some of the qualitative descriptions noted by visitors and others interviewed in his general comments on conditions in which the poor were living. Booth and his team used the information to then quantify and classify each street into one of 6 categories. They also would visit streets themselves to check on the reports of their trained observers though they would not access homes as they did not have the same rights of entry as the school inspectors.

Ingeniously, early on in the work, they checked their methodology by displaying the maps in offices visited by a range of members of the public and invited them to comment on the accuracy of the maps as a way of cross checking the accuracy of their data collection, an early example of what is often referred to as 'ground-truthing' in Geographical Information Science. It is clear that great care was taken to verify the work, and it appears that one of the principle original aims of the maps was to provide an easy method of cross-checking the observations, and ensuring that Booth and his team were correctly quantifying and classifying streets. Booth and his team also walked the streets with those involved in working in and policing the areas, filling notebooks with their observations about the characteristics of place. It is fascinating to read, how almost instinctively, a sense of place was embedded into Booth's research into social disadvantage by neighbourhood. Whilst he could perhaps be criticised for over reliance on those patrolling and working with those in neighbourhoods, rather than interviewing those within the neighbourhoods themselves, nevertheless his innovative mixed methodologies were able to provide fascinating insights into local neighbourhoods.

Booth's work was very detailed, but also comes from an important methodological standpoint; in order to understand neighbourhood social problems, it is useful to observe, quantify and describe what is present, and then it is possible to develop further theories and policies. This is particularly important where that knowledge is currently lacking. Although Booth set out to just describe London, he also found himself inevitably talking about what was being done to try and improve things, and making some suggestions himself for improvement. Ultimately though, he saw great value in excellent descriptive research in order to solve a problem. Both the research and methodology of Booth and his team continue to be highly influential to sociological researchers today (Sampson, 2009, Sampson, 2012).

2.1.3 Chicago School 1920s – 1960s

A similar but more ethnographic and less detailed approach was adopted by the so-called Chicago School in the 1930s. The origins of the University of Chicago sociology department date back to 1890 (the same time as Booth was doing his work in London), a time when immigrants from throughout Europe were coming to Chicago including Southern Italians, Germans, Irish, Russian Jews and various Eastern Europeans. This in turn led to sociologists from the University from the 1900s onwards and particularly through the 1920s and 1930s doing in depth ethnographic studies into those struggling to make a living on the street of Chicago; as some of them had direct links and experience of the lives of these immigrants, coming from the same or similar backgrounds, these studies were often nuanced and sympathetic (Melossi, 2008, 104-105). The researchers in 1920s Chicago, like Booth, also produced maps. Also like Booth their maps, although much less detailed, were an attempt to show a standardised summary of different types of areas in Chicago by categorising different areas of the city by a mixture of socio-economic and levels of criminality standards. Also, like Booth, it was felt that using a mixture of ethnographic and more qualitative techniques and an aggregation and summary of this data, a broad picture of the city and broad categories areas of the city could be produced.

As with Quetelet and Guerry this in-depth, considered and descriptive work (in this case more qualitative then quantitative) was built upon by later influential researchers. Clifford Shaw and Henry McKay (Shaw and McKay, 1942) combined this qualitative work with quantitative data to work look at the "relationship between the spatial structure and the immigrant population settlements therein, and indicators of the various "social pathologies", such as crime rate" (Melossi, 2008, 111) to develop the theory of social disorganisation and later this work has influenced Robert Sampson's work on collective efficacy (Sampson, 2012). In more recent times these mixed method approaches, where both quantitative and qualitative methods have been combined has become a little more unusual, and instead methodological approaches have arguably, for some, become more restrictive and explicitly linked to particular theories and schools of thought within criminology (Loader and Sparks, 2010).

Research in crime and place can be thought of as primarily taking place at a scale that can be labelled as micro, meso or macro . Micro analysis can be thought of as analysis that looks at the environment at the level of the building or street; meso analysis the level of the electoral district or ward, or possibly city or region, and macro analysis at the level of larger regions or a national scale. These are useful distinctions and although somewhat artificial I shall use them to consider the level of focus of research paradigms in crime and place. The idea of considering crime at these broad areal units or categories of analysis was suggested originally by Paul and Patricia Brantingham, whose ideas have become very influential in the Crime Science paradigm (Brantingham & Brantingham 1991, Wortley & Mazzerole, 2008). Within the crime science paradigm the emphasis has tended to be on the micro and meso elements only as the next section will consider.

2.2 Micro and Meso Research - Crime Science

From the 1980s and 1990s a new type of place-based crime analysis comes onto the scene. The advent of computerised databases and standardised recorded crime systems led to an explosion in the amount of data now available to those interested in studying actual crimes, as opposed to offenders. Over time faster computers and better analytical software has made the analysis of these data suddenly much quicker. In a very influential paper Lawrence Sherman and colleagues used a technique which could highlight crime clusters or 'hotspots' at a very localised level (Sherman et al, 1989). This was able to show that crime was not distributed randomly across the city and that different crimes were distributed in different places. Sherman's hotspot work was at a micro scale and was looking at crime street by street. It also used a technique which did not rely on using pre-defined administrative boundaries and thus was potentially finding 'actual' concentrations of crime rather than those that were in part influenced by the social make-up of the existing administrative boundaries (such as electoral or census districts). Whilst Sherman's work was very influential to crime mapping, crime analysis and research particularly in the crime science area, Sherman's main interest has been in being at the forefront of developing what has since become known as experimental criminology. This particular paradigm of experimental criminology will not be discussed further here as it does not have a particular focus on crime and place; also, this approach is best suited to research where there are already clear hypotheses to be tested, whereas in the case of vandalism and place further research is needed to develop such testable hypotheses.

2.2.1 Crime Science

Separating out and concentrating on crime counts rather than offender information, and focusing specifically on offences rather than the broader aspects of person and society was a very deliberate move on the part of crime scientists such as Gloria Laycock and Ron Clarke. Both had worked for the UK Home Office during the What Works era and strongly felt there was a strong need to focus on the specifics of crime – the what and where of offences. There was a need for a focus on 'wheredunnit' as opposed to the 'whodunnit' (Sherman, 1995, 37 in Eck & Weisburd, 1995), something it was felt that criminology had been failing to do (Clarke, 2004). Crime science in part came out of a desire to "generate more political interest in situational crime prevention" (Laycock, 2005, 5). Indeed crime science development is closely tied to the development of situational crime prevention and problem oriented policing (POP) (Laycock, 2005).

Crime science is:-

> "a distinct approach to crime control, which merges prevention and detection under a scientific umbrella" (Laycock, 2005, 5).
>
> "outcome focused" and "multi-disciplinary" (Laycock, 2005, 6).
>
> "dependent upon testing hypotheses in different contexts – addressing, not only what works, but where, how and when"(Laycock, 2005, 8).

It is particularly noticeable that Gloria Laycock mentions, where how and when but not *why* as being important in the quote above, this I feel is deliberate. Crime Science argues that it is operating under, and offering a distinctly different paradigm to general criminology, and distinctly chooses to operate on what, where, when, and how questions, rather than why questions. It is thus a distinctly pragmatic approach aimed at providing solutions to crime problems. In an influential, and deliberately provocative, opinion piece in the European Journal of Criminal Policy Ron Clarke argues criminologists must "make the discipline useful" (Clarke, 2004, 57). This means a need for change of emphasis in research focus so that crime can be prevented:-

> "Where prevention and control are the objectives, research will need to focus more on how crime is committed and less on why it is committed. Understanding the steps in the process of committing crime, and under- standing the conditions that facilitate its commission, helps us see how we can intervene to frustrate crime."

The focus should be on how we can prevent crime, not (just – if at all) how to understand it better. It is important to remember that Ron Clarke was one of the members of the What Works team working in the home office in the 1980s and this no doubt influenced his later involvement with the development of crime science.

To emphasise this distinction Ron Clarke drew up a table of techniques that fitted into crime science paradigm and other techniques he felt were more appropriate to criminology. This table is quoted in part below in Table 2.1. Clarke sees crime science as pragmatic, an approach that can get rapid effective answers that can make a real difference by leading to policy relevant crime prevention strategies. Perhaps most controversially Clarke appears to be arguing research should aim to be produced quickly and effectively, which inevitably means less focus on rigour and very detailed methodologies.

> "In the typical research project, more weight is given to its internal validity and methodological rigour than to its creativity and insightfulness....In fact, in the fast moving world of the future it is likely that criminology will have to sacrifice some scholarly rigour in favour of timeliness and relevance." (Clarke, 2004, 60)

Table 2.1 – Ron Clarkes' Differences between Criminology and Crime Science

Criminology	Crime Science
Mission	
Understand criminal	Understand crime
Long term social reform	Immediate crime reduction
'Pure'	'Applied'
Theory-led	Problem-led
Shun policy	Embrace policy
Theory	
....	….
The WHY of crime	The HOW of crime
....	….
Research methods	
Cohort studies	Crime patterns
Criminal Careers	Hot spots
Regression analysis	Crime mapping
Self-reported delinquency	Victim surveys
Randomised control trials	Crime specific case studies
Long term studies in depth	Rapid appraisal techniques
Applications and audience	
....	….
Scholarly treatise	Policy briefs
....	….

(Taken from Clarke, 2004, – extract from Table 1, p56)

Crime Science based methodologies, as discussed above tend to focus on street or building level (micro), or at the broadest neighbourhood level (micro-meso processes). Hotspot based analysis continues to be very popular (Tabangi et al, 2010). Recent examples have included predictive or prospective hotspot mapping to look at where future burglaries and robberies might occur. This draws upon existing well used crime mapping methodologies of hotspot maps and extends them into a predictive framework (Johnson, Bowes and Pease, 2005; Van Patten et al, 2009). Indeed researching burglary has frequently been a target, and driven development of innovative techniques in crime science analysis (Johnson et al, 2007, Johnson & Bowers, 2009). Spencer Chainey has over recent years devised a vulnerable localities index (VLI), a simple composite measure to assess vulnerability of local neighbourhoods to crime and disorder (Chainey, 2008). These examples also emphasise how there is often an emphasis in crime science on what is described as the urban or environmental backcloth (see also Mcord et al, 2009) defined as:-

> "What surrounds us in an urban environment includes centers of activity, roads and pathways, well known landmarks, and parks as well as neighborhoods with different socio-economic and demographic character. We move around in the urban environment from one activity node to another sometimes with fixed location goals (such as a specific restaurant) and sometimes with general area goals (the entertainment district)" (Brantingham et al 2009, 90)

Another very interesting strand of recent crime science is street segment group trajectory modelling. This is work that has been done by Elizabeth Groff, David Weisburd and others and has examined whether crime over time by street have distinct and different trajectory patterns (Weisburd, 2004, Groff et al, 2009, Groff et al, 2010) , research which draws on group trajectory analysis from developmental criminology (for discussion of this as relates to offenders and the life course see McAra and McVie, 2012) and suggests that places too might have crime careers.

Crime science's strengths are that its (somewhat relentless) focus on the micro places is clearly demonstrating the importance of the impact of micro-processes on crime; processes often ignored by other researchers on crime who concentrate on macro processes. Crime Science demonstrates that some crime is strongly influenced by very ordinary everyday activities, such as typical times people leave home, go to work, send their children to school, return home and so on. This means there is a need to focus on crime patterns at the hourly and daily level as well as over longer periods of times, for example across years. It tends to produce research that is easy to explain to policy makers and often directly policy relevant. It works closely with policy makers and those 'at the coal face' and runs conferences aimed equally at practitioners and academics. It gets rid of some of the potentially unnecessary mystique surrounding some criminological methodology and theory in favour of simple and easy to apply approaches. A lot of its approaches are exploratory which is well suited to areas that are currently under-researched and currently theory lite.

Crime Science has a lot in its favour but there is also much to critique. Crime Science methodologies have come in for broad critique, indeed authors writing in *Crime Science New approaches to preventing and detecting crime* describe some it as making "some criminologists apoplectic with rage" (Smith and Tilley, 2005, xv). Some of these more 'apoplectic' responses will be discussed further in the cultural criminology section below where the broad general critique of quantitative methods by cultural criminologists will be considered in more detail. More general critiques have included: is it actually science or just masquerading as science?; that its techniques are too simplistic for 'proper' science; that there is sometimes a failure to recognise the exploratory nature of much crime science research and it is painted / suggested to be explanatory when it does not go this far (Young, 2011). It may also be methodologically weak. Tim Hope put's it thus in a highly critical review of the book *Crime Science New approaches to preventing and detecting crime* mentioned above:-

> "This emergent 'discipline' seems to have unreliable scientific foundations: an inductive epistemology (scientific realism); an inadequate historiography (technological evolutionism); a utilitarian objective (crime reduction) that leads to teleological reasoning; and an apparent technical foolhardiness. Such a combination would seem more likely than not to lead to methodological error and inferential bias in its research programme. Yet despite—perhaps because of—these scientific deficiencies, crime science has had considerable appeal among criminal justice practitioners and policy-makers in the UK, not least because it appears to offer easily comprehensible approaches and solutions to complex crime control problems. Yet the price of currying political favour has been oversimplification." (Hope, 2006, 250).

Whilst I do not agree with the suspicion Hope expresses about inductive techniques he makes an important point that crime science is not in fact being scientific *enough.* In developing methodological techniques and choosing research problems to focus on it relies on a single theory base – Routine Activities / Rational Choice – which researchers in the field of cultural criminology find particularly problematic (Hayward, 2007, Young, 2011). Thus as crime science over-simplifies, by moving towards fast re-acting methodologies and slimmed down theory, it tends to miss complex problems that only would come to light by using more complex, long-term and rigorous approaches (such as cohort studies and multi-level modelling) and multiple theoretical approaches.

Finally crime science arguably needlessly splits away from criminology by creating a new, but unrequired discipline, rather than trying to work within the existing discipline to improve it. This issue of growing silos in criminology, and its potential implication for reducing public communication of criminology, rather than enhancing it, is considered in detail by Ian Loader and Richard Sparks in *Public Criminology*. They argue for a pluralistic criminology which will "foster exchange and debate between different criminological approaches" (Loader & Sparks, 2011, 144) and a move away from the negative impact of:-

> "criminology's recurring tendencies to exist under conditions of passive toleration and indifference, to engage in hostile bids to colonize the whole field, or to file for divorce and set up in a more comfortable home"(Loader & Sparks, 2011, 144)

(It is important to note that this concern is aimed not just at crime science, but also experimental criminologists, those interested purely in social structure issues, and cultural criminologists.)

The above criticisms I feel have merit, however, there has also been a strong critique of the use of empiricism in general both within crime science and more widely in criminology by those in the cultural criminology paradigm which I find much less convincing. This critique and potential problems with it are discussed in some detail below in the section on cultural criminology. However, I also feel a key issue with research methodologies in the crime science paradigm in regard to research on crime and place is, that although it is understood that there are micro, meso and macro levels of influence on crime, the methodological approach tends to be bottom up without considering how to best model or factor in wider top-down structural factors or consider feedback between the situational and structural. It is effectively assumed structural factors can be incorporated into a situational approach using simple proxies or ignored.

Given that the review of crime and place in chapter 1 suggests that both situational and structural factors impact on crime and place with significant effects, Crime Sciences' approach becomes problematic in that it can tend to relentlessly focus on the situational, and use only methodologies extremely well suited (but only suited) to considering these situational factors at the micro level. This means that the potential importance of structural factors might get missed and therefore not considered relevant. This omitting of structural factors has the potential of leading to bad policy making especially if crime science methodological approaches alone are relied on for the production of crime prevention policy. The potentially problematic focus on micro places and crime has led Ralph Taylor to argue persuasively that to fully understand issues of crime and community it is important that processes that interact between micro and macro levels are considered. A focus purely on micro problems will fail to do this, instead a multi-level approach is needed (Taylor, 2010). Multi-level approaches are discussed in section 2.4.

It would be unfair to suggest that all those who are associated with the crime science approach and favoured theories are **only** concentrating on the micro. In putting crime in its place David Weisburd et al (2009) have put together a volume where a number of contributors emphasise the importance of using multiple scales. Brantingham et al (whose theoretical work includes the highly influential crime pattern theory much relied on by those in the crime science paradigm) state:

> “no single level of aggregation can constitute the “best” unit of analysis for studying the spatial or temporal patterns in crime. Data should be collected at the most detailed level possible and aggregated upward to fit the requisites of theory or the limitations of data unit aggregations of those elements of urban backcloth thought to be important. That is, in looking at different levels of aggregation, researchers must consider aggregation of crime units into different areal units for comparison against the urban backcloth” (Brantingham et al 2009, 90).

They demonstrate a novel method using agent based fuzzy modelling to look at multiple scales which seek to remedy this. Even with this work they remain focused to some degree on more micro factors of influence – the urban backcloth – rather than considering factors such as how cycles of relative deprivation may affect things over a long period of time, so in some ways all this work does not recognise the importance of looking at crime at multiple scales it still remains focused on micro explanatory factors.

Other researchers *are* looking at macro factors – but potentially to the detriment of considering detailed repeating micro spatial and temporal processes – something that crime science methodologies can excel at. This more macro research and it's limitations will now be considered.

2.3 Meso and Macro Examples – Spatial Econometrics; Ethnographic Structural and Cultural research

2.3.1 Spatial Econometric Approach – Haining, Wikström and others – Meso level

At around the same time as Sherman's work was being recognised and taken up by police forces in the United States a more econometric approach was developing in Europe to crime. One of the first to look spatial grouping of crime was Per Olof Wikström who looked at crime in Urban areas in cities in Sweden (Wikström, 1991). He mapped data from criminal records and combined it with various socio-economic data much as Guerry and Quetelet had done to explore crime patterns in urban areas. Whilst much of Wikström's work was descriptive tables he was also able to use more sophisticated techniques (such as multiple regression and path analysis) to look at the relative weight of different factors. However as the data was much more detailed he was able to look at crime within the city – not just across regions as had been done before. Wikström's work also interestingly showed that different crimes had quite different distributions across the city. Wikström has gone on to develop much more complex methodological approaches to looking at crime, person and place that are discussed further below in the multi-level section. Wikström's work was primarily at a city wide or meso level.

Vania Ceccato and Robert Haining revisited Wikström's work a decade later. Here the aim was to use more complex spatial techniques to examine patterns of crime across the city (Ceccato et al, 2002) and repeat analysis for the same city Wikström had analysed a decade later. The research used standardised offence ratios which compared local neighbourhood offence rates against the regional offence rate, and then looked to see where groups of high offences were clustered. They then went to look at how this might be explained but used more sophisticated regression techniques (spatial lag and error models) to specifically control for spatial autocorrelation (discussed briefly in section 2.5 and also in chapter 3) – basically the issue that with geographic data adjoining areas are not independent and thus this breaches some of the standard assumptions of statistical inference for statistical models that do not specifically control for this (Haining, 2003).

Haining and Ceccato's work is mainly at the meso level; indeed Haining has highlighted that often areas chosen for analysis need to be a certain minimum size to avoid the small number problem where too few observations occur in a given area making appropriate standardisation difficult (Haining, 2003, Haining et al, 2010) and at a single geographic level and for a fixed time period. It involves work with numbers only and does not combine the quantitative and qualitative methods, and thus is unlikely to reflect the lived experience of a particular neighbourhood. Haining and Ceccato have gone on to use this type of analysis to explore many aspects of crime and place including vandalism and place – discussed in more detail in chapter 1, (Ceccato and Haining, 2005), acquisitive crime in transition states (Ceccato and Haining, 2008) and the impact of crime on apartment prices (Ceccato and Oberwittler, 2011). Much spatial econometric work is characterised by use of complex and detailed statistical models which aim to in some way compensate for specific problems (from a statistical point of view) in carrying out inference with spatial data (Haining, 2003). Some of these problems are highlighted in chapter 3. For example Haining has recently argued that advanced geostatistics analysis could be used to handle missing data and irregular boundary issues for social science data (Haining et al, 2010).

The advantages of spatial econometric research are that it enables explanatory analysis, which can provide reliable and replicable explanations of factors which may influence concentrations of crime and place. Key disadvantages are that it is complex to understand and explain (thus running into Ron Clarke's critique of more complex criminological models, Clarke, 2004). It is heavily reliant on number (thus running into the general critique of empiricism made by cultural criminologists see section below 2.3.1; Young, 2011). Finally a problem with some spatial econometrics is that it uses a global statistic; thus it will give explanations for crime across a whole city (whilst controlling for neighbourhood variation) but is unable to analyse difference in more micro local variation (unlike for example techniques like Geographic Weighted Regression (GWR) – Fotheringham et al, 2002; Fortheringham et al, 2000); spatial econometrics can sometimes thus treat spatial autocorrelation as a problem to be solved, not a possible source of useful information in its own right.

2.3.2 *Structural Ethnographic Research – the work of Loic Wacquant – Macro structures matter*

Another approach to looking at crime and space has been to look at much broader crime trends using a number of detailed ethnographies and also careful analysis of political, academic and institutional discourse . This has links back to the early work of the Chicago school, and the work on Loic Wacquant fits this style of analysis. He spent a number of years living, observing and interviewing those living in 'ghetto' and marginalised areas in France and America, and also exploring the institutions that governed these areas. Wacquant considers that in depth ethnography, involving periods living in areas which have characteristics you need to understand more about, where you engage in careful participant observation, is an important part of research. Equally analysis of political and institutional discourse, both current and historical is important. Wacquant, a student of Bordieu, is keen that one should engage in a number of different ethnographic practices which explore both the life world of the individual and that of the institutions around them and how they interact and react with one another. He argues:

> "*ethnographic observation emerges as an indispensable tool*, ... But, lest one condemn oneself to monographic myopia, fieldwork cannot for a single moment do without institutional analysis, and vice versa" (Wacquant, 2008, 9)

For Wacquant a strong grounding in existing theoretical arguments, should be a starting point followed by the use of ethnography to further enhance and develop theory. He is also an advocate of in-depth and detailed ethnographic practice – potentially taking place across one or more years in a few selected sites, rather than the quicker multi-site, more 'liquid ethnographic' approach advocated by cultural criminologists discussed below. Wacquant's work therefore is mainly concerned with the influence macro elements, but through its' ethnographic nature it crosses the macro, meso and micro realms, indeed it does not consider such distinctions of scale important. However, because of its' focus on the influence of structural factors, it tends to often neglect the importance of situational factors. Wacquant, although stressing issues around persistent inequality, because of his strong preference for ethnographic methodology, fails to make use of quantitative and visual methods. Such methods could potentially enhance his arguments around advanced marginality, complementing the evidence he presents which he has gathered using an ethnographic approach.

Criminologists such as Jock Young and Jeff Ferrell have used a similar ethnographic approach to look at both micro and macro issues, but their particular suspicion and antithesis to quantitative methods sets them apart from theorists such as Wacquant. Wacquant, although having a clear preference for a mix of strong ethnographic work and national, institutional and historical case study examples, is less specifically vehemently critical of quantitative work per se. Cultural criminology like crime science has in recent times become something of a self-publicising movement and therefore will now be considered along with its particular, problematic, critique of quantitative methods.

2.3.3 Cultural criminology and its' Quantitative critique

Methodologically cultural criminology can be characterised by being very pro-ethnography and in some cases explicitly anti use of numeric data. They often single out work from those of crime science and situational crime prevention for particularly strong criticisms. To a certain extent cultural criminology's methodological standpoint is as much defined by what it is opposed to than by what it stands for. Ferrell, Young and Hayward champion ethnographic work focusing on the social constructions of identity and place (Ferrell, Hayward and Young, 2008). They suggest various qualitative methodological techniques as being appropriate for the study of crime.

> "Cultural criminologists employ a plethora of methods in their analyses, including (and I will resist the temptation to place this list in a table) ethnography, photographic fieldwork, in-depth unstructured interviewing, documentary filmmaking, participatory action research and visual/media/discourse analysis, amongst others."(Hayward, 2012a, 28)

However, rather than ethnography being a long drawn out process, as in Wacquant's work, they suggest it can be done quite quickly, and interesting insights obtained through shorter observation periods, with reflexive, inductive and innovative use of differing ethnographic methods in a series of single or multiple short case studies – a liquid ethnography (Ferrell, Hayward and Young, 2008). These methods have the advantage of simultaneously allowing macro, meso and micro factors to be considered by the research design, although since case studies are often focused on a small area or small group of individuals there can be challenges in generalising findings, research focus can be quite narrow and illustrative and whilst excellent in representing the lived experience perhaps less useful in developing complex theory unlike the more detailed work of researchers such as Wacquant. Hayward has also recently eloquently expressed a concern that place is often not carefully enough considered in methodological and theoretical consideration in criminology

> "Spatial analysis is fundamental to criminological inquiry. Frequently, however, the way space is utilized and conceptualized within criminology leaves much to be desired. From the statistical abstraction of Quetelet's cartes thematiques to the flawed semiotic interpretation of urban space in Wilson and Kelling's 'Broken Windows' hypothesis, criminology has all too often taken space for granted,

> proceeding with an implicit notion of spatiality that approaches the environment simply as a geographic site and not as a product of power relations, cultural and social dynamics, or everyday values and meanings." (Hayward, 2012b, 441)

However, an example of the more extreme critique of cultural criminology against the use of abstraction – and particular number and statistics comes in *Cultural Criminology – An Invitation* where Jeff Ferrell, Jock Young and Keith Hayward express concern against the ongoing appearance of datasoraus in criminology -

> "a creature with a very small theoretical brain, a huge methodological body, a Byzantine and intricate statistical gut, and a tiny inconclusive tail wagging mindlessly from database to database"(Ferrel, Haywayd and Young, 2008, 169)

This quote is not in the main body of text but under an illustration of a rather amiable looking cartoon dinosaur sat on its haunches with a very small head (labelled theory), and with an extremely large (possibly obese) belly covered in equations (labelled methodology), and a small wavy tail labelled conclusions. Whilst this illustration is no doubt intended to be deliberately provocative (and to get students to think and probably smile), cultural criminologists critiques can also be more measured (Hayward, 2007).

Whilst there is no doubt that criminology can be guilty of bad science (Hope, 2011, Hope, 2006) much of Ferrell et al.s examples of the problem are poorly chosen and in some cases the criticism and its response can turn into something of a trade in academic insults. Keith Hayward referred to Ken Pease, who has actively argued for crime science, as:-

> "Ken Pease, one of the high priests of the neo-classical revival" (Hayward, 2007, 234)

And further complained that rational choice theorists insisted in a quantitative and statistical based methodologies.

> "Reaching its highest form in sophisticated algebraic expressions, contemporary RC theorists of crime now test the efficacy of crime prevention initiatives by reducing the mind of the potential offender to a statistical formula" (Hayward, 2007, 234)

Whilst these criticisms are not without foundation, they led Ken Pease, whilst defending crime science and arguing it was not negating the value of social theory, to implicitly suggest that cultural criminologists are neither " good empirical criminologists" – a charge they would probably reject, or "bona fide scientists" – less problematic as I do not think most cultural criminologists would identify themselves explicitly as scientists, but then unhelpfully he finally goes on to describe cultural criminology as often "vacuous" or "sneering":-

> "None of the above [[an argument for a paradigm shift from criminology to crime science]] should be taken to minimize the role of good social theorizing in understanding crime and justice, nor to challenge the status of good empirical criminologists as bona fide scientists. While often vacuous and/or opaque, and sneering in tone, the emergent tradition of cultural criminology (to take one extreme example) hypothesizes trends capable of empirical test and reveals unrecognized assumptions (see, for example, Hayward, 2007)."(Pease, 2008, p3)

A similar debate has been conducted, but in a much more measured tone between, Graham Farrell (Farrell, 2010) and Keith Hayward (Hayward, 2012a).

Whilst the Hayward-Pease and Hayward -Farrell debates may be entertaining reading for some, it tends to send those interested in studying crime and place into their respective methodological corners. The result is that there is a danger that research from either side of the methodological divide is not being integrated, and equally research that integrates the strengths of qualitative and quantitative methods is often not being commissioned, This can lead to much research *either* following the crime science simpler statistics micro-style methodological approach or the cultural criminology ethnographic approach. Indeed Hayward expresses concern that Farrell's critique of his original article has the potential to cause this problem.

> "Such universality has the effect – whether intentional or not – of establishing an oversimplified binary distinction between, on the one hand, RCT and SCP, with its recourse to 'statistical method' and 'empirical evidence', and, on the other, what Farrell sees as a postmodern 'liquid [cultural] criminology' (Farrell 2010: 55) that (when it comes to its analysis of expressive crimes) is 'ambiguously defined' (Farrell 2010: 55) and 'lack[s] any obvious unifying concept' (Farrell 2010: 54)." (Hayward, 2012a, 22)

The strong anti-quantitative position has been further reiterated by Jock Young and though Young is also at pains to state that he is not against the use of quantitative methods altogether, his suspicions are clear. His prescribed solution proposes distinct limitations to quantitative research. He potentially requires such a degree of certainty about the nature of data before quantitative techniques could be used that it could prevent much criminological research using quantitative methods at all (although Young might consider this a good thing). However, the points he raises about the limitations of quantitative data should be carefully considered by all those intending to use number in their research:

> "Am I suggesting an open season on numbers? Not quite: there are obviously ... numbers which are indispensible to sociological analysis...There are things in the social landscape which are distinct, definite and measurable, there are things which are shadow figures, approximates like those that frequently occur in biological sciences, which are the best we can do in the circumstances, there are many others that are blurred because we do not know them, others which are blurred because it is their nature to be blurred. Precision must be constantly eyed with suspicion, decimal points with raised eyebrows. There are very many cases where statistical testing is inappropriate because data are technically weak – it will simply not bear the weight of such analysis. ...Will this mean an end to quantitative

> work? No far from it, it is more a question of setting rules and limits, of discriminating between the solid and subjective, of determining where statistical testing is useful and where it is a distraction,... numbers are signs to be interpreted within specific cultural contexts, figures in themselves do not have any magical objectivity." (Young, 2011, 54-55).

Unfortunately, both sides of the debate consistently seem unwilling to find middle ground and the danger becomes that never the twain shall meet and graduate researchers find themselves being positioned firmly in one tradition or another, reading their own journals, attending their own conferences, firmly entrenched in a single methodological outlook and discouraged from integrated research. This again brings to mind Loader and Sparks concerns about lack of pluralism in criminology in *Public Criminology* (Loader and Sparks, 2011). It also fails to put into effect Anthony Bottoms exhortation to early career researchers to use a mix of techniques as appropriate to the research question and theoretical problem under consideration (Bottoms, 2008). In this sense the same silo mentality problem can be levelled at both crime science and cultural criminology.

One way critiques of simplistic quantitative criminology can be addressed is to look at how the challenges raised by critics are met through more complex multi-level modelling techniques. These approaches are heavily informed by detailed theory and also make use of qualitative research to enhance and further develop models. Examples of this style of research include the 'modern Chicago school' research of Robert Sampson and others, as well as Wikström and his team innovative methodological approaches to researching situational action theory are considered below. This type of research is barely considered by Young in his recent critique of empiricism (Young, 2011). Another way forward, is to take lessons from how a similar problem in human geography has been tackled through the Critical GIS approach. This approach innovatively combines qualitative and quantitative methods to explore data and to review and generate theory. Critical GIS approaches use number reflexively, remaining aware of the limits and value of number and categorisation and looking at innovative ways that integrate lived experience into research. Some examples of multi- level approaches to crime and place are discussed next, and then some of the potential lessons for criminology coming out of provided by the Critical GIS approach are discussed after this.

2.4 Multi-level approaches

There have been some very interesting recent developments in multi-level approaches to investigating crime and place. Here criminologists and sociologists are investigating crime and place at a range of scales using innovative mixed methods, this is often done to look at relationships between neighbourhood disadvantage, community cohesion and crime, and highlight the role of individual, neighbourhood and city characteristics (Wilsem et al, 2006, Hipp and Perrin, 2006). Here there is much more mixed methods research with a mix of long term longitudinal studies, local surveys and interviews and various innovative analytical techniques employed. However this work often involves using data collected over a number of years. Two particular examples are highlighted below: the work of Per Olof Wikström and his team on the PADS+ study and the work of Robert Sampson other on the PHCDN in Chicago.

2.4.1 Investigating Persons and Environment Interaction to develop and test Situational Action Theory (the PADS+ study)

Per Olof Wikström has with colleagues Dietrich Oberwittleter, Kyle Treiber and Beth Hardie (and on occasion Vania Ceccato) has been involved in the development of a large cohort study the *Peterborough Adolescent and Young Adult Development Study* (PADS+) (Wikström et al., 2012). A particular innovative part of the work has been the space-time budget concept. This as based on time-budgets, already used in a number of disciplines, which look at for example, how much of a person's time is spent on work or leisure. The space-time budget went beyond this by asking people not only what were they doing at a given time and where they were doing it, but also raising questions about the detail of the setting they were present in. This was done by interviewing the young person and asking them, in detail, on an hourly basis about what they had been doing over a 4 day period in the previous week. It therefore constructed for those interviewed, a detailed space – time diary of their movements and activities over a 4 day period. It was then possible to geocode the locations where individuals had been over set periods of time, and see where this overlapped with other individuals. Since the individuals interviewed were also part of the cohort study, a great deal of data about their background, and general behaviours could be cross-referenced with this data. Also information about the locations where the individuals had spent time could be cross referenced with community survey data which provided information about residents perception of local neighbourhoods. In total 3,491 space time interviews were conducted over the PADS+ study providing a wealth of new innovative data not previously collected. (see further Wikström et al, 2012, 67-76)

A particular strength of Wikström et al.'s work is the way the research design allows explicit consideration of the interaction between person and environment, and also effective ways in which it allows for this to be quantified and analysed. The PADS+ design also deliberately allocated data to census Output Areas, a small area statistical geography, from which larger areas could be easily modelled as required, enabling micro, meso and macro effects to be explored, The space time budget aspect of the research design appears to be a unique feature developed for this study; this enabled how participants were affected by particular situational factors, including temporal aspects of these, to be analysed as part of the study – an aspect completely missing from many cohort study designs.

Wikström et al.'s work can be critiqued for not specifically exploring institutional factors – there have been no interviews with key community actors for example. Secondly the methodology did not use any independent observations of community space – instead it relied on residents' perceptions of areas close to their homes from a community survey. The study therefore although using a wide variety of techniques ultimately entirely relies on information categorised, coded or quantified in some way; there is an absence of any ethnographic element and an absence of any consideration on how institutional factors such as interaction with local community leaders (as the in the PHCDN – Sampson, 2012 - discussed below) or the criminal justice system (as in the Edinburgh Study of Youth Justice and Crime – ESYTC see McAra and McVie, 2012) may affect levels of youth crime. The PADS+ study whilst wide-ranging and a fascinating source of information has a design that does not allow for a complex understanding and representation of all elements of place, in particular structural and institutional factors, which theorists such as Sampson and Wacquant consider important. PADS+ can be critiqued therefore for being overly reliant on a quantitative methodology and for failing to capture the more complex cultural and structural elements of place.

2.4.2 'Modern Chicago School' Robert Sampson and PHDCN

Robert J. Sampson with colleagues including Steve Raudenbusch has been involved for around fifteen years in the hugely ambitious and utterly fascinating 'Project on Human Development in Chicago Neighbourhoods (PHDCN)' also often known as 'The Chicago Project' which Sampson describes in detail in his recent book Great American City Chicago and the Enduring Neighbourhood Effect (Sampson, 2012). Chicago was chosen principally, not because of its links to the sociological and ecological theory of Chicago academics of the past but, because an area was sought which had:-

> "sufficient representation of the three largest race / ethnic groups in American society - blacks, Latinos and whites - combined with various socio-economic status (SES)." (Sampson, 2012, 76)

Choosing a study area that was representative of multiple facets of American society was therefore a key methodological aim for the project.

What perhaps is so impressive about the Chicago project is that it is a research project which has successfully explored multiple elements of the person, place and crime interaction. It has achieved this by using an innovative mix of quantitative and qualitative methods. The project employed use of secondary data, longitudinal cohort studies which followed people over 8 years as they moved around the city (and in some cases across America), community surveys, interviews with community leaders, and the innovative use of systematic social observation (SSO) of street segments. There were also interesting usages of a lost letter experiment and data from a Cardiopulmonary Resuscitation (CPR) Study. The rolling cohort studies were the backbone of the project with in home interviews, and children and young people of a range of ages (0, 3,6,9,12,15 or 18) being included in the data and the young people being interviewed / assessed on 3 occasions, two and a half years apart. Community leaders (the key informant study) were also interviewed on two occasions seven years apart, which enabled work to be done to look at consistency (or non-consistency) of key actors in the community over time.

Chicago was divided up into 343 neighbourhood clusters (NCs):

> "groups of 2 or 3 census tracts containing around eight thousand people. Major geographic boundaries (e.g. railroads, tracks, parks, freeways), knowledge of Chicago's local neighbourhoods, and cluster analyses of census data guided construction of the NCs so that they were relatively homogenous" (Sampson, 2012, 79).

Eighty areas were then selected using stratified random probability sampling such that they represented neighbourhoods occupied by an even mix of races and people with varying socio-economic status. These areas were then subjected to detailed study. This included the systematic social observation (SSO) part of the work which was particularly interesting. SSO sought to provide an independent but replicable way of observing and recording the outward state of the local environment. This was done by recording both using video and survey instruments completed by independent observers who completed this contemporaneously with the video, by driving along each street in the selected NCs and the video and observer simultaneously recording details on each "face block: the block segment on one side of the street", where appropriate the observers also recorded audio commentary of what they were seeing at each moment in time. A further random sample of face blocks were selected for coding from the videotapes:-

> "From the videotape, 126 variables were coded, including detailed information on physical conditions, housing characteristics, businesses and social interactions occurring on each face block. Much like the original Chicago School of urban sociology, SSO takes researchers to the streets and provides the sights, sounds and feel of everyday life". (Sampson, 2012, 90)

The lost letter study including leaving letters in different neighbourhoods and seeing if they were then posted onto a specific return address (see Sampson,2012, p217-219). The CPR study used detailed data on cardiac arrests throughout Chicago in 1987 and 1988 which included the geocoded location of the cardiac arrest victim. Sampson and his team then also analysed where the cardiac arrest occurred (at home / on the street etc) time of the 911 call, if witnessed, and they cross referenced this with information they had on neighbourhoods, to find out when CPR was more likely and if this varied by neighbourhood.

If the data collection for the PHCDN was innovative so was the subsequent data analysis. Analysis of data in the Chicago project was at multiple levels "including block groups, tracts, community areas and relational patterns that cut across neighbourhood boundaries" (Sampson, 2012, 79). As such the study has been truly multi-level considering a range of factors at the micro, meso and macro levels and going well beyond more limited crime science, spatial econometric and cultural criminology studies which have all been limited in scope in some way. A wide range of innovative methods, both quantitative and qualitative, have also been employed to analyse the wealth of data coming out of the 15 years of study which have included trajectory modelling, network analysis, various spatial and multi-level models as well as the use of case studies (Sampson, 2012). Sampson's work is a fine example of the more pluralist criminology that Ian Loader and Richard Sparks recommend.

Criticism of the methodological approach of Sampson's crime and place work seems to be quite rare, although Jock Young has expressed concern about the "positivistic fashion" of some of Sampson's work while simultaneously complimenting him for his caution in reporting his findings (Young, 2011, 116). A criticism that could be made though, is that the main body of work currently has not so far paid enough attention to situational factors (such a lot of data has been collected and archived that further study of these factors in the future is possible). Similarly the research does not give enough attention to measuring everyday temporal factors – e.g. behaviours in the same neighbourhood in the morning compared to the evening – and the research design has not allowed for these to be considered. The Chicago project has also been a long, involved, labour intensive, and expensive affair, thus runs into Ron Clarke's critique that large scale studies fail to meet the need for fast response, reasonably priced simpler but effective answers to the problems of crime and place (Clarke, 2004); it is obviously beyond the means of many researchers to be involved with, or find funding for, such an ambitious project. Large projects like the Chicago PHCDN also potentially take away funding which could alternately be used for a larger number of smaller but informative research projects.

2.5 Human Geography and Quantification Resistance – Finding a Solution - Lessons from Critical GIS

This section considers the increased use of Geographical Information Science techniques to understand place based social phenomena, its' critique, and the launch of the qualitative GIS 'movement' as a response to this. Qualitative GIS recognises the value of using both quantitative and qualitative techniques and of using techniques often thought of as mainly quantitative in qualitative ways; this, it is, argued is a potential way forward for criminology.

Spatial science has long recognised there are major challenges in quantifying space often ignored or glossed over by researchers outside geography. There are two key issues of concern in spatial science; spatial autocorrelation and the Modifiable Areal Unit Problem (MAUP). *Spatial autocorrelation*, simply put, is the issue that "data from locations near one another in space are more likely to be similar than data from locations remote from one another" (O'Sullivan and Unwin, 2003, 28). This can be a particular problem for many statistical models that rely on an assumption that data are independent (Field, 2005). The *modifiable areal unit problem (MAUP)* is where different correlations (relationships) between data can be seen to occur for the same variable dependent on what level of areal unit is chosen for aggregation of data (Openshaw and Taylor, 1979, Openshaw, 1984). The problem can be one of zonation, how the boundaries are drawn, or scale – the size of the geographical unit chosen. Openshaw himself suggested that use of different scales or zonation might help to understand different relationships that might only occur at some scales and not others (Openshaw, 1984).

However, human geography has moved from a great welcome of quantitative techniques to deep suspicion. Deep suspicions expressed many years ago in geography mirror a number of the concerns of cultural criminologists now. In human geography, there was what is often termed the quantitative revolution, where there was a strong move towards using quantitative analysis, embracing new techniques of mathematics and computing in the 1950s and 1960s. By the late 60s and early 70s the value of these techniques as against qualitative methods began to be hotly debated, and soundly critiqued, including by one very influential geographer David Harvey who had previously been in the quantitative camp. Harvey's argument included that radical and critical geographers could not reliably use quantitative methods. A minority of critical geographers did continue to successfully use quantitative techniques for critical research but there was a general move away to qualitative research (for a detailed historical summary see Barnes, 2010). Within much of human geography positivism became a dirty word, and by association empiricism (meaning here use of number) and quantitative techniques were often shunned.

A main argument advanced had merit in that it suggested that too often numbers were accepted as a universal truth without challenge and ignoring how techniques for gathering those numbers may have been influenced by issues of identity, social structure and social construction. Some have argued, the fashion for qualitative, ethnographic research led to almost a disappearance of number based data in geography, and a loss of mathematical expertise – Richard Schearmur suggests that "thirty years of academic bludgeoning" from both within geography and elsewhere in social science has led to "a generation of innumerate students, some of whom are now politicians" (Schearmur, 2010, 1009). This characterisation is extreme, as Barnes discusses (Barnes, 2010), quantification never disappeared from geography completely, but it did reduce substantially.

From the early 1990s the advent of various geographical information systems (GIS) and tools, including in the last decade a proliferation of easy to use, off the shelf, spatial analysis packages (Tita & Radill, 2010), some of which were free or low cost, began to lead to a renaissance of the use of quantitative geographical based techniques. Debates between Openshaw (1991) and Taylor (1990) over the value of the use of GIS in many ways mirrored the debates about quantification in geography two decades earlier. Taylor expressed great concern that quantification using GIS was going to lead to a "maverick geography" (Taylor, 1990, 212) with geographers becoming dangerous jacks of all trades, whilst Openshaw said GIS offered great opportunities for "geographers to break free of their self imposed disciplinary boundaries" (Openshaw, 1991, 625). Others were concerned that GIS was becoming ubiquitous with little consideration of its wider impact on society or the power imbalances in how the technology was being used and what data was being made available to who (Pickles, 1995).Overall there was great debate and critique within geography about whether the use of GIS was just a return to the bad old days of quantification, or whether these new software tools could in fact be used in a theory/position neutral way equally well. (Schuurman, 2000, Schuurman and Pratt, 2002).

More recently there has been active advocacy of using quantitative techniques including GIS in a critical way that takes account of some the earlier critiques of quantitative methods (Kwan. 2004, Kwan & Schwannen, 2009, Ellis, 2009, Barnes, 2009, Schwannen & Kwan, 2009) and demonstrations that GIS can be successfully used in a qualitative way (Cope and Elwood, 2009). Indeed many argue that GIS itself is not inherently quantitative – Maria Pavlovskaya expresses it beautifully here:-

> "In truth, most spatial techniques in GIS require spatial imagination (e.g. to grasp buffering or overlay), logical thinking (e.g. combining layers in site selection or multi-criteria evaluation), or intuitive grasp (in visual examination) and, therefore replicate qualitative reasoning common to all geographic research. This affinity with human reasoning has also been obscured for a long time by the unfriendly user

> interfaces of many GIS programmes and applications...In the end, despite the consistent labelling of GIS as a quantitative tool, it's most common functions are rather qualitative" (Pavlovskaya, 2009, 20 in Cope and Ellwood, 2009)

The problem of the need to be quite highly computer literate to use GIS persists, although developments of easy to use Exploratory Spatial Data Analysis (ESDA) interfaces such as OpenGeoDa (previously GeoDa see Anselin et al, 2006[5]) have lessened this issue.

A particularly interesting strand of GIS has been Participatory GIS (PGIS) where individual community members are actively involved in making and recreating maps of their local area. Sarah Elwood discusses the use of GIS by community activists illustrating how "grassroots groups create a mixed methods, multi-epistemology, GIS practice" (Elwood, 2009, 60). Another innovative example of a project using PGIS methodology s the work of Steve Cinderby, which used GIS to reach hard to reach groups and get their input into their views of public spaces, this included getting people on the street to visit consultation stalls and put flags on maps along with comments about the space, and then later digitising and shading these maps to summarise responses (Cinderby, 2009, see especially pages 5-8). Using GIS therefore opens up the opportunity of using, exploring and representing number, and using computers in qualitative ways. It offers a method of critical and qualitative empiricism quite distinct from that criticised by the cultural criminologists, and which their current critique of crime mapping ignores. It is therefore felt that using GIS in qualitative and critical ways offers a way to examine vandalism and place in a way that bridges the gap between crime scientists and cultural criminologists.

2.6 Why Criminologists should Count – A Personal view on the value of combining quantitative and qualitative methods in criminological research

Early in my research career, during my Masters course, I wanted to use quantitative methods in my research, but much of the writing in human geography was highly critical of these methods. There seemed to be few voices which recognised the validity of some of these concerns but then made the case for quantitative research. It was then recommended that I read Sarah McLafferty's article 'Counting for Women' (McLafferty, 1995)[6]. I found the article very influential; she strongly argued for the value of data analysis and that it was not the methods, but the way in which they were applied, that were often at fault. She argued that quantitative research was able to highlight striking universal differences, and can thus assist in producing

[5] - More information on OpenGeoDa is available at https://geodacenter.asu.edu/ogeoda (accessed 26 October 2012) OpenGeoDa has now been returned to its original name of GeoDa.

[6] I am grateful to Professor Lynn Staeheli for this, at the time of writing based at the Univeristy of Durham.

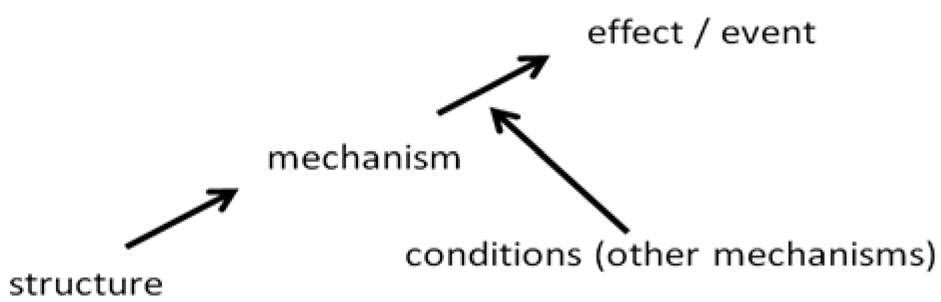
informed policy and effecting political change. It was possible for quantitative research to be conducted in a way that was "a more fluid process involving data exploration and constant questioning and revision of ideas"(McLafferty, 1995, 440). This more reflexive way of working with number chimed with me. I feel that the participatory and qualitative GIS approaches outlined above demonstrate exciting possibilities for gaining interesting insights when research is conducted using these approaches which combine qualitative and quantitative methods.

Criminologists, I would therefore argue, should embrace the possibilities of using quantitative analysis in their research, but carefully consider how they can use number-based approaches in more reflexive ways. One of McLafferty's key messages was that it was essential that quantitative and qualitative researchers collaborate; she was particular speaking to feminist geographer researchers in her article then, however, I would argue this message applies equally to criminologists today. Methods such as crime mapping and liquid ethnography seem to me to have the potential to be highly complementary and should not be considered as only appropriate for articulation of a particular theory, or a particular approach to understanding crime such as Crime Science or Cultural Criminology. Crime maps could help cultural criminologists identify potentially interesting areas for ethnographic study. Equally a short visual ethnography project could inform crime scientists seeking to understanding more about factors that might be causing an area to be a crime attractor.

An additional issue facing criminology and its various silos can be that one silo or group have a particular language or way of discussing their research and theories which may be relatively inaccessible to academics and policy makers closely associated with another silo. Whilst you could argue that this means that those in the silo should just make their explanations more accessible, and there is merit in this argument, to express ideas properly, be they technical or philosophical, often requires precise and sometimes discipline-specific language. There are good reasons for specialisation in academic research but there also need be people who can act as bridges between silos in a discipline and between disciplines. There is a place for multi-disciplinary and more generalist researchers who understand enough about competing fields to translate between them and build bridges, thereby hopefully starting to bring researchers from different silos together. By working together we can better understand the multitude of complex causal processes that impact on why crime happens in some places but not others. This role of translator and enabler is something I hope to do as a researcher, and hope that research I outline here may encourage others to take up this role too. In that sense, rather than seeing myself as part of anyone particular group within criminology I see my role as similar to that of the 'democratic underlabourer' as described by Loader and Sparks (2011) 124-133. In particular I am interested in building a knowledge base employing multiple methodologies that can be useful for professional practitioners working to understand issues of crime and place on the ground, and theoretical criminologists alike. I thus want to be a researcher working between silos seeking to increase overall understanding of crime and place for academics, policy makers, police and anyone else interested in these issues.

I feel that within criminology and wider sociology there are a number of, sometimes competing, theories of crime and place, all of which, currently, appear to have something to offer in improving our understanding of why crime happens in some places and not others. We need to use a research framework which allows these multiple theories to be explored. Such a research framework should allow use of data from a range of different sources, and allow us to examine data with a range of methods; this may in turn shed further light on the relevance of these multiple theories. If we retreat to silos and assume that we should only give weight to particular groups of theories and explore these only with particular methods, we run the risk that we miss important mechanisms that are influencing social processes.

Here I find the critical realist approach to causation and studying social phenomena as outlined by Andrew Sayer particularly useful. In so far as I have a position, I would describe myself as a realist influenced by Sayer's work. Sayer describes the critical realist view of causation in a diagram which I reproduce below in Figure 2.1 where structures are a "set of internally related elements whose causal powers, when combined are emergent from those of their constituents"(Sayer, 2000, 14).



Reproduced from Figure 1.2 (Sayer, 2000, 15).

Figure 2.1 A critical realistic view of causation

I find this explanation of the causal process useful as it seems to helpfully capture the competing and complex processes which seem to occur in real world situations and certainly when trying to understand crime and place. An important part of this view of causation is the idea that sometimes different mechanisms can produce the same result. So in the example of vandalism, high concentrations of vandalism could be due to the presence of advanced marginality in an area, or separately caused by the presence of a crime attractor, or both. Since this type of causation process assumes there will be a range of mechanisms, sometimes in competition, that can influence a final outcome, you might expect to find a range of sometimes competing theories trying to explain these processes. In a phenomenon as complex as crime and place, it is therefore not surprising, that we do find a range of theories, each of which may have value, as it is likely there are a range of mechanisms at work which contribute to the crime occurring (or not occurring) at a given place and time. The best that we can often hope for is a "practically adequate" explanation of social phenomena (Sayer, 2000, 43) given our current state of knowledge. It is therefore important to have a research framework which makes space for these multiple theories to be examined. My proposed methodological framework for this research will now be discussed.

2.7 Where next for crime and place research methodology- Methodological Objectives of this research

It is important to note that one of the key areas in which the use of spatial analysis techniques, GIS and visualisation methods have flourished in the last 10 to 15 years is crime and place research (Tita & Radill, 2010, Chainey & Ratcliffe, 2005). This is perhaps because criminology, despite the robust debates about the appropriateness of quantitative and qualitative techniques, has generally never rejected out of hand the use of number. It has not suffered from the almost binary reaction that appears to have occurred within human geography at certain times. A number of senior and respected criminologists, e.g. Anthony Bottoms, and sociologists working within criminology e.g. Robert Sampson and John Laub, have made use of both quantitative and qualitative techniques for groundbreaking research throughout their careers (Bottoms, 2008). Anthony Bottoms actively advocates graduate students to consider using a mix of techniques, in a theoretically informed way (Bottoms, 2008).

The above geographical debates have, with a few notable exceptions (Ratcliffe, 2002), tended to be somewhat ignored by those involved in using spatial analysis and visualisation to research crime. One issue arising from this has been that spatial analysis of crime is often being done in isolation of the meaning of place. Spatial analysis techniques at aggregate level have been used to explore particular social and community based theories around crime and place, although these techniques often either ignore or skirt around issues such as MAUP and spatial autocorrelation (Tita and Radill, 2010). A further problem may be that that Ron Clarke's (2004) labelling of crime mapping techniques as 'crime science' has perhaps led crime mapping visualisations to be restricted to the silos of crime science and environmental criminology when they did not need to be[7].

The above debates, and my own stated position, suggest there is a need for an increase of recursive and reflexive use of spatial analysis. This should be allied with the use of qualitative techniques, however that has so far been little done within spatial crime analysis. One potential way forward is to use Exploratory Spatial Data Analysis (ESDA) visualisation techniques (Theus, 2005). ESDA is basically exploratory data analysis (EDA) with a spatial element (the S bit of ESDA). The aim of exploratory data analysis is, to take a more recursive approach rather than using a more classical approach of statistical analysis which can be quite linear (Figure 2.2).

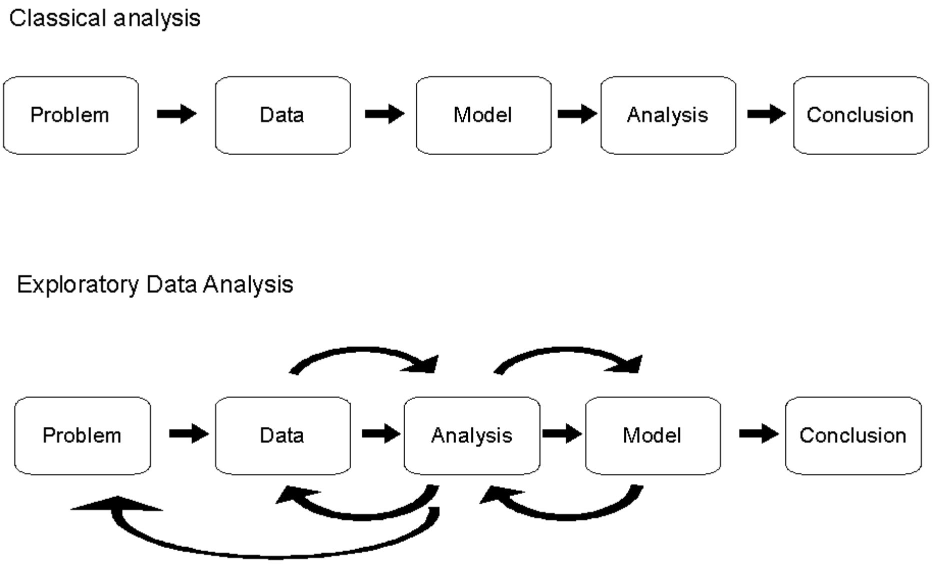
Tukey, one of the key early proponents of EDA, argued that EDA was an essential first step in statistical analysis.

> "Exploratory data analysis can never be the whole story but nothing else can serve as a foundation stone – as the first step" (Tukey 1977)

The aim of EDA is to allow the data to speak for itself by visualising patterns in data through a number of techniques; it is inductive and deductive and allows hypotheses to be suggested whilst avoiding problems that might be caused in analysis by the presence of outliers (Anselin 1999, Tukey 1977, Fotheringham et al, 2000). EDA avoids the "strictly linear thinking typical of classical studies". (Theus, 2005) (see Figure 2.2). EDA therefore employs different and additional techniques to those in classical studies, in particular it is very graphical, makes fewer assumptions but can also be criticised as potentially being less rigorous.

Luc Anselin has actively promoted the use of ESDA for researching crime and place (Anselin, 2008). However, so far, ESDA has been little used explicitly as a methodological framework for exploring issues around crime and place, although much research in the crime science field could be said to be exploratory and/or descriptive in nature. This is despite the fact that ESDA is a good choice of methodological approach for research where there are many gaps in our understanding as it makes so few initial assumptions, allowing for exploratory observations to be a starting point, and for research to recursively build from this point. This research project has therefore actively chosen to use ESDA as its key methodological research framework and this is detailed further in Chapter 3.

[7] Early in the research process I mentioned to a fellow (and supportive) criminology PhD student I was planning on using crime mapping techniques to explore vandalism "Crime Science?" they said in a slightly disparaging tone.



adapted from Engineering Statistics Handbook, http://www.itl.nist.gov/div898/handbook/eda/eda.htm, accessed 18 February 2008; and Theus (2005)

Figure 2.2– Comparison between classical analysis approach and exploratory data analysis

Linking ESDA with techniques from qualitative GIS gives the opportunity to understand the wider context underlying number, thus meeting some of the current criticisms of cultural criminologists of some of the work in crime science. However, ESDA is also a simple replicable and fast reacting approach that meets the requirements of crime scientists. I believe use of crime maps using ESDA has the potential to meet the needs of all criminologists not just crime scientists.

Robert Sampson recently argued in his presidential address to the American Society of Criminology that:-

> "...neighborhood contexts are important determinants of the quantity and quality of human behavior in their own right.." [and we therefore need to] "...expand the traditional focus of neighborhood effects on individuals to examine a family of neighborhood effects across multiple units of analysis, outcomes, and time scales" (Sampson, 2013, 4)

Yet as has been discussed above much research into crime and place uses methodologies that focus at either micro or macro scales. Issues such as MAUP and spatial autocorrelation discussed in section 2.5 above highlight that being conscious of the effects of scale and zonation is vital. In chapter 1, the view was put forward that both situation and structure matter in understanding crime and place and to understand both these factors it will be essential to look at issues of vandalism and place at more than one scale.

Bringing together these various issues, the aims of this research from a methodological point of view are therefore:

- To investigate the value of using an Exploratory Spatial Data Analysis methodological approach to examining research questions related to crime and place.
- To look at how ESDA techniques and qualitative techniques including ideas from qualitative GIS might be used
- To consider the necessity of exploring multiple spatial and temporal scales in crime and place research, is it enough to just concentrate on micro or macro scales or do both need to be considered

Chapter 3 which follows details the methods used to better understand vandalism and place taking into account the methodological aims of this research as well as the theoretical questions raised in Chapter 1.

3 Methods

The methods chosen for the research had to answer the following theoretically informed research questions as summarised in chapter 1. Are there areas (places) that experience high and low concentrations of vandalism year in and year out? Do concentrations of vandalism change over space and time, and are there any particular patterns that appear to exist? And do places which experience either low or high concentrations of vandalism over time appear to have any common features or shared characteristics?

In order to answer these research questions the methods chosen had to meet some specific requirements. As discussed in chapter 2 it was decided to use Exploratory Spatial Data Analysis (ESDA) as the investigative and analytical framework as this recursive framework is well suited to research questions where there is little other existing research in the field to draw on. The operation of the ESDA framework is expanded on in section 3.1 below. It was decided that using both quantitative and qualitative data, taking a mixed method approach, was the best way meet the challenge of representing the multi-scale complexity of crime and place. Quantitative data would be from nationally available secondary sources available to most researchers, whilst qualitative data would be gathered directly by the researcher. Data also needed to be capable of reflecting the complex context of local micro and macro interactions to allow exploration of the links between vandalism and place. Detail of the data selected for the project are given below, along with a consideration of ethical issues and an explanation of the considerations in choice of city for the case study and choice of the case study area within this city.

By choosing a mixed method and ESDA based approach the research would also critically assess the methodological research objectives identified in chapter 2. It would be investigating the value of using an Exploratory Spatial Data Analysis methodological approach to examining research questions related to crime and place. It would then look at how ESDA techniques and qualitative techniques including ideas from qualitative GIS might be used to better research crime and place. Finally consideration would be given to the necessity of exploring multiple spatial and temporal scales in crime and place research, is it enough to just concentrate on micro or macro scales or do both need to be considered? It was therefore important that all the methods chosen would enable this critical evaluation.

The research needed to use clear methods that could be replicated by others. Where possible the research used existing methods already commonly used within criminology and/or geography for exploring data with a spatial context. The methods chosen for visualisation were standard graphical techniques such as histograms, line graphs and box plots along with those more specific to ESDA such as parallel co-ordinate plots and excess risk mapping, and the visualising of Kernel Density Estimation (KDE) and Local Indicators of Spatial Association (LISA) using maps. These methods and the reasons for their selection are detailed and explained below.

To complement the quantitative analysis and visualisation a series of focus groups were held with Police Officers directly involved with neighbourhood policing. These focus groups drew on existing methods from criminology, geography and participatory GIS to give Officers a way to 'talk to the map', both by doing their own shading of where they considered high and low vandalism areas to be, and commenting on these and by showing them the results of analysis of police recorded data on vandalism in their area over the study period and inviting them to comment on this. Further detail of the focus group process is given below.

Finally in order to assess and summarise patterns of vandalism over time, following the focus groups, Group Trajectory analysis was conducted which enabled areas of high and low vandalism to be categorised into set groups allowing reasons why areas might be either consistently low or high over time to be considered in the light of both focus group commentary and the secondary socio-demographic quantitative data.

3.1 The Analytical Framework – Exploratory Spatial Data Analysis

One of the particular challenges of this research is, because it is being undertaken at a time when there is so little existing research into vandalism and place there were no examples of existing research that could be used to generate clear testable hypotheses. Equally there was no existing theory which could be drawn on which suggested what spatial distributions of vandalism across place and time might be likely. It was therefore decided to adopt an analytical framework with a strong emphasis on taking an exploratory approach.

Exploratory Spatial Data Analysis is a recursive and inductive approach. It takes spatial data and explores the data using various visualisation techniques. The ESDA approach is very reflective and reflexive. It allows the data to paint interesting patterns (Theus, 2005, Anselin et al. 2006). The ESDA process emphasises looking at the whole data available; as such it can both highlight general trends but also emphasise interesting outliers. ESDA based techniques emphasise multiple visualisations of the same data using a number of different techniques, and then viewing these visualisations side by side. ESDA also suggests using the same visualisation styles to view different years of data side by side, making it easy to spot similarities and differences in data. Bespoke ESDA software such as the open source package OpenGeoDa used in this project, easily allows multiple different styles of visualisation of the same data such as histograms, box plots and maps. OpenGeoDa also allows 'brushing and linking' of data

(Anselin, 2003). Brushing and linking is a process where a record or records in a dataset can be highlighted (the brushing process) and then for all visualisations of the same dataset the same record is highlighted (the linking process). This same brushing and linking process can be used for different types of visualisation for example comparing box plots with a map and a histogram. In this way it is very easy to quickly pick out interesting patterns in the data using ESDA software.

Interesting patterns generated through ESDA can in turn indicate and suggest further research questions. By having this flexibility ESDA also allows seeking of additional data or methodologies that might better assist in answering these research questions as the research process develops. The ESDA process therefore meets some of the concerns expressed by criminologists such as Keith Hayward and Jock Young who are concerned by the rigidity of some classical style quantitative analysis (as discussed in chapter 2). However, whilst the process of deciding on research questions and research methods may be iterative, the manner of the quantitative analysis done via ESDA visualisation techniques can be clearly documented and therefore the analysis can replicated. This means ESDA also retains one of the key advantages of classical quantitative analysis, methods can replicated, whilst allowing for a more creative and reflexive approach to the analysis of number.

The ESDA based analysis of the key research questions identified for this research project proceeded in an iterative and repetitive manner; visualisation of data led to analysis which then might then lead back to reconsideration of existing research and theory, or even a rephrasing of the research questions, or have led directly to modelling. After some models were run this then led to further considerations of existing research visualisation of data analysis and so on. Figure 3.1 represents the types of looping back between phases in the research process that occurred.

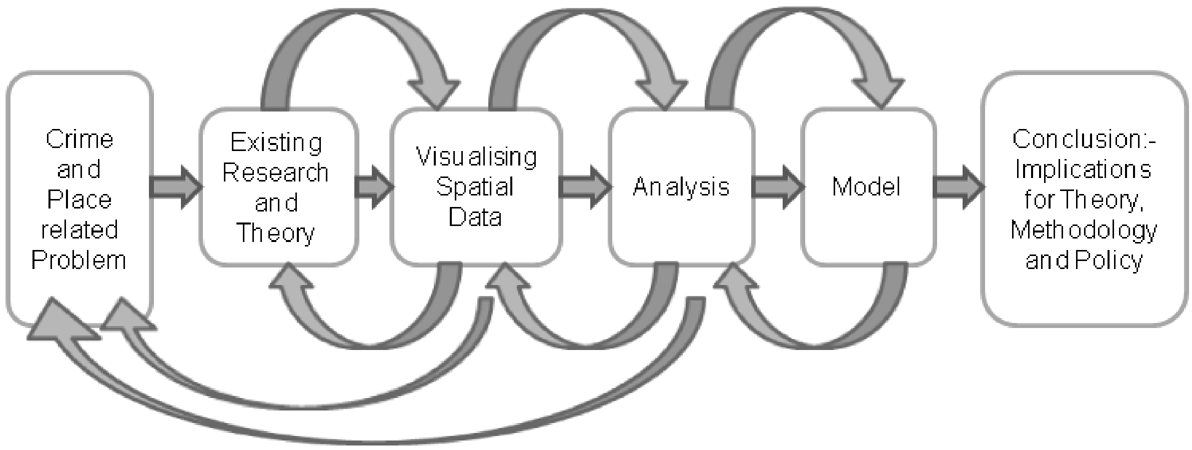


Figure 3.1 – Exploratory Spatial Data Analysis (ESDA) of Crime and Place– the process

Since ESDA is a recursive process it is easy to incorporate a mixed methods approach into the ESDA framework. Initial exploratory analysis of the quantitative data sources outlined above informed visual materials to be used in qualitative focus group based research of the study area. Subsequently reviewing results of qualitative data collection from focus groups and further analysis of socio-demographic data in the study area led to a return to methodological literature and the selection of the final modelling process (Group Trajectory Modelling) used to explore the relationship between vandalism and place. This chapter will now go on to detail the actual data and methods used within the ESDA framework.

3.2 Choosing the Quantitative Data Sources

3.2.1 Data on Vandalism – Data chosen and reasons for choice

It was decided that the principle data source used to represent levels of vandalism occurring in different areas should be police recorded crime data on vandalism. This data source was chosen for a number of reasons. Police recorded crime data is now typically held with both spatial and temporal information attached (Chainey & Ratcliffe, 2005). Most police forces hold crime data which for every crime recorded, including information on type of crime, the location (often referred to in Scotland as the locus) of the offence, and the date and time at which the crime is thought to have occurred. Crimes are typically recorded as point based locations, and this gives the option for aggregating the data to several different scales from one initial dataset, allowing multi-scale analysis from this dataset. This is very important from a methodological point of view as it allows you to say unequivocally that differences in results at different scales are due to scale only and not because data is from different sources. Finally police recorded crime data is a typical resource used by researchers studying crime and place. Researchers working within the crime science paradigm typically use police recorded crime data as a source of data on crime for their research on neighbourhood areas experiencing crime (for example Sherman, 1989; Weisburd et al.2012). Researchers working in development criminology have looked at levels of recorded crime compared with self reported crime (McVie and McAra, 2012). Researchers working in the field of collective efficacy have looked at recorded crime levels and compared them with perceptions of crime (Sampson, 2012).

My personal experience included working for a local authority for five years and included over two years working with recorded crime data (and other analysts and researchers who used this data). In the region in which I worked there were several different police forces but they had very similar common crime recording practices. Most police forces recorded a full address for the location of the offence; many would also record a 6 by 6 figure grid reference based on the British National grid (known commonly as an Easting and Northing) which gave the precise location of the offence to a 1m precision. Offences would always be allocated to a single point location. While working for the local authority my job included checking accuracy of recorded location addresses, against supplied grid references, and 'cleansing' the data to ensure address and grid reference matched. Actual accuracy of locations recorded by police can be very variable (Chainey and Ratcliff, 2005). However, research by Jerry Ratcliffe has suggested that provided at least 85% of addresses were accurately geo-coded (i.e. the grid reference allocated based on looking at a map and address given for the crime in records match) this should be sufficient for data to provide a reasonable representation of high and low concentrations of crime when analysed (Ratcliffe, 2004). Most police forces also recorded the date and time of the offence, and since they often cannot be sure of the precise timing of the offence would often record this in the format of date and time from and date and time to giving a range of time in which the offence was thought to have occurred.

Once research began, various informal and more formal discussions with various police force personnel and civil servants working for local government established that crime recording practices in Scotland are very similar to those I'd experienced in England and Wales. This meant that police forces in Scotland held data on crimes of vandalism, along with a precise location and a timescale within which the offence was believed to occur. From 1 April 2004 they had also been recording crimes in accordance with an agreed crime recording standard: the Scottish Crime Recording Standard (Scottish Government, 2012). This means that crimes are (or at least should be) recorded in the same way across all police forces in Scotland with police held data on occurrences of vandalism, recorded using the same descriptive codes across parts of Scotland. These data are also reported as a national statistic by local authority and police force area on an annual basis by the Scottish Government (for example see Scottish Government, 2012).

There are established reporting codes for a group known as Group 4 which includes various categories which are defined as types of vandalism. These are also the codes for offences that have been used to define Vandalism etc. as released on the Scottish Neighbourhood Statistics website. These codes are:-

Table 1:- SIMD Vandalism etc – Breakdown of coded offences within the definition

SCJD Code	Description
32/001	Fire-raising excluding muirburn
32/003	Muirburn
33/001	Vandalism, reckless damage and malicious mischief
33/002	Reckless conduct with firearms
33/003	Flying aircraft to the danger of life or property
33/004	Endangering rail passengers
33/005	Reckless driving at common law
33/006	Culpable neglect of duty
33/007	Endangering ship by breach of duty, obtain ship by misrepresentation
33/010	Computer Misuse Act 1990
33/011	Culpable and reckless conduct (not with firearms)
33/012	Vandalism
33/013	Reckless damage
33/014	Malicious mischief

It was decided to request all data in Group 4 from a police force so if necessary data could be directly compared with nationally held data. It was then decided, since some coding in Group 4 is for offences very different to vandalism, to restrict the codes used for analysis to descriptions clearly related to vandalism. In addition to the coding above the data received from police included splitting vandalism into vandalism to vehicle and vandalism unspecified (i.e. to something other than a vehicle). The actual crime categories used in the analysis are detailed in appendix 3 which assesses the data quality of the crime data obtained.

3.2.2 Socio-economic data chosen and reasons for choice

Socio-economic data was chosen on the basis of four main criteria. The first criterion was that it had to be in some way related to existing theory on the relationship between vandalism and place. The second criterion was that it should be data that was available on a national basis, data that could be obtained for any part of Scotland. The second criterion was put in place so it might be possible for other researchers to replicate or test the research in other parts of Scotland. The third criterion for the data was that it should be neighbourhood or small area data available either in aggregate form or in a form that could be allocated a specific point location either by digitising from existing map data or from a full postcode or address and then transformed into aggregate form as required. In practice quite a lot of socio-demographic data is now made available at aggregate small area level through the Scottish Neighbourhood Statistics website, www.sns.gov.uk. Most data is released at Datazone level, generally only census data is released at the smaller Output Area (OA) level and data at a finer scale than this is only available through special products or special requests to institutions that hold the data. (More detail and definitions of spatial scales used is given in section 3.7). The fourth criterion was that there should be no additional cost in obtaining the data, it should be freely available to academic researchers and most analysts working in the public sector.

The first additional socio-economic data chosen for analysis was data on the age structure of the population. The data chosen were mid –year population estimates at Datazone level developed and made available by the General Register Office for Scotland (GROS) now part of the National Records for Scotland (NRS). This is made available on an annual basis in five year age groups for the total population and split by males and females. It is published for free download by the Scottish Government through the Scottish Neighbourhood Statistics website. This level of detail meant it would be was easy to produce exploratory maps and charts exploring population age mixes and this helped in ensuring the eventual case study area chosen would have a balanced mix of ages within the area. Having this detail of population structure also enabled producing graphs such as population pyramids which could be used to quickly visualise localised demographic structures.

The second set of socio-demographic data used was derived from the Ordnance Survey open source mapping products, OSOpenData. Ordnance Survey data was chosen as it has a long standing reputation for high accuracy, the researcher was familiar with working with Ordnance Survey data products and the data used is now freely available. The mapping product provided point locations for parks and recreation areas and schools. Green space is also represented using vector based polygons. The same data was available as raster based visualisations – standard reference maps - and these could therefore be referred to as a cross reference when visualising the vector data. This data was particularly useful as it could be visualised in a bespoke way to produce simpler reference maps containing less data to highlight the presence of particular features. The point based data provided by this product could also be used to calculate whether a particular feature was near another feature or fell within a particular boundary.

As it was not possible to get population or business data at a very localised level an additional dataset was used to derive proxy localised information. The dataset used was the Gridlink product produced by Royal Mail and the Office for National Statistics and freely available for download for academic research use from EDINA. This data set was chosen as it provides a detailed national grid easting and northing grid reference to 6 figures each, i.e. northing – 6 figure; easting – 6 figure, for each centroid of every full postcode. This means this dataset can be used to plot a point on a map using a geographic information system for every postcode in the UK. Along with this location information for each postcode, information is given on the number of delivery points (locations post can be delivered to), and these are then split into residential and business addresses. Data is available in spreadsheet or database format. Data can be downloaded on a per local authority basis. The data is updated once every quarter of the year as postcodes are either phased out or new ones introduced or new data on delivery points is made available. This dataset was particularly useful as it allowed data on postcodes within a given boundary to be aggregated to give separate count of the total number of residential and business address points in the area. As it is regularly updated, if a new property is built or properties demolished this is reflected in the postcode data so it provides a very up to date snapshot of business and residential property activity in an area. This dataset is thus very useful for examining changes over time in levels of residential or business property in an area. It can give a very current indication of residential and business density within an area. It can act as a proxy for which areas are predominantly occupied by people, which by businesses and which are a mix and how this changes over time. Since the routine activity approach to understanding crime and place (Felson, 2008, Felson & Boba, 2010) is strongly related to local routine activity patterns such as going to a place or work or leisure from a residential address, it was important to have data that could reflect local business and residential mix.

Since alongside the routine activity approach, Sampson (2012) and Wacquant (2008) suggest that persistent relative inequality may be a key issue for understanding crime and place, a socio-demographic indicator was selected that could act as a proxy for relative inequality. The indicator chosen as a proxy for relative inequality was the proportion of population in receipt of one or more welfare benefits awarded to those on low or no income compared with the rest of the population. This indicator was developed for the Scottish Index of Multiple Deprivation and is available at the Datazone level for all of Scotland. The indicator was not available for every year of the study period but was available for key dates at the start of the study period in 2004 and 2009 as well as some intervening years. Due to changes in the types of available welfare related benefits the exact composition of benefits used to calculate the indicator varied slightly between years in some cases but as the indicator is one of the key components of the Scottish Index of Multiple Deprivation (SIMD) the composition of the indicator in a given year is well documented (Scottish Government, 2004; Scottish Government 2010). The data for the indicator can be freely downloaded from the Scottish Neighbourhood Statistics website. Exploratory analysis showed that across years there was little change between Datazones which had high and low proportions of populations on income related welfare benefits. This made this 'high welfare' indicator a good proxy measure for persistent relative inequality.

A final socio-demographic indicator was chosen as it had had both links to routine activities and persistent inequality. This was an indicator of school attendance at secondary school. Secondary school data was used as pupils of secondary school age (11 and over) were more likely to be involved in crime than younger pupils. The indicator is a part proxy measure for routine activities as pupils attending school are likely to be at the school building during set hours. Thus an area with poor school attendance might be expected to have more children present in the local area on more occasions which, since young people are potentially more likely to be involved in vandalism than adults, might suggest an area might be at higher risk of vandalism. Poor school attendance also was a potential proxy for relative inequality since school attendance (school absence) is one of the measures used in considering education deprivation. Exploratory analysis showed high correlation between areas with poor school attendance and high welfare levels. The attendance data was taken from the September return to the Scottish Pupil Census for school age pupils attending publicly funded schools excluding special schools[8]. The data is expressed as the percentage in attendance at school per Datazone.

As the presence or absence of collective efficacy appears from existing research to be important for understanding crime and place it would have also been useful to have indicators that provided some measure of levels of collective efficacy at a local level. However there was no national dataset available with data at a small enough scale. In other studies, voter participation, or participation in community organisations has been used but there were no data sources

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[8] Data is collected as part of the ScotXed www.scotxed.net. Source: metadata for Attendance data downloaded from Scottish Neighbourhood Statistics website accessed 23 December 2011,

similar to this in Scotland. It was therefore decided that either locally collected data by a local authority or qualitative data collection methods in the study area would have to be the only source of data on collective efficacy. It transpired only the qualitative data could be used. There was a local survey that asked some questions that might have been useful indicators of collective efficacy but the survey was not comprehensive enough, as it focused particularly on areas where the local council managed housing or local facilities only, and did not survey other more affluent areas.

3.3 Choosing the Qualitative Data Sources

3.3.1 Use of local 'experts' –working with Police Officers responsible for Neighbourhood Policing

The main data source chosen for qualitative data was to seek the perceptions of local Police Officers involved in neighbourhood or community policing. These were Police Officers who were tasked to work directly with local communities walking around the streets of local neighbourhoods, attending local community meetings and liaising with other people working for other public sector bodies in the local neighbourhood. Most police forces in Scotland at the time of the study had at least some Police Officers performing this type of role as part of a wider reassurance policing strategy (Fyfe, 2010). These Police Officers were chosen to be a focus for the study because they had long term experience of local communities and also an understanding of local crime problems. Police Officers also are trained to observe things, they are therefore likely to build up clear perceptions of differences and similarities between local areas as they are trained to record and retain information. These Police Officers also had beats which required them to survey and understand a whole area in total, not just places they might be regularly called out to. As such Community Police Officers were simultaneously trained observers and local neighbourhood experts making them ideal for commenting on varying perceived characteristics of local areas that experienced high and low levels of vandalism.

Police Officers were also likely to define vandalism in the same way as it was recorded in police data so there would be a level of consistency in understanding between the quantitative and qualitative data on vandalism. This meant these Officers would also potentially find it easier to be able to comment on maps produced from this data, since they would already be familiar with the data as they recorded some of it themselves. Finally there was unlikely to be any issue around data protection in showing Police Officers detailed analysis of their own data, which potentially could identify details of specific streets targeted with vandalism. Showing this level of detail of crime data to people outside the police force might have been felt to be inappropriate by police force data protection personnel.

3.4 Ethical Issues

Informed consent was sought from all participants who were directly interviewed; this was done through use of consent forms. The consent forms used for data from participants who are directly quoted in this thesis can be found in Appendix 1.

There was potential concern that areas identified as having high levels of vandalism could be stigmatised by the research. Wacquant (2008) discusses how areas of advanced marginality often acquire specific negative reputations. It was felt important that the research findings publicly reported should not further add to stigmatisation of already marginalised areas. A deliberate decision was taken not to name any precise areas identified as having high and low levels of vandalism and to produce maps at a scale that would make it extremely difficult to identify a particular collection of streets.

There are potential data protection issues arising from the use of crime data. If the crime data supplied could be used to identify an individual site of vandalism then there was a possibility it could also identify an individual victim. To avoid this it was decided that the minimal data necessary would be collected. This meant that the location of the offence as a grid reference and or postcode would be requested, but importantly the name of the victim and address of the vandalism offence location would not be requested. Secondly any data that is classed as sensitive under the Data Protection Act, as crime data is, must be stored securely. It would therefore be important to design a method of holding data so it could be held in encrypted format in secure locations at all times. I had already developed a system for secure data storage of crime data during my MSc research (Bates, 2008) which had worked well so it was decided that a similar system for data storage would be proposed to the police when data was requested from them.

3.5 Choice of Study area, and reason why

3.5.1 Choice of City in Scotland

An early decision was made to look at Edinburgh as the city from which to choose the study area for the research. This sections sets out why Edinburgh was initially chosen as the city where the focus of analysis would take place. The original intent of the study was to look at vandalism in Scotland as there has been no recent published research into the relationship between issues of place and vandalism in Scotland, yet it remains a very common crime. The decision was made to look at vandalism in an urban environment, existing research into vandalism and place by Ceccato and Haining (2005) and Wikström (1991) had concentrated on cities so it made sense to build on this by looking at an urban area.

The two major cities in Scotland are Edinburgh and Glasgow, with the other urban settlements with populations over 125,000 being Dundee and Aberdeen. The city chosen needed to be a city that had a significant proportion of vandalism per 10,000 population, and reasonably high counts of vandalism to ensure that sample sizes in small areas would be big enough. As Table 3.1 shows in all cities there was a significant amount of recorded vandalism suggesting that on this basis of selection alone any of the larger Scottish cities might be suitable as a study area. Settlements boundaries were originally defined by the General Registry Office of Scotland in 2000[9], derived from analysis of residential postcode density, high residential address density postcodes were defined as urban and these were used to build the settlement areas (GROS, 2001, Scottish Executive, 2006). However there is quite a large amount of variation between the urban settlement area and the local authority boundary for all areas; in Aberdeen and Edinburgh the local authority boundary includes quite a large rural area to the west of the city, whereas the City of Glasgow local authority boundary falls within the greater Glasgow settlement. Police recorded crime data is released to the local authority administrative data boundary unit only by the Scottish Government; it is not made available at settlement level.

Table 3.1 Scottish Cities - Local Authorities and Settlements - Population and Area and Police Recorded Vandalism

	Urban Settlement Population Mid Year Estimate 2004	Local Authority (LA) Pop -ulation Mid Year Estimate 2004	Urban Settlement Area in Hectares	Local Authority Area in Hectares	Police recorded Vandalism etc. per 10,000 population in LA area 2004-5	Police recorded Vandalism etc. count in LA area 2004-5
Glasgow	1,171,390	577,670	36,104	17,517	334	19,290
Edinburgh	457,420	453,670	11,953	26,308	248	11,243
Aberdeen	188,760	205,710	6,410	18,583	274	5,641
Dundee	151,530	142,170	4,734	5,937	281	3,999
Data sources: Population and Crime Data GROS, Scottish Government, Scottish Neighbourhood Statistics. Areas based on settlement and local authority boundaries 2001, calculated by author using ArcGIS, derived from Ordnance map data used with permission of HMSO © Crown Copyright and database right of the Crown 2003. All rights reserved.						

As can be seen in Table 3.1 Glasgow and Edinburgh are clearly the largest cities in Scotland both in term of population and area of the local authority city boundary, and both also have high counts of vandalism per 10,000 population and high counts of recorded vandalism cases. At the

[9] See http://www.gro-scotland.gov.uk/statistics/geography/scosett/results/settlements-in-2000.html -

time of the research Strathclyde covered Glasgow and Lothian and Borders covered Edinburgh, so both cities were also covered by single police forces. Using an area covered by a single police force is important for case study selection as it prevents any localised effects that might be caused by differing crime prevention policies between forces. This suggests either Edinburgh or Glasgow would be good candidates for a city from which case study areas could be selected. However, there were three principle reasons for favouring Edinburgh over Glasgow. Firstly Edinburgh has a more obvious boundary to the city area than Glasgow. In Edinburgh the main urban area falls within the City boundary, whereas in Glasgow, the City of Glasgow boundary falls within a greater urban area. Deciding where the exact edge of Glasgow is, therefore, more complex as there is a large urban sprawl that spills out from the Glasgow local authority boundary. The urban settlement area of Glasgow in fact spreads across 7 local authority areas: - East Dunbartonshire, East Renfrewshire, Glasgow, North Lanarkshire, South Lanarkshire, Renfrewshire and West Dunbartonshire (GROS, 2001).

Figure 3.2 shows both the urban settlement footprint and local authority boundaries for Glasgow and Edinburgh. This shows clearly how the local authority administrative boundary of Glasgow falls within a greater Glasgow area. Only a small part of the Edinburgh conurbation falls outside the local authority boundary; this is a distinct area known as Musselburgh, originally a separate settlement, now absorbed into Edinburgh as part of the Edinburgh settlement as the Edinburgh conurbation has expanded.

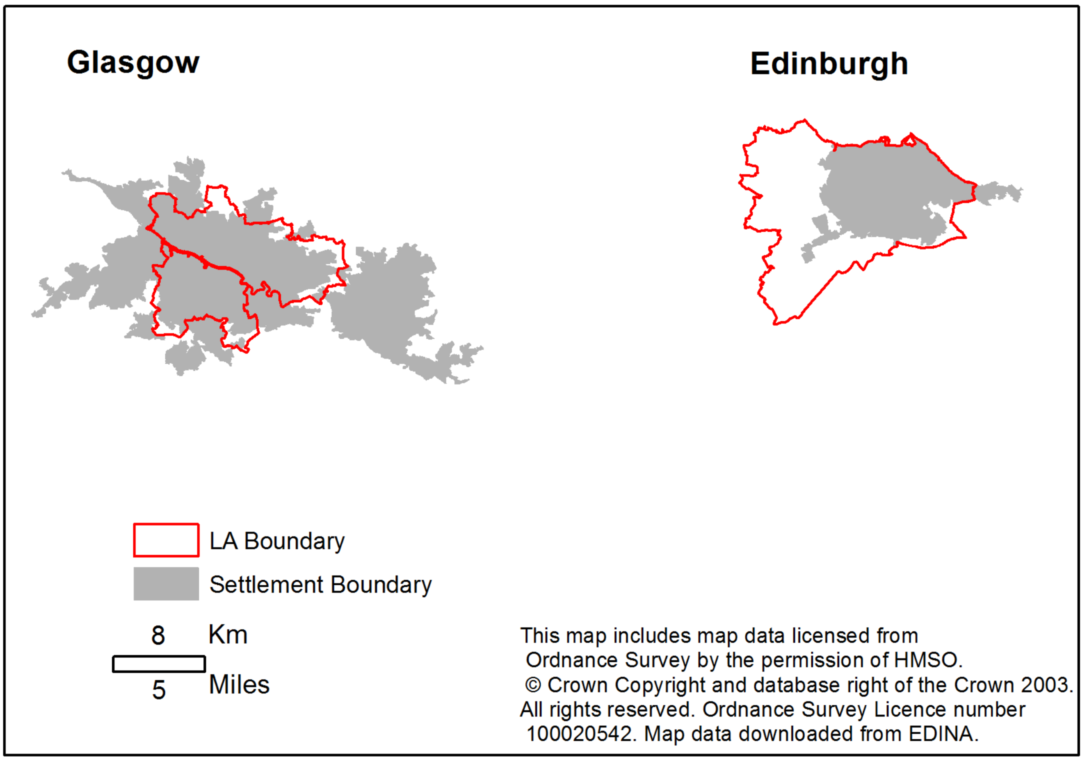
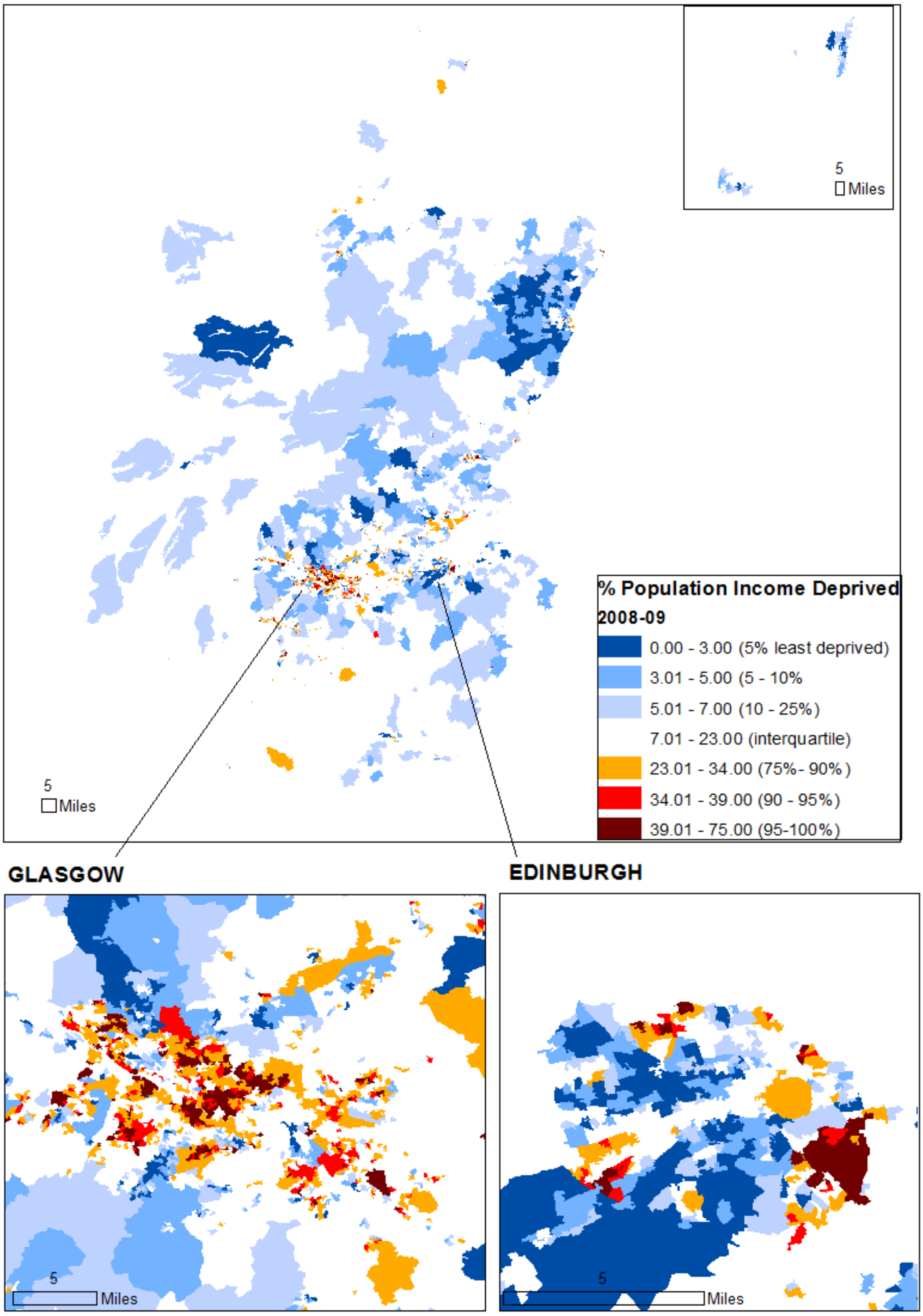


Figure 3.2 Cities of Glasgow and Edinburgh, urban footprint and administrative local authority boundaries

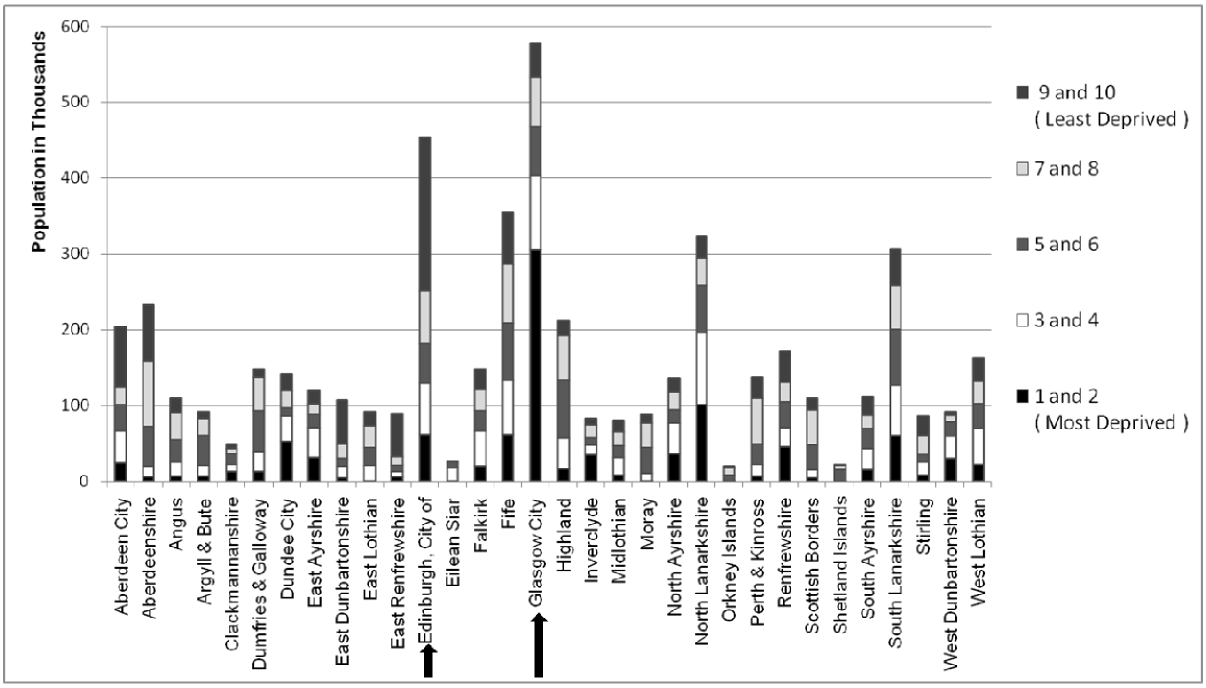
There were two other major reasons for choosing Edinburgh rather than Glasgow, and both of these were that particular issues in Glasgow might confound the results, or be particularly unique to Glasgow, which might make the results more difficult to generalise. The first issue is one of relative deprivation. As has been discussed in Chapter 1, the existence of persistent inequality is theorised to have influence on levels of crime and disorder. It was therefore important that the city chosen had a range of relatively deprived areas, from most deprived to least deprived. However, Glasgow and the surrounding area have a very high proportion of some of the most relatively deprived areas in Scotland. Figure 3.3 shows the proportion of the population that were amongst the most and least income deprived using the geographic unit of Datazone across Scotland.

As can be seen in Figure 3.3 the majority of the most relatively income deprived areas (based on income calculated from a number of key social welfare benefits) - the dark brown, yellow and orange areas - are concentrated towards the Southern and Central parts of Scotland in an area generally known within Scotland as the Central Belt, with Glasgow to the West and Edinburgh to the East. However, there is a particular concentration of income deprivation in the Glasgow area, and relatively few areas that are relatively *not* income deprived (the blue areas). Edinburgh has a number of these blue relatively *not* income deprived, but also has a number of the relatively deprived areas. As Figure 3.4 demonstrates Glasgow City has a very high proportion of its' population in living in areas found to be the most relatively deprived compared with other local authorities (according to the Scottish Index of Multiple Deprivation 2006), and Edinburgh has a higher proportion of people living in relatively least deprived areas. Although Edinburgh is sometimes characterised as affluent and Glasgow as poor the data represented in Figures 3.2 and 3.3 suggest that the context is much more complex than this. However, there certainly are clearly very high concentrations of highly relatively deprived areas in Glasgow, making it unlike the majority of Scottish local authorities.



Data source: Percentage of population income deprived by Datazone based on combined key benefits Scottish Government - downloaded from Scottish Neighbourhood Statistics (SNS) sms.gov.uk as released 03 November 2011. Datazone boundaries are © Crown copyright. All rights reserved 2009.

Figure 3.3 – Relative income deprivation in Scotland with a focus on Edinburgh and Glasgow areas



Source: derived from data from Scottish Government and General Registers of Scotland (GROS) –SIMD 2006 Deciles and population estimates downloaded from Scottish Neighbourhood Statistics www.sns.gov.uk, accessed May 2009 © Crown copyright. All rights reserved 2009

Figure 3.4 – Population of each Local Authority distributed between Scottish Index of Multiple Deprivation 2006 groupings (SIMD deciles)

A further reason against choosing Glasgow was a concern that research suggests relatively high concentrations of sometimes highly territorial gangs in certain parts of the city, compared with other local authority areas (Bannister et al, 2010, Bannister and Fraser, 2008). As research suggests there is thought to be some links between gang behaviour, territoriality and vandalism, this again might skew results of research in such a way that it might be difficult to interpret without some associated in-depth research into local gang behaviour. This would potentially have taken the research well beyond the parameters of the original research aims. This is not to say that gang membership is not present in Edinburgh, but research suggested that there were not as strong territorial effects as might be present in Glasgow, so there was less chance of this skewing results. Again this suggests that research from Edinburgh might potentially be more generalisable to other cities than Glasgow.

Finally there was a pragmatic reason for selecting Edinburgh; the University of Edinburgh already had a working research relationship with Lothian and Borders police, who were responsible for policing the City of Edinburgh; the University had received data and undertaken research with them in the past and it was hoped that this research relationship could be built upon to facilitate this research.

3.5.2 Choice of Study area within City

A number of criteria were set for the choice of the study area. The study area needed to be big enough to have a variety of social contexts and to provide a sufficient sample size of crimes of vandalism per local neighbourhood area to enable meaningful quantitative analysis to be carried out. However, the study area also needed to be small enough that the number of external local political and policy influences would be minimised, and that it was possible for areas within it to be well understood by individuals working or living in the area.

A first key criterion was the area selected must have a varied range of environments including shops, schools, residential areas, business and retail parks along with recreation areas. It was important that a full range of normal routine activities would take place in the area and there was a mix of potential crime attractors. The final study area selected met these criteria by including a couple of major recreation areas. On the business side, there was a large out of town style retail park, a high street type area, and some smaller retail areas. There was a good mix of residential and business areas - this was checked by doing some preliminary exploratory analysis of business and residential postcodes using the Gridlink product discussed in section 1.1.2 above.

It was important the study area did not include parts of the city centre. It was felt that city centres have particular properties that are typical of city centres but not necessarily of the broader environment. Examples of city centre specific characteristics for Edinburgh included high concentrations of shops and bars, high volumes of outside visitors (in the case of Edinburgh this includes large numbers of international visitors), and routine events particular to the city. In Edinburgh there are a number of international festivals when overall routines of the city change greatly and the city centre is visited by very large numbers of people for a large part of a twenty four hour period (for example during the Edinburgh Festival Fringe and Hogmanay festivals). The final study area selected did not include any of the main city centre areas of Edinburgh to avoid these specific characteristics that might have skewed results.

The study area selected should be managed by a small number of Senior Police Officers. Since different Senior Police Officers might have a particular influence on local policy within their area, it was preferred to reduce the number of management influences on the area. By selecting a study area managed by a single Chief Inspector, this reduced the likelihood of differences in crime levels within the study area being due to different management styles of Senior Officers. The study area selected was managed by a single Chief Inspector and single Superintendent above him. Informal discussion with members of Lothian Borders police, the local Edinburgh police, and consideration of Council documentation established that the City of Edinburgh is divided into Neighbourhood Management Areas (NMAs), also known as Community Planning Areas for various administrative purposes. These areas mirrored existing local council ward boundaries, typically containing two or more wards. Selecting an area managed by a single Chief Inspector also selected a single NMA managed by single teams for certain administrative purposes of the local City Council. The only exception to this common management approach was that the study area chosen was split into two Neighbourhood Partnership Areas corresponding to local councillor electoral ward boundaries. This meant there were separate community meetings for two sections of the study area. However the boundaries of these two areas were clearly defined and could be delineated easily both for analysis of data and for visualising the data in map form.

Since a key research question was to explore whether high and low concentrations of vandalism occur and reasons why this might occur, the study area chosen needed to be likely to have a mix of both high and low levels of vandalism within the area. The Scottish Neighbourhood Statistics website releases recorded police crime data at the intermediate geography level and this was used to check that the area had the potential to have areas with both high and low recorded vandalism rates and counts. The study area selected met these criteria.

A final criterion of the area is that it needed to have a mix of socio-demographic characteristics, for the key secondary data selected for analysis as discussed in section 1.1.2. The study area chosen was particularly suitable because exploratory analysis of key indicators determined it had a varied mix of socio-demographic characteristics and also reflected the socio-demographic characteristics of the key indicators for the city of Edinburgh as a whole.

3.6 Accessing Quantitative and Qualitative Data

3.6.1 Accessing data from the police

Having identified Edinburgh as the city for study, over a 9 month period various conversations took place between the researcher and members of Lothian and Borders police. An initial approach involved a letter to the Chief Constable with a one page outline of potential research followed by an interview with a senior member of staff about the type of data the police service held. This established the police force held data that was likely to be suitable for this research project. There were some further more informal discussions with various Police Officers, analysts and civilian staff who worked for Lothian and Borders Police, some by arrangement, and others at conferences and other networking events. This culminated in an invitation to submit a formal research proposal to Lothian and Borders Police. A Chief Inspector with interest in the research, referred to the researcher from other research contacts they had with the University of Edinburgh, discussed the research proposed with the researcher and also offered to look over a draft version of the proposal. They made some very helpful suggestions of additional information that might be needed. This included suggesting providing additional detail on how data was to be analysed and securely stored to ensure that use of data would comply with Data Protection Act restrictions. The research proposal included an outline of the research proposed along with details of methods to be used for analysis of the data and a detailed section on proposals for secure data storage. A copy of the final proposal was then forwarded by the Chief Inspector to relevant personnel within Lothian and Borders Police. A copy of the final research proposal can be found in Appendix 2. The proposal was very specific about the area of Edinburgh in which the research would be conducted so references in the proposal which would identify the study area have been redacted. Following receipt and approval of the research proposal by the Superintendent who managed the area incorporating the intended study area the researcher was then invited to meet with staff responsible for Data Protection issues and release of police data to outside agencies. These staff gave final approval for data to be released as well as providing a named liaison who could be contacted with any further queries about the release or content of the data supplied. Once the data was received checks were undertaken to ensure that the data supplied was of sufficient minimum quality to be used in the research. Data quality checks and results are detailed in Appendix 3. A final part of the access process was reporting back results of focus groups. This was done via a knowledge exchange event the following year and additional follow up work is planned.

3.6.2 Accessing other secondary data

Accessing secondary data required no special permissions and incurred no costs. All data used was either available for public download through the Scottish Neighbourhood Statistics website, or available for download to those undertaking academic research through the academic EDINA service.

3.7 Challenges for Statistical Analysis of Spatial Data specific to this research – Spatial Autocorrelation, MAUP, the Small Number problem and the Multiple Testing problem

3.7.1 Modifiable Areal Unit Problem (MAUP)

As described briefly in chapter 2, section 2.5, the Modifiable Areal Unit Problem (MAUP) occurs when the same data produces different statistical results dependent on how the data is aggregated. There are two parts to MAUP. The first, is the issue of scale chosen e.g. fine or coarse, that is to say, the potential number of units an area is divided up into, as at the choice of a researcher, the same case study area can be divided into, for example, 100 or 50 units. The second issue is one of zonation: data could be aggregated to exactly the same scale but different boundaries then chosen, in other words zonation is an issue of how the same 100 spatial units in a given study area might be differently partitioned or configured by different researchers (Haining, 2003). Both the scale and zones chosen for analysis will effect results of statistical tests for the same data, in other words the same statistical test, for the same data aggregated to a spatial unit, can produce different results purely due to the scale or set of zone chosen for that area. A particular problem with zonation is that many spatial clustering and autocorrelation tests rely on some form of weight matrix which determines which areas are contiguous (next to or adjoin) one another. Every time the zones used are changed then this will potentially change which areas are contiguous. As Openshaw (1989) discusses, Geographic Information System software now allows data to be easily aggregated in an "immensely large number of ways producing a distribution of results" (Openshaw, 1989, 273) and there is little guidance on what scale or zoning system should be used. For crime analysis in Scotland there remains little guidance on the ideal scale or zone configuration to use. Openshaw suggests you may wish to consider choosing your scales and zones in advance of analysis so you are not seen to be modifying your scale or zone in response to your results. However, it may also be useful to consider using different scales and/or zoning methodologies, and potentially then modifying these zones, as part of a process to examine underlying spatial patterns. The choice of scales and zones for this research is discussed below.

3.7.2 Spatial Autocorrelation and Spatial Dependency

In chapter 2, section 2.5, a brief definition of spatial autocorrelation was given, which summarised the issue of spatial autocorrelation as an issue that occurs because things tend to be like other nearby things. It can be usefully described as follows "[i]f the presence of some quality in a county of a country makes its presence in neighbouring counties more or less likely, we say that the phenomenon exhibits spatial autocorrelation" (Cliff and Ord, 1973, 1) . To give a more detailed explanation: where data at a given data point, or as represented by a data object, for a given attribute, has similarly high or similarly low values to its neighbours, this is generally referred to as positive spatial dependence or autocorrelation. Where nearby data are dissimilar, for example if an area (i) has high values but neighbouring area (j) has low values, or vice versa, this is often referred to as negative spatial dependence or autocorrelation. Both Haining (2003) p74-87, and Cliff and Ord (1973) chapter 1, give examples of both types of dependency. If the data values in neighbouring locations are independent or random than they can be said to have no spatial autocorrelation.

A number of statistical tests have been developed to test for the presence of spatial autocorrelation including joint count statistics, Geary's C and Moran's I (see further Cliff and Ord, 1973, Haining, 2003). Both local and global versions of these tests are available and this research has used both the global test, Moran's I, and local tests, Getis and Ord's G_i* and Anselin's Local Moran's I (these are detailed below.)

Spatial autocorrelation is both a useful property, and a property that breaches the assumptions of a number of statistical tests which rely on some assumption of randomness or independence in data being used for analysis. Spatial autocorrelation is useful, since testing for the presence of it can be undertaken to see whether data for neighbouring areas have similar or dissimilar values. So, in the case of crime data, testing to see if there is positive spatial autocorrelation present can be used to see if similar high or similar low levels of crimes appear to occur in neighbouring locations or whether apparent concentrations of low numbers or high numbers of crimes could have occurred just due to a random or independent process. However, if, for example, you wish to examine which factors might be influencing *why* certain areas have high levels of crime and others low levels, then many of the statistical tests you would use to examine this, presume some level of independence in the data being analysed. The assumption of independence in data is breached if spatial autocorrelation is present and this can then skew results if certain statistical tests are used. Where spatial autocorrelation is an issue for the data analysis methods used in this research, it is discussed below.

3.7.3 The small number problem

The small number problem typically occurs in data where there are small counts of relatively rare events and/or where the population or size of an area in which the event occurs (which you would use as a denominator to calculate a rate for that event) is very variable. In the case of crime data both issues can occur. It is not unusual to want to produce crime rates for some existing spatial unit used in other analysis such as counties, wards or some other geography specifically developed for the analysis of census data. Such spatial units can often have very variable populations, whether this is a variation of physical size, or a variation in the population of people living in the area. Where this is the case, if raw rates are used, where the observed value is simply standardised by a denominator, if the denominator number is small this can lead to rates appearing artificially high or low. This means that extreme rates for areas with small populations can dominate or skew any map.

An obvious solution is to use some kind of adjustment which adjusts the rates towards some overall expected value for the population. Haining (2003) p197-8, provides some examples of these types of adjustments, and Gelman and Price (1999) detail a more complex Bayesian adjustment that can be used. However, Gelman and Price (1999) demonstrate that these Bayesian adjustments, in the case of their paper, based on posterior means, can be too conservative and can lead areas to appear to be much more uniform than they actually are and genuine extreme cases in areas with small populations may be missed. Gelman and Price (1999) demonstrate the small number problem can also occur with count data. A final linked problem with small numbers, which also affects calculation of statistics, is that a distribution of small numbers will often not have constant variance, i.e. there is more likely to be a high level of variation in how much each small areal unit varies from an overall mean value, rather than a similar level of variation across all areal units. This breaches the assumptions of some statistical tests and may skew the results of others. Gelman and Price suggest a solution is to "produce multiple maps based on imputations from the posterior distribution"(Gelman and Price, 1999, 3233) or to shade maps showing levels of uncertainty about results where Bayesian adjustments have been used. A further solution could be to aggregate data to a coarser scale so that the data no longer contains small numbers. This leads to issues with MAUP, discussed above, but also may lead local geographic variations to be missed (Kennedy, 1989) and real differences at a local level to be ignored (Haining, 2003). Since as discussed in chapters 1 and 2, there is existing theory on crime and place suggesting that some important interactions may be occurring at a street by street level, aggregation to large data units may miss important local processes and may not always be appropriate.

Overall the presence of small numbers in a dataset causes statistical noise in data, making it more difficult to tell what are genuinely interesting or unusual groups of, for example, high or low clusters of cases, and which are statistical artefacts caused by the small number problem. The potential impacts of the small number problem on the mapping methods and statistical tests used in this research are discussed below.

3.7.4 The multiple testing problem

Many statistical tests are constructed so that the chances of a Type 1 error (dismissing your null hypothesis when it is in fact true) can only occur either 5% or maybe 1% of the time, a significance level of 0.05 or 0.01. This means that if you run 100 hypothesis tests on the same data, and, for example, your null hypothesis is that the process you are testing for is random, and the alternate hypothesis is the process observed is not random, then if you have set a significance level of 5%, then for 5 cases you may, just by chance, assume that the process you have observed is not random, when in fact it is. This is often referred to as the multiple testing or multiple comparison problem. This can be a particular problem when testing to see if clusters exist, as is often done in crime research, since "[i]f there are *n* tests (corresponding to the *n* sub areas that partition the study region) then as *n* increases the probability of finding a cluster increases to one" (Haining, 2003, 252). For example, in spatial analysis you frequently run a hypothesis test for each given area in your dataset *i* to check whether it is in some way like or unlike its' neighbour *j* (however you have decided to define how an area is contiguous to another). If your study area contains 500 areas this means that you are potentially doing 500 tests; if you have set significance level α at 0.05, then potentially in 25 cases you will think you have found a significant cluster, when in fact you should have not dismissed the null hypothesis that the cluster you observed has just been generated by a random process. Where multiple testing is a potential issue for analysis done in this research project, this will be discussed below. There are various corrections that can be applied to try and control for the problem, however some may over-correct and be too conservative. This issue is also discussed with reference to specific statistical tests below.

3.8 Scales chosen for analysis

It was important that multiple, multi-layer spatial and temporal scales were used as the research was explicitly setting out to see if the scale and zones at which vandalism data were analysed at had an impact on apparent high and low levels of vandalism in a place. This was explicitly to explore the Modifiable Areal Unit Problem raised in chapter 2 and discussed in 3.7 above. Secondly since (as discussed in chapter 2) in current crime and place methodology debates some are using the smallest micro scale available whilst others use broader macro scales or use multi-level models. It was therefore very important to examine data at more than one scale and see if the scale chosen had an impact on research findings.

3.8.1 Spatial Scales

For this research a deliberate decision was made to use boundaries commonly in use for crime analysis for the research, and also to use boundaries for which socio-economic data is routinely released and where data are freely available to download for use in non-commercial research. This decision had two advantages. Firstly, the boundaries used were more likely to be familiar to Police Officers being asked to comment on the data in focus groups. Secondly it meant that anyone wishing to replicate or repeat the research for other parts of Scotland could easily use exactly the same boundaries.

In American studies a common unit chosen to be the smallest micro unit is the street segment, or face block (Weisburd et al, 2012, Taylor, 1997, Sampson, 2012). Using this as a micro measure works well in America because most cities are based on a grid pattern and street segments / blocks are often of a uniform size. There is not a similar equivalent in the United Kingdom (or Scotland) where street lengths and shapes can be very variable, a few may be based on grid patterns, but in a city like Edinburgh this is an exception not the norm. It was therefore necessary to select another micro unit that would similarly represent a space in which micro community interactions might take place, but took account of the varied layout of the typical European city.

The smallest spatial scale chosen for this research were uniform 100m by 100m grid cells. Given the emphasis in recent literature on the importance of using micro scales (Weisburd et al, 2009; Weisburd et al, 2012) and given this project aimed to investigate whether there were micro scale differences in levels of vandalism in places it was important that the lowest (finest) level of geographic scale chosen for investigation was as small as possible. The 100m size was chosen as this was the minimum scale at which data quality checks suggested that the crime data provided had sufficient precision for analysis. A uniform grid cell was also chosen as the smallest unit as it meant that data could be analysed as counts for each geographic unit. Grid cells are similar to street segments of the United States studies in that they are of a uniform block shape; unlike street segments they may not represent a local community residential space. Grid cells have been typically used for hotspot analysis in both the UK and the United States (Chainey & Ratcliffe, 2005). The set of 100m by 100m grid cells covering the study was created using the CrimeStat software which was given the upper right and lower left boundaries of X and Y of the study area. It was then cropped using ArcGIS to only include complete grid cells that were within or overlapped along the edge of the study area boundary. Using a grid cell provided a uniform block shape over which locations of crimes of recorded vandalism could be plotted and joined to the grid cell they fell within (using GIS software). Each crime record was therefore assigned to a grid cell by plotting the crime locus using ArcGIS and then using a spatial join procedure to assign the crime to a grid cell. This then allowed the count of crimes of vandalism in each grid cells to be determined by aggregating together the crimes which fell within the same grid cell. A disadvantage of this approach was that it meant that data at the grid cell level might be affected by the small number problem.

The next geographic scale of chosen data was Output Area (OA) which has been recommended as a suitable small scale unit (Oberwittler and Wikström, 2009). Output Areas are a statistical geography developed by the General Register Office of Scotland to provide areas of similar population size; they are built from postcode data. As such they can vary physically in size , with a sparsely populated Output Area having a much larger physical size than a densely populated one. As such they too can be affected by the small number problem where data us standardised by the physical area of the OA. OAs are the smallest statistical geographical unit available produced to have a mean population of around 120 people (Derived from: Census 2001)[10]. Output Areas were originally developed to provide small area geography for aggregate census data from the 2001 census[11]. Output Areas can be seen as a measure of small neighbourhoods similar to street segments, but unlike street segments they will be much more variable in size. They provided a useful proxy for small neighbourhoods with the advantage that they are widely used as a small area data unit. In general, OAs in the study area were larger than 100m by 100m grid cells, as the median area of an OA was 1.59 hectares. Crime records were allocated to OAs via a spatial join procedure using ArcGIS. Counts of crimes in each OA were then calculated.

The final small area geography used was the Datazone. Datazones are a statistical geography originally devised for the reporting of the results from the 2001 Census and are the next level up from OA. They have been developed to have relatively homogenous populations of around 100 to 500 people and built from OAs (Scottish Executive, 2004). They were used for analysis as this the smallest scale at which most small area data is released publicly. Using Datazones also enabled analysis to see if this broader scale was fine enough to detect micro differences in high and low levels of vandalism.

It is important to note that a key limitations of this approach is although it did allow data to be analysed at different spatial scales it did not explicitly control for the effects of zonation (MAUP). However, whilst OAs were generally larger than grid cells, and thus scale effects were being considered, as they also had very different and varying boundaries to the grid cells it was not possible to definitively say what degree of differences was due to scale of different boundaries (zonation). An additional approach could have been to use a larger grid scale alongside 100m by 100m scale, for example 1000m by 1000m, this would have allowed just scale effects to be considered (as a similar zonation strategy would be in use for both grid based spatial units) although this was not done here.

[10] Census data was obtained from CASWEB Key Statistics Table 1 – data is for All People, data is Crown copyright reproduced with permission of HMSO. There are 42,604 output areas, over 99% of output areas have a population of less than 250 people, 23 have a population of over 500 people.
[11] As detailed at http://www.gro-scotland.gov.uk/census/censushm/scotcen2/scotcen28/scotcen25/index.html last updated 12 Sept 2012 accessed 18 September 2012 and in downloadable document 2001 Census Geography Classifications.

Ideally it would also have been useful to have produced a differently zoned set of boundaries of an equivalent sized population but different shaped set of OAs i.e. at exactly the same scale but with different boundaries. This could have allowed zonation effects to have been explicitly controlled for. However the underlying census data used to derive the original OAs is not publicly available and would have had to been specially requested, it was considered methodologically challenging to do this, and that it would add a number of additional research questions taking this approach outside the scope of the research.

3.8.2 Temporal Scales chosen for analysis

Data was analysed initially on an annual basis. Financial year periods were chosen 1st April in year 1 to 31st March year 2 as these are commonly used for reporting crime data (for example see Scottish Government, 2012). This enabled analysis to consider overall trends of crime across a six year period. In addition for each of the six years analysed the data was further broken down in terms of how many crimes occurred in which hour in a given year, how many crimes occurred on a given day of the week, and how many crimes occurred in which month of each year. Hourly analysis was undertaken to see if there was a difference in levels of daytime and evening vandalism. Literature reviewed in chapter 1 suggests that there tends to be more vandalism in the evening than in the daytime. Similarly days of the weekend were considered as existing literature suggested there was a phenomenon of weekend vandalism with more vandalism occurring then than on working weekdays. Finally months were analysed to look for general trends of seasonality to check if there appeared to be more vandalism in summer than winter for example.

This temporal analysis was conducted for each 100m by 100m grid cell, OA and Datazone. As counts were very low at the grid cell level for hours and months, data was further aggregated so hours were considered in 4 hour groups, sufficient to see if crimes of vandalism were occurring in the morning, afternoon, early evening, later evening or overnight. Again due to small counts the data were also grouped in two month blocks for analysis of the vandalism across months.

3.9 Assessing Quantitative Data - Basic Visualisation of crime data – Graphs and SVR and KDE maps

General techniques used for visualising data using the ESDA process included standard techniques such as scatter plots, box plots, histograms (Field, 2009) and more advanced techniques such as parallel co-ordinate plots standard deviation and excess risk mapping. Parallel co-ordinate plots are similar to standard trend graphs but show trends for each data-point individually. In this case this meant parallel co-ordinate plots could be used to show trends across each geographic unit simultaneously across each year of the study period. To highlight the presence of outliers, as well as examining general trends data was mapped as aggregate counts for 100m by 100m grid cells and presented using such techniques as box maps and standard deviation maps using OpenGeoDa. Box maps function in the same way as standard box plots shading data within the interquartile range, from interquartile range to 1.5 times either below or above the interquartile range, and then separately highlighting the data beyond 1.5 times the interquartile range (beyond the typical whiskers of a box plot). Standard deviation maps map data around the mean and then also separately high light cases which are 1 standard deviation, 2 standard deviations and more than 2 standard deviations from the mean using different shading for these groups of data.

OA and Datazone aggregate data were mapped as both counts and rates. Rates were used since there was great variation in the size of OAs and Datazones counts alone could be misleading as some areas had higher counts than others just because they were much larger than others. When dealing with vandalism a rate by area is recommended (Ceccato and Haining, 2005). Excess risk mapping where the Observed value is compared with the Expected value is preferred to raw rates (Haining, 2003, Ceccato and Haining, 2005) as this emphasises extreme values less and also provides a clear way of comparing local variation with the overall rate for the area. As maps were to be presented to Police Officers and it was important that the techniques could be clearly understood so a simple style of excess risk mapping was used that for each areal unit (OA or Datazone) the observed value was divided by the expected value to give a Standardised Vandalism Ratio (SVR). The observed value was the actual count of recorded crimes of vandalism in a local area. The expected value was the value a local area might be expected to have if it had exactly the same rate of vandalism as the study area as a whole. It was calculated by working out the rate of vandalism per hectare for the whole study area and then for each areal unit multiplying this by the area of that areal unit (OA or Datazone). SVR maps used a scale which showed areas of low risk where levels of vandalism were a quarter or less and between a quarter and half that might be expected compared to the rate across the whole study area. Similarly SVR maps also highlighted potential high or excess risk areas where levels of vandalism were between double and 4 times the level that might be expected, and 4 times or more the expected level. Presenting the maps with SVRs rather than raw rates had the advantage that it partially counters the aspect of the small number of problem where raw rates will tend to either over-emphasise high rates and under emphasise low rate where the denominator (in this case area of the OA) was small. Using SVR mapping extreme low (and extreme high values) were included in a general category of whether a quarter the expected levels of vandalism (or over 4 times for high values). It also had the advantage, as discussed above, that is was simple to interpret and present to others. Limitations of the SVR maps that should be born in mind are that: they share the disadvantage of more complex Bayesian mapping solutions in that they may lead to genuine extreme values being missed, as for example all values of 4 or more times are grouped together when visualised; and also that the standardisation used was potentially too simple a method to truly correct for extreme values, whereas more complex Bayesian methods using multiple map imputations might have provided a better correction.

At grid level standard hotspot analysis (Quartic Kernel Density Estimation) was conducted. The KDE style of mapping was chosen as it is commonly used by police forces across the United Kingdom (Chainey & Ratcliffe, 2005) and therefore was likely to be a mapping style Police Officers were very familiar with. KDE mapping involves assigning each of the points representing the location of an offence to a grid then applying a smoothing technique which weights the data according to how many other offences occurred nearby. KDE takes each location of a crime *i* and this gives the crime a weight based on the number of other crimes falling within a given distance of the offence. Quartic kernel density uses a smoothing technique that gives more weight to crimes that are closer to *i* than those further away (Lloyd, 2010). In practice this means that a given grid cell has a higher value if there are a tight cluster of crimes in the same location than if crimes are dispersed over a greater area. When mapped using the KDE technique, grid cells are shaded darker if they have a higher value, allowing the technique to highlight crime hotspots.

KDE is only an appropriate technique to use if there is already a degree of clustering in the data; the data was also specifically tested for clustering. The two methods used were generating a Nearest Neighbourhood Index, and Ripley's K, both of which are widely accepted methods of testing for clustering. Both methods see if the mean distances between observations are significantly smaller than might be expected if the same number data points were randomly distributed across the same area; Ripley's K is felt to be the more robust method (O'Sullivan & Unwin, 2010, Lloyd, 2010). Both were calculated to check results against each other using two different techniques and also because the software calculating the Nearest Neighbourhood Index helpfully can provides a table of the mean distances to the 1st, 2nd to 5th and 10th nearest crimes as requested. It is recommended that these distances can then be used to set the bandwidth of the kernel used in the KDE (Chainey & Ratcliffe, 2005). The NNI, Ripley's K and KDE analyses were performed using the free software package CrimeStat version 3. The KDE process in CrimeStat generates a square grid that encompasses the study area which could be reused in further analysis.

The equation for quartic KDE method used by CrimeStat3 is expressed as

$$g(x_j) = \Sigma\left\{(W_i I_i)\left(\frac{3}{\pi\tau^2}\right)\left(1 - \frac{d_{ij}^2}{r^2}\right)^2\right\} \qquad (3.1)$$

W_i represents the weighting at the point location, I_i the intensity at a point location, r the radius of specified bandwidth, and d_{ij} the distance between any two given crime points the incident location *i* and j other points of crime in the region (Levine, 2004, 8.8).

Maps using the KDE technique were produced at Grid level only and were produced for each of the six years of the study period. Maps were then presented in a '6 up' - comparison format where 6 maps, one map for each year, were placed on single A4 size image. Care was taken to ensure that every image for each year was at exactly the same scale. As a default 1:85000 was used as the chosen scale since this was coarse enough to prevent any individual locations to be identified. Using multiple maps side by side enabled results for all years to be examined simultaneously easily.

A limit to KDE is that whilst it is very effective as a visualisation tool for exploring the presence of possible 'hotspots' there is no statistical technique for evaluating whether these KDE 'hotspots' are actually hot (Ratcliffe & McCullagh, 1999). Local Indicators Spatial Association do offer statistical methods for assessing significance of clustering and these were the next technique applied to the data. KDE also only highlights 'problem' high areas but does not also highlight where there are very low concentration of vandalism. LISA allows analysis of both significant hot and cold spots. Methods used to detect spatial autocorrelation and calculate LISA are now discussed. (The same 100m by 100m Grid file generated by CrimeStat 3 for KDE was then cropped to the study area for use in the LISA analysis.)

3.10 Assessing Quantitative Data Testing for Spatial Autocorrelation and LISA analysis

3.10.1 Spatial Autocorrelation

As discussed section 3.7 one of the unique properties of spatial data is that they can be spatially autocorrelated. The data was tested for spatial autocorrelation using Moran's I, a commonly used global statistic. The statistic was calculated using the software OpenGeoDa (Anselin, 2006)[12]. It is important to test for spatial autocorrelation in data as the presence of spatial autocorrelation means data are not independent and this can violate assumptions that must be met for some statistical tests to be valid (O'Sullivan & Unwin, 2010, Haining, 2003).

Moran's I measures global spatial autocorrelation by assessing covariance between actual data (*i* units) for a given geographic unit (in this case Grid, OA or Datazone) and adjoining geographic units (*j* units). What is considered to be an adjoining geographic unit is set using weighting schema.

Cliff and Ord (1973) state the Moran's statistic as:

$$I = \frac{n \sum_2 w_{ij} z_i z_j}{W \sum_{i=1}^{n} z_i^2} \qquad (3.2)$$

Where, for the chosen study area, z_i represents a given value at location i minus the mean $(z_i - \bar{z})$, z_j represents a given value at location *j* minus the mean $(z_j - \bar{z})$. z is a variable which must be ordinal or higher. $\bar{z}$ is the mean of all values at all locations across the study area. The numerator will be positive provided z_i and z_j are both greater than or less than $\bar{z}$ (Haining, 2003, Lloyd, 2010, Cliff and Ord, 1973). W is a weight matrix, $\sum_2 w_{ij}$, calculated for all possible combinations of pairs of areas i and j in the study area.

The weight matrix records whether a location *i* and *j* are proximate (next to) to each other or not. Different types of weight matrices can be produced to measure this proximity in different ways. For example, location *i* and location *j* might be assessed as proximate because they are adjacent to one another, so they may be considered neighbours because they are contiguous (share a boundary), or they may be proximate because they are within a certain distance of one another. The Moran's I statistic allows a wide range of weight matrices to be used, with the choice of weights a decision for the researcher. Every row of the matrix represents a single location *i* (for values *i*=1 to *n*) and each value in the row indicates (in the most simple form) whether all other possible locations in the study area (for values *j*=1 to n) are a neighbour or not. For a simple binary contiguity weights matrix a location *j* might be given a value 1 if it is a neighbour to *i* and 0 if it is not a neighbour. Adding a simple binary weight matrix to the equation ensures that only locations which are considered neighbours are included in a calculation as the combinations of pairs of *i* and *j* areas are considered in turn. Weight matrices can be much more complex than this simple binary form (see Haining, 2003, 82-87) but, other than use of row standardisation, more complex weights were not used here. In OpenGeoDa, the

[12] OpenGeoDa is free open source software available from GeoDa Center for Geospatial Analysis and Computation https://geodacenter.asu.edu/projects/opengeoda (accessed 27 November2013).

package used in this research to calculate Moran's I, all weight matrices are row standardised so each row will sum to 1 and the total weight matrix sums to the number of observations. Values in the weight matrix are therefore 0 when an area is not a neighbour, and some fraction of 1 if the value is a neighbour. This has the effect that where weight are row standardised n / W will equal 1 (Haining,2003) which can simplify calculations slightly.

Equation 3.2 can be rewritten as:-

$$I = \frac{n \sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij} (y_i - \bar{y})(y_j - \bar{y})}{\sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij} \sum_{i=1}^{n} (y_i - \bar{y})^2} \qquad (3.3)$$

Where *n* is the number of geographic units; y_i is the value at location *i*; y_j is the value at location *j*; $\bar{y}$ is the mean of all values across the *n* geographic units. Note that $\sum_2$ (featured in equation 3.2) is alternately written as $\sum_{i=1}^{n} \sum_{j=1}^{n}$ (featured in equation 3.3) which is a double summation; this means that you start with the value *i* at location 1 (*i*=1) and the value *j* at location 1 (*j*=1), then consider the value *i*=1 and the values *j*=2 through all relevant values up to and including *j*=n. You then move onto the value of i=2 and it's relation to all relevant values of *j*, until all relevant values of i and j have been accounted for and so on (Lloyd, 2010, 55-56).

The observed value of Moran's I *O*[I] calculated, using equation 3.2 or 3.3 above, is then assessed by comparing it against the expected value *E*[I] of Moran's I which, for the equation above calculated as -1/ 1-*n* (Cliff & Ord 1973, Getis, 2010). *E*[I] is thus (dependent on *n*) usually small and negative; *E*[I] is usually just slightly below 0. *E*[I] will be smaller if *n* is large. *E*[I] is the value I would have if no spatial autocorrelation is present in the data, in other words if there were spatial randomness and independence. Significance is assessed by comparing *O* with an assumed distribution of all possible I values distributed around *E*[I] and testing against the null hypothesis *E*[I]= *O*[I]. Cliff and Ord (1973) demonstrate that this distribution can follow a normal distribution and this can be used to assess significance, however, significance for Moran's I is now usually assessed using Monte Carlo computer simulation (discussed below).

If *O*[I] is positive and significant compared with *E*[I] this is referred to as positive spatial autocorrelation. It follows from the equation above that this will occur where neighbouring areas (as defined by the weight matrix) are either similarly greater than the mean value or less than the mean value, and this occurs where a local area is positively correlated with neighbouring values. Where *O*[I] is negative and significant, this is referred to as negative spatial autocorrelation and indicates that a local area is negatively correlated with surrounding areas (see Cliff & Ord, 1973, p20 for an example). It is also important to note that since the statistic is based on deviations from the mean, values of Moran's I can also be skewed if there are extreme (high or low) outliers in the data which can lead to under- or over-estimation of the level of spatial autocorrelation (Fortin & Dale, 2005).

The weighting schema used in this research was a Queen weighting with a contiguity value of 1. This was chosen as it is a simple commonly used weighting schema (Anselin et al. 2006) and at the time the research was conducted there was no guidance on the weighting scheme to be used to consider the spatial distribution of crimes of vandalism. To understand what a Queen weight with contiguity 1 is, imagine a chess board and the Queen piece. If in figure 3.4, the Queen piece was at location *i*, it could move to any neighbouring location surrounding *i*, so for a Queen weight, all neighbouring grid squares immediately adjoining grid cell *i*, are considered neighbours. Contiguity 1 means that only the gird cells that have a border right next to i are considered. So for a given location *i*, the grid cells which completely surround the grid cell in all directions to a depth of one grid square, will be considered as neighbours and all other locations not neighbours, and in a simple binary weight matrix each of these would be given the value 1 and all other possible locations the value 0 (Figure 3.4).

0	0	0	0	0
0	1	1	1	0
0	1	*i*	1	0
0	1	1	1	0
0	0	0	0	0

Figure 3.4 Example of Queen Weight – squares adjacent to *i* labelled 1 and non-adjacent squares labelled 0.

Computing significance of Moran's I can be complex and has been a matter of some debate (O'Sullivan and Unwin, 2010, Anselin, 1995). OpenGeoDa, the software used here, uses a pseudo random Monte Carlo style permutation test to calculate significance. In this method, multiple computer simulations generate many sets of possible data values for the study area by randomly swapping data values around the study area (here 9999 permutations were used for all pseudo random testing), and these simulations are then used to calculate a distribution of multiple possible values of Moran's I for these multiple simulated data sets, centred around the expected value of Moran's I, converted to z scores. The observed value of Moran's I (converted to a z score) is assessed against this distribution and a significance value is generated allowing assessment of whether the null hypothesis, that the observed value is equal to the expected value of Moran's I, can be safely rejected. If the significance value for Moran's I is below a chosen level of significance (usually 0.05 is used) then the null hypothesis can be safely rejected, and the data can be said to have significant spatial autocorrelation. This pseudo random Monte Carlo method of generating significance, referred to as conditional randomisation in Anselin (1995); is preferred by Luc Anselin, one of the key authorities on spatial autocorrelation and LISA, and implemented in GeoDa, so it was felt appropriate to use this method for significance testing. An annotated screenshot example of GeoDa output for this permutation significance based testing is shown in Figure 3.5.

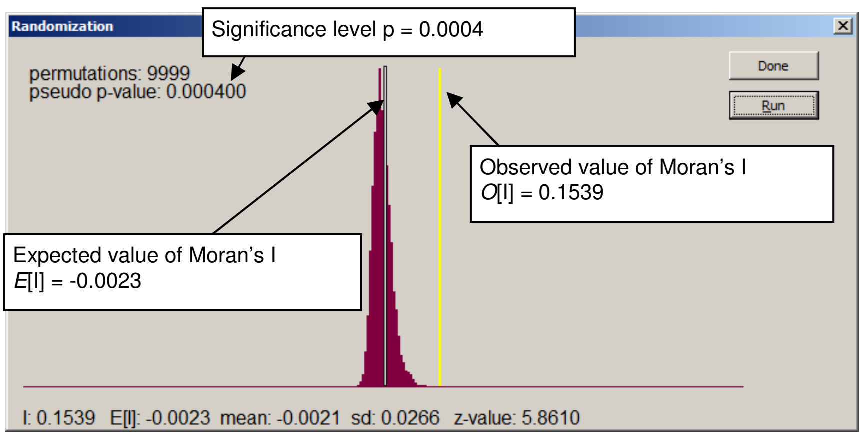


Figure 3.5 – Screen shot from GeoDa showing results of Moran' I test with significance calculate using a permutation test annotated to highlight observed and expected values

For calculating Moran's I for rates, a corrected version of Moran's I recommended by Assunção and Reis (1999) has been used which they call an Empirical Bayes Index (EBI). This is implemented in GeoDa (Anselin, 2006, Anselin 2008) and will be referred to as Moran's I with EB rates or EBI in results. EBI corrects for the issue that rates for areas with varying populations can have very varied levels of variance (this is also linked to the small number problem). Since the Moran's I statistic uses variance as part of the calculation, calculating Moran's I for raw rates where areas have varying populations can skew results and make it more difficult to calculate precise significance levels. The EBI statistic adjusts Moran's I for varying population size by equalising variances by replacing z_i with an adjusted z_i* value. (For the equations see further Assunção and Reis (1999) p2157, and Haining (2003) p246 Equation 7.16). This and other similar corrections rely on assumptions about the underlying spatial structure of the data which then influences choice of weights which may be arbitrary (Haining, 2003). However, it was felt that this correction was adequate for this research. Alternative more complex methods based on geo-statistics which make less assumptions about the underlying spatial structure of data are available (Goovaerts and Jacquez, 2006) but have only been recently developed for use in crime mapping (Kerry et al., 2010) and were outside the scope of this research.

3.10.2 Local Indicators of Spatial Association (LISA) – G_i and Local Moran's I*

Local Indicators of Spatial Association are based on disaggregating a global measure spatial autocorrelation but produce indicators to test whether a given area is more or less like its immediate neighbours. They make a virtue of the presence of spatial autocorrelation enabling testing of the degree of similarity or difference between local areas, providing a statistic for each local area which can show how like or unlike its neighbours it is. The values can be tested for statistical significance. Luc Anselin defines a LISA as any statistic satisfying two requirements:

> "a. the LISA for each observation gives an indication of the extent of significant spatial clustering of similar values around that observation; b. the sum of LISAs for all observations is proportional to a global indicator of spatial association." (Anselin, 1995. 94)

LISAs provide a way of seeing if hotspots are actually hot (Ratcliffe & McCullagh, 1999) but have the added advantage that the analysis will also show up statistically significant cold spots. Using LISAs was therefore ideal for examining if there were both high and low levels of vandalism present in the study area. Two LISA indicators were used in this analysis – G_i*and Local Moran's I.

G_i*

G_i and G_i* are LISA statistics based on Getis and Ord's global G statistic (Ord & Getis, 1992, Getis & Ord 1995). It has been found to be useful for assessing crime hotspots (Ratcliffe & McCullagh, 1999) as it can assign a level of statistical significance to clusters, and is again a recommended technique for crime analysis (Chainey & Ratcliffe, 2005). The simplest expression of G_i is:

$$G_i(d) = \frac{\sum_j w_{ij}(d) x_j}{\sum_j x_j} \quad \text{where } j \neq i \qquad (3.4)$$

$w_{ij}(d)$ are spatial weights, x_j are the values (e.g. crime counts) at location j. In G_i the *j* locations are defined as all area locations within a specified distance of an *i* location excluding *i* (as in Figure 3.4 above). G_i* is the same calculation but includes the i value as well as the relevant j. G_i and G_i*effectively calculate for a given local area the sum of all local values in the area, and then calculates what proportion the local sum is of the total sum for the area; if local values are high then G_i will be positive, if local values are low then G_i will be negative (O'Sullivan & Unwin 2010, Anselin, 1995). For vandalism then G_i* can give an indication of where there are groups of areas with significantly high levels of vandalism or groups of areas with significantly low levels of vandalism. It was therefore an ideal way of exploring if there appear to be areas with consistently high and consistently low concentrations of vandalism year in and year out.

Both the expected value of G_i and the variance can also be calculated, this enables calculation of z scores which allow significance to be assessed. Getis and Ord have developed more complex versions of the equation but the concept remains the same (Getis & Ord 1995, O'Sullivan & Unwin, 2010). ArcGIS 9.3 was initially used to calculate G_i*, this software provides uncorrected z scores.

G_i* is subject to the multiple testing problem in that each location *i* has it's own statistic so each location is being tested for significance, so multiple tests, equal to the number of areal units are being carried out. This means that the chances of a type 1 error, in this case wrongly assuming that a random process is not responsible for the cluster observed, increases, as the number of areal units being analysed increases. Thus a Bonferroni correction was also applied to the z scores generated (Ord & Getis, 1995, Ratcliffe & McCullagh, 1999, Chainey & Ratcliffe, 2005). Initially this was approximated from a figure in Chainey & Ratcliffe (2005) p170, and then later an exact Bonferroni corrected z score was used based on the correction α/n, where α is the required significance level and n is the number of observations, and α =0.05, along with the Sidak correction, $(1 - (1 - \alpha)^{1/n})$, as suggested by Anselin (1995). It has been argued that, rather than using z scores to calculate significance, pseudo significance generated through Monte Carlo simulation might be more reliable (Anselin, 1995, O'Sullivan & Unwin, 2010) as the Bonferroni correction is overly conservative and takes no account spatial autocorrelation in the underlying data (Anselin,1995). Two approaches were taken to allow for this, initially Gi* statistics were mapped with uncorrected z scores at significance levels of 0.05 in 0.01 and 0.001 in varying shades of grey form lighter to darker, with the darker grey representing the 0.001 significance, and the Bonferroni corrected z score for the 0.05 significance mapped in red or orange. When presenting maps to Police Officers it was explained that the grey shaded grid squares were likely to include some areas which were not actually significant, but that the red areas might be a too conservative approach and the 'reality' was likely to be somewhere between the two. Later during the research process a new release of the OpenGeoDa software allowed calculation of G_i^* using both z score and pseudo random permutation based significance methods (as per the calculation of Moran's I discussed above), so data was then re-analysed using GeoDa. GeoDa refers to these conditional randomisation methods for calculating significance as 'pseudo p' significance and this labelling is used from now on in this research. Initially G_i^* was calculated for aggregate counts of crimes of vandalism at 100m grid cell scale using a distance weight which was equivalent to a Queen weight contiguity 1 weight matrix, i.e immediately adjoining grid cells were assessed as being neighbours. Subsequently in OpenGeoDa a Queen weight contiguity 1 weight matrix was used to calculate G_i^* at Grid, OA and Datazone scales. The weight matrices used to calculate G_i^* were row standardised (weights were adjusted so they all sum to 1 at the end of each row in the matrix). At OA and Datazone scale the pseudo p significance based G_i^* analysis was run on both counts and SVR standardised rates.

Local Moran's I

Local Moran's I is a LISA based on Moran's I. Local Moran's I is expressed by the equation:

$$I_i = z_i \sum_{j=1}^{n} w_{ij}\, z_j, j \neq i \qquad (3.5)$$

Where z_i and z_j are deviations from the mean (Anselin, 1995, Lloyd, 2010). Anselin also provides an alternate equation where z_i is divided by a constant m_2 where $m_2 = \sum_i \frac{z_i^2}{n}$. The I_i statistic is often more widely reported in this alternate version (see Getis, 2010, 270, Fortin and Dale, 2005, 154, Lloyd, 2010, 111).

Local I_i is positive when either high or low values are near each other and I_i is negative when high values are next to low values or vice versa (Anselin 1995, O'Sullivan & Unwin, 2010,). Since the value of I_i does not provide a method of distinguishing between whether there are neighbouring high next to high or low next to low values Anselin recommends using the Moran Scatterplot to do this (Anselin, 1995, Anselin, 2008). In the Moran scatterplot plot the horizontal *x* axis is the variable being analysed (e.g. counts of vandalism) and the vertical *y* axis is the spatially lagged version of that variable, that is to say, the average of values at neighbouring locations (Anselin, 2008, 112) where neighbouring locations have been defined through a weight matrix. The four quadrants of the scatter plot can then be used to identify which areas have high values next to high values, low values next to low values, high next to low values, and low next high values. The scatterplot does not provide any measure of significance. It is recommended a pseudo significance Monte Carlo type simulation procedure is then carried out to determine which local areas have significant high-high, low-low, low-high and high-low local I scores (Anselin, 1995, Lloyd, 20010, O'Sullivan & Unwin, 2010). Significance is calculated by comparing the observed value of I_i with an expected value of I_i with reference to a distribution of multiple possible I_i values calculated using a Monte Carlo permutation type process (similar to that described in section 3.10.1 above). OpenGeoDa automates this process, making it simple to do, for any set of aggregated values in a geographic dataset. OpenGeoDa provides a Moran's I scatter plot, visualises the results in map form showing the high-high, low-low, high-low and low-high I_i values and a map of statistical significance. OpenGeoDa allows the I_i values, the cluster type and significance level to be saved as additional variables alongside existing data. (OpenGeoDa requires data to be in the format of geographic data files formatted for ArcGIS software - shapefiles - as the main form of input file; data can also be saved out in this format and mapped in other packages, such as ArcGIS, which was done here.) Local Moran's I was calculated for data at Grid, OA and Datazone scales. An example of a Moran Scatterplot, and how it is used to provide additional information on Local Moran's I, using the research data, is given in Chapter 4. At Grid level Local Moran's I analysis was run on count data, at OA level Local Moran's I was calculated for both Counts and Rates.

As calculating Moran's I and Local Moran's I on raw rates can lead to misleading results (Anselin, 2008, Assunção and Reis, 1999), due to the small number problem and large variation in variance, Local Moran's I was calculated for counts and SVR rates at OA level, as well for rates as using the Local Moran's I Empirical Bayes (EB) method available in OpenGeoDa (Anselin, 2006). The SVR based calculations Local Moran's I were run, in addition to the EB method, as this method was simpler to explain to the Police Officers, as they were also already being shown maps of rates calculated as an SVR. (In practice results for Local Moran's I, calculated using SVR, were found to be near identical to results produced using EB method for this data). Both Local Moran's I EB maps and Local Moran's I SVR maps were produced, but only the Local Moran's I SVR maps were used with focus groups. The only correction used to counter the small number problem, for count data, for Local Moran's I, was the use of multiple permutations to calculate significant levels (see below). There were no other corrections for extreme values and uneven levels of variance, so this may have skewed results. Like G_i*, as significance tests are done for each of *n* values, Local Moran's I also experiences the multiple testing problem and this was accounted for by using conditional randomisation and producing several runs of multiple permutations of maps when assessing significance as recommended by Anselin (1995) and implemented in OpenGeoDa (see below.)

Local Moran's I was a particularly useful tool to use as it not only allowed identification of high and low areas as G_i* does, but also enabled high areas next to low areas and low areas next to high areas to be identified. It was a very useful complementary analysis to look for high and low levels of vandalism to run alongside G_i*. By running two different types of LISA statistic it was also possible to check whether areas that appeared to have high and low levels of vandalism were consistent regardless of the slightly different statistical methods used to consider this. This reduced the likelihood of areas being identified as high or low vandalism areas due to artefacts from the statistical methods used alone and the problems of statistical noise due to the effects of the small number problem and multiple testing problem.

For initial analysis comparison sets of 6 maps per A4 page (one map for each year of the study period on a single year) were produced for both G_i* and Local Moran's I. This enabled side by side comparison of significant high and low levels of vandalism across the study period, so assessment could be made visually to see whether the significant high and low levels occurred in the same places year on year or if there was variation across time. G_i* standard z score based significance maps were produced with Bonferroni correction just at grid level as it was intended they would be directly compared with the A4 6 maps per page grid based KDE maps, this was consistent with existing methodologies in use for hotspot mapping (Ratcliffe & McCullagh, 1999; Chainey & Ratcliffe, 2005) and allowed testing to see if G_i* maps appeared more useful visually for detecting important hotspots than KDE maps. Local Moran's I maps were produced at Grid, OA and Datazone level as this was very easy to do within the automated procedures within GeoDa. Later when OpenGeoDa automated procedures for pseudo significance testing for G_i* these maps were also produced at Grid, OA and Datazone level using this method of significance testing.

By producing maps at different scales using the same methods with the same data, it was possible to assess visually if scale had an impact on which areas appeared to have high or low levels of vandalism. In this way both the actual presence of high and low levels of vandalism was assessed as well as the impact using different scales and visualisation techniques. For pseudo significance based maps, several versions of the same map were produced using 9999 permutations to check for stability of significance values. Using multiple maps, produced for multiple years using multiple techniques, also made it more likely that areas that were just appearing to have significantly high or low levels of vandalism due to statistical noise, due to the small number or multiple testing problems, might be more likely to be spotted. However, a key limitation remains, that since all the techniques above do not completely correct for these problems, there still remains a possibility that some values in the maps may be due to statistical noise. A recent paper suggests that factorial kriging methods might provide an more effective way of calculating a Local Moran's I, and highlighting local crime concentrations, while better correcting for the small number and multiple testing problem (Kerry et al , 2010). Anyone undertaking this type of analysis in the future should consider using this technique alongside more commonly used techniques such as KDE, or G_i* and Local Moran's I as implemented in GeoDa.

3.11 Assessing Quantitative Data - Visualising and Analysing Socio-demographic Data

The same methods as discussed above in section 3.9 were used when visualising socio-demographic data. Since the business and residential address data from the Gridlink dataset (numbers of business addresses and residential addresses per postcode) were not pre-aggregated to set scales, this data was transferred into an Access database to facilitate aggregation. Address and business postcode locations were joined to the same 100m by 100m Grid cell boundaries developed for analysis of the crime data using ArcGIS. As the Gridlink product already provided associated OA and Datazone for each the postcode it was not necessary to derive this using GIS. Some additional methods were employed to derive locations of schools and parks and in assessing the demographic mix of the area.

Residential and business address data was aggregated to Grid, OA and Datazone level using the snapshot data from Gridlink for May 2004 to May 2010. This meant that there were 7 years separate sets of residential and business address data running from just after the start of the study period on 1 April 2004 to just after the end of the study period on 31st March 2010. Again by creating multiple maps that could be viewed simultaneously it was possible to assess overall trends, and to see whether there was a similar level of stability or change in address data to levels of crime. It was expected that the crime data might exhibit a lot more volatility than the address data (unless parts of the study area were being substantially demolished, rebuilt or redeveloped), as vandalism is done by people who move around whereas buildings are inherently stable objects. Mapping address data in a similar and complementary way to the recorded crimes of vandalism data was very useful as it could provide a benchmark of what visualisations of a stable process looked like in the study area across the study period which could then be compared with crime levels. Mapping with residences and businesses also allowed for visual assessment of how much the presence of hotspots or coolspots of crime in certain areas might be just be due to high or low concentrations of residential addresses.

The locations of schools and recreation areas were derived from a single time point at the end of the study using Ordnance Survey 2010 vector maps. This decision was made after other exploratory analysis and evidence from focus groups suggested that there had been little change in the position of parks and schools over the study period, but also because this was the first time period for which open-source map data with significantly less copyright restrictions had been made available. The Ordnance Survey data provided point locations of schools, these were then used to select which grid cells and Output Areas were within 100m of a school using ArcGIS distance based selection methods. A single point location was also provided for recreation areas and parks, and this was initially used to select Grid cells and OAs within 100m of a park. However when the grid cells and Output Areas selected were overlaid over a map showing locations of schools and parks, the method was successful for schools and parks at OA level, but only functioned for schools at Grid level. Grid cells were then overlaid over an Ordnance Survey map showing borders of recreation areas as green space and green space areas containing a park recreation point were assumed to be park areas and all grid cells within this area were manually selected.

Finally with population data in order to look at demographic mix across the study area, individual population pyramids were constructed for each Datazone within the study area for the first year of the study period 2004, and the last year of the study period 2009. This enabled comparison of two time points at the beginning and end of the study period. Population pyramids can be used to give an indication of population structure in an area, for example whether a population is mainly older people, mainly younger people or a mix. The population pyramid shapes for each Datazone were considered in turn visually, and then grouped into groups of similar shapes representing Datazones with similar population structures through visual assessment. This was then used to classify Datazones into a particular population structure type, where a specific structure of old and young appeared present. This was a very exploratory technique, but allowed consideration by comparing these population structure classifications alongside maps of high and low vandalism areas within the study areas, to see whether any of these high or low crime areas appeared to have a particular population mix. This allowed some exploratory consideration of whether a mix of older and younger people, as opposed to mainly older or mainly younger people had any apparent relationship with high and low levels of crime.

3.12 Gathering and Assessing Qualitative Data – The Focus Groups

Following initial analysis of recorded crimes of vandalism and socio-demographic data the next step was to conduct focus groups with Police Officers who worked in neighbourhood policing within the study area. This involved developing a new and innovative methodology for gathering data about high and low crime areas. This section explains how these focus groups were conducted, then explains the rationale and research sources that were used to develop the methods used, and finally briefly discusses the how focus group were analysed.

3.12.1 Order and structure of focus groups

Focus groups were organised by approaching Senior Officers and arranging a time to run the focus group with Senior Officers first, and then more junior Officers. Since the police service is a strictly hierarchical organisation it was felt appropriate to hold focus groups with Senior Officers first. This enabled more Senior Officers to know what the process was their more junior Officers were being asked to be involved in. Having experienced the focus groups the Senior Officers were happy to authorise running focus groups with more junior Officers. They also tasked an Officer to get other Community Police Officers to volunteer to take part in focus groups. Following the initial pilot focus group which was held within a Senior Officer's office, focus groups were held in a meeting space within a local police station within the study area so it was easy for local Officers to attend. It was also a safe and secure place. It was not possible to access the room without official police authorisation as it was within the police station. This may have encouraged Police Officers to be able to be frank about their perceptions of local areas. The police were asked to allow a period of 90 minutes for focus groups to allow time for discussions to develop. [13]

The process of the focus groups proceeded as follows. The researcher introduced herself and introduced the research. The researcher gave each participant information about the research, explained that participants were free to leave at any time, and invited them to sign the consent form, this included them giving consent for recording of the focus group. Recording of the focus group began after introductions so that names of participants were where possible excluded from the recording. Using a semi structured approach Officers were then invited to discuss their perceptions of where high and low levels of vandalism were in the area and to shade these in on a paper map using different coloured highlighter pens. The question themes the researcher used to provide the structure are given in Appendix 4.

[13] To thank participants I also brought along high quality biscuits which were left with participants after the focus group ended. Tea and coffee were also provided by the police station.

The paper map was a large A to Z style scale map on which all street names were given as well as key features such as parks and schools to ensure that Officers could use this map to identify areas they were familiar with, but also so the annotations they made could later be converted to digital form. A separate paper map was used for each focus group. Officers were asked to label the areas shaded with letters or numbers so when they referred to them at a later stage which area they were referring to could be identified via the audio. Once high and low areas were identified, Officers were asked about what they perceived the characteristics of these areas to be specifically prompting them to describe the people in the area, the physical layout and community.

Officers were then shown maps of the crime data for the area. This began by showing them a single map using KDE style hotpot mapping and checking they were familiar with this, before moving on to G_i* maps and Local Moran's I maps (labelled LISA maps) and explaining how these were extensions of KDE but allowed high and low areas to be specifically highlighted. Also made available to them were the 'six-up' – 6 maps per A4 page - maps. KDE and G_i* maps were shown at Grid level to be compatible with hotspot maps they were likely to be used to. The Local Moran's I maps were produced at OA level as initial exploratory analysis had shown that this was the scale at which these best showed up low areas of vandalism. Maps in each style and for each year were also printed on acetates so they could be overlaid over a 1:50,000 Ordnance Survey map of the area so Officers could identify referencing this, and the large A-Z paper street map, where locations highlighted by the crime maps were.

As Officers were shown these maps, it was stressed that their perceptions were not being tested in anyway, the researcher was just inviting them to comment on the high and low areas identified in the crime data maps, and then consider how these compared with the maps they produced. Officers were not asked any specific questions about their views of quality of recorded crime data, although the format of the focus group was flexible enough that they could raise this issue if they wished. Officers were then asked to comment on characteristics of any additional high and low areas identified by the crime data maps not present in their own maps. Finally the Officers were invited to comment on how patterns of high and low vandalism appeared to change or remain stable across the study area, and why they thought this might be.

The focus group structure was therefore specifically designed to treat Officers involved in Neighbourhood Policing as people with a respected level of specific knowledge and expertise about levels of vandalism in local communities in a non-threatening environment. Officers were invited to share this knowledge and expertise with the researcher, just as the researcher shared her knowledge and expertise by producing crime maps from their data for them to comment on.

The researcher claimed no knowledge or expertise about the local area. Officers taking part in the focus group were colleagues reasonably comfortable talking in front of one another. To ensure this was the case, a deliberate decision was taken to ensure that only Officers of a similar rank would be in each focus group. Three focus groups were held in total, one with senior Officers covering the whole area and then one for each of the two Neighbourhood Partnership areas within the study area.

3.12.2 The concept of talking to the map

Although the methodology developed above is new and innovative it was closely based on the participatory GIS based tradition in research, getting local people to use maps when talking about their understanding of their local area. The methods were also directly influenced by, and built upon, existing research from criminology and geography where Police Officer's perceptions marked on maps have been combined with analysis of recorded crime data. These methods have all in various ways invited people to talk to the map.

Three main sources were used to develop methodology. The first was work by Ratcliffe & McCullagh (2001) asking Police Officers to predict where they believed crime might occur and then checking these predictions against actual crime hotspot maps (Ratcliffe & McCullagh, 2001). Ratcliffe & McCullagh's research got Officers to identify locations of crime hotspots on street maps. It found Officers had no difficulty in doing this, but also found that correlation between Officer perception and empirical levels of crime hotspots (based on analysis of police crime data using G_i*) was very variable. Small focus groups were then run to consider possible reasons for the difference. As in this research Senior Officers were used to recruit more junior Officers to the research and focus groups were carried out at police stations. The research clearly suggested that Police Officers have a good understanding of levels of specific crime in areas they police and are easily able to comment on this in map form. The second source of inspiration for the method developed was the work of Massimo Craglia, Robert Haining and Paulo Signoretta on actual and perceived High Intensity Areas (HIAs) of crime in Sheffield (Craglia et al, 2005, Haining, 2007). In this research they compared actual levels of police recorded crime in small census based geographic areas which spatial data analysis suggested were HIA areas, with police perceptions of where HIA areas were at Census ED level (a small area geography similar in size to the Scottish OA). This research concluded that both police perceptions and modelled quantitative data may be important in understanding areas where there are high concentrations of crime especially when a particular local context might impact on potential levels of crime. The final source used to develop the research method was the work of Steve Cinderby in the Participatory GIS tradition who has successfully obtained useful data about perceptions of local areas by getting local residents to annotate maps by annotating them to show areas where they were concerned about crime levels, and then obtained very useful data about resident perception of these areas (Cinderby, 2009). In particular, in research in Salford, Cinderby made use of large scale street and aerial maps and got local residents to use numbers, stickers and flags and then write comments about each sticker they had added enabling comments to be later matched with areas and analysed by theme. A general textbook was also used to provide guidance on organising focus groups (Bryman, 2008) and advice sought from Dr Anna Souhami based at Edinburgh University with particular expertise in doing research with the police[14].

3.12.3 Focus Groups - Analysis

Focus group recordings were listened to and relevant sections partially transcribed very quickly after they had taken place. The hard copy maps were also digitised using ArcGIS 9.3 and were also photographed so images on the hard copy maps could be referred to during analysis of the focus group material. A thematic analysis process was used whereby key themes about the characteristics of areas were identified and then relevant quotes arranged under these themes. These themes were then reconsidered in light of their relationships to existing theory on crime and place, and the focus group material then considered again to ensure all relevant themes had been considered.

3.13 Group Trajectory Analysis

The final method of analysis employed was group trajectory analysis. Following consideration of the material from the focus group and also exploratory analysis of vandalism crime data it was clear that there appeared to be some areas with low levels of vandalism and others with varying but high levels of vandalism (the results confirming this are reviewed in chapter 4). However, none of the methods employed to this point provided anyway of empirically assessing whether there were clear separate trends between high and low areas. A method was therefore sought that could assess with a degree of statistical significance if there were different groups of areas which had high or low levels of vandalism. The method chosen was Group Trajectory Analysis, a form of Latent Class Analysis and a method that has been comprehensively employed within developmental criminology (McAra and McVie, 2012) and more recently used to look at differing trajectories of crime places across street segments in Seattle (Groff et al, 2009, Weisburd et al, 2011, Weisburd et al, 2012). The technique has been particularly

[14] I am very grateful to the advice I received from Dr Anna Souhami taken from her experience working in this area which contributed particularly to ensuring that police officers did not feel as if they were being evaluated during the research process.

developed by Nagin (Nagin, 1999, Nagin, 2009) and provides a method of finding distinct statistically significant groups who follow different trajectories across a number of years within a single data-set. It can be used with both count data and categorical data.

The method was selected as exploratory analysis suggested that there were at least three distinct groupings within the data: high, low and other. Group trajectory analysis would provide a method of identifying which areas fell into which of these group. However it was also possible there might be more than one type of high group or more than one type of low group; group trajectory analysis would also potentially enable differing sub-groups of high and low areas to be identified. The method is particularly useful where there is no existing theory to suggest what existing groupings of trajectories might be for a given crime in a given location (Weisburd et al, 2012) as was the case with this research. Group trajectory analysis produces probabilistic groups, in other words it will tell you which areas are most likely to be in which group, and therefore has sometimes been criticised for a lack of certainty in its findings (Osgood, 2010, see also McAra and McVie, 2012). However, others have argued that this does not prevent it being a very useful exploratory tool (Weisburd et al, 2012).

3.13.1 Count based models

The package Mplus was used to run the group trajectory models[15]. It comes with a very comprehensive manual that includes examples of different styles of models (Muthen & Muthen, 2010). The first type of models run were count based models. Count based models have previously been used for analysis of crime data across areal units (Weisburd et al, 2012). Two types of count model were likely to be most appropriate to crime data because it contains a high level of 0 counts. One is a zero inflated Poisson model, the other a negative binomial model (Hilbe, 2011). Mplus offers both types of model so both were tried and compared. Models were run also run at two scales to check for MAUP effects, Grid and OA. There were less than 100 Datazones within the study area and it was felt this small a sample might be insufficient to generate valid results. Trajectories across the six years of the study period were analysed using the aggregate data for each year analysed in the exploratory analysis already undertaken. Models were run assuming that linear, quadratic and cubic trajectories were all possible (as this provided the best fit). Best fit was assessed in accordance with Adjusted Bayesian Information Criterion (BIC) scores. Models were run starting with assuming there was only one group with data, and then the number of groups being tested for was incrementally increased until the best fitting model was found. This meant it was always necessary to run at least one additional

[15] I am very grateful to Dr Paul Norris, University of Edinburgh, for offering me brief training sessions in Mplus and getting me started in Group Trajectory modelling and for suggesting use of categorical models when I had errors in the count based models.

model beyond the best fitting model obtained. Once the best fitting model was found, additional statistical measures of significance were run to check that the apparent best fit model was significantly better than the model with one less distinct group.

Count models were run for the study period data divided into the annual groups. When the models produced interesting and useful results the method was then also applied to investigate if there were stable trajectories in each year for hours within the day (using 4 hour groups to avoid very small counts), across days of the week, and the months of the year (using 2 month blocks).

At the OA scale it was also important to run trajectories on standardised data due to the large difference in the physical size. Previous studies of trajectories across crime and place have not considered how to treat rate data so a methodology had to be developed. Continuous group trajectory models in Mplus assume a normal distribution, and the data was not normally distributed so these could not be used. Simple transformations of the data did not solve this problem. Instead both raw rates and Standardised Vandalism Ratios were converted to counts by multiplying the values by 10 and then rounding which allowed both Poisson and Negative Binomial count group trajectory model methods to be used. These methods produced valid results but generated errors; in particular standard errors were not always robust so a different method was sought for the analysis of rate data.

3.13.2 Categorical models

The solution to continuous and count based group trajectory models being inadequate was found by converting the rates to categories and using categorical based modelling. Group Trajectory Models are a type of latent class modelling, a technique initially developed for finding whether there were distinct groups of respondents to the same survey who answered a set of questions with categorical answers in similar ways within their group, and also if there were also distinct groups of respondents who each answer a set of categorical questions in a similar way. This type of grouping of distinct sets of respondents who answer sets of categorical questions in similar ways is particularly useful in fields such as psychology where Likeart style scales (e.g. give a rating of 1 to 5 where Not Likely is 1 and very Likely is 5) are frequently used (Nagin, 1999).

In this research the groupings of categories were from low levels of vandalism to high levels of vandalism, and the set of questions was a set of years. The results for each year can be thought of as an answer to a series of questions one for each year where it asked in this year rated from 1 to 5 levels of vandalism in the area, where the lowest levels of vandalism were rated as Low (1) and the highest level of vandalism rated as High (5). Standardised Vandalism Ratios (SVRs), already calculated for exploratory analysis, were used to apportion the results for each year into one of 5 categories. Categories based on SVR ranged from the bottom category - OAs where levels of vandalism were less than a quarter below the expected level of the study area, to the top category – OAs where levels of vandalism were more than four times the expected level for the study areas as a whole. These categorical models were found to perform much better, with far fewer errors, than the raw rate and SVR rounded count models so were preferred. Latent class models provide details on what proportion of each category falls within in each trajectory group for each year analysed. These proportions were charted for each group to identify whether a group was comprised mainly of, for example, low areas, high areas or some mix of high and low.

3.13.3 Group Trajectory Analysis Limitations – The issues of spatial autocorrelation and small numbers

An additional concern with using group trajectory modelling is that like many other statistical techniques it assumes the data points are independent; they are not in some way autocorrelated. However, since in spatial data there is often positive spatial dependency, where neighbouring data often has similar values to neighbouring data, as discussed above, this assumption was breached. This spatial dependency was accounted for in two ways. The first way was to check to see if the level of spatial auto-correlation in the data as measured by Moran's I. As chapter 4 shows, both at Grid and OA level Moran's I statistics were significant, but the value of I was generally quite small, around 0.3, so an assumption was made that spatial autocorrelation was relatively weak, (as per O'Sullivan and Unwin, 2010 who suggest values of I of 0.3 or less can be considered weak). Although it is also possible some of the values of Moran's I may also have been skewed by large variance, a large number of 0 values in the data, and the scales and zones used to analyse the data, so this assumption may have been misplaced. Secondly the categorical technique was again used with both Grid and OA data this time using categories based on G_i* analysis (calculated using OpenGeoDa with pseudo p significance – see section 3.10.2) where data were assigned to one of three categories, Significant Low areas, Significant High areas and Non Significant areas. Results from these G_i* based categories were then cross referenced against the Grid based count results, and the SVR OA categorical results. Using G_i* as a category explicitly recognised spatial autocorrelation in the data in advance of group trajectory analysis, but, other than the fact that repeated runs of the multiple permutation process had been used to derive the significance levels in maps, it did not control for the fact that some of the areas falling into high and low categories may have done so just due to statistical noise or artefacts in the data (the multiple testing and small number problems). Using G_i* based categories also did not correct for the fact that the categories themselves were derived from the spatial structure within the data and therefore the data were not independent – as group trajectory analysis assumes. It is important to note that both the assumption that spatial autocorrelation was weak, and that G_i* categories might help understand levels of spatial autocorrelation in the data when used for group trajectory analysis, were very simplistic assumptions and did not resolve the problem of spatial autocorrelation.

An additional problem for group trajectory analysis is the small number problem. Group Trajectory Analysis groups together areas with similar high or low values. However, it does not take account of the fact that if the small number problem is present some of the extreme high or low values are effectively artefacts caused purely by high levels variation occurring between areas, just because the counts are small, and/or where area denominators varied in size which where the denominator was small as was the case for OAs. No specific correction was used here for the small number problem. This meant that some areas grouped into extreme high or extreme low groups could have been placed in these groups purely due to the small number problem and not because they actually were areas with particularly high (or low) levels of vandalism. Using SVR categories will have helped to reduce extreme values slightly but is a simplistic method which failed to fully correct for the problem.

To resolve the issues of effect of the small number problem and spatial autocorrelation on Group Trajectory Analysis requires additional research. Towards the very end of this research, a paper was released that may provide a method of examining trajectories which specifically controls for spatial autocorrelation and also seeks to address the small number problem. Law et. al. (2013) specifically highlight that group trajectory analysis fails to correct for spatial autocorrelation or the small number problem. As a solution they use a Bayesian approach which is able to borrow strength through both time and space and specifically allows for the underlying spatial structure of the data being analysed. However, their approach analyses just two years and also assumes linear trajectories, for non-linear trajectories they suggest that spline regression may provide a solution.

3.14 Getting at the Why

All the methods considered so far provided a way of assessing were there actually high and low levels of vandalism, enabling the research questions: are there areas (places) that experience high and low concentrations of vandalism year in and year out? do concentrations of vandalism change over space and time? and are there any particular patterns that appear to exist? The methods outlined above also enabled investigation of he value of using an Exploratory Spatial Data Analysis methodological approach to examining research questions related to crime and place. This considers how ESDA techniques and qualitative techniques including ideas from qualitative GIS might be used to better research crime and place, and understanding the necessity of exploring multiple spatial and temporal scales in crime and place research. The results which answer these questions are considered in chapters 4 and the first section of chapter 5.

However, these methods whilst very good for highlighting differing interesting patterns did not of themselves get at why these patterns might persist. To understand this required an answer to the following question: - do places which experience either low or high concentrations of vandalism over time appear to have any common features or shared characteristics? Two main methods were used to obtain an answer: exploratory analysis of factors which might influence which areas were members of which trajectory groups and the integration of ESDA and focus group results.

3.14.1 Exploratory analysis of factors influencing membership of Trajectory Groups

Once distinct high and low groups had been established through group trajectory analysis in Mplus, additional explanatory indicators for a single time period could be added in to the analysis to assess those which might be influencing which areas fall within which trajectory group. Mplus allows two ways in which this might be done: a) examining if the means of the explanatory indicators for each of the distinct groups are significantly different, and b) conducting multinomial logistic regression. Both were used here.

Typically in multinomial logistic regression the dependent (outcome) variable is a categorical variable with three or more categories and the independent (explanatory) variables can be continuous or categorical variables. In multinomial regression one of the categories of the dependent variable will be treated as a reference category (e.g. Category A), model results then report which explanatory factors under consideration significantly influence why data fall into the group Category B compared to Category A or why they are in group Category C rather than Category A, however software packages vary in the how they decide which of the categories should be the reference category. Mplus has the advantage that it makes no assumptions and instead automatically conducts a series of multinomial logistic regressions treating each of the distinct latent class groups identified as the reference category in turn. Results are slightly limited since for each regression undertaken, Mplus only gives results for significance of the explanatory independent variables not the level of variation the regression explains. Mplus calculates significance by using a pseudo class draw method (Muthen & Muthen, 2010). It was felt that this was sufficient as it was intended that the models be exploratory only, not confirmatory, and the primary interest was in which indicators had potential explanatory power rather than the predictive capability of the model.

A further key limitation of the logistic regression analysis used here was that it failed to take account of spatial autocorrelation in the data. Multinomial logistic regression assumes that cases are independent, however, if there is spatial autocorrelation in dependent or independent variables this assumption is likely to be breached. If the assumption of independence is breached is can cause over-dispersion in the errors which can limit standard errors and potentially lead independent (explanatory) variables to be found significant when in fact they are not (Field, 2009); as no corrections were made for spatial autocorrelation in the multinomial logistic regression analysis this could have occurred in this research. An additional assumption in multinomial logistic regression is that explanatory variables do not have a high degree of multicollinearity, i.e. they are not correlated with one another. If the explanatory variables are spatially autocorrelated, this may then lead to multicollinearity, and thus bias in the results. Here the assumption was made that the degree of spatial autocorrelation (and potential multicollinearity) in the data was not sufficient to bias results, however, a key way to check for this is to repeat the same model but also correct for spatial autocorrelation within the model structure and this was not done here. Anyone doing future research in crime and place using multinomial logistic regression is recommended to consider also running multinomial logistic regression models which correct for spatial autocorrelation; for examples of these see Haining, (2003. The results of the multinomial logistic regression analysis are discussed in chapter 5. Results of multinomial regression were also cross checked with information from focus groups and other ESDA to see if this information supported the regression findings.

3.14.2 Integrating focus group results and ESDA

The second way in which factors might be influencing which areas had high and low levels of vandalism were assessed was much more qualitative. Using the thematic based initial analysis of focus group material, the comments of focus groups were then revisited and reconsidered in the light of results from the group trajectory analysis and the patterns of high and low vandalism across the study period identified through the LISA analysis, along with visualisations of socio-demographic data produced for the study area and the multinomial regression results. The results of these multiple methods were then combined to tell the complex stories of vandalism and place across the study region by considering each of the two neighbourhood partnerships in the study area in turn and particularly focusing on selected locations highlighted by focus groups as having high or low levels of vandalism. The results of this multi-method ESDA approach to understanding vandalism and place are presented in chapter 6.

The Results Section – Chapters, 4 5 and 6

In this Results section I shall look the at the findings across the case study areas as a whole. There are then a number of distinct patterns within the case study area and I shall review these by looking at the overall case study area in two sub-sections and then comparing and contrasting these two sections in the next two chapters. Figure 4.1 shows these two case study sub-areas EdinburghA and EdinburghB within the overall case study area. In the Figure, only recreation areas and schools within the study area or bordering the area are highlighted. Much of the case study is self contained with greenspace/ unsettled areas forming natural boundaries; there is an exception to the North West of the area in grid squares B1 and B2. The self contained nature of much of the case study area therefore limits the potential problem of edge effects – an artificial boundary not representing an actual boundary.

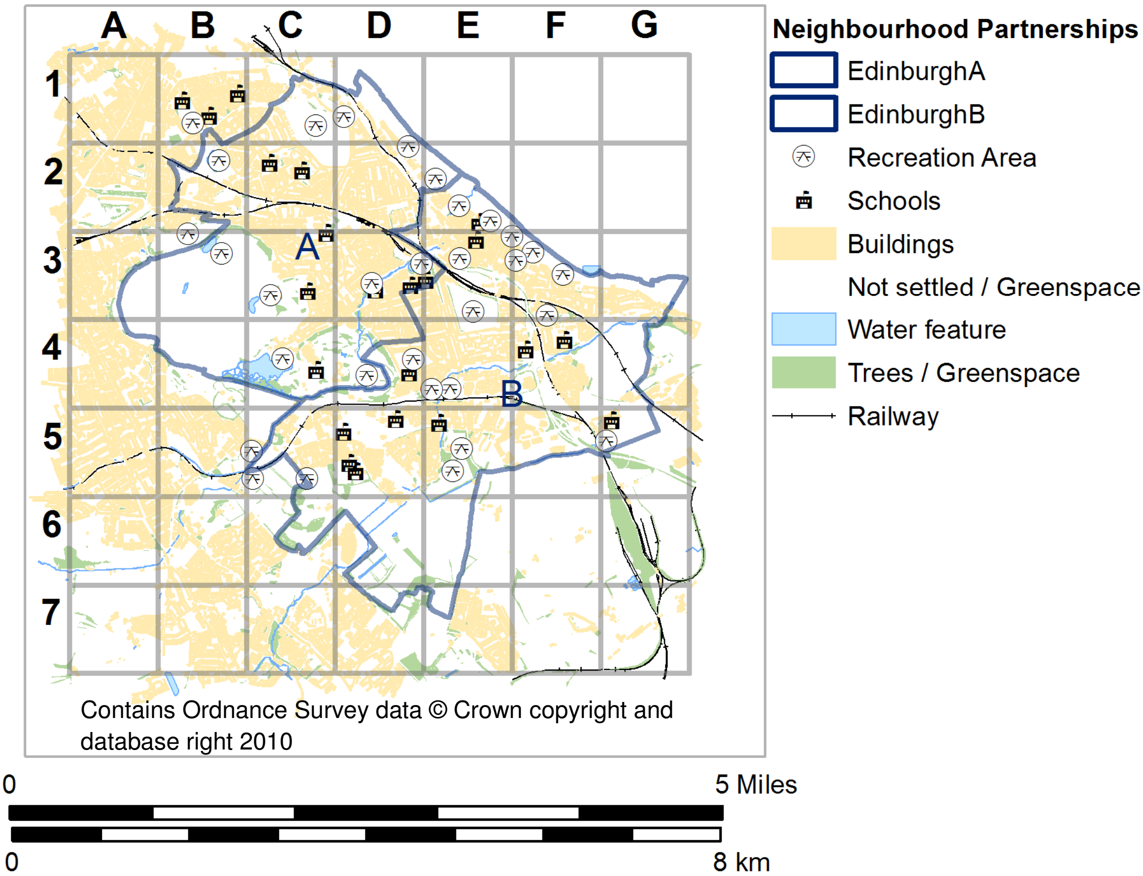


Figure 4.1 – Case Study Area – divided into EdinburghA and EdinburghB

The labelling and shading of the above map is derived from Ordnance Survey open source street view vector map information. Specific areas are not labelled to simplify the map and partially anonymise the area. The railway is highlighted particularly as this is a natural barrier that has been in place for many years, indeed historical maps show the railway present before many of the buildings were developed. Much of the case study area contains post-war (1950s and later) housing though some of the properties are much older, whereas the railway is present on maps from the 1850s and beyond.

Chapter 4, which follows, begins by summarising themes from results that are common across the whole area highlighting key patterns of recorded vandalisms that are observed. Chapter 5 looks specifically at stability and change over time as explored through Group Trajectory Analysis including some explanations for these changes across the whole study area. Chapter 6 then look in more detail at the potential explanations of why some areas experience different levels of vandalisms to others.

4 Exploratory Spatial Data Analysis of Vandalisms – Key Findings and Some Methodological Challenges

4.1 Introduction

This chapter looks at some key themes with particular methodological relevance and also describes the overall patterns across the case study area. These themes are firstly clustering and spatial autocorrelation –this section presents evidence that vandalism across the case study area show statistically significant clustering. The second theme discusses how there were distinct high and low areas of vandalisms year on year – but also that police recorded crimes of vandalism were generally rare events in most areas occurring perhaps only one or two times a year. The third theme discusses the importance of scale, and how the different scales used both highlighted the existence of the modifiable areal unit problem with this data, but also how different processes might be highlighted by different scales. The fourth theme presents a brief note on the impact of standardising data. The chapter ends with a brief note highlighting the complexity of vandalism and why this requires additional analysis using results from group trajectory analysis and focus groups.

4.2 Clustering and Spatial Autocorrelation

A first step in analysing the data was to check the presence of clustering; **both Nearest Neighbour clustering and analysis using the Ripley's K technique confirmed that there were significant clusters of vandalisms**. In both cases the analysis demonstrated that, whilst clustering can occur due to random effects, that was not the case here and you could be at least 95% sure that you were not making a mistake in assuming that vandalisms tended to cluster together across the study are in each year analysed, that is to say the location of vandalism distributed in such a way that distances between cases were smaller than might be expected if the distribution was just due to chance (significance of at least 0.05%). Table 4.1 shows Nearest Neighbour Index results for the recorded vandalisms data Vandalisms and Fire-raising – VFR - (a sub-set of the Group4 crimes originally supplied including only crimes related to smashing, breaking, writing on, setting fire to or otherwise damaging things – the crimes of vandalism, malicious mischief and fire-raising).

Table 4.1 – Nearest Neighbour Indexes for Group 4 Vandalisms counts by years for study area

	All Vandalisms and Fire-raising (VFR)	
	NNI	Sig. (p)
2004/05	0.3279	0.0001
2005/06	0.43	0.0001
2006/07	0.40	0.0001
2007/08	0.3437	0.0001
2008/09	0.30	0.0001
2009/10	0.3794	0.0001
* NNI is based on user input area (i.e. Actual area of study area)		
In general an NNI <1 shows clustering		

Figure 4.2 shows Ripley's K results for the year 2004-05, 2005-6 and 2006-7 plotted on a chart, with Figure 4.3 showing Ripley's K results for subsequent years. Ripley's K is a slightly more robust measure of clustering. It looks at observed distances between crimes and then compares these with what would be the expected maximum and minimum distances between crimes if there was no clustering. The L(t) in the chart represents the observed value the L(t)Min value is the minimum expected value and the L(t) Max the maximum expected value. These results show that as the L(t) value is above the upper and lower bounds of the L(t) Min and L(t) Max values there is significant clustering of recorded vandalisms present in all years

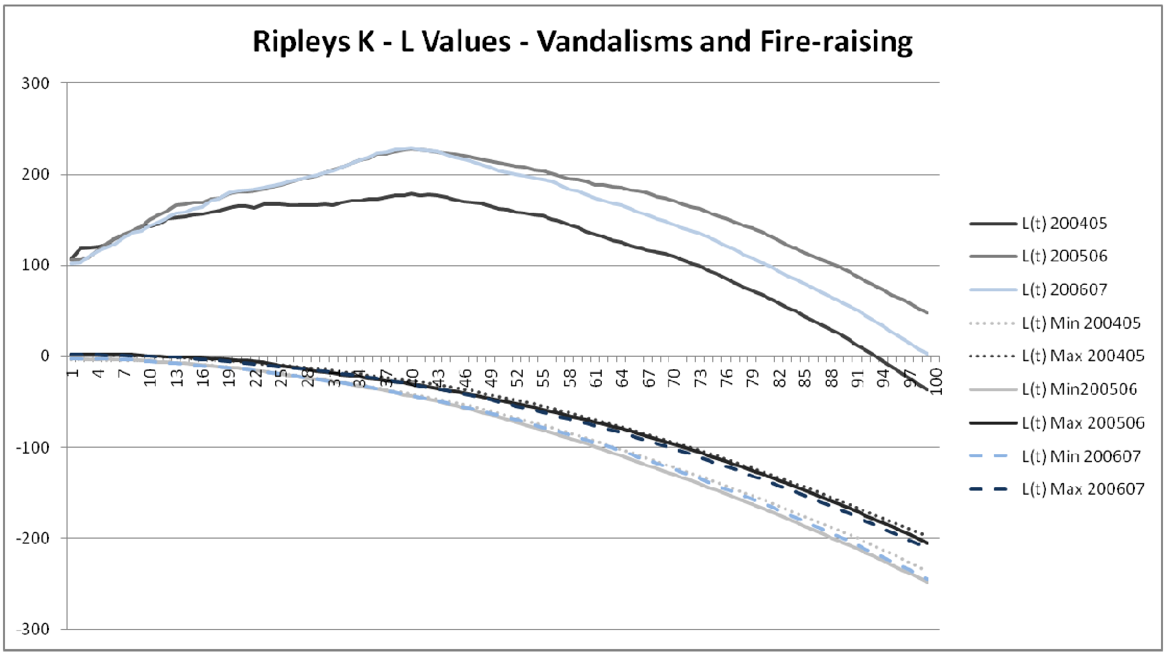


Figure 4.2 – Ripley's K results for Vandalisms and fire-raising (VFr) recorded crimes in 2004/05, 2005/6 and 2006/7

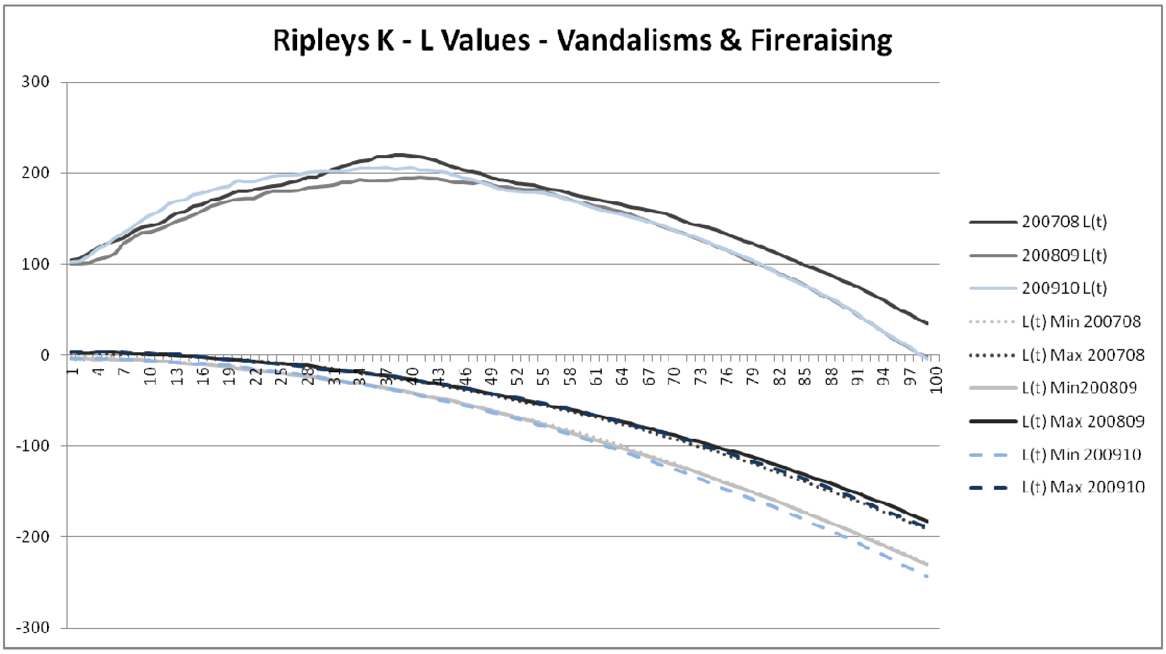


Figure 4.3 – Ripley's K results for Vandalisms and fire-raising (VFr) recorded crimes in 2007/8, 2008/9 and 2009/10

A common measure of clustering considered is the distance between one crime location and next nearest crime, or 5th nearest crime or 10th nearest crime. Fifth nearest and 10th nearest crime can be a more meaningful measure than just the closest crime as it is not unusual for 2 or 3 crimes to occur in exactly the same location. The nearest neighbour distance to the 5th crime and the 10th crime is shown in Table 4.2 and Figure 4.4 below. Over the first four years of the study period the average nearest neighbour distances suggest that vandalisms may have become slightly more concentrated (closer together) in some locations as crime levels increased and stayed high. When the levels of vandalism declined in the last two years of the study period, crime concentrations appear to have become more dispersed.

Table 4.2 – Nearest Neighbour Distance VFR

Year	Crime locations	Distance in metres to nearest...	
	No of. Crimes	5th crimes	10th crime
200405	1577	74.7	122.4
200506	1787	72.9	119.8
200607	1783	71.0	119.0
200708	1783	67.2	117.1
200809	1357	81.0	137.0
200910	1147	93.0	153.4

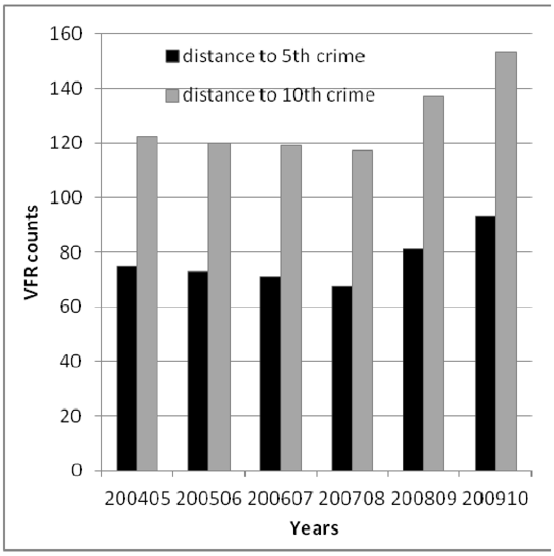


Figure 4.4 – Distances to 5th and 10th nearest Vandalism crime location

An example of mapping this clustering is presented in Figure 4.5 below which shows a cluster map often referred to as a hotspot maps. More precisely Figure 4.5 shows a map produced using Kernel Density Estimation (quartic bandwidth set to 10th nearest neighbour distance – scaled in multipliers of means) at the 100m grid scale. This visualisation smooths the data so that where there are higher concentrations of vandalisms next to each other these are given greater weight and where there are lower concentrations given less weight. The visualisation thus slightly over emphasises high areas and slightly under emphasises lower areas; however it produces a smooth clear visualisation showing areas around which concentrations of crimes are likely to be located.

The map shows that within the case study area between 1 April 2004 and 31st March 2005 there were clusters of recorded crime, especially in the North West, East and South of the case study area (areas shown additionally highlighted by a red semi-circle). Similar maps were produced for all years and all show clustering of crimes in similar areas, although the precise location of clusters changes by year

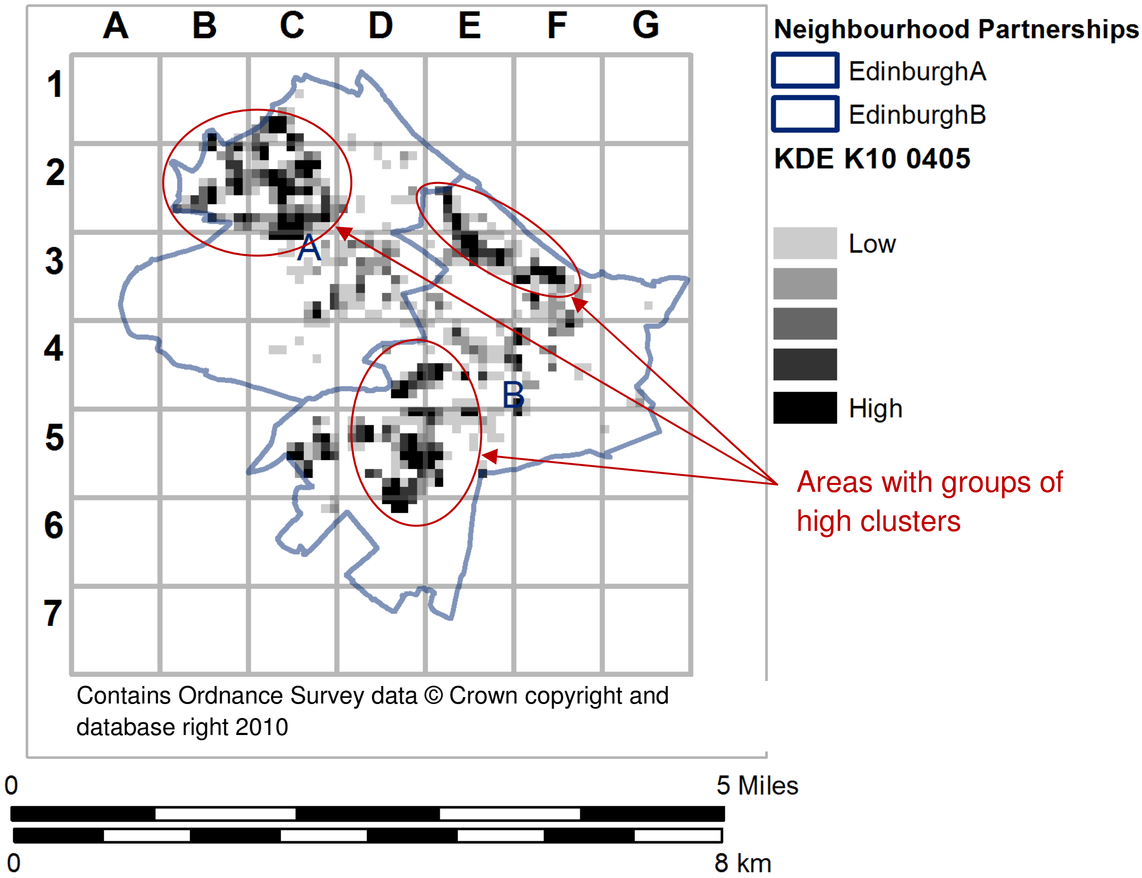


Figure 4.5 – Kernel Density Estimation – Recorded Vandalisms including Fire-raising 2004-5 with a base a section showing different scales of aggregation used to visualise case study data – produced for a 100 x 100m grid

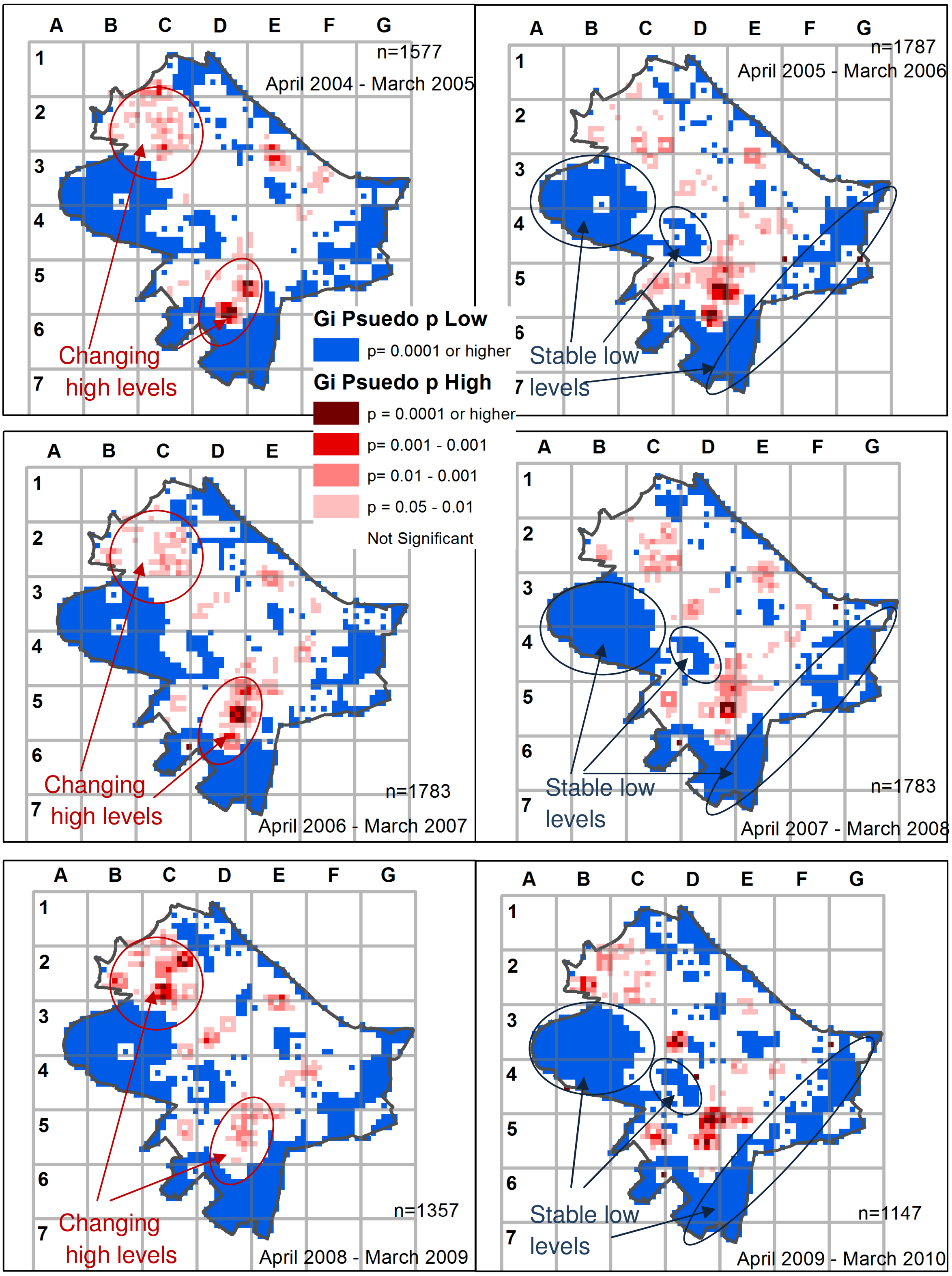
Kernel density analysis thus usefully shows concentrations of crime, but it does not highlight where these concentrations might be statistically significant (as previously discussed in chapter 3 no statistical testing is built into the technique); it is an effective but purely descriptive visualisation technique. It is also a useful technique for visualising high concentrations but does not as usefully highlight low concentrations of vandalism. LISA analysis which can visualise significantly high and low areas of vandalism was found to be much more useful in this research and will now be considered.

4.3 Vandalism - there are high and low areas but it is a rare event

The second key point to make is that regardless of scale across the whole case study area **there were always areas where there were concentrations of high areas of vandalism and concentrations of low areas of vandalism**. As described in chapter 3 techniques which can show both high and low levels of clustering at an aggregate scale are known Local Indicators of Spatial Autocorrelation (LISA). The two main methods of LISA analysis used here, G_i* and Local Moran's I did show that there were significant groupings of high and low vandalisms across the case study area in all years . Figure 4.6 shows the presence of these high and low concentrations of vandalisms using the G_i*technique with pseudo random p values calculated using 9999 iterations of the data using OpenGeoDa 1.0.1 (October 2011 release) (Anselin, 1995; O'Sullivan & Unwin, 2010).

The red areas are areas where the average value in these grid cells which surround a given 100m grid cell (the local average) are significantly high when compared with the global average for the whole area. The darker red colour are areas where significance is higher – which in this case (because the null hypothesis is that the concentration is due to a random process) suggest that for those dark pink, red or dark areas we can be 99% certain or better (significance 0.01 or better) that we have not mistakenly assumed that this a real high concentration of vandalisms when it is in fact a random effect. For the lightest pink areas there is a significance of 0.05. This finding is consistent for all years of recorded vandalism data. In the case of the low areas found through the pseudo p technique these are fairly stable year on year whereas the higher concentrations of vandalism move around (although they remain broadly within the same areas). There are also some more stable high areas (this is discussed further below as the chapter moves on to consider trajectories over time).

In fact it turns out it does not matter which techniques you use to look at this the overall picture (LISA or KDE); every year in the case study area there are always areas with statistically significant high concentrations of vandalism and some other areas which have low concentrations of vandalism. Although different techniques do potentially highlight different phenomena year in and year out this pattern is repeated regardless of technique or scale used. In every year there are high areas of vandalism and in every year there are areas where there are low numbers of vandalisms. In many of the consistently low vandalism areas these are areas where no vandalism has occurred at all, year in year out .



All Vandalisms - Vandalism, Malicious Mischief and Fire-raising

Figure 4.6: High and low concentrations of vandalisms G_i* pseudo p

Figures 4.7-4.9 shows data for 2004/5 mapped using different techniques and different scales, regardless of technique and scale, areas of both high vandalisms and low vandalisms stand out. The finding that there are high and low concentrations of vandalisms in some areas and not others and that this persists in some areas in some way over time is very clear, at least for this case study area. In Figure 4.7 areas with high concentrations of vandalisms are or lower r darker shades of grey or darker shades of pink and red. Figures 4.7-4.9 demonstrate that this consistency of high and low vandalism areas is not just down to a particular visualisation technique being used but can be seen at different scales and using different methods of visualisation. Figures 4.7 and 4.8 also highlight some interesting differences between Local Moran's I and G_i* analysis. As discussed in chapter 3, both G_i* and Local Moran's I techniques are useful for highlighting high and low areas of vandalism with some measure of statistical significance. Figure 4.7 shows G_i* using random Monte Carlo simulation to give pseudo p values for low and high values at 100m grid scale. G_i* visualisations using this method are very useful for showing significantly high and low pockets of vandalism.

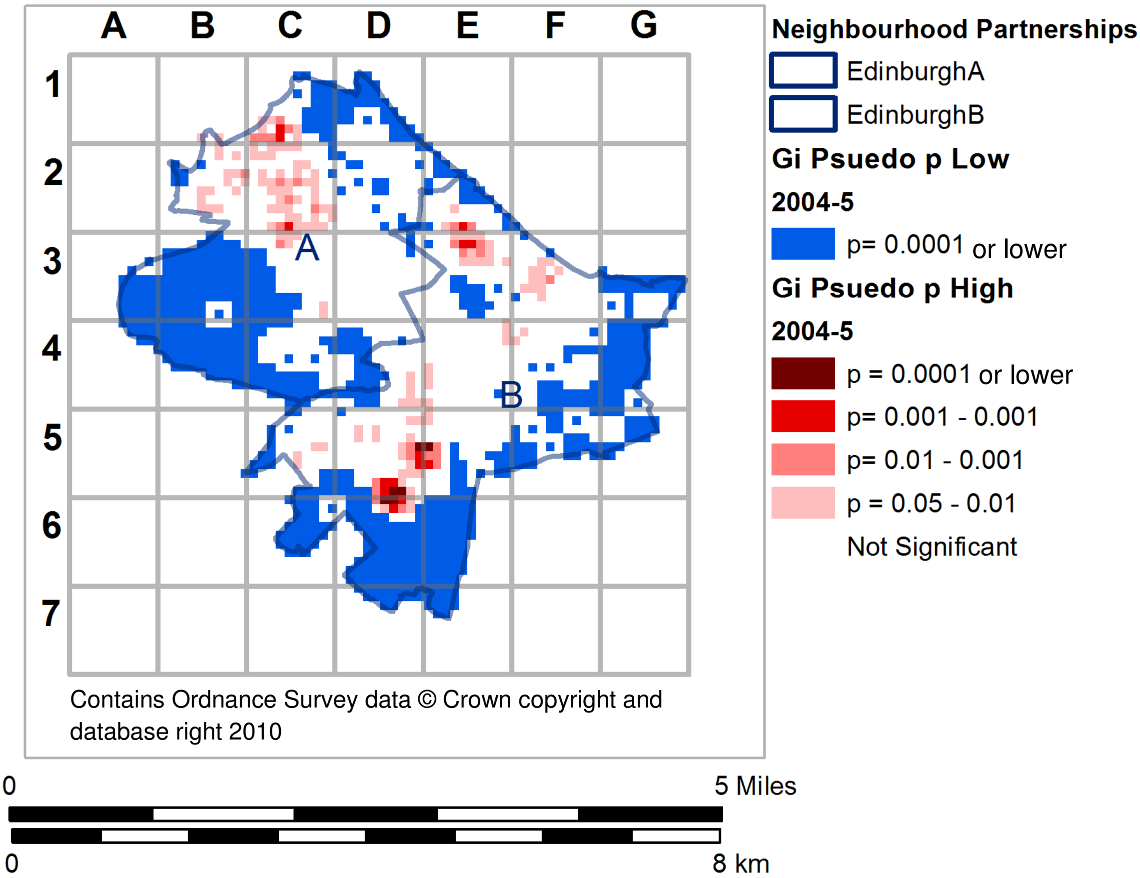


Figure 4.7. – G_i* (randomised Monte Carlo based significance – pseudo p) – Recorded Vandalisms including Fire-raising 2004-5

The Output Area (OA) level was found to be particularly useful for highlighting concentrations of low-low local neighbourhoods. Areas which are significant at p0.05 or lower are shown. The analysis in Figure 4.8 shows a standardised rate of vandalisms per hectare and thus allows for the fact that OAs can be different sizes, allowing for comparison of like with like. It is predicated on the assumption that vandalisms since they are done to objects in space are best standardised by units of area rather than units of people.

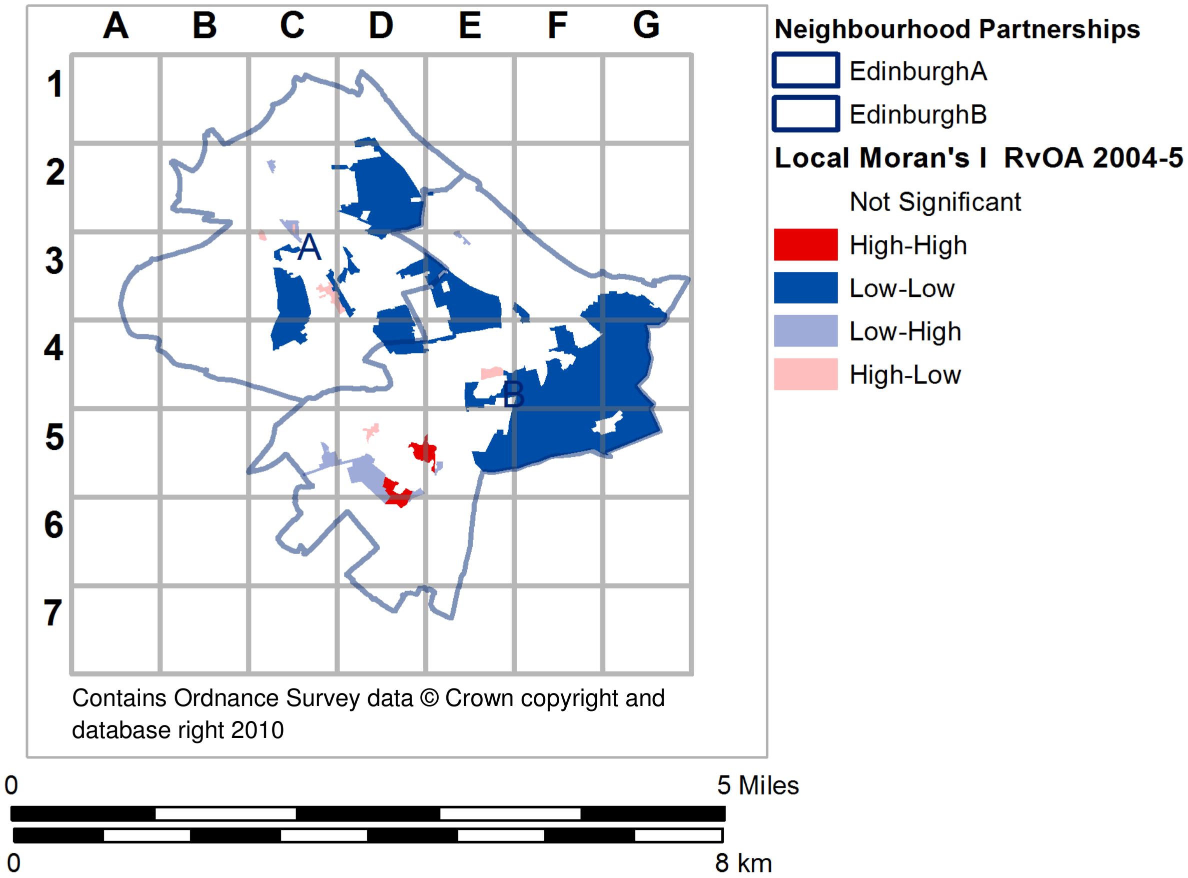


Figure 4.8 – LISA – Local Moran's I – OAs– Recorded Vandalisms including Fire-raising 2004-5 Standardised Vandalism Ratios (SVR)

The final figure 4.9 shows a standardised vandalism ratio again where vandalisms are standardised by hectare at Datazone scale. This has been calculated by dividing the observed level of vandalism in the area by the level that might be expected for an area of that size based on the rate of vandalisms for the study area as a whole. It therefore has a very simple and easy to understand scale – 0.5 means the area has half the rate of vandalisms per hectare that might be expected, 2 means the area has double the rate of vandalisms that might be expected. Generally the Datazone scale was found to be too large for picking up micro patterns of vandalisms across neighbourhoods. However the SVR method of visualising data was found to be a very useful exploratory visualisation used at all scales as an initial method to explore data.

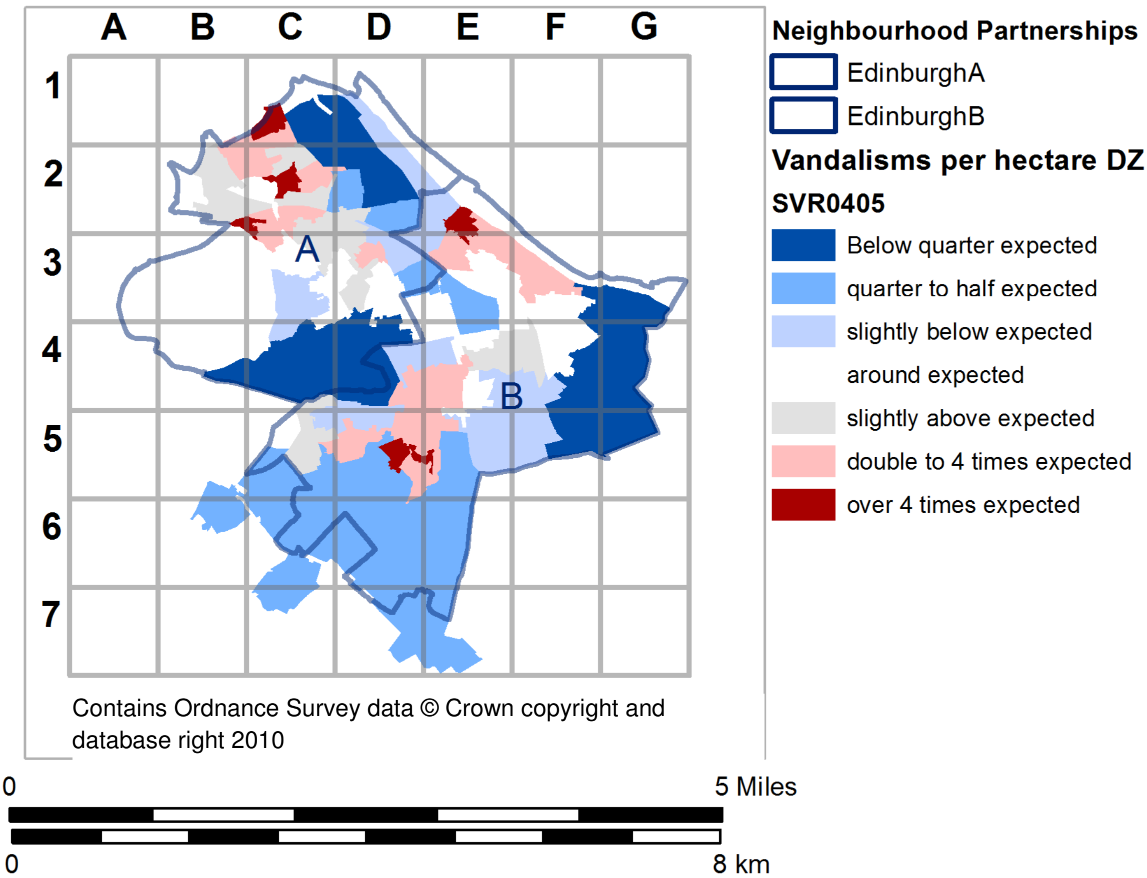


Figure 4.9–Standardised Vandalism Ration - SVR

Since the techniques shown in Figures 4.7 to 4.9 measure slightly different things at different scales it is perhaps not surprising that they highlight different aspects of vandalism concentrations; this is potentially useful as it can give a broader picture of the data under study; this will be returned to in more detailed discussion of results for EdinburghA and EdinburghB.

It is important to note that vandalism is also a rare event – in every year in the majority of areas there were no or only 1 or 2 recorded vandalisms that occurred in the year. As the Table 4.4 shows, in the study area there was around 1 vandalism per hectare per year, and this rate fell in 2008-9 and 2009-10. As a count per OA (a crude measure of a rate per similar sized population) there were on average nearly 4 crimes per OA in the years where counts were high between 1st April 2005 and 31st March 2008 with counts falling to 2.5 vandalisms per OA. Since OAs vary in size greatly an alternative comparator is to look at rates for OAs at a median size – this gives a rate of 1.7 vandalisms per hectare in the years where rates were highest falling to just over 1 in years where rates were lowest (Table 4.4).

Table 4.4 – Average Area Counts and Rates for Output Areas (OA)

Year	Area average (mean) per OA Counts	Area average (mean) per hectare	Rate for OA of Median size 1.59 ha
2004-05	3.5	0.9	1.5
2005-06	3.9	1.1	1.7
2006-07	3.9	1.1	1.7
2007-08	3.9	1.1	1.7
2008-09	3.0	0.8	1.3
2009-10	2.5	0.7	1.1

It is important to note that standardisation can also be important for exploring data, once data is scaled up and it can be valuable to look at both counts and rates. Figure 4.10 compares the distribution of counts and rates. The white area of the graph represents areas above and below the area average. The top of the graphs shaded grey and black shows the proportion of areas between 2and 4 times and over 4 times the area average. The bottom of the graph shaded darker and lighter grey shows the proportion of areas up to a quarter and between a quarter and half the area average.

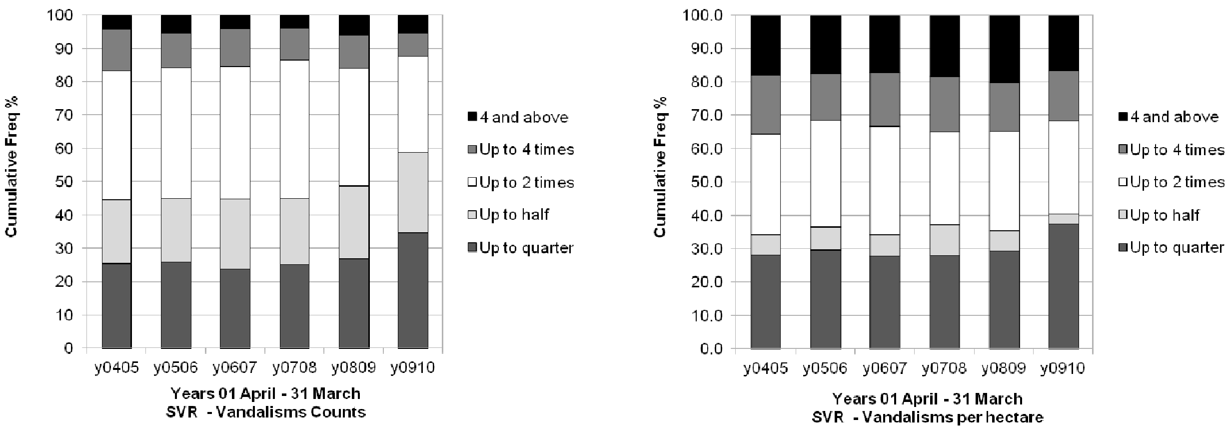


Figure 4.10: Standardised Vandalism Ratio (Observed / Expected) by year for OAs

This illustrates across the study area there are many more OAs at double the area average for rates of vandalisms per hectare per OA (around 35%) compared to counts of vandalisms per OA. OAs as they have some kind of homogeneity may be thought of as an equivalent to mini-neighbourhoods. The stability of this pattern can be further demonstrated by taking the best fit (loess) curve over a histogram and overlaying them for each of the years showing counts of vandalisms per Output Area (counts per homogenous population) (Figure 4.11). There is an extremely stable shape year in and year out of counts of vandalisms per OAs with around 200 the majority, (dropping to around 160 in 2009-10) in all years experiencing 0-2 vandalisms per year. This tails off very sharply so in a given year only 20 Output Areas experience 10 or fewer of cases of vandalism. The majority of areas are experiencing a very low number of vandalisms every year and exactly the same pattern occurs year in year out. It is a negative binomial shape of curve (rather than a Poisson curve as the mean and variance are not equal in any year).

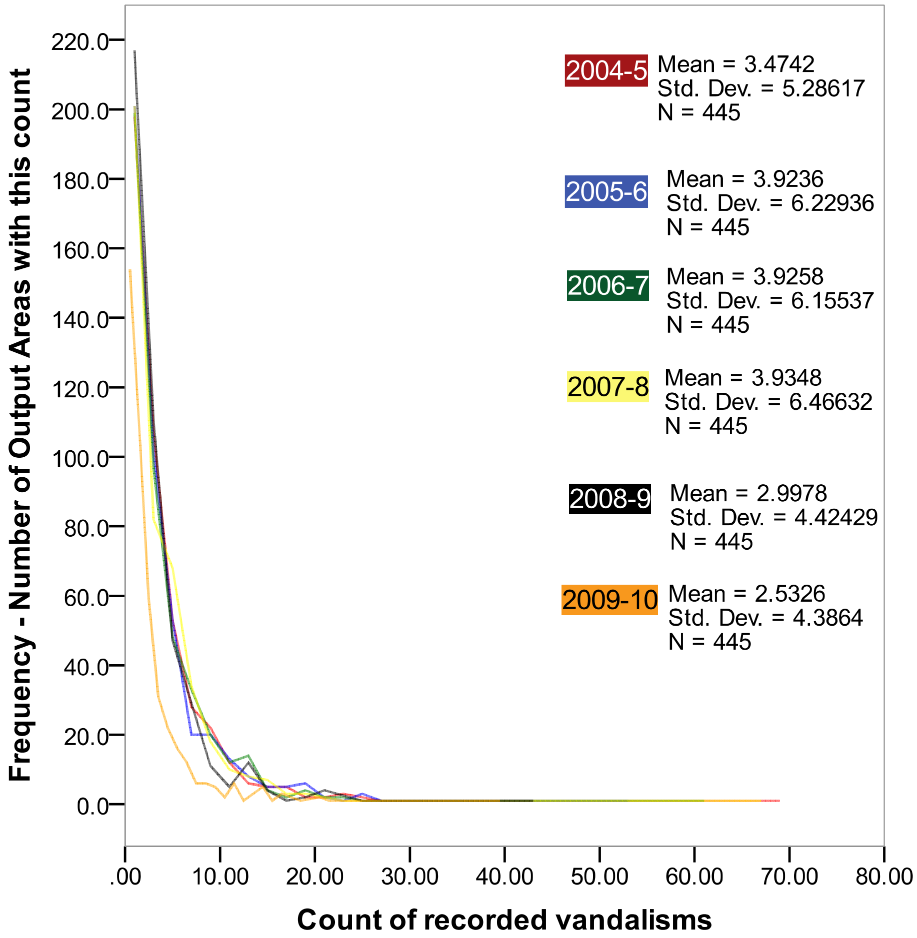


Figure 4.11 – Counts of vandalism per OA (best fit curves to histograms)

In comparison when looking at counts per 100m grid square it is striking how many grid squares have no cases of vandalism (Figure 4.12) - over 75% in most years and over 80% of grid cells by 2009-10, have no recorded cases of vandalism. Indeed over 90% of grid cells experienced 2 or less vandalisms *per year* making a recorded vandalism happening in the study area very rare (Table 4.5).

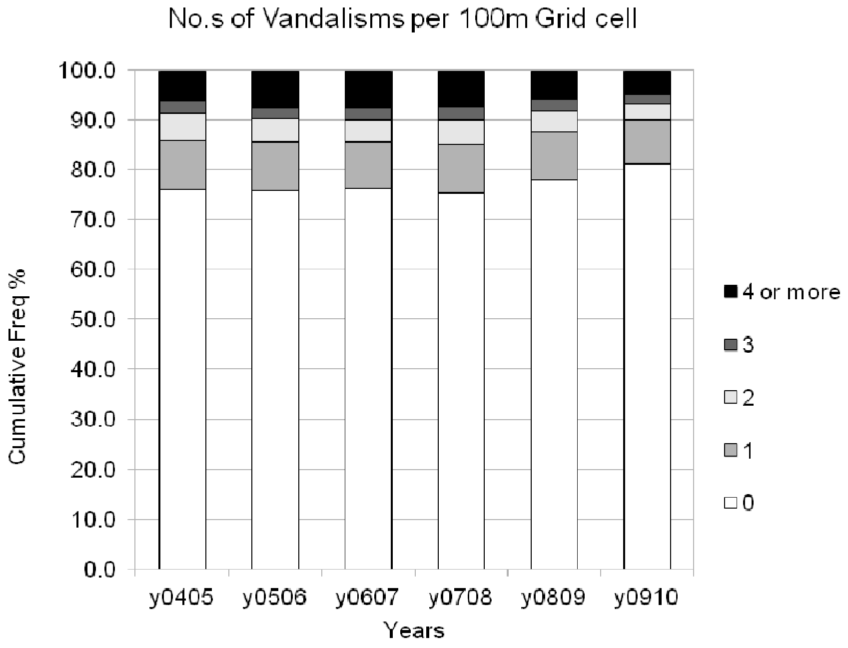


Figure 4.12 – Counts of vandalisms per 100m grid cell by financial year.

Table 4.5 Proportion of grid cells with 1, 2, 3 and 4 or more vandalisms per year

All Vandalisms - Percent %						
Counts	**y0405**	**y0506**	**y0607**	**y0708**	**y0809**	**y0910**
0	76.1	75.9	76.3	75.5	78.1	81.2
1	9.9	9.7	9.5	9.8	9.6	8.9
2	5.4	4.7	4.3	4.9	4.1	3.2
3	2.5	2.1	2.4	2.6	2.5	1.9
4 or more	6.1	7.5	7.5	7.3	5.6	4.8

This high number of very low counts in grid cells is in part due to the grid cell being a more arbitrary unit than an Output Area and in part accounted for by the distribution of residential areas in the study area Figure 4.13 shows that nearly 63-4% of grid cells in May of each year in the study area have no address counts. A lot of the study area is therefore not taken up with residential use. Not including 0 count cells, a further 2-3% of areas have less than a quarter of the area average of address counts per grid cell (1-3 addresses), 2-3% have between a quarter to a half the area average (4-6 addresses), 11-12% have around the average number of addresses (7 to 14 addresses), a further 11% have a count of between 25 to 48/49 addresses (2to 4times average), and the remaining around 8% of grid cells have counts of over 4 times the average(range 49/50 - 298/285 – 285 is the maximum count from 2008 onwards). Theses ranges remain very stable across years.

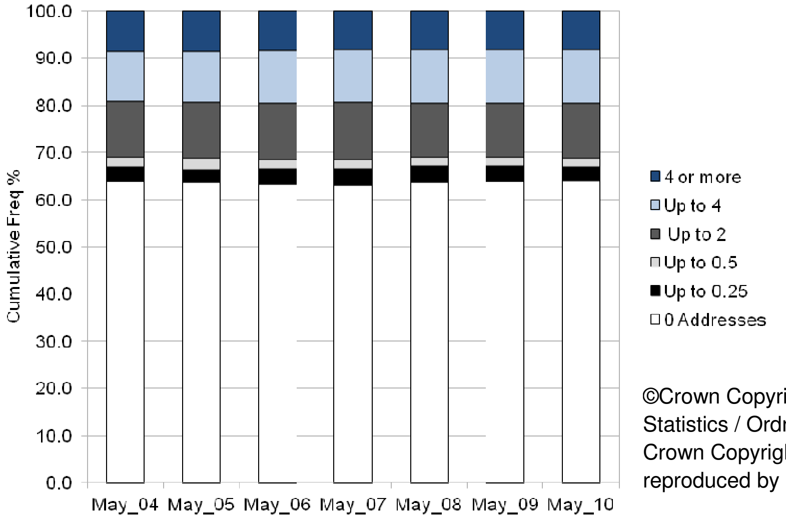
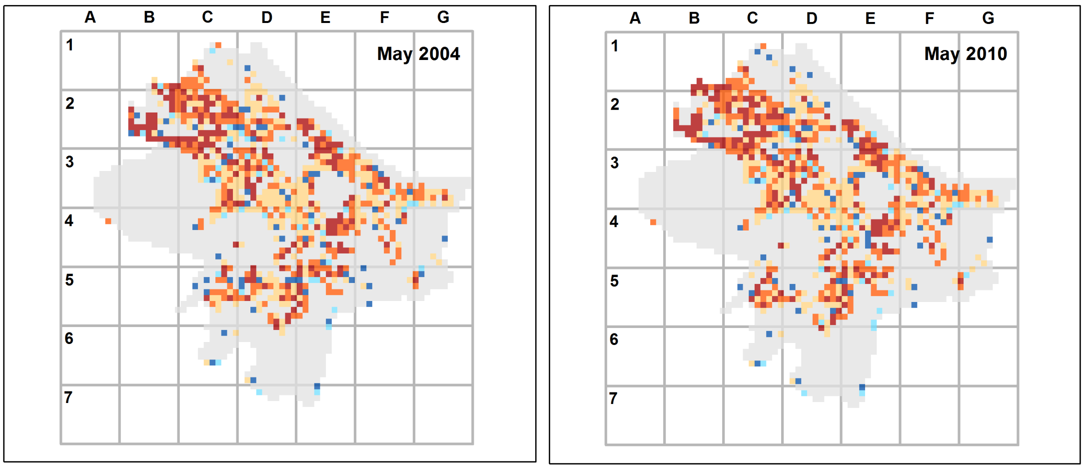


Figure 4.13 – Count of residential addresses by 100m grid areas

The overall spread of residential addresses for May 2004 and May 2009 is shown in figure 4.14 below – only two years are shown below as there is very little change. This shows that the study area has a number of areas with no residential addresses, and residences are concentrated in certain areas of the study area only. (Figure 4.14)



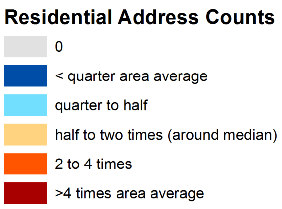
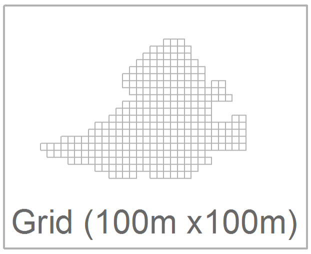


Figure 4.14 – Residential Address Counts in May 2004 start of study period to May 2010 just after end of study period

4.4 Scale matters

As might be expected, as you scale up, the number of areas experiencing no vandalism decreases, there is also clear evidence of the Modifiable Areal Unit Problem (MAUP). Figures 4.15A-C show histograms for all counts of vandalisms and fire-raising in 2004 to demonstrate as the data is aggregated up to a coarser scale (from 100m by 100m Grid to Datazone) the number of areas with 0 values declines. Once data has been aggregated to Datazone there are only areas with 0 counts in 2008; 0 counts are very common at the grid cell level in all years – suggesting that vandalism locations may be very localised (or at least the recording of them is...). Histograms for other years show a very similar distribution to 2004

100m Grid



Mean = 0.75

Median = 0

Standard deviation = 2.27

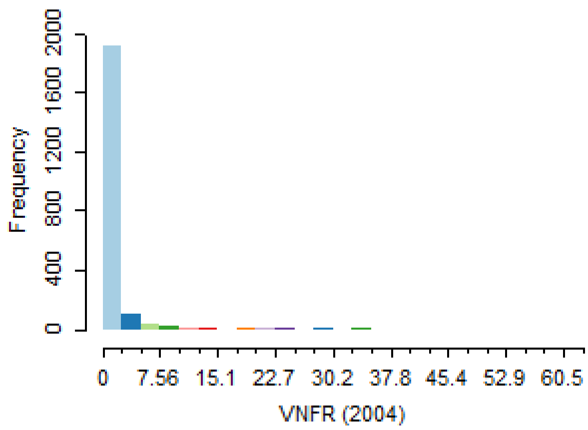
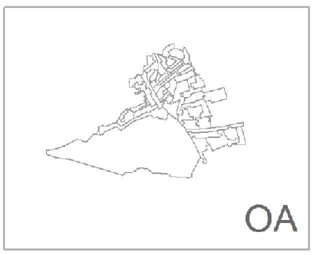


Figure 4.15A Histograms of counts of police recorded vandalisms and fire-raising in 2004 at 100m Grid cell

Output Area (OA) (Revised)



Mean = 3.47

Median = 2.00

Standard deviation = 5.29

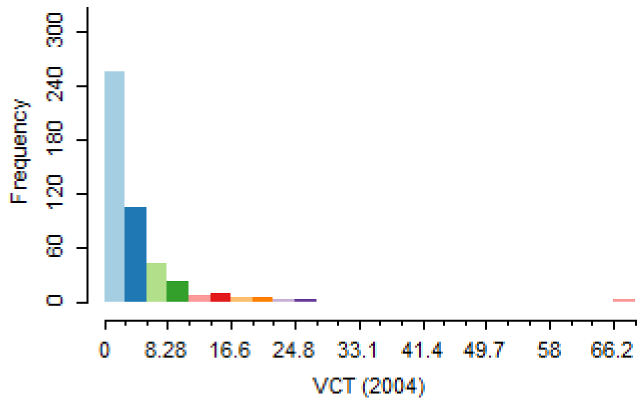


Figure 4.15B Histograms of counts of police recorded vandalisms and fire-raising in 2004 at OA

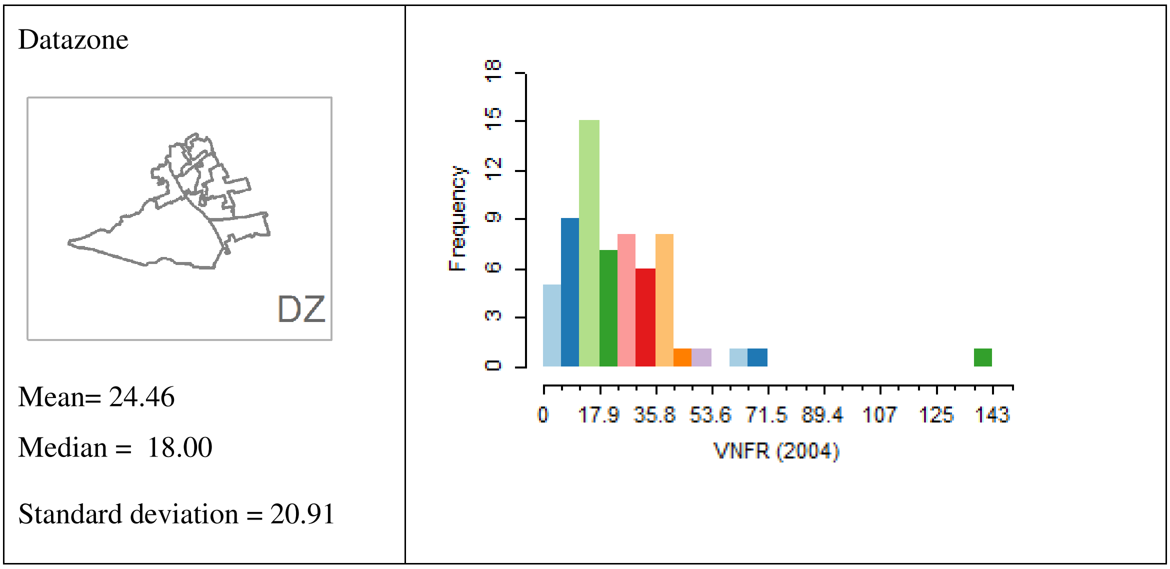
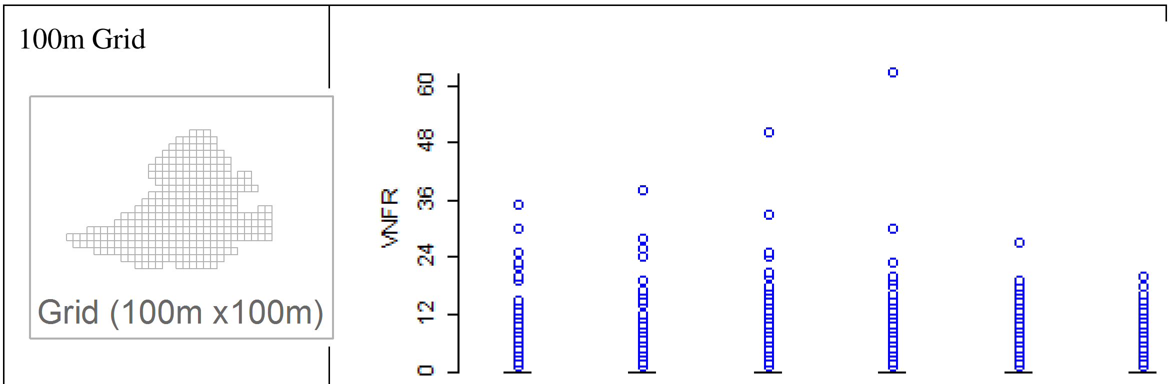


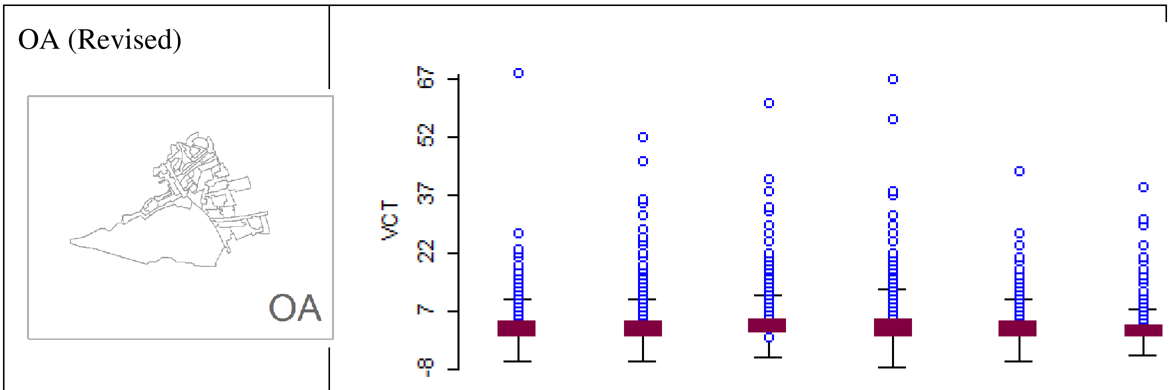
Figure 4.15C – Histograms of counts of police recorded vandalisms and fire-raising in 2004 at Datazone

Figures 4.16 A-C below uses box plots to show that this trend of fewer low values at coarser scales holds in all years and also highlights how in all years there are relatively few high values although this is again less pronounced at coarser scales.



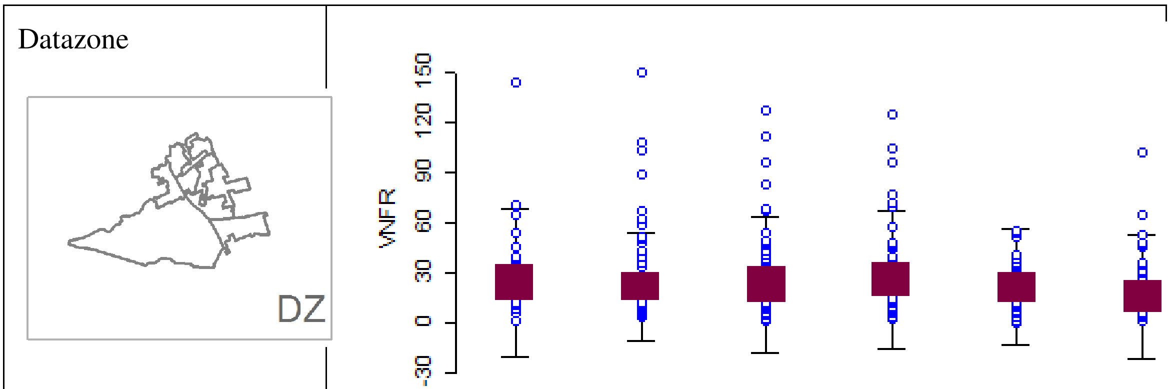
	2004	2005	2006	2007	2008	2009
min	0	0	0	0	0	0
max	35	38	50	63	27	20
Q1	0	0	0	0	0	0
median	0	0	0	0	0	0
Q3	0	0	0	0	0	0
IQR	0	0	0	0	0	0
mean	0.7517	0.85	0.8496	0.8496	0.648	0.5468
s.d.	2.267	2.559	2.632	2.678	1.917	1.745

Figure 4.16A – Box plots of counts of recorded vandalisms and fire-raising at different scales (Grid 100m x 100m)



	2004	2005	2006	2007	2008	2009
min	0	0	0	0	0	0
max	69	52	61	67	43	39
Q1	0	0	1	0	0	0
median	2	2	2	2	2	1
Q3	4	4	5	5	4	3
IQR	4	4	4	5	4	3
mean	3.474	3.924	3.926	3.935	2.998	2.533
s.d.	5.286	6.229	6.155	6.466	4.424	4.386

Figure 4.16B – Box plots of counts of recorded vandalisms and fire-raising at different scales (OAs)



	2004	2005	2006	2007	2008	2009
min	1	3	1	2	0	1
max	143	149	127	124	55	101
Q1	12.5	13	12	15	12	6
median	18	20	21	19	17	13
Q3	34.5	29	32.5	35.5	29.5	24.5
IQR	22	16	20.5	20.5	17.5	18.5
mean	24.46	27.57	27.67	27.83	21.06	17.81
s.d.	20.91	26.98	25.22	24.68	13.7	17.18

Figure 4.16C – Box plots of counts of recorded vandalisms and fire-raising at different scales (Datazones)

The fact that scale and the type of zoning strategy used can effect even simple statistical modelling is the well known Modifiable Areal Unit Problem (MAUP). Table 4.5 presents the mean and standard deviation of vandalisms per 1 hectare as measured based on counts per 100m grid square, and then counts per hectare per Output Area and Datazone. As might be expected, despite the fact this is the same data and therefore means and standard deviation should be very similar, actual results shows quite a lot variation based on the scale used, and this again emphasises the importance of exploring the data for the study area at more than one scale.

Table 4.5 – Effect of Scaling and Zonation on mean and standard deviation of vandalisms per hectare for all years in the case study period

Area	N (observations)	Mean						Standard Deviation					
	Year	0405	0506	0607	0708	0809	0910	0405	0506	0607	0708	0809	0910
Datazone	63	1.6	1.7	1.8	1.8	1.5	1.1	1.3	1.6	1.7	1.6	1.3	1.2
Ouput Area	445	2.4	2.4	2.6	2.5	2.0	1.5	4.4	4.8	4.2	4.0	3.4	3.0
Grid cell	2094	0.8	0.9	0.9	0.9	0.7	0.6	2.3	2.6	2.6	2.7	1.9	1.7

The modifiable areal unit effect can also be seen in operation when the Moran's I statistic for levels of spatial autocorrelation at different scales are compared in Table 4.6, where for the same data, different scales and different zones, along with counts compared with rates of the same data all affect results. Across the study area in general there is some spatial autocorrelation, it is generally not very high but it is significant and is likely to affect the independence of the data to some degree. Here significance is assessed using a pseudo randomisation process (9999 iterations implemented in OpenGeoDa 1.2.0). (For a further discussion of these statistics see chapter 3, section 3.10).

All OA and Grid measures of global autocorrelation (Moran's I and EBI) are significant and greater than 0 but less than 0.3 so at OA and Grid level spatial autocorrelation is present but quite weak (Table 4.6). At Datazone level, for rates (measured using EBI), spatial autocorrelation is weak but also below 0.3, for counts, in 2005-6, 2006-7 and 2007-8 – the years when vandalism counts were highest across the study area - spatial autocorrelation is over 0.3 but is still less than 0.5. In 2008-9 counts at OA and Datazone level show virtually no spatial autocorrelation (although it is still present for rates and at grid level). This may be due to a particular drop off in levels of vandalism in certain OAs and Datazones in the Edinburgh B area in that year (which will be discussed further in the specific analysis of the Edinburgh B area). In summary there is some spatial autocorrelation of data at all scales as measured by Moran's I but it is not a very strong effect.

Table 4.6 Table of Moran's I and EBI – a measure of global spatial autocorrelation - at Grid, Output Area (OA) and Datazone level

	2004-5		2005-6		2006-7	
Area Level	**I**	**sig.**	**I**	**sig.**	**I**	**sig.**
Grid 100m count	0.2085	0.0001	0.2404	0.0001	0.2008	0.0001
OA count	0.1402	0.0002	0.2078	0.0001	0.1778	0.0001
OA rate (EBI)	0.1539	0.0004	0.2125	0.0001	0.2281	0.0001
Datazone count	0.2433	0.0007	0.4482	0.0001	0.3967	0.0001
Datazone rate (EBI)	0.2544	0.0008	0.2251	0.001	0.2551	0.0008
All values significant						
	2007-8		**2008-9**		**2009-10**	
Area Level	**I**	**sig.**	**I**	**sig.**	**I**	**sig.**
Grid 100m count	0.1834	0.0001	0.2114	0.0001	0.2163	0.0001
OA count	0.1345	0.0004	0.0591	0.02	0.1874	0.0001
OA rate (EBI)	0.1713	0.0001	0.1916	0.0001	0.1507	0.0001
Datazone count	0.315	0.0004	0.064	0.1389	0.2426	0.002
Datazone rate (EBI)	0.2162	0.004	0.1879	0.0076	0.1222	0.0432
All values significant except red value						

Another interesting aspect of scale can be considered by looking at LISA (Local Moran's I) analysis at different scales. Local Moran's I has the advantage that it can highlight high areas that are surrounded by high areas, low areas that are surrounded by low areas and outliers where a high area is next to mainly low areas or a low area next to mainly high areas. Figure 4.18 shows how the quadrants of a standardised Moran Scatter plot can be used to identify these potential high-high, low-low and low high and high-low areas; for a Moran Scatter plot the original value (in this case counts of vandalisms in Datazones in the study area in 2005-6) is plotted against the spatially lagged value (here the average of all neighbouring areas – calculated using a queen contiguity weight) and this is then standardised around a mean value of 0.

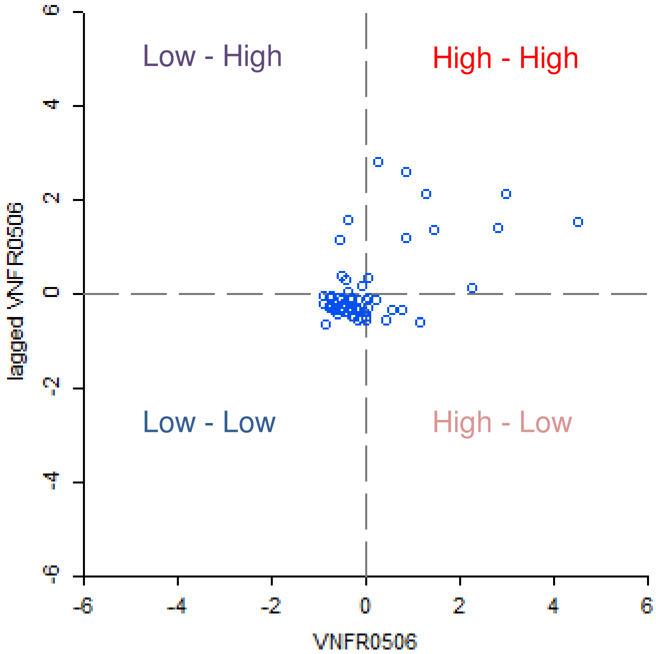


Figure 4.18– Moran Scatter plot – Vandalisms and Fire-raising counts at Datazone level

However, the scatter plot on its own does not highlight if these areas are statistically significant. A Monte Carlo type randomisation is employed within OpenGeoDa which then can be used to highlight areas of 0.05 significance or better. Thus areas which are high-high, low-low, low-high or high-low can be mapped; through brushing and linking in GeoDa, which points on the scatter plot these represent can also be highlighted in the map to demonstrate how the type of phenomena has been identified (Figure 4.19). In all subsequent Local Moran’s I analysis presented here the Moran's I scatterplots will not be shown

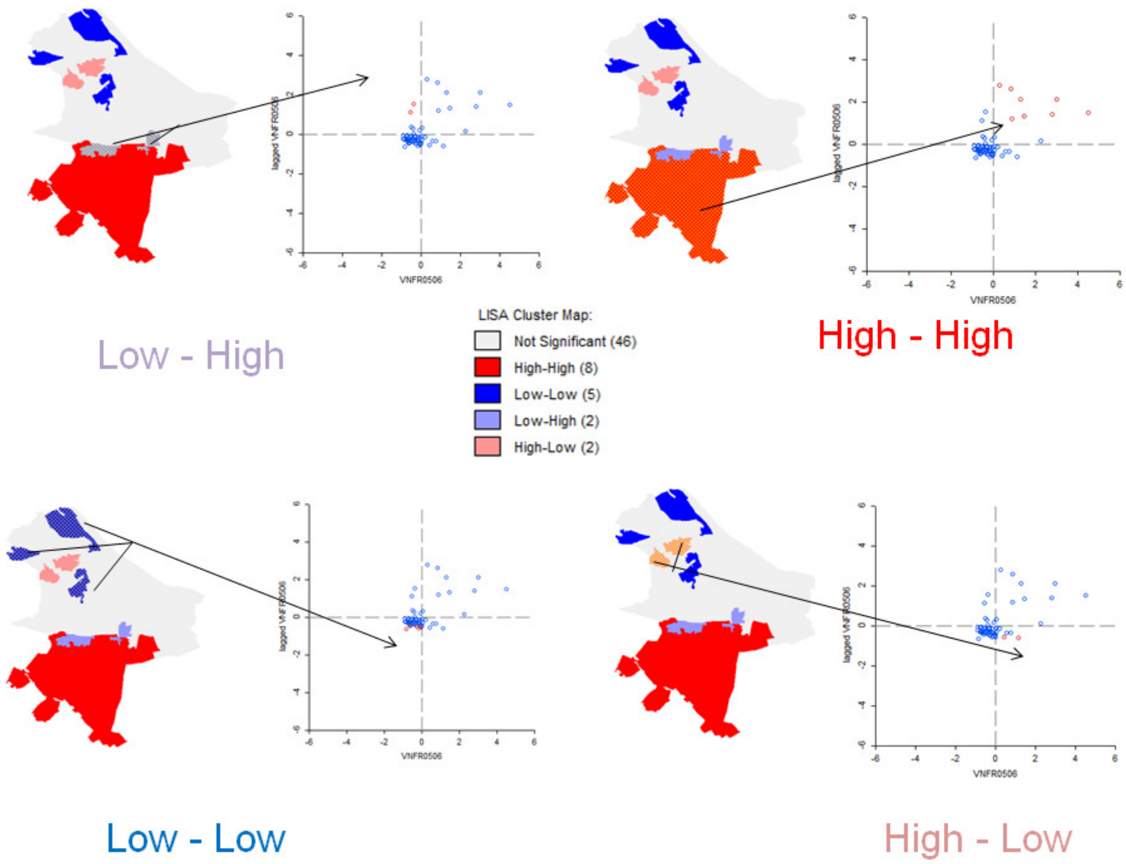
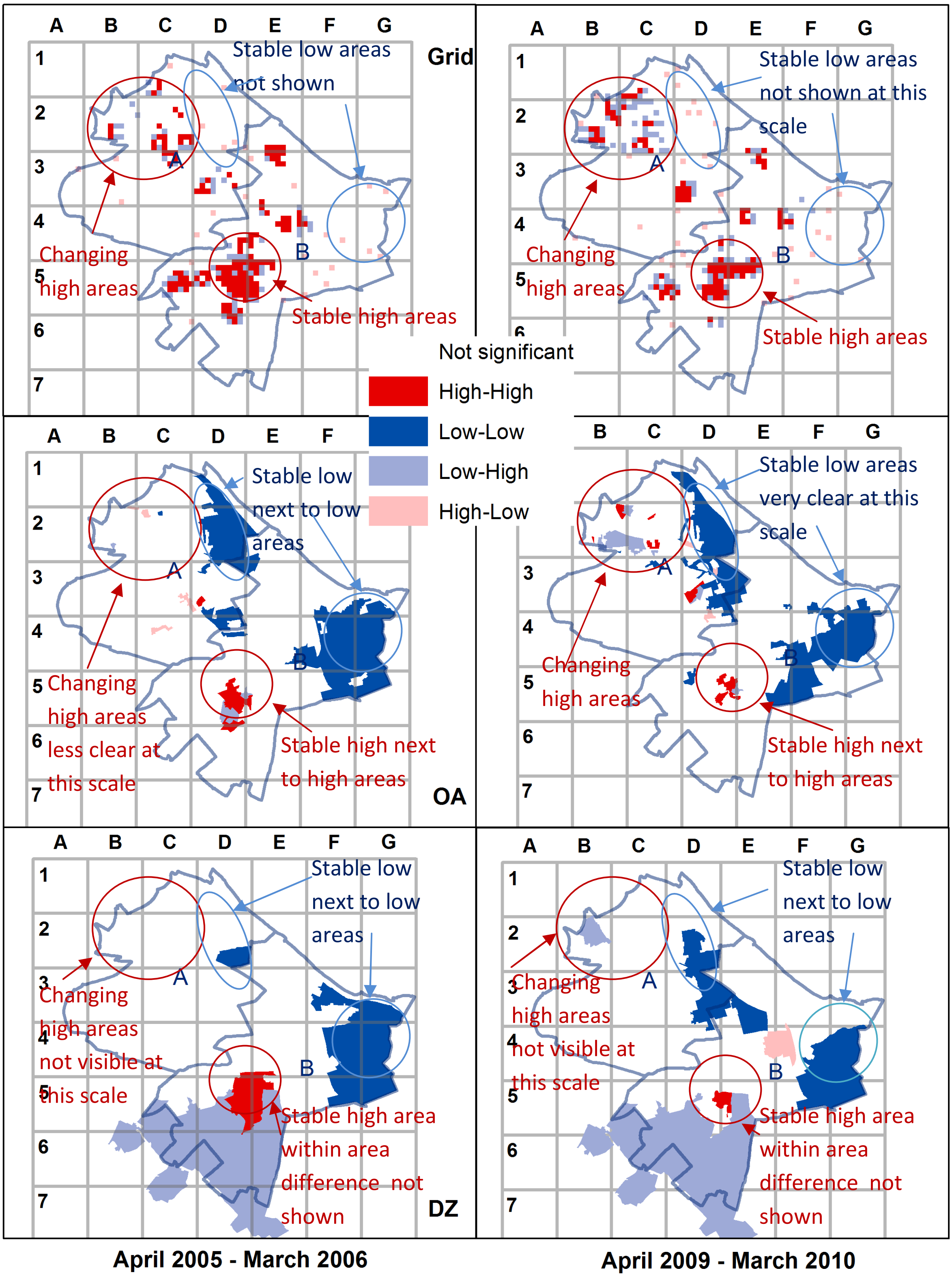


Figure 4.19 Local Moran's I (LISA) maps for Counts of recorded Vandalisms 2005-6 - significant 0.05 or greater brushed and linked to Moran's Scatterplot

Observing how Local Moran's I for the same data operates at different scales highlights some interesting phenomena which highlight how analysing data at different scales and zones of aggregation can highlight different processes that may be happening at different scales. Just data for 2005 and 2009 is shown here to illustrate how differences caused by scaling are consistent in two different years. Similar effects of scale were observed in all years. At Grid level mostly high areas next to high areas with some high areas next to low areas are highlighted, no low areas next to low areas are highlighted as significant. The grid maps also highlights well how in some areas there are pockets of high areas next to low areas (see especially C2). The OA maps shows Local Moran's I analysis using EB rates (a recommended method of analysing rates using LMI similar to the SVR method used above, see further chapter 3, section 3.10). At OA level low areas next to low areas tend to stand out. This is partly because some of these low-low Output Areas are larger than the high areas next to high areas highlighted and therefore the shading of these larger areas dominates the map. A small number of Output Areas which are high next to low areas are also highlighted.



All Vandalisms - Vandalism, Malicious Mischief and Fire-raising

Figure 4.20 – Local Moran's I analysis at Grid, OA and Datazone (DZ) scales 2005 and 2009

At Datazone level, as there are only 63 Datazones in the study area, fewer areas are highlighted and the pockets of high areas seen at grid and OA level, as for example shown in C2, disappear altogether. Simply put, as the scale becomes coarser, micro relationships are lost, especially in areas where there are micro concentrations of high numbers of recorded cases of vandalism. There is just one area around D5 and E5 where it is apparent at all scales there are high areas next to high areas. Looking at the grid scale maps at the top of Figure 4.20 it becomes apparent that this is a particularly large and tight cluster of high levels of vandalism in micro areas next to other high levels of vandalsim in micro areas so this cluster remains robust up to and including Datazone level. However, as the data is visualised at coarser scales subtleties of this area of high next to high areas of vandalisms, at grid and Output Area it is apparent that in this area there are some low areas next to high areas, at Datazone level this detail is lost.

Considering analysis with LISA measures, it was felt that G_i* statistics appeared most useful for looking at processes at the very micro level (Grid level), but the Local Moran's I statistic appeared particularly useful for examining processes at the small neighbourhood or Output Area level. This was backed up by comparing maps, based on these Local Moran's I and G_i* measures, with the maps Police Officers had drawn in the focus groups highlighting high and low areas. In the focus groups acetate's were overlaid over a reference map so Officers could identify the areas picked out by their recorded crime data. They were easily able to do this. Figure 4.21 and 4.22 show digitised versions of the Officers maps made in focus groups alongside the LISA measures. As Figure 4.21 shows the G_i* analysis seemed particularly useful for picking out the smaller micro level high concentrations whereas, at the OA level, Local Moran's I analysis seemed particularly useful for picking out neighbourhoods with low concentrations of vandalisms (Figure 4.22).

Figure 4.21 uses G_i* analysis to identify areas at a 100m by 100m Grid scale which have significant high levels of vandalism. Areas shaded in grey or orange represent statistically significant adjacent grid squares with similarly high levels of vandalism. Significance for G_i* in this map has been assessed comparing z scores to a normal distribution. The darker the grey shading the higher the significance level (that is to say the less likely that if you assume this cluster has not occurred due to a random process that you will be wrong). However since G_i* analysis can suffer from the multiple testing problem, as multiple hypothesis tests have been carried out here, in this case potentially for 2,094 separate locations, there is a strong chance that in a number of cases areas have been found to be significant when they are actually not. The map is therefore likely to contain a certain level of statistical noise. To correct for this problem a Bonferroni correction is also included; this corrects the significance level for the number of multiple tests made; locations that are still significant once this correction has been made are shown in orange. A Bonferroni correction at the 0.05 significance level was used here and is labelled Bfc sig 0.05. As the Bonferroni correction is thought by some to be too conservative, both uncorrected and corrected significance levels are shown. The actual level of significant clusters is probably represented by a mix of all the orange and some of the darker grey areas and this is the way the measure was explained to Police Officers. (The correction used here is based on Chainey and Ratcliffe (2005) – see further section 3.10.2 for a discussion of G_i* and applying corrections to compensate for the multiple testing problem).

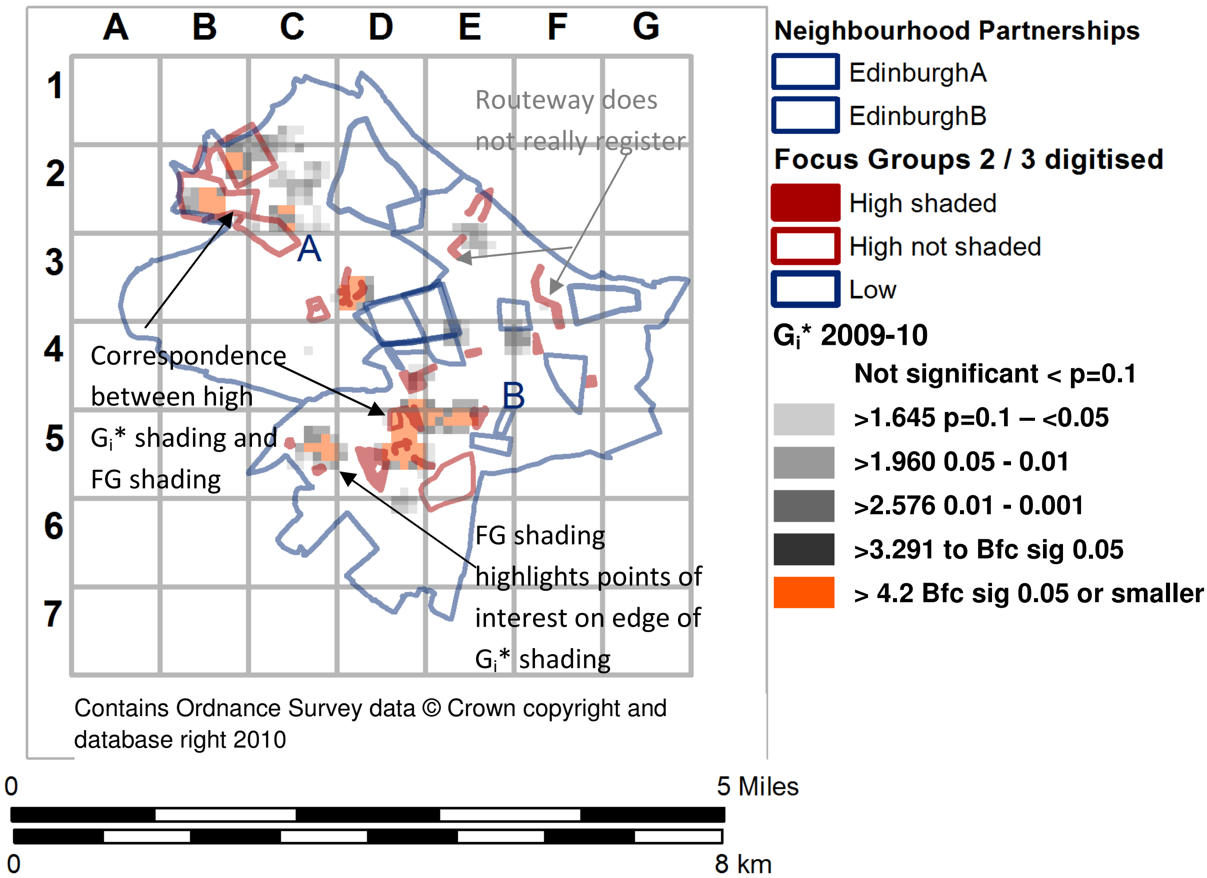


Figure 4.21 – High concentrations of vandalisms shown by G_i* compared to digitised focus group maps

As can be seen there is quite a close, though far from perfect correspondence between the high areas highlighted by the G_i* analysis and the maps drawn by Police Officers in focus groups. Routeways generally do not seem to be picked up by Grid level analysis e.g.at F3– this may be since there was no attempt to match the 100m grid zones with existing roads or paths they are just an arbitrary grid laid across the study area. Also more ‘novel’ map annotations – such as the V shape representing an area along the front of a road way (at E2) and the field boundary where fences were broken for access (E5) are also not selected. In C5 there is an area where vandalisms are shown as concentrated and the area as a whole is not shaded but two points felt to be crime attractor points for vandalisms on the edges of this area are highlighted.

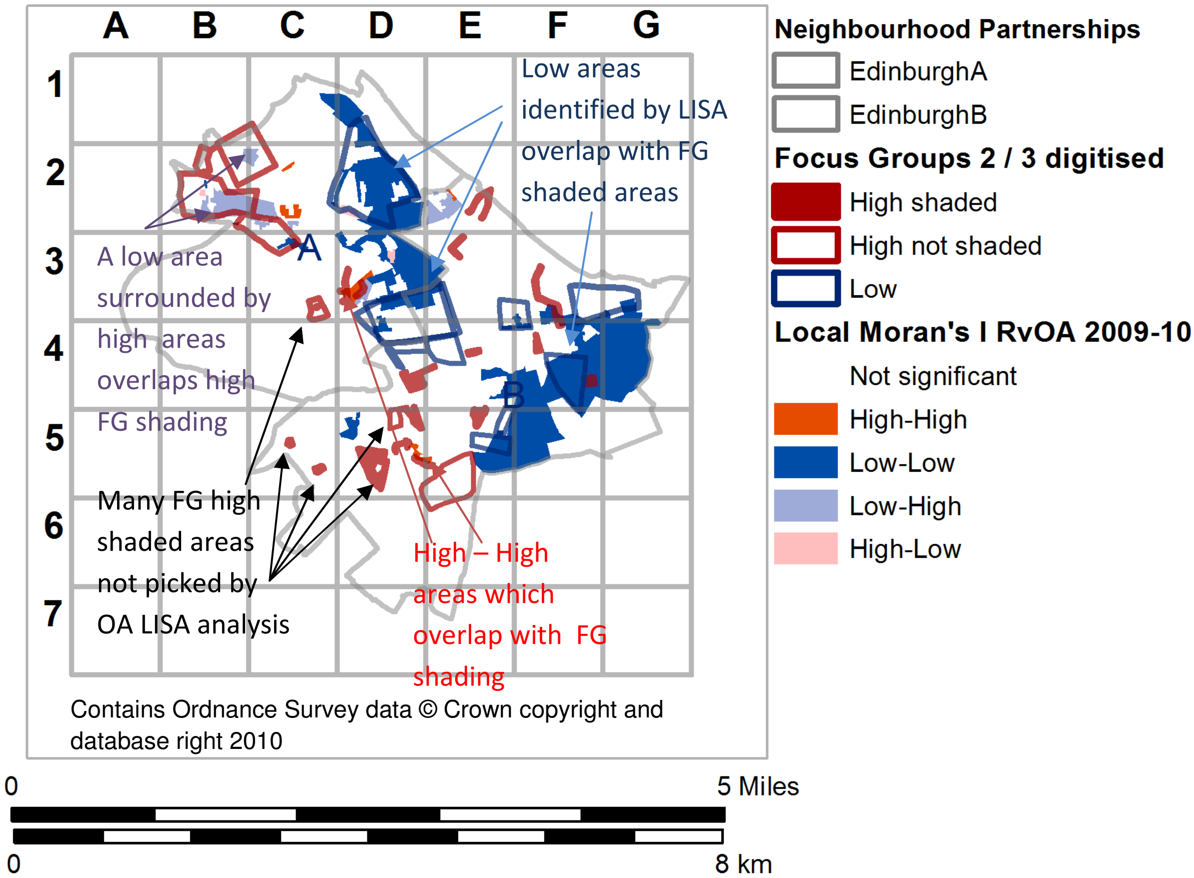


Figure 4.22: comparison of Local Moran's I analysis at OA level compared to digitised focus group maps

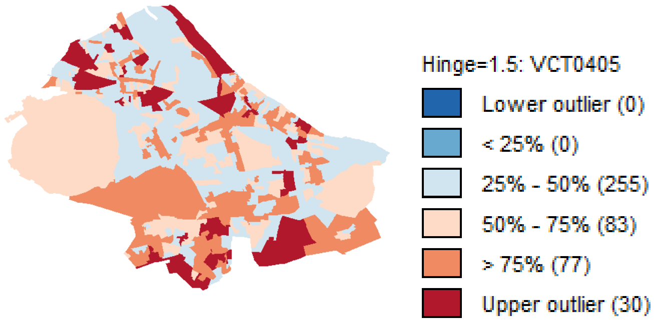
Figure 4.22 suggests Local Moran's I analysis is quite good at picking out a number of areas with consistently low levels of vandalism which were also picked out by the Police Officers own mapping of where they perceived low areas to be. There is overlap between almost all of the low-low areas highlighted by Police Officers and the LISA low-low areas. However, many of the low-low areas appear larger from the Local Moran's I OA maps compared with the focus groups this may either be that police in focus groups were underestimating areas where there are few or no recorded vandalisms or that the OA boundaries do not precisely fit the boundaries of low vandalism neighbourhoods. Both, these figures suggest that any pre-determined scale or zoning system can never duplicate exactly the varying sized areas that the Police Officers perceive to have high and low concentrations of vandalisms – partly as the Police Officer perceived the high and low areas as being at such varying scales.

4.5 Standardisation matters

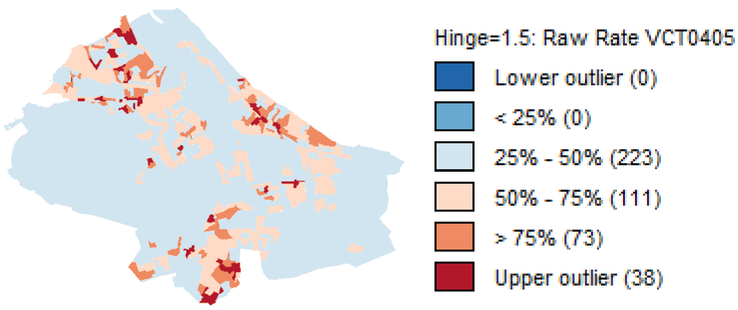
To gain a full understanding of patterns of vandalisms across the area it was found very useful to explore the data using OpenGeoDa using different ways of standardising and visualising the data at Output Area level. This was done to see if standardisation had a noticeable effect on which areas were then perceived as high or low areas. Two types of standardisation were used – counts in pre-defined zones and rates per hectare over these zones. The pre-defined zones used were Output Areas and Datazones which are created based on similar sized homogeneous resident populations. Counts of vandalisms per a OA represent counts per the homogenous population of this area, therefore providing some indicator of the population affected by vandalism. Alternately rates of vandalisms per hectare were also used to represent how much vandalism had actually taken place in the available space that could be vandalised, a measure of vandalisms impact on space. This is a kind of proxy for the population at risk, as the thing at risk is an object in space, as vandalism is a crime aimed at things rather than people. Taken together counts and rates by these pre-defined zones represented a measure of vandalism across place – a concept that represents both place and people.

The interesting question methodologically is did using these different standardisations (using the same zone shape and data) produce differing results and visualisations. What was found is that they did (see Figure 4.23) but generally areas with very high levels of vandalisms showed up as problematic whichever standardisations were used. However, because Output Areas and Datazones vary a lot in size, standardising the data meant that areas that appeared problematic and having high counts just because they were large spaces, did not skew the data as much when it was standardised by hectare (Figure 4.24)

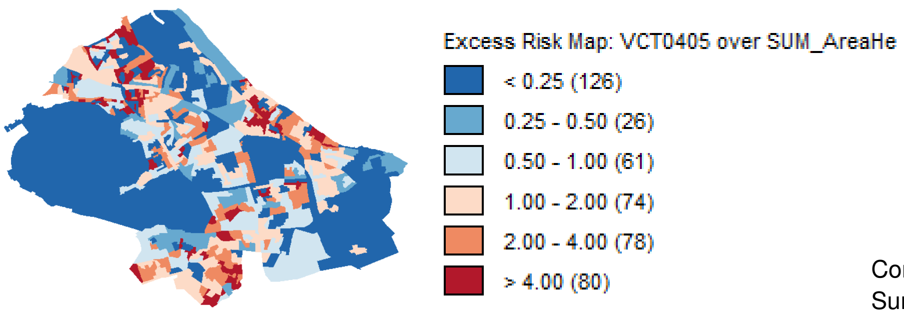
Figure 4.23 shows the map of recorded vandalism counts and compares this with simple rates of vandalism per hectare and visualisation of a standardised vandalism ratio. As can be seen some areas show up as being high values / upper outliers in all maps (counts and simple rates are based on a 1.5 hinge - i.e. values greater than 1.5 times the interquartile range, above and below the interquartile range are highlighted). The legend generated for the SVR map is perhaps more intuitive to interpret, and therefore very useful for a presentation to an audience without particular knowledge of statistics, who may not intuitively understand what scaling the data according interquartile ranges means. This mapping style was one presented to police focus groups along with kernel density maps. However there are also some larger Output Areas with high counts of vandalism which are in the upper outlier range, when these are standardised as vandalisms per hectare, some of these areas fall into the lower quartiles of the data.



Counts – Count of all recorded Vandalisms (inc Fire-raising)

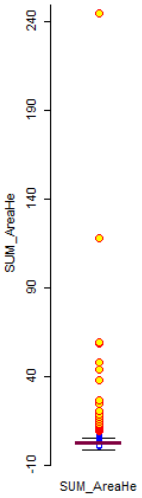


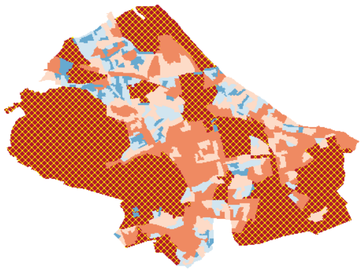
Simple Rate – Vandalisms per hectare



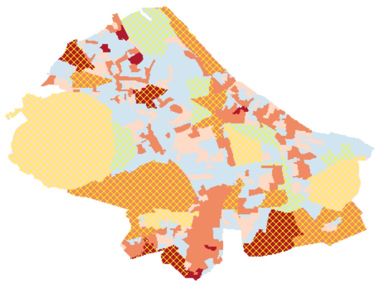
Excess Risk / Standardised Vandalism Ration (SVR)

Figure 4.23 – Comparing counts and Standardisation of Recorded Vandalisms aggregated to OA (output of simple ESDA maps produced with OpenGeoDa)

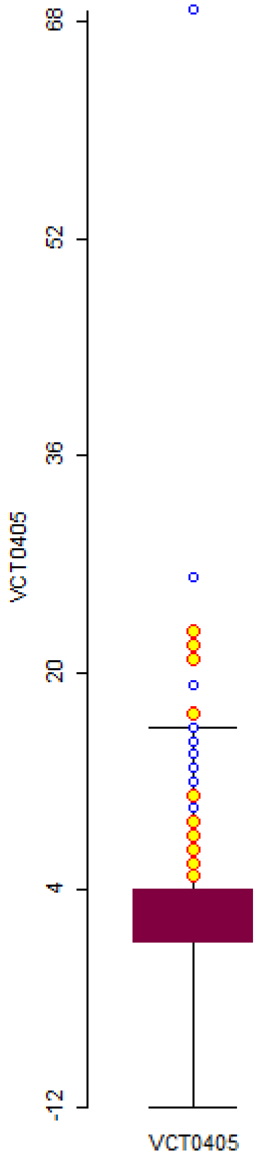


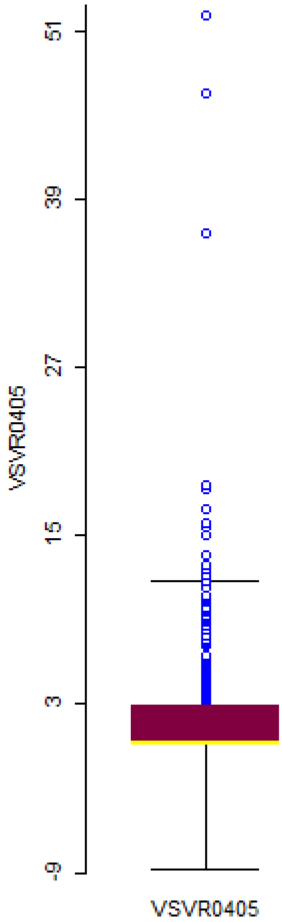


Hinge 3.0 Outliers brushed - OA areas by Hectare (outsize areas)



Hinge 3.0 Vandalism Counts linked to above plot





	VCT0405		VSVR0405
min	0	min	0
max	69	max	52.05
Q1	0	Q1	0
median	2	median	1.1
Q3	4	Q3	2.95
IQR	4	IQR	2.95
mean	3.474	mean	2.547
s.d.	5.286	s.d.	4.774

Box plots for Counts and SVR standardisation linked to outlier ‘large area’ Output Areas

Figure 4.24 – Effects of a large area can skew counts but has less effect on data standardised by area

This effect is further shown in figure 4.24 where Output Areas which are much larger than the other Output Areas in the study areas (at above 3 times the range of values the middle 50% of the data have) are highlighted. As can be seen a number of these areas have high counts, but none have some of the highest rates of vandalism. Standardisation also had an effect on looking at changes over time using trajectory models, although it did not affect overall patterns of high and low areas that were identified.

A little later in the research process updates to the OpenGeoDa programme allowed G_i* analysis to be completed simply at Output Area level (based on pseudo significance levels generated by an Monte Carlo Markov Chain –MCMC - process) using the same underlying weights as used for LISA analysis. This enabled comparison of Output Area counts and rates for different years using G_i*- a process not available through OpenGeoDa when the focus groups were held. These visualisations, like the Local Moran's I analysis previously carried out, looked at both counts and rates at OA and Datazone level and illustrated the value of looking at different types of standardisation to understand the complexities of concentrations of vandalisms in the area.

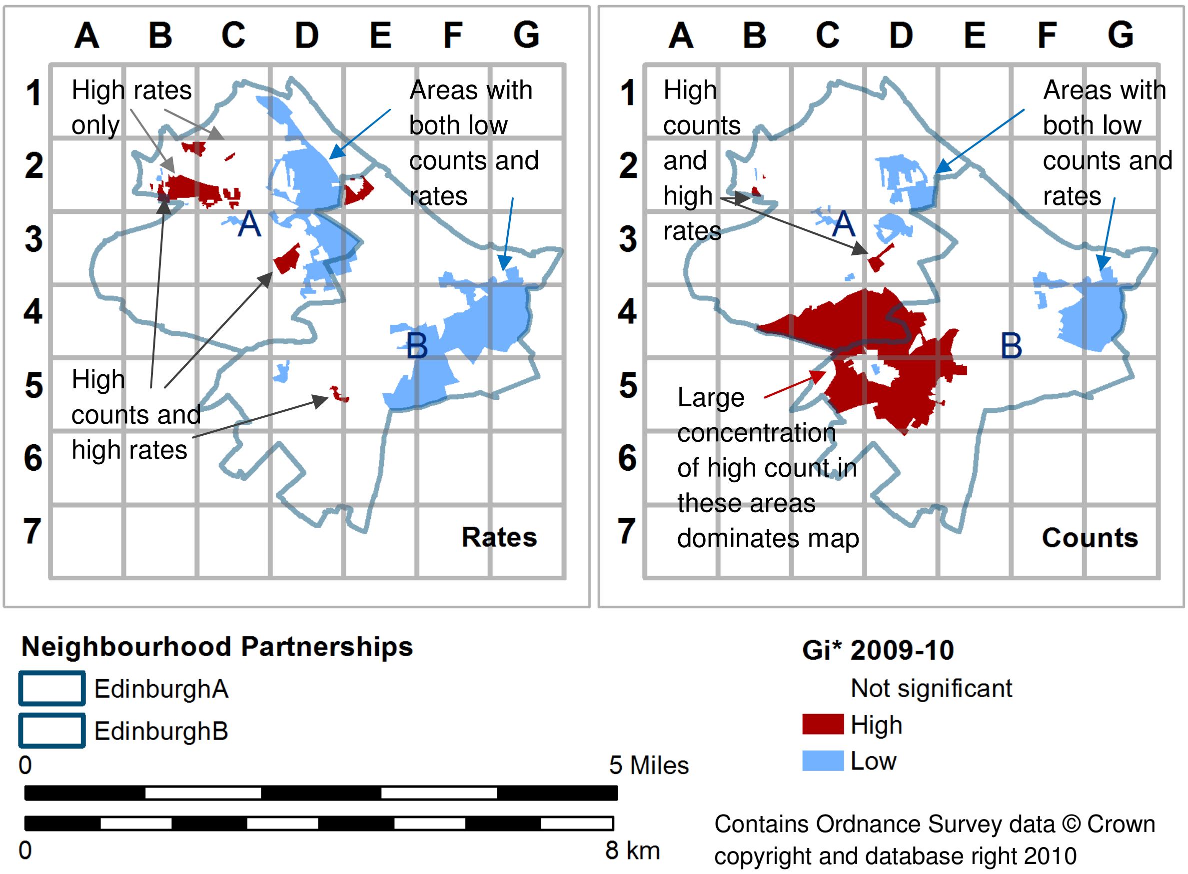


Figure 4.25: G_i* High and Low Areas – Vandalisms - Rates per hectare per OA and Counts per OA (Significant at p0.05 or better)

Figure 4.25 using counts to visualise data using the G_i* technique allows high counts across larger OA in some cases to dominate the visualisation, whereas for low rates some larger areas can also dominate the visualisation. However, by viewing both these visualisation side by side, thereby not giving one priority over the other, some interesting areas that have both high and low concentrations of vandalisms at OA level for rates per hectare are highlighted. For the small mini-neighbourhoods where both rates and counts are significant, these are areas where there is both significantly high (or significantly low) levels of vandalisms in terms of available space to vandalise things but also occurring (or not occurring) within a mini-neighbourhood in which people have similar characteristics (since OAs are designed with the aim the populations to be relatively homogenous at least as at census day in April 2001). The maps also suggest that since using a counts based visualisation, the south east of the map clearly dominates in terms of high counts, thus the south east is where the greatest volume of vandalisms across the area occur and therefore might appear to be the area with the biggest problem.

However, if rates are considered, instead of counts, there are also areas in the north west of the case study area where there are significantly high levels of vandalism where local communities may feel they are adversely affected by vandalism and therefore my be very concerned by this, even though counts are much lower than for those living in the south of the case study area. Policy makers concentrating on volume crime might be tempted to focus on the south of the area ignoring the north of the area as using counts these areas might appear less important; however rates of vandalisms in the north of the case study are significantly high so residents may have legitimate cause for concern. Using both counts and rates to visualise data can therefore potentially give insights into the potential contrasting impacts of vandalisms on local communities.

4.6 A brief note on vandalisms complexity

> "So in summary I'd say you've got the transient, people passing through area with the alcohol, under the influence of alcohol where generally you wouldn't get damage, but they're doing it because they're either drunk or they see them as being more privileged than they are so they'll go and do a little bit of nuisance on the way through. The places where it's really run down already, and not looking very nice anyway I think young people tend to think, {A says in background "What does it matter"} well, if we cause damage here what does it matter, you know, the place is run down, it looks a mess, we're not really gonna make it worse let's have a bit fun smashing a window or something which then appears to go away as the area gets developed. You've got the stuff that is either boredom, anti-social behaviour or maybe to do with a little bit of hatred for other people where things are being thrown at windows causing damage, and then you've got your tagging, your graffiti"(Community Officer Focus Group 3)

Vandalism is a complicated phenomenon as the above quote demonstrates. All the above analysis might suggest that vandalisms can be considered as one homogenous group of similar crimes which all cluster together as high concentrations of crimes in certain locations. This conclusion should not be reached as the above quote demonstrates that there are many kinds of vandalism taking place in the study area in different types of places for different reasons. The measure used - All Vandalisms and Fire-raising – therefore provides a useful proxy measure for the overall phenomena.

4.7 Chapter 4 – Concluding remarks

Key research questions to be considered therefore are:-

4) Are there areas (places) that experience high and low concentrations vandalism year and year out?

5) Do concentrations of vandalism change over space and time, and are there any particular patterns that appear to exist?

6) Do places which experience either low or high concentrations of vandalism over time appear to have any common features or shared characteristics?

These results show that the simple answers to questions one and two are yes there are places that experience high and low concentrations over time and there is change over time. Turning to the second part of question it has been quite difficult from the multiple visualisations shown here to unpick the precise patterns over time occurring, there is some suggestion of changing high areas, and more stable low areas but this is not clear. In the following chapter 5 we move on to look at the nature of these patterns using group trajectory analysis which allows these patterns to be identified more clearly. This results section has not addressed question 3 at all (characteristics of high and low areas) and this will now be considered towards the end of chapter 5, and in much more detail as we examine the nature of vandalisms in the Neighbourhood Partnership areas Edinburgh A and Edinburgh B in Chapters 6.

Methodologically the aims of this research are to:-

- To investigate the value of using an Exploratory Spatial Data Analysis methodology to examining research questions related to crime and place.
- To look at how ESDA techniques and qualitative techniques including ideas from qualitative GIS might be used

This chapter has demonstrates that ESDA techniques such as KDE clustering and in particular LISA analysis using Gi* and Local Moran's I can provide invaluable insights into crimes such as vandalism showing conclusively the presence of high and low vandalisms. Ground truthing these visualisations by reference to maps drawn of high and low areas by Police Officer involved in community policing has been shown to be a useful way of assessing some of the strengths and weaknesses of these techniques.

A further key methodological aim was to

- consider the necessity of exploring multiple spatial and temporal scales in crime and place research, is it enough to just concentrate on micro or macro scales or do both need to be considered

This chapter has demonstrated that a number of key challenges are posed by scale as vandalism data visualised and reported at different scales can yield very different results. It also suggested that from a practical point of view Police Officers actually interpret crime occurring on the ground in terms of different scales (some crime problem areas are seen to be just a single part of a street or building, other areas are whole neighbourhoods). So, for policy makers using different scales reflects the reality of needing to consider areas both street by street and strategically. The research suggests that is valuable to consider data at a very micro scale but also to look at data at a coarser scale. The chapter has also briefly flagged up that standardising crime data should be considered carefully and simultaneous use of different standardisations should be considered. Finally a note was made of how this ESDA analysis is not on its own able to capture all the multi-faceted complexities of vandalisms, qualitative data from focus groups alongside the ESDA analysis has been needed for this.

However, none of the discussion of techniques used so far has demonstrated a technique which enables an analyst or researcher to simply summarise how vandalism concentration changes across years using mapping, or provides methods to explore why this might be; in other words, in addition to just showing results from a number of years, it would be considered further how temporal concentrations might be investigated and represented. As this was a further key aim of this project, so we now move on to look at changes over time in more detail and consider the patterns identified within these trajectories across time using group trajectory analysis.

5 Analysing Changes over time Using Group Trajectory Analysis

5.1 Introduction

This chapter begins by looking at how patterns of high and low levels of vandalisms across six years can be summarised into a single summary map, rather than using multiple maps. It uses Group Trajectory Models to demonstrate how this can be done and demonstrates how the areas experiencing vandalisms can be broadly grouped in four groups. These four groups are: a mostly High group experiencing the highest volume of vandalisms; a medium group (Drifting – High) who experience over 2 vandalisms a year but much less than the high group; a low group who perhaps will experience 1 or 2 vandalisms a year (Drifting – Low); and a very consistent very low group of areas who experience no, or perhaps occasionally one vandalism a year (Consistently Low). Examining these patterns at both Output Area (OA) and Grid Scale demonstrates that while these groupings are robust to scale, the choice of scale does affect the complexity of processes observed, and the ease of summarising the phenomena. OA analysis produces a clear summary visualisation but loses some potentially important complexity demonstrated by analysis of Grid data. There is a brief report of trajectory models looking at temporal effects, how levels of vandalism change through the day, across days of the week and months. The chapter then goes on to do some exploratory analysis using multinomial logistic regression to offer possible explanations of why areas fall into High, Drifting and Consistently Low groups. This is done by considering why areas fall within the 'High' or Drifting groups compared to the 'Consistently Low' group or why they are in the Drifting or Consistently Low group compared to the High group. The analysis uses variables based on nationally available Scottish socio-demographic and map data which are used as proxies for potential theoretical explanations related to Routine Activities, Use and Abuse of Space and and Persistent Inequality. These models suggest all these factors are relevant, but the scale data are analysed at can be crucial to the possible explanations offered. Finally a concluding summary assesses how well these group trajectory models answer the research questions posed by the theoretical and methodological review.

5.2 A process of stability and change

The overall trend of recorded vandalism across the study area showed that crime increased from 2004-5, being at its highest between 1 April 2005 and 31st March 2008, falling noticeably in the years 2008-9 and 2009-10 (Figure 5.1). As discussed in Chapter 4, the initial ESDA and focus group discussions suggested that there might be some areas which had stable low values over years and also some areas where values tended to be high year on year; these sub-groups are effectively hidden within this overall trend.

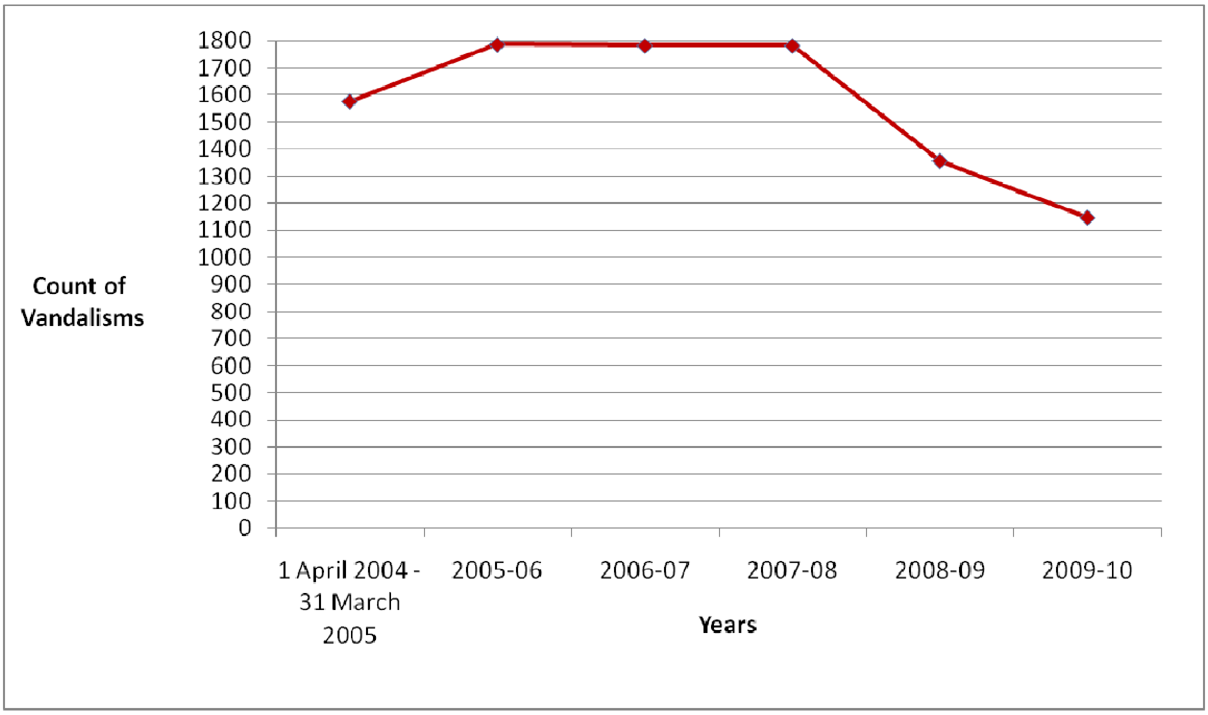


Figure 5.1 Overall trends in vandalisms and fire-raising across the study period

As reported in Chapter 4 clustering, as represented by nearest neighbour distances, also changed over time with vandalisms becoming less tightly clustered in 2008-9 and 2009-10. Generally results reported in Chapter 4 suggest there was both stability and change in high and low levels over time but assessing the nature of this change just by looking at multiple visualisations was proving complex. Generally results reported in Chapter 4 suggested that low areas seem to be relatively stable over time but areas with high concentrations of vandalism tend to move around more. This appears to be a key finding from the Exploratory Spatial Data Analysis to this point. However, it would be useful to clarify or confirm this finding using additional visualisations and exploratory techniques.

The first method tried was to look at changes between years. What was found was that counts were so low in a number of areas, even at the coarser Datazone level, that it was difficult to clearly detect changes using a simple analysis which assessed if the change year on year in localised areas was what might be expected compared to the change year to year across the study area as a whole. As an alternative parallel co-ordinate plots were used at multiple scales (Grid, OA and Datazone). These plots show an individual trend line for each individual areal unit. Whilst the plots did show some evidence of consistently low areas (with low concentrations of vandalism year on year) and fluctuating high areas (where high concentrations of vandalism were generally above average but levels varied year to year). It was difficult to pick out clear potential groups of high and low areas, and at the finest scale (Grid) there were so many different trajectory paths the plots were difficult to read and potentially misleading.

It was therefore decided that after using these basic ESDA techniques and finding them not that successful for clarifying patterns of high and low areas over time, a more advanced technique would be used which could find latent classes (distinct groups of trajectory paths) within all the different trajectories occurring across the study period. The technique needed to handle low numbers by using either zero inflated poisson or negative binomial models. It also needed to establish on some form of probabilistic basis how likely it was there actually were patterns of low and high trajectories over time as seemed to be suggested by the LISA and G_i* visualisations and the parallel co-ordinate plots. Thus analysis moved on to look at Group Trajectory Analysis as this technique is able to find distinct groups of trajectories within a large data set (often known as latent classes), and provides a statistical basis for establishing and assessing the most likely groups of values (as discussed in chapter 3). Only the results of negative binomial models are presented here as they were generally found to perform better than zero inflated poisson models with generally having lower Adjusted BIC scores – the preferred measure of fit for Group Trajectory Models.

Group trajectory analysis found there were clear latent class groupings of high and low areas. Broadly speaking at both 100m by 100m Grid and OA – the two scales at which group trajectory analysis was undertaken - the simplest model which demonstrated the patterns found at both scales is a latent class model of 4 classes. This style of 4 class model was seen in much of the group trajectory analysis undertaken (including when the data was looked at for just the case study sub-areas) so is presented first here as it provides what may be the more generalisable result that may be most likely to apply to other areas.

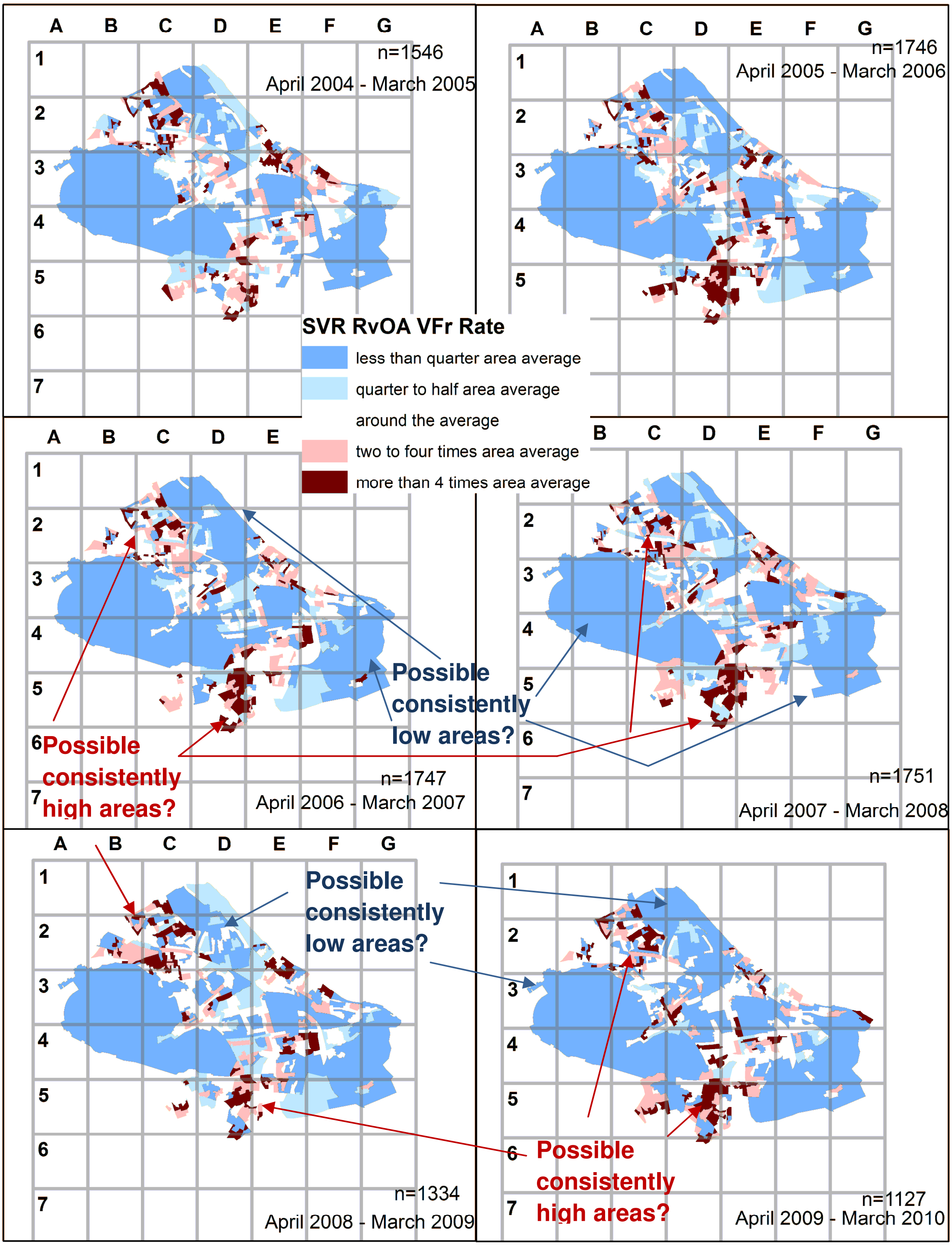
These four classes are:

1) **High** - a class of areas where vandalisms were fairly consistently high.
2) **Drifting to Low** - where vandalisms are above average but not necessarily very high.
3) **Drifting to High** - where vandalisms were low but not 0 in every year.
4) **Consistently Low** - where vandalisms were consistently around 0 in the area year on year.

A number of different group trajectory models were analysed. Those with the best fit, clearest groups and least errors are presented here, some additional models are presented in Appendix 5. This chapter begins discussion of these models by looking at one of the simpler models the four class OA Categorical model.

5.2.1 The Four Class Categorical Output Area (OA) Model

The preferred OA 4 class categorical model is presented here first. This model is both fairly simple to explain, and provides a very useful summary of overall trends across the study area. This model is presented in some detail so the stages of deciding how to describe each of the latent class groups discovered by the modelling process are made very transparent. Subsequent group trajectory models are presented more briefly.



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All Vandalisms - Vandalism, Malicious Mischief and Fire-raising

Figure 5.2 Standardised Vandalism Ratios for each year across the whole case study area for Output Areas (OAs).

For each year OAs were assigned to one of 5 categories depending on their standardised vandalism ratio (SVR) of cases of vandalism and fire-raisings per hectare. Category 1 (Low) were OAs where rates of vandalisms per hectare were less than a quarter that of the area average; Category 2 (Below average) were OAs with rates of vandalisms per hectare between a quarter and half that of the average for the area, Category 3 (Around Average) were areas where the rate was around the average rate per area; Category 4 (Above Average) was OAs where the rate of vandalisms per hectare was two to four times the area average; and Category 5 (High) was those OAs with the highest rates of vandalisms 4 or more times the areas average. These categories can be seen mapped for each of the years of the case study period in Figure 5.2; the complexity of patterns year by year is clear. Figure 5.2 suggests that some high areas and some low areas might be consistent – but just looking at the images it is very difficult to pick out clearly which these areas might be.

The group trajectory model was therefore seeking to see if it was possible to summarise figure 5.2 which shows the SVR for each of the six years of the case study period into a single explanatory model which showed whether there actually were groups of high and low areas across the six year period. The group trajectory categorical analysis provides a way, which includes a statistical best fit measure, which allows these groups of high and low areas across time to be identified and described. It proves to be an extremely useful way of summarising these high, low and in between groups into one single map. Once these groups have been identified reasons why certain areas are in the high or low groups can be considered (and this is done in the second section of this chapter and in further detail in Chapter 6 which look at the case study sub-area Neighbourhood Partnership areas). Figure 5.3 shows this 4 class summary model for Standardised Vandalism Ratio categories.

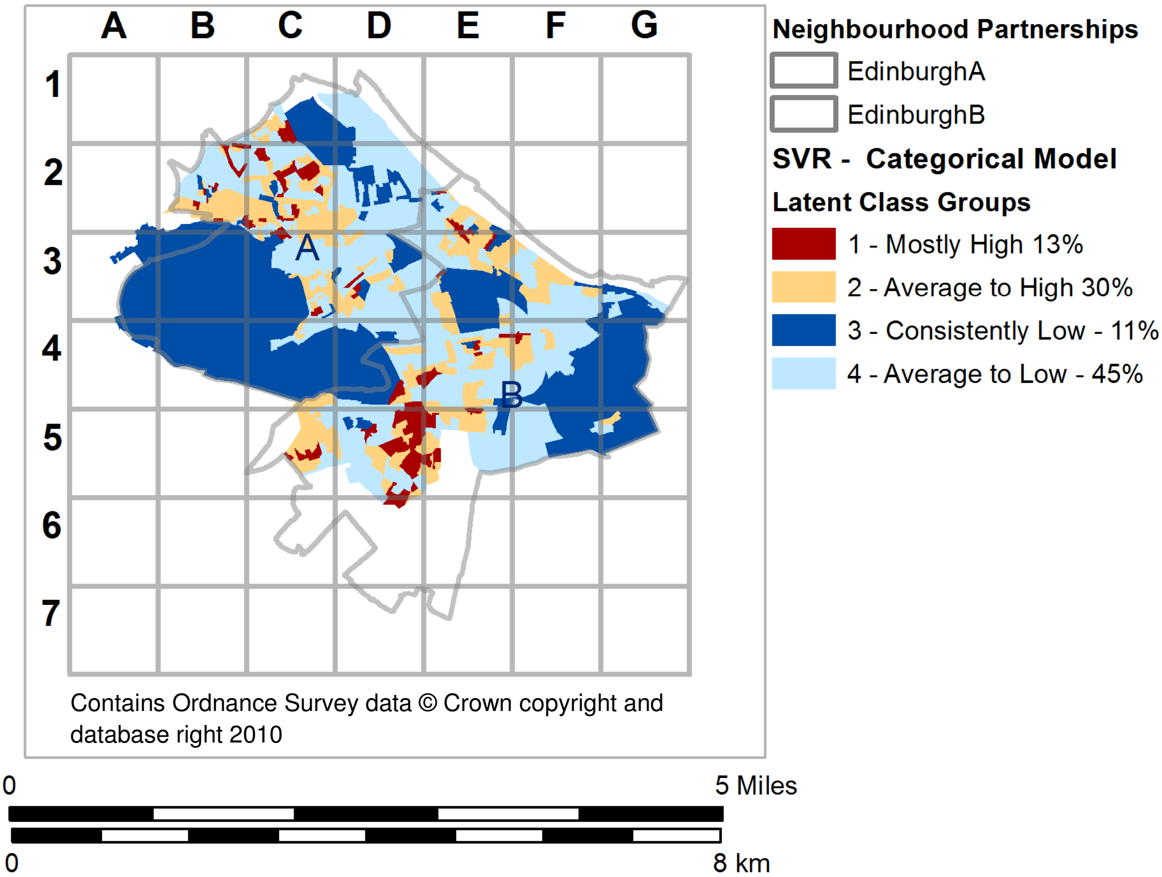


Figure 5.3: Four Class SVR Group Trajectory Model – Map of Case Study Area

This model shows that around 13% of OAs fall within a Mostly High latent class (this is the High group); 58 areas are most likely to be in this group. As ESDA analysis had already indicated that areas tended to move between SVR groups it was not surprising to find that each of the 4 latent classes identified there was a mix of SVR categories (and it is usual in latent class models to find a mix of categories in each latent class group). This High group is made up predominantly of areas that were in the High or Above average SVR categories.

In Figure 5.4 the majority of High Group (labelled Mostly High) - is made up of the SVR category 5 (High) every year with 71% in 2008-09 and 87% in 2005-06 falling in this high category. A smaller proportion was in SVR Category 4 (Above Average) - between 10 and 20% depending on the year. A few of the Output Areas in this class fell in Category 3 around average, between 3 and 7%. Only 1% (often less) of the Output Areas were in the below average or low classes (Figure 5.4).

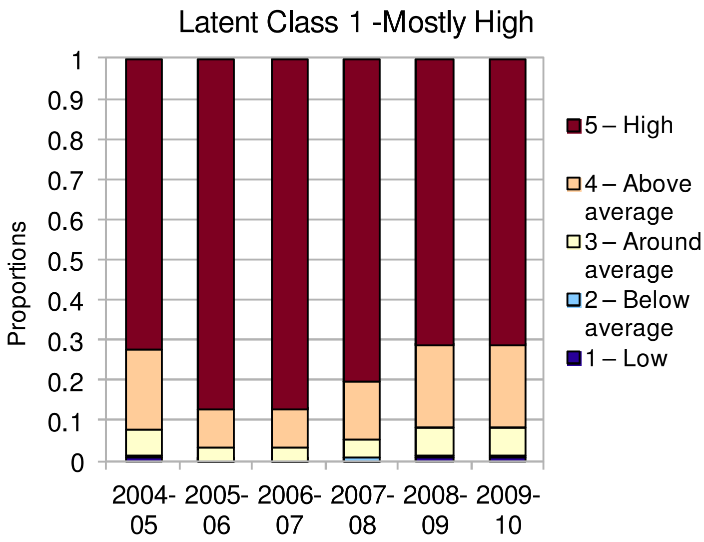


Figure 5.4 OA Categorical 4 class model – membership of Latent Class 1 – the High Group

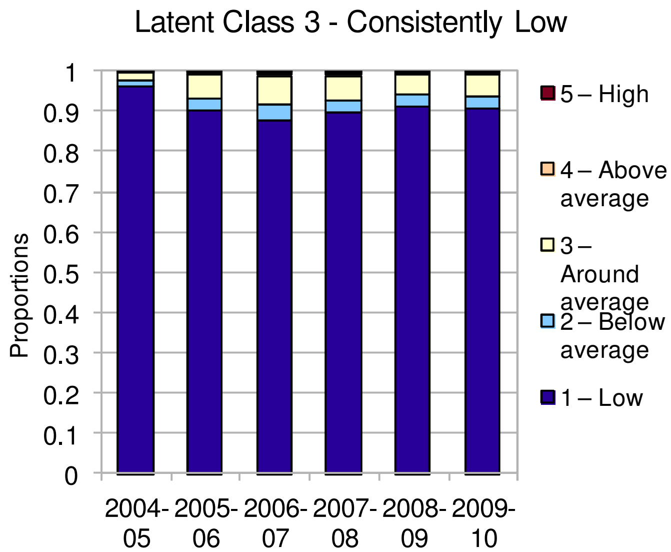


Figure 5.5 OA Categorical 4 class model – membership of Latent Class 3 – Consistently low.

In Figure 5.5The Consistently Low class, latent class 3, is made up of areas that are almost entirely in the low category – category 1 where the rate of vandalisms per hectare is less than a quarter of that of the area's average. Of the Output Areas most likely to be in this class between

88% (2006-07) at the lowest and 96% at the highest (2004-5) are in the low category 1. Only around 1% or less of this Consistently Low latent class were in the high or above average SVR categories (Figure 5.5). This class makes up 11% of all Output Areas with 49 Output Areas most likely to be in this class.

Figure 5.6 shows the consistently low areas and the mostly high areas mapped. The darker areas are Output Areas that have a higher probability of being in either the High (latent class 1 – labelled Mostly High) group or the Consistently Low group (latent class 3). There is a clear cluster of High areas in Edinburgh B around the D5 reference cell, and a grouping of High areas that adjoin some consistently low areas in Edinburgh A in cell C2. There are then groupings of consistently low areas at D2 and F4 and G4. The big blue area B3, C3, C4 is mainly a very large park and recreation area. Explanations for why these areas are where they are will be considered in additional detail in Chapters 6 and 7 when commentary from the focus groups with Community Police Officers is discussed– general explanatory factors based on socio-demographic data are considered in the next section of this chapter.

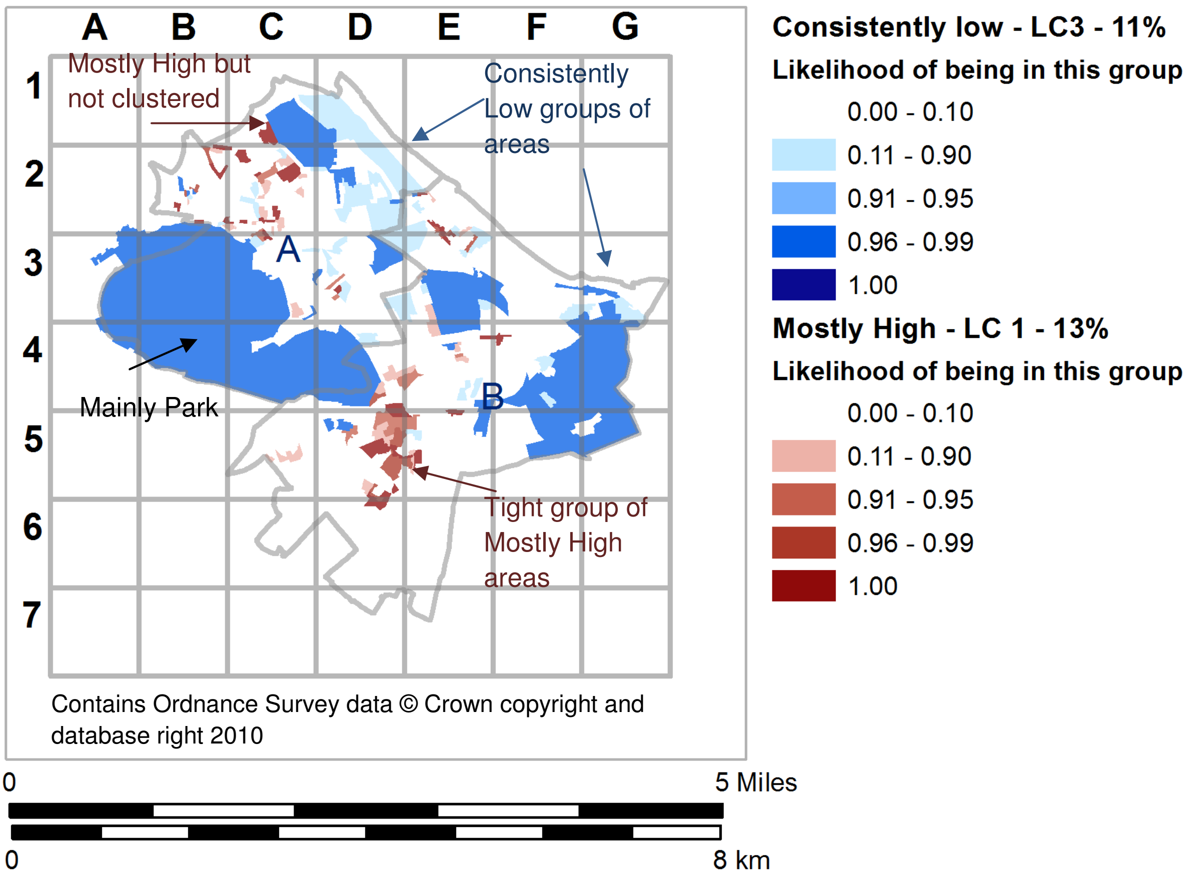


Figure 5.6: SVR Output Area (OA) Group Trajectory model - Probability of an OA being in a particular latent class - Consistently Low and High OAs mapped

The group trajectory model is a probability based maximum likelihood model, thus it shows the propensity to be in one class rather than another, and also provides information on other possible latent classes an Output Area could be in; there is no overlap between the Output Areas in the High (latent class 1) and the Consistently Low (latent class 3). In other words OAs are either in the High class or the Consistently Low class (never both). The Consistently Low (latent class 3) does overlap with Class 4 the average to low (Drifting to Low) class but not the average to high (Drifting to High) class 2 or the High class. Similarly the High Class does overlap with the Drifting to High class 2 but not the Drifting to Low class 4 (Figure 5.7).

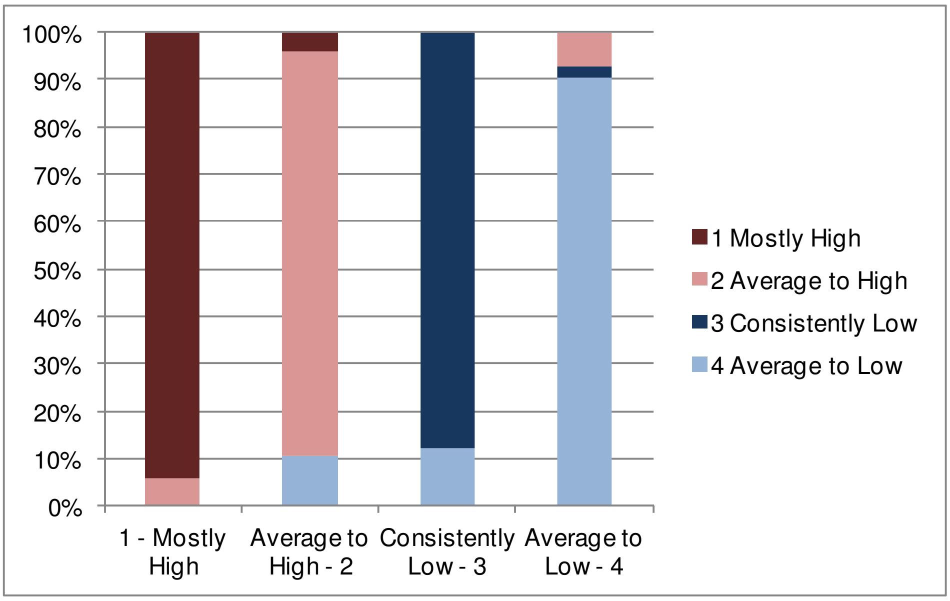


Figure 5.7 – SVR Categorical Model - Proportion of OAs falling in one group that could also fall within another latent class group

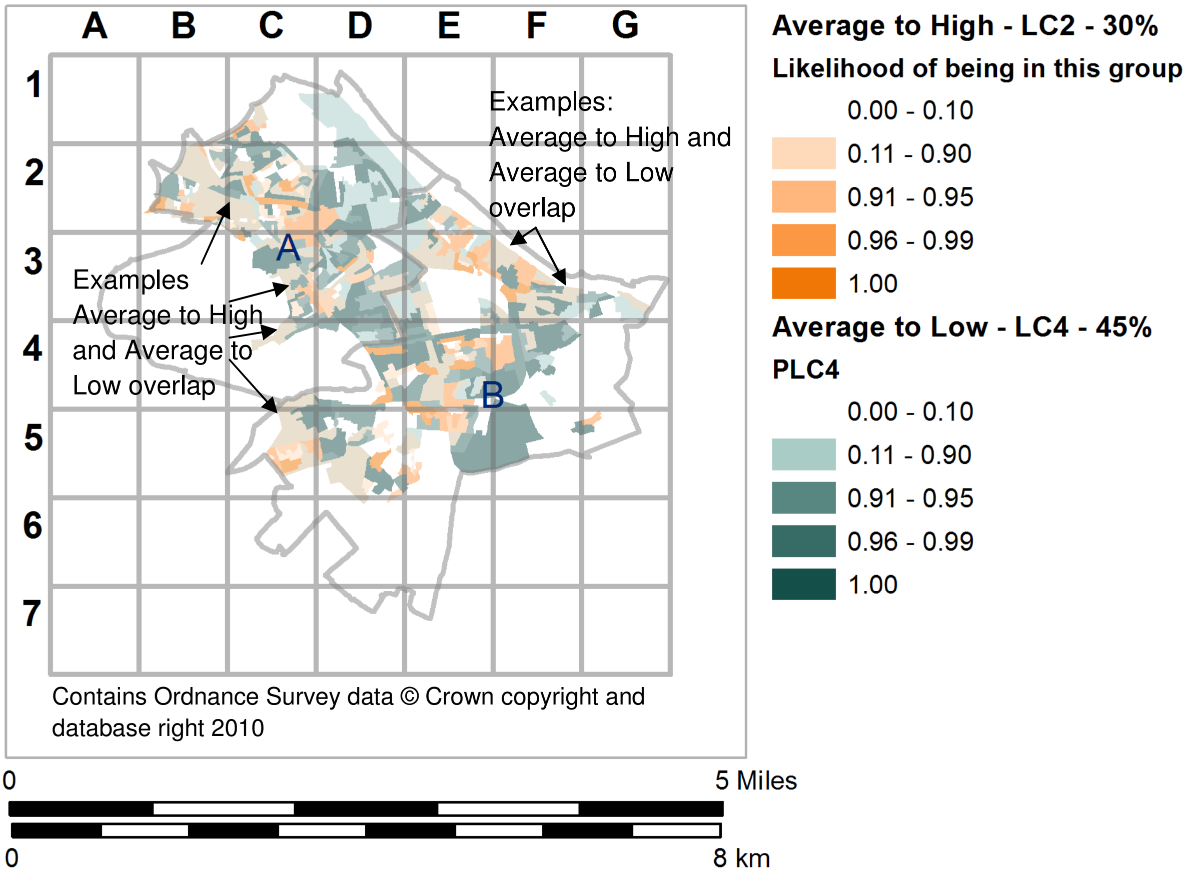


Figure 5.8 – SVR Categorical 4 class model - Overlap of OAs in the Drifting to High (LC2) and Drifting to Low (LC4) Classes mapped

The Drifting to High (Average to High) and the Drifting to Low (Average to Low) overlap more with each other as can be seen in Figures 5.7 and 5.8. In figure 5.8 the green shading for the average to low and the orange shading for the average to high classes has been made slightly transparent so where the OAs become a muddy yellowy green colour this indicates an overlap in whether the OA could be in the Drifting to High or the Drifting to Low class. Some examples of this are highlighted through the annotations to the map. A similar overlap can be seen in the make up of which SVR categories make up the latent class groups. Latent class 2 the Drifting to High group is primarily comprised of the around average (Category 3), Above Average (Category 4) and High (Category 5) categories. Whilst latent class 4 (Drifting to Low) is comprised mainly of the Around Average (Category 3) and Low (Category 1) SVR categories. (Figure 5.9)

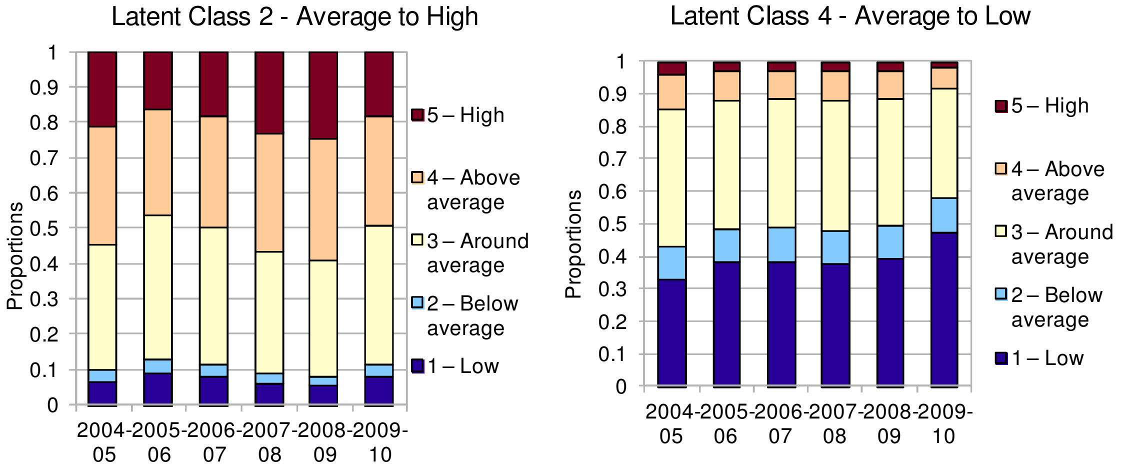


Figure 5.9 SVR 4 class Categorical OA model – SVR categories in the Latent Class 2 Drifting to high and Latent Class 4 Drifting to Low

5.2.2 The Four Class 100m by 100m Negative Binomial Count Model

The second model presented shows the group trajectory analysis at 100m by 100m grid levels of counts of vandalisms and fire-raising. The Grid count model tested to see if there were latent groups (or classes) within the overall trajectory trend of crimes shown in Figure 5.1; in effect were there two or more classes grouped around similar mean levels of vandalism count in each year following a similar shape of trajectory path across the six year of the study period, but did these groups themselves have the same trajectory as that seen for the area as a whole or did they have their own different and distinct trajectories? This type of model works slightly differently to the categorical model above as it also enables a series of trajectory paths to be drawn to predict the mean values of each of the 'discovered' groups in a given year. This is best demonstrated using actual results of the 4 class grid model. Figure 5.10 shows the trajectory paths of 4 groups identified by the Negative Binomial count model for the 100 by 100m Grid scale. As can be seen the trajectory paths of the groups identified, and plotted on the graph as trend lines in Figure 5.10, are distinctly different.

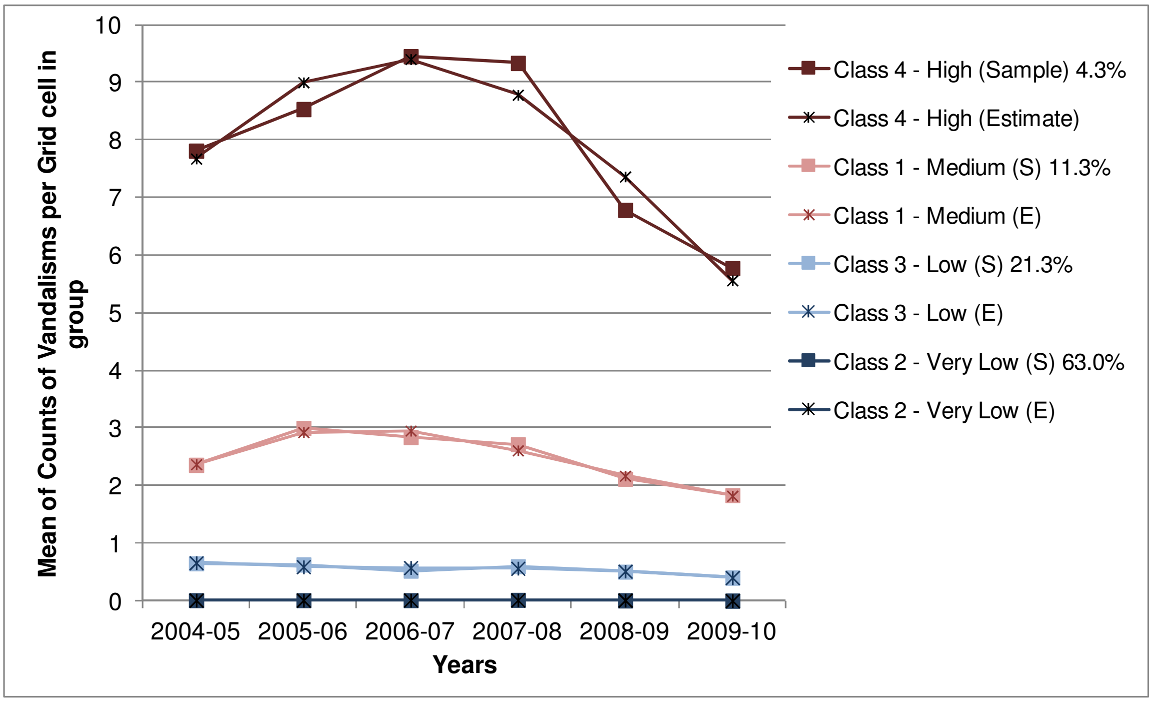


Figure 5.10 Four Class Group Trajectory Model for 100m Grid Cells – Vandalism counts – Trajectory Paths of Groups

For the first group - Latent Class 4 – High - when the means of all the grid cells in that group are taken and plotted the trajectory is a similar shape to that for the whole area in Figure 5.1 but it rises more sharply than the overall area in earlier years of the study period and falls off more steeply in later years. For this High class two trajectory lines are plotted (as for all other groups) – the top line with square blocks represents the actual means of the sample falling within this group, the narrower lines with the stars represents the values of means estimated for each class by the model. The estimate and sample are fairly close in values for the high values with some differences. Mean values in this group vary from around 5.7 at the lowest in 2009-10 to 9.5 in 2006-07. The Medium group (Drifting to High - Latent Class 1), making up 11.3% of the 2,094 100x 100m grid cells in the study area, shows a much more similar trajectory path to that of the whole area – this is a group of cells whose means vary around 2- 3 counts of vandalisms per grid cell (the estimated means derived from the model are very similar to the sample means).(Figure 5.10) The third group is a Low group (Drifting to Low - latent class 3) of group cells which make up 21.3% of grid cells in the study area – here the mean of the group is around 0.5 so grid cells in this group typically experience 1 vandalism in one year but 0 in the next. The final group is the Consistently Low group at this scale, a very low group and is the majority of grid cells in the area, nearly two thirds (63%) of grid cells are in this group – and these are typically micro sized areas experiencing 0 vandalisms in the year. (Again for both the low and very low models the estimated means are extremely similar to the sample means). For both the low classes the trajectory path is much flatter than that of overall counts in the area per year.

This Four Class Grid model demonstrates that as we drill down to the micro scale there are very few areas actually experiencing recorded vandalism. Over 95% of the areas in the case study area are experiencing on average two or less vandalism a year, reinforcing the argument that locations with recorded vandalisms are rare. Whilst the models are differently constructed (one uses actual counts, the other representative categories) it is interesting to contrast this Four Class Grid Negative Binomial Count Model with the SVR Categorical 4 class OA model. In the SVR Categorical OA Model 13% of Output Areas (mini –neighbourhoods) come in the High group (experiencing higher levels of vandalisms than the area average), in the Grid Count Model 4.3% of the 100 by 100m micro-areas are in the High group, although a further 11.3% are in the Drifting to High (Medium) group. This suggests that, although at the micro level (Grid) very few locations are affected by high concentrations of vandalisms, a greater proportion of neighbourhoods (as represented here by OAs) may be experiencing some high concentrations of vandalism somewhere within the local community, albeit that it may not occur on their doorstep.

For the model using Grid data, as with the model using OA data, there is no overlap between the High class and the Consistently Low (very low) class (Figure 5.11). There is some overlap between the Drifting to High (medium trajectory) and High classes, and also overlap between the Drifting to High (medium trajectory) and Drifting to Low (low trajectory) classes. Similarly there is some overlap between the Consistently Low (very low trajectory) and (Drifting to Low) (low trajectory) classes. As with the Output Area model, the Grid model can also be used to produce a summary maps shaded according to the likelihood that a grid cell may be in particular class (Figure 5.12 and Figure 5.13).

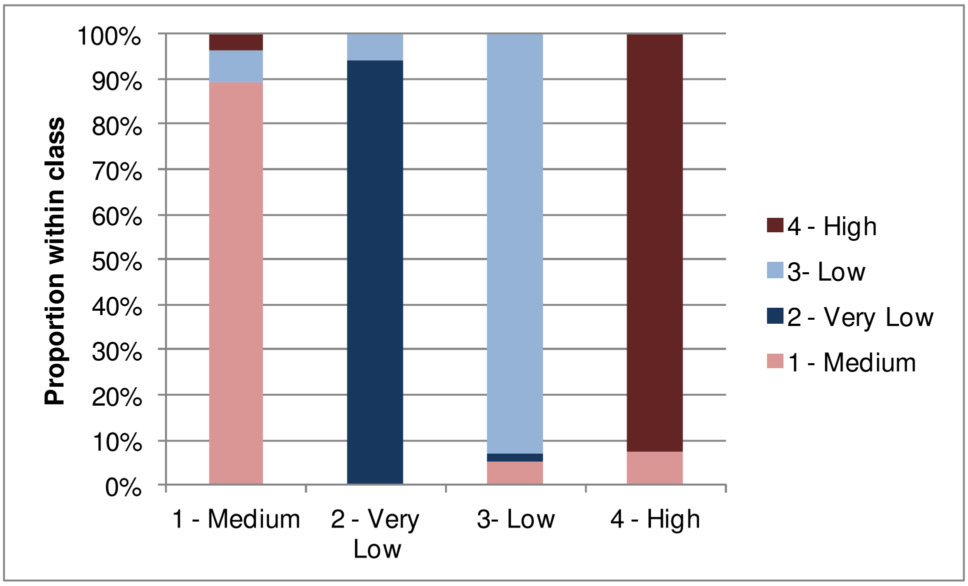


Figure 5.11 – Grid Count 4 class model - Proportion of Grid Cells falling in one group that could also fall within another latent class group

Examining Figure 5.12 which shows the High, Drifting to High (medium trajectory) and Drifting to Low (low trajectory) classes mapped, the Consistently Low class is not included in the map. The shading of each class has been made partially transparent so that the classes can overlap and where a grid cell has a probability of being in more than one class it can be shaded with colours for both these classes and this shading will overlap. The darker the shading of each class, the higher the probability that the grid cell falls within this group. Although it is a little more difficult to pick out than in the OA maps above (Figures 5.6 and 5.8) the overlap between classes seen in the chart above (Figure 5.11) can also be seen here for example there is overlap between Drifting to High (medium trajectory) and High groups (with some grid cells having a likelihood of being in both of these groups) – see for example on the border of E2 and E3. Interestingly in Figure 5.11, whilst there are no overlaps between High and Drifting to Low (low trajectory) areas, you do get locations where grid cells in the High group are adjacent to grid cells in the Drifting to Low group (see around the top of C2 and in B2). In other areas you are more likely to get a mix of Drifting to Low and Drifting to High (medium trajectory) micro-areas (for example C3 / D3) or a mix of High and Drifting to High areas (for example D5 / E5). This again demonstrates how a neighbourhood might feel if there is a vandalisms problem even though in many locations in the neighbourhood there is no vandalism as vandalism is scattered across the local area so although they may not happen next to your house, they might occur in the next street or at your local shop in areas you are familiar with.

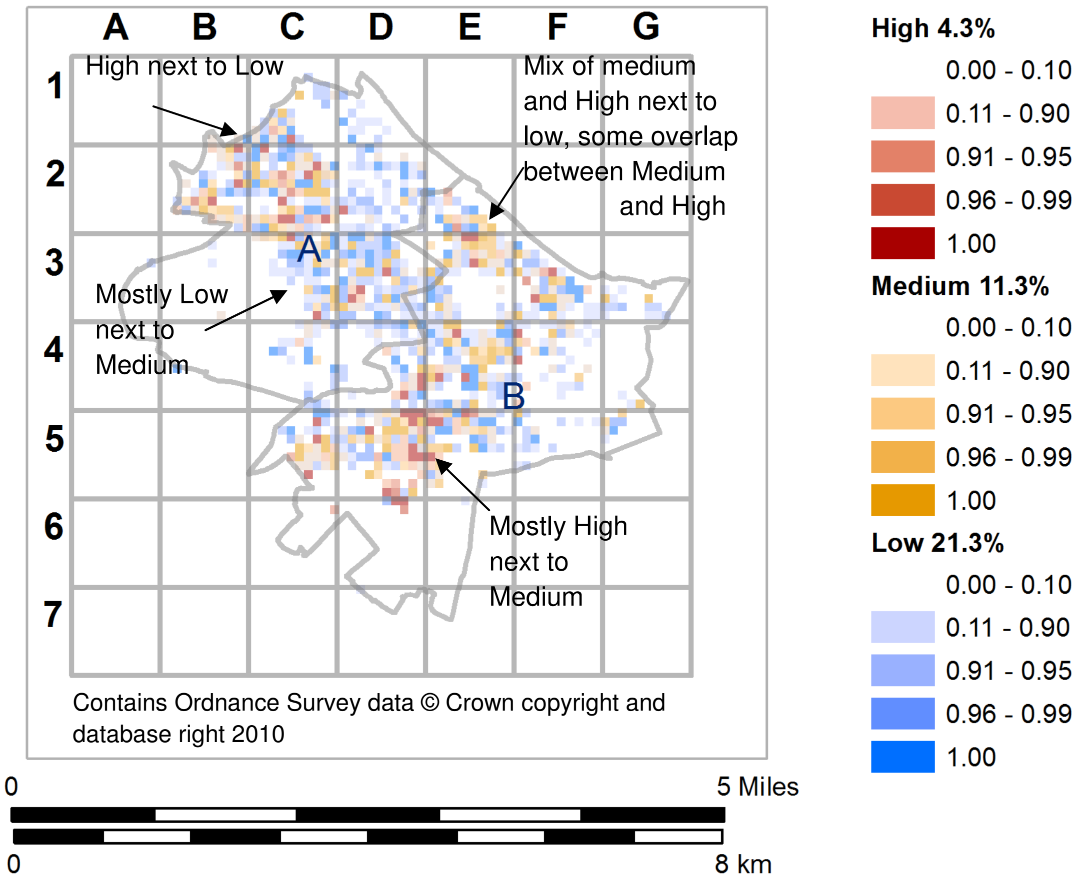


Figure 5.12 – Grid Count 4 Class Group Trajectory model – High, Medium and Low areas mapped

Looking at the visualisation of low and very low areas shown in Figure 5.12 one striking feature is that many of the very low areas have a very high probability (over 99% likely) of being in the very low group which can be seen from the fairly uniform dark shading of the very low groups. There is clear overlap between the low and very low groups. It should also be noted how nearly two thirds (63%) of the case study area is experiencing no vandalism at the micro scale. Overall taking the Drifting to Low and Consistently Low (very low trajectory) areas combined the vast majority of areas in the case study (84.3%) are experiencing no recorded vandalism – and this is consistent year on year. Also of interest are the white areas (voids) where there is no shading within the study area – these are areas where the grid cell is only likely to be in the high or medium group (see annotations on Figure 5.12); these voids are in effect the areas where vandalism occur and are in very localised spaces.

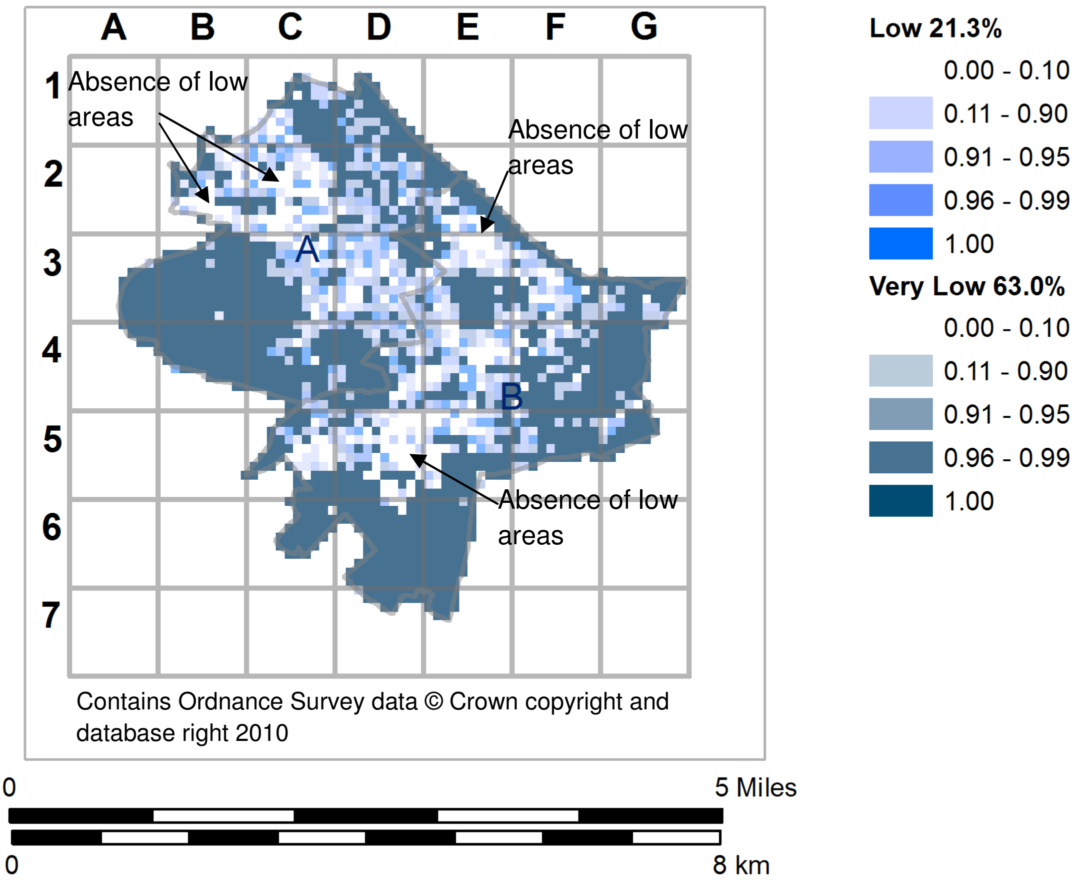


Figure 5.13 – Grid Count 4 Class Group Trajectory model – High, Medium and Low areas mapped

5.2.3 Group Trajectory Models – the value of modelling both a ultra-micro and mini neighbourhood alternate scales

In the above section there has been discussion of how at the ultra-micro grid level vandalism appear to be a very rare event, however when levels of vandalism are considered at a small neighbourhood level what Figure 5.12 and 5.13 above make clear is that whereas hotspot maps may suggest many areas are experiencing a vandalism problem as the eye is drawn to all the areas in which recorded crimes are occurring, what group trajectory analysis visualisations makes clear is that in many micro areas no vandalism occurs at all. It is therefore very important to consider what effect levels of recorded vandalism might be having at more than one scale. Figure 5.14 directly compares maps of the Four class OA Categorical Model with the Four Class Grid Count Model. Both models are similar in that they examine rates per hectare but they differ in the zonation and scale used. As can be seen the boundaries of the grid based are and OA areas do not match exactly – this is because the Ward boundaries on which the study area is based, and which the local police also use as their reporting units, do not exactly match the OA boundaries. This is because the Ward boundaries are produced for electoral and political purposes and the OA boundaries are produced as a statistical geography. Both Models show high and low areas consistent over time as being in broadly the same areas. However, the Grid model highlights how there are micro pockets of high vandalisms, and how very much of the case study area has similarly very low levels of recorded vandalisms (63%). The OA model has both the disadvantage and advantage that it loses some of the complexity of the Grid based model. It is much easier to see which areas are broadly low areas or broadly high areas, but some of the very localised variations are lost.

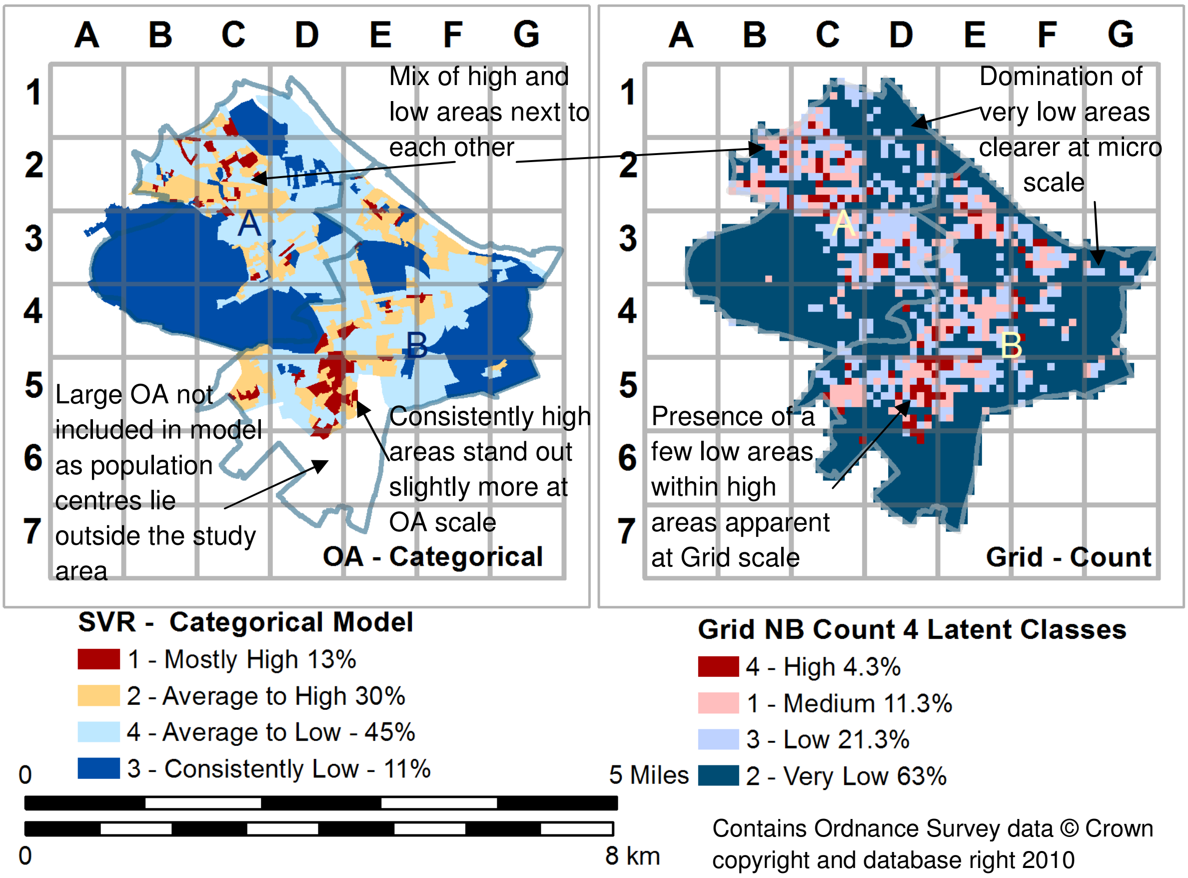


Figure 5.14 Comparing the Group Trajectory Four Class Models for OAs (Categorical Model) and Grid (Negative Binomial Count Model)

Possible explanations for these very localised differences in high and low areas, particularly as suggested by focus group discussions, are discussed in Chapter 6. Factors that may be common to being in a high or alternately a low group in the case study area are presented in the next major section of this chapter.

5.2.4 Assessing Model Best Fit

At this point the fit criteria of the models will be considered in a little more detail. The best fit of a Group Trajectory model is assessed using the Adjusted Bayesian Information Criterion

(BIC), generally the lower the Adjusted BIC score the better the fit – this is however a process of diminishing returns. It can be difficult to judge precisely which model is the best fit when the lowest Adjusted BIC scores are quite close together. In Grid Count and OA categorical models presented above additional models with more latent classes (5 and 6 classes) were run to see if they provided a better fit, whilst the Adjusted BIC score continued to reduce the differences became quite small. Examining differences between Adjusted BIC levels proved to be a very quick and a good method of spotting the likely most useful model (see Table 5.1 and Figure 5.13). Where differences in BIC values were small it proved useful to use the additional more robust significance testing provided by Mplus to assess which. The stars on the charts in Figure 5.15 represent these significance levels (actual values listed in Table 5.1)

Table 5.1 –Best Fit results Group Trajectory Analysis Grid Count and OA Categorical SVR Models

	Grid Count			OA Categorical SVR		
Latent Class	Adj. BIC	Adj. BIC difference	Significance where tested	Adj. BIC	Adj. BIC diff.	Significance where tested
1	24724.71			7988.32		
2	20409.61	4315.10	-	7211.10	777.22	-
3	19381.49	1028.12	-	7010.23	200.87	0.0082
4	19120.21	261.28	0.0008	6942.01	68.22	0.0000
5	19010.60	109.61	0.0159	6927.23	14.78	0.0000
6	18984.40	26.20	0.0507	6925.12	2.11	0.0348
Significance values based on Lo - Mendell - Rubin Adjusted Likelihood Ratio test in Mplus v6.11						

Joseph Hilbe (Hilbe, 2011) suggests that once the difference between BIC levels is less than 30 improvements in models can be marginal and that certainly appeared to be the case here. Using these methods of assessment, whilst the 4 class model might be the most generalisable model, the 6 class models were the best model for both the grid count model and SVR categorical OA model (in the case of the OA model the differences are quite marginal). The 6 class Grid models was also able to highlight specific interesting trajectories that may be particular to this case study area – but also could be present in other similar areas. The 6 class SVR categorical OA model has little to add on overall explanatory power to the 4 class model, however the 6 class grid model does appear to have some particularly interesting additional groups so is now considered here.

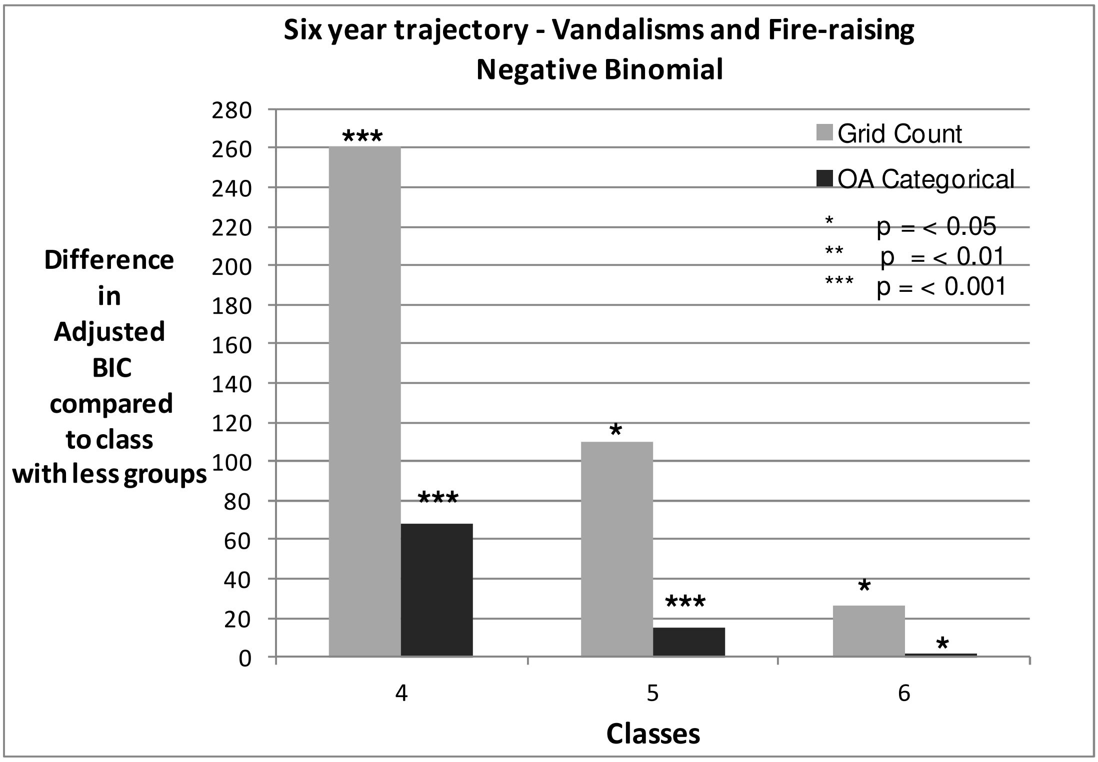


Figure 5.15 Chart showing Best Fit results (Adjusted BIC Difference) for 4, 5 and 6 class models of 6 year Group Trajectory Analysis of Vandalism Counts per Grid, and the SVR OAs Categorical Model

5.2.5 The Six Class 100m by 100m Grid Negative Binomial Count Model

The 6 class Grid model like the 4 class grid model comprises broadly speaking high groups, low groups and some in the middle, but the model also provides some interesting additional information about the higher groups. Basically the high group from the 4 class model splits into two groups a very high falling group and a high stable group. Figure 5.16 graphs the trends of these individual groups determined at grid level. Two lines are shown for each class, the S line represents the average of the actual sample, the E line represents the estimated values; both are shown for completeness. The largest group of areas is class 5 – Very low Stable, the presence of a consistent low group was suggested by the previous ESDA analysis, and this model confirms the existence of a group of areas which have 0 levels of vandalisms year on year Group 5 – the Very Low Stable groups - makes up just under two thirds of the case study area (61.9% of all grid cells). These areas are generally, though not in all cases, in areas where there are no or very few residential addresses. The next largest group – about a fifth (19.8%), class 2, is the Low Stable group, areas that generally have very low levels of vandalisms but may not have 0 vandalisms every year. A further 9% of areas make up the Medium group (class 6) where there are usually around 2 vandalisms a year (this is above the mean level for 100m grid square aggregation) but still quite low. The next, 5.6% of areas (so less than 6 in a 100), are the High Stable areas (class 4); these are areas with on average 6 vandalisms falling to 4 by 2009-10. So already the analysis demonstrates that only a small minority of areas within the study area account for the majority of recorded vandalisms for the whole area. There is then a rather interesting group (class 1) where originally levels were low but they seem to have increased over the last 3 years in the study period. It is not clear what is driving this but it may be linked to demolition and regeneration, or it might be a statistical anomaly. This will be discussed further when accounting for patterns in the EdinburghB area is considered in detail in the subsequent chapter. The final and smallest group, Very High (class 3), represent less than 1% of the areas; these are a small number of areas, usually adjoining other high areas, where very high counts of vandalisms are recorded in a very small number of areas. The trajectory groups are here then shown split between two maps; one map shows 3 groups with higher counts, Figure 5.15, whilst Figure 5.16 shows the lower count groups.

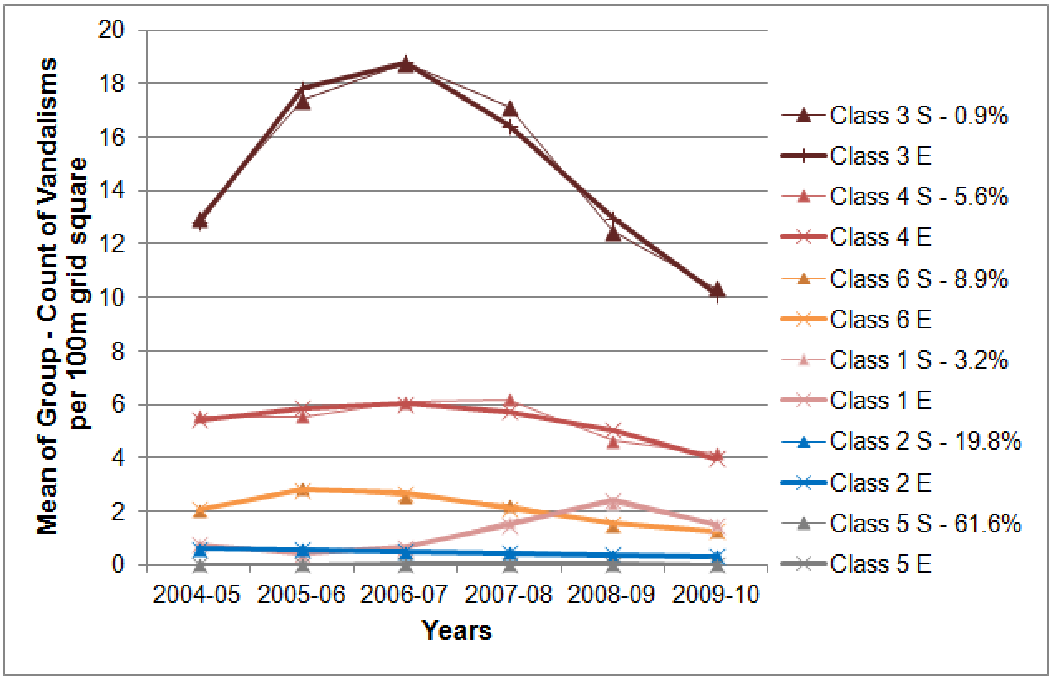


Figure 5.16 – Graph of distinct trajectories of vandalism counts across years at 100m grid level – Grid Count 6 class model

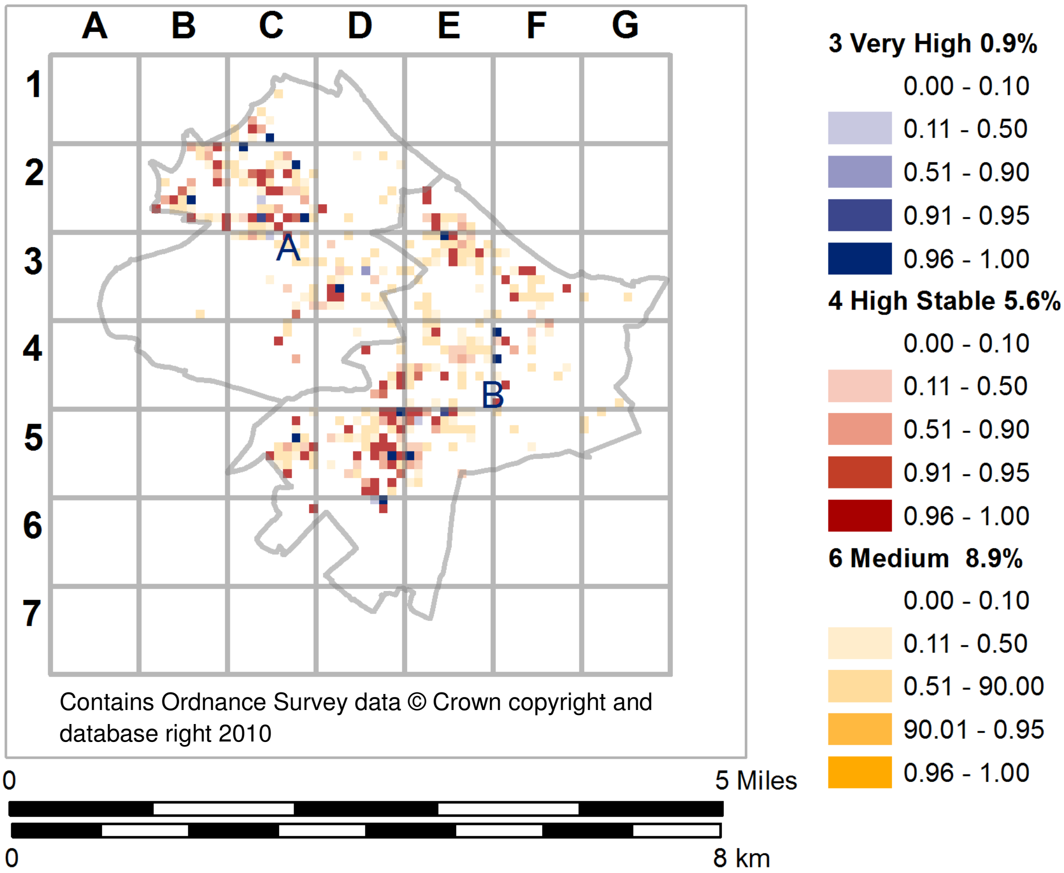


Figure 5.17 100m grid cells – Group trajectory groups – higher count groups

In each of the classes highlighted in Figure 5.17 note how the Very High groups (latent class 3) typically fall as a single location within other high areas, these blue high points therefore may be thought of as specific focus points of high crime (assuming accuracy of recorded crime locations is sufficient to pinpoint these). The darker the shading of a grid group, the more certain it is that a grid cell falls within that particular group. There is also a lot of overlap between the High Stable and Medium groups. The Medium group also consistently overlaps with the low group (not shown). For both low and medium groups there are many grid cells for which it is less than 90% likely whether they are in either the low or medium group, or alternately the high or medium group. The group trajectory analysis low groups are shown in Figure 5.18. The probability of the majority of 100x 100m grid cell that fall into this group is generally over 95% so we can be fairly certain that most of these areas are in this stable low group. Many of the areas in the very low groups are areas with no residences or parks – but this is not the case for all of these very small micro areas. This is considered further when the data is examined in conjunction with information from focus groups presented in the following chapters.

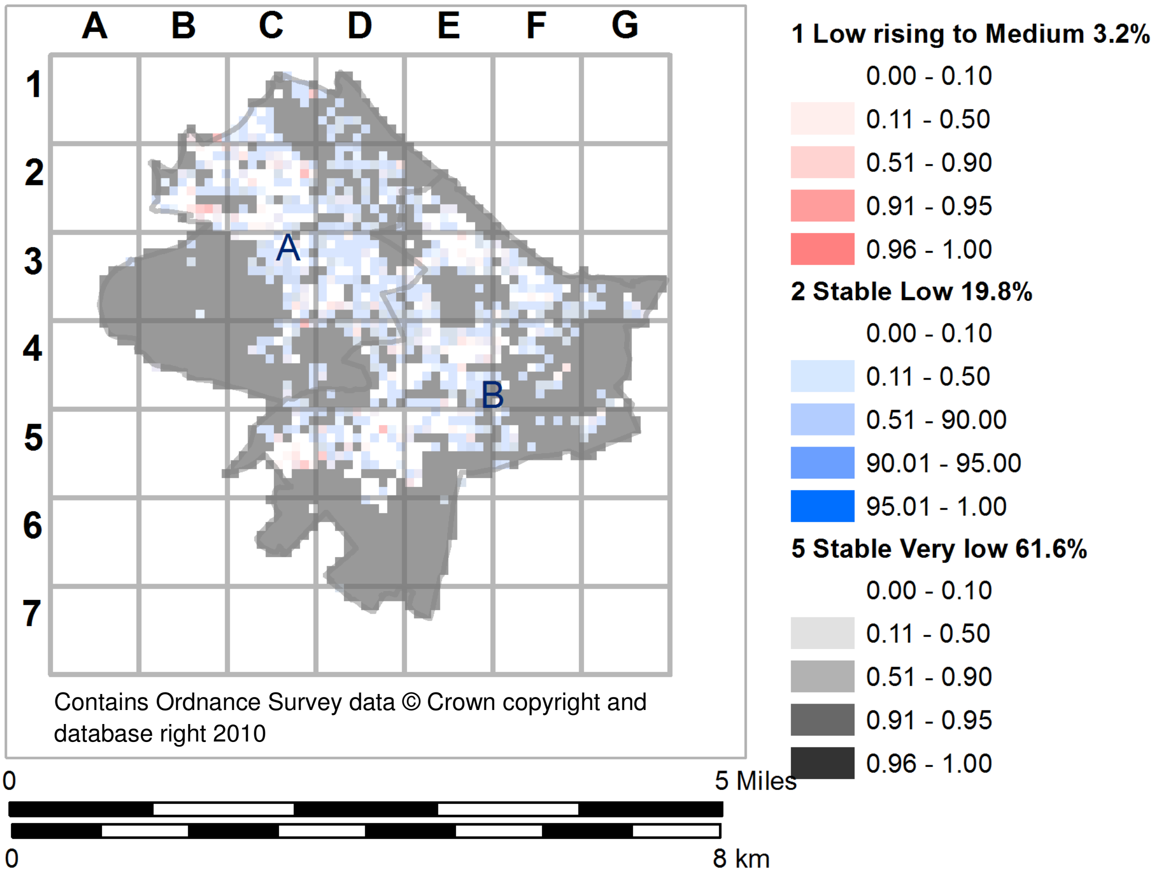


Figure 5.18 100m grid cells – Group trajectory latent class – lower count groups – The more likely an OA is in the group the darker the shading

5.2.6 Assessing whether high and low groups of areas – next to each other - are consistent over time – G_i Categorical Models*

The models presented so far have assumed that the underlying data is not linked and as the Moran's I was found to below 0.3 in all years (Chapter 4, Table 4.6 above) this might be a reasonable assumption to make. LISA analysis in Chapter 4 showed clear grouping of high and low areas adjoining one another so the final two models presented here use categorical analysis at both grid and Output Area level to look at rates of vandalism assessed to be in either a high, low or non-significant group at OA and grid levels.

For both of these models data was divided into three categories based on the G_i* pseudo significance (for example visualisations of these see Chapter 4 figures 4.6 and Figure 4.25) LISA analysis. The High Category was for areas where the mean of the immediately surrounding areas (Queen weight contiguity 1) and including the area itself were significantly high, compared to the areas average (p=<0.05). The Low Category were areas where the mean of the surrounding areas and the area itself were significantly lower than the area average ($p=<0.05$). The non significant areas were all other areas that did not fall within the high or the low categories. Full detail of the models is given in Appendix 5.

Comparing the OA Gi* categorical model with the SVR categorical model (Figure 5.19) demonstrates that at OA level there are only significant low areas next to low areas in the same areas year on year; these are shaded darker blue in Figure 5.19. Unlike at grid level there is no specific latent class group made up of mainly high areas next to high areas (and one does not appear with the more detailed 6 class model either. There are a group of areas where there are a mix of high, low and non significant areas (shown in grey in Figure 5.19) some of these areas contain more OAs with means around the high or average to high group (for example in D5) whilst others contain a mix of high and low Output Areas within the same neighbouring areas (for example C2). This supports what was suggested by comparing LISA analysis at both Grid and OA level in Chapter 4, this being that at OA level it is easier to identify clearly areas where there are low concentrations of vandalisms than at Grid level where particularly high areas stand out but some low concentrations are missed.

In other words at the very micro level there are clear clusters of high vandalisms, but they do not span across whole neighbourhoods but there are whole neighbourhoods which experience very few vandalisms. Analysing data that is spatially auto-correlated using a Group Trajectory based analysis using LISA derived categories (based on G_i*) does provides a useful summary of where high and low concentrations are but analysis at both a localised micro level (Grid) and a more coarse mini-neighbourhood level (OA) is needed, analysing at just one scale could lead to some important locations for high or low vandalisms being missed and omitted from consideration. Additional detail and commentary on the G_i* categorical models can be found in Appendix 5.

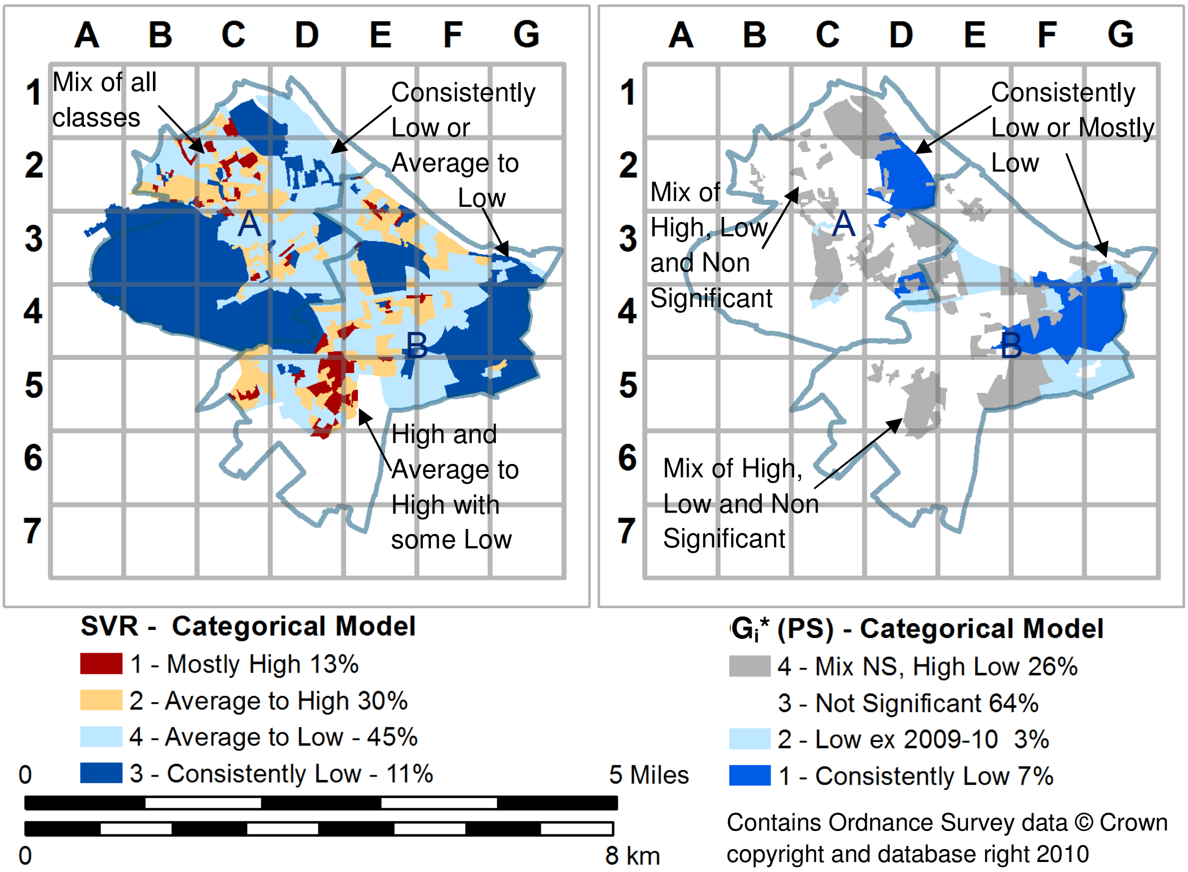


Figure 5.19 – Group Trajectory Analysis 4 Class Models at OA level – Comparing the SBR based categorical model with the G_i* categorical model

Taken together all these models suggest that there are clear high and low concentrations of vandalisms across the case study areas stable across years. However within and around of these high areas there is a complex mix of high and low locations some of which may be very close to one another and a few locations to which a very high number of the vandalism cases are recorded. High areas are in the minority – the majority of areas tend to have very low levels of vandalisms or no vandalisms year on year. In a few areas there is a concentrated vandalisms 'problem' of high areas next to each other. A number of other areas are 'no or low problem' areas where no or very few recorded vandalisms ever occur. The reasons behind these differences are considered across the study area as a whole in the next section and further at a more local level in Chapter 6.

5.2.7 Temporal Models

A final note is presented here about whether trajectories vary across the day, across days in a week and across months. As discussed in Chapter 3 various methods were used to analyse temporal effects however they were all found to yield very similar trajectory paths whether counts or rates were studies or OA or grid scale considered. Models found in high areas there is an extremely stable pattern of more vandalisms late afternoon and evening and at other times of day and this pattern holds at both OA and Grid scales and for counts and rates. Charts of these models year by year are given in Appendix 5. The chart shown in Figure 5.20 is typical of the hourly pattern through the day seen in all years analysed.

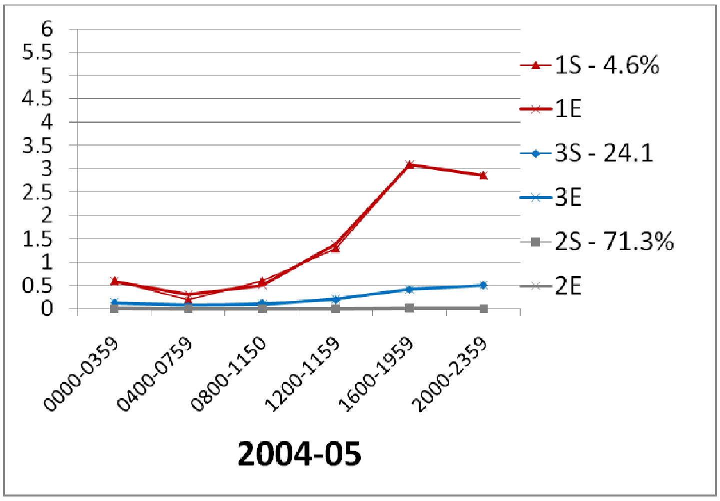


Figure 5.20 Trajectory Paths: 4 hour Groups Grid Counts (Accurate Times recorded with around a 2 hour minimum accuracy level)

There was some evidence of a trend through the week where more vandalism occurred on Fridays and Saturdays where typically 4 classes were identified, the high class did not follow a clear trend, but the next highest class in all years showed a slightly increased level of vandalism on Friday and Saturday. Figure 5.21 gives the example of the trajectories observed in 2009-10. There were no clear trends observed across months.

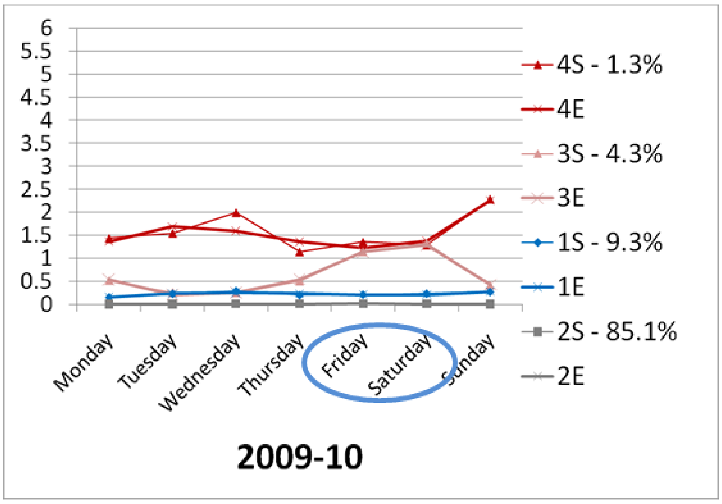


Figure 5.21 Trajectory Paths: Days of the week Grid Counts

5.3 Exploring possible explanations for high and low levels across the years using latent class groups

The next stage was to take the models and examine in an exploratory manner what explanatory factors might be relevant. Group Trajectory modelling is limited in that it does not allow you to consider how each year is explained separately and as a group, but rather how the group of years might be explained by single explanatory variables reflecting the overall time period. As explained in Chapter 3 the variables selected were chosen to reflect key potential theoretical explanations and where possible were available at a point level so they could be aggregated up to Grid and output level.

As this was intended to be a first stage exploratory model the variables were chosen were basic proxies easily available from established national datasets. Additional information about these variables and reasons for their choice can be found in Chapter 3, section 3.22. As a proxy for both routine activities and use of space, from the Royal Mail Postcode Directory (Gridlink product) the average of residential addresses at May 2004 to May 2009 (Residential Addresses) and the average of business addresses May 2004 to May 2009 (Business Addresses) both per grid square or per hectare in Output Areas, were used to provide a proxy measure of residence and business density in the case study area.

Also for routine activities and use of space, locations of schools and recreation areas (see Figure 4.1 for these locations) were derived from Ordnance Survey Street View OS OpenData Mapping as at April 2010, and then OAs and Grid within 100m of a school (School Nearby) and OAs either containing, within a recreation area, or with a recreation area within 100m were also identified (Recreation Area Nearby) as these might be areas where young people might choose to hang out. (Full details of how these measures were derived are detailed in Chapter 3).

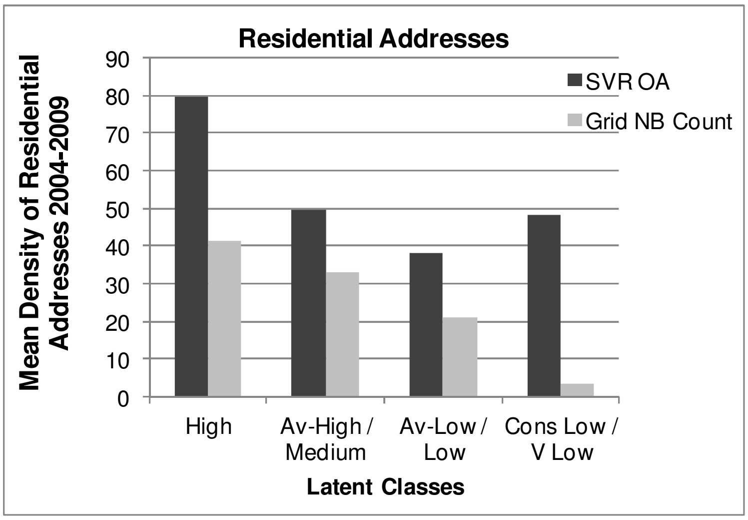
It was not possible to get a measure of persistent relative inequality as similarly measured data across the study period were not available and also were only available at Datazone level and not at a more detailed scale, so to provide a rough proxy two clearly defined measures related to relative deprivation were used. The first of these measures was a measure of income deprivation at 2009 - did the Output Area or grid cell fall within a Datazone that was either in the upper quartile or lower quartile of most income deprived Datazones in Scotland (as calculated using Scottish Index of Multiple Deprivation). So the two variables used here were, were a relatively high proportion of the population in receipt of key welfare benefits (High Welfare – falling within the Income Deprived Upper Quartile –) or was a relatively low proportion of the local population of the general neighbourhood in receipt of key benefits (Low Welfare – falling within the relatively Income Deprived Lower Quartile) . Income deprivation was used as rough proxy for general relative inequality. The second measure was a measure of School Attendance in 2008. This School Attendance measure was used for two reasons, first it is one of the recognised composite measures of education deprivation in the Scottish Index of Multiple Deprivation, and also it could act as a very rough proxy for possible school truancy which might indicate that more children might be around to vandalise things (within that Datazone). Two measures of School Attendance were derived – Poor School Attendance (within the Datazone that was amongst Datazones falling within the lower quartile of School Attendance rates in Scotland); and Good School Attendance (within Datazone in upper quartile of school attendance in Scotland). Further details of how these measures Income Deprivation and School Attendance were derived from pre-existing Scottish Neighbourhood Statistics Data are detailed in Chapter 3.

Residential Addresses and Business Addresses were continuous measures; all other variables were binary, a value of 1 indicating that the relevant factor was present, and a value of 0 representing that the factor was not present. Finally at Output Area level only, a variable for age composition of the area was sort. ESDA of the demographics of the case study area (discussed in more detail in Chapter 6) suggested that age composition might be an important factor; in general it seemed that areas with a younger mix of ages might have more vandalism, whilst areas with a mix of older, younger and people of other ages might have less vandalism. An age composition variable was therefore sought to represent not just the proportion of young people, but the mix of ages in the population. No ideal measure, which was also a standard national statistic at Output Area level, could be found, so median age at 2001 census was used as the best available proxy for age composition. OA models were run with the additional median age variable but were interpreted cautiously as the variable used was from a time period before the study period began; the model results are reported here, as the effect of adding in this additional control is interesting.

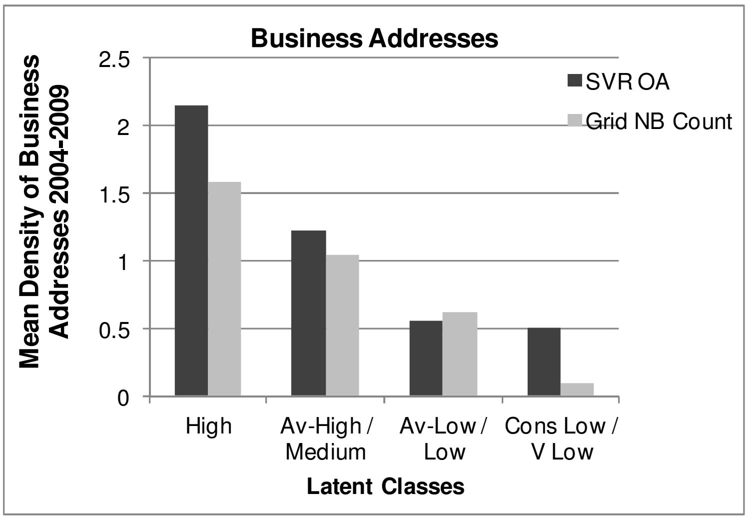
Group trajectory analysis allows for potential explanatory variables to be examined: – firstly the mean values of each variable within each trajectory class are considered, and secondly a multinomial logistic regression model is run which compares the influence of each variable on whether an area falls within a particular group by comparing it to a reference class, so for example what might influence being in a particular group is compared to, for example, the Consistently Low group present in a number of the models. Results relating to means of trajectory groups are examined first, 4 class OA SVR Categorical, Grid NB Count are considered. The OA G_i* Categorical 6 class models along with the 7 class Grid G_i* Categorical models were also analysed in this way, but results were confusing with a number of errors generated, these models are presented in Appendix 5.

5.3.1 *Comparing possible explanatory factors - OA SVR Categorical and Grid Negative Binomial Count Models*

Figures 5.27 and 5.28 shows comparative charts for the 4 class Group Trajectory Models SVR Categorical OA and Grid Negative Binomial Count presented at the beginning of this chapter.



High Areas have a greater density of residential addresses. There are very few residential addresses in the Grid Cells with very low levels of vandalisms.

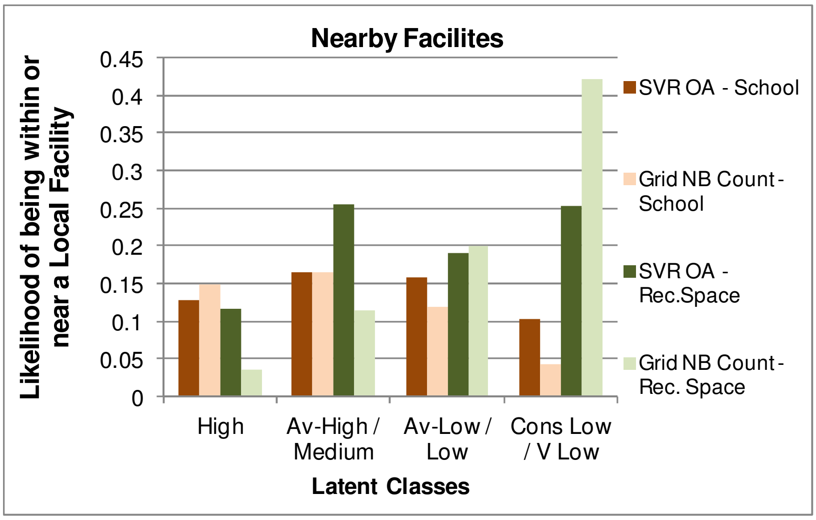


High areas have a higher business density. The density of businesses in the Grid Consistently Low class is very low indeed.

Figure 5.22 Means of Explanatory Variables relating to Routine Activities and Use of Space -Business and Residential Addresses for the OA SVR Categorical 4 Class Model and the Grid Negative Binomial Count 4 Class Model

Figure 5.22 presents the mean values of the variables related to routine activities and use of space, Residential Addresses, Business Addresses and the proximity of local facilities – Schools and Recreation Spaces. In areas with high counts of vandalism the latent class 1 (High) there are generally a higher density of addresses and a greater concentration of business addresses – put simply there are more homes and businesses. Areas which are on the Drifting to Low and

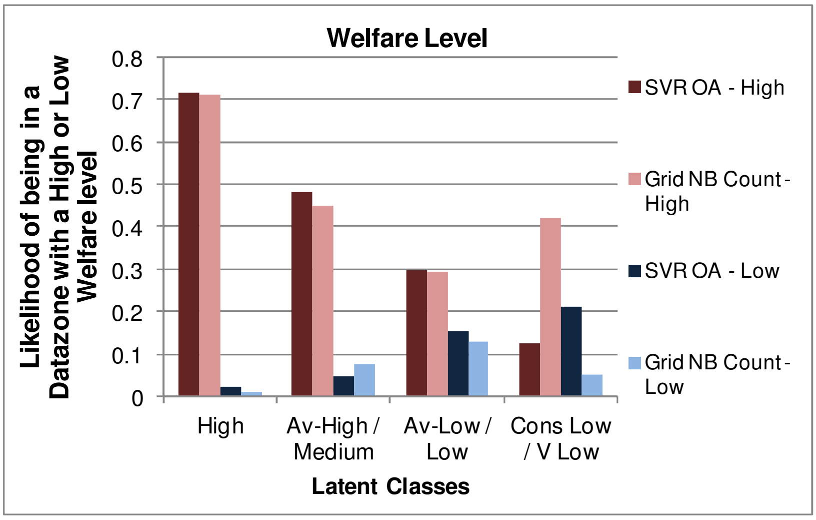
Consistently Low latent class groups in the models have less homes and businesses. This lack of residential and business addresses is particularly marked for the Grid based model.



High Areas less likely to have a recreation space. Consistently Low Grid Areas are less likely to have a nearby school and more likely to have a park than other groups.

Figure 5.23 Means of Explanatory Variables relating to Routine Activities and Use of Space -Recreation Areas and Schools for the OA SVR Categorical 4 Class Model and the Grid Negative Binomial Count 4 Class Model

Turning to Local Facilities, as this is based on a binary variable the mean represent the percentage of areas falling in that category. In Figure 5.23 it appears that not being close to a school may be a protective feature as areas labelled Very Low (Grid Model) and Consistently Low (OA Model) tend to be less likely to be a near a school than other areas. Interpreting the effect of recreation space is more complex. Whilst at OA level there is no clear trend, at Grid level recreation space actually seems to make it less likely an area will experience vandalisms, indicating at the localised micro level very few vandalisms are recorded across recreation spaces (this could be because they are recorded to just one location within a park and not at all relevant locations within it).



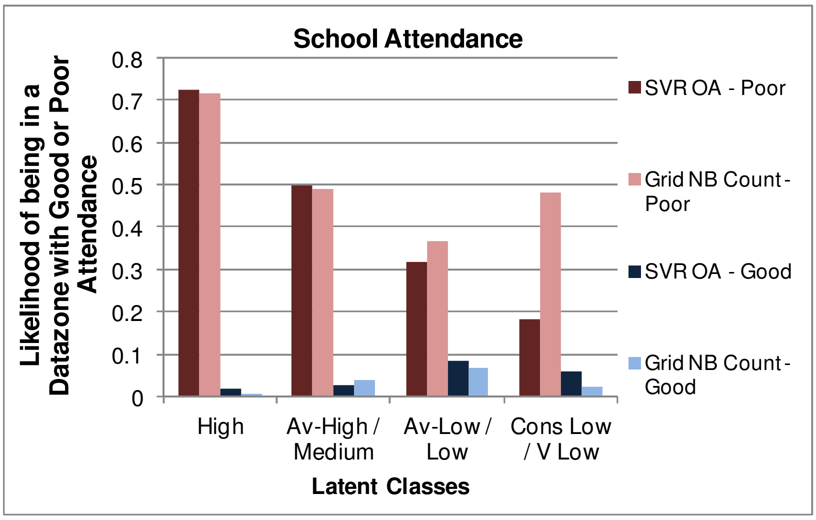


Figure 5.24 Means of Binary Explanatory Variables relating to Relative Deprivation for the OA SVR Categorical 4 Class Model and the Grid Negative Binomial Count 4 Class Model

Figure 5.24 shows that areas with High levels of vandalisms across the 6 year case study period are more likely to be within a Datazone where a high proportion of the population are in receipt of income related welfare benefits, they are also very unlikely to fall within in a Datazone where relatively few of the population claim income related welfare. High areas are also areas more likely to have poor school attendance and not to be in an area. Looking at OA Categorical SVR the means for high welfare and poor school attendance start high and then steadily decrease as levels of vandalism in areas reduces. In a mirroring effect likelihood of an Output Area within a particular latent class falling in a Datazone with low welfare or good school attendance tends to increase as levels of vandalism decrease (this effect is clearer for low welfare than good school attendance). This suggests that if an OA falls within a Datazone with high welfare levels and poor school attendance these might be risk factors making it more likely that an area might have a high levels of vandalism, and if an area falls within a Datazone with good school attendance and low welfare levels these might act as protective factors which make it more likely that the mini-neighbourhood will experience a low level of vandalisms. Looking at results for the Grid Model groups in the Very Low category appear actually more likely to be in a high welfare (42%) and poor school attendance (49%) area, than those in the Low categories. This may be because some of the grid cells in the Very Low category are within Datazones with high welfare levels and poor school attendance, but they also tend to be in areas which have parks. If at grid level, the presence of recreation space appears to make vandalism less likely this may counteract the possibility that being within an area with high welfare levels and poor school attendance increases levels of vandalism, so levels of vandalism remain very low. Alternately, this may reflect that at the very micro level, the effect of the wider community experiencing relative inequality may not have a direct effect on individual micro locations. What is needed is a method which enables us to look at the relative effect of a particular variable holding all other variables constant on the influence it appears to have on whether an area falls within a High or Consistently Low group. This can be assessed by considering the multinomial logistic regression results.

Table 5.3 looks at what factors might be influencing why an area falls in a High, Drifting to High (labelled Medium) or Drifting to Low (labelled Low) group compared to being in the Consistently Low group (Very Low), all other explanatory variables held constant. The Consistently Low group acts here as what is known as a reference group. The exp(B) column in the table is an odds ratio and as such explains how more or less likely a particular variables influence makes it that a particular area falls into one latent class as opposed to the other (holding all other variables constant). Factors that are significant and positive are shown highlighted in pink, and factors that are significant but have a negative effect are highlighted in blue. In the case of OAs an OA is more likely to be an High Group as compared to the Consistently Low group if it has a higher proportion of residential addresses (although the effect of this is negligible), and is 12.8 times more likely to be in the High group than the Consistently Low group if it falls within a High Welfare Datazone. Comparing this with the results for the Grid model is very interesting, Like OAs Grid cells are more likely to come within a High group as opposed to the Very Low group if they have a higher proportion of residential addresses (1.1 times more) and if they come within a High Welfare Datazone (3.1 times more likely – about a quarter less than for Output Areas but still significant).

Table 5.3 Multinomial Logistic Regression Models OA SVR Categorical and Grid NB Count – Comparing Other Classes with Reference Class of Consistently Low Groups

	OA SVR Categorical						**Grid NB Count**				
Reference Class:	**Consistently Low**					Reference Class:	**Very Low**				
High	B	S.E	**exp(B)**		p	**High**	B	S.E	exp(B)		p
Intercept	-2.01	(0.53)		***	(0.000)	Intercept	-4.45	(0.29)		***	(0.000)
Residential Addresses	0.01	(0.00)	**1.01**	*	(0.029)	**Residential Addresses**	0.07	(0.01)	**1.07**	***	(0.000)
Business Addresses	0.49	(0.61)	1.63		(0.425)	**Business Addresses**	0.46	(0.09)	**1.59**	***	(0.000)
School Nearby	-0.22	(0.73)	0.80		(0.77)	**School Nearby**	1.05	(0.39)	**2.85**	**	(0.007)
Recreation Area	-0.19	(0.62)	0.83		(0.756)	**Recreation Area**	-1.14	(0.41)	**0.32**	**	(0.005)
High Welfare	2.55	(0.76)	**12.82**	***	(0.001)	**High Welfare**	1.14	(0.42)	**3.11**	**	(0.007)
Poor School Attendance	1.02	(0.69)	2.78		(0.138)	Poor School Attendance	0.27	(0.43)	1.31		(0.524)
Average to High						**Medium**					
Intercept	0.14	(0.36)			(0.695)	Intercept	-2.57	(0.15)		***	(0.000)
Residential Addresses	0.00	(0.00)	1.00		(0.887)	**Residential Addresses**	0.07	(0.01)	**1.07**	***	(0.000)
Business Addresses	0.44	(0.44)	1.56		(0.464)	**Business Addresses**	0.41	(0.08)	**1.51**	***	(0.000)
School Nearby	0.06	(0.06)	1.06		(0.928)	**School Nearby**	1.36	(0.27)	**3.91**	***	(0.000)
Recreation Area	0.29	(0.29)	1.34		(0.516)	**Recreation Area**	-1.21	(0.25)	**0.30**	***	(0.000)
High Welfare	1.68	(1.68)	**5.34**	*	(0.012)	High Welfare	0.17	(0.29)	1.19		(0.547)
Poor School Attendance	0.52	(0.52)	1.68		(0.378)	Poor School Attendance	0.00	(0.29)	1.00		(0.990)
Average to Low						**Low 0 or 1**					
Intercept	1.41	(0.3)		***	(0.000)	Intercept	-1.4	(0.12)			(0.000)
Residential Addresses	-0.01	(0.00)	0.99		(0.138)	**Residential Addresses**	0.05	(0.01)	**1.06**	***	(0.000)
Business Addresses	0.30	(0.63)	1.35		(0.630)	**Business Addresses**	0.35	(0.08)	**1.42**	***	(0.000)
School Nearby	0.30	(0.60)	1.35		(0.620)	**School Nearby**	1.05	(0.24)	**2.86**	***	(0.000)
Recreation Area	-0.36	(0.45)	0.70		(0.422)	**Recreation Area**	-0.69	(0.17)	**0.50**	***	(0.000)
High Welfare	1.01	(0.66)	2.76		(0.124)	High Welfare	-0.4	(0.24)	0.65		(0.071)
Poor School Attendance	0.12	(0.58)	1.13		(0.835)	Poor School Attendance	-0	(0.23)	0.96		(0.873)
* p <= 0.05, ** p <=0.01, *** p<=0.001											
Low Welfare and Good School Attendance excluded from model due to very high Standard Errors											
Probability calculated based on pseudo class draws in Mplus 6.21											

Turning to the Average to High (OA) or Medium (Grid) groups for OAs only High Welfare is significant making it 5.3 times more likely a OA will be in an Average to High group. At Grid level High Welfare is not at all significant but the presence of more Residential addresses (1.1 times more likely) Businesses (1.5 times more likely) and a School nearby (3.9 times more likely). Interestingly, for Grid micro areas, the presence of a school nearby makes an area nearly 4 times more likely to be in the Medium group compared to the Very Low group; whereas the presence of a nearby school makes it only around 3 times as likely a micro area will be in the High group compared to the Very Low group. Recreation Areas make it a third likely (around 3 times less likely) that an area will be in the Very Low Group compared to the Medium group. Comparing whether an area falls within the Average to Low group to the Very Low group at OA area level no factors are significant suggesting little differences between the social demographic nature of these groups. However at Grid level there are significant factors – again these are Residential Addresses (1.1), Business Addresses (1.3), School Nearby (2.9) as potential risk factors, and the presence of recreation area a protective factor making it about half as likely (2 times less likely) that an area will be in the low area compared with the very low area. At grid level the factors that make an area not be in the low group are very similar, in particular the presence of businesses, a school nearby and a lack of recreation areas make being in a very low area less likely; the notable additional risk of an area being in the high group, as opposed to the medium or low groups is the whether the area falls within a high welfare area. This is further illustrated by instead of using the Consistently Low / Very Low Group as a reference group, instead using the High group as the reference group.

Table 5.4 Multinomial Logistic regression Models OA SVR Categorical and Grid NB Count – Comparing Other classes with Reference Class: - High

	OA SVR Categorical						**Grid NB Count**				
Reference Class:	**High**					Reference Class:	**High**				
Average to High	B	S.E	**exp(B)**		p	**Medium**	B	S.E	exp(B)		p
Intercept	2.15	(0.47)		***	(0.000)	Intercept	1.89	(0.30)		***	(0.000)
Residential Addresses	-0.01	(0.00)	**0.99**	**	(0.009)	Residential Addresses	0.00	(0.00)	1.00		(0.218)
Business Addresses	-0.04	(0.05)	0.96		(0.355)	Business Addresses	-0.05	(0.04)	0.95		(0.199)
School Nearby	0.27	(0.51)	1.32		(0.592)	School Nearby	0.32	(0.39)	1.37		(0.415)
Recreation Area	0.48	(0.52)	1.62		(0.349)	Recreation Area	-0.07	(0.47)	0.93		(0.878)
High Welfare	-0.88	(0.55)	0.42		(0.112)	**High Welfare**	-0.96	(0.44)	**0.38**	*	(0.028)
Poor School Attendance	-0.50	(0.54)	0.60		(0.347)	Poor School Attendance	-0.27	(0.44)	0.76		(0.543)
Average to Low						**Low 0 or 1**					
Intercept	3.42	(0.46)			(0.000)	Intercept	3.06	(0.29)		***	(0.000)
Residential Addresses	-0.01	(0.00)	**0.99**	***	(0.000)	**Residential Addresses**	-0.02	(0.00)	**0.99**	***	(0.000)
Business Addresses	-0.18	(0.08)	**0.83**	*	(0.027)	**Business Addresses**	-0.11	(0.05)	**0.90**	*	(0.014)
School Nearby	0.52	(0.51)	1.67		(0.310)	School Nearby	0.00	(0.38)	1.00		(0.993)
Recreation Area	-0.17	(0.52)	0.84		(0.741)	Recreation Area	0.45	(0.42)	1.56		(0.283)
High Welfare	-1.54	(0.54)	**0.22**	**	(0.004)	**High Welfare**	-1.57	(0.41)	**0.21**	***	(0.000)
Poor School Attendance	-0.90	(0.52)	0.41		(0.082)	Poor School Attendance	-0.31	(0.42)	0.73		(0.458)
Consistently Low						**Very Low**					
Intercept	2.01	(0.53)		***	(0.000)	Intercept	4.45	(0.29)		***	(0.000)
Residential Addresses	-0.01	(0.00)	**0.99**	*	(0.029)	**Residential Addresses**	-0.07	(0.01)	**0.93**	***	(0.000)
Business Addresses	-0.49	(0.61)	0.62		(0.425)	**Business Addresses**	-0.46	(0.09)	**0.63**	***	(0.000)
School Nearby	0.22	(0.73)	1.24		(0.765)	**School Nearby**	-1.05	(0.39)	**0.35**	**	(0.007)
Recreation Area	0.19	(0.62)	1.21		(0.756)	**Recreation Area**	1.14	(0.41)	**3.11**	**	(0.005)
High Welfare	-2.55	(0.76)	**0.08**	**	(0.001)	**High Welfare**	-1.14	(0.42)	**0.32**	**	(0.007)
Poor School Attendance	-1.02	(0.69)	0.36		(0.138)	Poor School Attendance	-0.27	(0.43)	0.76		(0.524)
* p <= 0.05, ** p <=0.01, *** p<=0.001											
Low Welfare and Good School Attendance excluded from model due to very high Standard Errors											
Probability calculated based on pseudo class draws in Mplus 6.21											

Table 5.4 describes what is significant to ensure that an area does not end up in the High Group, that is to say the factors that make a place not likely to be an area with high vandalisms. Interestingly this is not entirely a mirror opposite of why areas are not in the very low / consistently low groups. For both OA and Grid Models not being within a High Welfare area makes it less likely that the area will be in either Low or Consistently Low groups rather than

the High group. For the Grid Models, not being in a high welfare area is also a protective factor that means an area falls in a Medium group rather than the High group. So whilst at Grid level being in High Welfare group did not necessarily act as a clear risk factor to prevent a area being in an area being one with very low vandalisms, it does seem that if the area does not fall in a high welfare area it is significantly less likely to be an area with a high level of vandalisms. For Average to Low (OA) groups and Low (Grid) groups the factors reducing the likelihood of being in the high group are very similar; low Residential Addresses have a significant but negligible effect; having less businesses helps (0.8 OAs, 0.9 Grid) and not being in a High Welfare area has a substantial effect (0.2 for both Grid and OA models). At the Medium (Drifting to High) level compared to the High level there is a notable difference between Grid and OA scales, at OA level only less residential addresses has a negligible effect, at Grid level not being in a High Welfare area is significant. Also comparing why areas are have very few vandalisms, here there is a clear difference between the OA model and the Grid model; for the OA model only Residential Addresses (negligible) and Not being in a High Welfare (0.1) group are important; but at the Grid level a range of routine activity / use of space factors have a significant effect, residential addresses are again negligible in effect, however low number of Businesses (0.6) and not having a school nearby (0.4) lead an area to be in the very low group compared with the high group, being in or near a recreation area makes an area 3 times (3.1) as likely to be in the very low group; finally at Grid level not being in an area where a high proportion of the population are in receipt of welfare benefits also benefits, though not as much as for the OA model (0.1 – OA, 0.3 – Grid).

What is not clear from these results is why there is some disparity between grid results and Output Area results; this raises very interesting questions which will be further discussed in the conclusion. It appears this disparity may be greater looking at factors which influence why areas are not very low areas (why they fall into the higher groups) than compared with the reasons as why areas have low vandalisms (why they *are not* in the higher groups). It could be because the measures of high welfare and poor school attendance at Grid level are not accurate enough and there is reliance on a proxy that is too coarse to properly explain local micro differences. Is it that this is just another example of the Modifiable Areal Unit Problem? Alternately does it reflect that at the micro level, routine activity type processes and routine use of space actually have more impact and explanatory power at street by street level whereas relative inequality has more influence over neighbourhood level processes? Focus groups comments certainly suggest that some factors affecting levels of vandalism might be very localised, whereas that relative inequality and deprivation was a more general factor affecting wider areas. This will be considered further in chapters 6.

If we run the 6 class Grid based model looking at comparison between all groups and the very low group it gives a very similar picture to Table 5.3 but also explains why some areas fall into a very high group as opposed to the stable high group compared to the very low. Table 5.5 sets out the results of this multinomial logistic regression. What is particularly interesting here is that it is clear that the higher the business density (represented by business addresses), the more likely an area will have a high level of vandalisms compared to the very low area. Being a high welfare area only has an impact on a grid area falling in the high group **not** the very high group. This may mean that if policing and governing agencies, or researchers, only concentrate on the highest areas, the worst hotspots, they might tend to think that relative deprivation does not have much effect, but this belief might be misplaced.

It was wondered whether other variables missing from the model might have a significant impact. As discussed earlier ESDA of demographic data suggested population mix might be an issue but the only variable available to test this was from 2001. An exploratory model based on SVR OA 4 class model included this as an additional variable. As Table 5.6 confirms ESDA findings suggesting median ages tend to be lower in Output Areas falling within High and Average to High areas, but does its inclusion affect the multinomial model significantly?

Table 5.5 Multinomial Logistic Regression Model Grid NB Count 6 Class– Comparing Other classes with Reference Class: - Very Low

	Grid NB Count 6 class Model				
Reference Class:	**Very Low**				
Very High	B	S.E	exp(B)		p
Intercept	-6.67	(0.81)		***	(0.000)
Residential Addresses	0.07	(0.01)	**1.1**	***	(0.000)
Business Addresses	0.51	(0.10)	**1.7**	***	(0.000)
School Nearby	1.29	(0.68)	*3.6*	*	(0.058)
Recreation Area	-1.70	(1.05)	0.2		(0.105)
High Welfare	0.59	(0.78)	1.8		(0.448)
Poor School Attendance	1.65	(1.00)	5.2		(0.100)
High					
Intercept	-4.02	(0.25)			(0.000)
Residential Addresses	0.07	(0.01)	**1.1**	***	(0.000)
Business Addresses	0.45	(0.09)	**1.6**	***	(0.000)
School Nearby	1.16	(0.36)	**3.2**	***	(0.001)
Recreation Area	-0.92	(0.33)	**0.4**	**	(0.005)
High Welfare	1.18	(0.38)	**3.3**	**	(0.002)
Poor School Attendance	-0.09	(0.38)	0.9		(0.807)
Medium					
Intercept	-2.58	(0.17)		***	(0.000)
Residential Addresses	0.06	(0.01)	**1.1**	***	(0.000)
Business Addresses	0.42	(0.09)	**1.5**	***	(0.000)
School Nearby	1.29	(0.30)	**3.6**	***	(0.000)
Recreation Area	-1.24	(0.29)	**0.3**	***	(0.000)
High Welfare	0.08	(0.31)	1.1		(0.792)
Poor School Attendance	-0.10	(0.31)	0.9		(0.734)
Low rising Medium					
Intercept	-3.72	(0.30)		***	(0.000)
Residential Addresses	0.07	(0.01)	**1.1**	***	(0.000)
Business Addresses	0.36	(0.12)	**1.4**	**	(0.002)
School Nearby	1.34	(0.46)	**3.8**	**	(0.004)
Recreation Area	-1.05	(0.47)	**0.4**	*	(0.025)
High Welfare	-0.27	(0.50)	0.8		(0.590)
Poor School Attendance	0.32	(0.50)	1.4		(0.521)
Stable Low					
Intercept	-1.37	(0.12)		***	(0.000)
Residential Addresses	0.05	(0.01)	**1.1**	***	(0.000)
Business Addresses	0.36	(0.09)	**1.4**	***	(0.000)
School Nearby	1.01	(0.25)	**2.7**	***	(0.000)
Recreation Area	-0.65	(0.17)	**0.5**	***	(0.000)
High Welfare	-0.38	(0.26)	0.7		(0.144)
Poor School Attendance	-0.18	(0.25)	0.8		(0.459)
* p <= 0.05, ** p <=0.01, *** p<=0.001					
Low Welfare and Good School Attendance excluded					
Probability calculated based on pseudo class draws in Mplus 6.21					

Table 5.6 – Mean of Median Age in OA for the OA SVR Categorical 4 Class Model

Median Age	SVR OA
High	35.088
Average -High	39.746
Average -Low	43.604
Consistently Low	41.986

Table 5.7 presents the same 4 class OA SVR Categorical model as Table 5.3 but includes median age as an additional variable. Including this variable as a control suggests that being in an area where a high proportion of the population is in receipt of income based welfare actually increases the effect of High Welfare on being in a High group compared to the Consistently Low group from 12.8 in the original model to 15.4 in the revised model. Similarly the protective effect of not being in a high welfare group for areas in the Consistently Low group compared to the high group reduces from 0.08 to 0.07. Including this control does not noticeably affect the influence of High Welfare on being in an Average to High (Drifting to High) area compared to a Low (Drifting to Low) area. Median age also is significant itself, comparing all other groups with the consistently low group, the median age of the population of areas in the high group is likely to be slightly younger than the consistently low groups, for other groups it is not significant. Comparing all other groups with the High group, Median age is significant in all cases, all other groups compared to the High group are likely to have slightly older populations. Median age therefore does appear to have an effect, however this assumes that age mix has not changed substantially across the study area since 2001, this further suggests in future research it would be worth seeking a better measure of this demographic mix.

Table 5.7 Multinomial Logistic Regression Model SVR Categorical OA Model including Median Age – Comparing Other classes with Reference Class: - Consistently Low, and with Reference Class: - High

	OA SVR Categorical										
Reference Class:	Consistently Low					Reference Class:	High				
High	B	S.E	exp(B)		p	**Average to High**	B	S.E	exp(B)		p
Intercept	1.19	(1.49)			(0.422)	Intercept	0.23	(1.12)			(0.835)
Residential Addresses	0.01	(0.00)	1.01		(0.185)	**Residential Addresses**	-0.01	(0.00)	**0.99**	*	(0.038)
Business Addresses	0.47	(0.61)	1.60		(0.443)	Business Addresses	-0.03	(0.05)	0.97		(0.490)
School Nearby	-0.11	(0.73)	0.89		(0.88)	School Nearby	0.19	(0.52)	1.21		(0.711)
Recreation Area	-0.10	(0.63)	0.90		(0.873)	Recreation Area	0.39	(0.53)	1.47		(0.459)
High Welfare	2.73	(0.77)	**15.36**	***	(0.000)	High Welfare	-0.95	(0.56)	0.39		(0.088)
Poor School Attendance	0.72	(0.71)	2.05		(0.314)	Poor School Attendance	-0.33	(0.55)	0.72		(0.548)
Median Age	-0.08	(0.03)	**0.93**	*	(0.017)	**Median Age**	0.05	(0.02)	**1.05**	*	(0.050)
Average to High						**Average to Low**					
Intercept	1.43	(1.23)			(0.247)	Intercept	-0.41	(1.10)			(0.709)
Residential Addresses	0.00	(0.00)	1.00		(0.594)	**Residential Addresses**	-0.01	(0.00)	**0.99**	**	(0.006)
Business Addresses	0.44	(0.61)	1.55		(0.472)	**Business Addresses**	-0.17	(0.08)	**0.85**	*	(0.041)
School Nearby	0.08	(0.63)	1.08		(0.902)	School Nearby	0.43	(0.52)	1.53		(0.412)
Recreation Area	0.29	(0.45)	1.33		(0.518)	Recreation Area	-0.27	(0.53)	0.77		(0.612)
High Welfare	1.79	(0.67)	**5.97**	**	(0.008)	**High Welfare**	-1.80	(0.55)	**0.17**	**	(0.001)
Poor School Attendance	0.39	(0.60)	1.47		(0.521)	Poor School Attendance	-0.51	(0.54)	0.60		(0.348)
Median Age	-0.03	(0.03)	0.97		(0.265)	**Median Age**	0.09	(0.02)	**1.09**	***	(0.000)
Average to Low						**Consistently Low**					
Intercept	0.78	(1.2)	-		(0.520)	Intercept	-1.19	(1.49)	-		(0.422)
Residential Addresses	-0.01	(0.00)	1.00		(0.253)	Residential Addresses	-0.01	(0.00)	1.00		(0.185)
Business Addresses	0.30	(0.63)	1.36		(0.630)	Business Addresses	-0.47	(0.61)	0.63		(0.443)
School Nearby	0.31	(0.60)	1.37		(0.603)	School Nearby	0.11	(0.73)	1.12		(0.877)
Recreation Area	-0.37	(0.45)	0.69		(0.415)	Recreation Area	0.10	(0.63)	1.11		(0.873)
High Welfare	0.93	(0.67)	2.54		(0.164)	**High Welfare**	-2.73	(0.77)	**0.07**	***	(0.000)
Poor School Attendance	0.21	(0.59)	1.23		(0.723)	Poor School Attendance	-0.72	(0.71)	0.49		(0.314)
Median Age	0.01	(0.03)	1.01		(0.597)	**Median Age**	0.08	(0.03)	**1.08**	**	(0.017)
* p <= 0.05, ** p <=0.01, *** p<=0.001											
Low Welfare and Good School Attendance excluded from model due to very high Standard Errors											
Probability calculated based on pseudo class draws in Mplus 6.21											

5.4 Concluding Summary

Returning to the key research questions we can now answer as follows, assessing each of the research questions in turn:-

- Are there areas (places) that experience high or low concentrations vandalism year and year out?

This analysis clearly shows that there are distinct groups with High, Drifting to High, Drifting to Low and Consistently Low levels of vandalism.

- Do concentrations of vandalism change over space and time, and are there any particular patterns that appear to exist?

The analysis finds concentrations of vandalism do change over time and particular patterns do appear to exist. There are groups of High areas which tend to have a fluctuating high level of vandalisms, there are then a Drifting to High group at the medium to low range which have more stable levels of vandalisms, there is a Drifting to Low group which has just 1or 2 vandalisms a year, and a very stable Consistently Low group which has either 0 or may be 1 recorded vandalism in a year.

- Do places which experience either low or high concentrations of vandalism over time appear to have any common features or shared characteristics?

The analysis finds places with low or high concentration do appear to have some common features and shared characteristics. High areas are more likely to have slightly more residences, and more businesses than low areas. They are more likely to be in an area with relatively high welfare levels. The presence of schools sometimes makes an area more likely to suffer vandalism but not always. The presence of parks and recreation spaces makes an area potentially less likely to be vandalised, but this finding depends on the scale data is examined at. Areas tend to experience higher levels vandalism in the evenings and at weekends than at other times. However, there may be particular localised factors, as well as other additional factors not yet considered, which affect these common features and characteristics of high and low areas. It is also possible, since the multinomial logistic regression analysis did not correct for spatial autocorrelation, that this could have skewed results (as discussed in chapter 3) These factors will be further considered in Chapter 6 which brings together a range of ESDA techniques and a number of different data sources including information from the focus groups.

This chapter has less direct relevance to the methodological questions than chapter 4 however considering the methodological aims:-

- To investigate the value of using an Exploratory Spatial Data Analysis methodological approach to examining research questions related to crime and place.
- To look at how ESDA techniques and qualitative techniques including ideas from qualitative GIS might be used

This chapter has demonstrated the values of taking an Exploratory Spatial Data Analysis approach by taking the innovative approach of using spatial data along with group trajectory modelling, greater insights into the nature of vandalism and place have been obtained.

Turning to the final methodological objective:-

- To consider the necessity of exploring multiple spatial and temporal scales in crime and place research, is it enough to just concentrate on micro or macro scales or do both need to be considered.

This chapter strongly suggests, through this illustrative case study, that to understand the nature of how vandalisms and place are related it is necessary to consider data at more than one scale (both spatial and temporal); considering both micro and macro scales is likely to very beneficial and potentially essential. Further micro and macro factors will now be considered looking at responses from focus groups with Community Police Officers and how this data, along with the data already presented helps us to understand the nature of vandalisms in the two Neighbourhood Partnership Areas. The next chapter, Chapter 6, will examine the patterns of vandalism and the reasons for them in the two Neighbourhood Partnerships in the study area EdinburghA, and examine EdinburghB and also consider similarities and differences between the two areas.

6 Explaining High and Low patterns of Vandalism across the Case Study Area

6.1 Introduction

In this Chapter we explore where high and low locations of recorded levels of vandalism occur in each of the two Neighbourhood Partnership Areas EdinburghA (Section A) and EdinburghB (Section B) Using results of group trajectory analysis presented in Chapter 5 all places in the case study areas can be broadly assigned to one of three groups, the High Group, the Consistently Low group or the Drifting group. These groups provide a useful descriptive framework for patterns of vandalism across the study area. This introductory section describes these groups in a little more detail and then sets out the structure of the Chapter to follow.

6.1.1 The High Group

The High group is made up of locations that experience levels of vandalism well above the average. There are two types of High locations, Persistently High locations - where there are consistently high levels of vandalism across time, and Temporarily High / Very High locations where a location in a single year, or for just 2 or 3 years, experiences much higher levels of vandalism than it usually does, as well as much higher than the general average. Places in the High Group are in the minority. From socio-demographic analysis linked to group trajectory analysis presented in Chapter 5 these high groups appear to have risk factors related to both the use (and abuse) of space, routine activities and relative inequality. Group trajectory analysis (Chapter 5) suggests they will tend to have a higher concentration of businesses, are more likely to be near a school, but may also be in areas with an underlying social problem such as relative inequality. Other localised factors may also be at play, for example the role of recreation areas is less clear from the evidence presented in Chapter 5, and possible reasons behind this evidenced by focus groups discussions are considered here . This Chapter considers what localised factors might be that push an area into a high group and finds support for the group trajectory analysis results from focus group comments as well as highlighting some additional interesting localised issues around persistent inequality and regeneration of areas (discussed particularly in Section B).

6.1.2 The Consistently Low group

This group is made up of areas which year in year out have either zero or very few cases of vandalism. These locations have very stable stubbornly low levels of vandalism year on year. The numbers of places in the Consistently Low group far exceed the High group. Places in this group are notable for their complete lack, or very low level of the risk factors that would push them into the high group. Further support for this complete lack of risk factors (and other protective factors) are suggested by comments from the focus groups. Other localised factors may also be important including how the community is able to work together (collective efficacy) and these are also discussed in Sections A and B.

6.1.3 The Drifting Group

The Drifting group are places where levels of vandalism literally drift about, and localised factors can push the area into either having generally higher than average or lower than average rates of vandalism in a given year. A similar mix of risk and protective factors come up for the drifting groups. The more risk factors present the more likely an area will drift towards joining the High group, the more protective factors the more likely the areas will drift to joining the consistently low group. Interestingly, the scale data are looked at also determines how many locations are assigned to the drifting group, but at the OA level appears likely it is something around half to three quarters of small neighbourhoods. Drifting places can have very changeable patterns of high and low patterns of vandalism which are likely influenced by localised changes in risk and protective factors. There is an interesting example of a drifting area in the EdinburghA Neighbourhood Partnership and this is presented in Section A. The name of this group is inspired by the work by David Matza on Delinquency and Drift (Matza, 1964; Matza, 1969) where he argued that the vast majority of young delinquents were an ordinary normal young people with no special personality traits who given certain circumstances will drift in an out of delinquency often only being delinquent[16] for short periods of time before outgrowing it. The Drifting Group of places can be seen as neither having a serious vandalism problem nor a total lack of one.

6.1.4 Dividing the Case Study Area into Sub-Areas

For ease within each sub-area areas with characteristics that broadly fit the High Group, the Consistently Low Group and the Drifting Groups, or a mix of these groups have been highlighted. These key areas and the Subsection they are within are shown in Figure 6.1 The four key areas that will be considered in Subsection A are: Delta - a large area made up of a mixture of Drifting and high Output Areas / grid areas; Echo - an Area that is a good example of a Consistently Low; Foxtrot - a small and interesting area in the High Group that becomes persistently high across the study period; and finally, Indigo - an area on the border of

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[16] For Matza delinquency is a socially constructed concept produced by a given societies current standards and opinions of a particular point in time, activities also drift in and out of th definition of delinquency.

EdinburghA and EdinburghB which is generally low but in the Drifting category rather than the Consistently Low category. In EdinburghB five areas are highlighted: Juliet, a large High (and generally persistently high) area: Kilo, an area with many similar characteristics of Juliet but in the Drifting category: Lima, another good example of a consistently Low area; Oscar, an area which although in EdinburghB also impacts on the EdinburghA area, and finally Romeo, an interesting Drifting Low area which shares some characteristics with both Oscar and Delta but also has some very notable differences. The areas are labelled by the start of their names in subsequent maps Delta (D), Echo (E), Foxtrot (F), Indigo (I) in EdinburghA; and Juliet (J), Kilo (K), Lima (L), Oscar (O) and Romeo (R) in EdinburghB.

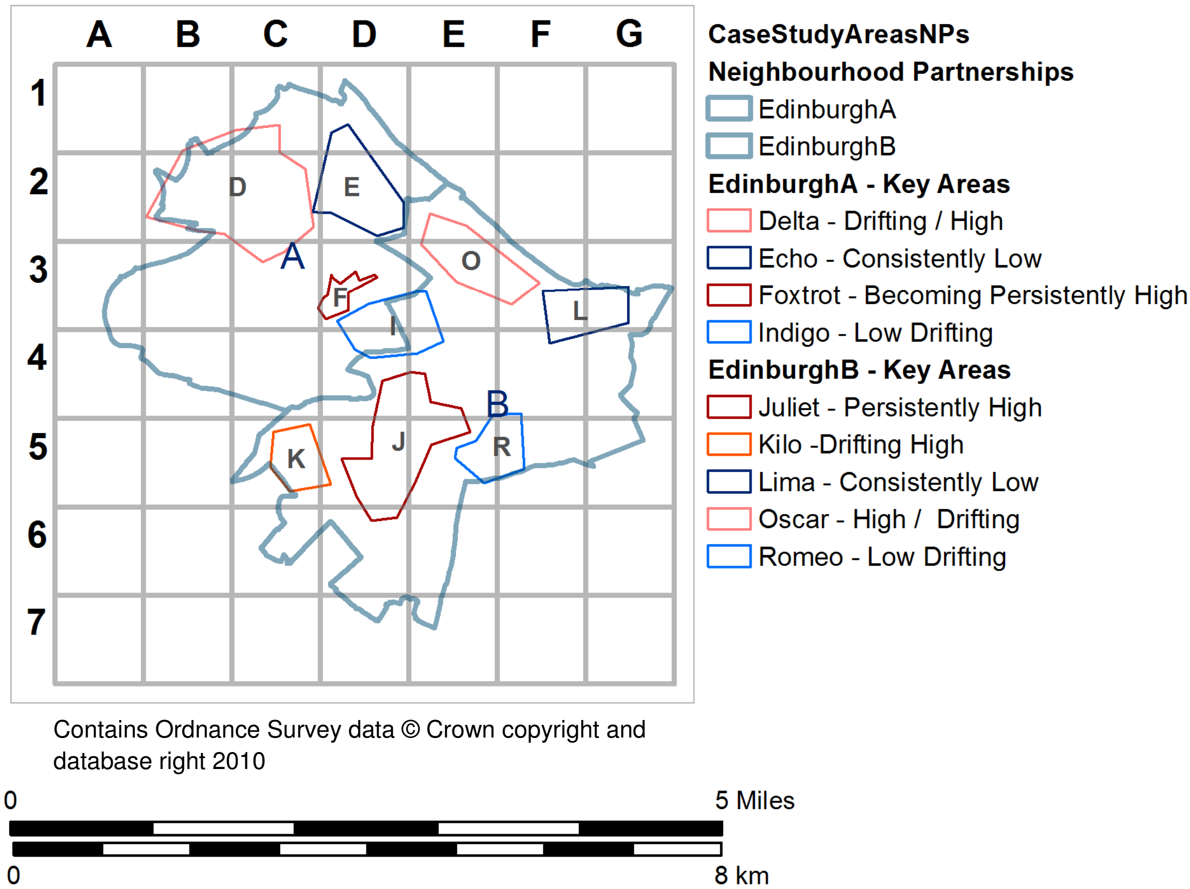

Figure 6.1 Key Areas for discussion considering EdinburghA and EdinburghB

6.1.5 Chapter Structure

This Chapter begins with a summary of group trajectory analysis for the two Neighbourhood Management Areas within the study areas of EdinburghA and EdinburghB. It then reports the findings from three focus groups held with a total of eight Senior and more junior Police Officers with responsibilities for community policing. It links analysis of these findings to analysis of recorded vandalism across the study area already partially presented in Chapters 4 and 5. Data from focus groups and vandalism data analysis is also linked to nationally available secondary socio-demographic data for the local area from national statistics, and secondary data derived from ordnance survey maps which represent the physical layout of the area (for example locations of roads, parks and schools). In a triangulation process, Section 1 identifies some of the broad trends using group trajectory analysis within the two NMAs, Sections 2 and 3 present more qualitative data showing patterns of vandalism for the nine key areas defined above and then brings together analysis of the focus group data and secondary data to account for these patterns. Section 2 of the Chapter discusses data that relates to the four key areas in EdinburghA, Delta, Echo, Foxtrot and Indigo (labelled D, E, F, and I in maps). Section 3 of the Chapter discusses data that relates to the five key areas Oscar, Kilo, Juliet, Lima and Romeo (labelled O, K, J, L and R in maps).

Three focus groups were held with Officers involved in Neighbourhood Policing which asked Officers to highlight on a map where they thought high and low areas of vandalism were and then to talk about the characteristics of these areas. The police station for Officers covering the Neighbourhood Partnership EdinburghA is in Oscar, so the Oscar area in EdinburghB and some surrounding streets is primarily policed by Officers policing EdinburghA. This leads to overlap in policing of EdinburghA and Edinburgh B, particularly in the Oscar area. This overlap between area boundaries and policing responsibilities meant there was some overlap between the two sections of the case study area discussed in the focus groups. Focus Group 1 was held with three Senior Officers whose responsibilities included managing Officers with responsibilities for Neighbourhood Policing; this focus group discussed vandalism in both EdinburghA and EdinburghB. Focus Group 2 was with two experienced Community Police Officers who had specific Neighbourhood policing responsibilities which meant they had been daily walking around and interacting with the local community in the streets of EdinburghA, their responsibilities included both general policing and attending local community meetings. Comments in focus group 2 mainly related to EdinburghA but also discussed parts of Oscar and Lima in EdinburghB. Focus Group 3 was attended by three Police Officers; two were very experienced Community Police Officers and the third more recently qualified. In practice quotes from this group come from the two more experienced Officers as the less experienced Officer mainly listened with interest to them talking, and was brought along primarily because this Officer was shadowing the more experienced Officers' work that day, and the focus group took place as part of their usual working day. Focus Group 3 primarily focused on EdinburghB, especially Juliet, Kilo and Romeo though there were some comments relating to Oscar, Lima and Indigo which overlapped both EdinburghA and EdinburghB.

This is a long Chapter broken into four distinct sections. Section 1 looks at distinct trajectory trends in the two areas. Section 2 considers patterns of vandalism and accounts for them in key areas within EdinburghA; Section 3 considers patterns of vandalism and accounts for them in key areas within EdinburghB. In Sections 2 and 3accounting for these patterns will be considered under four sub-headings which look at key themes arising from the results in each section. These key themes are taken from the relevant theory and theorists discussed in Chapter one and cover the analysis of focus groups accounts alongside secondary socio-demographic data and map data. The themes relate to the use and abuse of space including local conflicts over the use of space (Iveson ,2007) and crime pattern theory (Brantingham and Brantingham, 2008); routine activities and the everyday (Cohen and Felson, 1979; Matza 1964, Matza 1969); advanced marginality or persistent relative inequality; and community based interactions that may have links to theories of collective efficacy. Finally Section 4 will look at similarities and differences between EdinburghA and Edinburgh B and summing up common themes which account for patterns in areas with High, Drifting and Consistently Low levels of vandalism.

6.2 Section 1 - Comparing EdinburghA and EdinburghB – Broad Trajectory trends

Looking at patterns across the two Neighbourhood partnerships (EdinburghA and EdinburghB) the processes at work across these areas appear to be slightly different. EdinburghA is a very mixed area; there are pockets of high vandalism in some years that are mobile (a key example being Delta), there are also areas which seems to have Consistently low levels of vandalism (a key example being Echo). EdinburghB has a similar area with more mobile pockets in the North of the area in Oscar but a rather different large area with high levels of vandalism which seem more persistent and stable (Juliet) – not mobile like Delta. In Juliet vandalism levels appear to have been particularly high in 2005-6, 2006-7, and to some extent 2007-8 before beginning to fall in 2008-9 and 2009-10.

So does this affect overall trajectories of vandalism across the six years for the individual Neighbourhood partnerships? Group trajectory analysis which looks to see if there are separate distinct trajectory paths for different areas suggests that this is the case. Separate models were run for EdinburghA and EdinburghB; because of the large overlap between the policing of EdinburghB and EdinburghA and movement of people between areas particularly between Oscar and elsewhere, this is potentially a slightly artificial distinction but it does allow a check to see if there are some general differing trends between the areas. The type of model used was a Negative Binomial Count model, with the 5 class model found to give the best fit with the lowest Adjusted BIC . Analysis showed there are some clear differences among the means of areas with high and very high levels for vandalism for the 964 grid cells in EdinburghA and the 1199 grid cells in EdinburghB; areas with lower levels of vandalism were more similar. The mean of the very high group in EdinburghB, at its highest, is nearly double that of the very high group in EdinburghA. The levels of vandalism in both very high and high areas are generally much higher in EdinburghB until 2007-8. Figure 6.2 shows in both areas, analysing at 100m by 100m grid level, there are a very small number of very high areas (1%), some high and medium areas (16%), with the majority (over 80%) of micro areas falling within the low and very low groups areas in both Partnerships.

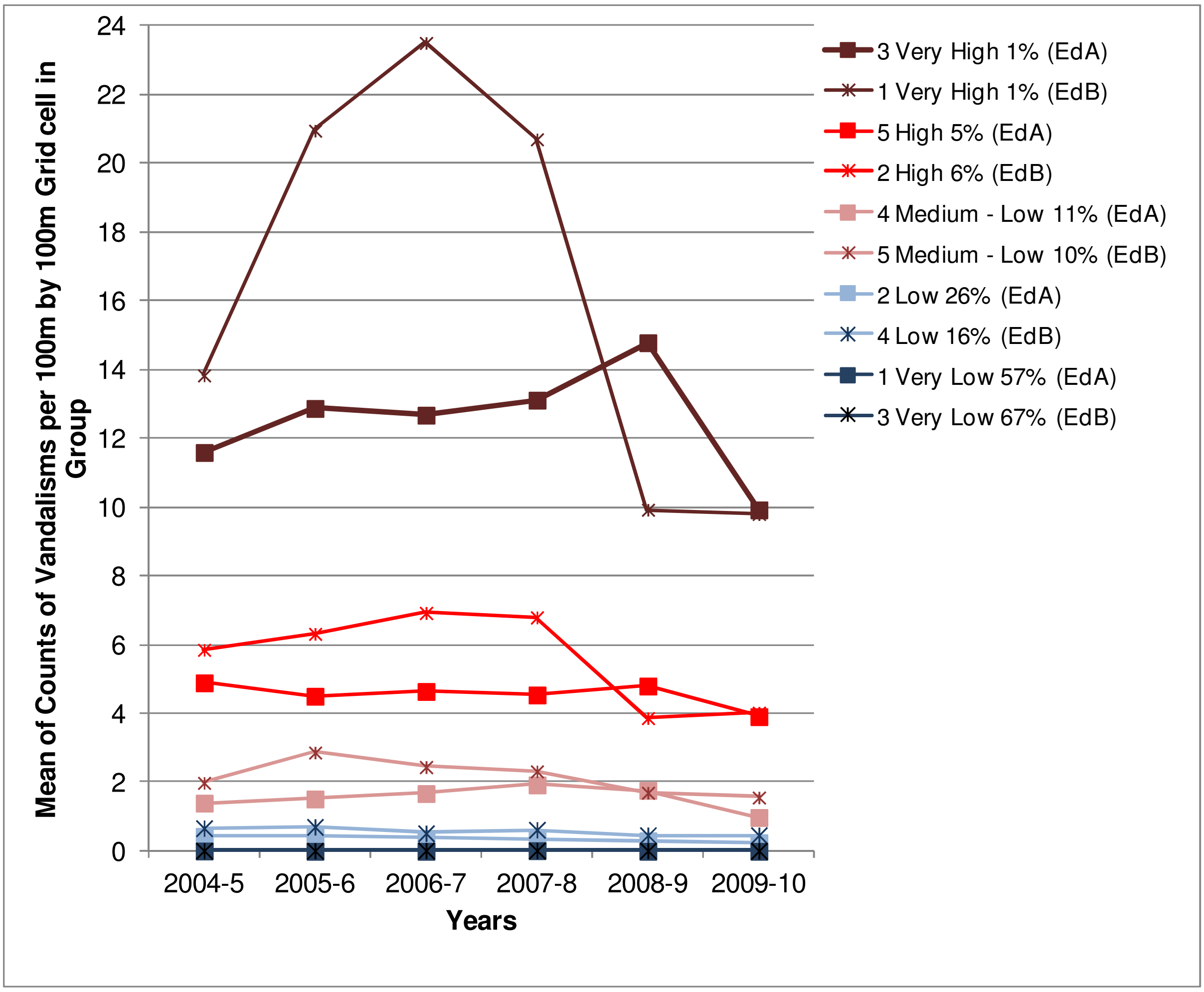

Figure 6.2 Groups of Trajectories of Mean Counts of Vandalism levels per 100m by 100m Grid Cell – Comparing EdinburghA and EdinburghB

As Figure 6.3 shows, the majority of the very high areas in EdinburghB fall within Juliet with one in Oscar and one in Kilo. There is a marked spike in the mean level of vandalism at these very high locations in 2005-6 to 2007-8 (rising from around 14 to above 20); this was also a time of high levels of demolition and rebuild in Juliet. In EdinburghA the majority of the very high areas fall within Delta, with one in Foxtrot and another just across a road from Foxtrot. In EdinburghA the very high areas mean counts increase slightly from 12 to 14 through most of the study period, before falling in 2009-10 to around 10. In EdinburghB mean levels of vandalism are generally higher than EdinburghA with levels becoming much more similar in 2009-10.

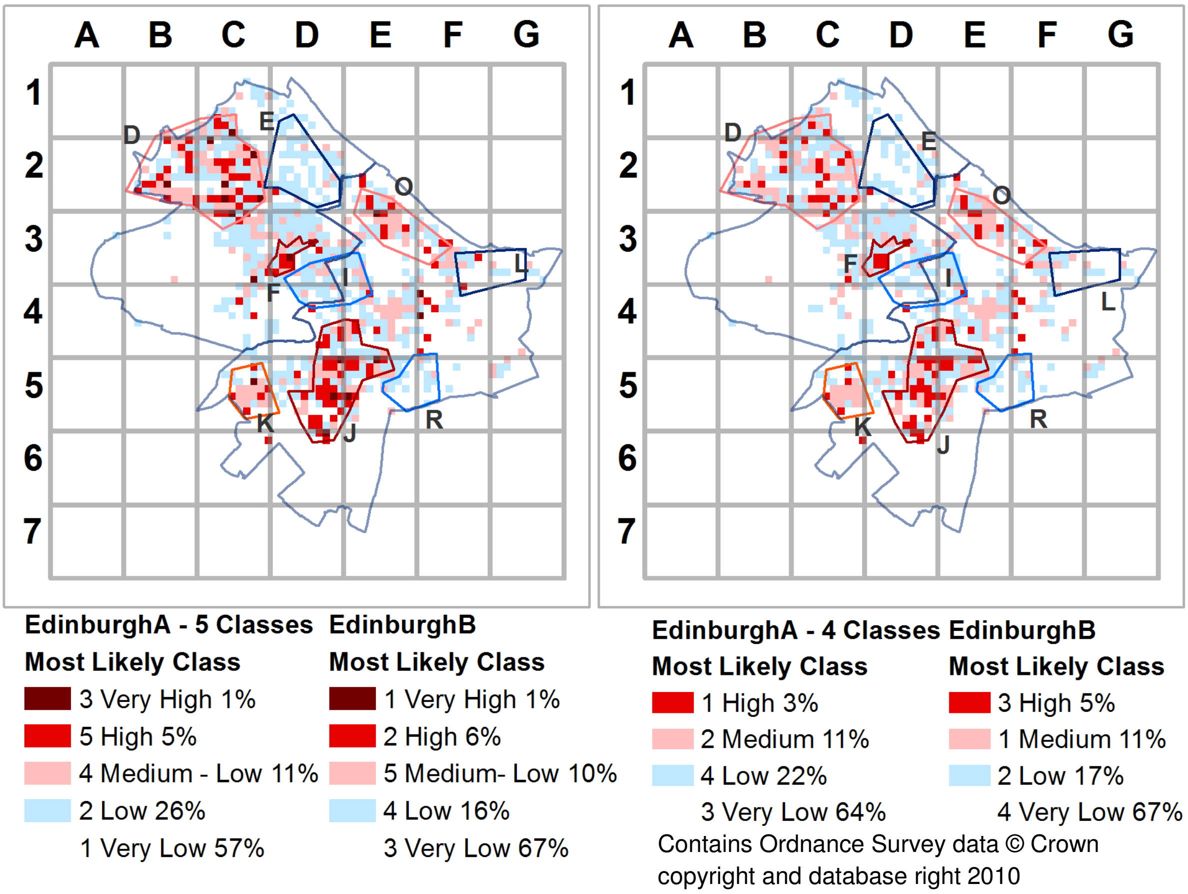

Figure 6.3 Comparing 4 and 5 class Negative Binomial Count Group Trajectory Models (Mapped) for EdinburghA and EdinburghB

The next stage was to look at potential socio-demographic factors for the two Neighbourhood Partnerships, using the same variables that had been used to look at the case study areas as a whole in Chapter 5. Were there differing broad explanatory factors for the two areas or were factors similar? Analysis found some significant differences. There were very few grid cells in the very high groups (only 10 in the EdinburghA high group and 9 in the EdinburghB high group) in the 5 class model. This was potentially too small a sample group to use in a multinomial logistic model (and in fact led to very high standard errors when looking at EdinburghB). Instead 4 class models were used, these simplify areas into one of four classes. The very high, high and medium groups of the 5 class models are simplified into two groups in the 4 class model, a medium group with a mean of between 2 and 4 vandalism a year, and a high group with a mean of around 8 to 10 vandalism in a year. The low group and the very low group in the four class model are very similar to the low groups in the 5 class model. These 4 class models also have the advantage that as they use more simplified groups, they are easier to generalise from and compare with other potential study areas. When mapped the 4 class model visualisation is very similar to the 5 class model, only in this 4 class model specific locations with very high counts are no longer highlighted (Figure 6.3).

The same method has been used to look at possible socio-demographic explanatory factors for group trajectories for the whole case study area as discussed in Chapter 5.This allows results of the case study area as a whole to be compared with the two local partnerships EdinburghA and EdinburghB. Table 6.1 and 6.2 presents these results. Table 6.1 compares what factors make an area more likely to be in the High group of areas (with a mean of between 6 to 10 counts of vandalism a year), the Medium group (with a mean count of around 2-3 vandalism a year) or the Low group (0 to 1 counts of vandalism a year) compared with being in the Very Low group (around 0 vandalism a year). These can be thought of as potential risk factors that may prevent an area having very low levels of vandalism. In the table factors which have a significant positive effect, that are more likely to be present for this group compared with the very low reference group are highlighted in pink, and factors which have a significant negative effect are highlighted in blue. In all areas residential addresses have a marginal significant positive effect. Also for all areas the presence of more businesses (around 1.5 times as many as a very low area) also makes it more likely an area won't have very low levels of vandalism.

Other factors are more varied between EdinburghA and EdinburghB. In EdinburghB the factor most likely to ensure that an area does not have very low levels of vandalism is having a school nearby. In EdinburghB for areas with high levels of vandalism, having a school nearby makes it around 5 times as likely the area will not have very low levels of vandalism, for areas with medium levels of vandalism a school nearby makes it over 6 times as likely that the area will not have very low levels of vandalism, and for areas with low levels of vandalism having a school nearby makes it 4 times as likely that the area will not have very low levels of vandalism. For EdinburghA having a school nearby is not significant. For EdinburghA, the factor most likely to make an area not have very low levels of vandalism is not being in a recreation area, the fact that low areas are not in a recreation area makes then around a fifth less likely to be in the very low group, medium and high areas are around a tenth less likely to be in a park or recreation area.

Table 6.1 Exploratory Models: Factors putting an area into a High Group, Medium Group or Low Group compared to the Very Low Group – Micro - 100 by 100m Grid

	Grid Negative Binomial Count - 4 class model - Multinomical Logistic Regression														
	Case Study Area					EdinburghA					EdinburghB				
Reference Class:	Very Low					Very Low					Very Low				
High	B	S.E	exp(B)		p	B	S.E	exp(B)		p	B	S.E	exp(B)		p
Intercept	-4.45	(0.29)		***	(0.00)	-3.53	(0.41)			(0.00)	-5.35	(0.46)			(0.00)
Residential Addresses	0.07	(0.01)	**1.07**	***	(0.00)	0.04	(0.01)	**1.04**	***	(0.00)	0.09	(0.01)	**1.09**	***	(0.00)
Business Addresses	0.46	(0.09)	**1.59**	***	(0.00)	0.52	(0.15)	**1.68**	***	(0.00)	0.49	(0.12)	**1.63**	***	(0.00)
School Nearby	1.05	(0.39)	**2.85**	**	(0.01)	0.23	(0.73)	1.26		(0.75)	1.51	(0.47)	**4.52**	***	(0.00)
Recreation Area	-1.14	(0.41)	**0.32**	**	(0.01)	-2.61	(0.75)	**0.07**	***	(0.00)	0.22	(0.50)	1.24		(0.66)
High Welfare	1.14	(0.42)	**3.11**	**	(0.01)	2.30	(0.70)	**10.01**	***	(0.00)	0.60	(0.50)	1.82		(0.23)
Poor School Attendance	0.27	(0.43)	1.31		(0.52)	-0.86	(0.68)	0.42		(0.20)	1.39	(0.56)	4.03		(0.01)
Medium															
Intercept	-2.57	(0.15)		***	(0.00)	-1.67	(0.22)			(0.00)	-3.05	(0.21)			(0.00)
Residential Addresses	0.07	(0.01)	**1.07**	***	(0.00)	0.04	(0.01)	**1.04**	***	(0.00)	0.08	(0.01)	**1.08**	***	(0.00)
Business Addresses	0.41	(0.08)	**1.51**	***	(0.00)	0.37	(0.15)	**1.44**	*	(0.01)	0.47	(0.12)	**1.60**	***	(0.00)
School Nearby	1.36	(0.27)	**3.91**	***	(0.00)	0.61	(0.45)	1.84		(0.17)	1.82	(0.34)	**6.18**	***	(0.00)
Recreation Area	-1.21	(0.25)	**0.30**	***	(0.00)	-2.72	(0.44)	**0.07**	***	(0.00)	-0.25	(0.34)	0.78		(0.47)
High Welfare	0.17	(0.29)	1.19		(0.55)	0.87	(0.50)	2.38		(0.09)	0.04	(0.37)	1.04		(0.91)
Poor School Attendance	0.00	(0.29)	1.00		(0.99)	-0.35	(0.48)	0.71		(0.47)	0.34	(0.37)	1.40		(0.36)
Low															
Intercept	-1.4	(0.12)			(0.00)	-0.42	(0.17)			(0.01)	-2.08	(0.17)			(0.00)
Residential Addresses	0.05	(0.01)	**1.06**	***	(0.00)	0.03	(0.01)	**1.03**	***	(0.00)	0.06	(0.01)	**1.06**		(0.00)
Business Addresses	0.35	(0.08)	**1.42**	***	(0.00)	0.29	(0.14)	**1.34**	*	(0.04)	0.44	(0.12)	**1.56**		(0.00)
School Nearby	1.05	(0.24)	**2.86**	***	(0.00)	0.58	(0.34)	1.79		(0.09)	1.40	(0.33)	**4.07**		(0.00)
Recreation Area	-0.69	(0.17)	**0.50**	***	(0.00)	-1.74	(0.24)	**0.18**	***	(0.00)	0.29	(0.23)	1.33		(0.21)
High Welfare	-0.4	(0.24)	0.65		(0.07)	0.16	(0.43)	1.17		(0.71)	-0.46	(0.32)	0.63		(0.15)
Poor School Attendance	-0	(0.23)	0.96		(0.87)	-0.51	(0.40)	0.60		(0.20)	0.45	(0.31)	1.57		(0.15)
* p <= 0.05, ** p <=0.01, *** p<=0.001 Probability calculated based on pseudo class draws in Mplus 6.21															

Being in a recreation area makes an area 13 times more likely to have very low levels of vandalism than high levels of vandalism in EdinburghA (see Table 6.2). This factor is less significant for the case study areas as a whole, and not significant at all for EdinburghB. This might suggest that either EdinburghA is unusual in that it has an extremely large park which has very few crimes of vandalism recorded in it and this skews the results, or in EdinburghB recreation areas do not have the protective effect that they do in EdinburghA. The result is slightly surprising for EdinburghA as young people drinking in parks was highlighted in focus groups as potentially leading to vandalism. It is possible that either they did commit vandalism in the park, but, because it was to a tree or shrub rather than property, it was not recorded as a crime, or it is possible that they committed vandalism in areas buffering the parks. This was not specifically tested for and had it been done so results might have been different.

Finally in EdinburghA, being in a high welfare area makes an area 10 times more likely to be in the high group and not in the very low group, this compares with around 3 times more likely for the case study area as a whole and this factor not being significant in EdinburghB. This is perhaps surprising since advanced marginality and relative deprivation were perceived to be such a big problem for Juliet in EdinburghB. It is important to note that this is only the case when looking at why areas are not in the very low groups, as will be seen in Table 6.2, not being in a high welfare area does seem to protect an area from being from having high levels of vandalism for both EdinburghA and EdinburghB, although this is more the case for EdinburghA. It is also only the case when assessing at the micro (grid) level why areas are not in the very low group, as can be seen from Table 6.3 when differences between factors which effect high and low levels of vandalism are considered at the larger small neighbourhood (OA level) then High Welfare becomes a more significant factor in EdinburghB (though still not as much as in EdinburghA).

Table 6.2 explores what factors put an area into the medium group, the low group or the very low group rather than being in the high group. These could be thought of as protective factors that prevent these areas having very high levels of vandalism. The fact that a grid cells does not fall within a Datazone where a high proportion of the population is in receipt of income related welfare benefits (High Welfare) acts as the most significant protective factor to prevent areas in EdinburghA having high levels of vandalism. The impact of this is greatest for areas which have very low and low levels of vandalism where not being in a high welfare larger neighbourhood (Datazone) means an area is between 10 and 8 times less likely (around a tenth as likely) to have high levels of vandalism. This still has an impact even for areas with medium levels of vandalism in EdinburghA where not being a high welfare area makes the area around 3 times less likely to have high levels of vandalism. For EdinburghB it is just for areas in the Low group only that not being in a high welfare area makes it a 3 times less likely an area will have high vandalism (interestingly it is not a significant factor for Vvery Low areas or Medium areas). There are no factors which make Medium areas significantly less likely to have high vandalism, however a number of factors do protect areas in EdinburghB from having high vandalism levels, these are: lower levels of residential addresses (the impact of this is fairly marginal); low numbers of business addresses (around three fifths) make it one and half times less likely that the area will have high vandalism; having most impact in EdinburghB and causing area to have very low levels of vandalism rather than high levels are not having a school nearby (around a fifth, 4.5 times less likely) and not being in an area with overall poor levels of school attendance (a quarter, 4 times less likely).

Table 6.2 Exploratory Models: Factors putting an area into a Medium Group, Low Group or Very Low Group compared to the High Group - Micro - 100 by 100m Grid

	Grid Negative Binomial Count - 4 class model - Multinomical Logistic Regression														
	Case Study Area					EdinburghA					EdinburghB				
Reference Class:	**High**					**High**					**High**				
Medium	B	S.E	exp(B)		p	B	S.E	exp(B)		p	B	S.E	exp(B)		p
Intercept	1.89	(0.30)		***	(0.00)	1.86	(0.42)		***	(0.00)	2.30	(0.48)		***	(0.00)
Residential Addresses	0.00	(0.00)	1.00		(0.22)	0.00	(0.01)	1.00		(0.75)	-0.01	(0.01)	0.99		(0.07)
Business Addresses	-0.05	(0.04)	0.95		(0.20)	-0.15	(0.08)	0.86		(0.07)	-0.02	(0.05)	0.98		(0.75)
School Nearby	0.32	(0.39)	1.37		(0.42)	0.38	(0.73)	1.46		(0.60)	0.31	(0.46)	1.37		(0.49)
Recreation Area	-0.07	(0.47)	0.93		(0.88)	-0.11	(0.88)	0.89		(0.90)	-0.47	(0.58)	0.63		(0.42)
High Welfare	-0.96	(0.44)	**0.38**	*	(0.03)	-1.44	(0.67)	**0.24**	*	(0.03)	-0.56	(0.53)	0.57		(0.29)
Poor School Attendance	-0.27	(0.44)	0.76		(0.54)	0.52	(0.67)	1.67		(0.44)	-1.05	(0.58)	0.35		(0.07)
Low															
Intercept	3.06	(0.29)		***	(0.00)	3.11	(0.40)		***	(0.00)	3.27	(0.46)			(0.00)
Residential Addresses	-0.02	(0.00)	**0.99**	***	(0.00)	-0.01	(0.01)	0.99		(0.08)	-0.03	(0.01)	**0.98**	***	(0.00)
Business Addresses	-0.11	(0.05)	**0.90**	*	(0.01)	-0.23	(0.08)	**0.80**	**	(0.01)	-0.05	(0.05)	0.96		(0.40)
School Nearby	0.00	(0.38)	1.00		(0.99)	0.35	(0.70)	1.42		(0.62)	-0.11	(0.46)	0.90		(0.82)
Recreation Area	0.45	(0.42)	1.56		(0.28)	0.87	(0.76)	2.38		(0.25)	0.07	(0.51)	1.07		(0.89)
High Welfare	-1.57	(0.41)	**0.21**	***	(0.00)	-2.14	(0.64)	**0.12**	***	(0.00)	-1.06	(0.50)	**0.35**	*	(0.03)
Poor School Attendance	-0.31	(0.42)	0.73		(0.46)	0.36	(0.63)	1.43		(0.57)	-0.94	(0.56)	0.39		(0.09)
Very Low															
Intercept	4.45	(0.29)		***	(0.00)	3.53	(0.41)		***	(0.00)	5.35	(0.46)			(0.00)
Residential Addresses	-0.07	(0.01)	**0.93**	***	(0.00)	-0.04	(0.01)	**0.96**	***	(0.00)	-0.09	(0.01)	**0.92**	***	(0.00)
Business Addresses	-0.46	(0.09)	**0.63**	***	(0.00)	-0.52	(0.15)	**0.60**	**	(0.00)	-0.49	(0.12)	**0.61**	***	(0.00)
School Nearby	-1.05	(0.39)	**0.35**	**	(0.01)	-0.23	(0.73)	0.80		(0.75)	-1.51	(0.47)	**0.22**	**	(0.00)
Recreation Area	1.14	(0.41)	**3.11**	**	(0.01)	2.61	(0.75)	**13.56**	***	(0.00)	-0.22	(0.50)	0.80		(0.66)
High Welfare	-1.14	(0.42)	**0.32**	**	(0.01)	-2.30	(0.70)	**0.10**	***	(0.00)	-0.60	(0.50)	0.55		(0.23)
Poor School Attendance	-0.27	(0.43)	0.76		(0.52)	0.86	(0.68)	2.37		(0.20)	-1.39	(0.56)	**0.25**	*	(0.01)

* p <= 0.05, ** p <=0.01, *** p<=0.001 Probability calculated based on pseudo class draws in Mplus 6.21

When the same data are considered at the small neighbourhood level (OA[17]) rather than the micro, around street level, 100 by 100m grid cell, factors related to use of space on the ground generally cease to be significant. Instead it is broader structural factors related to relative inequality that have impact (Tables 6.3 and 6.4). The models presented here are all SVR categorical models which look at whether for a given year an area falls into either lower than average (quarter of half of the average), around average or higher rates of vandalism (between 2 and 4 times the average, or over 4 times). The model then assesses are there groups of areas that have similar levels of vandalism.

The models find generally that areas fall into one of four groups. There is a Consistently Low group or Mostly Low group where levels of vandalism in the local neighbourhoods (Output

[17] There are 231 OAs in EdinburghA and 217 OAs in EdinburghB – there is a slight overlap between the areas with OAs who are bisected by the NMA boundaries being included in both areas.

Areas - OAs) in this group are generally around a half or less of average that of the wider area. This consistently low group is very similar for the case study as a whole and for the sub-areas EdinburghA and EdinburghB; it makes up around 10% of all areas. There is then a second group of areas which for the case study as a whole and EdinburghB is made up of areas that are around the average or below average; in EdinburghA this group is similar but differs slightly in that it contains average to low areas but also some area that are higher (between 2 and 4 times above area average). The proportion of areas falling into this second group also varies whether you look at study area as a whole or the sub-areas, 45% of the Output Areas across the case study area as a whole fall in the average to low group, fewer OAs, 39%, are in the average to low group in EdinburghB, whereas in EdinburghA, a greater proportion of areas (59%) are in a Low – Average - High group. This is likely to reflect the more fluctuating nature of levels of pockets of vandalism in EdinburghA compared to EdinburghB discussed above as well as the generally higher levels of vandalism in EdinburghB compared with EdinburghA.

Indeed when the two high groups are considered, areas in an average to high, and areas in a mostly high group (generally over 4 times the area average year on year), make up a much greater proportion of areas in EdinburghB then EdinburghA. In EdinburghB just under half of areas (49%) are in these two high groups (Average to High 35%, Mostly High 14%) compared with under a third in EdinburghA (Average to High 20%, Mostly High 8%).

Looking at Table 6.3 across the case study area, and in both the sub-area neighbourhood partnerships the factors which make it most likely that a neighbourhood will experience high levels of vandalism rather than consistently low or mostly low levels of vandalism are being in a high welfare Datazone (that is to say the proportion of population receiving income related welfare benefits is amongst the top 25% in Scotland). For EdinburghA an area with high levels of vandalism is 15 times more likely to be in a high welfare area than an area with low levels of vandalism. For EdinburghB an area with high levels of vandalism is nearly 13 times as likely to be in a high welfare area, and around 9.5 times as likely to be within an area where levels of school attendance are amongst the worst 25% in Scotland. High Welfare is also significant for an area being in an average to high group across the case study area as a whole (6 times more likely to be in an area with high levels of vandalism than low levels) and nearly 19 times more likely in EdinburghA. The other factor that has some possible significance, is having a slightly younger population, this has some impact across the case study area as a whole for High compared to Consistently Low areas, and in EdinburghA only for Average to High compared to Mostly Low areas only. There are no significant factors putting an area in the lower group compared to the very low groups.

Table 6.3 Exploratory Models: Factors putting an area into a Mostly High, Average to High or Average to Low Group compared to the Mostly Low Group – Small Neighbourhood – OAs

	Output Area SVR Categorical - 4 class model - Multinomical Logistic Regression														
	Case Study Area					EdinburghA					EdinburghB				
Reference Class:	Consistently Low 11%					Mostly Low 13%					Consistently Low 10%				
	B	S.E	exp(B)		p	B	S.E	exp(B)		p	B	S.E	exp(B)		p
High	**Mostly High 13%**					**Mostly High 8%**					**Mostly High 14%**				
Intercept	1.19	(1.49)			(0.42)	1.20	(2.36)			(0.61)	-2.35	(2.40)			(0.33)
Residential Addresses	0.01	(0.00)	1.01		(0.19)	0.00	(0.01)	1.00		(0.77)	0.02	(0.01)	1.02		(0.06)
Business Addresses	0.47	(0.61)	1.60		(0.44)	0.29	(0.37)	1.33		(0.44)	1.19	(1.22)	3.27		(0.33)
School Nearby	-0.11	(0.73)	0.89		(0.88)	0.43	(1.15)	1.53		(0.71)	-0.75	(1.09)	0.47		(0.49)
Recreation Area	-0.10	(0.63)	0.90		(0.87)	0.22	(0.93)	1.25		(0.81)	0.18	(1.07)	1.19		(0.87)
High Welfare	2.73	(0.77)	**15.36**	***	(0.00)	2.69	(1.33)	**14.76**	*	(0.04)	2.54	(1.08)	**12.73**	*	(0.02)
Poor School Attendance	0.72	(0.71)	2.05		(0.31)	1.31	(1.12)	3.70		(0.24)	2.24	(1.14)	**9.42**	*	(0.05)
Median Age	-0.08	(0.03)	**0.93**	*	(0.02)	-0.10	(0.05)	0.91		(0.07)	-0.03	(0.05)	0.97		(0.53)
Average to High	**Average to High 30%**					**Average to High 20%**					**Average to High 35%**				
Intercept	1.43	(1.23)			(0.25)	4.65	(1.90)			(0.01)	-1.64	(1.93)			(0.39)
Residential Addresses	0.00	(0.00)	1.00		(0.59)	0.00	(0.01)	1.00		(0.68)	0.01	(0.01)	1.01		(0.47)
Business Addresses	0.44	(0.61)	1.55		(0.47)	0.13	(0.36)	1.14		(0.72)	1.14	(1.22)	3.11		(0.35)
School Nearby	0.08	(0.63)	1.08		(0.90)	0.41	(0.94)	1.50		(0.67)	-0.24	(0.90)	0.79		(0.79)
Recreation Area	0.29	(0.45)	1.33		(0.52)	-0.90	(0.73)	0.41		(0.22)	1.22	(0.73)	3.37		(0.10)
High Welfare	1.79	(0.67)	**5.97**	**	(0.01)	2.94	(1.18)	**18.86**		(0.01)	1.24	(0.83)	3.45		(0.13)
Poor School Attendance	0.39	(0.60)	1.47		(0.52)	-0.69	(1.02)	0.50		(0.50)	1.51	(0.81)	4.51		(0.06)
Median Age	-0.03	(0.03)	0.97		(0.27)	-0.11	(0.04)	**0.89**		(0.01)	0.03	(0.04)	1.03		(0.51)
Average to Low	**Average to Low 45%**					**Low - Average - High 59%**					**Average to Low 39%**				
Intercept	0.78	(1.2)			(0.52)	3.03	(1.53)			(0.05)	-1.55	(1.96)			(0.43)
Residential Addresses	-0.01	(0.00)	1.00		(0.25)	-0.01	(0.00)	1.00		(0.22)	-0.01	(0.01)	1.00		(0.71)
Business Addresses	0.30	(0.63)	1.36		(0.63)	0.08	(0.39)	1.09		(0.83)	0.97	(1.25)	2.62		(0.44)
School Nearby	0.31	(0.60)	1.37		(0.60)	0.27	(0.77)	1.31		(0.73)	0.40	(0.87)	1.49		(0.65)
Recreation Area	-0.37	(0.45)	0.69		(0.42)	-0.88	(0.54)	0.41		(0.10)	0.39	(0.75)	1.47		(0.61)
High Welfare	0.93	(0.67)	2.54		(0.16)	1.63	(1.14)	5.09		(0.15)	0.52	(0.84)	1.67		(0.54)
Poor School Attendance	0.21	(0.59)	1.23		(0.72)	-0.26	(0.94)	0.77		(0.78)	1.14	(0.81)	3.14		(0.16)
Median Age	0	(0.03)	1.01		(0.60)	-0.03	(0.03)	0.97		(0.33)	0.05	(0.04)	1.05		(0.22)

* p <= 0.05, ** p <=0.01, *** p<=0.001 Probability calculated based on pseudo class draws in Mplus 6.21

Table 6.4 looks at protective factors, factors which might prevent an areas being in the mostly high group. Factors that make areas likely to be in the consistently low group compared to the high group are just the reverse of Table 6.3. Not being in a High Welfare areas is protective, areas in the consistently low group are between 12 and 15 times less likely to be in a high area, similarly for EdinburghB they are also 9.5 times (1/0.11) less likely to be in an areas with poor school attendance. Interestingly for EdinburghA only, not being in an area with poor school attendance also makes the difference as to whether an area falls in the average to high group or the high group, an OA with the average to high levels of vandalism year in year out is around 7 times less likely (1/0.14) to be in area with poor school attendance than an area with mostly high levels of vandalism. Not being in a high welfare area is also a protective factor for areas with average to low levels of vandalism across the case study and in EdinburghB (although not

EdinburghA). In the case study area as a whole, an area with average to low levels year on year of vandalism is 6 times less likely to be in a high welfare area, and in EdinburghB and area with average to low levels of vandalism is around 7.5 times less likely to be in a high welfare area, than areas that come within the group of Output Areas that have mostly high levels of vandalism year on year.

Table 6.4 Exploratory Models: Factors putting an area into a Average to High, Average to Low or Mostly Low Group compared to the Mostly High Group – Small Neighbourhood – OAs

	Output Area SVR Categorical - 4 class model - Multinomical Logistic Regression											
	Case Study Area				**EdinburghA**				**EdinburghB**			
Reference Class:	**Mostly High 13%**				**Mostly High 8%**				**Mostly High 14%**			
	B	S.E	exp(B)	p	B	S.E	exp(B)	p	B	S.E	exp(B)	p
Average to High	**Average to High 30%**				**Average to High 20%**				**Average to High 35%**			
Intercept	0.23	(1.12)		(0.84)	3.45	(2.26)		(0.13)	0.71	(1.75)		(0.69)
Residential Addresses	-0.01	(0.00)	**0.99** *	(0.04)	0.00	(0.01)	1.00	(0.54)	-0.02	(0.01)	**0.99** *	(0.02)
Business Addresses	-0.03	(0.05)	0.97	(0.49)	-0.16	(0.11)	0.85	(0.14)	-0.05	(0.07)	0.95	(0.49)
School Nearby	0.19	(0.52)	1.21	(0.71)	-0.02	(1.01)	0.98	(0.98)	0.51	(0.77)	1.67	(0.51)
Recreation Area	0.39	(0.53)	1.47	(0.46)	-1.12	(0.99)	0.33	(0.26)	1.04	(0.86)	2.83	(0.23)
High Welfare	-0.95	(0.56)	0.39	(0.09)	0.25	(1.01)	1.28	(0.81)	-1.31	(0.85)	0.27	(0.12)
Poor School Attendance	-0.33	(0.55)	0.72	(0.55)	-2.00	(0.96)	**0.14** *	(0.04)	-0.74	(0.96)	0.48	(0.44)
Median Age	0.05	(0.02)	**1.05** *	(0.05)	-0.02	(0.05)	0.98	(0.73)	0.06	(0.03)	1.06	(0.08)
Average to Low	**Average to Low 45%**				**Low - Average - High 59%**				**Average to Low 39%**			
Intercept	-0.41	(1.10)		(0.71)	1.83	(1.97)		(0.35)	0.81	(1.78)		(0.65)
Residential Addresses	-0.01	(0.00)	**0.99** **	(0.01)	-0.01	(0.01)	0.99	(0.21)	-0.03	(0.01)	**0.97** **	(0.00)
Business Addresses	-0.17	(0.08)	**0.85** *	(0.04)	-0.20	(0.11)	0.82	(0.07)	-0.22	(0.14)	0.80	(0.10)
School Nearby	0.43	(0.52)	1.53	(0.41)	-0.16	(0.91)	0.85	(0.86)	1.15	(0.78)	3.15	(0.14)
Recreation Area	-0.27	(0.53)	0.77	(0.61)	-1.10	(0.85)	0.33	(0.19)	0.21	(0.92)	1.24	(0.82)
High Welfare	-1.80	(0.55)	**0.17** **	(0.00)	-1.07	(0.94)	0.34	(0.26)	-2.03	(0.86)	**0.13** *	(0.02)
Poor School Attendance	-0.51	(0.54)	0.60	(0.35)	-1.57	(0.90)	0.21	(0.08)	-1.10	(0.96)	0.33	(0.25)
Median Age	0.09	(0.02)	**1.09** ***	(0.00)	0.07	(0.04)	1.07	(0.13)	0.09	(0.04)	**1.09** *	(0.02)
Consistently Low	**Consistently Low 11%**				**Mostly Low 13%**				**Consistently Low 10%**			
Intercept	-1.19	(1.49)		(0.42)	-1.20	(2.36)		(0.61)	2.35	(2.40)		(0.33)
Residential Addresses	-0.01	(0.00)	1.00	(0.19)	0.00	(0.01)	1.00	(0.77)	-0.02	(0.01)	0.98	(0.06)
Business Addresses	-0.47	(0.61)	0.63	(0.44)	-0.29	(0.37)	0.75	(0.44)	-1.19	(1.22)	0.31	(0.33)
School Nearby	0.11	(0.73)	1.12	(0.88)	-0.43	(1.15)	0.65	(0.71)	0.75	(1.09)	2.12	(0.49)
Recreation Area	0.10	(0.63)	1.11	(0.87)	-0.22	(0.93)	0.80	(0.81)	-0.18	(1.07)	0.84	(0.87)
High Welfare	-2.73	(0.77)	**0.07** ***	(0.00)	-2.69	(1.33)	**0.07** *	(0.04)	-2.54	(1.08)	**0.08** *	(0.02)
Poor School Attendance	-0.72	(0.71)	0.49	(0.31)	-1.31	(1.12)	0.27	(0.24)	-2.24	(1.14)	**0.11** *	(0.05)
Median Age	0.08	(0.03)	**1.08** **	(0.02)	0.10	(0.05)	1.10	(0.07)	0.03	(0.05)	1.03	(0.53)
* p <= 0.05, ** p <=0.01, *** p<=0.001 Probability calculated based on pseudo class draws in Mplus 6.21												

Results presented in Tables 6.3 and 6.4 suggest that factors that influence whether a small neighbourhood experiences a vandalism problem are broader structural social factors not more local factors relating to use of space and routine activities. This raises some very interesting questions for further research. By looking at vandalism at this still small but coarser neighbourhood level is this accurately reflecting the broader impact of more structural effects such as relative inequality on residents, or is it just failing to spot the importance of more localised effects that occur at street level such as where the schools and businesses are? Is it the lack of a measure of micro level inequality and reliance on a broad level proxy measure (Chapter 5) that is causing the differing results? The fact that this research in this case study area so clearly raises these questions has potentially important theoretical and methodological implications for crime and place research, it also raises interesting challenges for policy makers – this will be considered further in the concluding Chapter 7.

6.3 Section 2 - Results EdinburghA

6.3.1 About the Neighbourhood

Figure 6.4 provides a context map of the EdinburghA area. This Neighbourhood Partnership comprises a mix of residential and business locations as well as having two large parks and recreation areas. The large park area shown in B3 and B4 is a very large public park and is a popular location for walking for many Edinburgh residents and also tourists visiting Edinburgh. The smaller recreation area shown in C1 and C2 is a large golf course and local park. There is another small park and loch within C2 which can be a popular hangout for local young people. The sports centre marked with a star inside the study area is a public sports centre, the sports centre marked with a star just outside the area is a football stadium that attracts football fans from across Edinburgh. There are two major railway lines which cut through the area, one running through a set of industrial estates to the east of the area and the other cutting through the middle of the Neighbourhood Partnership through residential areas. There are only limited points where these railway lines can be crossed. Alongside the second railway line are a number of small businesses which follow both the line of the railway and a fairly major road route shown as a thin pink line (this is a major local road but can be crossed easily at frequent pedestrian crossing points). Historical maps show that these railway lines date to at least 1850 and pre-date much of the development of business and housing in the area. There is a particularly dense area of residential housing, some of it tenement flats in and around C2. The areas around D2 and to the south of D3 are less densely populated.

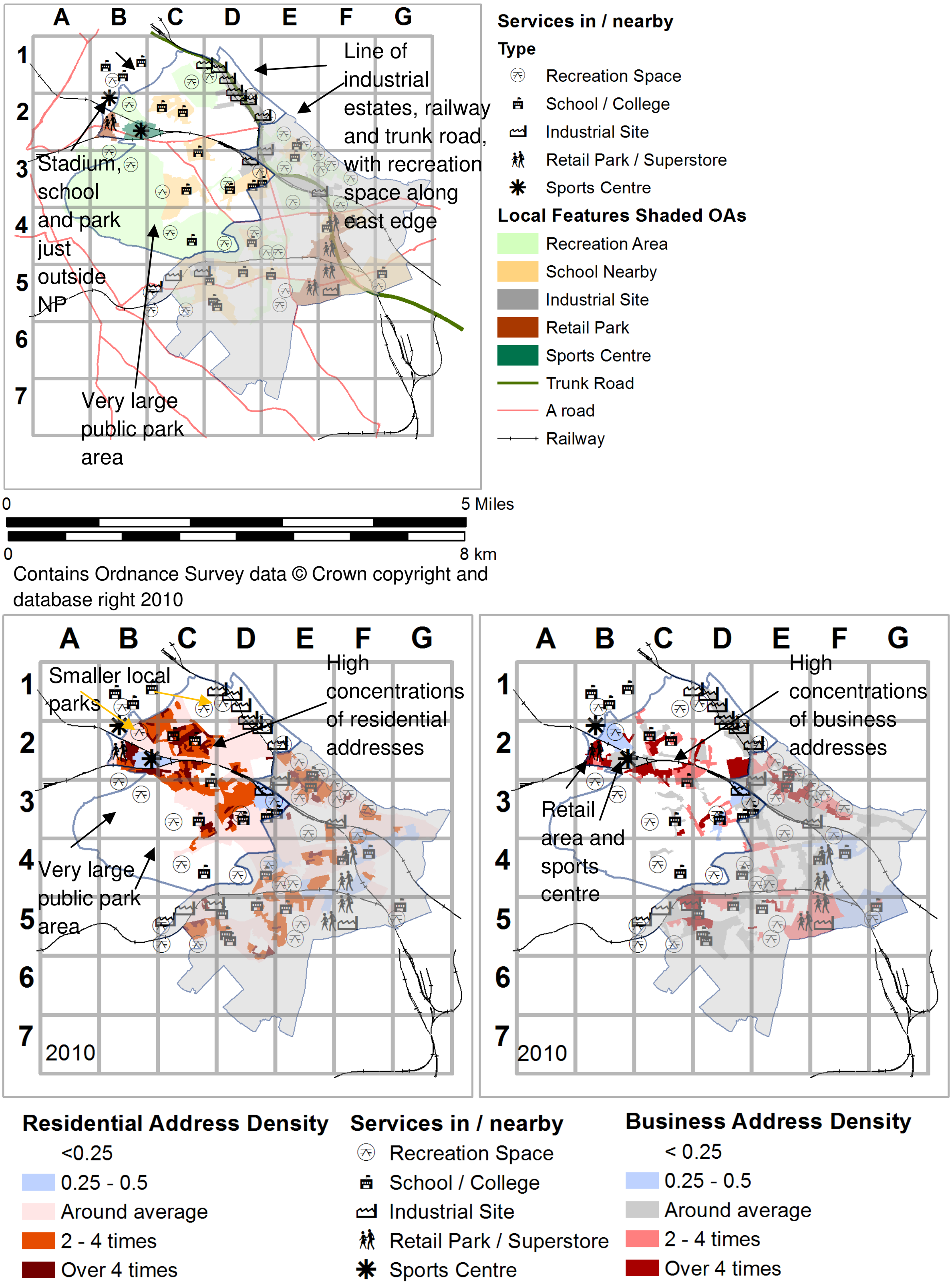

Figure 6.4 Neighbourhood Partnership EdinburghA Context Maps

6.3.2 Describing Patterns in Space and Time – Edinburgh A

The first key question asked in the Focus groups was: 'were there high and low concentrations of the vandalism in this study area?' Figure 6.5 shows a number of different annotation styles used by Officers. Police Officers in all focus groups were able to clearly annotate maps to highlight areas where they perceived there were both high and low levels of vandalism.

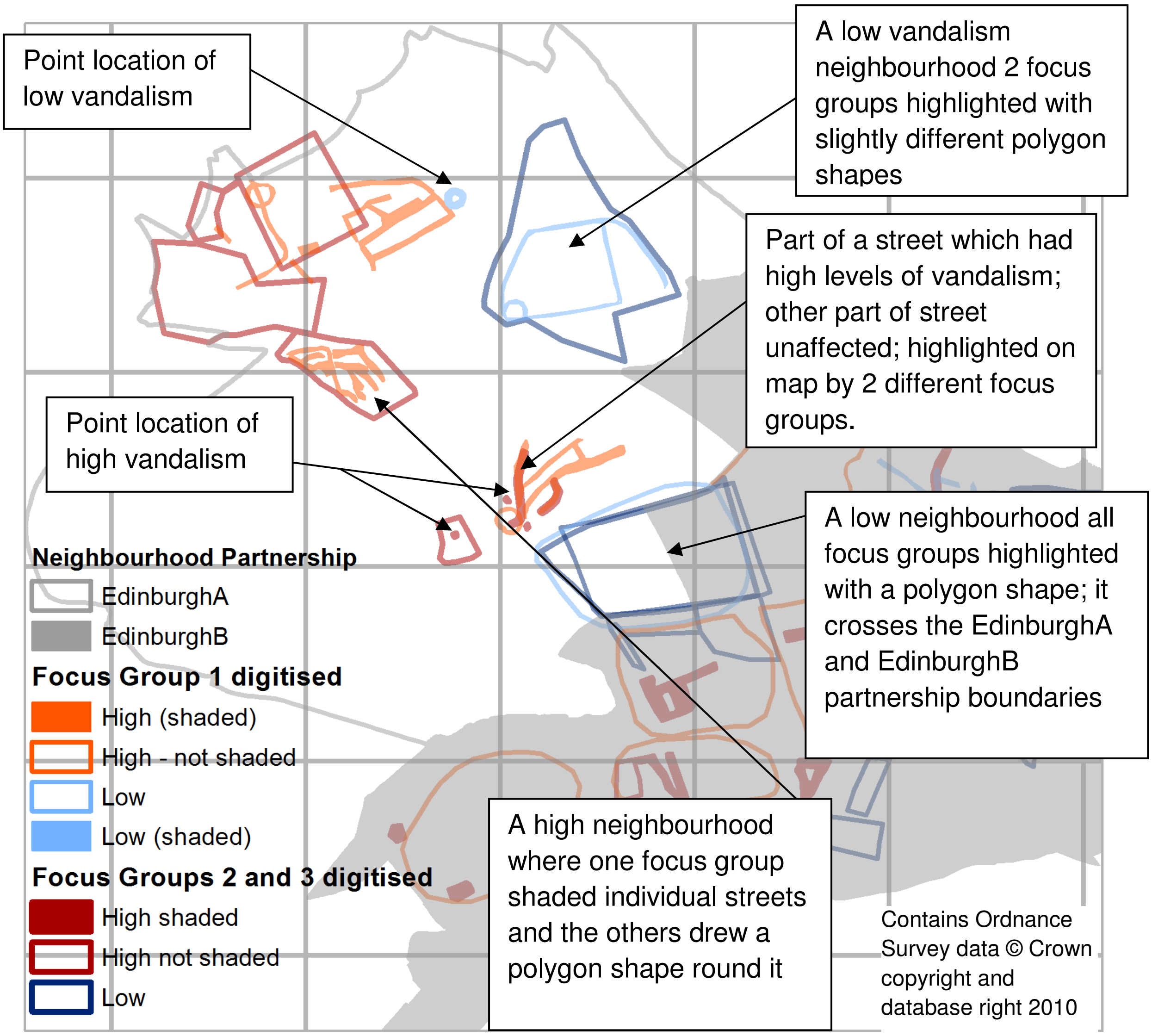

Figure 6.5 Digitised Maps of Focus Groups zoomed in to show different styles of annotation

This great variety of annotation styles clearly shows that Officers perceived areas of high and low concentrations of vandalism as occurring at different scales. There is also a suggestion that they perceived local processes that affected vandalism as potentially taking place at different scales, with some effects being very localised to specific locations and others permeating throughout the local neighbourhood. Figure 6.6 shows how focus group annotations have been used to inform the boundaries used to define the key areas Delta, Echo, Foxtrot and Indigo. Senior Officers involved with community policing in Focus Group 1 shaded streets throughout much of Delta area, whereas Community Officers in Focus Group 2 shaded the west of Delta. Taken together (along with recorded vandalism data), Delta was a clear area of interest as it has fluctuating high levels of vandalism across the area. Delta comprises a number of areas with some different but generally similar characteristics highlighted by focus groups and so these areas have been grouped together. Foxtrot is a small distinct area which was highlighted as the same small number of streets. In one case the lower half of a single longer road, which shared similar characteristics. Foxtrot was highlighted in a very similar way in both Focus groups 1 and 2 as a specific area with high concentrations of vandalism unlike other areas nearby. Echo is a larger residential estate area comprising a number of streets with consistently low levels of vandalism highlighted as a block area in both focus groups – the boundary chosen for Echo follows broadly that of the area highlighted by focus group 2. Indigo is a block of streets which were highlighted by all three focus groups as having low levels of vandalism and a fairly affluent local neighbourhood where streets shared a similar character.

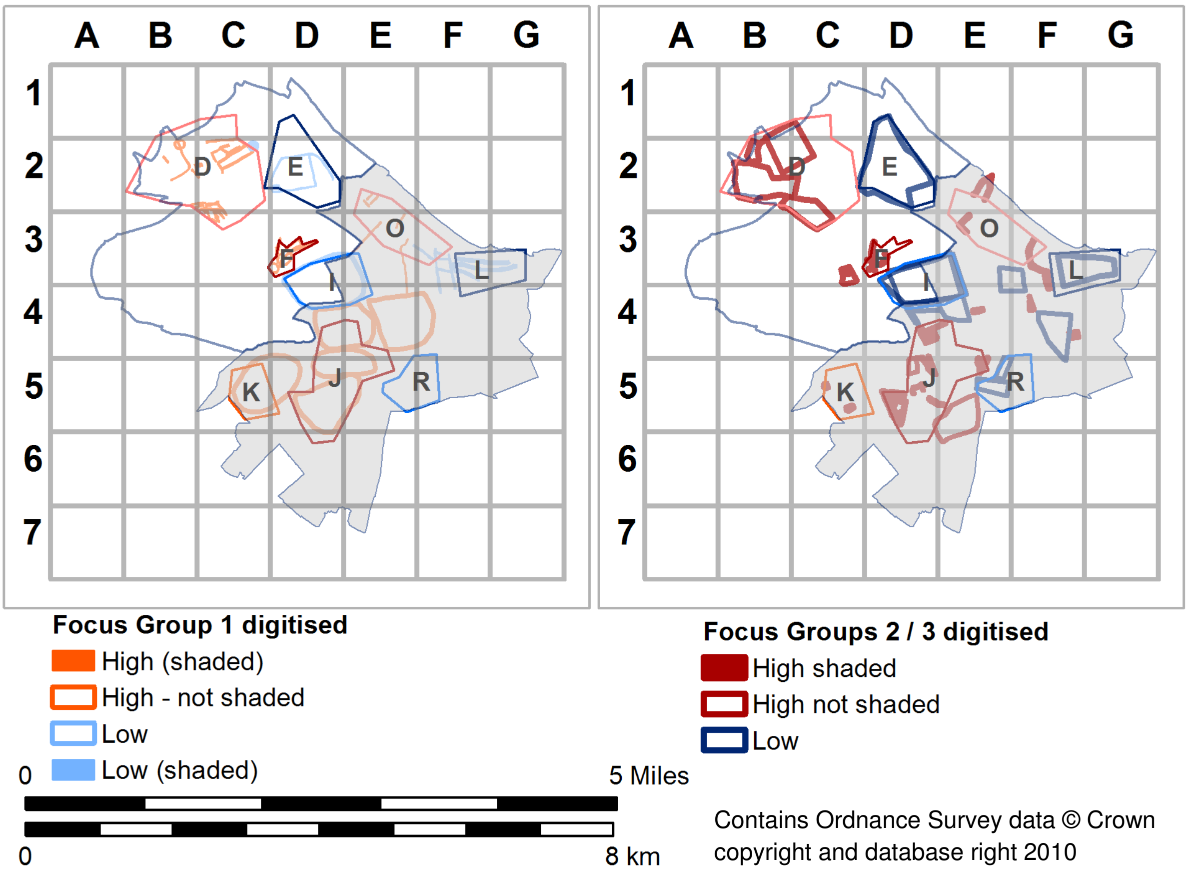

Figure 6.6 – Key Areas as Highlighted in Focus Group 1, 2 and 3 – Focus on EdinburghA

As discussed in Chapter 4 police recorded crime data also consistently showed high and low areas of vandalism across the study area, however different styles and scales of mapping of the same data were able to highlight concentrations of vandalism in different ways. The following figures use slightly different visualisations to highlight how patterns of vandalism vary across the EdinburghA area and within Delta, Echo, Foxtrot and Indigo over space and time. One key aspect of patterns of recorded high vandalism in the EdinburghA area is that although they generally occur across a similar neighbourhood area every year, precise locations seemed to be more mobile. Figure 6.7 shows high concentrations visualising the G_i* technique using a commonly promoted methods for assessing significance (shading by significant z scores) for all 6 years. The visualisation looks slightly different to the visualisation of the pseudo random G_i technique in Figure 4.6 in Chapter 4. This is because the method for assessing significance used by ArcGIS used to prepare this map in figure 6.5 is different to that used by OpenGeoDa used to prepare the map in Figure 4.6 in Chapter 4. It is based on z-scores rather than Monte Carlo Markov chain (MCMC) style generated significance (for more information see Chapter 3).

The EdinburghA area is the area not shaded over in grey. Red circles indicate high concentrations of vandalism that appear slightly mobile particularly in the Drifting Group Area - Delta). Delta appears often to experience high concentrations of vandalism in particular micro local neighbourhood locations (represented by 100x100m grid cells) but the precise locations of high levels of vandalism appear to move around slightly year by year. In 1st April 2004 to 31st March 2005 Foxtrot had no significant levels of vandalism or fire-raising; however this changes in the following years and by 2009-10 the levels had increased in this small areas such that many of the micro neighbourhood locations in this area had highly significant levels of vandalism.

Using the Local Moran's I technique at 100 x 100m grid level produced similar results to the G_i* results. However visualisations at Output Area level nicely highlight concentrations of low areas next to low areas in EdinburghA (Figure 6.8). As discussed in Chapters 3 and 4, Local Moran's I considers whether there is a similar level of covariance in surrounding areas compared with co-variance across the area as a whole– in other words are the differences between a local area and its surrounding area significantly above or below average compared to the differences between areas across the area as a whole. Like G_i*, Local Moran's I highlights an area with high concentrations of vandalism that is surrounded by other high concentrations of vandalism (shaded red), a low area surrounded by low areas of vandalism (shaded blue). Areas which have a high concentration of vandalism when areas that are around them are low are shaded pink, and areas that are low when areas around them are high are shaded purple.

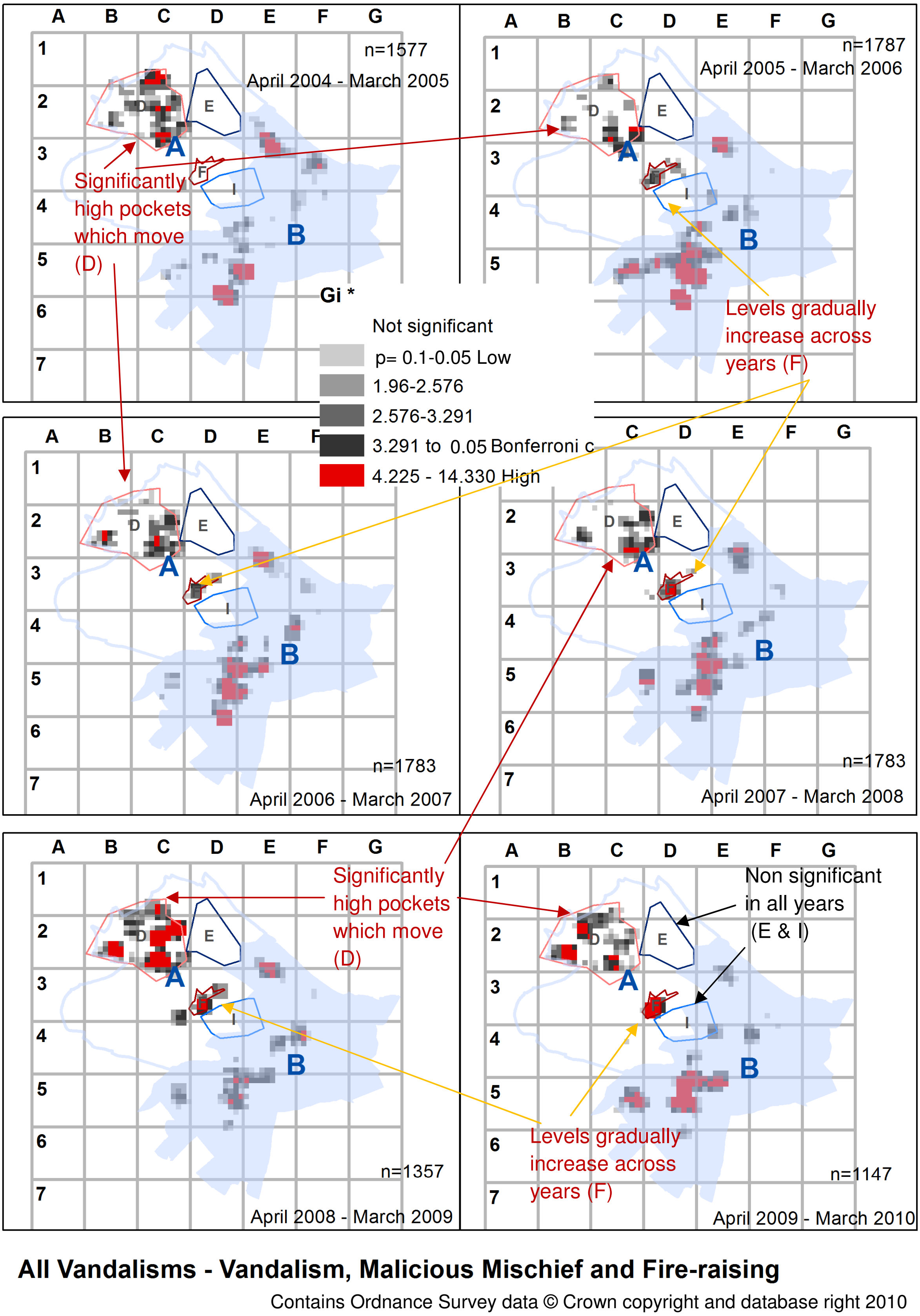

Figure 6.7: Vandalism in micro-neighbourhoods across the study period in EdinburghA using G_i* (row standardised z-scores)

Figure 6.8 looks at where low concentrations of vandalism occur year on year across the study area and uses the Local Moran's I technique at Output Area level to assess this. Since Output Areas were originally produced to show census data at the small area level they can be thought of as small neighbourhood areas of a few streets. They are still of a form of small micro neighbourhood but are at a coarser scale than the 100m grid scale. Since they were designed to be relatively homogeneous they can be thought of as being a close fit to actual small neighbourhood clusters based on similarity of residents and type of housing and tenure of the area. Thus data analysed at Output Area level assesses how levels of vandalism affect small local neighbourhoods, rather than pockets of vandalism like grid analysis. Analysing data aggregated by Output Areas shows which local neighbourhoods experienced high or levels of vandalism.

Figure 6.8 shows Local Moran's I map visualisations based on a rate which compares whether the number of vandalism per hectare in a neighbourhood are like or unlike other neighbourhoods around. Thus answering the question: is a low neighbourhood next to other low neighbourhoods? By using this standardised rate per hectare different sizes of neighbourhood are controlled for. Since vandalism happens to objects in physical space, and it is not possible to get a count of all available surfaces and things that might be vandalised, it makes sense to standardise by hectare (that is the physical area that has the potential to be vandalised.)

As can be seen in Figure 6.8 within both Echo and Indigo there are a number of Output Areas which consistently are low areas surrounded by low areas. These low vandalism neighbourhoods were not highlighted by G_i* analysis or the pseudo G_i analysis. This is because at the OA scale the levels of vandalism are low compared to their neighbours. However analysis of data at 100m Grid square levels (pockets of vandalism) shows that within these neighbourhoods there may be one or two isolated occurrences of vandalism in a given year. This means the neighbourhood is not completely vandalism free every year but it does have a very low rate of vandalism each year, as do the neighbouring areas nearby. If analysis was only done at the more micro level of 100m grid, these low-low neighbourhood patterns would have been missed. This highlights the value of analysing the data at a range of scales to understand the underlying patterns of concentrations of vandalism across the study area.

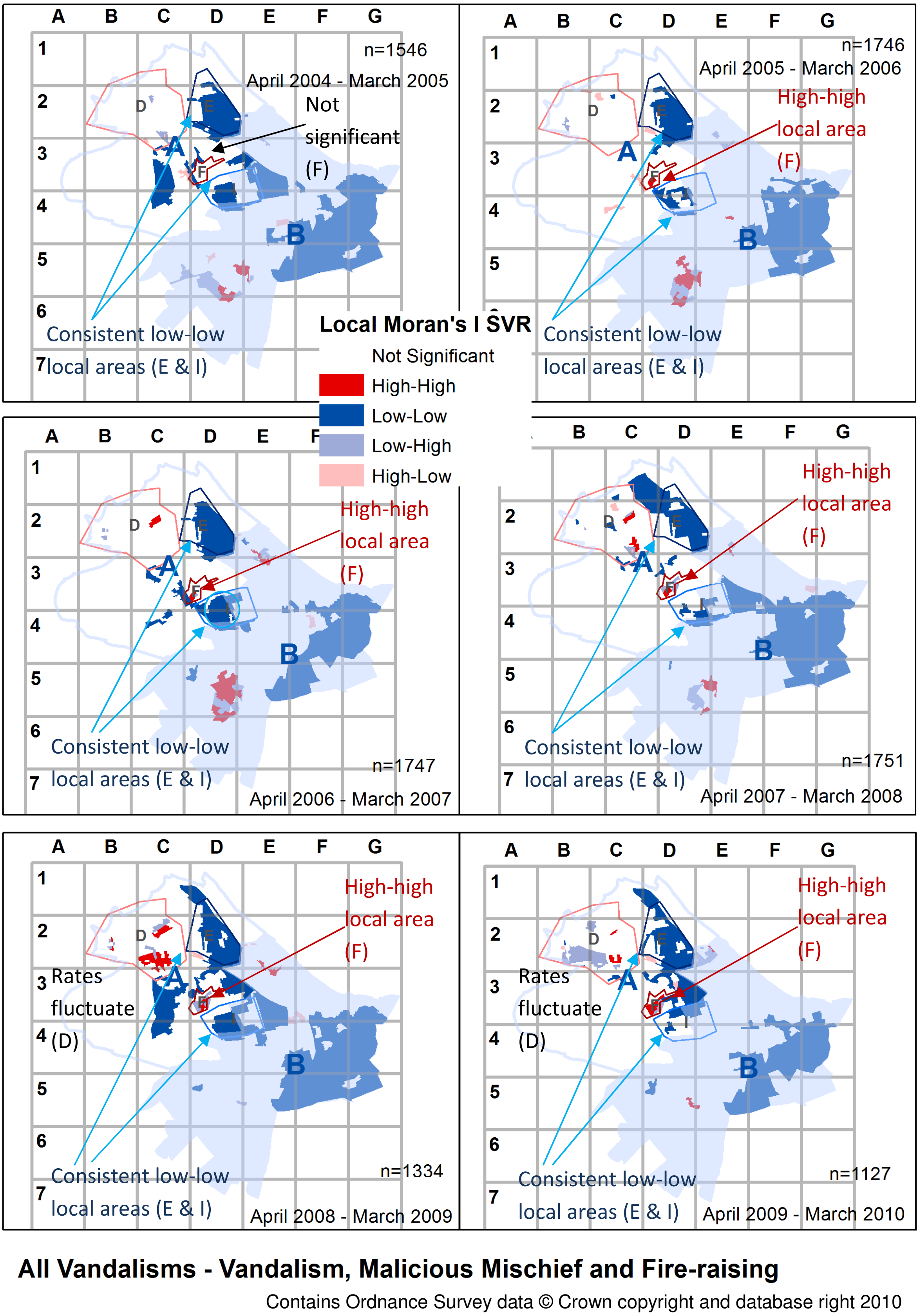

Figure 6.8: Highlighting concentrations of vandalism rates per hectare in local OAs across the study period in EdinburghA using Local Moran's I

However, the changing pattern of high pockets of crime in Delta apparent from the Gi* analysis in Figure 6.7 is much less clear using Local Moran's I visualisation at the Output Area scale; this again suggests the value of multiple types of analysis at multiple scales to build a comprehensive picture of patterns of vandalism across the case study area (discussed in Chapter 4). It also suggests that these high pockets of vandalism in Delta may be quite small and localised as they are not large enough for them to be registered at the slightly larger OA scale. However the similar growing persistence of a high neighbourhood in Foxtrot from 2005-6 onwards is also shown by the Local Moran's I analysis suggesting in this case that vandalism across the whole of the Foxtrot neighbourhood is having an impact.

These differences in which areas are highlighted as high or low is not because certain Output Areas in the Echo area are much bigger than the Output Areas in Delta. As Figure 6.9 shows most of the Output Areas in Delta, Echo and Foxtrot are quite similar in size. It therefore appears that there is a genuine concentration of low next to low neighbourhoods in Echo every year.

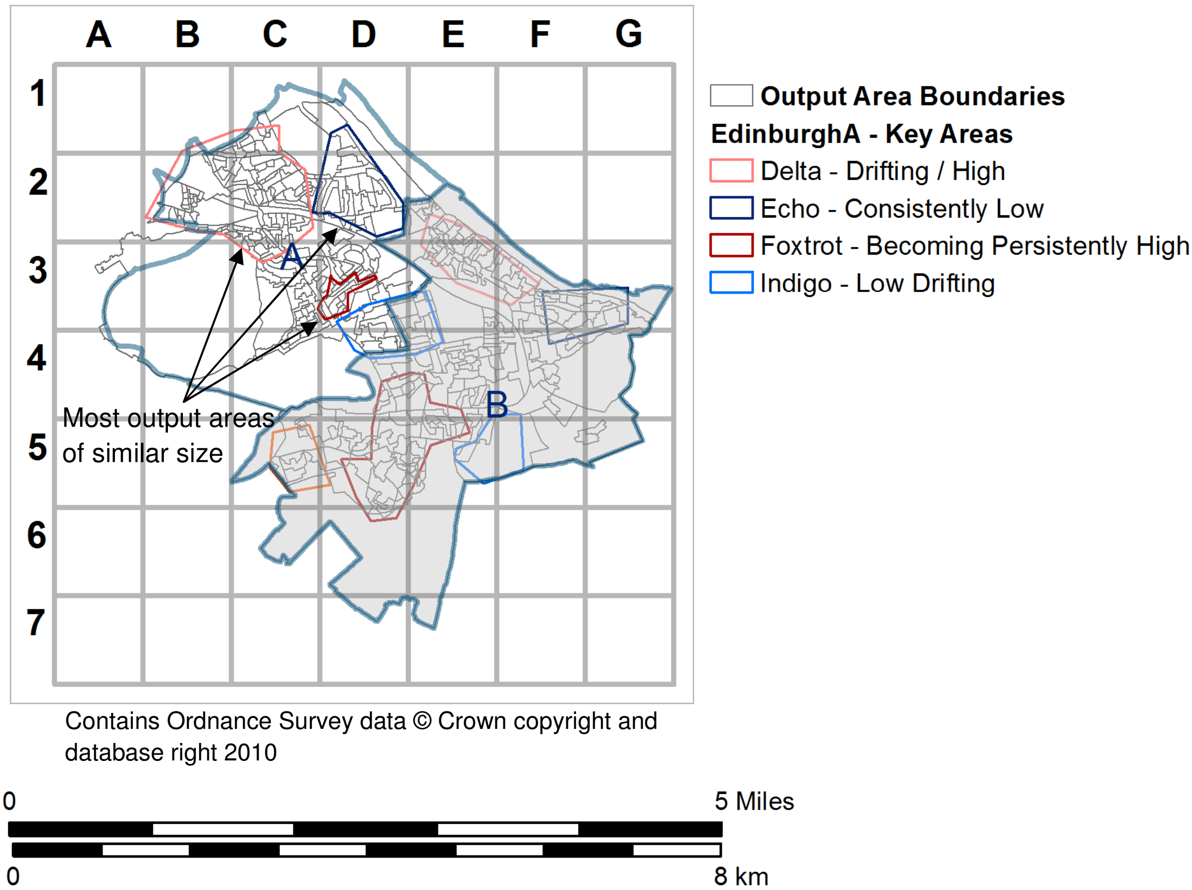

Figure 6.9 Comparing Output Area sizes in the EdinburghA study area

As Output Areas are based on homogeneous population characteristics an alternative way to look at the data is to look at *aggregate counts* at Output Area level using the lens of Local Moran's I analysis. This shows which areas with similar sizes and types of population (although not necessarily a similar area in hectares) have for example high counts of recorded vandalism surrounded by similarly high counts of recorded vandalism in the immediately neighbouring areas as can be seen from Figure 6.9. This provides further insight into the pattern of high and low concentrations of vandalism in the Edinburgh A study area.

An initial insight from Figure 6.10 is that not standardising the data can make some large areas appear to have high concentrations when in reality this is purely due to the large size of the Output Area (an issue discussed in more detail in Chapter 4). One local neighbourhood which has higher values in 2005-6 and 2006-7, is also much larger than the other Output Areas that surround it so it has higher counts. However, this is not always the case, in 2007-8 there is an area within Echo which shows up as having higher counts than surrounding areas and although it is also larger than adjoining areas in this year it has a higher level of counts than other years (the number of vandalism in the area rises from 2 or 3 per year to 6 per year in that year). This area is unusual in 2007-8 compared with other years, generally Echo has Output Areas with low next to low counts of vandalism in all years. The maps again emphasise the changing nature of where high and low concentrations of vandalism occur in the Delta area. In each year within Delta there are combinations of significant high areas next to high areas, low areas next to high areas and high areas next to high areas. However, precisely how these combinations arise and their position in space varies from year to year. This again corroborates Figure 6.7 and 6.8 in suggesting that Delta is an area where patterns of vandalism fluctuate year on year. Delta is an area where often higher concentrations of vandalism occur; but the precise local pockets where these occur vary a lot across years.

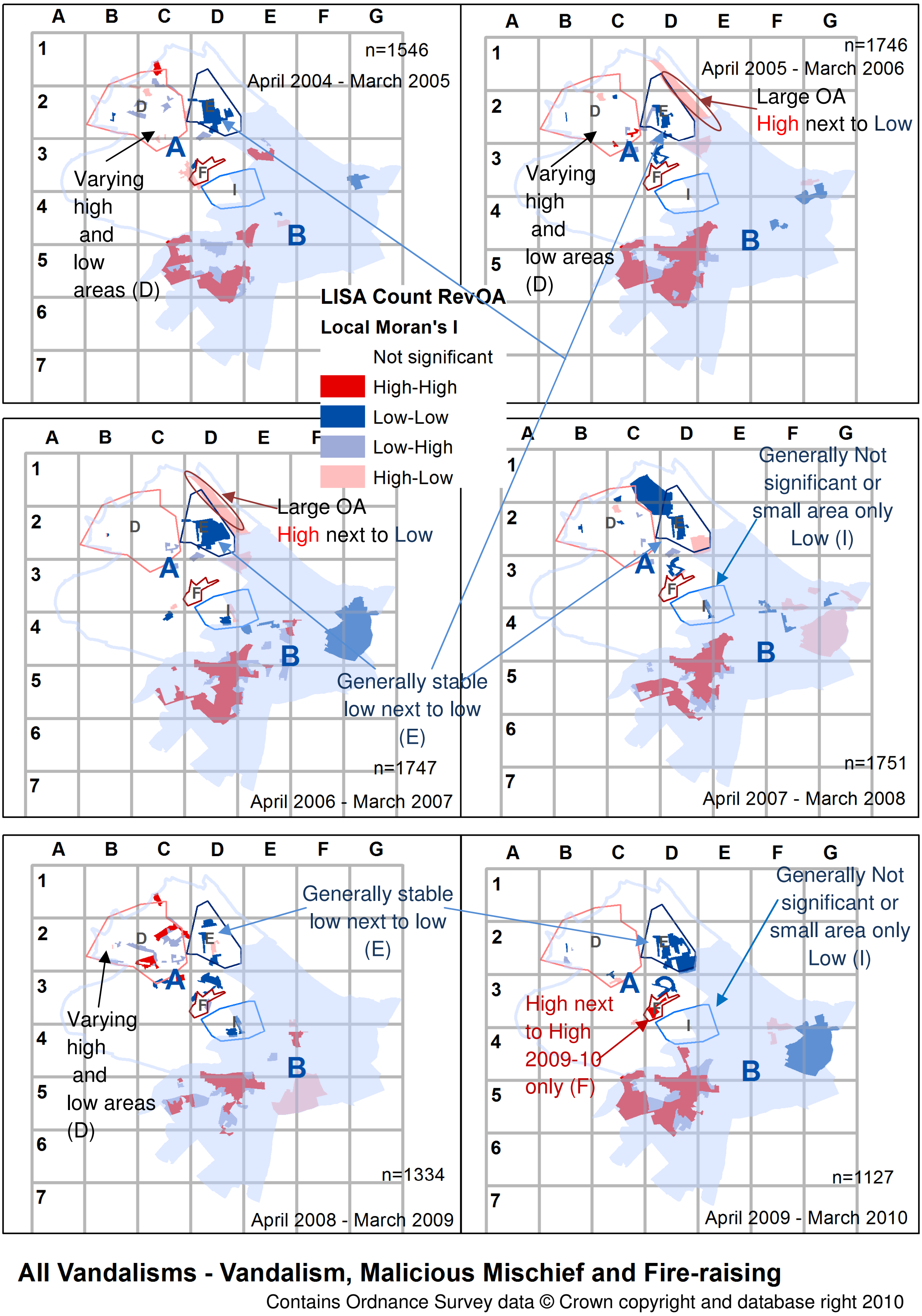

Figure 6.10: Highlighting concentrations of vandalism counts in local OAs across the study period in EdinburghA using LISA – Local Moran's I

The overall patterns of vandalism across the six years are neatly summarised by the group trajectory analysis (Chapter 5). The Group Trajectory SVR Categorical OA analysis groups Output Areas into one of four groups; areas which are generally high (compared to the area average for vandalism per hectare); areas which fluctuate between average and high; areas that fluctuate between average and low, and areas that are consistently low. This is compared with the high groups from the 6 group negative binomial count model (shaded by the likelihood that a given grid cell falls within the group) in Figure 6.11. Counts in grid cells in the Very high group fluctuate between a mean of around 12 crimes of vandalism a year rising to a high of just over 18 in 2006-7 before falling to around 10 in 2009-10. Counts of vandalism crimes in the stable high group vary around 6 per year, and counts in the medium group are around two per year. Overlaying boundaries of the Key Area descriptive groups again highlights the fluctuating nature of the Delta area. The majority of Output Areas within Delta are either within the average to low group or the average to high group – they are generally drifting in character. In other words, most of the neighbourhoods within Delta either drift between levels of high and average and low and average. There are some mostly high areas, and a few consistently low areas but these are in the minority. Delta also has a few grid cells which fall into the very high group, and a number of pockets of grid cells which are in the stable high class so although the majority of areas in Delta are around or below average, there are a few pockets of high vandalism but they do not dominate the area. Delta can thus be summarised as a Drifting area with Temporary High pockets, the High pockets can be described as temporary as they do not appear to form definitive clusters and are often mobile across years.

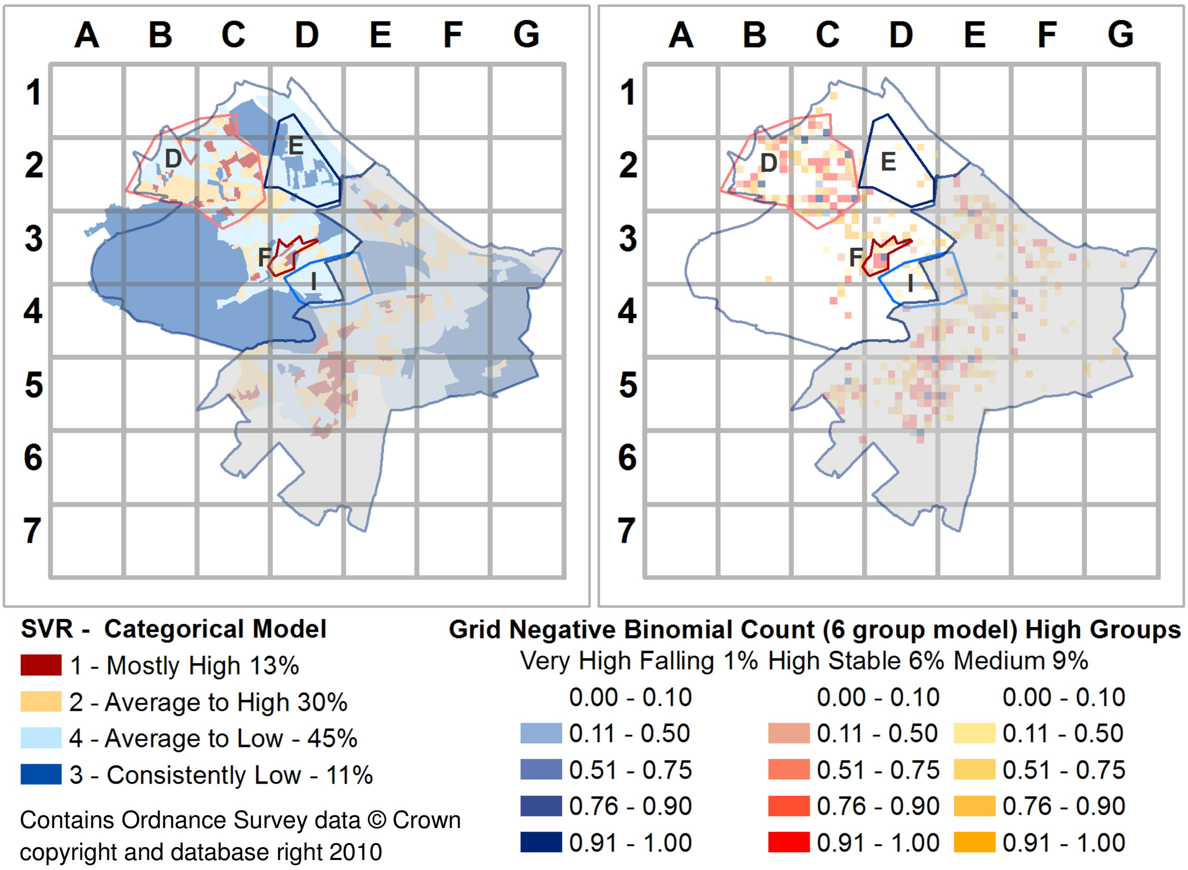

Figure 6.11 Group Trajectory Model Summaries with a Highlight on Edinburgh A– OA Categorical 4 Class and Grid Count 6 class (high areas only) Models

Foxtrot, a much smaller area than Delta, has mostly high and average to high Output Areas. Looking at pockets of crimes of vandalism as represented by grid cells here it has a clear pocket of high stable and very high areas towards the west and south of Foxtrot. This is further highlighted in that seems to have been a mainly high next to high pocket of grid cells from 2005-6 onwards in Foxtrot (Figure 6.11) Foxtrot is therefore a good example of an area that has become a Persistently High area.

Figure 6.11 and 6.12 both highlight the consistently low nature of Echo, and to a lesser extent Indigo. By all measures, Echo is a Consistently Low area; it is made up of consistently low and average to low areas (based on the SVR categorical model). It has **no** areas which are high, or medium pockets of crime, and at Output Area level it is clearly mainly comprised of a cluster of low next to low Output Areas. Echo is also the only area where, for Output Areas, the categorical and the count group trajectory models both suggest the area is a consistently low area (see figure A5.2, appendix 5). Indigo has mainly low areas but also an average to high area, and some pockets of medium levels of recorded vandalism year in year out. It is thus better described as a Drifting Low area – it does not show the clear absence of crime seen in Echo.

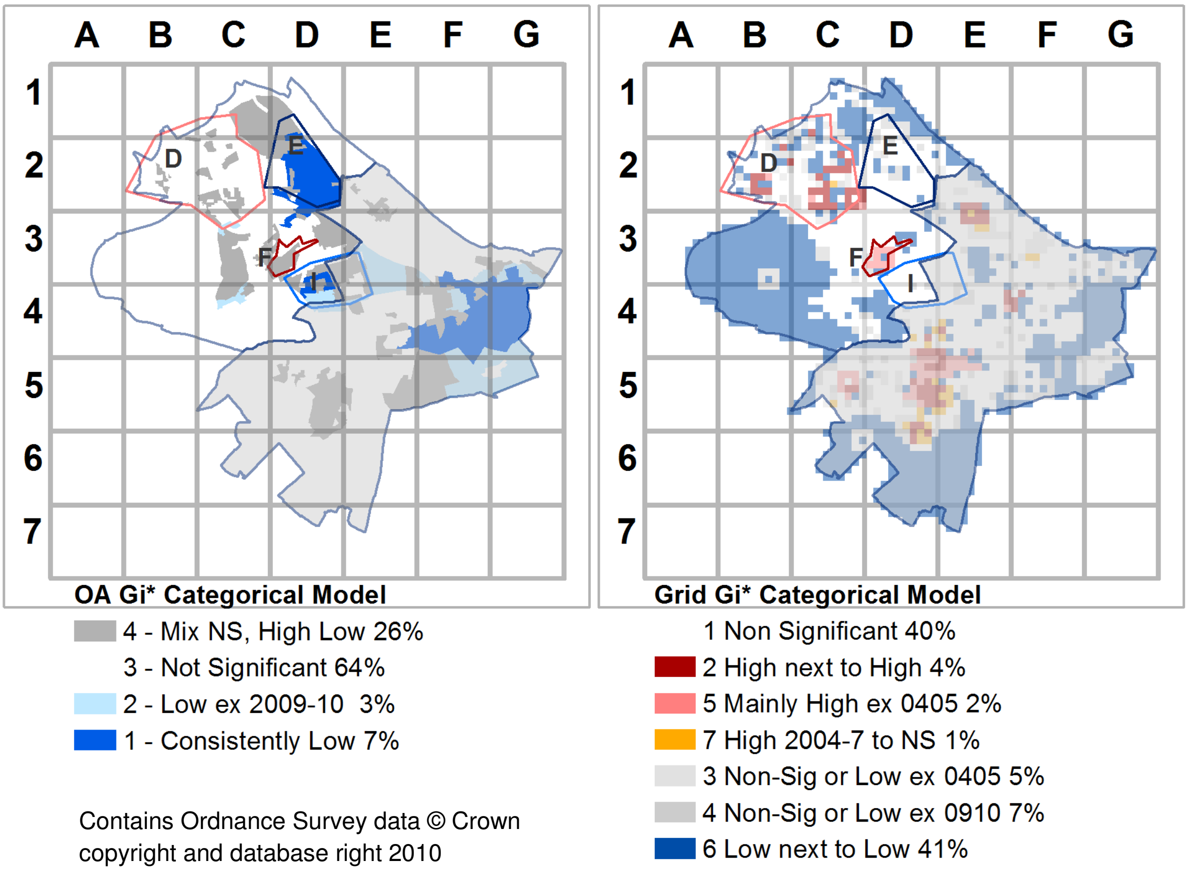

Figure 6.12 Group Trajectory Model Summaries with a Highlight on EdinburghA– OA Categorical Gi* 4 Class and Grid Categorical Gi* 6 class

6.3.3 Accounting for patterns

Use (and Abuse) of Space

One theory, particularly put forward by Paul and Patricia Brantingham, is that the environmental backcloth is an important way of understanding concentrations of crime. There is clear evidence to support this theory in the patterns of crime described above. This is best highlighted by looking at simplified representation of the environmental backcloth taken from the Ordnance Survey StreetView maps of the area for EdinburghA. Figure 6.13 shows simplified information on the overall layout of the area, where the shops are, where the schools area, where there are high concentration of addresses where business are located. Residential areas, schools and parks are shown in the map on the left and business areas, sports centres, roads and railways on the map on the left.

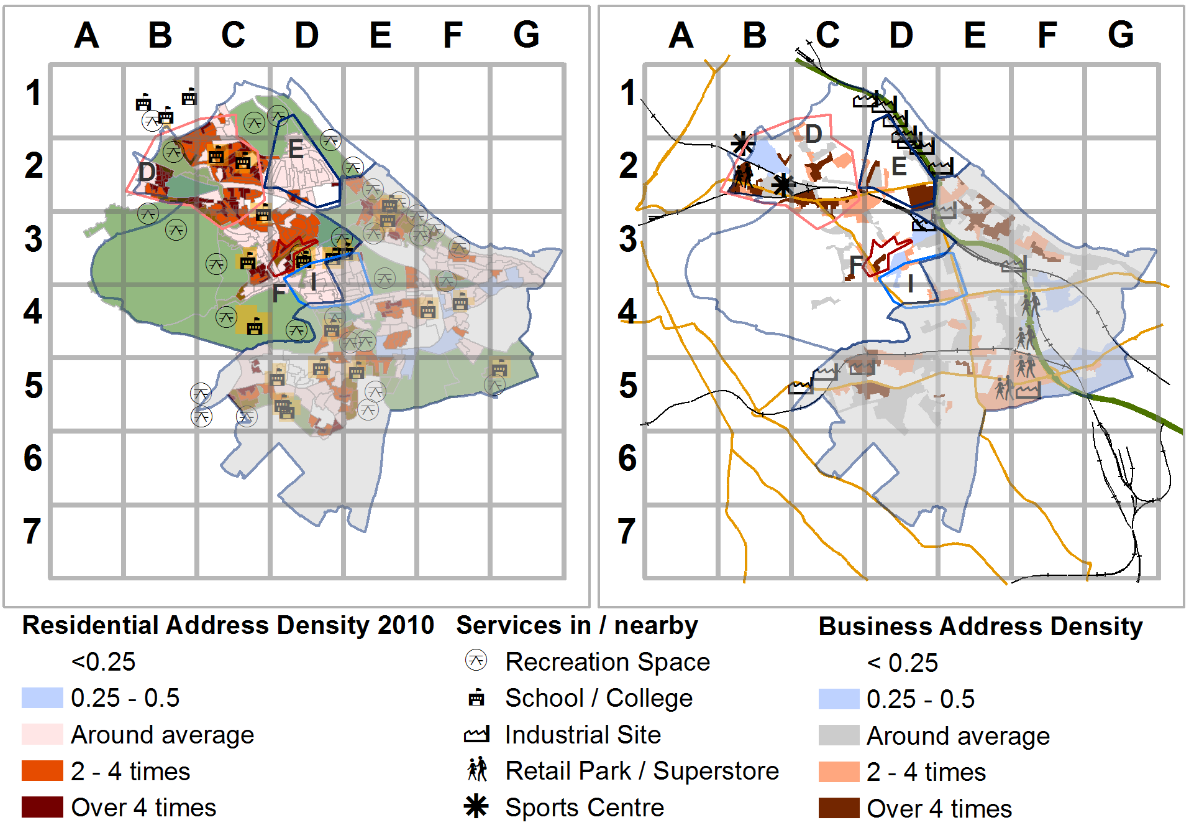

Figure 6.13 – Environmental Backcloth – EdinburghA

What is particularly striking about Echo is a complete lack of parks, schools, and shops within the Echo area. In other words there is no need for anyone to walk through the Echo area to get to a particular potential crime attractor focal point such as a shop or school. Delta by contrast has a lot of people living near each other (high address density), a number of shops, schools, a sport centre, a retail centre and two park areas that were noted by Community Officers as being a particularly popular place for young people to hang out. In one there were some derelict buildings in the park the young people liked to use as a "Gang hut".

> "There's a tree-line about here and you get kids going up with drink at weekends, there's a shop about here...". [Indicates along the side of the large public park on the edge of Delta]."That's been a magnet for years for kids hanging about" (Community Police Officers Focus group 2)

In this following quote about the second park there is an interesting reference to how natural barriers within the Delta can also delineate boundaries where young people will hang out (in this case the railway).

> "I think there's some drinking in the park, there's been a few calls there a wee basketball court just there the other side of the loch and there's nowhere they can really go south of it because of the railway line stops them." (Senior Officers Focus group 1)

Both these quotes also illustrate how Community Officers would often talk quite precisely about how particular locations, for example within a small area of park, were crime attractors. Delta has this relative cornucopia of places that people might choose to go and visit; a few of these people will have a propensity to vandalise property and therefore will almost inevitability vandalise something on the way past.

In sharp contrast Echo is a relative desert when it comes to crime attractors. The only reason to go in to Echo is if you live there, or if you are visiting someone who lives there. Indigo on the other hand is interesting because, although it also has no potential crime attractors for those who lived within the area, unlike Echo it was noted by Community Police Officers as an area that people would cut through in order to get home on return from recreation or perhaps visiting a local pub.

> "the kind of damage that you'd get in there [Indigo] would be people passing through, damage to a car, maybe a car wing mirror broken or that type of thing, that generally are people that are passing through from maybe a pub, maybe from [Foxtrot] area back to [parts of Juliet], and you'll see a trails that'll go like there to there to there, where've you got a report of a car wing mirror being broken at 1030 and at 11 o'clock at night there and at 1130 there, so that invariably will be one person, maybe's it's part of a group that's going through causing that damage as they go" (Community Police Officer Focus Group 3)

This is not to say that every shop or school was a crime attractor. Certain shops were places where young people chose to hang out and tended to be in the High areas or next to High pockets of vandalism, and others shops were not crime attractors and tended to be in Drifting and Consistently Low areas There were a number of areas in both Foxtrot and Delta seen as key hang out point. This was particularly notable just to the west of Foxtrot where a small group of shops were seen as a 'magnet' for young people.

> "There's a [small main brand Supermarket] here, a petrol station, and it tends to be a bit of a magnet, there bus stops here.... you know it's a very busy road and you've got [street in Foxtrot] which is here, which is a major magnet for kids, you've got kids from this area, but you've also got, a lot of kids that hang about in this area come from [Kilo in EdinburghB] and areas and come down" (Community Officer Focus Group 2)

There was similarly a shop on the edge of Echo that did not attract young people hanging out although no specific reasons were given for this.

Deviance occurring as an everyday activity, and actions that are not deviant becoming deviant as young people come into conflict with others who perceive their actions as problematic is a theme of David Matza's and Kurt Iveson's work (Matza, 1969, Iveson 2007). There was evidence that these kind of problems were occurring in both Delta, and Foxtrot. An interesting example was given from an area just across the road from Foxtrot that was seen as having experienced a particular conflict between a local resident and young people within the local neighbourhood where a single incident of vandalism (viewed by police as relatively minor)had occurred. This single incident had left the resident very concerned whenever young people gathered nearby on subsequent occasions. This quote is from a conversation with the voices of two different Community Officers speaking in turn. It also demonstrates the tensions Community Police Officers can face in trying to police vandalism, on the one hand not wanting to restrict young people who are not behaving in a criminal way, but at the same time wanting to prevent youthful play becoming more extreme and escalating into harassment or vandalism.

> -" you see this guy, it's not that it's wrong, but he phones us a lot, all the time, as soon as a bunch of kids sort of gather he's phoning us and I think it's because he's had his window smashed before and it"
> ~ "Previous experiences and he's worried it's going to happen again"
> - "It's not that there's actually been any vandalism "
> ~"The kids drinking, and running about shouting and swearing and perhaps like knocking on windows rather than smashing them..."
> -"He's probably right, I think an intervention would probably stop some vandalism going on but you know there not been that much recently" (Community Police Officers Focus group 2)

Routine Activities and the Everyday

The above environmental backcloth suggested above also strongly supports one of the key aspects of routine activities theory – that where you have a suitable target, a motivated offender and a lack of suitable guardians crime can occur. The retail estate in Delta was seen as something of a 'problem', as compared to another large retail area in EdinburghB. It lacks good place management, and there was a suggestion of general lack of effective guardianship.

Another issue could be lack of guardianship caused by either poor security, residents who were away from a residential area in evenings or daytime, or where property had been built new but was still partially empty. A particular problem area was identified on the edge of Delta by some Community Officers because a set of flats were on a route young people used to the local public park, but as they were under-occupied and had worse security compared to some other nearby areas they had become a target for vandalism.

> "They started building them during the boom time and the economy obviously started deteriorating a little bit and, when you drive round it there's sort of half developed building there....Regularly get the stairs doors were getting kicked in, the common stair doors, vandalism to cars in the car park I think it's mainly kids are using it as a gang [park] if you like, they're coming into the common stair."....."I think it would have been better had it been full but the way it is ...".
>
> Following concerns raised by police and residents to the managers of the block action had been taken.
>
> "so they are putting in fences, higher fences around access to the park to try and [stop] access from the park and they're putting in CCTV to the, around the doors and things, [big] signs to try and make it more of a deterrent, but I think it's just the

> location of it, it's an easy target if you like" (Community Police Officers, Focus Group 2)

In low areas such as Echo and Indigo there was a general perception that people were more likely to be members of a local neighbourhood watch scheme and encouraged to report any concerns to local police.

The presence of the availability of a suitable target and lack of guardianship (Delta – Drifting High area), or a lack of targets and better guardianship (potentially Echo – the Consistently Low area -and Indigo the Drifting Low area) does not explain why such mobility was seen in the crime concentrations in Delta. This phenomena of mobile vandalism hotspots is something that was specifically discussed in focus groups. The interviewer asked why things had changed or stayed the same in high and low areas. The reasons put forward by Community Officers for the mobility of levels of vandalism across Delta ties strongly with another aspect of both Felson and Cohen's Routine Activities Theory that much crime is a just an everyday normal activity, and as such, the locations where crimes occur are linked to an individual's every day routines. In which places does a person choose to spend time sleeping, eating, working and or playing?

Given one of the motivations for vandalism can be play, the locations chosen to hang out by young people and adults may be a key factor affecting where vandalism occur. More than that, if routines change, then locations of vandalism might be expected to change too. It was such a change of routine behaviours of young people across the year that Community Officers identified as being a possible reason for the mobility of vandalism 'hotspots' in Delta.

> "I think there have been it's just it's changed obviously as they've got older and moved out but then the younger generation have come in and taken over"..."It kind of goes in cycles, you know [Foxtrot] gets problems, [Area in the North of Delta] gets problems, it kind of depends of what kids you've got in the area at the time, most of the vandalism is kids, you get the odd piece of vandalism off a drunk guy walking home on the main routes"(Community Officer Focus Group 2"

There was a sense that the young people of an area of one generation might have particular places they chose to hangout, and then the generation following on might choose somewhere else to go. This could mean that over a 5 to 6 year period the principal hangout points for young people could change across Delta perhaps two or three times. As young people, grew up and grew out of doing vandalism so the places that were particular favourite childhood haunts would temporarily grow out of vandalism too, before perhaps some years later potentially becoming attractive to young people again.

> "you get those areas it tends to be small wee groups of kids and they'll grow up from there to a couple of years later they'll maybe grown up and grown out of it, and another area will have a bit of a problem" (Community Officer Focus Group 2)

A secondary factor suggested was that on occasion individuals, who were familiar with a particular location, were sometimes a reason that vandalism happened in some areas and not others. Once these specific individuals were either caught and arrested, or grew up and grew out of vandalism, or for some other reason left a place, then the area was no longer a target for vandals.

> "I would say the main characters now, kind of age wise would be kind of just going into teens or early teens, and that's obviously 2010, 5 or 6 years ago... would be too young to be out there causing the problems that they do now...."(Community Officer Focus Group 2)

Persistent Relative Inequality (Advanced Marginality)

Looking at a map of where high and low levels of population receiving income based welfare benefits and where areas with good and poor school attendance (compared with Scotland as a whole) were in the study area, what is immediately clear is the complete absence of high welfare areas in Echo, and the presence of some low welfare areas in Echo (Figure 6.14). Whilst the causal relationship of low welfare to low vandalism concentrations is unclear, both the Consistently Low area (Echo) and the Drifting Low area (Indigo) had proportions of their population who were relatively affluent, and (especially for Indigo) a number of the children and young people in the area who were amongst the top 25% of Scottish young people for reliably attending school. A Community Police Officer described both Indigo and Echo jointly as

> "Quite affluent areas, the properties there are relatively expensive". (Community Officer Focus Group 2)

Another Community Officer described Indigo as:

> "a middle class area I would say, bungalows it's all private owned stuff in there, people that have employment".(Community Officer Focus Group 3)

In contrast both Delta and Foxtrot had areas with children and young people in the worst 25% for attending school, and a population (for Datazones covering about half of the area of Delta and a Datazone covering most of Foxtrot) who were amongst the 25% relatively most deprived in Scotland in that the a high proportion was in receipt of income related welfare benefits.

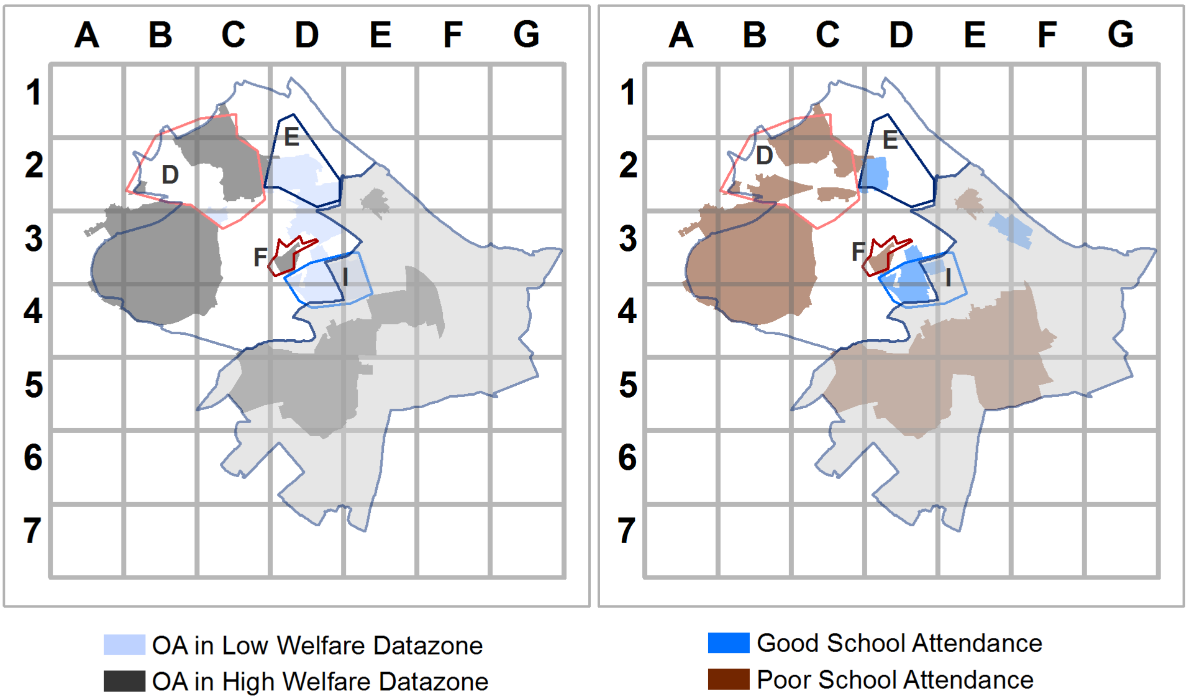

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Figure 6.14: Social Welfare – EdinburghA

What was particularly striking in Focus groups 1 and 2 were the descriptions of Foxtrot as an area apart in EdinburghA, quite distinct from the areas around it. The language used to describe Foxtrot strongly indicated that it was perceived as a 'problem area'.

> "lots of nice flats, professional people and it backs straight onto [Street in Foxtrot] which is arguably the most nightmare street we have in the area so, causes the most problems... Foxtrot is flats, 2 storey generally, open stairs, 4 / 5 stories perhaps, it's the ugliest area there's no beating about the bush there..." (Senior Police Officer – Focus Group 1)

It was an area described by a second Senior Officer in focus group 1 as having "no sense of pride". There was a strong sense that although it was a very small area, this was an area with very distinct underlying social problems and that meant that many of the young people who lived there were involved with agencies trying to address these problems.

> "[Foxtrot] – a lot of issues in [Foxtrot]. ... [Foxtrot] is probably, well arguably, the most socially deprived areas in the whole of [EdinburghA]. And the kids, particularly a handful of the kids who live there just now, are just a nightmare to be honest with you, we've got kids who are as young as 13 who are probably stacking up charges quicker than you can draw breath, and that brings its own problems because the social work get involved the council get involved but it's long term and

> these kids are still going round thinking they rule the place and it's very difficult to address that in the short term, vandalism there is a long term issue "(Senior Police Officer – Focus Group 1)

Whereas in other areas especially Delta there was a suggestion that young people might come to a spot to congregate for a particular reason, and then from that for varying reasons, vandalism occurred as a secondary effect. In Foxtrot the perception was that young people were directly vandalising the areas where they lived.

> "although with [Foxtrot] I don't think you've got the problem so much with kids coming in and causing issues it's very much inner bred if you like, but the kids there do tend to cause a lot of problems" (Senior Police Officer – Focus Group 1)

Community based interactions / Collective efficacy

One of the interesting elements about EdinburghA was that the Consistently Low and Drifting Low areas appeared to have a distinctly different demographic make up to other parts of the neighbourhood partnership. This is illustrated by Figure 6.14 where Datazones have been classified into different types where they have a specific demographic mix. This demographic mix was identified by graphing national Datazone population estimates for the numbers of men and women in five year age bands. Across the case study area by looking at population pyramid shapes for all Datazones in the case study areas for the years 2004 and 2009, six distinct population mix descriptions were visually identified. A population pyramid for each type is shown as a small image below the map in Figure 6.15. Figure 6.15 shows the population pyramid for the whole of the case study area the proportion of females in each age group is shown out of all females shown in dark grey and the proportion of males in light grey.

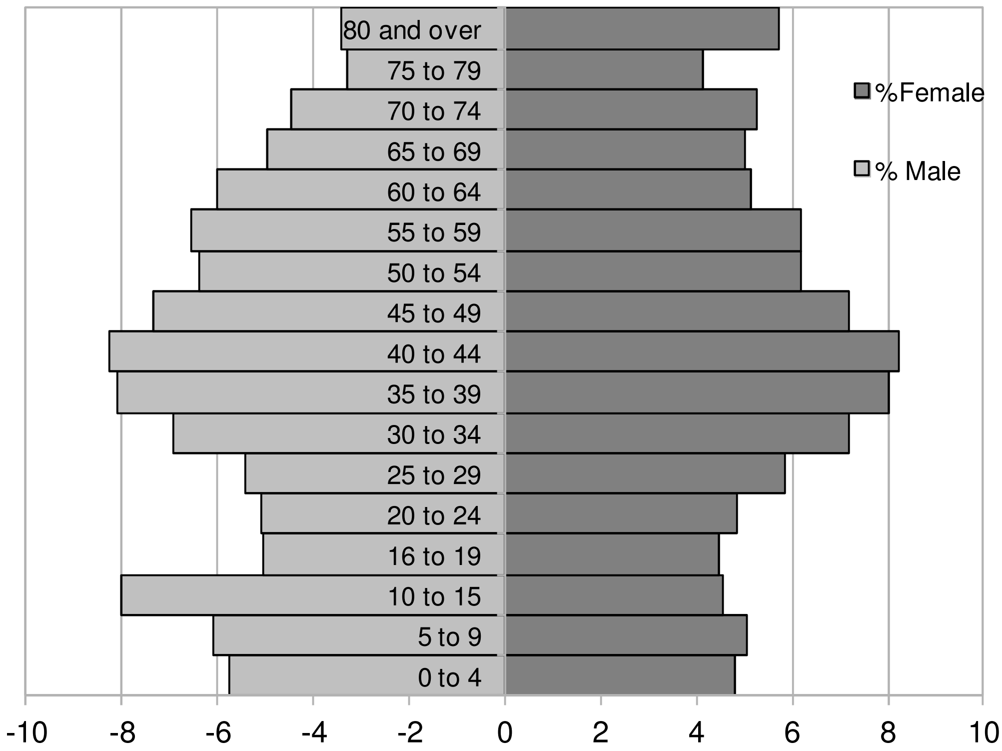


Figure 6.15 – Population Pyramid – Age Profile Complete Case Study Area in 2004

Population pyramids often have fairly distinctive shapes. A pyramid shape such as the shape labelled '1 Younger People and Children' in figure 6.16 (Type 1) indicates a larger number of children aged 15 and under, a range of people between 20 and 50 but few over 55s. The shape labelled '3 Younger people' in figure 6.16 (Type 3) indicates younger people, especially those aged 25 – 35, with very few older people or children, indicative of a population of people of working age; this population could also include some students at University or College.

As Figure 6.16 shows Both Echo and Indigo, Consistently Low and Drifting Low areas have a very similar population mix – labelled '2 Families & Older'(type 2). Type 2 is a population with children (especially those aged 10-15), and adults aged over 40. This suggests a mix of families with older children and parents and also a sizeable population of retired people. What distinguishes Type 2 from Type 1 is that for Type 2 there are far fewer people aged under 40, and far more people aged over 55. For Echo and Indigo this means that even though there are children living in the area, there is also a sizeable contingent of older people, and more older people living in the area compared to other high areas for example Foxtrot (Type 4 'Family age only') and Delta (population type very mixed but no Type 2 populations).

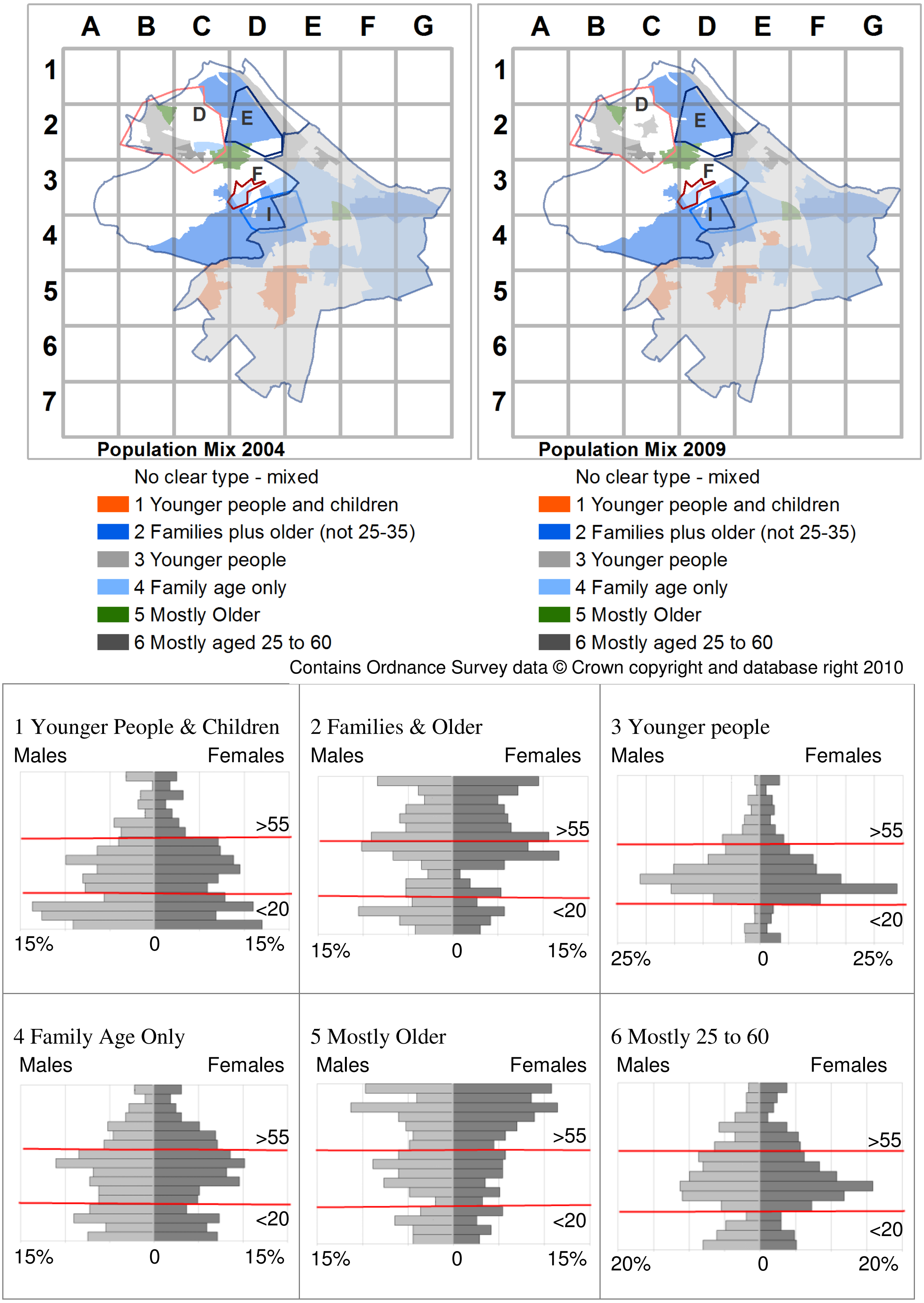


Figure 6.16 Population Mix in EdinburghA

This reflects analysis of potentially socio-demographic explanatory factors in Chapter 5 (see Table 5.7 and related discussion) which suggested that areas with consistently low and average to low levels of vandalism might have slightly older populations. Is there something about a mixed population which has children and young people living alongside slightly more mature adults that is somehow protective compared to when children and young people live amongst younger adults? Could it be that since some vandalism is carried out by drunken adults on the way home and both Echo and Indigo have comparatively few 25 – 35 year old people leading to lower levels of vandalism? More research is needed to understand whether there is a direct effect of the demographic make up of the community on levels of vandalism or whether a certain demographic make up is just a reflection of either more affluent or relatively less affluent communities and this just happens to correlate with high and low levels of vandalism.

The Echo and Indigo demographic make up was reflected by comments in focus groups.

> "sort of professionals and families etc., elderly people live in those and it is very much community orientated you know they'll have their neighbourhood watches and that kind of thing". (Community Police Officer Focus Group 2 describing Indigo and Echo [EdinburghA] and Lima [Edinburgh B])

Also interesting in the above comment is the phrase "community orientated". When asked by the interviewer to clarify what was meant by this the Community Police Officer went on to say:

> "they're keen to be involved with community issues and lot of them will get involved with community issues and lot of them will get involved with neighbourhood watch schemes and come to community council meetings and what have you. They are very aware of what's going on in their immediate, I suppose surroundings, a lot of the residents there will fight to have things, things done" (Community Police Officer – Focus Group 2)

In contrast it was felt that residents of Foxtrot and parts of Delta were less likely to try and get together to resolve local problems and to a certain extent vandalism and anti-social behaviour was tolerated:

> "Whereas I think some of the areas [refers to part of Delta and a small area opposite Foxtrot] and what have you I don't know, I suppose some of the individuals just aren't really bothered about what's going on around them." (Community Police Officer – Focus Group 2)

When Community Police Officers were then asked if local residents saw someone writing graffiti would they step in or otherwise report it, it was felt that in part of Delta and Foxtrot these behaviours was more likely to be tolerated but that there would be a different reaction from residents of Echo, Indigo and Lima who would be likely to intervene in some way.

> "I think here [part of Delta] and what have you I think it's more tolerated by the residents I don't know if they expect it but they're used to that happening whereas in [Indigo and Lima] or what have you I think they would say something or if they were too scared to they'd certainly get on the phone to the police straight away" (Community Police Officer – Focus Group 2)

However it was felt that if an individual living in the Drifting High and High areas like Delta and Foxtrot felt they were being individually targeted for vandalism they would contact police, they also said there were a number of complaints from these areas about antisocial behaviour.

This all suggests that collective efficacy, the capacity of the community to self-organise and solve local problems, (Sampson, 2012 – see Chapter 1), could be slightly stronger in areas such as Echo and Indigo, but slightly weaker in areas such as Delta and Foxtrot. It is important to note that the strength community relations were not spontaneously raised as a particular problem in EdinburghA in either Focus Group 1 or 2, and the comments above were in part due to specific questioning in the focus group. In contrast problems in community relations were raised spontaneously as a problem for EdinburghB. Officers in focus group 3 talked about Indigo and Lima as being a notably contrasting area to certain other areas within Edinburgh B (especially contrasted to Juliet). This Chapter now goes on to consider these issues further as part of its consideration of the patterns of vandalism in EdinburghB.

6.4 Section 3 - Results EdinburghB

6.4.1 About the Neighbourhood

EdinburghB is a mixed area with quite affluent areas and some areas of quite highly concentrated poverty especially in Juliet and Kilo. This was an issue raised specifically in focus groups and is discussed further below. To the North East of the Neighbourhood partnerships is an area that is one of the oldest parts of the case study area and was originally a separate settlement on the edge of Edinburgh. Looking at Figure 6.17 this is the area in grid cells E2, E3 and F3. It comprises a mix of residential houses including some quite densely occupied flatted areas in E2 and E3 and a main street of shops, cafés and bars which shows up as a red and pink line of Output Areas in the right hand map at the bottom of Figure 6.17. To the east of these shops and homes is a large strip of community recreation area which includes a promenade along a large river estuary which forms a type of beach front. This is an area which is visited by people from across the case study area, and in summer on sunny days, by people from other parts of Edinburgh too.

In E5 and F5 (the area shaded pink in the bottom right map in Figure 6.17) there is a very large retail park, which is again visited by people from across Edinburgh and also people living outside the city who come in on one of the major trunk roads into Edinburgh (shown as a green line on the top map in Figure 6.17). This trunk road forms a natural barrier across the south of the area, along with the railway line making the areas to the west of it slightly cut off from the areas to the east. There are easier crossing points further north in EdinburghB around E3. The areas in D4, E4, C5, D5 and E5 are mainly residential with a mix of homes and schools although there are also some small groups of shops. This is a much recently settled area compared to E2, E3 and F3. The area in grid cell C5 is slightly different as it has a mix of shops, residential housing and to the west of the area some small industrial estates slightly apart from the residential housing. Much of these areas have significant levels of social housing provision for people on lower incomes by local Council and Housing Associations. Particularly in D5 there has been quite a lot of demolition, rebuilding and regeneration which had begun before 1st April 2004 (the start of the case study period) and was continuing through the case study period and after the end of the case study period (31st March 2010).

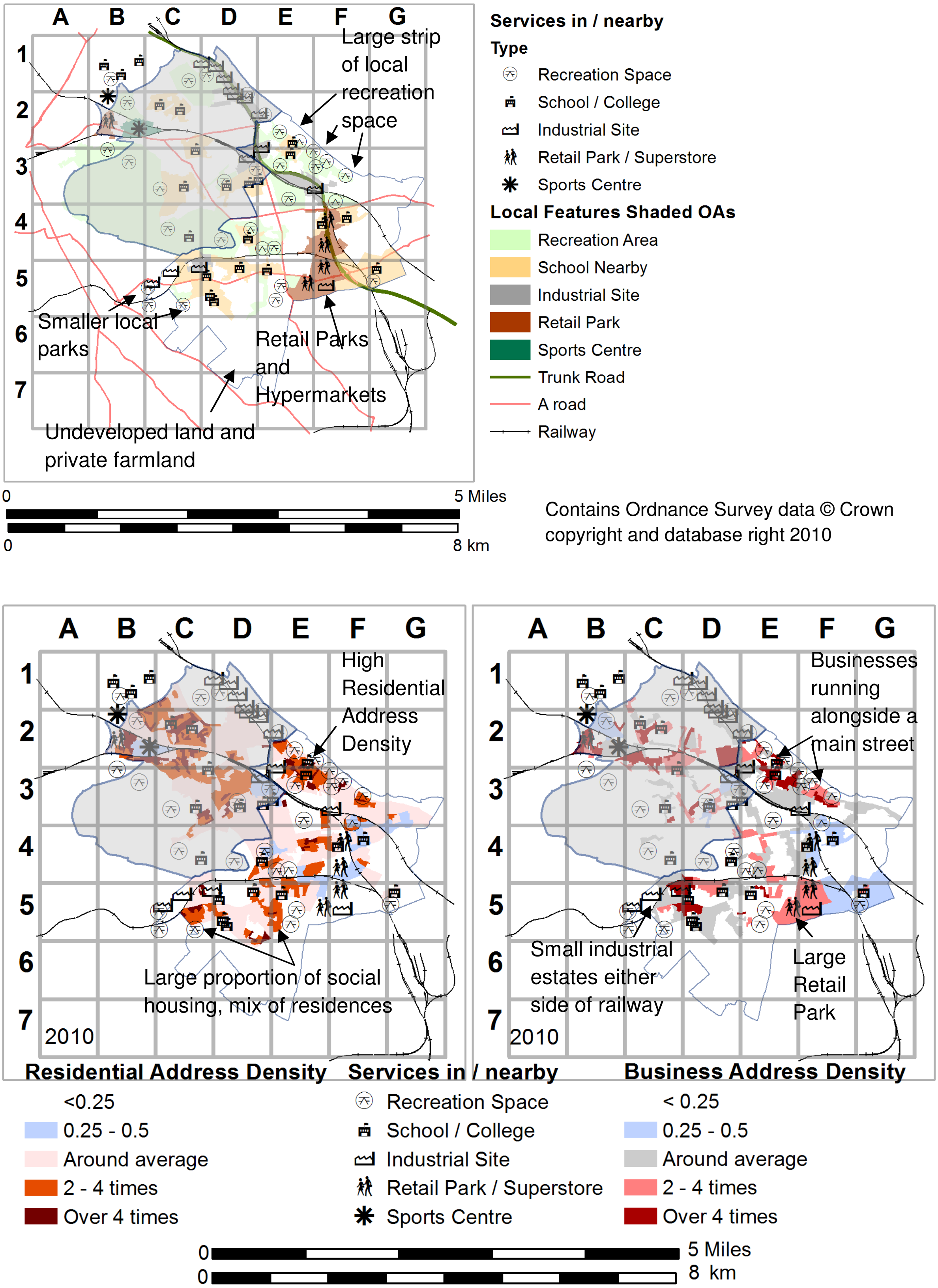


Figure 6.17 Neighbourhood Partnership EdinburghB Context Maps

6.4.2 Describing Patterns in Space and Time – Edinburgh B

Edinburgh has five key areas that have been highlighted for discussion in these results. Oscar (marked on the maps as O) is the area with the high street and beachfront promenade. Figure 6.18 below show how the key areas selected for discussion of Edinburgh B results, Oscar, Indigo, Kilo, Juliet and Romeo, relate to annotations made on maps in the focus groups. As for EdinburghA, Community Police Officers drew on maps with highlighter pen, and these annotations were subsequently converted to an electronic map by copying the same style, shape location and thickness of lines onto an electronic Ordnance Survey street map using ArcGIS. In the case of Oscar a number streets were marked as having high levels of vandalism. The streets ran from the recreation areas and bars in and around the Oscar area to residential areas elsewhere in EdinburghA and EdinburghB. These streets were often used by residents as routes home from areas of recreation. These 'route-ways' with high levels of vandalism were shaded along relevant roads and are shown as a series of single lines cutting across and coming out from the Oscar area.

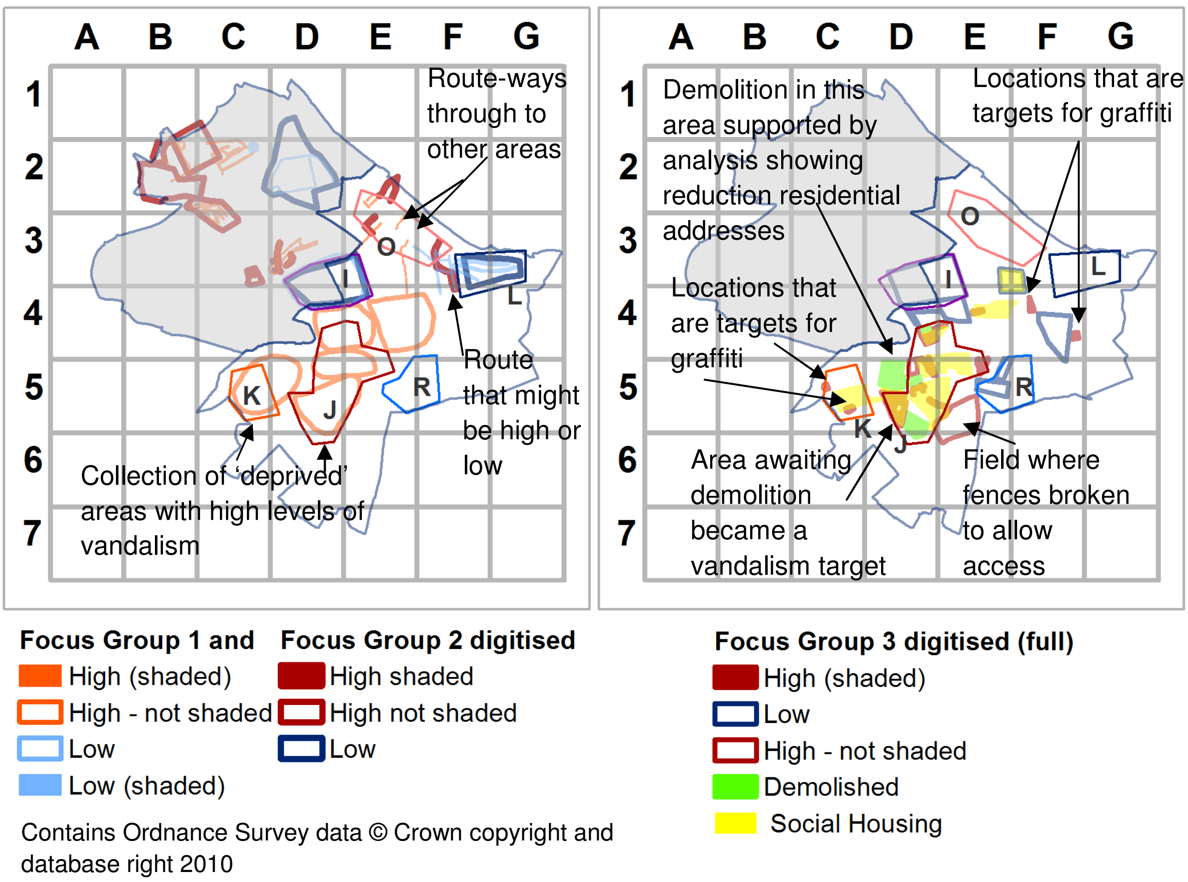


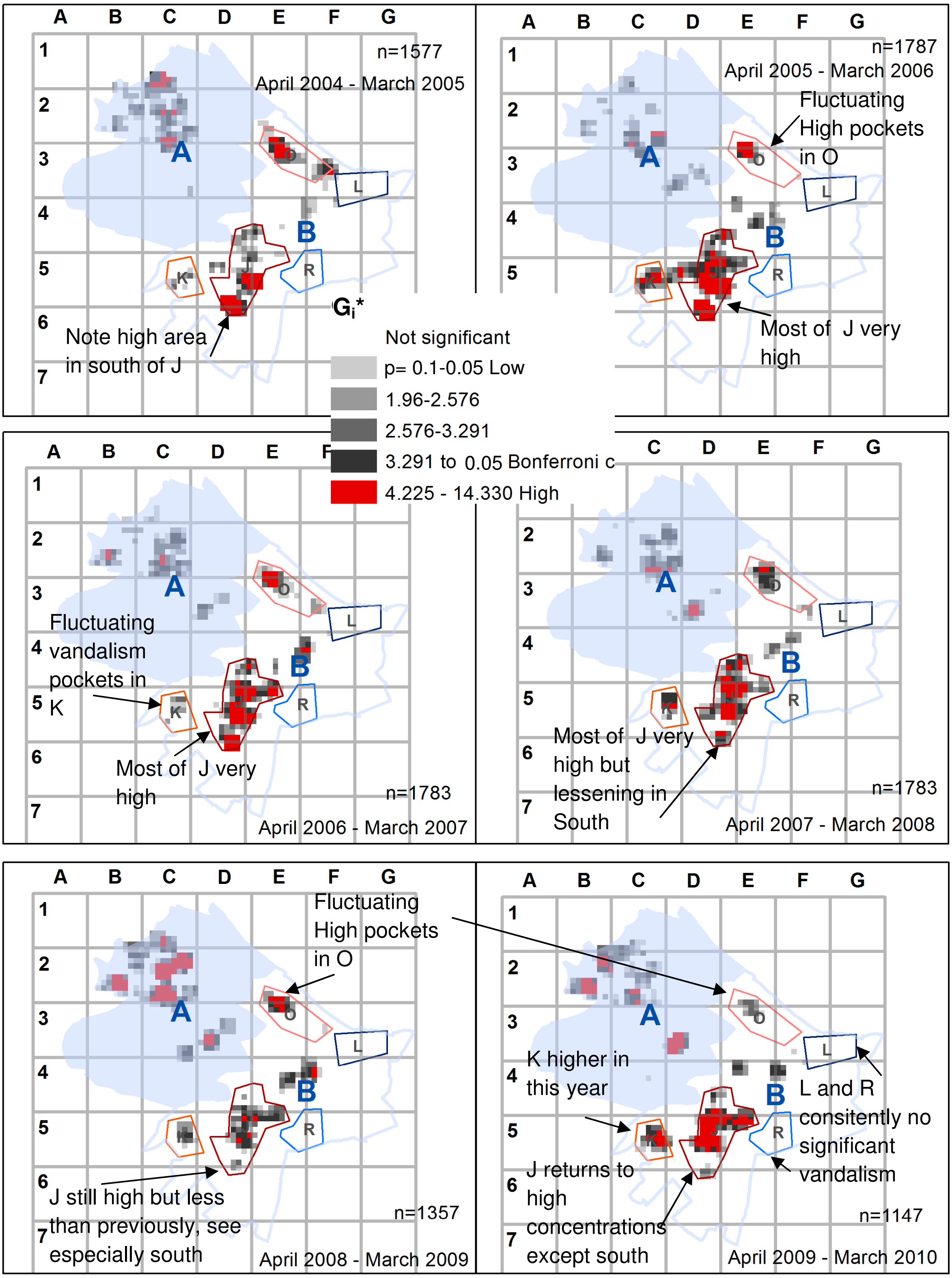
Figure 6.18 Focus Group annotations on maps digitised - showing high and low levels of vandalism in EdinburghB

It was noted in focus groups that vandalism occurred to property along these routes (often smashed wing mirrors on cars for example). It is notable that Focus Group 1and 2 highlighted different roads as key problem route-ways and there was one road the Officers in focus group 1 highlighted as low vandalism and Officers in focus group 2 highlighted as experiencing vandalism from people passing through. Just to the south of Oscar is Lima, a mainly residential consistently low vandalism area. In Focus Group 1 this was marked as a series of streets that were free from vandalism, in Focus Group 2, Lima was marked as a whole area with generally low levels of vandalism. As can be seen from the right hand map Focus Group 3 did not mark up any of the areas in Oscar and Lima as this was generally policed by Officers from EdinburghA whose police station was based within Oscar so they policed this part of EdinburghB by arrangement with Officers from EdinburghB whose police station was near Kilo and Juliet.

Juliet is a series of three linked estate areas which all together experience Persistently High levels of vandalism. Interestingly the Senior Officer in Focus group 1 marked these areas fairly imprecisely with large circles and described the problems there as strongly linked to relative deprivation (see further the discussion on advanced marginality below) whereas the Community Police Officers in focus group 3 marked a large number of specific locations across Juliet that experienced problems, some of which were streets, some were shops some were small estates. All had specific problems with high levels of vandalism. Where areas experienced low levels of vandalism, Focus group 3, like Focus group 2, did not mark individual target points but marked up whole areas that were relatively vandalism free. In Kilo although the Senior Officer also marked this as a problem area, in focus group 3 the Community Police Officer identified far fewer locations that were problematic just identifying two specific points where problems occurred.

In focus group 3 Officers went on to add additional shading to just high and low areas pointing out areas that had been demolished in recent years which they shaded in green. They also shaded on the map areas which were predominantly social housing areas. Looking between the digitised shading in focus group 1 (left hand map) the collection of areas noted as deprived and having higher levels of vandalism, are also in many cases based on the shading by police Officers in focus group 3, areas described as having high concentrations of social housing. There was not up-to-date data on social housing (only census data from 2001) so it was not possible to check levels of social housing on a yearly basis for the study period, and it was felt that census data might be unreliable for many parts of EdinburghB because of the large scale demolition and rebuilding that had been taking place in the area. Analysis of address density derived from GridLink clearly showed a reduction in residential address postcodes in the northern green area on the edge of Juliet. Changes in the other green area to the South of Juliet were less clear perhaps partly because there has been rebuilding in this area so postcodes may possibly have been reassigned rather than deleted.

Turning to maps and analysis of patterns of police recorded crimes of vandalism across EdinburghB, Figures 6.19 and 6.20 show that Juliet was an area where there were high levels of vandalism year on year in many micro locations. Whilst vandalism is not always in exactly the same locations, levels of high vandalism were quite stable within the area. However, there were some interesting exceptions.



All Vandalisms - Vandalism, Malicious Mischief and Fire-raising

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Figure 6.19 Vandalism in micro-neighbourhoods across the study period in EdinburghB using G_i* (row standardised z-score. corrected)

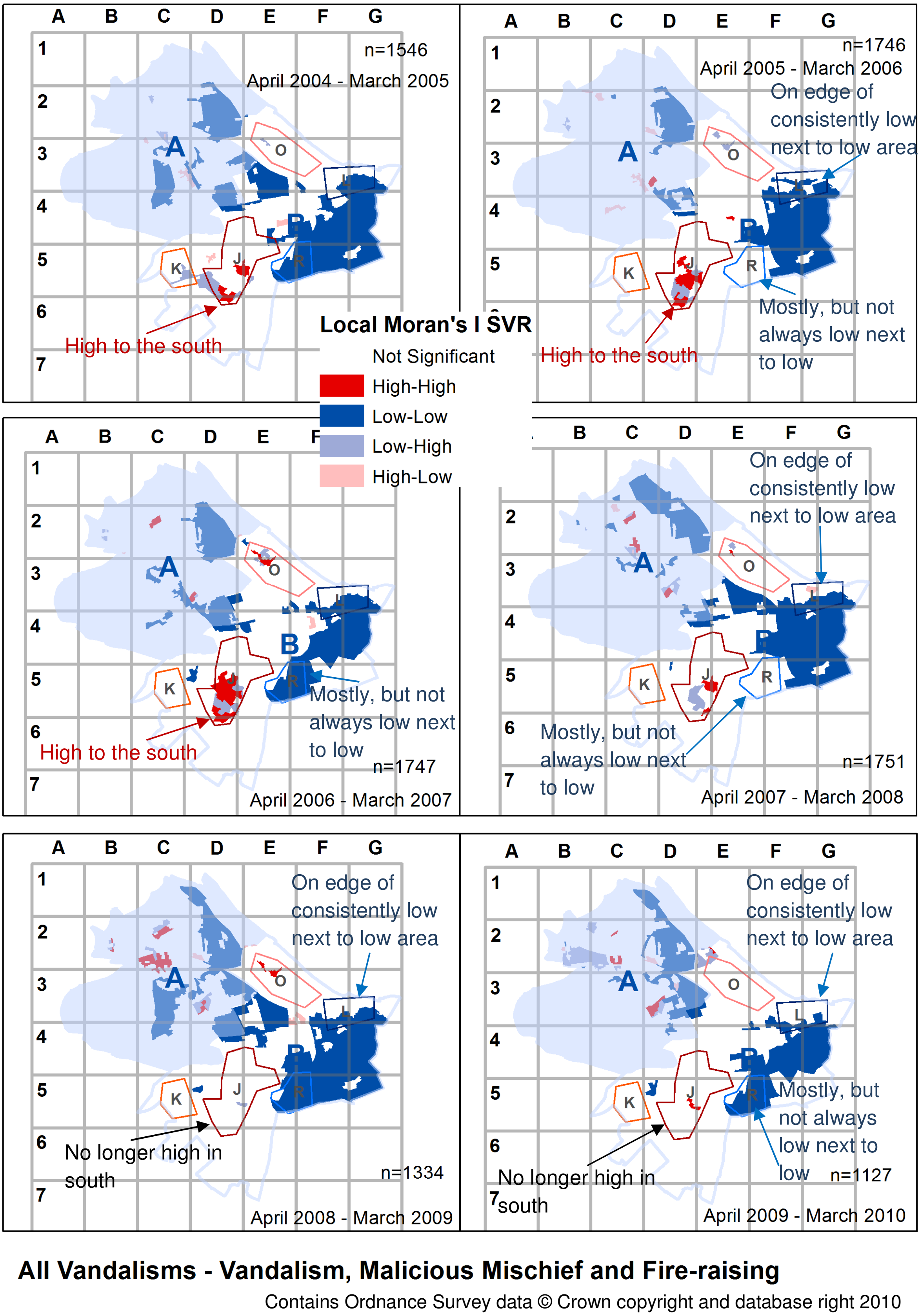
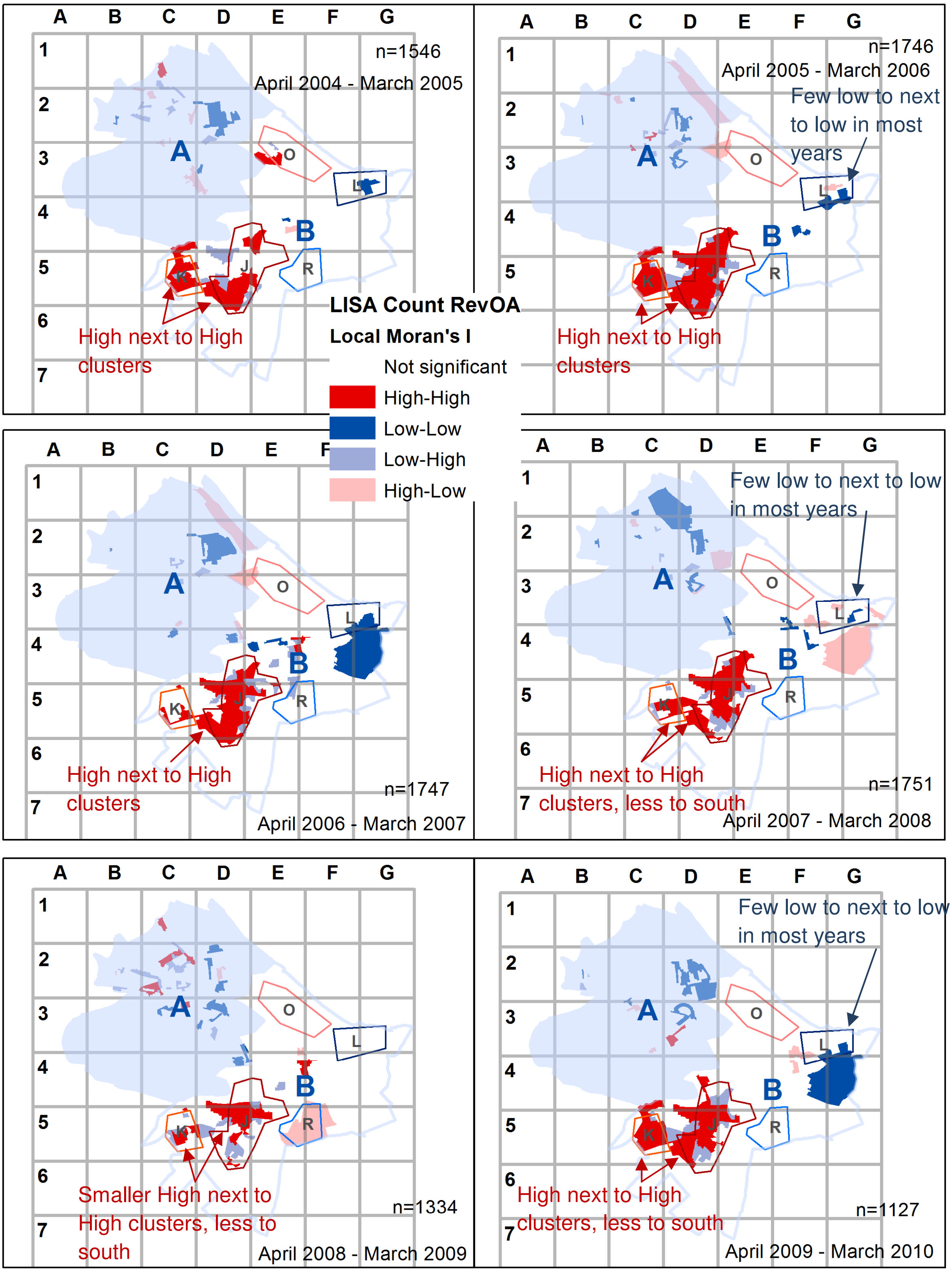


Figure 6.20 Highlighting concentrations of vandalism rates per hectare in local OAs across the study period in EdinburghB using Local Moran's I

One interesting area is an area to the south of Juliet, which begins in 2004-5 and 2005-6 by being a clear hotspot for vandalism but then this appears to decrease markedly by 2008-9 and 2009-10. This area ties in with the south end of J demolition area highlighted by Community Police Officers in focus group 3 (Figure 6.25). Juliet is thus a Persistently High area with some localised fluctuations partially explained by changes in the physical structure of the area. Kilo whilst also having some high pockets of vandalism, levels fluctuate more than in Juliet suggesting it might be a Drifting area (tending towards High) rather than Persistently High like Juliet.

What is very interesting looking at Figure 6.21 is that volumes (counts) of vandalism at the small neighbourhood level (Output Area) are very generally high in both Kilo and Juliet, and there is a band of high areas spanning across much of Kilo and Juliet over most of the study period. This consistently high volume of vandalism perhaps goes some way to explain why the Senior Officer in focus group 1 broadly marked up most of Kilo and Juliet as problematic. In terms of which areas had the highest counts of crime it is clearly both areas. However when these are viewed as rates only Juliet shows up as having Output Areas with particularly high levels of vandalism, and the at the micro (grid) level, Juliet is more likely to have highly significant concentrations of vandalism. Visualisations suggest that vandalism problems in Juliet may be more serious than the problems in Kilo. This was also reflected by focus group 3 which identified a large number of vandalism hot spots including a whole collections of streets in Juliet but only two fairly small locations in Kilo.

Oscar is an area which at the micro level has a fairly stable concentrated pocket of vandalism towards the north end of the area (Figure 6.21) although the strength of this concentration varies over the years. Oscar generally appears to be an area where levels fluctuate suggesting it is a Drifting High area. Romeo is an interesting area which on micro based maps (Grid) and rates per output level appears to be a consistently low area, but when mapped as counts appears to be high. This is because Romeo has few residential properties so it is drawn as a large Output Area. It is in fact mainly a large Retail Park (see discussion on Use and Abuse of Space below). It is therefore more appropriate to use rates to assess levels of vandalism in Romeo, and Romeo is best classified as a Low Drifting area. Finally Lima appears as a Consistently Low area in all visualisations.



All Vandalisms - Vandalism, Malicious Mischief and Fire-raising

Figure 6.21 Highlighting concentrations of vandalism counts in local OAs across the study period in EdinburghB using LISA – Local Moran's I

Looking at the group trajectory analysis which summarises the 6 years of the recorded vandalism into single maps showing trajectories of patterns of vandalism across the years, Juliet clearly comprises mainly high and very high areas (Figure 6.22). It has by far the biggest concentration of Mostly High and Average to High groups of Output Areas of anywhere in the case study area. Juliet also at the micro grid level has many clusters of high stable and very high falling areas. Juliet is clearly a Persistently High area. Within Juliet there were some interesting differences between areas that are picked up through the grid based analysis of G_i* categories (looking at which micro areas had high next to high areas year on year). In Juliet there are three distinct trajectories. Areas where there are high next to high areas every year of the case study period. There are areas, especially to the south of Juliet, where vandalism starts high but thenfalls, which may well be linked in some way to demolition and rebuilding. Finally there are some areas which began low in 2004-5 but then increase to high next to high in subsequent years (Figure 6.23). There was a suggestion from focus groups that these might be areas where people who had lived in demolished areas might have moved to (although additional further research would be needed to confirm this):

> "you can see the people have moved and the ...crimes have moved at the same time, but I think it ties, that some of that does tie in" (Community Police Officer – Focus Group 3)

In contrast both Oscar and Kilo have a much greater mix of average to high, high and average to low areas with much smaller concentrations of high levels of crime, again suggesting these are Drifting High areas (similar to Delta discussed above; this will be considered further in section C).

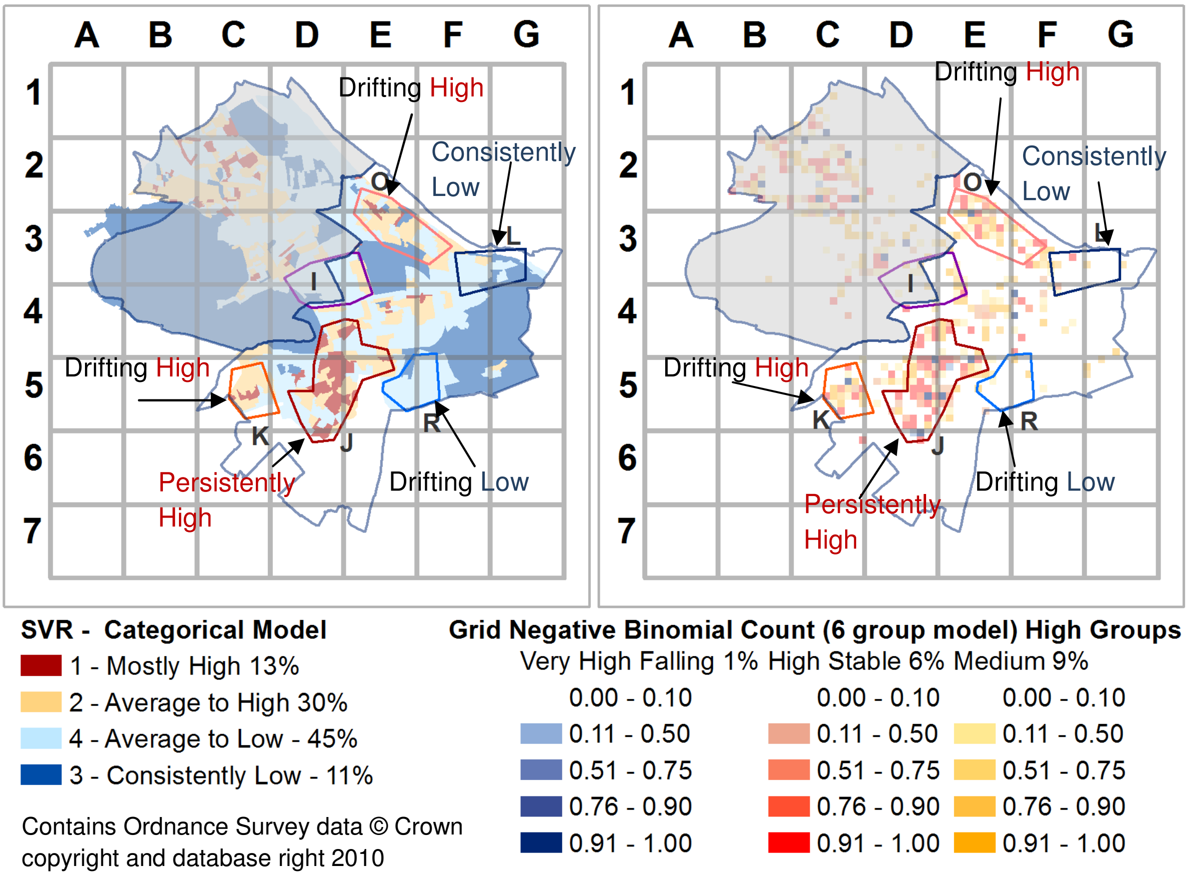


Figure 6.22 Group Trajectory Model Summaries with a Highlight on EdinburghB–OA Categorical 4 Class and Grid Count 6 class (high areas only) Models

Romeo is an area which is Drifting Low. It is mainly comprised of average to low areas with a mix of high low and non significant at OA level. Romeo has no pockets of high or medium vandalism (Figure 6.23). Romeo is not in the consistently low group. It has a mix of high, low and non significant neighbourhoods across the study period, and does not have large groups of significantly low next to low micro areas (Figure 6.23). Lima is a Consistently Low area although the evidence for this is not as incontrovertible as that for Echo (discussed further in section C below). It has generally consistently and average to low areas, no high areas, and a very small number of average to high areas. Comments from focus groups discussed below, suggested this was an area generally free from vandalism. Areas to the south of Lima, are also consistently low. These were not discussed in focus groups at all so have not been highlighted for further discussion, but it is likely this is due to absence of crime attractors, a low number of domestic residences, and a lot of empty space with no people. The influence of the use (and abuse) of space across EdinburghB will now be considered in more detail for the highlighted key areas.

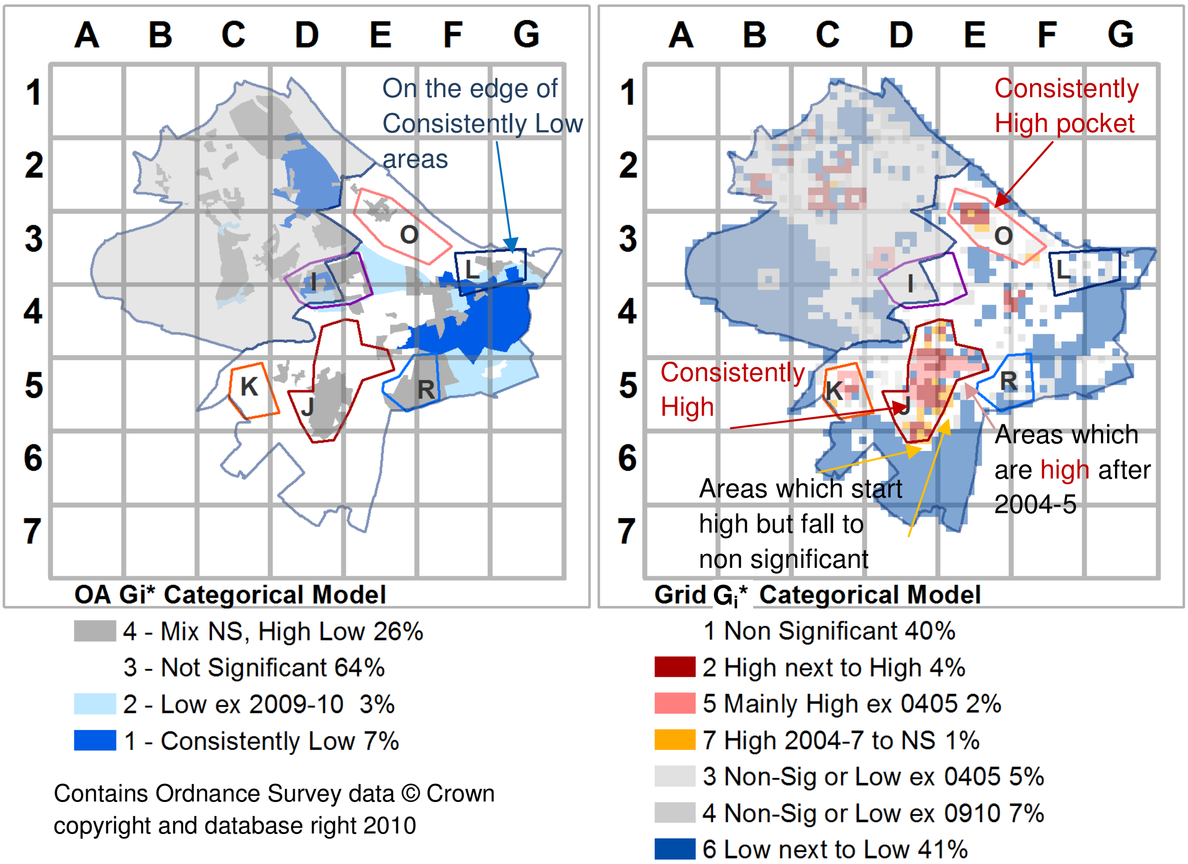


Figure 6.23 Group Trajectory Model Summaries with a Highlight on EdinburghB–OA Categorical G_i* 4 Class and Grid Categorical G_i* 6 class

6.4.3 Accounting for patterns

Use (and Abuse) of Space

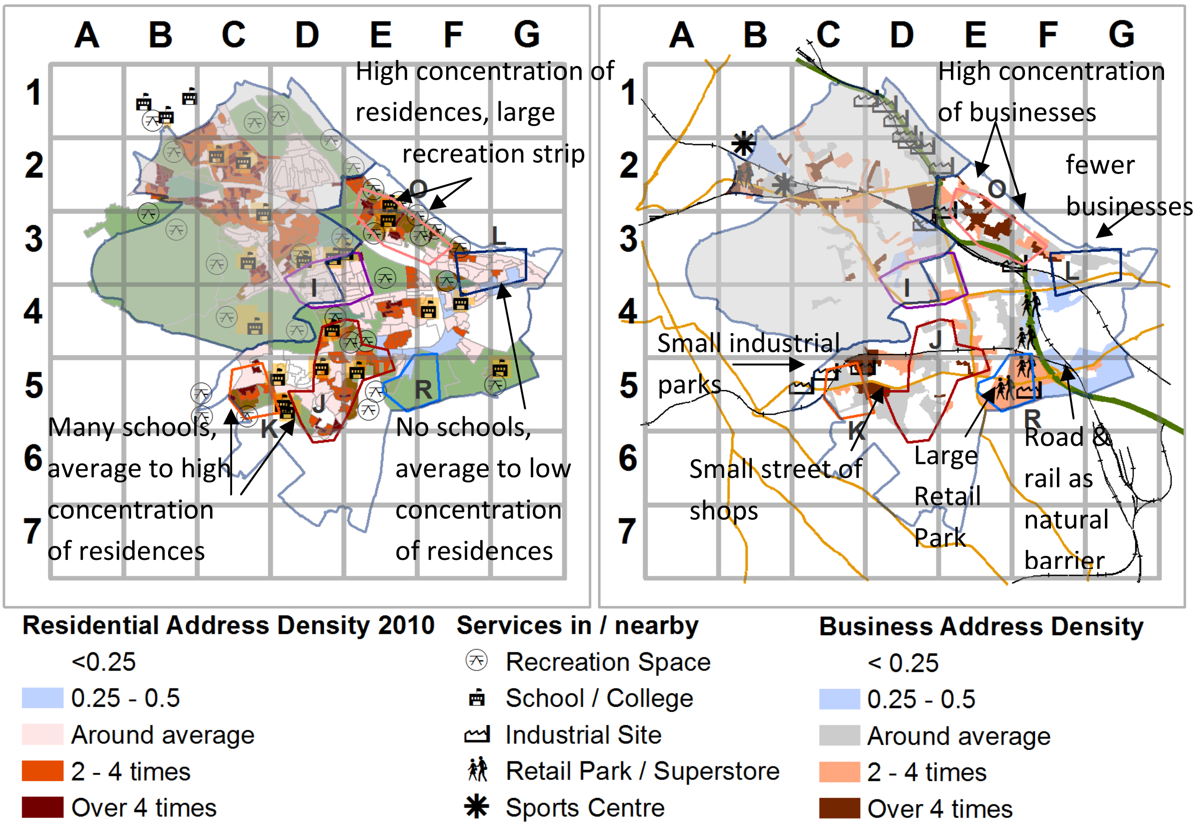


Figure 6.24 Environmental Backcloth EdinburghB

Figure 6.24 shows residential and business use across EdinburghB. Oscar, like Delta is an entertainment hub attracting people from outside the area and across EdinburghA and EdinburghB. Oscar has a large collection of crime attractors, shops, pubs, and a recreation strip. As discussed above this meant there were a number of roads used between Oscar and other areas along which people returning home from entertainment, often drunk, tended to walk, engaging in vandalism as they went.

> "Yeah, I think probably people that are drunk, walking home from the pub, and take it upon themselves to kick off the wing mirrors and smash windows" (Community Police Officer, Focus Group 2)

Oscar was also a location where there was a local promenade with large visible wall space that was used by graffiti writers. Community Officers suggested there would be cycles of graffiti where walls would be repainted and then this would act as a blank canvas which graffiti writers would then reuse. The wall would then be repainted and the cycle would continue:-

> "you find there is a lot kind of wall space, and that's one thing you do find with the graffiti you'll find it'll get painted over and then it's just a magnet to come back... It attracts them back because that's what they're looking for a nice big open space that people are going to see" (Community Police Officer, Focus Group 2)

In contrast to Oscar, Lima is an area with a lower residential density and much fewer shops, and although the promenade continues there are no areas of public entertainment such as shops, pubs and arcades at this point. Lima is also generally free of routes that people would naturally cut through to go form Oscar to elsewhere. Lima was highlighted as an area where vandalism did not tend to occur compared to Oscar.

> "Areas that never get targeted for vandalism....you do get other things" (Community Police Officer Focus Group 2 – discussing Lima)
> "I can't really remember last time we had a vandalism out that way if at all" (Senior Police Officer Focus Group 1 – discussing Lima)

Demolition, rebuild and regeneration were a re-occurring theme that quite dramatically effected opportunities for vandalism in EdinburghB especially in and around Juliet.

> "There's been quite a change in the dynamic of our area over the last 5 years, which probably differs for the areas we cover to the [EdinburghA], in that there's been so much money [spent on regeneration projects]" (Community Police Officer, Focus Group 3)

Figure 6.25 shows counts of residential addresses (based on counts of residential postcodes per 100 by 100m grid cell) in May 2004 just after the start of the study period and just after the end of the study period in May 2010 with the Key Areas overlaid along with the demolition shading from focus groups. (A version of these address count maps without these overlays and detailed annotation can also be seen in Figure 4.14 in Chapter 4.) Generally address counts were very stable throughout the study area, barely changing across the six year period but areas in Juliet were a clear exception.

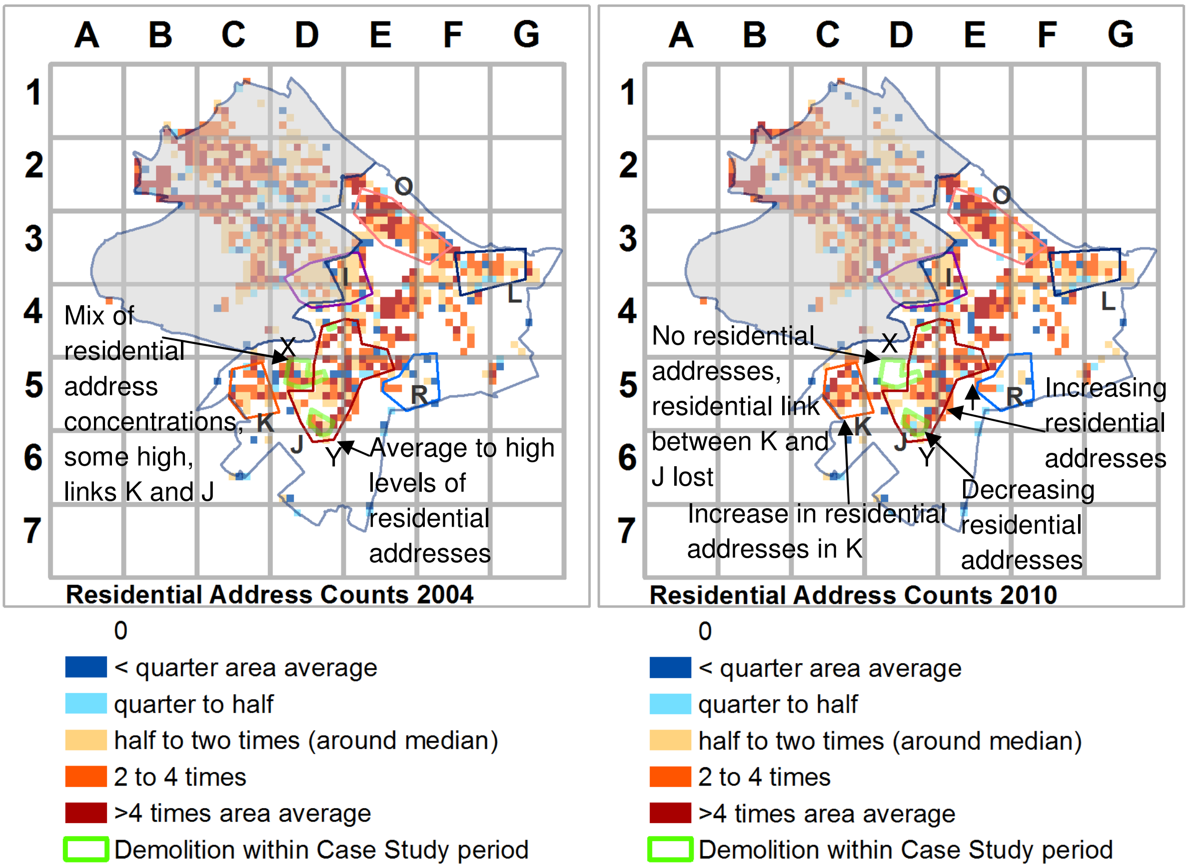


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Figure 6.25 Edinburgh Residential Addresses EdinburghB 2004 and 2010 – Demolition Areas annotated by Focus Group 3 in Green

Officers in focus group 3 identified two larger areas that had been demolished and the demolition then cleared away during the study period as well as a small area to the north of J. These two larger areas can be seen Figure 6.23 highlighted in green, and are labelled X and Y. Area X was completely demolished and the land left as empty green space.

Figure 6.26 EdinburghB - Part of Area X after complete demolition (Photo by Author: March 2011)

Figure 6.26 shows part of area X as it was by 2011. Demolition was complete, the area grassed, but little rebuilding has taken place, there is a small amount of newly built or recently refurbished housing just visible in the picture. Over the same period, substantial rebuilding, refurbishment and regeneration was taking place on other parts of Juliet and Kilo and this is reflected by volumes of residential addresses which were increasing in other parts of the area. Area Y did not experience quite the same radical demolition programme, with complete removal of addresses. Although the effect when mapped as in Figure 6.23 is much less dramatic than area X, on the ground the effect of the demolition and rebuild is still very evident on the ground. When personally visiting area Y in March 2011, it was found that by that time large parts of the area were completely empty of housing and converted to basic green space. It had been grassed in a similar way to the photo above. There were however still some tower blocks present leaving some high concentrations of housing remaining in the area, plus a few lonely blocks of housing not demolished remaining at the very south of J and some properties which appeared recently newly built or refurbished. On the ground Y was clearly an area that had undergone recent and substantial changes. This background context of ongoing demolition, rebuild and regeneration was frequently reflected by comments in focus group 3.

Properties awaiting demolition were seen as providing places for young people to congregate, to make dens and play. This in turn led to damage to property from young people wanting to access these empty or part empty buildings leading to recorded vandalism in these areas. There was no real suggestion that there was any direct maliciousness, more it was an opportunistic attempt by young people, perceiving a place as abandoned, to appropriate the space as their own.

> "So the question is what is the reason for young people thinking because somewhere is disused it's acceptable to trash it, is it because they think it's going to be demolished so it doesn't matter, some of the young people we spoke to, whilst they didn't answer the question in that way, they were looking for somewhere to go and hang out and they saw it as being empty a particular section of it so that's what they did , and because it was empty and because they perceived that it was going to be demolished or refurbished, what was there in its existing format didn't matter, and we had to try and convince them that it did matter that it still belonged to somebody you know it still belongs"(Community Police Officer – Focus Group 3)

Once buildings were fully demolished and the area either rebuilt or greened over the location would cease to be attractive to young people and levels of vandalism decreased.

Some vandalism occurred as play by young people and would sometimes escalate into conflict with adult residents. This might begin with young people involved in relatively innocuous activities such as throwing snowballs, which might then escalate to them throwing snowballs at windows of local houses. When they ran out of snow they would then switch to stones, if this got a reaction out of the householder this then might escalate further even though the initial intent of the young person or child might be play related. Here again is an example of how competing uses of space can lead to conflict between different users of place who want to use it in different ways. The householder wants to be able to quietly occupy their residence, the young person is looking for a thrill, and sees throwing something and then getting a reaction as a way of getting this excitement.

> "certain householders.... react to that, they'd give the kids a row, the kids would then see that as fun so they'd come back they'd throw even more snowballs cos they're getting a reaction. Snow goes away, what they throw, they throw stones and things like that, so whether or not their intent was to cause the damage to the windows their act in what they're doing could result in damage... but the reason that they're doing it is maybe because they are getting a bit of excitement out of it" (Community Police Officer, Focus Group 3)

The Police Officer went on to say that had the householder ignored the child initially then they might not have been targeted for vandalism, as getting the reaction was part of the entertainment for the young people.

One other interesting comment about residents of Kilo and Juliet is that they would often tend to spend time only in a small number of local areas that they knew. For them their mental map of known areas might be very small, so whilst they might go as far as Oscar, or public houses near Foxtrot, they would be unlikely to visit Edinburgh city centre. This hyper localism was explained by an analogy by a Community Police Officer in Focus Group 3 in this way:-

> "Because people in there have got a passion about the bits, the subdivisions of the areas within which they live, almost like a separate town to them, to some people, probably going out of the [Kilo] area going to the City Centre, would be like you or I taking a day trip to Dundee" [The city of Dundee, is around 60 miles north, at least one and a half hours travel time away from Edinburgh city centre].

In this way for many residents of EdinburghB, especially Kilo and Juliet, their local mental map of the area and potential crime opportunities– assuming they had a propensity to commit vandalism – was much smaller than perhaps some other residents of the case study area. This may in part explain the high concentrations of vandalism across Juliet if these were the areas where many people spent most of their days not venturing elsewhere, whether as resident or travelling through the area; in contrast, other people in other locations might have a bigger mental map, and therefore spread their vandalism across a broader area. Other aspects of individuals' daily routines were also important in the distribution of vandalism across EdinburghB as this Chapter now considers.

Routine Activities and the Everyday

In Oscar there was a strong suggestion that patterns of vandalism were strongly linked to the standard routine weekly activity for many of going out and drinking at the weekend, particularly Friday and Saturday night, which led to drunkenness amongst some of those going home, some of whom then vandalised things as they went.

> "[Oscar], is definitely one where a lot of them [incidents of vandalism] do tend to be drink fuelled, smashing shop windows and that's, I don't want to say standard, but a lot of people wake up and see, find their cars damaged in [Oscar] and it's just people Friday and Saturday night going home" (Senior Police Officer, Focus Group 1)

This supports the picture of high areas experiencing higher levels of vandalism on Fridays and Saturdays and on the evenings suggested by the group trajectory analysis (Chapter 5). Also tying in with annual routines was a suggestion that in Oscar there were more problems in summer months as people were more likely to visit the recreation strip then:

> "I would also say [Oscar] becomes busier for vandalism in the Summer months, when you've got people migrating down here for the Summer...spend the day drinking and it becomes an issue, you don't really get as much in the ... Autumn and Winter months" (Community Police Officer, Focus Group 2)

Although was no clear evidence for seasonality shown in patterns of vandalism across months shown by the group trajectory analysis of recorded vandalism data (Chapter 5).

Sometimes local routines can be very specific to an area and that this can make vandalism more likely. This appeared to be the case in parts of Juliet. An issue highlighted in Focus Group 3, specific to Juliet, was that within the area there was a tendency for people to have less respect for natural boundaries and there was a local saying along the lines of "you walk as the Crow flies". For some of them it would be considered routine to cut straight across gardens, or fenced off areas if that was the most direct route to somewhere because that was just the quickest route to where they wanted to go; this could be something as innocent as visiting Aunties house, or potential criminal activity such as running away from the police or going somewhere to deal drugs:-

> "you tend to find that even in squared off areas where there are fences and gardens often people will cut through people back gardens to go somewhere .... there was an issues which I think has been resolved slightly with fences being damaged, bars being bent on fences to allow people to pass through" (Community Police Officer, Focus Group 3)

Where there were certain locations that were perceived by Community Police Officers as particularly attractive to graffiti writers (especially around Kilo and also in some isolated areas above Romeo, to the East of Juliet and West of Lima), if there was also little opportunity for natural surveillance, and the area was a good target, that this might attract graffiti based vandalism. Here is an example from Focus group 3 talking about an area near Kilo which was a building slightly set aside from other residential areas, not overlooked.

> "the main road that's coming through here now really busy road, but there's lots of hedges along the side of the road and there's a footpath that runs adjacent to the road and between that then is another hedge and then the building [face] and on the building it's just completely covered with graffiti tags and I think part of the reason for that is because it's a big, big place, big fresh canvas and it's fairly secluded as well because even though the roads right there they can't really be seen" (Community Police Officer, Focus Group 3)

Similar factors allied with a lack of guardianship also attracted young people to hang out in an area to the area, for example a local school in Juliet had closed and was becoming derelict:-

> "And that has resulted in acts of vandalism to the community centre to the football pitches and we are actively dealing with anti-social behaviour [comprising] young people in the area who are drinking and other issues that are going on in the community there mainly noticed by the people who live right next to the park, the difficulty with that location is that there isn't any CCTV there, so we don't have the benefit of that evidence, we don't have the benefit of there being any neighbours there either so, which is part of the reason why the young people go there but that does bring up its own issues "(Community Police Officer, Focus Group 2)

Poor guardianship and low natural surveillance was also seen as a reason why some streets were more likely to be a target of vandalism from inebriated people heading home and this was why certain streets between Oscar and other areas were thoughts to experience vandalism whilst others might not:-

> "Off the high street you tend to find a lot of people use kind of [route-way out of Oscar] as a route home kind of around here and because it's off the main drag a lot of the times it won't get witnessed it's quite dark and quiet" (Community Police Officer, Focus Group 2)

Equally if an area was perceived as having high levels of guardianship then Community Police Officers perceived that this led to fewer vandalism problems. Romeo, despite potentially being in some ways an ideal crime attractor with many retail spaces and cafes, was described as having a great security team and very good CCTV which prevented a range of crimes including vandalism. Romeo was in part seen as not a problem as the police did not often have to intervene (hence perhaps explaining the low levels of recorded crimes of vandalism) as most matters were prevented by intervention of the local security team.

> "They have one of the best security teams of any shopping park, to be honest in the UK, very very switched on, people don't get away with things there, so if they've ever tried it they've learned their lesson (laughs) so whilst they do suffer from shopliftings and things like that for the size of the retail park, it's very very minimal drain on our resources I would say where even as we plan forward to Christmas, we know it not as high, we would probably have more issues with [within Delta] retail park which is tiny ....But it doesn't have its own security team which this does" (Community Police Officer, Focus Group 3)

Persistent Relative Inequality (Advanced Marginality)

The perception of a problem can often change on how it is conceptualised or in this case visualised. Figure 6.27 is a case in point. The map on the left shows the areas highlighted as having high or low levels of vandalism in the focus groups. The figure on the right shows a summary of volumes of vandalism. Many of the areas perceived by Community Officers in focus groups as having particularly high levels of vandalism are also those with particularly high volumes of vandalism. This is particularly the case for Juliet. Now in some cases the same areas also have high rates, but this is not always the case. For example area K has consistently high counts across the case study period (Figure 6.27 below) but not high rates (for example see Figure 6.22 above).

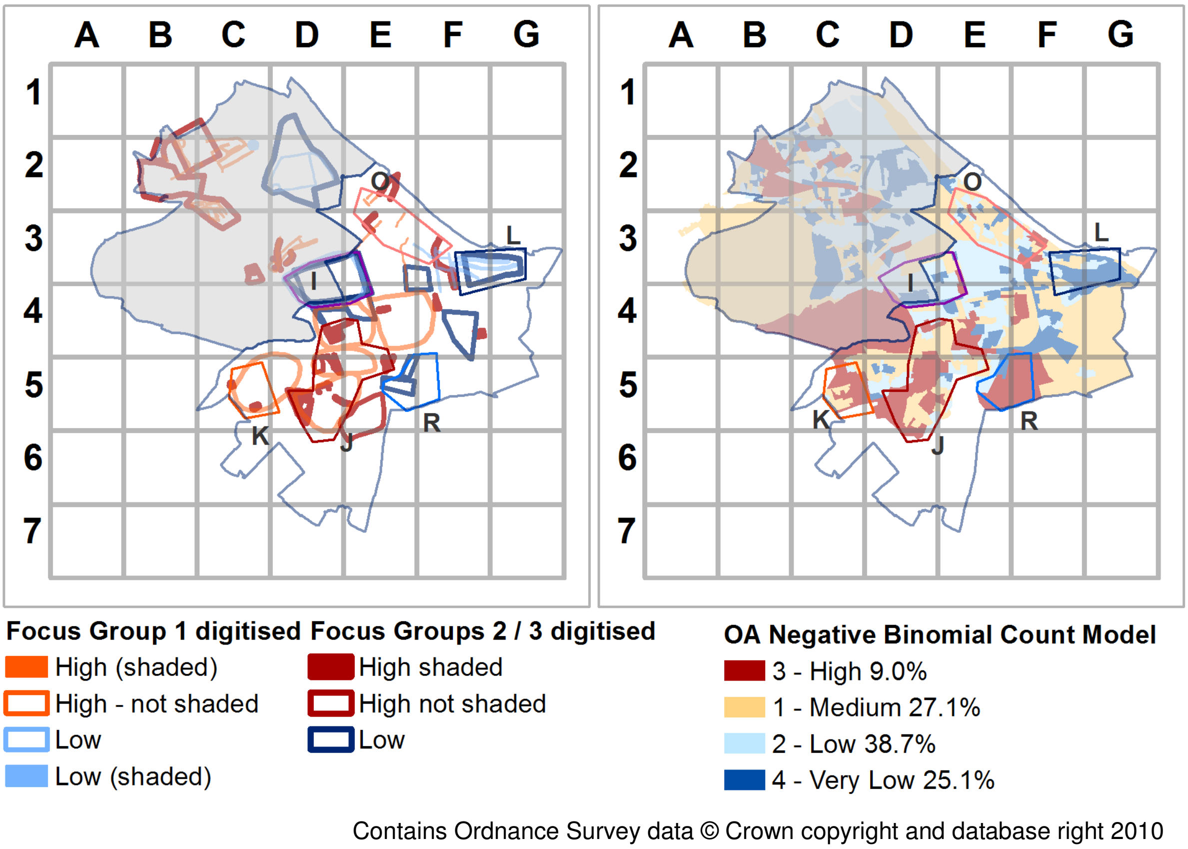


Figure 6.27 Comparing Focus Group Shading with High Medium and Low counts of Vandalism in Output Areas across the study period in EdinburghB

A number of these areas were identified as being high vandalism areas were also those where a high proportion of the population were in receipt of income based welfare payments compared to Scotland as a whole. This becomes particularly clear if the results of Focus Group 1 (more Senior Officers) are compared with Output Areas that fall within the upper quartile of all Datazones in Scotland with the highest proportion of the population who are income deprived.

The large orange high areas in K, J and adjoining J and above R, are also all areas that have a high proportion of the population in receipt of income based welfare payments, and poor school attendance (Figure 6.28). It is undoubtedly the case that many areas highlighted in Juliet as having high vandalism in Focus Group 1 and Focus Group 3, were also areas with a high proportion of population in receipt of income related welfare, but there were also other areas where there were lower levels of vandalism, but still at Datazone level, a high proportion of the population who were in a relatively deprived area. Analysis of explanatory factors of group trajectory patterns (Chapter 5) suggests that a high proportion of the local population being in receipt of income related welfare might be a relevant factor. Whilst there is no clear evidence that relative deprivation directly causes vandalism from focus groups, the two clearly do co-exist together.

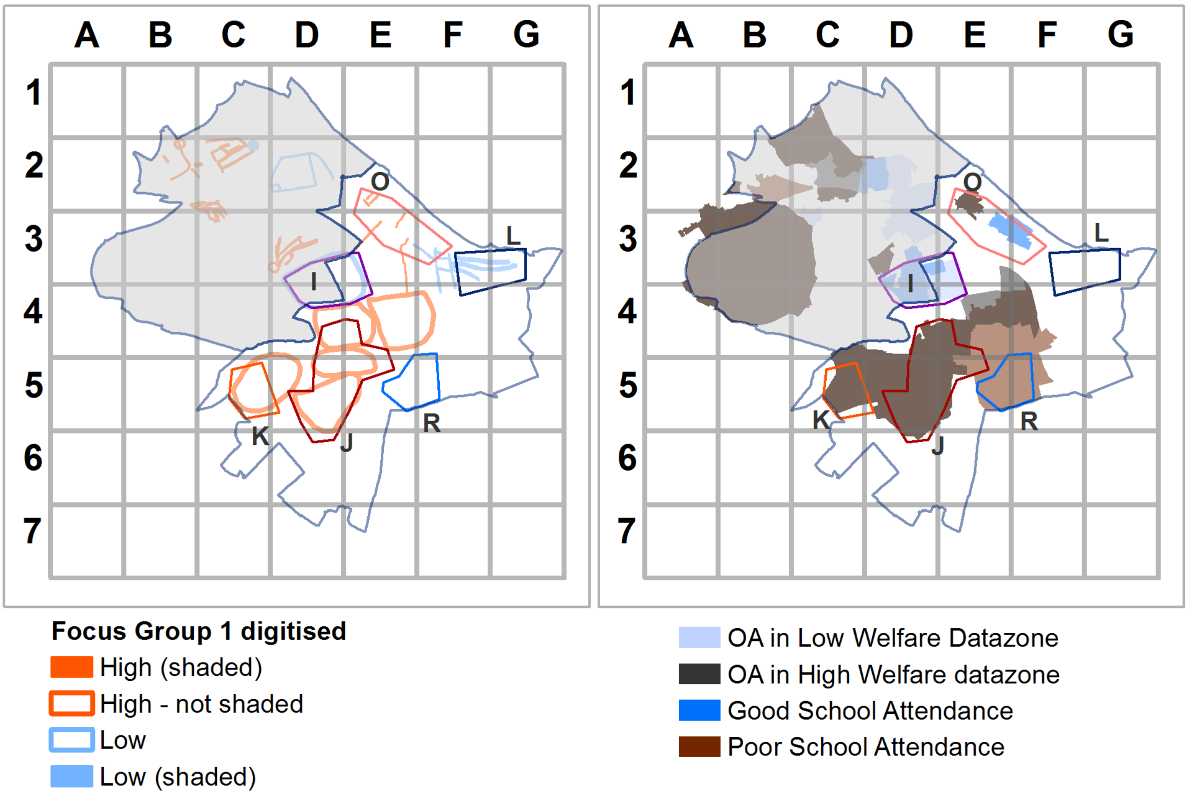


Figure 6.28 Comparing results of Focus Group 1 with Analysis of areas with High and Low proportions of population in receipt of Welfare, and Poor and Good School Attendance in EdinburghB

What is interesting is there were suggestions that these very deprived areas were also often areas which had a very poor local reputation, and that poor local reputation may have led locals to care less about the area and potentially this might be a reason for them being ambivalent about, or possibly engaging directly in acts of vandalism. On a number of occasions Community Police

Officers with considerable experience of policing EdinburghB spoke of areas which had both a reputation and a reality of being a place where the residents had many social problems. These areas were particularly within Juliet and the social problems were not new but had been persistent through generations

> "it's families who have been long term unemployed, generations of unemployment, generations of [alcohol and drug abuse], that kind of thing, and it's kids with real low expectations, with low horizons that are going to that school. In fact the school is [School within Juliet], uh huh, so under-occupied that's it's probably not going to be around in the next 5 years."(Community Police Officer – Focus Group 3)

In turn there was a perception that these very serious social problems which went back generations were strongly linked to high crime in the areas.

> "These are deprived areas where there are a significant number of chaotic families that lead chaotic lifestyles and have done for generation on generation, so there's a broad spread of deprivation that significantly contributes to the crime that manifests itself in these areas" (Senior Officer – Focus Group 1)

This reputation often persisted even after efforts had been made to improve things in area J; the quote below from two Community Police Officers in Focus Group 3, speaking in turn, vividly set out the challenge of trying to convince a local resident of how regeneration projects and other initiatives in the area were trying to improve things when the local perception of some residents is strongly that the area has a longstanding problem.

> - "Yeah, social ignorance and an element where people don't really care too much about how clean and nice looking their environment is and maybe that is because they think well we don't live in a very nice place anyway"(Community Police Officer 1 – Focus Group 3)
> - "Like the chap we found 2 months ago who was relieving himself behind a wall and on that occasion we gave him a warning, it's someone who is known to us, and I think is words were it's an 'S'-'H'-'I'-'T'-hole and what difference does it make, and we're saying well actually do you know we're making a real effort here we're working with the council we've done this we've done that we've built new fences we bored him to tears for fifteen minutes telling him about all the things that we're trying with the council and the housing associations do, and that sort of behaviour isn't acceptable, but there's an apathy, or an assumption that's it's [Juliet], you know. Which you have to battle you know because we can't really change some learned behaviour really, you know, for some yes but not all" (Community Police Officer 2 – Focus Group 3)

This quote is very interesting in the light of the theoretical arguments and research of Loic Wacquant on advanced marginality (Wacquant, 2008) and the research Robert Sampson (Sampson, 2012) relating to persistent inequality and the persistence of perceptions of an area as one with a disorder problem. These arguments suggests that some areas can have such a high level of persistent inequality that they can become highly marginalised from the mainstream, and in particular Sampson's work suggests that where people perceived disorder as an ongoing problem in areas that were in the past problematic, even if things then improved, perhaps because of local reputation, or a particular social or racial make up, people continued to perceive the areas as a problem. What is key is that it is not just the people outside the area who perceive somewhere as a 'problem' area, but the people who live within it too. Indeed Juliet is one of those areas, where parts of it have a reputation so soundly entrenched as a 'problem' that they have appeared as a typical example of a problem estate in some fictional Edinburgh crime novels and films. It was one of the reasons why it was decided not to name areas within the case study so as not to entrench that reputation further.

In one case long term reputations were so bad it had led to one area being totally demolished (the area labelled in X in Figure 6.25 above).

> "some people... very passionate about the area, but other people felt it had become so run down that... that it had to be removed from the map and start again, to get away from there. It's a place where people go to take drugs, or other things that would go on in the area. But it was kind of a symbol of the heavy drug use of the 80s" (Community Police Officer, Focus Group 3)

As Figure 6.25 above showed this area X on the edge of Juliet really has, actually, been completely removed from the map. In other areas where demolitions had taken place, there were more mixed emotions about whether it was a good idea to replace the area especially towards the area in the south of Juliet.

> "an area where it wasn't a nice place to be, it wasn't a nice place to go although people did feel quite passionate that it was their home and everything but it had got run down it had got neglected"(Community Police Officer, Focus Group 3)

Community based interactions / Collective efficacy

In many ways, demolition and rebuilding had a destabilising effect on areas as people found themselves moving from areas where they had lived for generations and having to move to new housing, sometime more than once. The moving between areas included a 'right of return' process so people could initially move out of one area to another whilst their 'hometown' area was demolished / refurbished and redeveloped, and then would have a choice later of moving back to the home-area, staying where they were or moving on again. This meant that, throughout the case study period from 1st April 2004 to 31st March 2010, much of the area of EdinburghB would have been a community in flux as people were moved around, perhaps for the first time having to leave an area where generations of their family had previously lived.

> Community Police Officer:- "...so basically what the right to return gives you is the right to move twice..."
> Researcher:-"So have some people ended up, kind of, moving out of areas that have been areas where they were brought up, where their families have been for years"
> Community Police Officer:- "M- huh, totally big time yeah "(Focus Group 3)

This could potentially have led to some loss of collective efficacy within the community as local community ties were severed, although this was not specifically mentioned. There was mention in focus group 3 of some ongoing issues with neighbour disputes in certain areas of Juliet, but the causes of these disputes were not discussed. Collective efficacy did appear generally lower within Juliet. Although this was not specifically tested in any way, comments from focus groups gave some examples that could be interpreted as indicative that Juliet was an area with low collective efficacy. There was some suggestion of racially motivated vandalism within EdinburghB in both Focus Group 1 and Focus Group 3 though how widespread a problem this was unclear. Police Officers in Focus Group 3 specifically mentioned that stone throwing at properties could occur due to racial harassment.

> "I think that stone throwing at windows the feeling is that it's sometimes out of hatred, it's sometimes because it's maybe because there's maybe somebody of a specific ethnic class living within a property" (Community Police Officer – Focus Group 3)

Unfortunately for the study period there was no data available on the racial make up of the area, the only data was from 2001, 3 years before the case study period. This was not investigated further but it is not possible to rule in or rule out whether racial tensions were a particular cause of vandalism in Juliet.

What was clear was that some vandalism in the Juliet area was due to unpleasant targeted vandalism aimed at specific individuals. In some cases this might be due to young people feeling a perceived slight from an individual and then as a group targeting their property, or competition between groups of young people from rival areas. In other cases, for example graffiti, could be linked to other criminal behaviour, with the implication being this was outside the 'normal' type of vandalism in the area and linked to other potentially more serious criminal activities:

> -"that was known people who were trying to express a message to somebody that worked nearby as opposed to being a tag if you know what I mean – {to colleague B} is that fair to say ?"
> -" Yeah, graffiti was directed at a person really"
> (Community Police Officers, Focus Group 3)

These poor community relations must also be contrasted with comments about local residents feeling passionate about their local community. Could this strong sense of place and local community ties on occasion lead to high collective efficacy? There was certainly evidence within Kilo of residents coming together to work with local authorities to improve a green space and turn it into local public park:

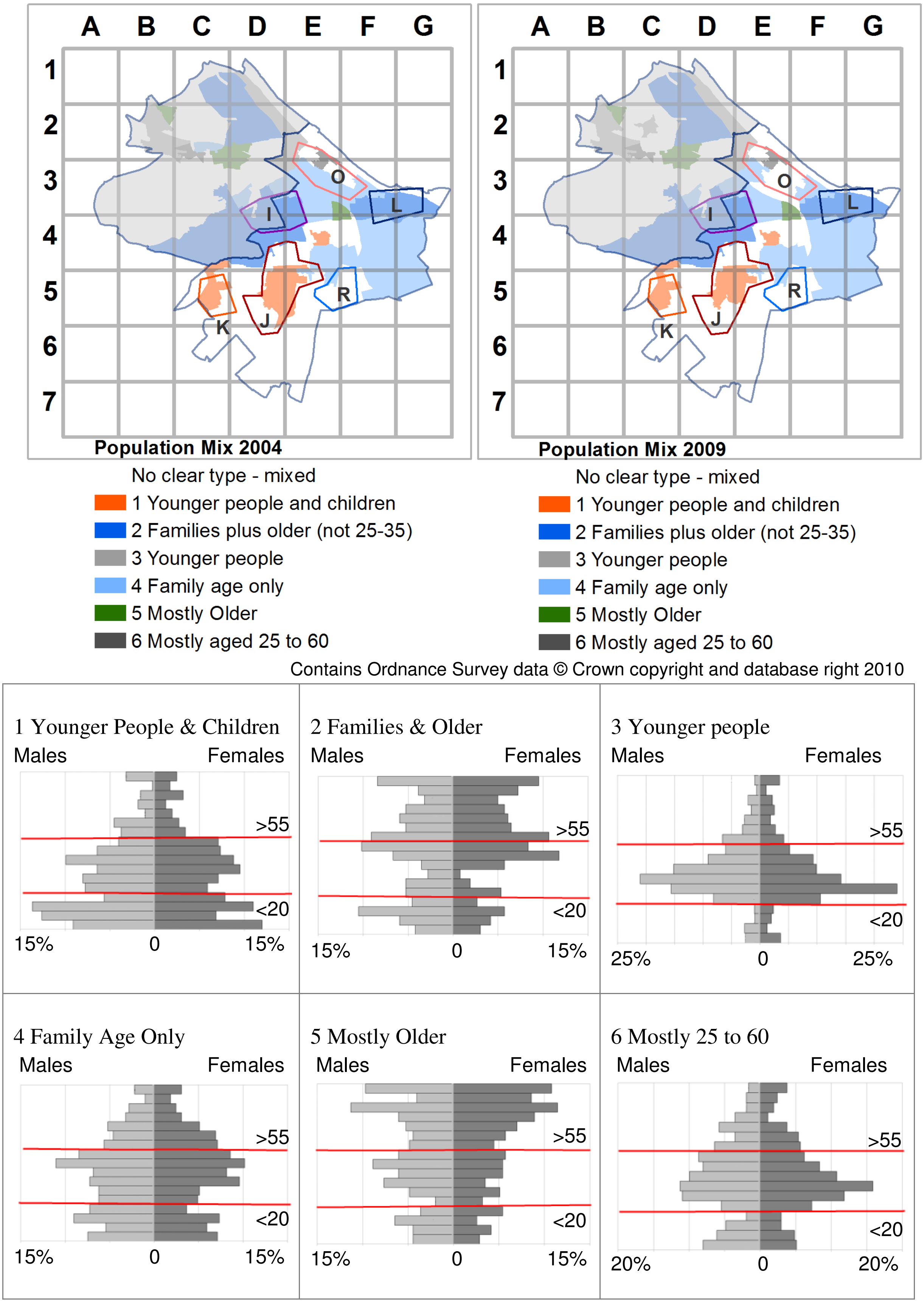


Figure 6.29 Population Mix in EdinburghB with example Population Mix Types

"There was a park .... where bikes used to get, you know motorbikes would be burnt out and there was extensive damage, they managed to pressurise the local housing associations into fixing that particular park, we were [there with trainee Police Officer who] commented on it, it looks great, really nice, isn't it"[pause while the trainee Police Officer assents] "it's looking really nice, and what a difference that's made I think that ties back into something you said before that when there are improvements peoples see it and they actually do, oh it's neat and tidy oh crikey I better keep it neat and tidy" (Community Police Officer, Focus Group 3)

However, it was also noted that limited budgets for public spending, and the great many local areas needing improvement meant there were limits to what local community action could do

"...there's so many things that need doing it's really just chipping away at the wee bits of it" (Community Police Officer, Focus Group 3)

In contrast, Lima was described by Officers in Focus group 2 as one of the community orientated places, where the local community would fight to get things done. Interestingly there is again an interesting possibility, as in EdinburghA that the population mix might have been effecting community interactions in some way and possibly thereby levels of vandalism. Looking at the demographic make-up of EdinburghB (Figure 6.29) Lima is an older and family type area, a Type 2 area where there are some children, along with residents aged 34 and older. It is also an area with fairly low vandalism levels year on year.

Much of Juliet and Kilo are both Type 1, younger areas where the majority of residents are aged under 55 and there are very high proportions of younger children, aged under 15 compared to other parts of the study area. (Interestingly the one Datazone that changes its demographic make up from mostly young to no specific type is to the South of Juliet, the area where the population was in flux due to demolition and rebuild). High proportions of younger children could in part lead to the higher levels of vandalism since the majority of those involved in vandalism are likely to be aged between ten and fifteen. An intriguing possibility though, is whether this lack of older people within the local community could have a detrimental effect on levels of local collective efficacy, the capacity of the community to come together to solve problems; this is speculation, but it leaves open further interesting avenues for future research.

6.5 Section C – Comparing the Neighbourhood Partnerships and Concluding Summary

This Chapter will now conclude by examining the similarities and difference between the key areas within EdinburghB and EdinburghA. It will begin by looking at differences between the patterns of vandalism observed across EdinburghA and EdinburghB. In doing so it will answer the third question posed at the end of Chapter 1: Do places which experience either low or high concentrations of vandalism over time appear to have any common features or shared characteristics? It will then look at the shared and different characteristics of High, Drifting and Consistently Low key areas, as suggested by interpretation of focus groups results and relevant local socio-demographic data. It will then summarise what these suggest about the characteristics of areas which experience high and low levels of vandalism.

6.5.1 The Persistent High areas - Juliet and Foxtrot

In terms of patterns of vandalism both Juliet and Foxtrot were areas that potentially had lower collective efficacy than other areas around them, and could be described as areas with persistent levels of inequality. For both Juliet and Foxtrot, the issue of deprivation was spontaneously raised by Officers when asked to describe the nature of the area. Both Juliet and Foxtrot were also described as areas with specific negative reputations, in Foxtrot this particularly seemed to relate to the poor quality of the housing and apathy of residents, in Juliet issues were broader than this and went back generations. For both areas, both local residents and outsiders were perceived by Community Police Officers as often considering areas as a problem. Both Juliet and Foxtrot were also described as having wider crime problems, in Foxtrot this was particularly linked to young people known to statutory agencies because of being arrested whereas in Juliet both adults and young people were described as engaging in crime. These negative perceptions of place were particularly strong in Juliet, so much so that parts of it had been demolished in the hope that some of the reputation could be "wiped off the map". In this way one of the key characteristics of Foxtrot and Juliet, that was not present in other areas, was they were areas that could be described as experiencing advanced marginality. Interestingly these differences are only partially reflected by models that seek to identify risk and protective factors that made areas fall within groups of areas with persistently high or mostly high levels of vandalism.,

In the models presented in Tables 6.1 to 6.4 above, being in an area with high welfare had more of an effect in EdinburghA than EdinburghB. This may be reflected by comments in focus groups strongly suggesting that Foxtrot was an area apart from much of EdinburghA, whereas much of EdinburghB was seen as having issues with relative deprivation, so Juliet was not as radically different to other parts of EdinburghB as Foxtrot was compared to other parts of EdinburghA. Whilst some issues in certain parts of Juliet were highlighted as particularly serious, a lot of these issues relating to advance marginality centred on local perceptions of the area, a factor not captured in quantitative models presented above in Tables 6.1 to 6.4 in section 1.

Juliet was a much larger area than Foxtrot, where some residents were said to have a very strong sense of belonging to certain places. A similar sense of belonging was not specifically mentioned in relation to Foxtrot, although, given the very small sample of Police Officers questioned this might have been apparent if more people had been questioned about the nature of the area. For Juliet, an additional potential strain in the area not present in Foxtrot was that this strong sense of belonging had been disrupted for many residents as they had been forced to move from place to place as parts of the area were demolished and rebuilt. These are factors revealed by focus groups that would be more difficult to quantify and represent in a model. Could the disruption that regeneration was temporarily causing to the local community have been a factor which caused the very high spike of high vandalism seen in EdinburghB between 2006-7 and 2007-8? More research would be needed to establish this. Juliet was also different to Foxtrot and other areas in the case study area in that overall it had a younger demographic with a greater proportion of younger children than other areas. Models suggest that younger ages may be a marginal factor across the case study area but it did not appear significant in sub-areas as a risk factor for having high levels of vandalism compared to consistently low levels.

Demolition in Juliet also provided opportunities for vandalism not available in Foxtrot. Young people in Juliet chose empty and half empty properties as places to hang out, and on occasion this led to damage being caused. Having no such similar places to go nearby, young people from Foxtrot and surrounding areas including Kilo and Delta instead gathered in local parks, and outside local shops and bus stops to hang out and sometimes drink; this then sometimes lead to vandalism in an area and confrontation with other residents.

The density of vandalism in Juliet was also explained by localised routine behaviours, and potentially limited local mental maps of areas. Linked to very strong links with particular places was a reluctance to visit areas very far from home. There was also perceived to be a tendency to walk ‘as the crow flies’ leading to people literally walking through fences increasing levels of property damage. For both Juliet and Foxtrot there was a sense that much of the vandalism was ‘home-grown’, people were vandalising the area in which they lived. This does not seem to be the case in other areas, where people passing through, or coming from outside of the area were responsible for much of the vandalism. This Chapter will now move on to discuss these areas, where vandalism was often caused by outsiders visiting the area because they were attracted by particular local facilities.

6.5.2 The Drifting High areas – Delta, Oscar and Kilo

In Delta and Oscar and Kilo locations which acted as crime attractors appears to have been a key reason why some areas experienced higher levels of vandalism than others. What acted as an attractor for vandalism varied but in Delta and Oscar a common element was a recreation area, where people chose to socialise and possibly drink and then vandalism might occur on the way home from this location. Areas which experienced vandalism also seem to have poorer levels of guardianship than other areas. Areas where vandalism occurred often lacked CCTV, lacked an active security presence, or had low numbers of local residents who could provide natural surveillance. In both Kilo and Oscar certain locations were particularly attractive to graffiti writers, both because they had large expanses of wall available to write on that could be seen by others, and because (particularly in Kilo) they were in areas where it was more difficult to see graffiti writers coming into and out of the area.

Routine activities also appeared from comments in focus groups to have a strong influence on levels of crime in drifting high areas. Group trajectory analysis (Chapter 5) suggests that vandalism is much more common in evenings and to a lesser extent weekends across the study area. In Delta, locations of vandalism were felt to move around as young people chose different places to routinely gather, as one generation of young people grew up and grew out of vandalism, another generation of young people would choose new points to gather and so locations of vandalism might move around. In Oscar routines of visiting the area to drink on Friday and Saturday nights made it more of a target at weekend, especially along roads used as routes in and out of the area. Comments in focus groups suggested Oscar was more of a target in summer months, although group trajectory analysis found no clear evidence of seasonality in levels of vandalism across the study area.

There were also suggestions of community conflict in both areas as young people and residents sort to use parts of the area in different conflicting ways. Various examples were presented of young people congregating and then getting into conflict with local residents, sometimes the 'reaction' from residents might escalate conflict with 'getting a reaction' sometimes being perceived to as adding to the sense of excitement for young people, and at other times young people reacting to disapproval of others and causing deliberate damage in response.

Whilst all these factors were also present in the persistently high areas, Juliet and Foxtrot, in Juliet and Foxtrot, they more emphasised as having an influence on levels of vandalism in

Oscar, Delta and Kilo than were specific issues around relative deprivation. This may not mean that issues around crime attractors, routine activities and lack of guardianship were not also important in Juliet and Foxtrot, rather that issues related to relative inequality were potentially less important in Drifting High area compared to Persistently High areas.

6.5.3 The Consistently Low and Drifting Low areas – Echo, Indigo, Lima and Romeo

One common factor for Echo, Indigo and Lima was a lack of locations ideal for vandalism in these areas (no crime attractors) and there were no entertainment centres that people would want to visit in these areas. These appeared to be areas where people did not choose to vandalise the area in which they lived, few people came through the area from outside who were likely to commit vandalism in the area. Indigo is an interesting area as it has slightly higher levels of vandalism than Echo and Lima, and also was identified as a place where vandalism ‘on the way through’ was more common, as people cut through the area from Oscar to Foxtrot or for example from Kilo to Foxtrot and so on. Echo was not on route to anywhere unless you lived there and this appears to be a protective factor for the area. A lack of schools and businesses is suggested by models as being significant, especially at the micro level, in protecting consistently low and average to low areas from high levels of vandalism. Romeo is an interesting exception in that it had a large retail park that could have been a crime attractor; for Romeo it was suggested that very good guardianship on the form of private security protected the area. Romeo is also slightly away from residential areas, which meant again there was no reason to walk through if on the way to somewhere else, like Echo this may also have been a protective factor.

Another protective factor in Echo and Indigo and Lima seems a lack of relative deprivation., One of the Community Police Officers who spent much of their time policing Juliet, an area with generations of unemployment, characterised these areas as different in that residents had jobs. Other Police Officers described these areas as relatively more affluent, being occupied by ‘professionals’ and with highly priced housing. Parts of these areas in Indigo and Echo included areas where residents were amongst the 25% of areas in Scotland with the lowest levels of people in receipt of income related benefits. They also included areas with good levels of school attendance. This sense that affluence, in the sense of *not* being deprived, might lead to lower levels of vandalism is supported by findings from models which suggest not being in a high welfare area makes areas more likely to have low or very low levels of vandalism rather than high levels.

Although not modelled due to lack of data, focus groups also suggested that residents in areas such as Lima, Indigo and Echo were more likely to come together and solve problems, joining local community groups and attending local governance meetings. This sense of potentially higher collective efficacy of residents was contrasted with potential apathy of residents in other areas, especially in persistent high vandalism areas such as Juliet and Foxtrot.

A demographic mix of both older people and families was possibly protective in Echo, Indigo and Lima. These areas all had a higher proportion of older people (over 55), as well as people of the age of older families (children aged 10-15 and adults aged 35-45). A slightly higher median age was found to make areas more likely to be amongst groups of areas with lower levels of vandalism in models.

6.5.4 Concluding Summary

The final research question asked:-

Do places which experience either low or high concentrations of vandalism over time appear to have any common features or shared characteristics?

The results above clearly suggest there are some common features and shared characteristics of high and low areas. Broadly risk factors which make an areas more likely have higher levels of vandalism compared with low areas are:-

- Younger people present in the area
- Crime attractors
- Local routines that encourage crime
- Poor Guardianship
- Conflicts over shared use of space
- Weaker collective efficacy than neighbouring areas

Additional factors common to persistent high areas not necessary present in high drifting areas

- Relative deprivation
- Advanced marginality
- Other more serious crime in the area
- A very localised outlook so the population remains concentrated in a fewer localised locations

Protective factors common to low areas and areas that drift between low and average levels of vandalism and which prevent these areas form having high levels of vandalism are:-

- Young people do not choose to hang out there
- A mixed population with both younger and older residents
- Good local guardianship
- No or very few crime attractors, including no schools
- An absence of relative inequality
- High collective efficacy

This research clearly shows all these factors are important. Further research is now needed to understand the relative degree to which these factor influence levels of vandalism. What the research does suggest is that vandalism is better thought of as a place crime not just a property crime. What causes high and low levels of vandalism is a complex phenomena better reflected by the more complex concept of place rather than simpler concept of community. Property implies just physical structures are relevant, place implies that physical structure alongside the perception of a location and the nature of the local community, the complex lived experience of somewhere all matter. Many of the relevant factors highlighted by this research are not just about the physical nature of place (although this is also important), but also wider structural issues such as levels of relative inequality, and entrenched attitudes to places built up over time. Simple responses such as just building higher fences or having increased levels of security could have big effects in some localised areas but are unlikely to resolve more complex issues related to structural issues such as conflicts between older and younger residents, poverty, poor education, an apathetic attitude to improving the local area and perceptions of areas as failing. Treating vandalism as a place crime opens up the potential of wider consideration being given to a more complex set of factors being relevant to why some places are likely to experience high levels of vandalism and others low levels, and is likely to lead to an improved understanding of the phenomena.

Chapter 7 which follows goes on to look at the broader implications of this research for crime and place theory and which research methodologies are likely to increase our understanding of vandalism and crime and place more generally. What all this means for policy makers, both for addressing high and low areas of vandalism and wider issues related to crime and place is also considered. Chapter 7 also makes recommendations for further research on three levels, research that will increase theoretical understanding, research into better methodologies for exploring crime and place, and research that will lead to better policy relating to vandalism and crime and place more generally.

7 Conclusion

This chapter will discuss theoretical , methodological and policy implications of this research. It will bring out broad themes identified by this research, it will consider what methods can usefully be used to study crime and place, make suggestions as to what these mean for those involved in developing theories around vandalism and more broadly crime and place and then finally consider how policy makers might usefully take steps to better understand levels of vandalism in the local area.

7.1 Methodological Implications

This section discusses what the implications of this research are more broadly for those who research and analyse crime and place.

7.1.1 Scale matters

The first clear message from this research for researchers and analysts is that scale matters. Differing patterns of vandalism were easier to see at different scales. In this research, a finer scale (100m by 100m grid) was better for spotting localised micro changes. Visualisations at this scale were able to show that there was a high degree of variation between high and low vandalism areas at a local level, high areas and low areas often adjoined each other. Scaling up, and using different boundaries to represent small neighbourhoods (OAs) and slightly larger neighbourhoods (Datazones) showed that visualisations at this coarser scale generalised the data, so that an area which at the micro grid scale was shown to have a mix of high and low micro concentrations of vandalism, at a coarser scale would appear to be just a high or low vandalism area, with these micro differences masked.

A second very interesting finding relates to the modifiable areal unit problem, which states that changing either the boundaries or the scale at which the researcher analyses the same data, will change statistical outcomes, and, these changes can be very marked (Openshaw and Taylor, 1979). Two key MAUP effects were noted when exploratory multinomial logistic analysis was undertaken of groups identified by group trajectory analysis. The first effect was that the significance of certain localised effects, the impact of being close to a school, the impact of parks and the impact of concentration of business addresses disappeared as the boundaries and scale changed from uniform 100m by 100m grid squares, to the larger small neighbourhood sized Output Areas whose shapes and area varied. Similarly whether or not an area was within a larger boundary where a high proportion of the population were claiming income related welfare benefits, was found to have a much higher impact on whether an area was likely to be a high vandalism area compared to a low vandalism area at the coarser Output Area scale than the finer grid scale.

Various possible explanations are offered for this. One possibility is that this may be purely as result of mathematical properties of the data at different scales. For example data may be more likely to tend towards the overall mean (O'Sullivan and Unwin, 2010) or it may be that as at a larger scale there are fewer cases of geographic units this causes sample sizes to be smaller and so factors having a smaller effect are not identified as being significant. As a rough rule of thumb a sample size of at least 600 is needed to pick up small effects and sample sizes at Output Area level analysed in this research were smaller than this (Field, 2010). A further possibility is that the zones chosen for OAs affected the results, OAs are of a very different design and very different shapes to regular grid squares, so the difference is due to a difference in partitioning rather than scale. Using zones which were regular grid squares but larger than the 100m by 100m grid squares could have yielded more consistent results. This finding would be interesting but the design of this study did not specifically test for the effects of scale and partition separately so it is not possible to fully disentangle which of these two MAUP effects have influenced results here. A study which specifically controls for MAUP scale and partition effects could investigate this further. A third possibility is that these results just reflect that the proxy measures being used to represent the social and demographic factors postulated to have a possible effect on high and low levels of vandalism were insufficient. Better, more localised measures of potentially relevant factors may have yielded more consistent results. Another possibility is that since spatial autocorrelation effects were not corrected for in either the group trajectory models that established the groups, or the multinomial models analysing which factors impact on whether areas have high or low concentrations of vandalism, this has skewed the results, with in the multinomial models some factors appearing to be significant when they are not. A fourth possibility is that a failure to correct for the small number problem while using data aggregated to micro scales has led to statistical noise and artefacts in the data which has skewed results. The final possibility is that certain factors genuinely have more impact at street by street level, whilst others have more impact across a broader neighbourhood. It certainly may reflect that certain factors might be perceived as having more impact at very local levels e.g. where the local shops and schools are, whereas other factors are perceived to affect a whole neighbourhood, for example, is a neighbourhood perceived as poor or affluent?

These results are interesting as they reflect the fact that crime science researchers who have often concentrated on the very micro level tend to emphasise the importance of situational factors and environmental backcloth (such as the presence of schools, parks and local businesses), whereas other researchers who have worked with data at slightly broader scales often highlight more structural factors such as persistent inequality as impacting on crime. Could it be that the scale chosen by these different researchers has had at least a partial impact on their results? Could it be that some researchers have not controlled adequately for MAUP, spatial autocorrelation and the small number problem? This research suggests that the factors that appear to be important could vary significantly depending on what scales you choose to analyse your data at. The focus of your lens may actively change which factors appear to predominate. Potentially different methods of modelling, to those used in this research, such as multi-level models which can assess how much variance in a model occur at different levels (which can be geographic scales) might help to unpick this further as might hierarchical Bayesian models. Both Bayesian modelling approaches and multi-level models can also potentially correct for spatial autocorrelation and the small number problem, and taking these approaches might be helpful, though many of these techniques are still to be fully developed (Law et al, 2013).

Whilst further research is needed to understand better what is going on here, this research makes it very clear that choice of scale and boundaries used to analyse data with a geographic element is an extremely important factor to consider. This research also suggests there is great merit, where possible, in attempting to replicate findings at more than one scale and using more than one zoning strategy, as this enables the researcher to actively comment on, and consider the effect of scale and partition on their results.

The research also found that it is a real challenge to find data for potential explanatory factors which may explain high and low vandalism areas at the very small micro level. Significant micro changes were being observed, but finding data which was collected to a national standard which potentially could explain why this difference occurred proved difficult. Much explanatory socio-economic data is only made available at the coarser scale of Datazone or larger. As this research found specific localised effects at the local output level and even at the smaller 100m by 100m Grid level this presents particular challenges for those involved in neighbourhood level research. Some data will be available at a more localised level if specifically requested, as the crime data used for this study was. However this has significant time and potential cost implications as data access has to be negotiated and in some cases data may not be available for free at this more localised level. The alternative is to use the data provided at a more coarse scale and hope that it acts as an adequate proxy. Here this was found to be a particular challenge when assessing local levels of relative deprivation and may be a further explanation for the varied results at different scales discussed above.

7.1.2 Crime maps are not just for crime science

This research has shown that crime mapping provides a dynamic and innovative way to visualise and elicit understanding of crime and place. By mapping six years of crime data using a variety of analytical techniques to highlight different aspects of patterns of high and low levels of vandalism, this research has been able to highlight how there are areas with stable low levels of vandalism and changing high levels of vandalism. These techniques could be used by anybody who was interested in looking at the dynamic nature of crime and place, not just to show broad trends but to highlight areas that are different to those around them. Such mapping techniques could therefore be used to highlight potential places that might benefit from further qualitative based research enquires, such as inviting local residents to make their own crime maps of an area, or narrative based interviews with residents who have lived in an area. Crime maps do not need to be just confined to researchers interested in finding particular areas for targeting a particular situational crime prevention response, instead criminologists and researchers should also consider how they could potentially innovatively use crime mapping to select areas for further case study work.

This research suggests there are ways of increasing understanding of crime and place by combining crime mapping with focus groups. Very rich research data was obtained in focus groups encouraging focus group participants to annotate maps themselves and then to talk about which areas they were highlighting as areas with high and low levels of vandalism. The maps helped to put the focus group participants in the local place context, and since participants were talking about a commonly known space it seem to encourage them to expand on their perceptions of levels of vandalism in the area. Focus group participants appeared to find the process non-threatening perhaps because they were being approached to share their expertise about areas they knew and using maps seemed to facilitate this well.

Mapping results can be a good way of making findings more accessible and opening them up to debate (just as Booth did with his results at the start of the 19th century). In this research using existing crime data alongside maps local Community Police Officers had annotated themselves, and comparing similarities and differences between different mapping visualisations led to some very interesting discussion about why things had changed or stayed the same. The provision of maps as a visual aid provided a very useful way of opening up discussion. This again suggested that crime maps can be used as a lot more than a method of monitoring police performance, or counting levels of volume crime, but instead could be used as a potentially innovative way of understanding local constructions of place. For example, in this research, questions about why certain areas appeared to have stable levels of high vandalisms, led to discussion in focus groups about perceptions of those places as communicated by local residents to community Police Officers. Crime maps are definitely not just for those interested in crime science as Ron Clarke suggested in his provocative essay (Clarke, 2004).

7.1.3 Simple and pragmatic is not sufficient, (neither is qualitative or quantitative only research)

This research suggests that there is a potential to present combinations of more complex techniques to a range of audiences by using appropriate visualisations This research used some reasonably complex quantitative techniques that went well beyond more simple kernel density estimation (KDE) based hotspot mapping often used by local police forces. Using more complex Local Indicators of Spatial Autocorrelation (LISA) techniques such as Local Moran's I and G_i* enabled both high and low areas of vandalism to be highlighted, whereas the simpler KDE maps were not able to highlight this as effectively. Increasing complexity in techniques used by combining LISA analysis along with Group Trajectory analysis led to additional useful techniques. By using maps it was possible to present reasonably complex findings in an accessible way, for example group trajectory analysis allowed patterns of vandalism across 6 years to be summarised in a single map. Complex techniques do not have to be presented in complicated ways; this research suggests good visualisation using maps has the potential to open up ways off sharing more complex results, without losing the detail, but without making the research inaccessible. Simple analysis may not always be the best way of getting analysis out to policy makers, though it is obviously important to present results as clearly and concisely as possible.

The cultural criminologists are right in that we also need a nuanced understanding of the complex nature of place but this research suggests that it can be possible to represent and highlight complexity using quantitative methods. The map based visualisations used in this research, although based on number, were able to demonstrate complex relationships between vandalism and place. However, this research strongly suggests that cultural criminologists are wrong to suggest, as some sometimes have (for example Hayward, 2007; Ferrell et al, 2008; Young, 2011), that there is often little value in doing quantitative research at all. There is a place for quantitative models, and though they may need to be quite complex, well presented results can be made accessible. This research has relied heavily on number based analysis, but has used it creatively in map based visualisations. Thus number based analysis can capture complex and dynamic relationships, but to do this the underlying analysis may need to use more complex rather than simpler techniques to highlight the micro of processes at play.

It may also be very important to supplement number based analysis with qualitative based research. Thomas Huxley wrote of

> "The great tragedy of Science – the slaying of a beautiful hypothesis by an ugly fact"(Huxley, 1843-4) [18]

Ugly facts are important, and a single outlier or quote from good qualitative research can potentially overturn hypotheses that are supported by previous number based analysis. This research did not generate any particularly ugly facts from its complementary qualitative analysis, however focus groups were able to raise interesting questions for further research, especially around the process of advanced marginality and the potential disruptive nature of regeneration in communities, that would not have been highlighted purely by number based data. Equally some comments in focus groups encouraged re-examination of number based data for evidence that complemented or contradicted comments from focus groups. This research strongly suggests that quantitative and qualitative research should be seen as complementary processes.

7.1.4 We need both micro level and macro level analysis

This research suggests that it is not enough to try to understand the relationship between crime and place by focusing purely on either micro or macro scales. Micro scales have the problem that they are too specific, you may end up focusing on factors having an effect at the very localised level such as the environmental backcloth. Factors such as locations of a particular school, bus-stop, hang out point, or shop selling alcohol do matter for understanding relationships between crime and place, but by only considering these micro factors this may miss the importance of additional factors such as differing levels of relative deprivation that may be in place due to policies imposed by governments and economic systems operating at a broader macro level. Qualitative research focusing on factors such as the lived experience of individuals in a place and other cultural factors, is also not likely to get at the complexity of the relationship between crime and place, since this relies on specific case studies of a number of individual experiences, and whilst this can highlight some very important micro and macro processes, it cannot highlight broad trends across an area in the way that number based research can. What is needed therefore is a mixed method multi-level approach that appreciates the value of place based context by using both quantitative research undertaken at multiple scales, and qualitative research that has the potential to highlight interesting, stimulating and ugly facts.

[18] (Huxley, 1893-4, Collected Essays 'Biogensis and Abiogensis' in Oxford Dictionary of Modern quotations, 7th ed, Ed Elizabeth Knowles (2009) online version 2012 accessed 29 March 2013)

7.1.5 Debating the Methodological Limitations

The research uses recorded crime data which may underestimate the level of actual vandalisms. It may also mean that if an area has a hotspot of crime in one year this might be because a high volume of crimes were recorded in that location; there could be other locations where high volumes of vandalism also occurred but these were not recorded in that year. By looking at data for six separate years any failure to report or record, or conversely over-reporting is partly controlled for, if these were isolated incidents, but this does not protect against an area which continually under-reports vandalism year on year. There was some suggestion in focus groups that there was a certain level of apathy and 'getting used to' certain behaviour which might have led some vandalism to not be reported, however this was felt to be in areas which already had higher levels of vandalism, and it was felt that in areas of consistently low vandalism residents would be more likely to report a crime of vandalism because these were unusual rather than the norm. If this was the case then the scale of difference between high and low areas would be greater, but it would still be the same areas that had high and low levels of vandalism, just the high areas would actually be even higher.

Consideration was given to using data from the Scottish Crime and Victim survey, however due to both sample size and confidentiality requirements this data is only currently released in request at intermediate geography level (Fohring, 2012). This was too coarse a level to enable study of micro levels effects which was one specific factor this research wanted to be able to consider in order that the broader micro / macro debates within criminology could be addressed.

Focus groups were only held with Police Officers. The positive aspect of this was that as trained observers Police Officers were able to provide considerable detail and comprehensive insights about local areas. The potential negative aspect is that the opinions of Police Officers would have been subject to bias built up over years spent within police culture. There is much research (Newburn & Reiner, 2012) that demonstrates that Officers, especially more experienced Officers like those questioned here, can build up accumulated stereotypical views of people (and therefore potentially places too) developed as a result of their immersion in police culture. This research could have been improved by holding focus groups with local residents and other community actors, whilst responses of others who were not Police Officers could have been similarly biased by the lens of their experience. Holding focus groups with a greater diversity of individuals might have provided a broader picture of the case study areas under consideration.

Sample size may have been too small to spot small effects at neighbourhood level - sample sizes of OA 445, possibly too small to see small effects, sample sizes of around 200 OAs (EdinburghA – 213; EdinburghB - 217) at neighbourhood level may only be able to detect large effects. At grid level, sample sizes were larger (2094 in the case study area). However once divided into subgroups by group trajectory analysis for the Multinomial regressions, numbers per group at grid level were even smaller. A larger study on a larger scale could correct this, but would be more costly to undertake than this research has been.

This study could have done more to investigate the partition aspect of the modifiable areal unit problem by using differently partitioned zones at the same scale. It could have also better controlled for which effects were due to scale and which due to partition by ensuring that areas created with a similar zoning strategy were analysed at multiple scales. The design of this study did not allow this to be fully investigated. Expanding the study design would have additional complexity to the study and added an extra layer of results to analyses to explain and therefore would have widened the studies scope considerably. However, had this been done, it would potentially have been easier to interpret results as it could have been possible to highlight how scale and partition was either similarly, or differently impacting on results.

As discussed above, this study could have done more to control for the effects of spatial autocorrelation and the small number problem when undertaking trajectory analysis and related multinomial regression. At the time the study was undertaken there were no existing methodologies which fully controlled for these factors when these techniques are used together, and group trajectory analysis coupled with multinomial regression was selected as it had been used by a number of researchers in this area. However methods are now being developed which explicitly control for these problems (Law et al, 2013) and should be considered for use in future research.

The research is partially reliant on the inherent data quality of the police recorded crime data used. It has assumed that the data is of sufficient quality for this research and has been recorded accurately enough for the scales it has reported at. There was a trade off between meeting data protection needs of the police and not asking for additional detail in the data not required for research, and receiving data in sufficient detail. This does mean that some of the variability in the data observed at the micro level could in part be due to variations in the accuracy of the geocoding or addressing of the data. It also meant that it was not possible to look at concentrations of vandalism on a street by street basis as it was not possible to be sure accuracy of data was sufficient to undertake analysis at this scale. However, it was felt that since police recorded crime data is currently the only source of local data which allows levels of crime across a very localised area to be analysed, it was important to use this data. Police crime data was also the only data source which allowed change of time to be considered at a grouped hour, daily and monthly level. Consistency of findings year on year in this research, which found similar high and low vandalism areas across years, appears to support the contention that the data are sufficiently reliable for at least spotting broad neighbourhood trends. If there was poor data recording then results might be expected to be more arbitrary than those observed.

Apart from the crime data used, this research was reliant on quality and availability of other secondary data from Scottish Neighbourhood Statistics. This is a challenge that faces all researchers and analysts. There is a strong argument for not using secondary data and only using data you have gathered yourself. You can ensure that data you gather yourself specifically answers the research questions you set rather than using data that was collected for some other alternative political or governance purpose, and then trying to use it as a proxy for your particular area of inquiry. This is a very valuable point, but gathering your own data is either very costly if you have a large sample, or if you have a smaller sample runs the risk that it will not be easy to replicate the results outside of your study area. The secondary data used here has the advantage that it was all national Scottish data freely available to researchers and analysts. It was available for all parts of Scotland with clear metadata setting out the way in which the data was obtained, it was also data that had been independently assessed by statisticians and deemed to meet a sufficient standard to be released as local neighbourhood statistics by the Scottish Government. Limitations to the data are made publicly available in metadata published on the website. Despite, and perhaps because, of these limitations this research has raised some very interesting methodological implications of doing research into crime and place

7.2 Theoretical Implications

7.2.1 Vandalism the place crime

This research has focused on which places experience vandalism and which do not, and in doing so it has suggested that to understand vandalism we need to understand not just what type of property is damaged, but broader place based contexts. This is not to deny that certain types of property might be more likely to be a target of vandalism than others, but to fully understand the impact of vandalism it is both necessary and helpful to broaden out our understanding to consider which places vandalism occurs in. This research has shown clearly that vandalism does not just occur randomly across space. Instead particular locations were targeted. Three main types of locations were identified, the High group, Drifting areas where levels of vandalism varied across years, and the Low group which had consistently low levels of vandalism year on year. The Drifting areas tended to be either Drifting High areas or Drifting Low areas. Drifting High areas tended to have levels of vandalism around the average rate for the area, with pockets of high levels of vandalism the locations of which varied over time. Drifting Low areas tended to have a mixture of levels of vandalism and average levels of vandalism, but very few or no areas with high pockets of vandalism.

When Police Officers concerned with neighbourhood policing were asked to describe characteristics of places that had high and low levels of vandalism although they did mention certain types of property which were targets of vandalism they often spoke of more complex interactions. Place is a multi faceted thing. It was these multiple qualities of place that were reflected in Focus Group explanations as they discussed why some places had high levels of vandalism and others did not. The vandalism process is in fact part of wider interactions between person and place. If we only think about the property aspect we potentially neglect the place aspect. This research suggests that it was not just the nature of objects present that influenced where vandalism occurred, but more broadly the nature of place(s) which influences vandalism.

Conceptualising vandalism as a place crime is a very helpful thing to do because it automatically signals that vandalism is a complex crime. If we oversimplify then all we do is make assumptions and overlook important things. In this case you need to reflect that vandalism is about a lot more than just something getting broken or damaged, it is also about the person who chooses to damage something and the place where they choose to do that in. The nature of a place does appear to have an impact on levels of vandalism.

Conceptualising vandalism as a place crime gives the opportunity to go beyond just the type of property damaged and who it belongs to, to think about the wider nature of where damage occurs, when it occurs, the relevant neighbourhood contexts and who might be doing this damage and why. For each of the groups of areas experiencing vandalism, High, Low and Drifting High and Drifting Low, each of these areas had distinct contextual factors influencing levels of vandalism. These factors link directly to theories of crime and place. The particularly relevant theories appear to be routine activities theory, theories around relative persistent inequality, and theories relating to use and abuse of space and community interactions. How this research supports and challenges these theories is now discussed in turn.

7.2.2 Revisiting routine activities and the everyday

Reconceptualising routine activities theory alongside long term life paths of people and places allows for an appreciation of the lived experience of people in places, which Keith Hayward felt had been lost (Hayward, 2007). It is time for other theorists within criminology and sociology to consider the benefits of adapting the routine activities approach alongside other existing broader structural theory. It has the potential to bring together macro and micro elements. An expanded routine activities theory can provide a framework within which to study the complex feedback loops, sometimes being played out across decades and generations that seem to be influencing the interaction between people, crime and place. Finally an expanded routine activities theory also has the potential for taking into consideration structural factors such as persistent inequality.

This research strongly supports this contention that the routine and everyday has strong effects on crime and place and strongly supports the idea that to understand why certain places have high levels of vandalism, you need to understand the routine activity context of those places. Daily and weekly routines are extremely important especially when considering the very micro scale impacts of vandalism. This research also suggests that it is not just a narrow but a broad concept of routine activity that is needed. Routine activities need to be understood not just as the daily rituals of going to work or school, and going out to play in the evening and weekend.

Interestingly the original routine activities theory argues that routine patterns of human activity at *both* the micro and the macro level matter (Felson & Cohen, 1979). However, Felson describes how he then split from Cohen and chose not to develop the theory within sociology and linked to social disorganisation theory but to ally it to the work of Ron Clarke, Paul Eck and the Brantinghams (Felson, 2008). Following this alliance between routine activities and the rational choice opportunity based theories of Clarke there has been a shift to a more micro focus of daily and weekly patterns rather than patterns over decades. Routine activities theory has become more focused on controlling place, making targets, more difficult to, well, target, and increasing guardianship though better 'place managers'. It is probably this emphasis on control which has led it to receive such criticism from cultural criminologists such as Keith Hayward (Hayward, 2004). Since Ron Clarke is also very strongly linked to the concept of crime science (Laycock, 2005, Clarke, 2004) and Clarke suggested that crime science was not criminology, this may explain why routine activities is often apparently ignored by criminologists and sociologists operating outside the crime.

In chapter 1 it was argued that there are interesting but not often discussed links between the work of David Matza and Marcus Felson (Garland, 1999). Just as Matza argued that most young people drifted in and out of crime this research suggests that places may also only be temporarily 'delinquent'. To use the language of Per Olof Wikström places can be 'criminogenic' (Wikström et al, 2012) but for many of these places they may not be criminogenic all the time, instead they drift in and out of having crime problems. This research has suggested that a number of areas within the case study area did not have consistent high levels of vandalism but instead drifted between high and low.

There is no reason why criminology and sociology cannot re-embrace the routine activities approach, although this will mean reconceptualising it and leading it in a different direction from the approach that one of its originators (Marcus Felson) has subsequently taken[19]. This can potentially be done if the focus of the routine activity approach moves from seeking to control human activity in space and instead considers the routinised elements of the complex life paths of different people moving through place and constantly interacting with each other, how this might lead people and places to drift in and out of crime. If people and places are only drifting in and out of crime, then we may need to be very careful about the type of interventions we make. Too little intervention could lead a place to drift into having higher and higher types of crime, but equally too much of the wrong type of intervention could push an area into persistent high levels of crime. This research suggests that high levels of demolition and upheaval caused by mass movements of the population across an area during a regeneration process may have been one of a number of complex reasons why one area considered in this case study temporarily experienced a spike in levels of vandalism. Further research is needed to see if, with time, this regeneration intervention was worth it and if the overall levels of vandalism across the area fall permanently, or if it just caused levels of vandalism to rise temporarily and then drop back to similar levels experienced in previous years. This research also suggests this kind of change takes place over decades and potentially generations so it may only be seen by long term studies, an approach often eschewed by crime science.

7.2.3 Persistent Relative Inequality / Advance Marginality cannot be ignored

This research strongly suggests that in order to better understand why certain areas experience high levels of vandalism and others do not we cannot ignore relative deprivation. This research suggests it is not just the presence of marginalisation and poverty, but relative inequality, the gap between rich and poor neighbourhoods that is important. Whilst not all areas of high relative deprivation also had high levels of vandalism, this research showed that areas which had consistently low levels of vandalism also did not have high levels of relative deprivation. In two areas, with consistently high vandalism in the case study area, apathy and frustration caused by poor perceptions of the area were linked by comment in focus groups to why people were reluctant to try to improve things locally. These comments reflect the suggestions from existing research that the presence of advanced marginality (Wacquant, 2008) or persistent inequality (Sampson, 2012; Sampson, 2013) may effectively blight an area, it is possible poor perceptions

[19] I am grateful to Professor Richard Sparks for suggesting this possibility to me early on in my research, although I have not returned to it in detail, this research suggests that this may a fruitful theoretical approach to take.

of areas could make it more difficult for local communities to work together to solve problems potentially making crimes such as vandalism more likely.

A final interesting aspect of this research is that there is some suggestion that in areas where there is greater disparity between poorer neighbourhoods and relatively affluent neighbourhoods, the influence of whether a neighbourhood is more or less relatively income deprived has more effect. Exploratory models found that in the EdinburghA area, where there was a bigger disparity between the relatively deprived and relatively affluent areas, whether or not an area was in a 'high welfare' area appeared to have a greater impact on whether an area had low levels of vandalism compared to high levels of vandalism, than in EdinburghB. (EdinburghB had overall higher levels of poverty than EdinburghA, but the difference between the most deprived and least deprived areas was less than in EdinburghA). If this finding can be replicated in other research then it suggests that it is not just the presence of marginalisation and poverty, but relative inequality, the gap between rich and poor neighbourhoods that is having most effect.

It is not clear from this research exactly what the links between persistent relative inequality and vandalism are, but this research strongly indicates that these links *do* appear to exist, and need to be better understood *alongside* our continuing understanding of routine activities and more practical and pragmatic short term approaches to preventing vandalism. Just as those working in the academic schools of sociology and criminology should re-embrace routine activities, so those working in the field of crime science should consider inclusion of the effects of inequality in their analysis. Ron Clarke has suggested those working in crime research should abandon (or at least give much less weight too) arguments around how crime is a product of "discrimination and disadvantage" (Clarke, 2004, 58-59); this research suggests that disadvantage (in the form of persistent inequality) remains an important factor for criminologists to focus on. Excluding the effects of inequality may cause bias in research findings in the crime science sphere. At a minimum, the effects of relative inequality need to be controlled for when evaluating short term crime reduction efforts; in the longer term, consideration needs to be given to whether making society more equal and giving communities currently marginalised a sense of hope and a way out of persistent inequality could potentially lower levels of crime. This is ultimately a political debate and will be considered further in the advice for policy makers section below.

7.2.4 Reflections on micro to macro processes - Community Interactions matter

This research suggests that both micro and macro community interactions have an impact on why varying high levels of vandalism occur in some places, and consistently low levels of vandalism occur in others. Examples of micro interactions mentioned by focus groups were precise locations young people chose to gather and not to gather. These micro interactions mentioned in focus groups were reflected by micro changes in the distribution of levels of police recorded vandalism, year on year, which could possibly be explained by changes in locations where people chose to hang out.

This research deliberately chose to focus on the nature of place rather than individuals' characteristics, nevertheless people were frequently mentioned in discussions in focus groups. Comments in focus groups strongly suggested you cannot divorce a person from place, or place from person when considering vandalism. Both interact closely with one another. Officers did not just talk about where there were high levels of vandalism but the actions and community interactions going on in these places that they thought were having an effect on levels of vandalism. Findings from both the focus groups and the exploratory multinomial logistic regression models suggest some of the person and place interactions had effects that were situational (for example local levels of guardianship). Some interactions had effects could be seen as both situational and cultural (for example conflicts over the use of places). Some interactions were influenced by factors best described as structural (perceptions of advanced marginality).

It was not possible to measure the presence of collective efficacy - how the community worked together to solve local problems, or measure local perceptions of areas quantitatively (at a local level) due to a lack of appropriate local indicators; it therefore was not possible to test for the significance of this or control for it in by exploratory modelling. However evidence from focus groups suggested that areas perceived by Community Officers as having low levels of vandalism (that were also found through quantitative modelling to have low levels of recorded vandalism year on year) were also perceived as areas where the community was potentially more likely to complain to local authorities if they saw vandalism occurring, and also areas where people tended to work together to improve things. Whilst this research was unable to present definitive quantitative evidence to support the collective efficacy thesis, there were plenty of comments in focus groups that suggested it is likely to be an important factor in understanding crime and place, and certainly no suggestion that collective efficacy was not relevant.

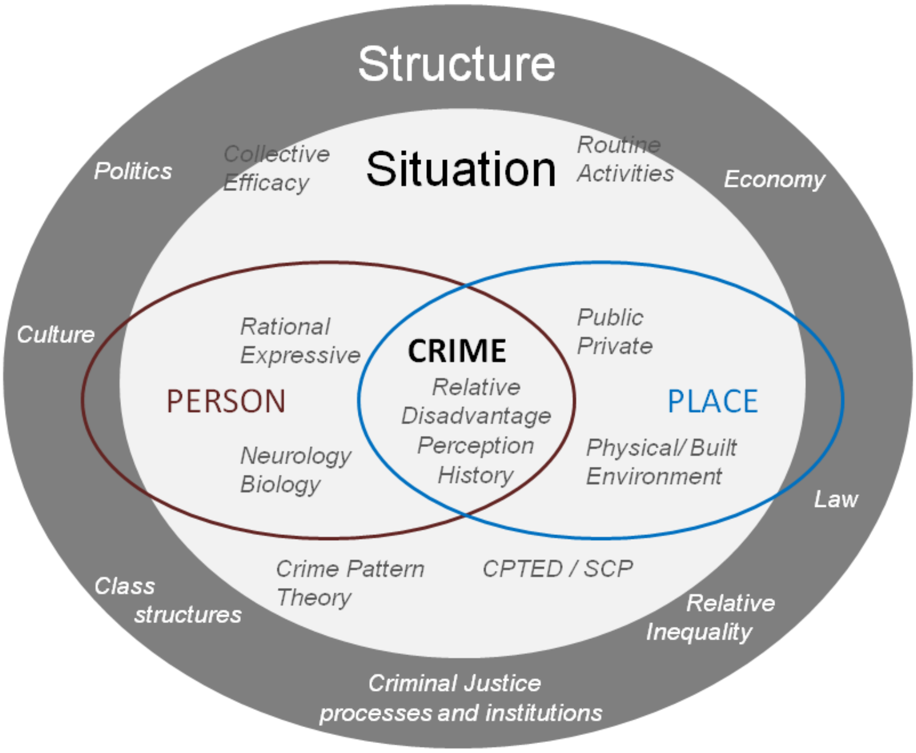


Figure 7.1 – The Structural and Situational (Macro and Micro) Theoretical framework for crime and place

The evidence of this research suggests that is not enough theoretically to look at just macro or micro theories of place. Instead we need an integrated theoretical framework that respects that both structural, cultural and situational factors all play a role in understanding why low level crimes such as vandalism occur in some places and not others, and why some people choose to commit vandalism in some places and not others. Figure 7.1 tries to capture a more holistic view of these interacting factors. This is a framework that respects both situation and structural factors and understands that these factors will overlap across both space and time and by doing this makes room for both structural and situational theories, as well as theories from developmental criminology and cultural criminology that highlight why people may choose to commit crimes in certain places.

7.2.5 Debating Theoretical Limitations

The key limitation of this research is that it has looked at where vandalism occurs not who does vandalism. This research is therefore unable to contribute further on what might motivate people to commit vandalism as it has not studied which people commit vandalism specifically. Focus groups suggest that people, who were younger, frustrated and those who consumed alcohol were likely to be involved in vandalism. However the research did not specifically look at who offenders, involved in vandalism in the case study area, were or interview any of them. The research is therefore unable to contribute to the debate on what makes a person more likely to commit vandalism than another (propensity). This research is however able to contribute significantly to a discussion about the types of places which experience vandalism and how this supports or detracts from current theories of crime and place, thus filling an important gap in existing research into vandalism.

7.3 Policy Implications

7.3.1 Treat vandalism as a place crime not a property crime

This research suggests that policy makers should consider treating vandalism as place crime and not a property crime. What does this mean in practice? It means that to understand why some areas have high levels of vandalism, why some areas have drifting areas of vandalism and other areas consistently low levels of vandalism will need the whole context of place to be considered. This can be done by focusing on both localised micro and broader neighbourhood contexts. It is important to concentrate on how the nature of places in which vandalism occurs may contribute to levels of vandalism in the area, not just to think about the physical property that is targeted. This chapter now goes onto suggest ways in which this might be done in practice.

7.3.2 Value the opinions of those on the ground (Micro matters)

It will be important to listen to reports about the nature of a local area from people who work and live in the local community. It could be useful to bring together people who work in the local area such as Community Police Officers, Teachers, Health workers and Community Wardens. These people could be shown maps of where there are high levels of vandalism and low levels of vandalism and asked to comment on the nature of these areas. Local analysts could, with permission, note or record these conversations and then look for common factors arising in high and low areas. These summaries should again be taken back to those working on the ground, and could be used as a set of talking points for developing local policies for reducing levels of vandalism in local areas.

7.3.3 Consider broad trends across your area (Macro matters)

In addition to paying attention to the views and experience of those working on the ground it is important that research and analysis is undertaken that can show broader trends across time. This research strongly suggests that across time there will be places where there are high levels of vandalism, places where there are consistently low levels of vandalism, and places where levels of vandalism drift between high and low over time. It will be important to undertake analysis to identify where these areas are likely to be. Once the broader contexts of these high and low vandalism areas are identified, factors common to Consistently Low areas of vandalism can be noted, and consideration given to how these conditions could be encouraged or replicated in areas currently experiencing higher levels of vandalism. Identifying areas with high levels of vandalism across time also usefully can highlight areas where resources aimed at preventing vandalism should be focused.

7.3.4 Have staff who can interpret and explain quantitative research

To fully identify High, Low and Drifting areas of vandalism and potential factors driving this it is likely that quite complex quantitative models will need to be constructed alongside equally important qualitative research. It will therefore be important to train researchers and staff to undertake, or at least be able to understand results of some more complex research techniques. It will be important that some local authority staff and police analysts can act as professional interpreters of more complex research to those with a more lay understanding. This means it is very important that those involved in producing policy on crime and place have at least some staff who can undertake this role.

7.3.5 Long term and short term goals needed (micro, macro and temporal solutions all needed)

This research suggests that local street level situational factors such as presence of schools or businesses can impact on levels of vandalism. These are the kind of factors that can be best understood from local intelligence and may be successfully dealt with by rapid local response. However, this research also suggests that more long term factors may be at play, such as within a given year where do local teenagers choose to hang out and how does this change year on year as different generations grow up and move on. Other complex factors that have built up over generations such as areas where residents have been on low incomes and without jobs for many years may also affect levels off vandalism These problems will need much longer term and complex political responses. It will also be important for the effects of local interventions to be monitored and appraised. Policy makers might find it useful to consider what steps can be taken in the short, medium and long term. Short term steps may include consideration of what situational crime prevention measures could reduce vandalism on a given street; medium term policy steps could involve better understanding the needs of local young people especially in terms of what space they need for socialising and play, and long term policy development may involve consideration of how the gap between the affluent and not so affluent can be reduced.

7.4 Additional Research needed

This research makes clear that many unanswered questions remain both regarding vandalism and more widely the interaction between crime and place. This research suggests that both situational and structural factors are impacting on vandalism. Like much exploratory research it flags up interesting questions that need further research. Key questions coming out of this research from a theoretical perspective are:

1) There appears to be a relationship between vandalism and persistent inequality, but which matters more, which communities are the most marginalised, or in which areas is there the biggest gap between rich and poor? Are high levels of vandalism most likely to occur in places where there is a significant degree of marginalisation, or are they most likely to occur in places where residents are most aware of the discrepancies between rich and poor neighbourhoods? Within Scotland further research could be undertaken looking at neighbourhoods where there are clear sharp delineations between relative levels of inequality compared with areas where the overall level of affluence across the community is similar and seeing what the impacts of these differences in relative inequality are on vandalism.

2) This research shows that routine activities have clear effects on levels of vandalism, but which routines are the most important, daily, monthly or annual routines, and whose routines, young people or adults? What about long term life path routine activities, for example as young people grow up and get a job and move in and out of places, how do these long term routines interact with changes in levels of vandalism in places? All these question require additional research

3) This research suggests that areas with vandalism can be usefully divided into areas with High levels of vandalism, areas where levels of vandalism Drift between high and low and Consistently Low levels of vandalism. It would be very useful to replicate this research in other case study areas within Scotland and elsewhere to see if these groups are relevant across the nation. Further explanatory research is also needed to assess what are the risk and protective factors that make an area likely to be either a High or Low vandalism area, and what triggers push drifting areas to the high or low ends of the scale.

This research has used crime mapping techniques to highlight the relationship between crime and place. It has not specifically tested how accessible the maps generated through LISA and group trajectory analysis are to policy makers. It would be useful to investigate how easily these more complex techniques can be understood and utilised by those making operational and policy decisions. This research suggests that we need to be able to look at multilevel, spatial and temporal effects to better understand the relationship between crime and places. What is therefore needed are multi-level models which include ways of accounting for both spatial and temporal effects. These models will need to be quite complex statistically, but that is perhaps not surprising given the complexity of patterns of vandalism highlighted by this research. Some research is currently ongoing in this area, by researchers such as Ralph Taylor and John Hipp (Taylor, 2010). This research suggests that further development of these techniques will be vital for improving our understanding of the relationship between crime and place.

We need to become better at assessing localised risks that may make crime more likely in some areas rather than others. Risk terrain modelling provides both a theoretical structure and clear methodological approach to assessing what might be potential crime risks in a particular place (Caplan et al 2011). So far research using this technique has predominantly be done using American data, it would be useful to see if this technique can be usefully transposed to a United Kingdom and specifically to Scotland given the increasing amount of local data being made available publicly through the Scottish Neighbourhood Statistics site. Also can this technique be coupled to this existing research into vandalism to predict past patterns of levels of vandalism, and thus suggest whether it might be useful for predicting future risk?

This research suggests there is great further potential in combining group trajectory analysis with LISA analysis. However, this research has used these methods on an exploratory basis. Further consideration is needed into how to best assess statistical significance when combining these techniques and whether there are any potential problems mathematically with combining these techniques. Specific issues such as multiple testing, spatial autocorrelation and the small number problem can skew LISA statistics and there is uncertainty about the best way to correct for these problems. Further research is needed to consider how best to do this; interesting work in the field of using geostatistics for assessing crime concentrations (for example Kerry et al, 2010) should be further developed. Work by Law et al (2013) suggests promising new techniques are being developed to enable us to look at changes in levels of crime over time, in particular places, which take account of issues such as the small number problem and spatial autocorrelation when using trajectory models. Their research suggests that taking a Bayesian approach to inference in trajectory analysis may be advantageous. These approaches should be further investigated along with further research into the best ways of correcting for statistical noise, and producing visualisation which can highlight degrees of uncertainty about results.

Finally this research highlights the value of qualitative research for highlighting 'ugly truths' and interesting facts. It is very important that research around the cultural understandings of place and how they relate to crime continues. Quantitative researchers on crime and place should be prepared to consider how findings from more qualitative and ethnographic research can and should influence the hypotheses they prepare for testing in their explanatory research.

Appendix 1 – Example Consent Form

This research is being conducted as part of a broader study aimed at exploring the place and time dynamics of vandalism. The study is part of work for a PhD in Criminology at the University of Edinburgh. The research is funded by a research grant from the Scottish Centre for Crime and Justice Research (SCCJR). The aim of this phase of the research is to better understand why some places experience persistent vandalism year in year out and some places do not. The focus group will be conducted by Ellie Bates, the researcher. This focus group will be confidential; and transcripts will be anonymised.

Please can you read the following statements and state if you agree.

I have been given a summary of the wider research project and been given an opportunity to ask questions about the research	Yes / No
I understand that participation is voluntary and I am free to leave the focus group at any time	Yes / No
I agree that this interview will be recorded and the audio recording will be retained until the end of the research project when it will be destroyed.	Yes / No
I agree that the audio recording will be transcribed into an anonymised text document and this transcription will be retained with the background papers of the research project.	Yes / No
I agree that my name and any names of other personnel I mention will be removed from the transcript and alternative names used to protect anonymity	Yes / No
I agree that the name of the organisation I work for, and a brief description of the type of work I do will be stated in the research write up.	Yes / No
I agree that sections selected from the transcript, selected at the researchers discretion, may be used in any publications, papers or presentations arising from this or related research projects	Yes / No

I agree my employment position can be described in the research as

....

I agree to take part in this research study

Signed...

Date...

Appendix 2 – Project Proposal

Research Proposal for Research into Persistent Vandalism in Edinburgh with Lothian and Borders police.

Introduction

This research is intended to form part of the core research for a Criminology PhD project exploring the Place and Time Dynamics of Vandalism. The overall aim of the research is to develop a richer understanding of the causes and mechanisms of persistent urban vandalism. The research has a particular focus on place, and seeks to answer the research question:-

> Why do some areas experience persistent vandalism problems whilst others do not?

The researcher proposing to do the research is Ellie Bates a PhD research student at the University of Edinburgh. My contact details are: [email], Mobile: *********. The PhD is being supervised by Susan McVie, School of Law and William Mackaness, Institute of Geography, School of Geo-Sciences. It is funded by the Scottish Centre for Crime and Justice Research (SCCJR).

Assistance Sought

The following specific assistance is requested from Lothian and Borders police

- Phase 1A: Permission to run 3 focus groups, 1 pilot group with senior officers (2 officers minimum) and 2 focus groups with community officers (8 officers, minimum 4 per group) in [StudyArea] section of ? division.
- Phase 1B: Access to recorded crime offence data and permission for a named person to be identified who can liaise with the researcher to clarify any queries she has on the crime data supplied. All data supplied would be stored securely and encrypted.
- Phase 2: Permission to hold a further feedback / knowledge exchange meeting where findings from focus groups and analysis of crime data is fed back to research participants and other interested officers.

After the initial first two phases are complete it is intended to carry out a third research phase. This will be informed by findings from the first two research phases. Any assistance required from Lothian and Borders police for this third research phase will be sought separately at a later stage. Further details of the proposed research are given below. It would be hoped to start the first two phases research as soon as possible, with phases 1 and 2 of the research being undertaken between July and October 2010.

Case study area

The proposed study area is the East Neighbourhood Management area of Edinburgh comprising the Neighbourhood Partnership areas of [EdinburghB] and [EdinburghA]. Both these neighbourhoods have high and low concentrations of relative deprivation and vandalism.

Feedback

A short interim report summarising findings would be supplied on completion of Phases 1 and 2; on completion of the PhD a report highlighting key findings from the thesis would also be supplied to Lothian and Borders Police. At least one presentation of key findings would also be given.

Background and potential benefits of research

Vandalism is a problem for many communities across Scotland negatively affecting the lives of people who live in them. Whilst there has been recent research into the broad phenomena of anti-social behaviour, there has been very little recent research into the more specific phenomena of vandalism. In particular, little is understood about why vandalism often persistently re-occurs year in year out in particular locations. Wider research into crime and place suggests that, opportunities to commit crime, levels of relative deprivation, and the capacity or belief that a community can work together may be relevant factors. Some recent theories suggest some areas may act as crime attractors or be more criminogenic than others. There is a strong need for a better understanding of why certain places experience persistent vandalism and others do not. Vandalism is a volume crime with a significant impact on crime statistics and therefore reducing levels of police recorded vandalism will obviously impact police performance figures. For local communities, vandalism is recognised as a signal crime, therefore an area with relatively high levels of vandalism may lead local people to perceive there is a crime problem in their area, even though this may not actually be the case. Whilst vandalism can sometimes occur in areas of high crime, gang activity or where there is a ready supply of alcohol, it is also possible local vandalism may not in fact be due to a wider crime problem but might just be due to high numbers of young people living in the area (a proportion of whom vandalise things), or that the design of buildings or street furniture in a specific area offer particular opportunities for vandalism.

There is currently limited research and guidance as to which of these factors might be most likely. There is therefore a need for police and other partners working with the community to be better able to understand, represent (including through mapping vandalism and other characteristics of an area) and potentially explain why certain areas are subject to vandalism. Research is needed that looks at both areas that have persistent vandalism problems and areas which do not; such research can enable lessons to be learned from both. It is hoped this proposed research can contribute to such an understanding and therefore assist police and their partners working with local communities to develop policies to both counteract vandalism, and also, where appropriate, reassure local people about the nature of vandalism in the area in which they live. It is therefore hoped that this research can be of direct use to Lothian and Borders police officers and staff, and staff in partner organisations concerned with community safety and directly involved in Community Policing.

Research Questions

The key question this research is seeking to answer is: why do some areas experience persistent vandalism problems whilst others do not? It can be broken down into a series of sub-questions:-

1) How do those working in policing and managing or otherwise actively involved in the community these areas define a persistent vandalism problem?

2) Which areas do they perceive has having a high or low persistent vandalism problem, and how does this compare with recorded crime figures for vandalism for the same areas?

3) What are the characteristics of areas identified as having either a high or low persistent vandalism problem, both as identified by those working or living in the area, and as can be identified from published secondary data from government and local government sources about these areas?

4) Based on this information how best can we visualise, and in particular produce maps of persistent vandalism that can help us understand, explore and consider solutions to the problem?

5) What variables are most appropriate to consider in order to produce a model which can seek to usefully predict which factors are most likely to affect whether an area is likely to have a persistent vandalism problem or not?

Choice of study areas

The proposed study area is East Neighbourhood Management area of Edinburgh comprising the Neighbourhood Partnership areas of [EdinburghA] and [EdinburghB]. Both selected areas have pockets of low and high relative deprivation (see for example Figure 1).

{Map removed as it clearly labels Study Area}

Figure 1 – Population that is Income deprived (2008) shown mapped based on the population –weighted centre of each Edinburgh data zone (the same geographic unit as used for the SIMD)

Crime data on vandalism, used in deriving the crime domain of the Scottish Index of Multiple Deprivation (SIMD), published through the Scottish National Statistics website, suggests that proposed study areas also had concentrations of both high and low levels of vandalism in 2007/8. Interestingly by mapping the same data on the number of recorded Group 4 vandalism crimes as either a rate per hectare – (Figure 2 - a crime density measure), or as a rate per those aged 10-19 (Figure 3– mapping with reference to an age group that is potentially likely to engage in vandalism), two rather different maps result. This suggests the selected study areas will enable issues, around the nature of the vandalism crime problem in particular places and how best to represent it, to be usefully examined.

{Map removed as it clearly labels Study Area}

Figure 2 – Vandalism (Group 4) 2007-8 as a standardised rate per unit area in hectares, – mapped as a value across each Intermediate Geography

{Map removed as it clearly labels Study Area}

Figure 3 – Vandalism (Group 4) 2007-8 as a standardised rate per population aged between 10 and 19, – mapped as a value across each Intermediate Geography

The figures presented above use a technique using an indirectly standardised ratio sometimes known as excess risk mapping or a standardised offence ratio (SOR); in these figures the observed value has been divided by the expected value based on the City of Edinburgh rate, thus a value on the key of 0.25 is one quarter the City of Edinburgh rate, a value 1 is the same as the City of Edinburgh rate, and a value of 4 is 4 times the Edinburgh rate.

Consideration of reported results of the Edinburgh Annual Neighbourhood Survey for 2007 and 2008[20] suggests in [EdinburghB], (an area which appears to have high levels of relative deprivation and vandalism), levels of satisfaction with how neighbourhood issues are dealt with, and the positive perception of how the community can influence decisions seems to have improved rapidly whereas in [EdinburghA], (an area with apparently lower levels of relative deprivation and vandalism), overall satisfaction levels with the neighbourhood and the perception the community has an influence over decisions seems to be decreasing. Including an area where neighbourhood satisfaction maybe increasing and another where neighbourhood satisfaction may be decreasing, is also useful for the study, particularly when considering the possible role of community cohesion.

Proposed Methodology

Phase 1A – Focus Groups

Focus group lasting for about 60 – 90 minutes where those attending will be asked to annotate a map to show which areas they consider to have both high and low levels of persistent vandalism. Participants will then be invited to consider characteristics of these areas and the discussion will be recorded. Participants will be asked to sign a consent form before the focus group begins to ensure they are giving informed consent to the research process. 1 pilot focus group and 2 focus groups are proposed.

- Pilot Focus Group: [Study Area]NMA
  1 focus group with at least 2 senior officers for the East area to pilot the methodology (and also so more senior officers can be introduced to the research process)

- Focus Group 1:- [EdinburghB] Neighbourhood Partnership / Ward
  A focus group with a minimum of 4 community officers with experience of policing the [EdinburghB] Ward Area – ideally officers will between them have experience of policing all sections of the ward.

- Focus Group 2:- [EdinburghA] Neighbourhood Partnership / Ward
  A focus group with a minimum of 4 community officers with experience of policing the

[20] Final reports produced by the Customer Research and Information Team and published by City of Edinburgh and available to download at www.edinburgh.org.uk

[EdinburghA] Ward Area – ideally officers will between them have experience of policing all sections of the ward.

Phase 1B - Analysis of crime data

Access to recorded crime data on recorded vandalism for the [Study Area]Neighbourhood Management areas would be requested. The vandalism offence codes requested would be the Group 4 offences as used in the SIMD 2009 (a list of the relevant SCJD crime codes is supplied in Appendix 1). The recorded crime data requested would be for the period 1st April 2004 to March 2010. The following minimum fields from the data would be ideally be required:

1) A unique identifier – e.g. crime number (to enable queries about specific data quality issues for a record to be chased up)

2) Scottish Government Justice Department crime code Time and date crime occurred at or between (e.g. date from, time from, date to, time to)

3) The locus of the offence supplied as easting, northing, and where available postcode(full address is not required for research and therefore it is preferred that this data is not supplied however by supplying the postcode it will be possible to do a simple data quality check to check if the grid reference matches the unit postcode area supplied, it will also be possible to see how many records were without postcodes, this will enable any potential data quality issues to be raised)

4) An identifier that can be used to identify any crime records that have been subsequently classed as not crimes so these records can be removed for analysis purposes.

It would also be requested that a named person be identified who can liaise with the researcher to clarify any queries on the crime data supplied.

The crime data on vandalism would be analysed and mapped using three mapping styles– standardised ratio choropleth maps at data zone level – similar to Figures 2 and 3. Hotspot maps using the Kernel Density Estimation (KDE) methodology and NNHC – Nearest Neighbour Hierarchical Clustering. This would enable concentrations of police recorded vandalism to be highlighted and then compared with areas officers had highlighted in focus groups.

There would be analysis of how findings from the focus groups in Phase 1A and crime data analysis above compare with available relevant government and local government published secondary data sources.

Phase 2 – Collation of Findings and Feedback to Participants / Knowledge Exchange

Following analysis and collation of findings a further meeting of up to 2 hours will be held where findings from these 3 focus groups are jointly reported back to officers involved in the focus group and any others (e.g. senior officers and crime analysts) who wish to attend. Those attending would be invited to discuss and feedback on the findings and would be consulted on what might be the most useful area to concentrate the further research in. At the feedback meeting some basic crime maps showing concentrations of vandalism based on recorded crime and some publicly available data on information on the demographics (e.g. population numbers, number of younger and older people, areas with concentration of deprivation) will be presented. At this point the discussion will also invite officers to consider any ethical issues they see arising for when research is published for example at what level is at appropriate to publish mapped data. Officers will also be asked to comment on what detail of both local crime maps and maps produced at the focus groups they feel it may be appropriate to share with partners in any further research.

A short interim report summarising the findings so far and information from the feedback would be produced and circulated to senior officers and participants.

Phase 3 – Additional Research

Following phase 1 and 2 it is currently intended that some additional research be carried out. The scope and detail of this will be informed by the Findings from Phase 1 and 2.

Separate consent would be sought from Lothian and Borders police for any additional participation of officers at this stage of the research. Additional analysis of crime data supplied at Phase 1B might also be undertaken at this stage. Advice from the police on who the most appropriate local partners working in community safety to contact for additional information might also be sought to prepare this phase of research.

It is anticipated the research might include some (but not all) of the following components:-

- Additional analysis of crime data supplied in Phase 1B looking at temporal patterns e.g. time of day, day of week
- Further consideration of published government and local government secondary data including the Edinburgh Annual Neighbourhood Survey, and local Viewfinder Survey
- Linking of findings to data collected for the Edinburgh Study of Youth Transitions in Crime.
- Identification of similar areas within the study area with high and low rates of vandalism for further more detailed study which may include:-
    - additional focus groups or interviews with local authority staff involved in housing and / or environmental management e.g. housing management staff, community wardens, local concierge or caretakers
    - additional focus groups or interviews with key community leaders, members of resident groups or local activists
    - on the ground inspection of physical building layout and local amenities

A report highlighting key findings from the final thesis would be supplied on completion of the PhD to Lothian and Borders police and at least one presentation of the work made to officers.

Proposed Data Security

To ensure data protection compliance and that data are securely and safely looked after, the minimum data security proposed is as follows:

All data collected would be held in an encrypted virtual drive file created using PGP encryption software. Encrypted files would only be accessible via a password known to the researcher and the researcher's PhD Supervisors.

It is proposed only the absolute minimum required crime data on recorded offences be supplied. The following data is therefore NOT being requested:

- house number or street address of offence location
- name of victim or offender
- date of birth or age of victim or offender
- address of victim or offender
- any descriptive details of the offence that would identify the offender or victim.

The only data which could potentially identify an individual required is the locus of the offence as a grid reference and postcode only.

Detail on proposed data collection, storage methods and analysis methods are given in Appendix 2. A summary of proposed minimum security to be put in place is given below:-

Initially recordings from focus groups and any crime data supplied would be transferred to a PGP encrypted file which would be stored securely. If potentially disclosive crime data (i.e. data with potential to identify an individual) is to be moved from police premises it would always be carried in encrypted form. A proposed process for transferring data is described in detail in Appendix 2.

It is preferred that files be stored on an external hard drive which when not in use would be kept at the researcher's home in a fireproof and waterproof lockable safe box. A copy of the data in the encrypted files would also be retained on the University of Edinburgh School of Geo-Sciences server space for postgraduate students based within the Institute of Geography building. Files on this server space are regularly backed up.

Alternative suggestions to home storage of potentially disclosive crime data include working on the data on the University servers only, working on this data within a Lothian and Borders police station, or sanitising the data so it is not disclosive before it is removed from police premises. Further details of these suggested methods are outlined in Appendix 2.

Analysed data not containing information that could identify individual persons would be kept in an encrypted PGP file on both the researcher's laptop, with a copy on the external hard drive.

All original data would be deleted within 5 years of the end of the research. If any data were required to be kept beyond this date, permission would be sought.

I am very happy to discuss any additional or alternative security requirements that the Police might have before they would be willing to supply data.

I have an Advanced Disclosure certificate from September 2009 and would be happy to renew this if required, and am also very happy to undergo any additional security checks or vetting requested by the police.

Ellie Bates, July 2010.

Appendix 1 – Group 4 Vandalism etc crime codes requested

The following crime codes would be required (this ensures that the data matches the SIMD vandalism data reported on the Scottish National Statistics Website).

SCJD Code	Description
32/001	Fire-raising excluding muirburn
32/003	Muirburn
33/001	Vandalism, reckless damage and malicious mischief
33/002	Reckless conduct with firearms
33/003	Flying aircraft to the danger of life or property
33/004	Endangering rail passengers
33/005	Reckless driving at common law
33/006	Culpable neglect of duty
33/007	Endangering ship by breach of duty, obtain ship by misrepresentation
33/010	Computer Misuse Act 1990
33/011	Culpable and reckless conduct (not with firearms)
33/012	Vandalism
33/013	Reckless damage
33/014	Malicious mischief

Appendix 2 – Proposed Data Security – Data Collection and Storage Additional Information

Below are summarised the proposed data collection methods and how data may be subsequently transformed by the analysis techniques planned This appendix also sets out how it is proposed the original data collected and subsequent data generated will be stored. If there are to be any significant changes to the research processes proposed these would be discussed with Lothian and Borders police in advance.

1. Proposed Encryption Software

The encryption software proposed to be used is PGP Desktop Home 9.7, PGP is an industry respected security product. PGP software includes the option to create a 'virtual disk'. This is an encrypted file that can be mounted and will appear as if an additional drive with a drive letter. A pass phrase or security key is required to mount the disk. This virtual drive file can be created on an external server or hard drive. This file can then be accessed on the server from a personal laptop with PGP installed and mounted as a drive. This is done simply by right double clicking on the virtual disk file, entering the passphrase at the prompt, the virtual drive e.g. Z is then mounted and accessed as if any other drive. Data can then be analysed and stored on this virtual drive. This enables the sensitive data to remain in an encrypted environment at all times. When not mounted the virtual drive appears as a file with a .pgd extension, this cannot be accessed unless the person attempting read the file has both the relevant PGP software and knows the passphrase. PGP desktop software also provides the PGP Shred tool which provides a much more thorough deletion process than provided through standard Windows software.

2. Data Collection and Storage: Focus Group Data

For interviews and focus groups a small portable recording device will be used to record the focus group. Large paper maps of Edinburgh will be made available for those attending the focus group to annotate. Focus groups would either take place on Lothian & Borders premises or in a meeting room at the University of Edinburgh – as will be most convenient for participants. Introductions will take place before recording begins to preserve anonymity of participants.

The recording device to be used is electronic and allows recorded audio files to be transferred via USB between the recording device and a laptop. Initially recordings from focus groups would be transferred to a PGP encrypted virtual drive on the researcher's laptop. The virtual drive file can then be transferred to a pen drive which would be carried on the researcher's person at all times until it was transferred to a more permanent storage option. The encrypted files would then be transferred to an external hard drive which when not in use would be kept at the researcher's home in a fireproof and waterproof lockable safe box. The annotated paper maps and consent forms used for focus groups would also be stored in this box

A back up copy of the focus group audio data stored within a PGP virtual disk file would also be retained on the University of Edinburgh School of Geo-Sciences server space for postgraduate students based within the Institute of Geography building. Only authorised persons with an authorised user name and password using a laptop or computer authorised to connect to the Institute of Geography local network are able to access files on this system.

3. Analysis and Storage: Focus Group Data

In order to enable analysis of focus group data – the recordings of focus groups will be partially or fully transcribed. Transcription will be into an electronic document. The document will be saved on a PGP encrypted drive created for analysed data. Notes on key themes arising from focus groups will be made – these will also be stored on the encrypted drive. These may then be transferred to a findings report and may form part of thesis chapters – findings report and writing for the thesis will not be stored on an encrypted drive. Comments will not be attributed to named individuals in the final write up to preserve anonymity.

Data from the paper maps produced in the focus groups may be either scanned into image files or directly transferred through a manual digitising process into a set of polygons creating an electronic boundary file that can be used with Geographic Information System (GIS) software. Any files created in this way will be stored in an encrypted virtual disk file, with a backup on University of Edinburgh servers as described above.

4. Data Collection and Storage: Crime Data

4.1 Data Collection

The ideal format is for data to be supplied either as an excel spreadsheet or text file (.csv format preferred) containing column headings and the data. Provided the researcher was authorised to take a laptop into the police station, the file can then be transferred onto the laptop directly onto a PGP encrypted virtual drive file within the police station. Transferring the file could be done by using a standard pen drive to take the raw data and transfer it to the PGP virtual file on the laptop. Any traces of the file on the original pen drive can then be removed by thoroughly deleting it using the PGP shred tool, a software tool that deletes data by both blanking the data and then over-writing areas of the disk where the data was previously stored. Alternately a pre-encrypted pen drive could be used. Once the data is stored in the on the virtual drive, this drive can be un-mounted which then leaves a single encrypted file with can then be transported either on the laptop or by copying it to an external pen drive or hard-drive. During this process at no time would any unencrypted data need to leave the police premises. Once the data was placed in an encrypted virtual drive it would always be subsequently accessed via an encrypted virtual drive only.

4.2 Data Storage

As analysis of data requires the use of specialist software installed on the researchers laptop (CrimeStat III, ArcGIS 9.2, GeoDa and OpenGeoDa, GWR software, SPSS, MLWIN) the researcher needs to connect her laptop to a drive or server holding the encrypted data.

There are 4 suggested options for storage of the encrypted original data and other point data files derived from it - *potentially disclosive data* - (see section 5 below for more details on outputs of analysis of the data). These options are:

1. Storing *potentially disclosive data* in a PGP encrypted virtual drive file on an external hard drive stored in the researcher's home. When not working on the data this

encrypted data on the external hard drive would be stored in a lockable waterproof safe box. A further encrypted backup copy would be retained on the Institute of Geography, School of Geosciences servers at the University of Edinburgh which can only be accessed by authorised users.

2. Storing *potentially disclosive data* in a PGP encrypted virtual drive file on the Institute of Geography, School of Geosciences servers at the University of Edinburgh which can only be accessed by authorised users; the researcher is able to work on data on this server within the Institute of Geography by connecting her laptop to the encrypted virtual drive file stored on the server either within the Institute of Geography building or directly from home via a secure VPN link.

3. Storing *potentially disclosive data* in an PGP encrypted virtual disk file on an external hard drive held on police premises and working on it in this location – however this would require Lothian and Borders police to allocate the researcher temporary work space and allow her to bring her laptop on to and off Lothian and Borders police premises and to take non-disclosive aggregate data derived from the potentially disclosive data (see section 5) off police premises.

4. Sanitising original data before removing the data from Lothian and Borders police premises. A sanitisation method would need to be agreed. Sanitisation of data is used by some England and Wales police forces before sharing point data with CDRP partners[21]. Techniques include assigning each crime to the centre of a postcode unit (e.g. EH1 1AA) rather than its' exact location, where any postcode experiencing less than 3 crimes in a given year the crime is assigned to an adjoining postcode with a higher crime level. Alternative sanitisation technique is to assign all data pre-aggregated to output area or data zone boundaries for each year of study. These techniques require some extensive additional work to process the data by either Lothian and Borders Police or the researcher (if the researcher was to process the data they would need to be given access to Lothian and Borders police computer with Excel, Access and ArcGIS software installed). This would still enable the research to be carried out but would introduce an additional level of error into the data supplied and would also limit the mapping and clustering techniques which could be used.

5. Analysing and storing data: crime data

Analysing the crime data will involve checking data quality and then transforming the data by aggregating it using various techniques.

Any data generated which enabled specific locations of individual crimes locations to be identified – *potentially disclosive data* - would be treated with the same security precautions that are agreed should be applied to the original raw data.

It is suggested that data generated through the analysis process which does not allow individual crime locations to be identified – *aggregated data* - be stored in a separate encrypted virtual

[21] Home Office (2010) National Support Framework for Delivering Safer and Confident Communities, Information sharing for community safety, Guidance and practice advice.

drive which the researcher retains on her laptop as this data will be required for further analysis work and will directly contribute to interim reports, published papers and the final PhD thesis. Backups of this encrypted aggregate data would be stored on an external hard drive stored in a lockable waterproof safe box. A further encrypted backup copy would be retained on the Institute of Geography, School of Geosciences servers at the University of Edinburgh which can only be accessed by authorised users.

- **5.1 Initial data preparation**
  The initial raw data supplied would be imported into a Microsoft Access database. Additional fields would be created from this data which summarise time fields and crime code fields into broader categories. (e.g. for time a Year, Month, Day of Week and Hour field would be created). This database can then be connected to either by a GIS software package (Arc GIS 9.2) or from a second Access database being used for analysis purposes only. Data from the database would be plotted using GIS software and a series of shapefiles created (shapefiles are file collections that can be read by various GIS software). Initially a shapefile of point data would be produced for the full data set by plotting the grid co-ordinates supplied for the locus of each offence. Using a 'point in polygon' tool each crime locus would be assigned to various set geographical boundaries it falls within (e.g. 100m grid square, output area, datazone, intermediate geography, ward). This produces a second shapefile which as well as the original data has additional fields which denote the geographic boundary (e.g. output area, datazone, ward) each crime has been recorded as occurring in. The shapefile derived would then be saved back into an Acesss geodatabase (a database with a collection of tables that can be read by the ArcGIS 9 software package). Initially a series of point shapefile for each year period of data supplied would then be produced (e.g. 1 April 2004 – 31 March 2005, 1 April 2005 – 31 March 2006 and so on) shape files for other time periods e.g. weekdays / weekends might be created at a later stage; these shapefile would be used as input files for packages that cannot read an Access database and require a shapefile as input (e.g. CrimeStat and Open GeoDa). All databases and shapefiles containing point data would be treated as require the same level of security as the original data supplied as they would contain details of individual offence locations.

- **5.2 Checking Data quality – locus of offence**
  A random selection of offence loci from the crime data would be displayed as points using GIS software and using the software's built in a point in polygon tool each of these points would be allocated to a unit postcode. A short analysis would be run to examine data quality which would check how many of the postcodes allocated. If less than 85% of the postcodes successfully match this may indicate there may be issues as to whether the precision of the crime locations recorded is sufficient for the crime mapping methodologies that are intended to be used. Locations where postcodes did not match would be examined to see how great the mismatch appears to be. Concerns about possible data quality would be raised with Lothian and Borders police. Further checking of data quality would require access to the full address of the offence loci. This check will inform at what detail level it will be possible to map the data with reasonable precision, for example if data appears to broadly accurate to postcode level it should be possible to map it to ~100m grid level, if data is less precise than this it is likely it can still be mapped at a coarser level e.g. output area or datazone level.

- **5.3 Checking Data quality – Time of offence**
  A check will be done to see how precisely the time an offence has been recorded by looking at the difference between time from and time to information and ascertaining for example how many vandalism offences are recorded to a precise time and how many are recorded as between a time period e.g. between 2200 1/04/2004 and 0800 2/04/2004. This check will inform how precisely the data can be examined over specific time periods, e.g. can the data be examined on an hourly basis or will it only be possible to look at daytime or night time crime or annual crime levels.

- **5.4 Mapping and Exploring the data**
  Data will be examined to see if there are any particular clusters (hotspots) of vandalism in particular locations and if concentrations of vandalism in localised neighbourhoods are lower or higher than might be expected. Mapping and Exploring the data initially requires using potentially disclosive point data as an input, but produces aggregate non-disclosive data as an output. Illustrative maps (using postcode data from the May 2010 postcode file) showing examples of point data mapped without aggregation can be seen in Figure 5. Figures 6 and 7 show examples of the same point data aggregated and mapped using various clustering and thematic mapping techniques that will be used in this study. Maps have been produced for the [StudyArea] NMA area and mapped at a scale likely to be used in research study (see further 5.5 below)

  - **5.4.1 Clustering based techniques**
    The following four techniques use a combination of CrimeStat III, GeoDa and ArcGIS 9.2 and require point based data as a shapefile as an input.
    Mean Nearest Neighbour Index – this technique calculates the average (mean) distance between all crime locations in an area and then calculates a score. The output is a text table which gives score and a table of mean distance for each k order i.e. k order 1 is looks at the mean distance between a point and the 1st closest point, k order 2 looks at the second nearest point, k order 3 looks at the third nearest point etc and so on. Output is as a table and chart; no area can be identified from this method.
    KDE – Kernel Density Estimation mapping involves assigning each of the points representing the locus of an offence to a grid then applying a smoothing technique which weights the data according to how many other offences occurred nearby. Areas where there are concentrations of offences are given are higher weight than areas where offences are less concentrated. Mapping would be to a minimum of a 100m^2 grid or larger to prevent disclosure of particular offence locations. The data output is a shapefile of grid squares; each grid square has a value based on the concentration of crime locations in that grid square. This is a common hotspot mapping technique.
    NNHC – Nearest Neighbour Hierarchical Clustering is a technique that analyses point locations of crime and looks for clusters of points, it then creates a boundary around these point locations highlighting the boundary of the area where a cluster of crime is located – but not the locations of individual crimes. The output is a shapefile with a series of either ellipses or irregular shapes which represent the extent of a crime cluster.
    Gi* - This is a mapping methods which uses data pre-aggregated to a grid and then a smoothing technique which calculates the significance of the concentration of offences

across a given study area. Mapping would be to a minimum of a $100m^2$ grid or larger to prevent disclosure of particular offence locations. The data output is a shapefile of grid squares; each grid square has a value based on the concentration of crime locations in that grid square. This is recommended and as an advanced hotspot mapping technique.

- **5.4.2 Thematic mapping**
  A second database for analysed aggregated data would be created. This database would be linked to the database of original crime recorded data created at data preparation stage (see section 5.1). Initially data would be prepared so it could be mapped at datazone level. The datazone is the smallest geographical unit at which the Scottish Government currently makes data available (through the Scottish National Statistics web site www.sns.gov.uk). Using Access database SQL queries a series of tables giving the number of crimes occurring in each year for each datazone would be calculated, this data would then be joined to a shapefile of datazone boundaries[22]. At a later stage data might also be aggregated and mapped at output area level – this is the geography used for the Edinburgh Index[23] - to a set of grid square e.g. a $100m^2$ grid, and at intermediate geography level (i.e. the same boundaries as Figure 2 and 3). Various thematic mapping techniques may be used but would include Excess risk (ER) (Standardised Offence Ratio) (for examples see Figures 1 – 3, and Figures 6 and 7).

- **5.4.3 Exploratory analysis and modelling of data**

  Aggregate data prepare for thematic mapping grouped at grid level, output area, or datazone level or above would also be analysed to look at statistical trends and relationships in the data using Excel, SPSS, GeoDa and potentially specific modelling packages for multi-level modelling and geographic weighted regression . Outputs from this would be as graphs or tables or numeric summaries which would not identify an individual's location.

- **5.5 Examples of Mapping Output**

[22] Available to download from Scottish Neighbourhood Statistics www.sns.gov.uk
[23] Created by City of Edinburgh, downloadable from www.edinburgh.org.uk

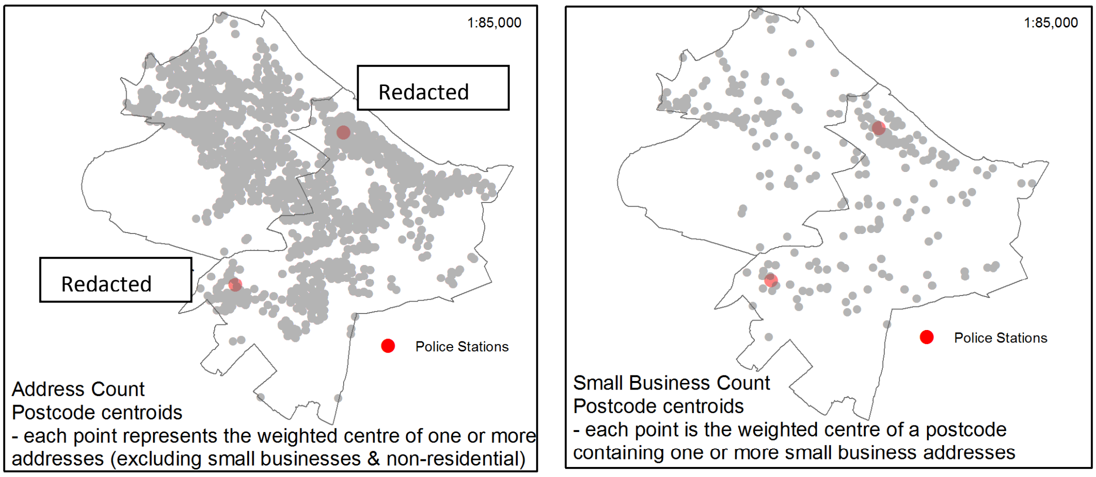
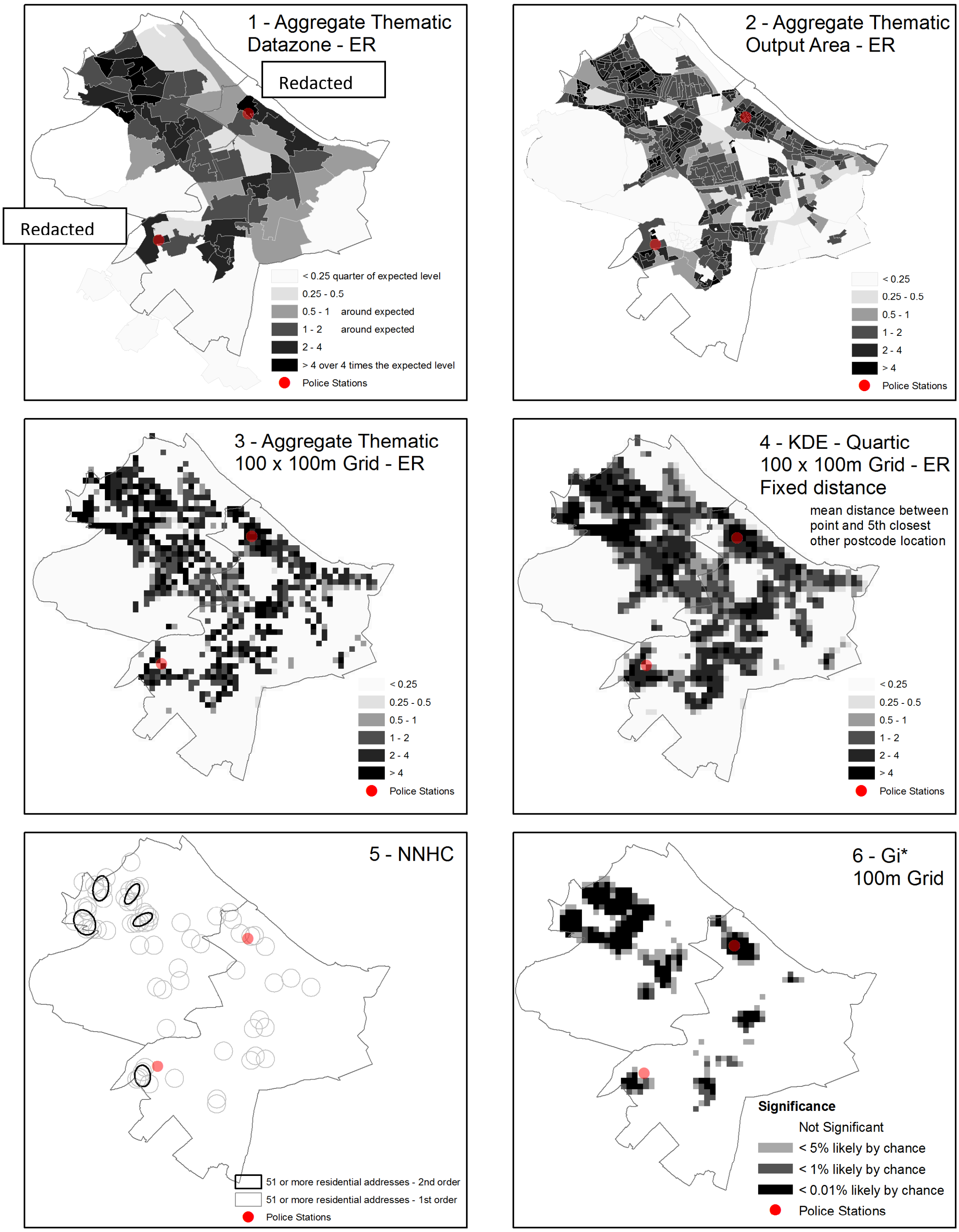


Figure 5 – Example of mapping of point locations only – using May 2010 postcode locations as an illustration. Data would be mapped in this style initially to check data, prior to aggregation and clustering of data– no maps in this style would be published.



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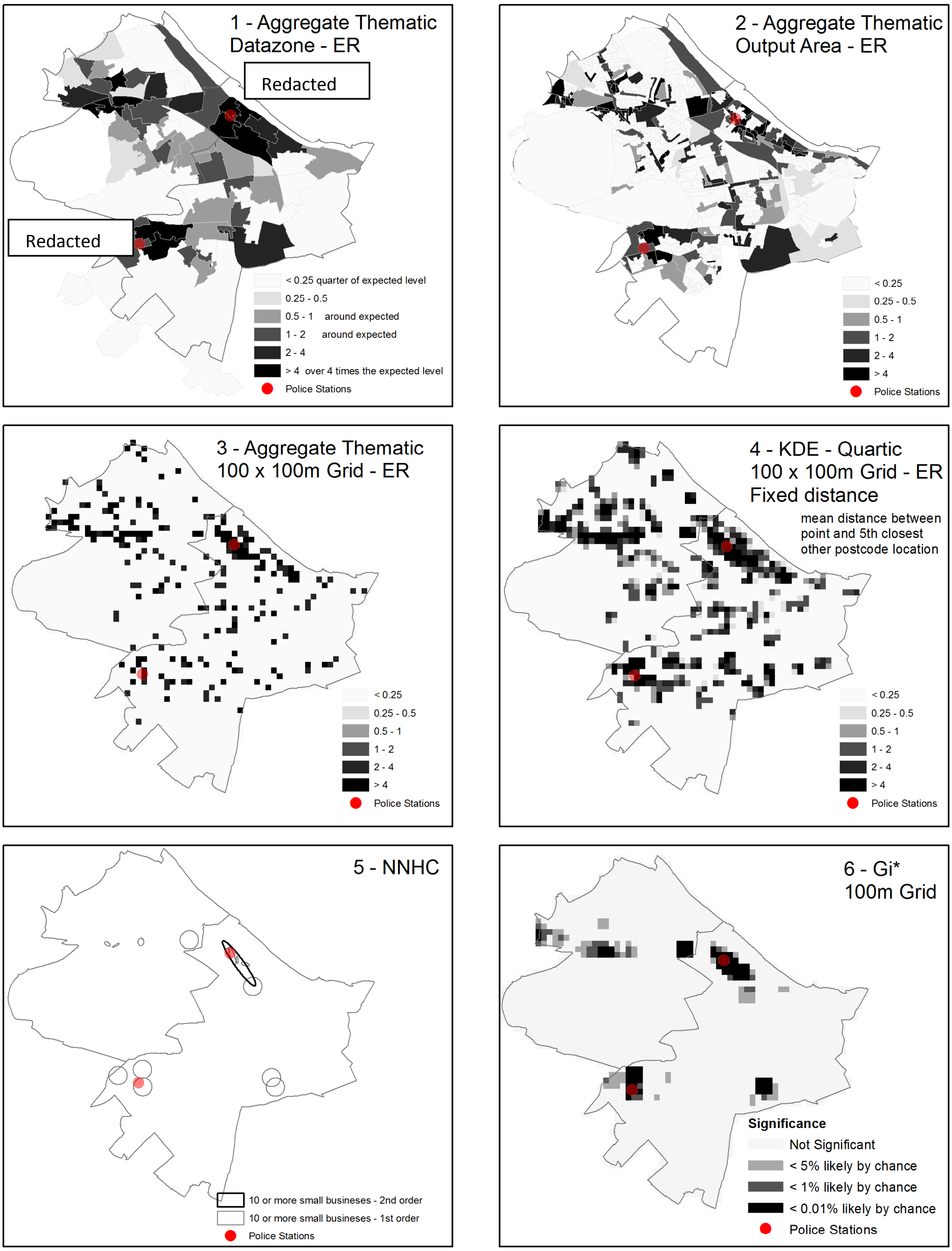
Scale of all maps
1:83,296
1 centimeter equals 0.832964 kilometer
0.80.4 0 0.8 Kilometers

Figure 6 – Mapping of Address Counts per unit area - a proxy for residential address density - using various aggregation and cluster identification techniques – Total records N=25,214



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Scale of all maps
1:83,296
1 centimeter equals 0.832964 kilometer
0.80.4 0 0.8 Kilometers

Figure 7 – Mapping of Small business counts per unit area - a proxy for small business density - using various aggregation and cluster identification techniques – Total records N-683

Appendix 3 - Checking Data Quality of Police Recorded Crime Data

Once the data was received checks were undertaken to ensure that the data supplied was of sufficient minimum quality to be used in the research. This initially involved checks that there were a sufficient number of crimes to provide a large enough sample size for analysis in each of the given years and that the vast majority of crime records supplied included location information. Table A3.1 below shows that the number of records with no location based information increased from 2004 to 2009, but never exceed 2.5%. In all years there were at least 1200 vandalism offences which were likely to provide a reasonable sample size for analysis. This is well above the minimum "acceptable hit rate' suggested by a Monte Carlo based simulations study by Jerry Ratcliffe's that finds that for a given crime table if at least 85% of records have a location reference then this should be sufficient to represent the actual geographic spread of recorded crime in an area over 95% of the time (Ratcliffe, 2004, 69).

Table A3.1 Number of recorded Group 4 crimes and Numbers which had no location (derived from S Valid Grid reference of postcode)

	Total records (Group 4)	No valid Grid Ref. or Postcode	
Year	N	N	%
2004-05	1636	13	0.8
2005-06	1830	24	1.3
2006-07	1834	25	1.4
2007-08	1891	40	2.1
2008-09	1463	29	2.0
2009-10	1259	28	2.2

A further test of quality was to look to see how precise the location data provided appeared to be. In most years just fewer than half the records supplied had both a grid reference and a postcode. As full addresses had not been supplied it was not possible to check that the precise point locations. However a test could be carried out to see for records with a grid reference, by comparing how close the police grid reference was to the grid reference for the centroid of the related postcode using the Gridlink dataset described in section 1.1.2 above to supply the location of the postcode centroid. Typically postcodes centroids in the area were 100m or less apart so it might be expected the locus (grid reference) would be within 100m of its associated postcode. As can be seen from Table A3.2 over 85% of records were the distances were within 100m of each other, and in over 92% of cases the distances were within 250m. This suggested fairly good consistency in precision of geocoding and again met the 85% hit rate above. However it was decided it would not be advisable that geolocations could be considered precise below around 100m, so aggregation to 100m by 100m grid cells would have to be the minimum acceptable precision that could be used.

Table A3.2 Precision of Location data in police recorded crime data where grid reference and postcode both present

Year	Records with both Grid Ref. and Valid Postcode		Grid Ref. and Postcode Centroid - distance apart (where both present)		
	N	%	% =< 50m	% =< 100m	% =< 250m
2004-05	799	48.8	74.3	91.7	97.9
2005-06	900	49.2	69.0	88.0	95.4
2006-07	885	48.3	69.8	87.3	97.2
2007-08	855	45.2	66.7	85.8	96.4
2008-09	570	39.0	69.0	87.3	96.1
2009-10	549	43.6	63.2	85.0	92.1

The final data quality check undertaken was to assess the accuracy of the time of crime of time. The crime records supplied had a time from and a time to date that the crimes had occurred at. Analysis was undertaken to see what the hour difference was between the earliest date and time that crime might have occurred (the from date and time) and the latest time and date the crime might have occurred. What was immediately apparent was that in many cases the exact time a crime of vandalism occurred was unclear. For just over half of cases (52%) the time span in which the vandalism occurred was to known to about one hour. The timing of the offence could be given to a 4 hour period for 59% of cases, with 75% of recorded crimes of vandalism having a time span of around 12 hours or less in which the offence may have occurred; and 90% of cases having a span of 24 hours or less; 95% of cases had a time span of 2.5 days (60 hours) or less; 98% of cases occurred within a 7 day period and 99% of cases had a time span of 14 days (345 hours) or less. The maximum time period given in which a recorded crime of vandalism might have occurred was 184 days. Figure A3.1 graphs these cumulative frequencies.

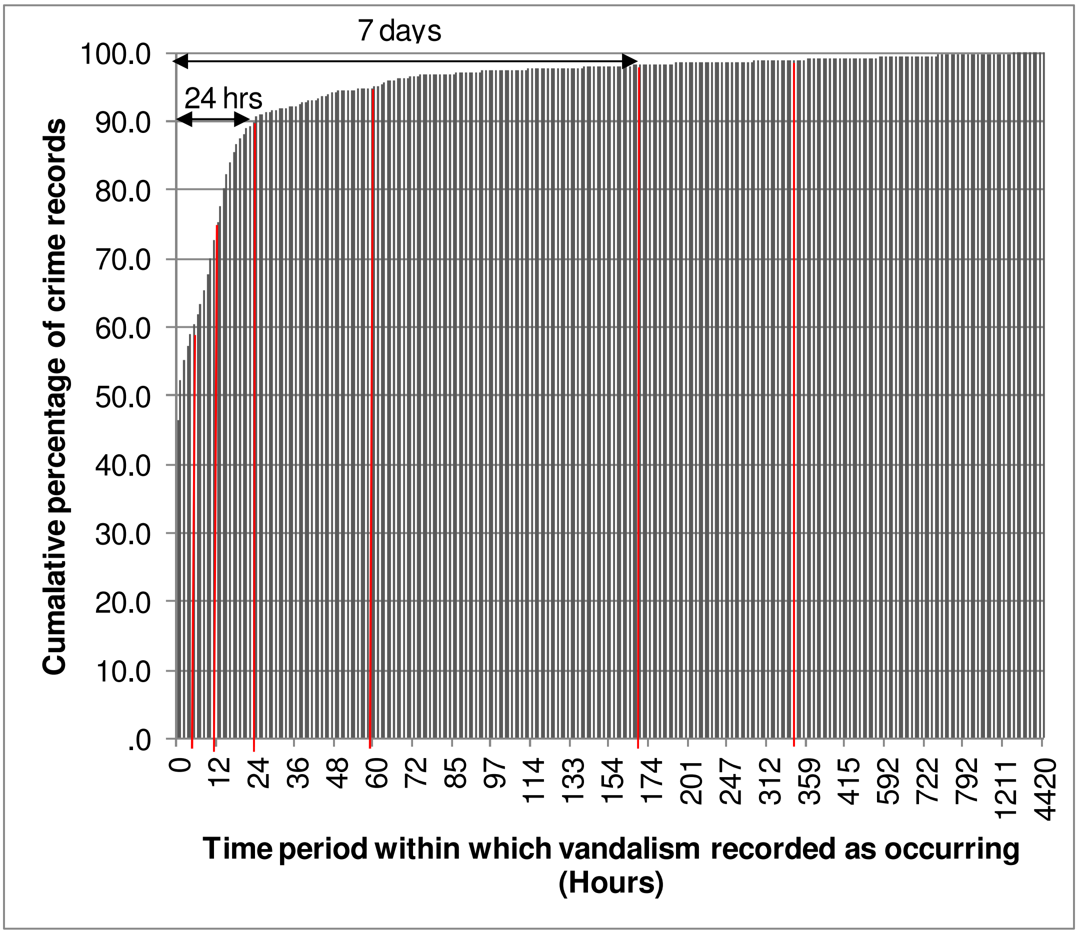

Figure A3.1 Crimes of Recorded Vandalism – Temporal Data Precision

Given the nature of vandalism as a crime where the perpetration of the act is often not observed, these results were perhaps not that surprising. Due this inherent uncertainty in the data it was decided that any analysis looking at the temporal distribution of vandalism on a hourly basis would be analysed based on the 'time from' date and time, with a separate analysis taking place of records where the time stamp accuracy was one hour or better, alongside analysis of all records. Analysis of temporal data on an annual, monthly, weekly or daily basis would be undertaken on all records only again use the time from date and time.

A final assessment of the crime data was to analyse how many records fell within which Group 4 etc vandalism sub-types and decide which crimes to include in the analysis of vandalism. Table A3.3 gives a breakdown of crimes which were classified as vandalism and fire-raising and were used for the general analysis. It was decided not to analyse the fire-raising records separately as so few were recorded. It would have been useful to distinguish between vandalism involving graffiti writing and vandalism involving smashing or breaking of property but this was not possible using the standard codes supplied. The only distinction was between crimes of vandalism to vehicle and crimes of vandalism unspecified and there was no theoretical justification to separate these so these crimes were grouped together. This meant of the 9,711 Group 4 crime records with valid locations supplied, in the final analysis 9434 crimes of vandalism, malicious mischief and fire-raising were considered.

Table A3.3: Breakdown of crime types in records supplied 1st April 2004 – 31st March 2010 with valid locations – Total Cases 9,711

SCJD Code	Description	Cases in Sub-Group
Defined as 'Vandalism and Fire-raising' and used main analysis: 9,434		
32/001, 32/003	Fire-raising	410
33/001, 33/012, 33/013 33/014	Vandalism, reckless damage and malicious mischief (to Vehicle)	4351
33/001, 33/012, 33/013 33/014	Vandalism, reckless damage and malicious mischief (Unspecified)	4673
Not included in main analysis: 277		
33/011	Culpable and reckless conduct (not with firearms)	241
33/002	Reckless conduct with firearms	35
33/005	Reckless driving at common law	1

Appendix 4 – Notes for semi-structured themes to be covered in Focus groups

Focus Groups Notes – Part 1

Introduction – what is this research about

[Give research brief]

In this session I would like you to think about 3 things-

- thinking about the area you work in [EdinburghA] / [EdinburghB] I'm sure that vandalism occurs across the area, what I'd like you to do is identify areas on this map that you consider have a vandalism problem year in year out and also areas that you think have no problem (or if there are no areas with no problem only a very minor problem).
- As you do this I'd like you to think about and discuss the types of vandalism that are considered a problem in these areas. [Dr Anna Souhami suggested doing the discussion this way round rather than trying to get an agreed definition first] [Ask them to number the areas as they mark them on the map]
- When you've done marked areas that have a problem and those that do not, I'd like you think about, based on your experience, what are the characteristics of the areas which have a problem , and the characteristics of areas that don't

[Prompt after map marked if not already come up in discussion]

I'd now like you think about for these areas you've highlighted [make sure areas are numbered or have letters e.g. area 1, area2, area A, area B]

- how you would describe the people who live there
- how you would describe the physical space – e.g. types of buildings / physical layout
- how would you describe the local community

if needed prompt

- **what sort of people hang around / are out and about in the area**
    1. age
    2. employed / not employed / retired
- **are there any problematic groups physical spatial aspects**

5) what are buildings like / what is the layout of the area
6) what is the building use - is it mostly business / residential, what about proximity to schools, and play or leisure areas
7) is it in good repair or is there derelict land
8) how clean is the area, how frequently is it cleaned up

nature of local community [also to check the collective efficacy questions from Sampson's etc work]

9) do people socialise much together, do people help each other out, do they organise local events,
10) is there much local activism - are any of them actively involved in trying to make the community a better place, do they tend to report problems to the police or the council
11) is there a strong sense of shared local community identity or local community history

Appendix 5 – Additional Group Trajectory Models and Some Associated Multinomial Logistic Regression Models

The Four Class OA Negative Binomial Count Model

In addition to looking at a categorical model a count model (like the count model for gird cells was also considered for OAs) as it was possible that method of standardisation might also affect the trajectory groups derived. The OA count model like the previous Count Grid models discussed looks at whether there were groups of OAs which had similar mean values of counts of recorded vandalisms in each Output Area (a homogenous neighbourhood). Considering counts is important as areas with the largest volume of crime may attract particular attention from those policing and governing areas. As table A5.1 shows the preferred model on best fit criteria is either the 4 or 5 class model. The 5 class model is around the 0.05% significance threshold so if we assume that is the no better than the 4 class model we are slightly less than 95% sure we are not wrong in making this assumption, however examining the results the 5 class model gives little additional explanatory power than the 4 class model. The 4 class model is therefore presented here. Like the other previous 4 class models so far presented this model splits the Output Areas into a High group (9% of OAs), a Medium group (27% of OAs), a Low group (39% of OAs) and a Very Low group (25.1% of OAs). Figure A5.1 shows it follows a very similar trajectory to the 4 class Grid Count model (see Figure 5.10 in chapter 5).

Table A5.1 –Best Fit results Group Trajectory Analysis OA Count

	OA Negative Binomial Count		
Latent Class	Adjusted BIC	Adj BIC diff	Significance where tested*
1	12523.07		-
2	11487.39	1035.67	-
3	11104.68	382.72	-
4	**11010.44**	**94.24**	**0.0506**
5	**10953.19**	**57.25**	**0.0517**
6	10949.64	3.55	0.4463
7	10947.59	2.05	0.3152
8	10946.21	1.38	0.4846
*Lo Mendel Rubin Adj. Likelihood Ratio Test			

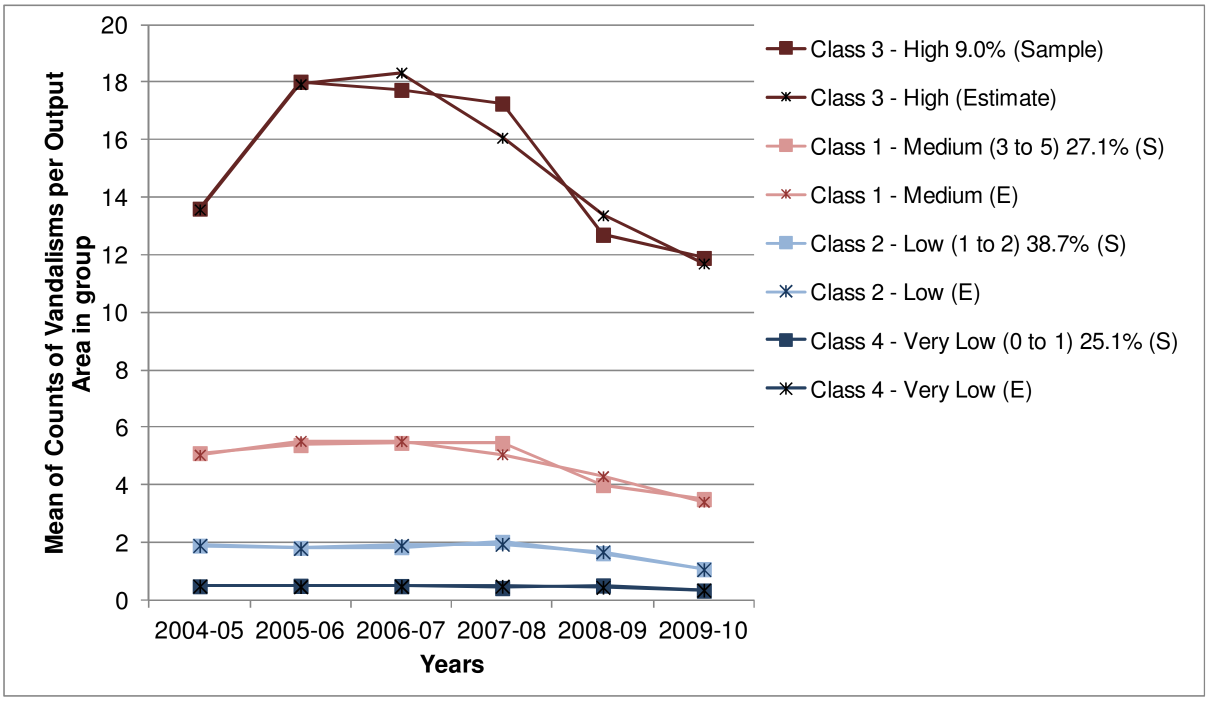

Figure A5.1 Four Class Group Trajectory Model for OAs - Vandalism Counts– Trajectory Paths of Groups

What is interesting is that, by looking at 4 class count model compared with the 4 class SVR categorical model, some very different areas stand out as being in either high and low groups, depending on which model is used (see especially D4 and F5 in Figure A5.2). As already discussed in chapter 4 in the standardisation section, this in part has to do with the varying size of OAs with some being much larger than others and therefore offering more potential opportunities in space for vandalisms to take place. There are however other areas which remain in the low groups (see D2 Figure A5.2) or the high groups (see much of E5 in Figure A5.2) in both models, suggesting whatever the factors are that make this an area in a low group (low vandalism concentrations) or a high group (high levels of vandalisms) are present for this area for both models. In assessing the nature of a vandalism problem it is suggested that since these differences between counts and rates are substantive it can be useful to examine both simultaneously. It may also go some way to explain why some areas may be more likely seen to have a problem with vandalisms than others and this is discussed further alongside data from focus groups in Chapter 6.

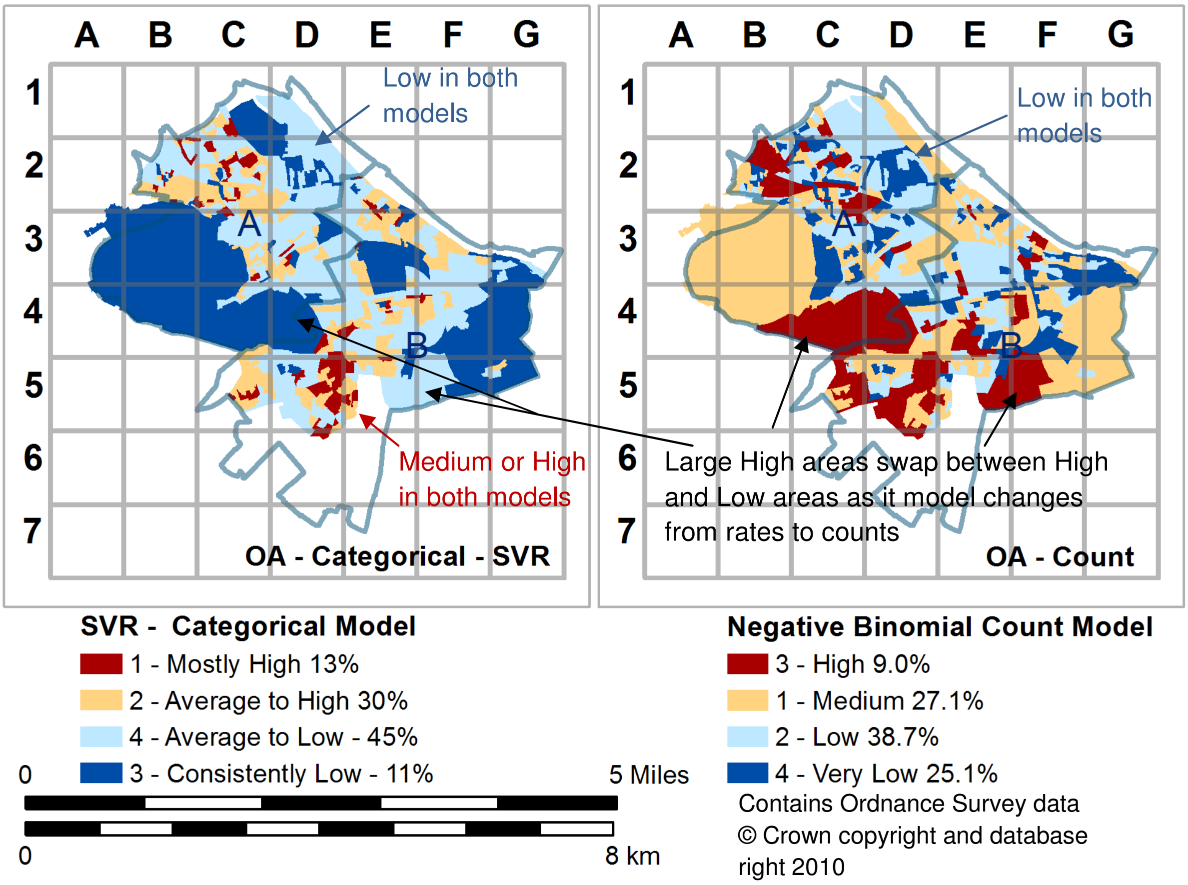

Figure A5.2 Group Trajectory 4 class models for OAs - Comparing Recorded Vandalism Rates per Hectare (Categorical Model) with Vandalism Counts (Negative Binomial Count Model)

Assessing whether high and low groups of areas – next to each other - are consistent over time – G_i Categorical Models*

For both of these models data was divided into three categories based on the G_i* pseudo significance (for example visualisations of these see Chapter 4 figures 4.6 and Figure 4.25) LISA analysis. The High Category was for high areas where the mean of the immediately surrounding areas (Queen weight contiguity 1) and including the area itself were significantly high, compared to the areas average (p=<0.05). The Low Category were areas where the mean of the surrounding areas and the area itself were significantly lower than the area average (p=<0.05). The non significant areas were all other areas that did not fall within the high or the low categories.

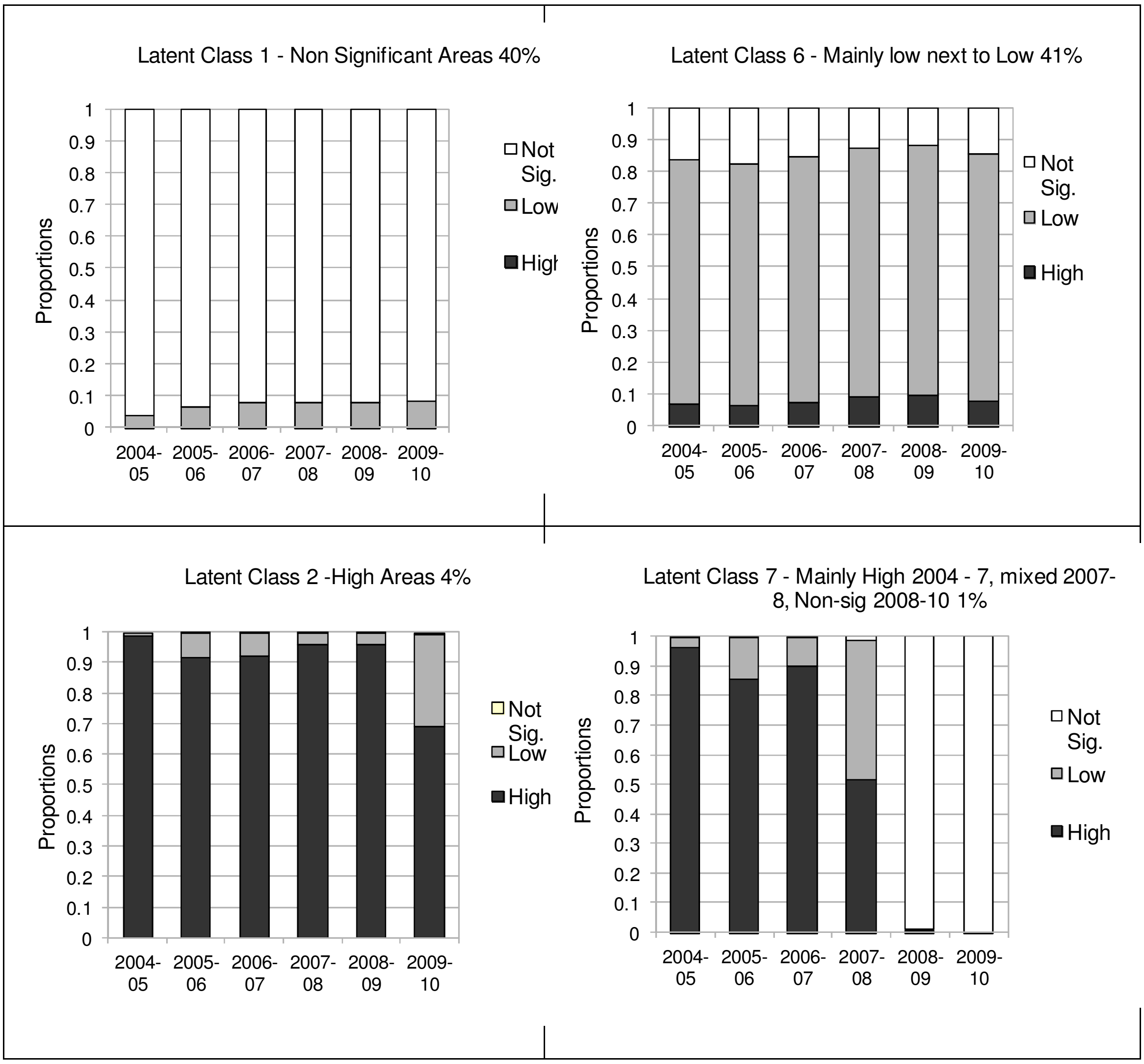

Figure A5.3 Grid G_i*(PS) Categorical 7 class Model – Make-up of Categories in the year in each of 4 key latent classes

In total at Grid level the best fit model identified was a 7 class model. As Figure A5.3 shows the biggest groups in this model were a Non Significant group (Latent Class 1) which comprised 40% of the grid cells in the case study area and a consistently Low next to Low Group which comprised 41% of the areas. Like the low and very low groups in the grid count model, these low groups in the Grid G_i* Categorical Model make up over 80% of all areas in the model. Another particularly interesting groups are the High next to High group (Latent Class 2) which comprise areas that were generally high next to high areas year in year out with a few exceptions where they become low next to low groups in some years. A further interesting group is Latent Class 7 (1% of all grid cells), a group which starts off appearing just like the high next to high group for 2004-05 to 2006-07 inclusive before becoming a mix of high and low areas in 2007-8 then all areas in this group becoming non-significant or low in 2008-9 and 2009-10. Charts highlighting the categorical make up of each of these groups in each year are shown in Figure A5.3. There is a further high group (Latent Class 5 – High all years except 2004-5) which is very similar to the High Group shown in all years except for 2004-5 when the areas in this group were mainly non-significant. There are then 2 other non significant groups one which are generally non significant but have a mix of Low and High groups in either 2004-5 (Latent Classes 3 and 4).

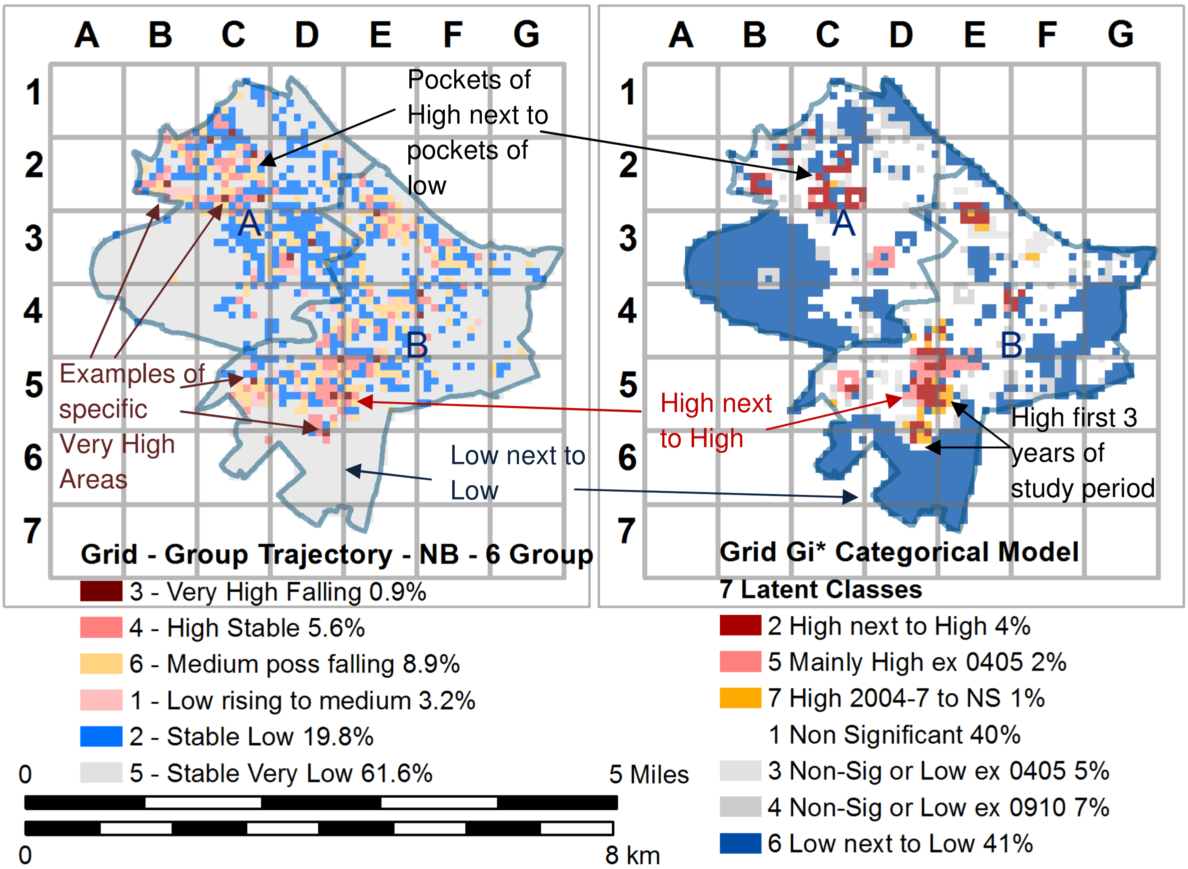

Figure A5.4 Comparing the Group Trajectory Grid Models Negative Binomial (NB) Count compared with G_i* Categorical Model.

Comparing the G_i* based Grid Categorical model with the 6 class Negative Binomial Count model highlights some interesting similarities and differences between the two. G_i Categorical model is less complex visually and clearly shows high and low areas, the Count based model highlights the further complexities of high and low areas but does not present as clear a summary. As Figure A5.4 shows both models pick out clustering of high areas in C2 and D5, however the G_i* model neatly emphasises the particular clusters of these groups more clearly than the Grid Count model. It also picks out an interesting grouping of areas that were high but the ceased to be significant from 2008-9 onwards (C6/D5). The count based model highlights particular individual locations of high counts of recorded vandalisms which are missed by the simpler summarising of the categorical G_i* model. Both models pick put low areas, but what

G_i* model does not make clear is that many of the non significant areas also have very low levels of vandalisms (perhaps only 1 or 2 a year at most) but they are not 0 vandalisms areas and so do not fall in the very low category.

Turning now to the next scale up and analysing G_i* categories at Output Area model interesting this model just picks out significant low next to low areas that are consistent over time, not high next to high and low adjoining areas like the Gird G_i* categorical model. Based on significance testing the best model is a 6 class model, however like previous OAs most useful summary model is a 4 class model. The 4 class OA G_i* Model breaks down into 4 groups which are either Non Significant; Mainly low and Non significant, Non Significant and Mixed and there is one Consistently Low group. The 6 group model splits Non-Significant and Mixed and Mainly Low and non-significant into additional classes but although these add interesting potentially localised detail, they potentially less easy generalise from than the overall summary presented by the 4 class model. The make-up of categories within the groups of this 4 class model are shown in Figure A5.5. The Non-Significant group (Latent Class 3) is the most common with just under two thirds 64%) of all OAs falling within this group, a further quarter (26%) of areas are wither some mix of non-significant high and low in each year (Latent Class 4). The consistently Low next to Low Group (Latent Class 1) is quite rare with less than 1 in 10 (7%) of the OAs in this group. The remaining Output Areas (Latent Class 2) are often in the low next to low category but not consistently enough to make the consistently low group (Latent Class 1).

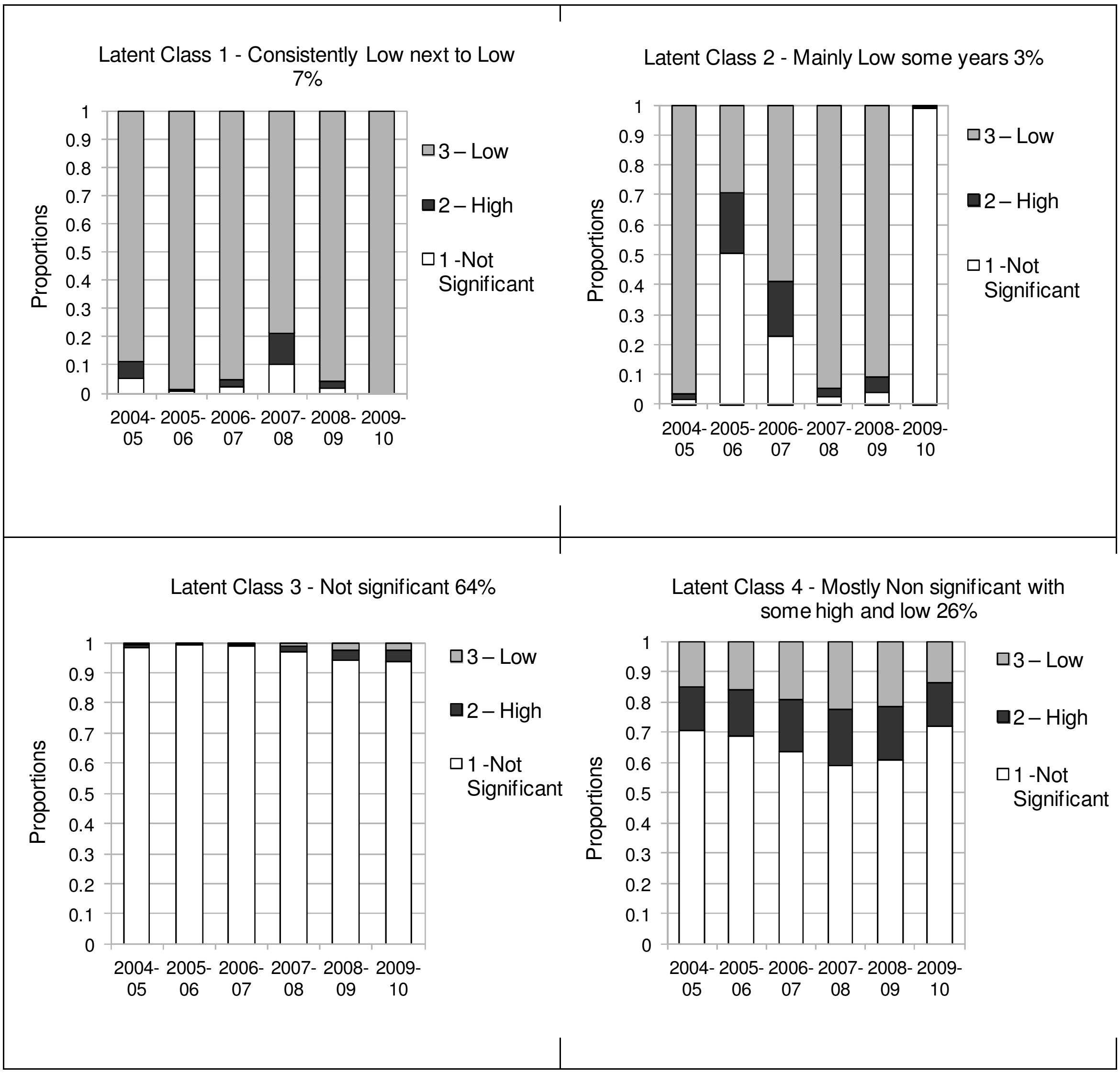

Figure A5.5 Output A G_i*(PS) Categorical 4 class Model – Make-up of Categories in the year in 4 latent classes

Considering the effects of Spatial Auto-correlation and Comparing possible explanatory factors - OA G_i Categorical and Grid G_i* Categorical Models*

Could it just be that part of the differences between grid models and Output Areas the models is due a failure to correct for spatial auto-correlation? There is no current standard way to correct for auto-correlation in group trajectory modelling, however to partially assess the impact of spatial autocorrelation the OA and Grid based G_i* Categorical models were also assessed. The OA model assessed was the 6 class model and the Grid based model the 7 class model they are presented separately. Results are interesting, showing some similarities but also some notable differences in the explanatory power of different variables between the LISA based models and the SVR and Count models, but are inconclusive as to whether spatial autocorrelation might be at the root of the problem. This in part because it was not possible to correct high standard errors and provide a comparative model at Output Area level, (these are even more of a problem in the 4 class G_i* model than the 6 class model which is why the 6 class model is presented here), and in part because the G_i* Categorical OA model only highlights consistently low areas, whereas the grid model highlights both High and Low areas so the models are not directly comparable with the previous models.

Considering the 6 class G_i* OA model there are a number of problems with high standard errors in this model and the full table comparing other groups with the Non Significant Group as a reference and then the Consistently Low group as a reference is presented in Appendix 5.2. However the results relating to non significant areas is interesting, assuming not it is not too adversely by problems with standard errors (errors are less problematic in this model than for the model with the consistently low group as a reference group). Taking the Non Significant group as the reference group, the only group which has significant explanatory variables is the consistently low group compared to the non significant group (Table A5.2) for all other groups results are non significant. This suggests that clusters of low next to low areas occur in areas with very few businesses (0.23); it is around 5 times less likely that businesses will be present in Consistently Low areas compared with non-significant areas. It is over 20 times less likely (0.04) that an area in the consistently low group has a recreation area present compared with a non-significant area. High Welfare has very large standard errors, this is likely to be due to the fact that analysis of means shows that no areas in the Consistently Low group were within Datazones in the High Welfare category. However a little under half of Consistently Low areas (43.6%) were within Datazones in the quartiles in Scotland with the lowest proportion of people in receipt of income related welfare benefits. It is perhaps not surprising therefore that Consistently Low areas are 6.7 times more likely to be in a Low Welfare area.

Table A5.2 Multinomial Logistic Regression Model G_i* Categorical OA Model 6 class – Comparing the Consistently Low class with Reference Class: - Non-Significant

	OA Gi* Categorical 6 class Model									
Reference Class:	**Non Significant**									
Consistently Low	B		S.E		exp(B)			p		
Intercept		(		)			(		)
Residential Addresses	-0.12	(	0.03	)	**0.88**	***	(	0.000	)
Business Addresses	-1.48	(	0.62	)	**0.23**	*	(	0.017	)
School Nearby	-1.69	(	1.21	)	0.19		(	0.163	)
Recreation Area	-3.13	(	1.14	)	**0.04**	**	(	0.006	)
High Welfare	-21.52	(	#####	)	0.00		(	1.000	)
Low Welfare	1.91	(	0.63	)	**6.77**	**	(	0.003	)
Good School Attendance	-1.49	(	0.90	)	0.22		(	0.097	)
Poor School Attendance	-1.05	(	1.07	)	0.35		(	0.326	)
Median Age	-0.05	(	0.04	)	0.95		(	0.249	)
* p <= 0.05, ** p <=0.01, *** p<=0.001									
Probability calculated based on pseudo class draws in Mplus 6.21									

Considering the Grid Gi* Categorical 7 class model presented in table A5.3 this is broadly similar to the 6 class grid model presented in table 5.5. For most areas a slightly higher density of residential addresses, and for some high areas a higher level of business addresses, is an important factor. This model makes it clear that for some high areas being within a high welfare area makes it far more likely a grid area will be in a High group rather than a non-significant group. The models also goes some way to explain why this is not seen comparing high areas to low areas directly. For very low areas being in a high welfare areas makes it 4 times more likely an area will be the very low group. This makes it unclear exactly what the impact of relatively high levels of inequality is on levels of vandalisms. High inequality is certainly present in a number of location where high levels of vandalisms occur, however it is also high inequality may also present in a number of areas with very low vandalisms. As discussed above this may be due to having to use a coarse proxy for relative inequality which does not properly represent actual levels of inequality at the micro level. Further consideration needs to be given into how levels of relative inequality at the micro level can be more accurately assessed.

Table A5.3 Multinomial Logistic Regression Model G_i* Categorical Grid 7 class

	Grid Gi* Categorical 7 class Model										
Reference Class:	**Non Significant**					**Low next to Low**					
High next to High	B	S.E	exp(B)		p	**High next to High**	B	S.E	exp(B)		p
Intercept	-3.76	(0.28)		***	(0.000)	Intercept	-3.49	(0.29)		***	(0.000)
Residential Addresses	0.02	(0.00)	**1.02**	***	(0.000)	**Residential Addresses**	0.06	(0.01)	**1.07**	***	(0.000)
Business Addresses	0.12	(0.05)	**1.13**	**	(0.010)	**Business Addresses**	0.19	(0.08)	**1.21**	*	(0.021)
School Nearby	0.42	(0.34)	1.52		(0.224)	School Nearby	1.94	(0.42)	6.97	***	(0.000)
Recreation Area	-2.78	(1.02)	**0.06**	**	(0.006)	**Recreation Area**	-3.38	(1.02)	**0.03**	**	(0.001)
High Welfare	1.81	(0.41)	**6.13**	***	(0.000)	High Welfare	0.37	(0.43)	1.45		(0.391)
Poor School Attendance	0.21	(0.40)	1.23		(0.610)	Poor School Attendance	0.25	(0.43)	1.28		(0.563)
	Mainly High excluding 2004-5										
Intercept	-4.82	(0.47)		***	(0.000)	Intercept	-4.55	(0.47)		***	(0.000)
Residential Addresses	0.01	(0.01)	1.01		(0.074)	**Residential Addresses**	0.05	(0.01)	**1.06**	***	(0.000)
Business Addresses	0.08	(0.07)	1.08		(0.239)	Business Addresses	0.15	(0.10)	1.16		(0.121)
School Nearby	1.12	(0.38)	**3.08**	**	(0.003)	**School Nearby**	2.65	(0.45)	**14.15**	***	(0.000)
Recreation Area	-0.54	(0.53)	0.58		(0.309)	**Recreation Area**	-1.14	(0.54)	**0.32**	*	(0.034)
High Welfare	0.59	(0.47)	1.80		(0.213)	High Welfare	-0.85	(0.49)	0.43		(0.082)
Poor School Attendance	2.10	(0.59)	**8.13**	***	(0.000)	**Poor School Attendance**	2.14	(0.61)	**8.48**	***	(0.000)
	High 2004-7, Low and High 2007-8, Non-Significant 2008-10										
Intercept	-5.07	(0.47)		***	(0.000)	Intercept	-4.80	(0.47)			(0.000)
Residential Addresses	0.01	(0.01)	1.01		(0.260)	**Residential Addresses**	0.05	(0.01)	**1.05**	***	(0.000)
Business Addresses	0.16	(0.06)	**1.17**	**	(0.009)	**Business Addresses**	0.23	(0.09)	**1.25**	***	(0.012)
School Nearby	0.01	(0.61)	1.01		(0.984)	**School Nearby**	1.54	(0.65)	**4.66**	**	(0.018)
Recreation Area	-0.68	(0.68)	0.51		(0.319)	Recreation Area	-1.28	(0.68)	0.28		(0.062)
High Welfare	2.57	(0.78)	**13.12**	**	(0.001)	High Welfare	1.13	(0.79)	3.10		(0.151)
Poor School Attendance	0.05	(0.73)	1.05		(0.944)	Poor School Attendance	0.09	(0.74)	1.10		(0.900)
	Non-Significant or Low except 2004-5										
Intercept	-2.24	(0.20)		***	(0.000)	Intercept	-1.97	(0.20)		***	(0.000)
Residential Addresses	0.00	(0.01)	1.00		(0.987)	Residential Addresses	0.05	(0.01)	1.05	***	(0.000)
Business Addresses	0.08	(0.06)	1.08		(0.166)	Business Addresses	0.15	(0.09)	1.16		(0.105)
School Nearby	-0.70	(0.52)	0.50		(0.179)	**School Nearby**	0.83	(0.57)	**2.30**		(0.145)
Recreation Area	0.19	(0.27)	1.21		(0.470)	Recreation Area	-0.40	(0.27)	0.67		(0.132)
High Welfare	0.68	(0.43)	1.97		(0.119)	High Welfare	-0.77	(0.45)	0.47		(0.086)
Poor School Attendance	-0.37	(0.44)	0.69		(0.404)	Poor School Attendance	-0.32	(0.45)	0.72		(0.475)
	Non-Significant or Low except 2009-10										
Intercept	-1.84	(0.18)			(0.000)	Intercept	-1.57	(0.19)		***	(0.000)
Residential Addresses	0.00	(0.00)	1.00		(0.487)	**Residential Addresses**	0.04	(0.01)	**1.04**	***	(0.000)
Business Addresses	0.03	(0.07)	1.03		(0.676)	Business Addresses	0.10	(0.09)	1.10		(0.295)
School Nearby	-0.36	(0.41)	0.70		(0.390)	**School Nearby**	1.17	(0.49)	**3.22**	**	(0.017)
Recreation Area	-0.01	(0.26)	0.99		(0.968)	**Recreation Area**	-0.60	(0.26)	**0.55**	**	(0.020)
High Welfare	0.02	(0.37)	1.02		(0.958)	**High Welfare**	-1.42	(0.38)	**0.24**	***	(0.000)
Poor School Attendance	0.34	(0.35)	1.40		(0.325)	Poor School Attendance	0.38	(0.36)	1.47		(0.289)
Low next to Low						**Non Significant**					
Intercept	-0.27	(0.10)		**	(0.006)	Intercept	0.27	(0.10)		**	(0.006)
Residential Addresses	-0.05	(0.01)	**0.96**	***	(0.000)	**Residential Addresses**	0.05	(0.01)	**1.05**	***	(0.000)
Business Addresses	-0.07	(0.07)	0.93		(0.337)	Business Addresses	0.07	(0.07)	1.07		(0.337)
School Nearby	-1.53	(0.29)	**0.22**	***	(0.000)	**School Nearby**	1.53	(0.29)	**4.60**	***	(0.000)
Recreation Area	0.59	(0.12)	**1.81**	***	(0.000)	**Recreation Area**	-0.59	(0.12)	**0.55**	***	(0.000)
High Welfare	1.44	(0.21)	**4.23**	***	(0.000)	**High Welfare**	-1.44	(0.21)	**0.24**	***	(0.000)
Poor School Attendance	-0.04	(0.20)	0.96		(0.833)	Poor School Attendance	0.04	(0.20)	1.04		(0.833)
* p <= 0.05, ** p <=0.01, *** p<=0.001											
Low Welfare and Good School Attendance excluded											
Probability calculated based on pseudo class draws in Mplus 6.21											

Temporal Effects within high and low areas

Before moving on to look at the more detailed focus groups comments on the case study area a final note is presented here about whether trajectories vary across the day, across days in a week and across months. As discussed in Chapter 3 various methods were used to analyse temporal effects however they were all found to yield very similar trajectory paths whether counts or rates were studies or OA or grid scale considered.

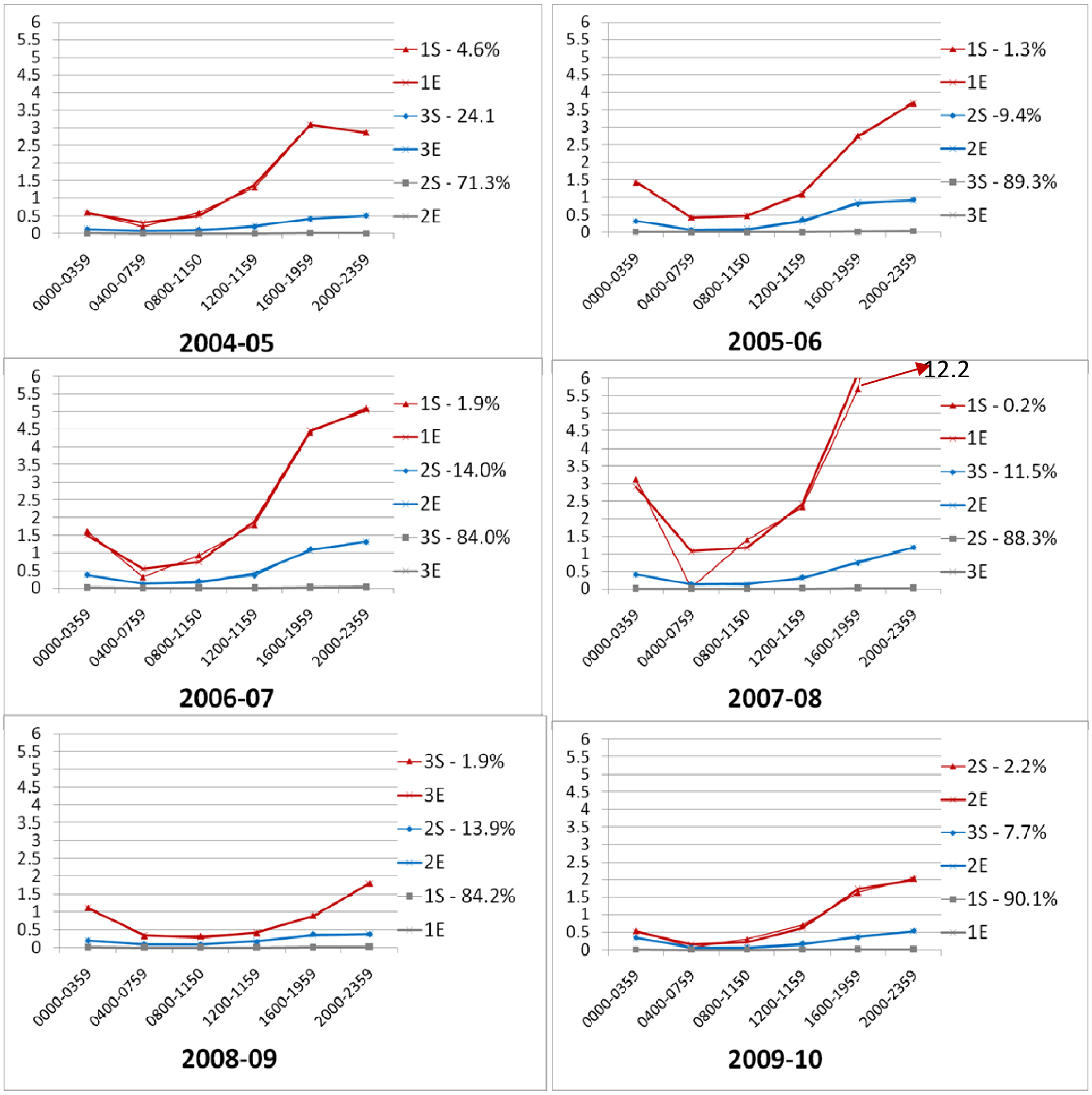

Figure A5.6 Trajectory Paths: 4 hour Groups Grid Counts (Accurate Times recorded with around a 2 hour minimum accuracy level) for the 6 years of the study period

Figure A5.6 demonstrates that in high areas there is an extremely stable pattern of more vandalisms late afternoon and evening and at other times of day and this pattern holds at both

OA and Grid scales and for counts and rates. The model fit results (Adjusted BIC) were also very unambiguous. Figure A5.7 just provides data for recorded crimes where the time of the crime was recorded with some certainty (around half of all crimes were recorded with this level of accuracy. All crime data (but where the precise time of some crimes is much less certain ranging from within 2 hours (around 50%) to within a day (just over 70%) to within 2 days (around 90%) shows exactly the same style of trajectory path although it rises less steeply in the evenings (reflecting perhaps that people were able to say the vandalism happened sometime over night but the victim is not sure when!).

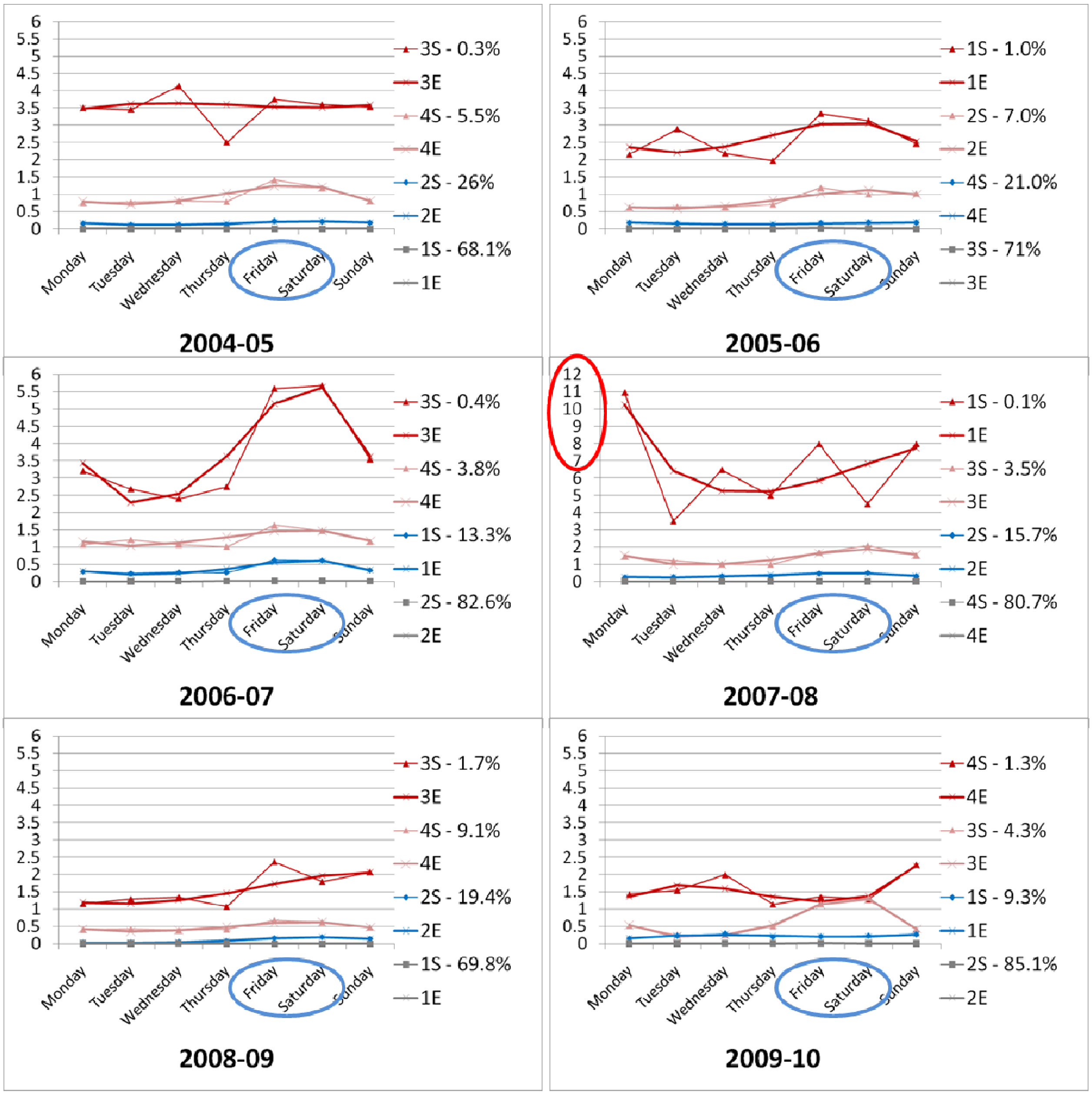

Figure A5.8 Trajectory Paths: Days of the week Grid Counts aggregated by year, for the 6 years of the study period

Looking at days of the week there are clearly 4 groups of high, medium, low and very low trajectories (following the standard pattern already seen in other models) but there also appears to be a slight increase in levels of vandalisms on a Friday and Saturday (Figure A5.8). Finally looking at data grouped into 2 month blocks there is very little clear trends apart from the now expected groupings of high, medium, low and very low areas with vandalisms in every year (Figure 5.9).

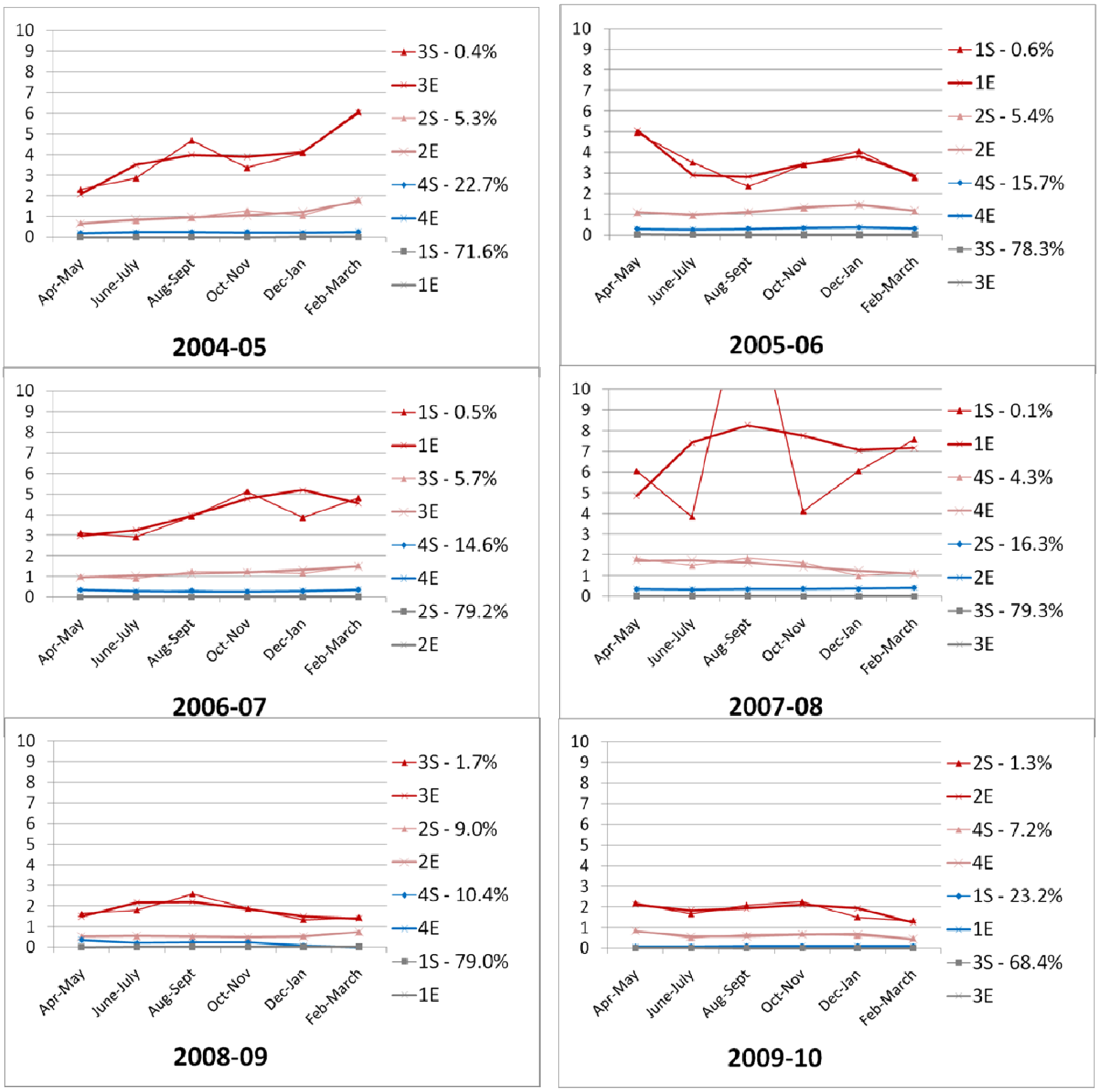

Figure A5.9 Trajectory Paths: 2 Month blocks, Grid Counts aggregated by year, for the 6 years of the study period

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