GIS and Crime Mapping

Spencer Chainey
Director of Geographic Information Science

UCL Jill Dando Institute of Crime Science

Established in 2001 as a permanent memorial to one of Britain's most popular TV journalists

Introduction

- The role of ‘place’ in crime
- The principal spatial theories of crime
- Crime mapping in practice – five examples
  - Intelligence gathering
  - Performance review
  - Crime analysis
  - Criminal investigations
  - Targeting reassurance
- Research agenda
  - Beyond blobology
  - Publishing crime statistics to the public
  - Spatial significance
  - Spatial regression
  - Modelling and simulation
  - Crime prediction

The role of 'place' in crime

- Two key considerations
  - Crime has an inherent geographical quality
  - Crime is not randomly distributed

The role of 'place' in crime

Crime has an inherent geographical quality

- The four dimensions of crime
  - Legal (a law must be broken)
  - Victim (someone or something has to be targeted)
  - Offender (someone has to do the crime)
  - Spatial (it has to happen at a place - somewhere, in space and time)

The role of 'place' in crime

Crime is not randomly distributed

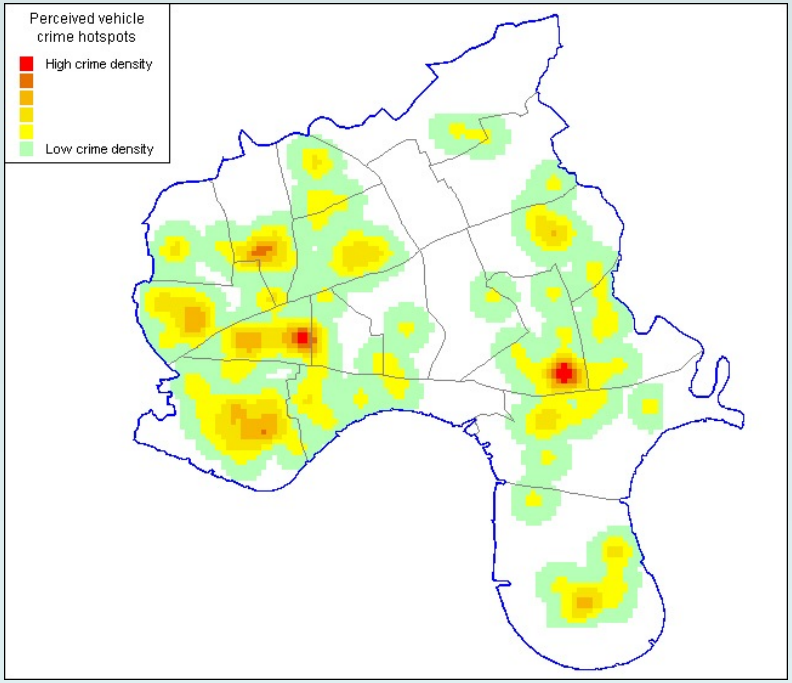
- If crimes were random
  - Equal chance of them happening anywhere at anytime
- But crime is not randomly distributed
- Concentrated into places of activity
  - Crime hotspots
- Series follow geographic patterns
  - Serious and volume crime

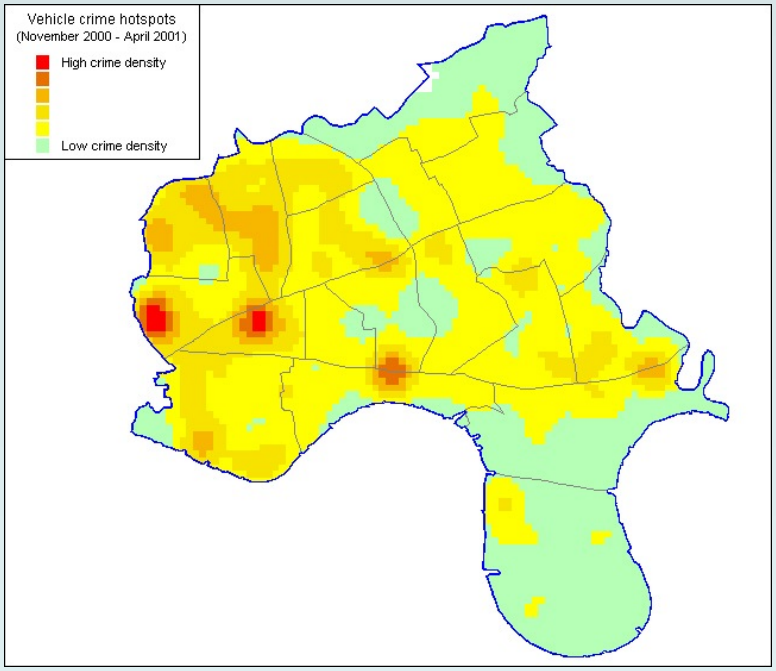
But why map it?

- Questioned as a “process that reveals what I already know”…

Example

A Crime and Disorder Reduction Partnership





Vehicle crime - 6% success rate

Routine Activity Theory

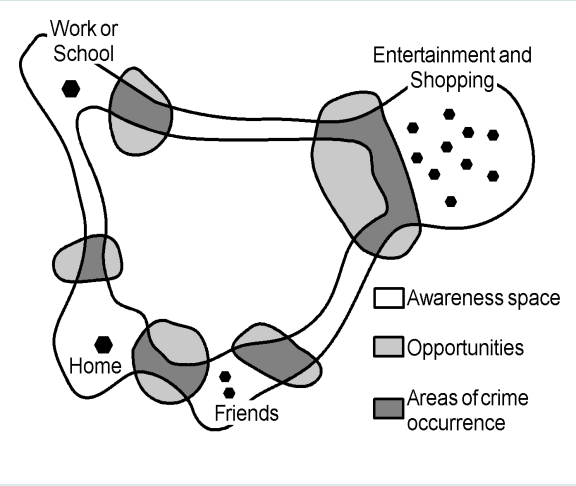
Cohen and Felson (1979)

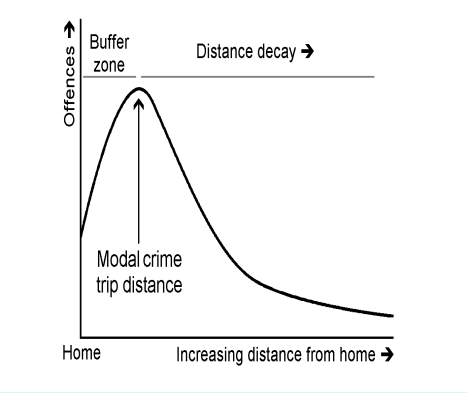
- States that for a crime to occur, three elements must be present
  - Motivated offender + Vulnerable target/victim – the presence of a capable guardian
  - With the crime occurring in some 'place', in space and time
- Illustrated by the 'Crime Problem Analysis Triangle'
- Helps to explain the interaction between offender and victim/target, and the influence of place
- And how we can address the problem

Crime Pattern Theory

Brantingham and Brantingham (1982)

- Personal activity space
  - Nodes: where people live, work, shop or seek entertainment
  - Paths: routes between nodes
  - Creates an 'awareness space'
- Offender awareness space
  - Opportunity space
  - Victims/targets interaction with offender's awareness space helps explain their risk to victimisation
- Offenders are restricted in how they move around space
  - 'Least effort principle'
  - people will usually exert the minimum effort possible to complete their tasks
  - shopping, performing recreational activities, visiting friends, traveling to work, and the journey to crime
  - decay in the frequency of activity against distance
  - meaning that offenders tend to travel short distances on average to commit their crimes





Crime Pattern Theory

Brantingham and Brantingham (1982)

- The distance decay function can though be different in shape and orientation to represent different types of offending behaviour
  - E.g. shopping trips can be divided into two general categories,
    - **Convenience shopping**: high frequency of short trips because people will tend to purchase items such as milk or a newspaper from the closest possible source
    - **Comparison shopping**: buyers are seeking more expensive items, looking for a wider range such as electrical appliances, designer fashion items, furniture, or cars.
- Distance decay difference - applied to crime
  - inquisitive criminal behaviour may be more frequent over shorter distances
  - organised and planned criminal behaviour may travel further distances to complete tasks.

Crime mapping …

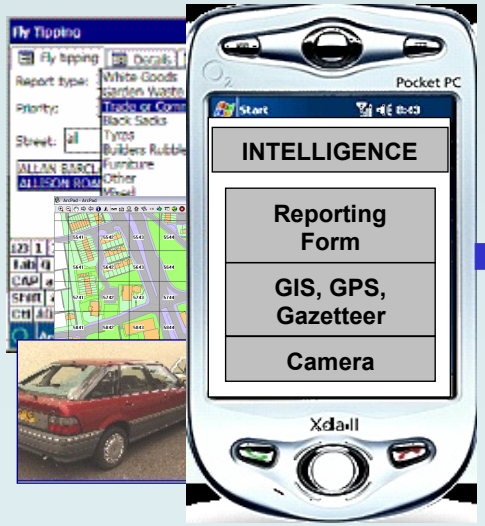
- "a progressive blend of practical criminal justice issues with the research field of geographical information systems and science" (Chainey and Ratcliffe, 2005)
- Exploits the inherent geographical quality of crime
  - Where do offenders live?
  - Where are the most vulnerable communities/targets located?
  - How do offenders travel to the crime location?
  - Why do crimes occur in one area and not another?
  - Where are our emerging problem areas?

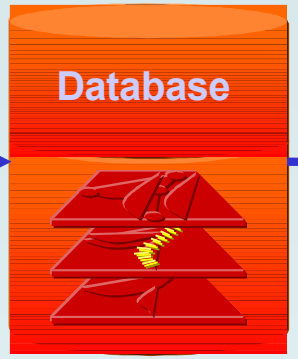
Some examples

UCL Jill Dando Institute of Crime Science

UCL Jill Dando Institute of Crime Science

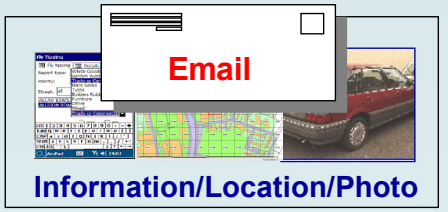
Gathering and disseminating community intelligence
(Neighbourhood Policing)



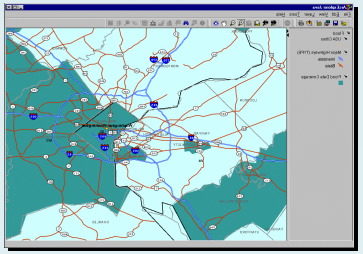


STREET PATROLS

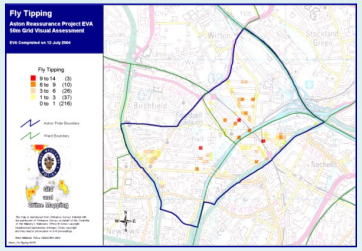
RESPONSE SERVICES



NEIGHBOURHOOD POLICING

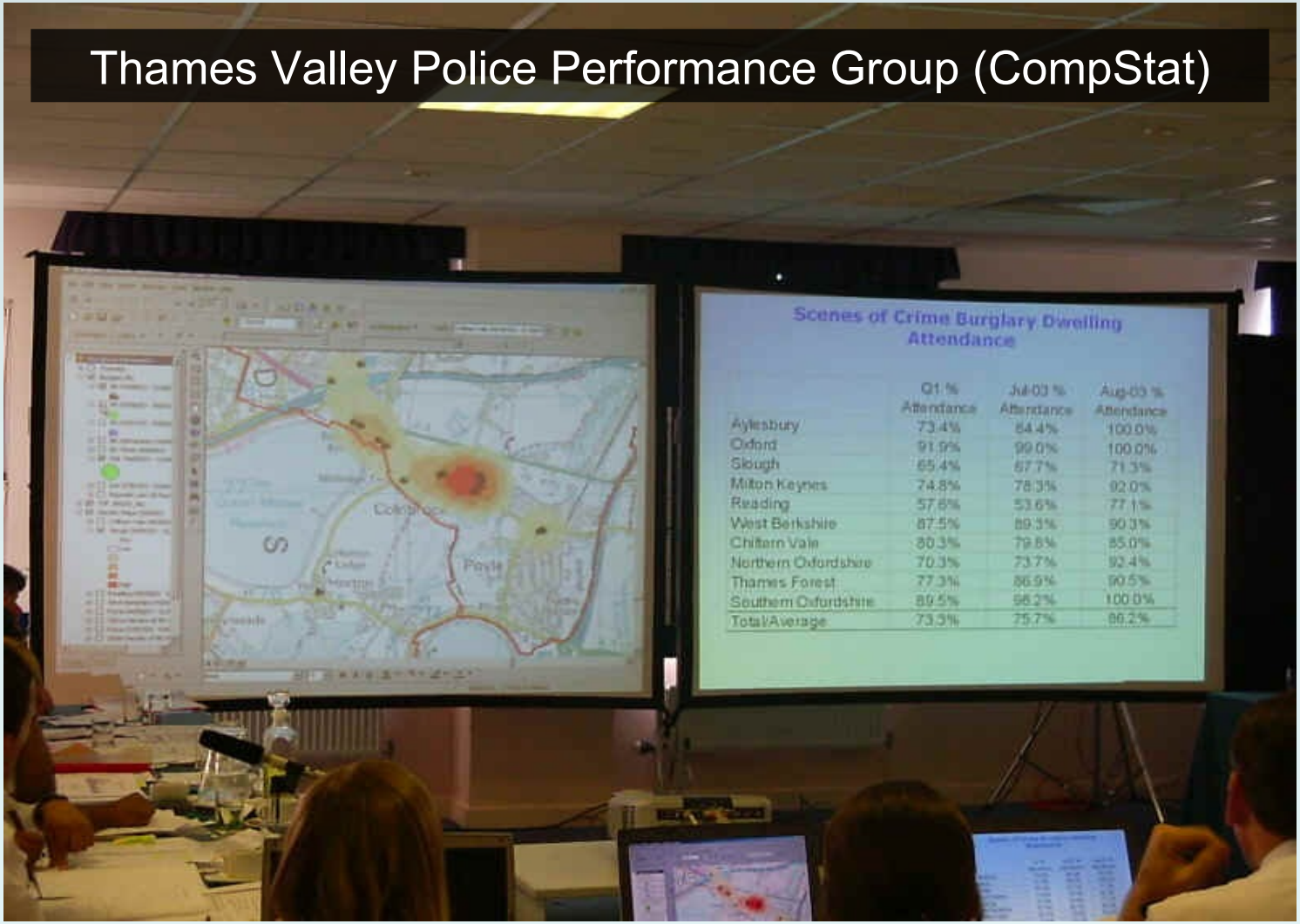


CDRP GIS



"Crime mapping technology has provided for an effective electronic mechanism that directly feeds into joint NIM control strategy and tactical processes" *Inspector Mark Kenwood*

Performance review



Going beyond the review of performance

- Non-analysts often interested in exploring beyond performance statistics
  - Often best placed to pose 'testable ideas' that the analyst can then explore
  - But need information systems/technology that suit this audience
    - Easy to use, reward the user with the information they require within three mouse clicks, available on one page, encourages them to explore

Ward	Burglary Sept06	Burglary Oct06	**Burglary change**	Robbery Sept06	Robbery Oct06	**Robbery change**	VAP Sept06	VAP Oct06	**VAP change**
De Beauvoir	6	3	-50%	3	3	0%	8	7	-13%
Nightingale	7	5	-29%	3	2	-33%	16	16	0%
Central	12	10	-17%	4	3	-25%	2	2	0%
Chestnut Grove	16	14	-13%	4	5	25%	16	17	6%
Trinity	17	15	-12%	7	8	14%	22	21	-5%
Townsmead	24	25	4%	12	12	0%	17	19	12%
Avon	6	5	-17%	5	5	0%	15	15	0%
Southbourne	12	15	25%	12	14	17%	20	23	15%
Southfields	18	16	-11%	18	21	17%	6	7	17%
All Farthing	25	24	-4%	24	38	58%	52	67	29%

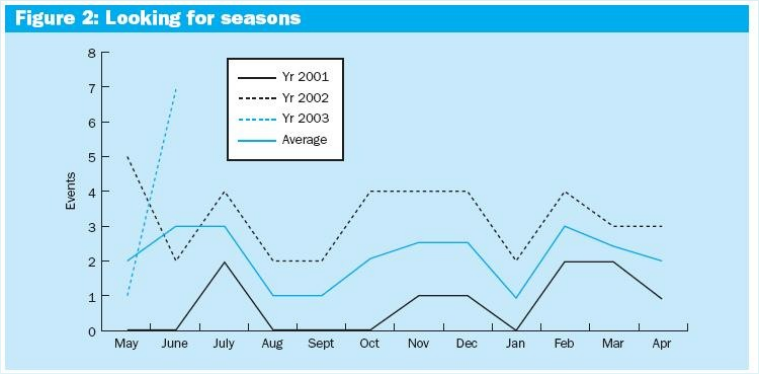
UCL Jill Dando Institute of Crime Science

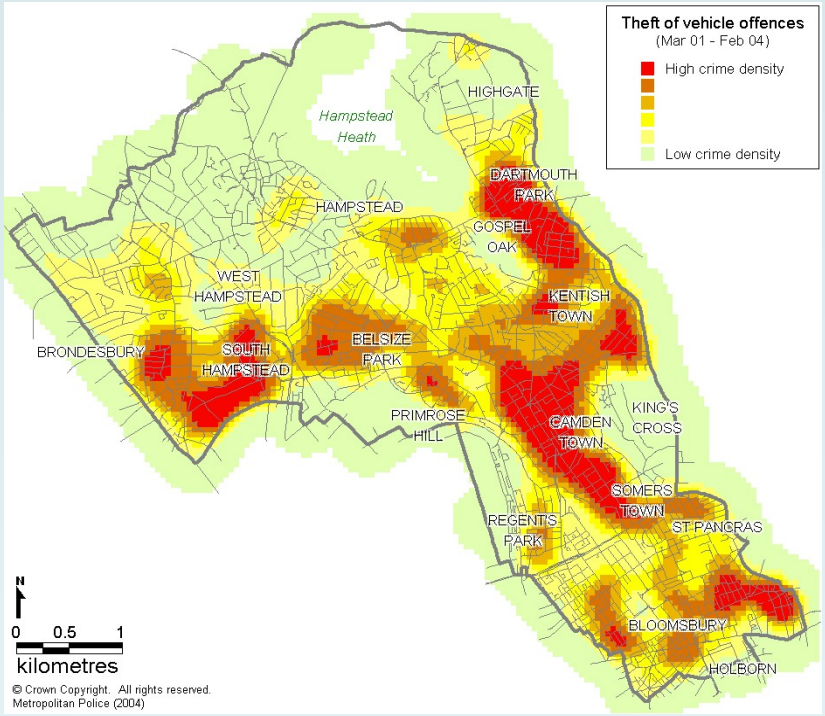
Crime analysis

Analysing vehicle crime in central London

"We think it relates mainly to **local residents** having their **cars** stolen **at night**" (The Police)

- Crime analysis involves breaking the problem apart and exploring the specifics of the problem
- We have a series of questions that we can turn into hypotheses
- Explore 'place' across these
- Helping to explain the problem

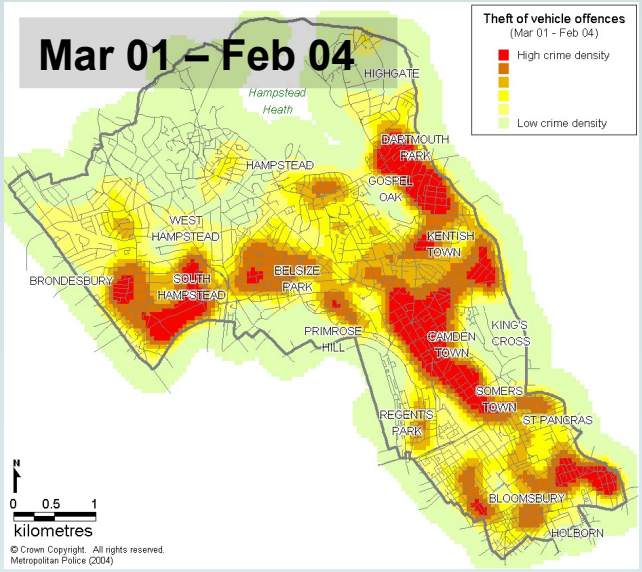




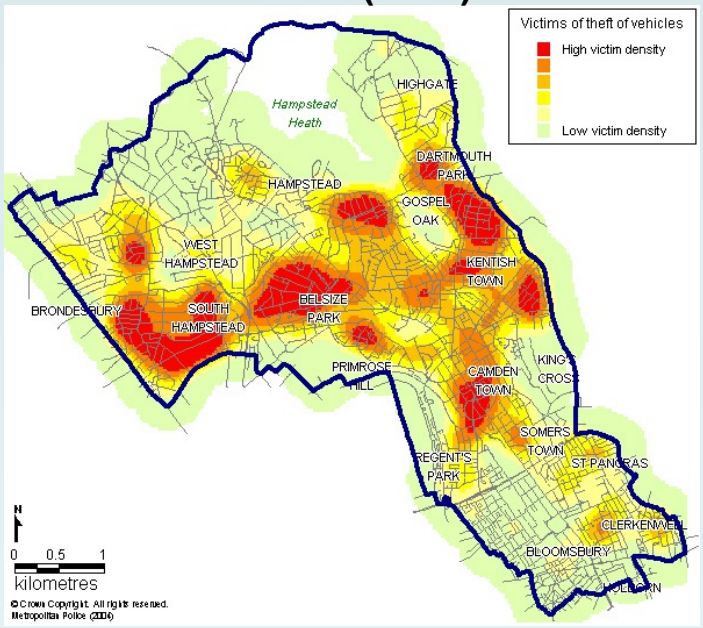
UCL Jill Dando Institute of Crime Science

Victims

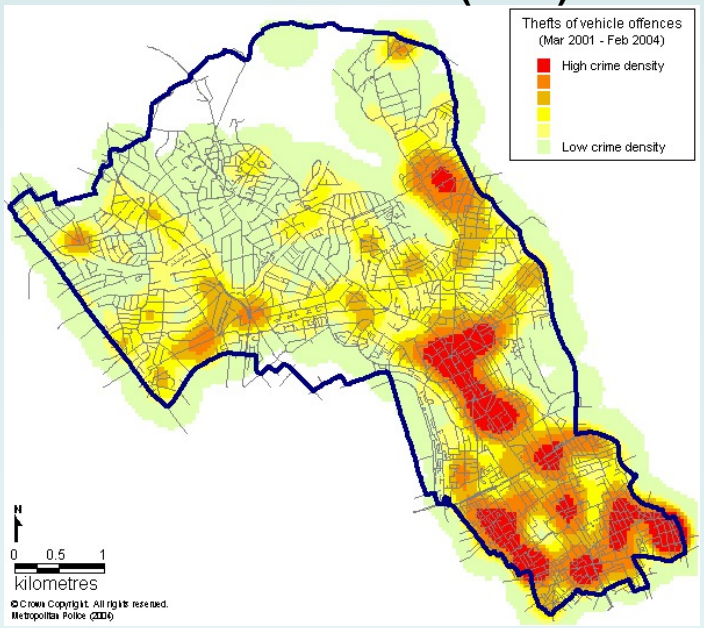
Theft of vehicles



Camden victims (58%)



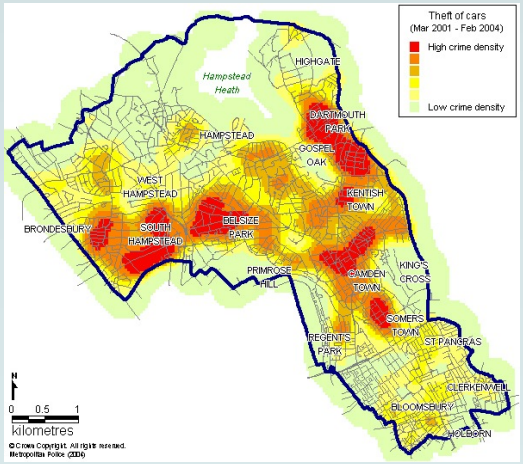
Non-Camden victims (42%)



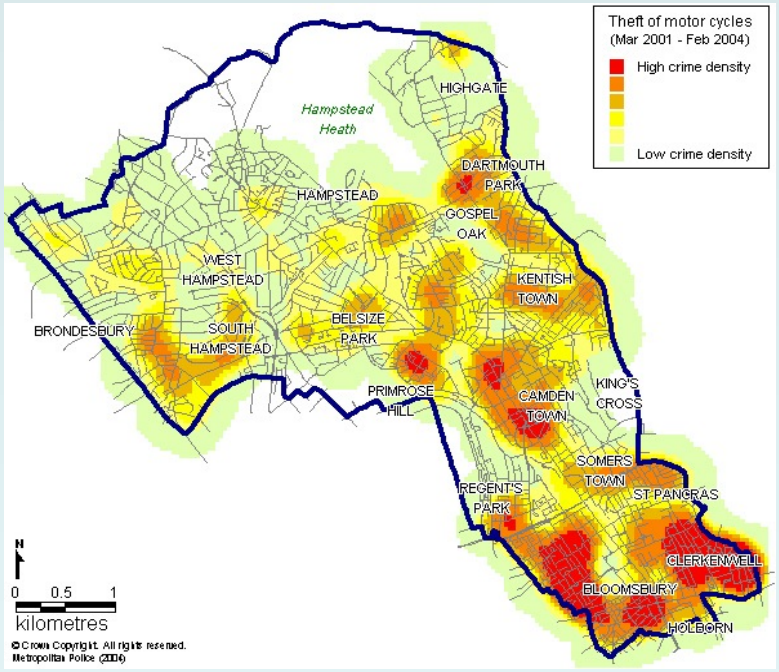
Type of vehicles stolen

Vehicle type description	Offences	%
Hatchback	1258	21.7%
Saloon	1433	24.7%
Estate	220	3.8%
People carrier	45	0.8%
Convertible	120	2.1%
Sports	42	0.7%
4 X 4's	4	0.1%
Moped or scooter	1494	25.8%
Motor cycle	755	13.0%
Motor caravan	11	0.2%
Van	274	4.7%
Other	50	0.9%
Not known	23	0.4%

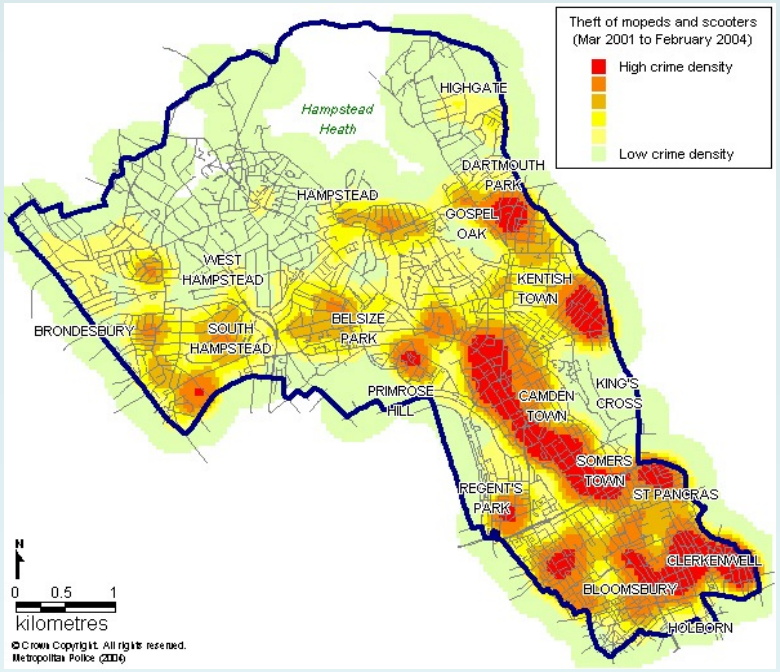
Cars



Motorbikes

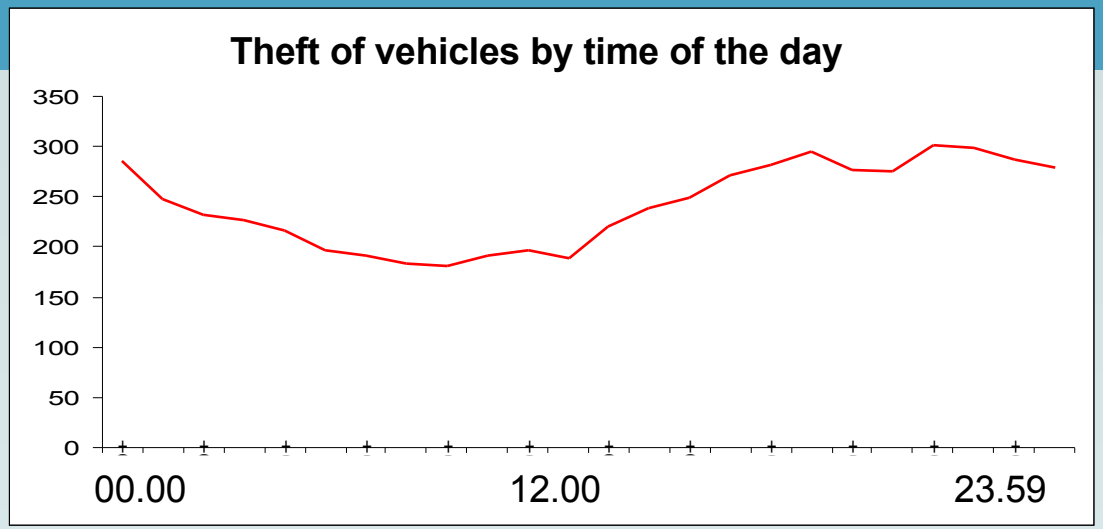


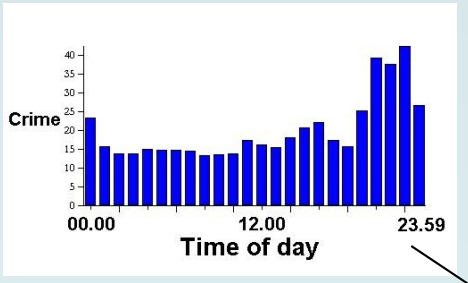
Scooters and mopeds

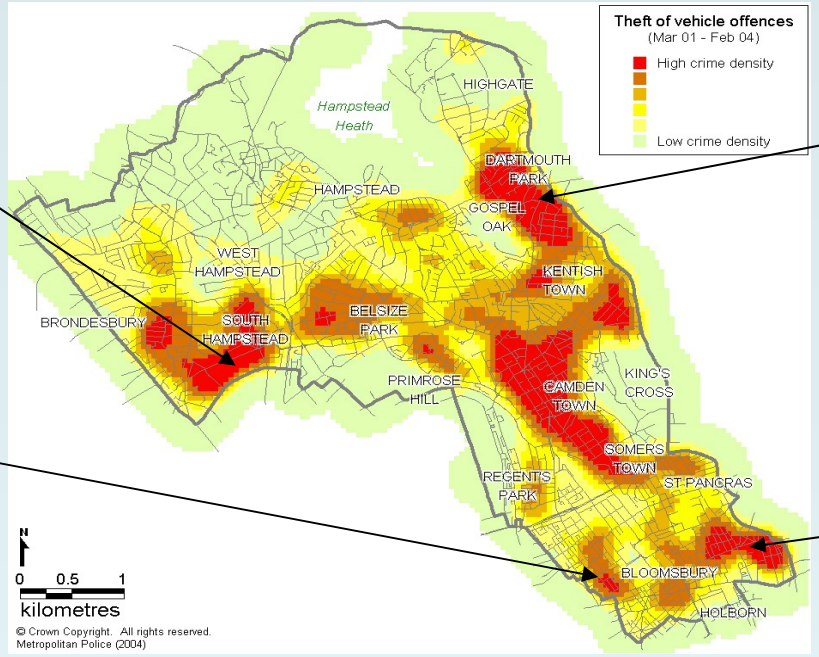


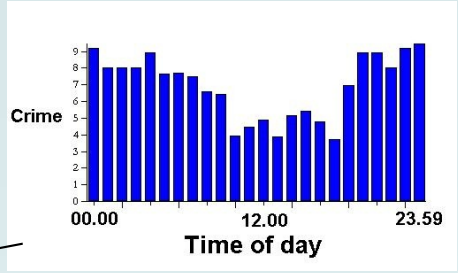
UCL Jill Dando Institute of Crime Science

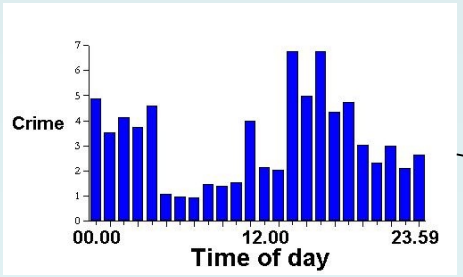
Place: space and time

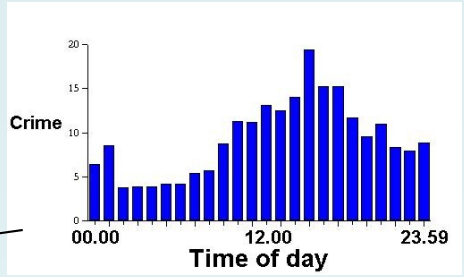






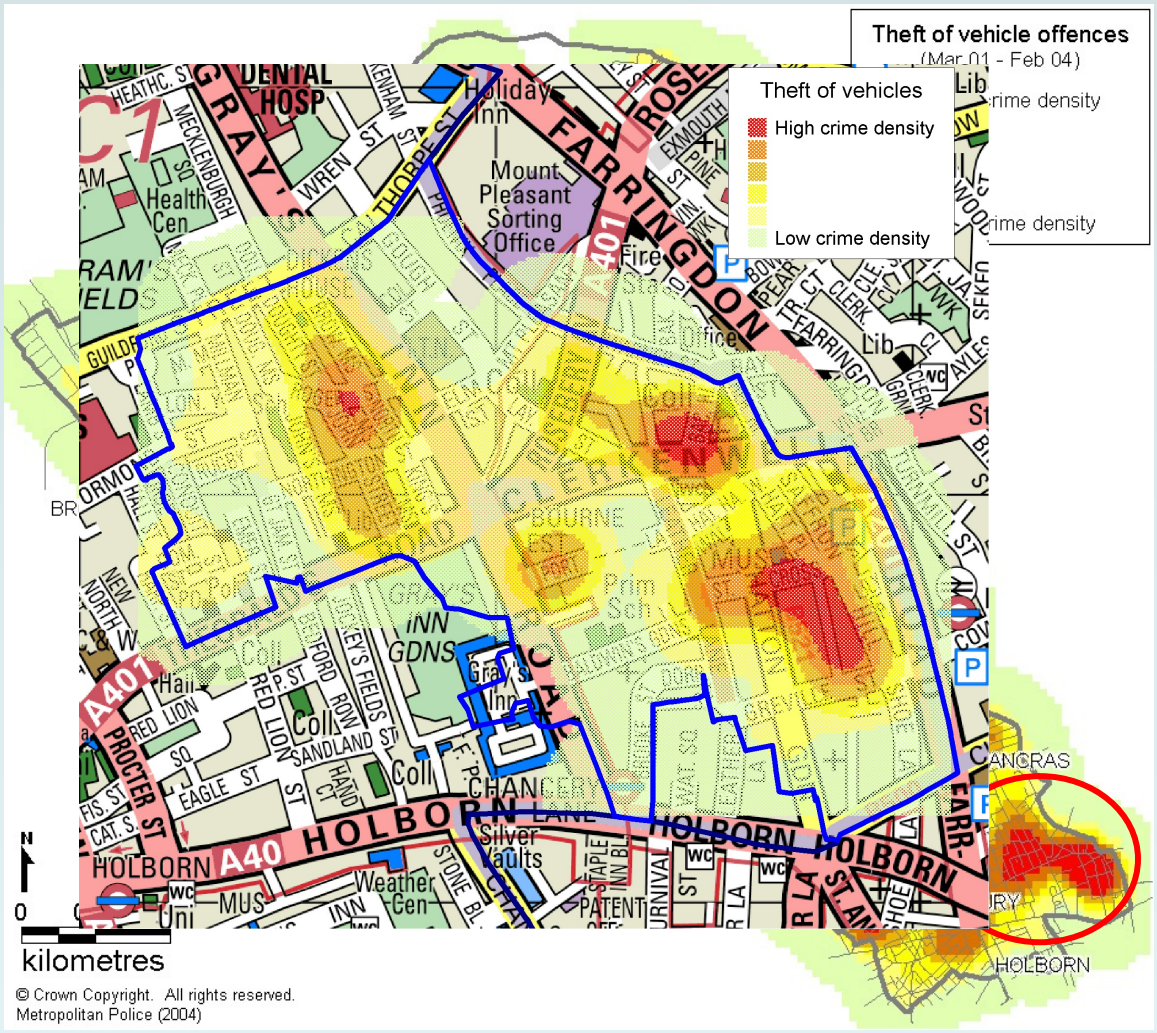




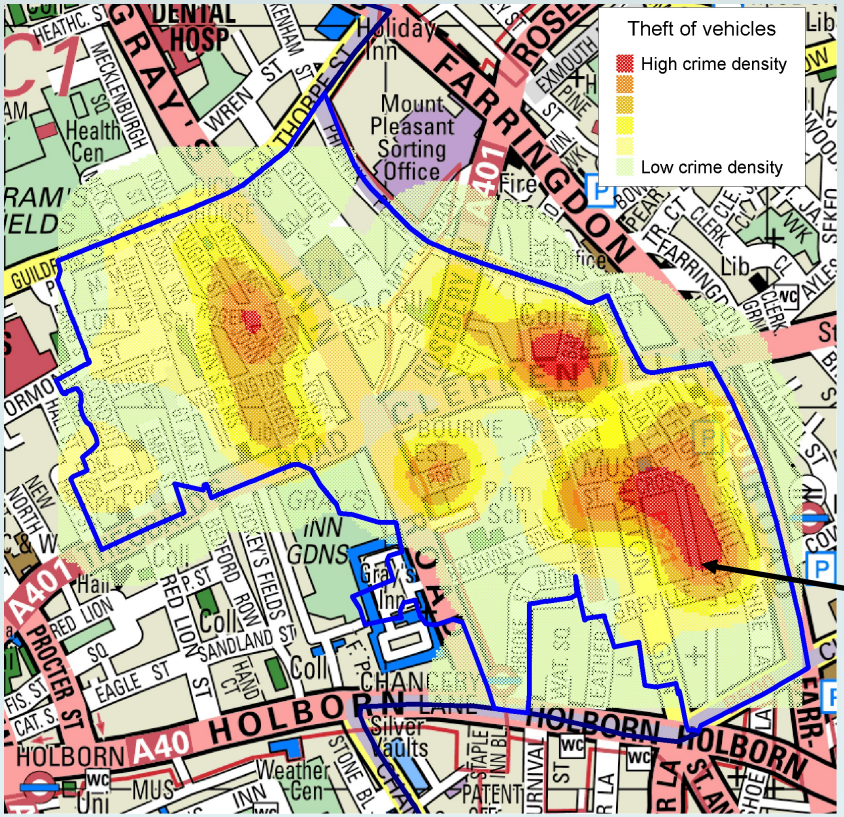


UCL Jill Dando Institute of Crime Science

Clerkenwell hotspot



Vehicle type	Camden	Clerkenwell (n)	Clerkenwell(%)
Car	51%	41	18%
Sports or convertible	3%	5	2%
Scooter or moped	26%	95	42%
Motor cycle	13%	70	31%
Van	5%	3	1%
Other	2.0%	10	4%
Not known	0.5%	0	0%



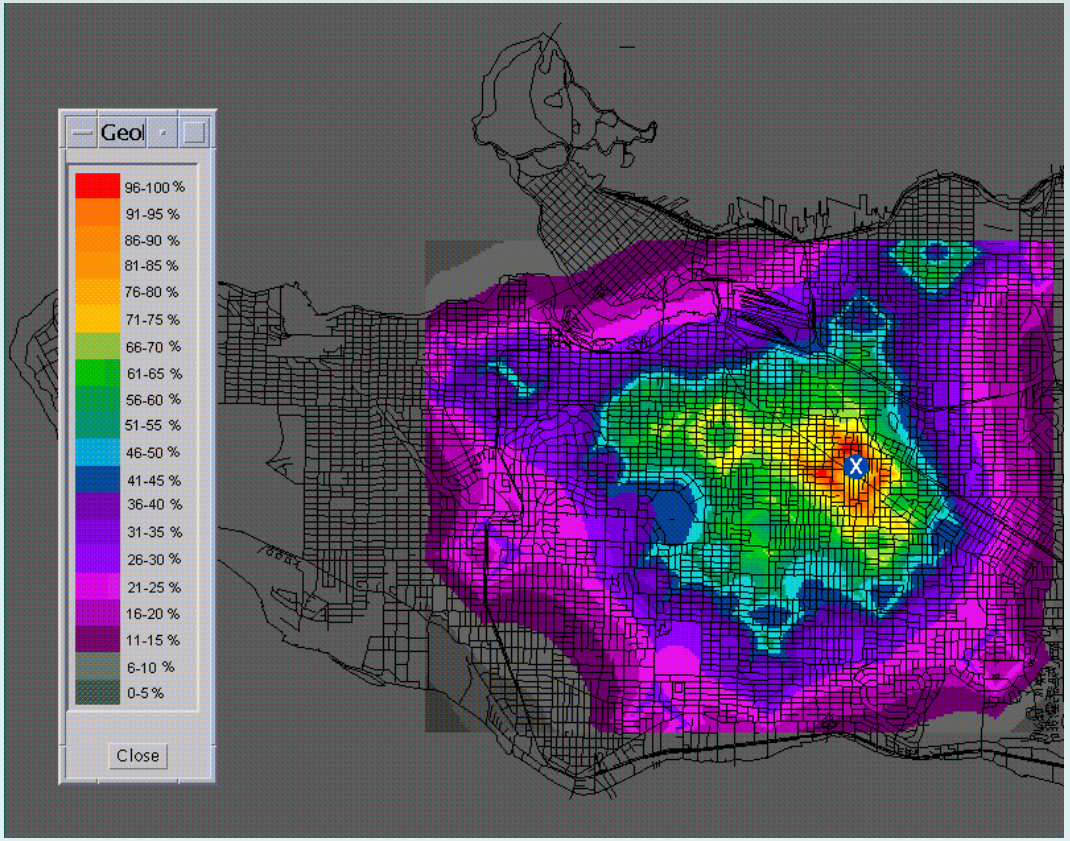
So it’s not all to do with residents having their cars stolen at night …

UCL Jill Dando Institute of Crime Science

Criminal investigations

Geographic profiling

- One of the biggest clues that an offender leaves behind when they commit a crime is where the crime happened
- Used to support an information management strategy for serial investigations
- Identifying the probable address of serial offenders

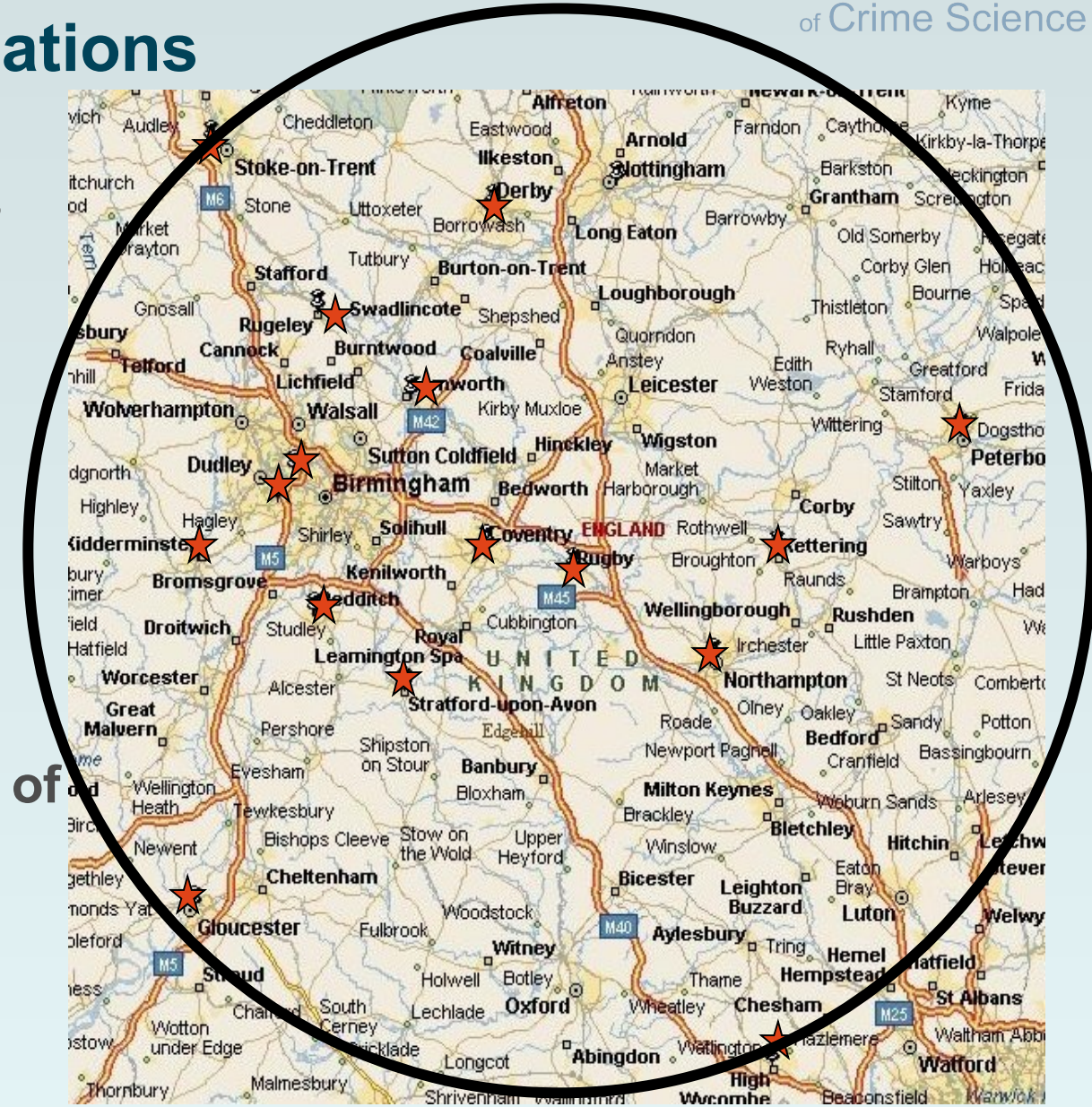


Criminal investigations

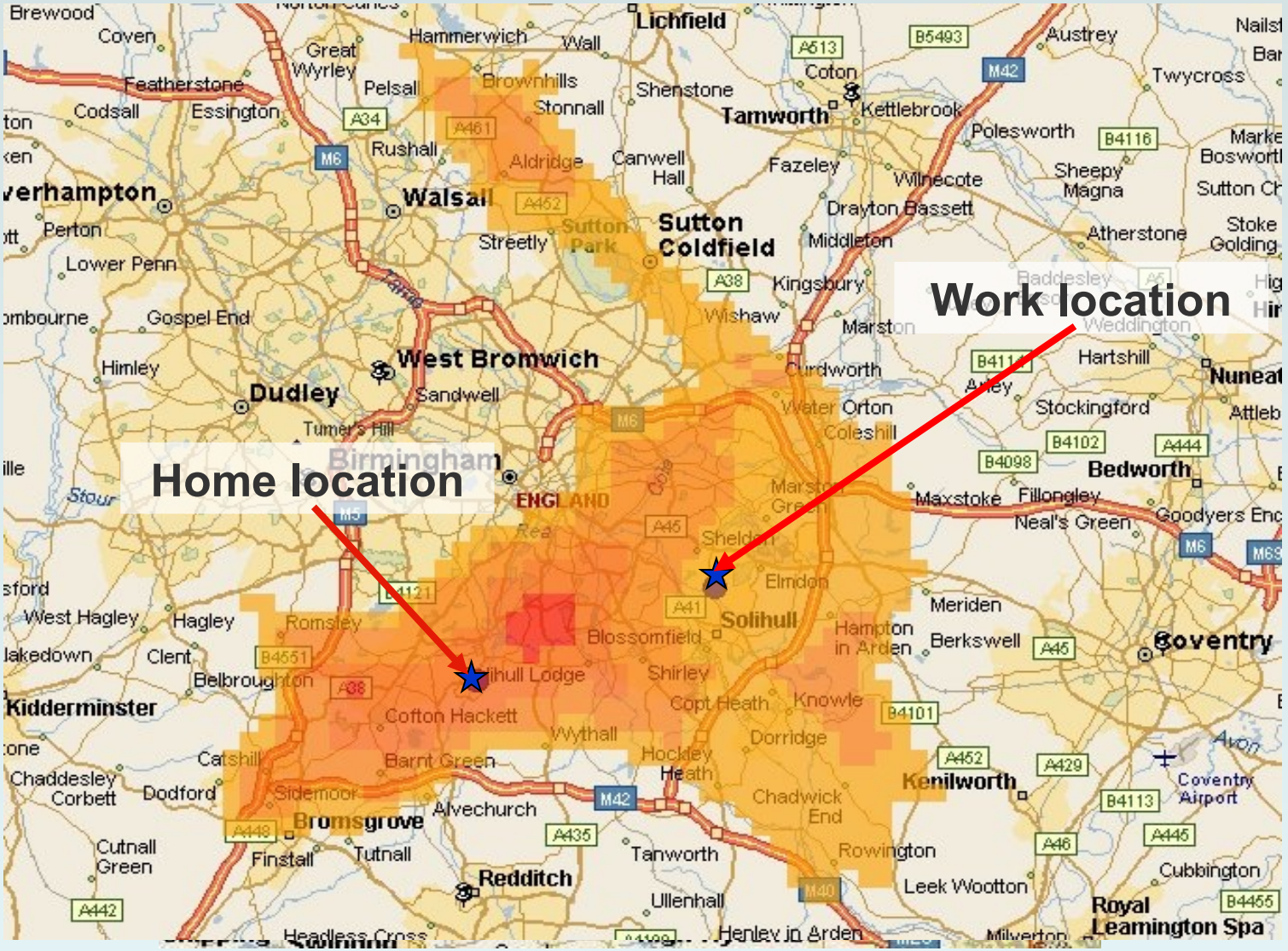
Geographic profiling

- 24 armed robberies 1995-2005
- 10 Police Forces
- 11,300 sq. miles
- 6.5 million people

- BBC CrimeWatch appeal
- Prioritising identity of suspects



Geographic profiling

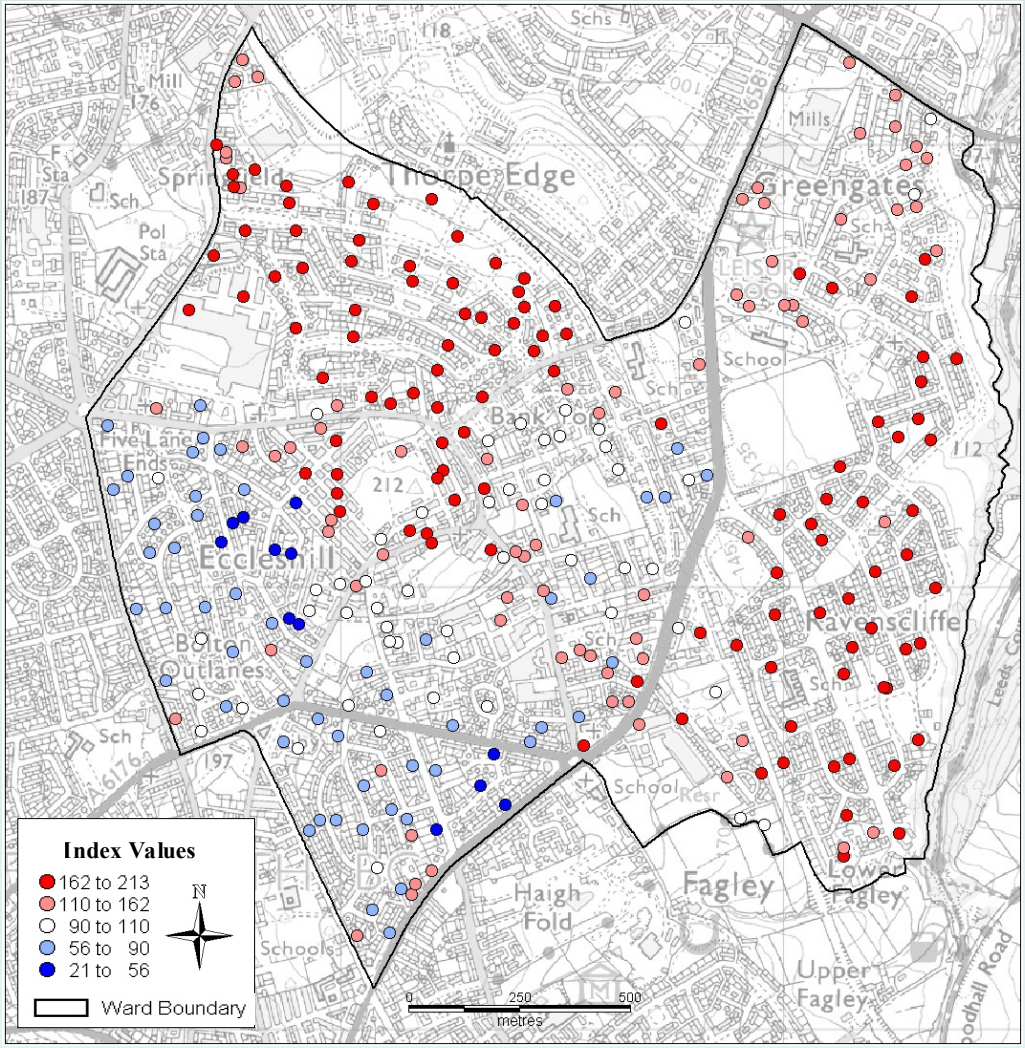


High fear neighbourhoods

Reassurance targeting

- Geodemographic data linked to the British Crime Survey
- E.g. The relative likelihood of the resident population perceiving teenagers hanging around as a very big problem in Eccleshill, Bradford

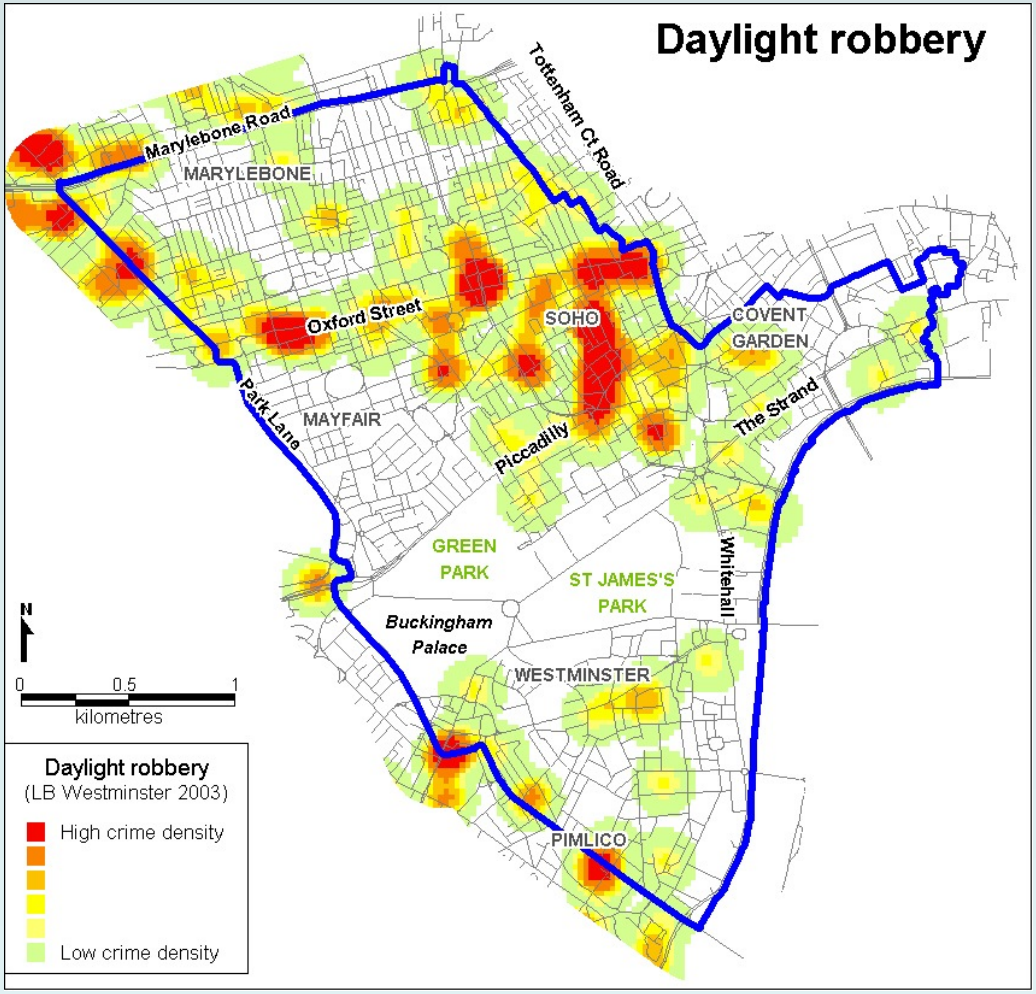
  (Source: Ashby, Chainey and Longley, 2008)



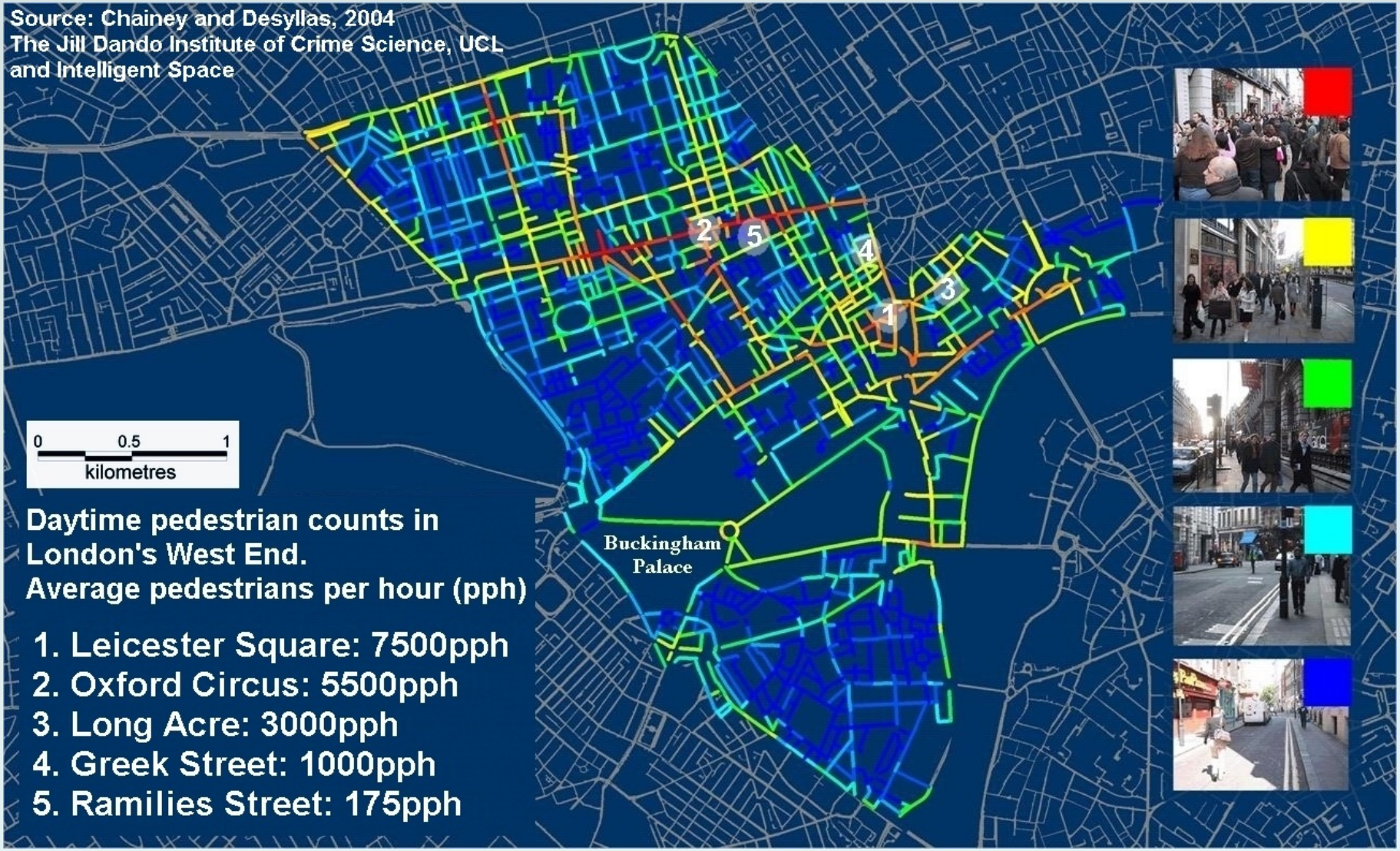
The future – crime mapping research

- To date research has been limited to exploring the where and when
  - Identifying retrospective concentrations of crime in space and time, and treating space and time discreetly
- More robust treatment to the current techniques
  - E.g. kernel density estimation: influence of cell size and bandwidth
- Exploring space and time together
- Beyond blobology
- Publishing crime statistics to the public
- The *significance* of where and when (spatial significance)
  - E.g. understand how unusual the crime pattern is
- Why (spatial regression)
  - E.g. relationship between why crime happens where it does against other features
  - Not just as a *global* relationship but as a *local* relationship
- What if (spatial modelling)
  - E.g. if we target an intervention to a particular place what impact may it have, including displacement and diffusion of benefit effects
- Where and when will it happen again (predictive modelling)
  - Forecasting, early warning system, predictive crime mapping

Beyond blobology - defining hotspots

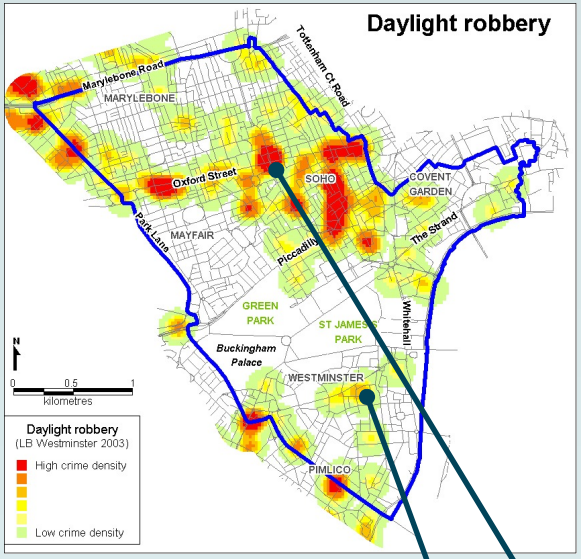


- Crime generators
  - High volume, low rate
- Crime attractors
  - High volume, high rate
- Crime enablers
  - Low volume, low rate


Source: Chainey and Desyllas, 2004
The Jill Dando Institute of Crime Science, UCL
and Intelligent Space
0
0.5
1
kilometres
Daytime pedestrian counts in
London's West End.
Average pedestrians per hour (pph)
1. Leicester Square: 7500pph
2. Oxford Circus: 5500pph
3. Long Acre: 3000pph
4. Greek Street: 1000pph
5. Ramilies Street: 175pph
Buckingham
Palace
1
2
3
4
5

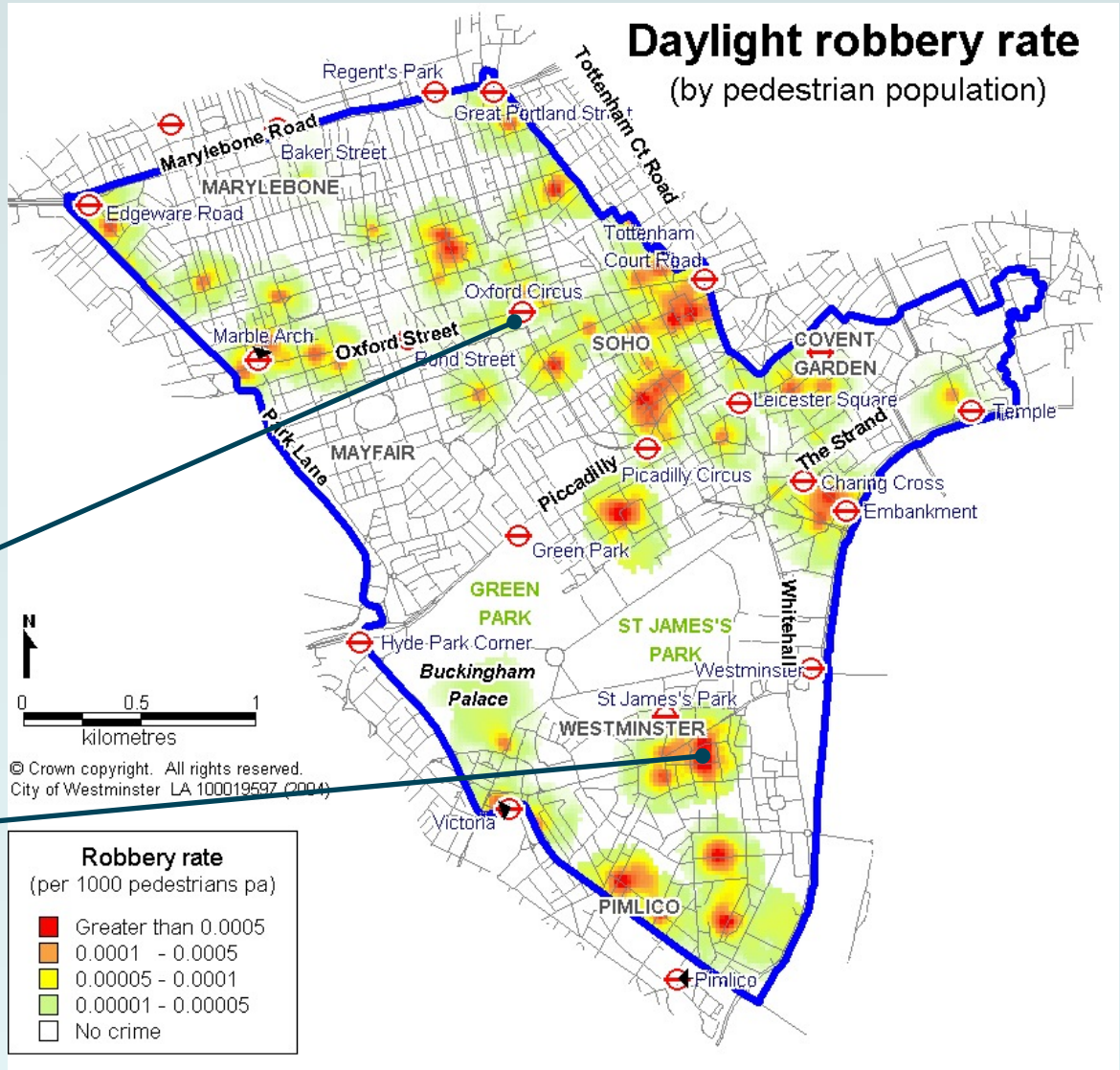
UCL Jill Dando Institute of Crime Science

Beyond blobology - defining hotspots



Oxford Circus: crime generator

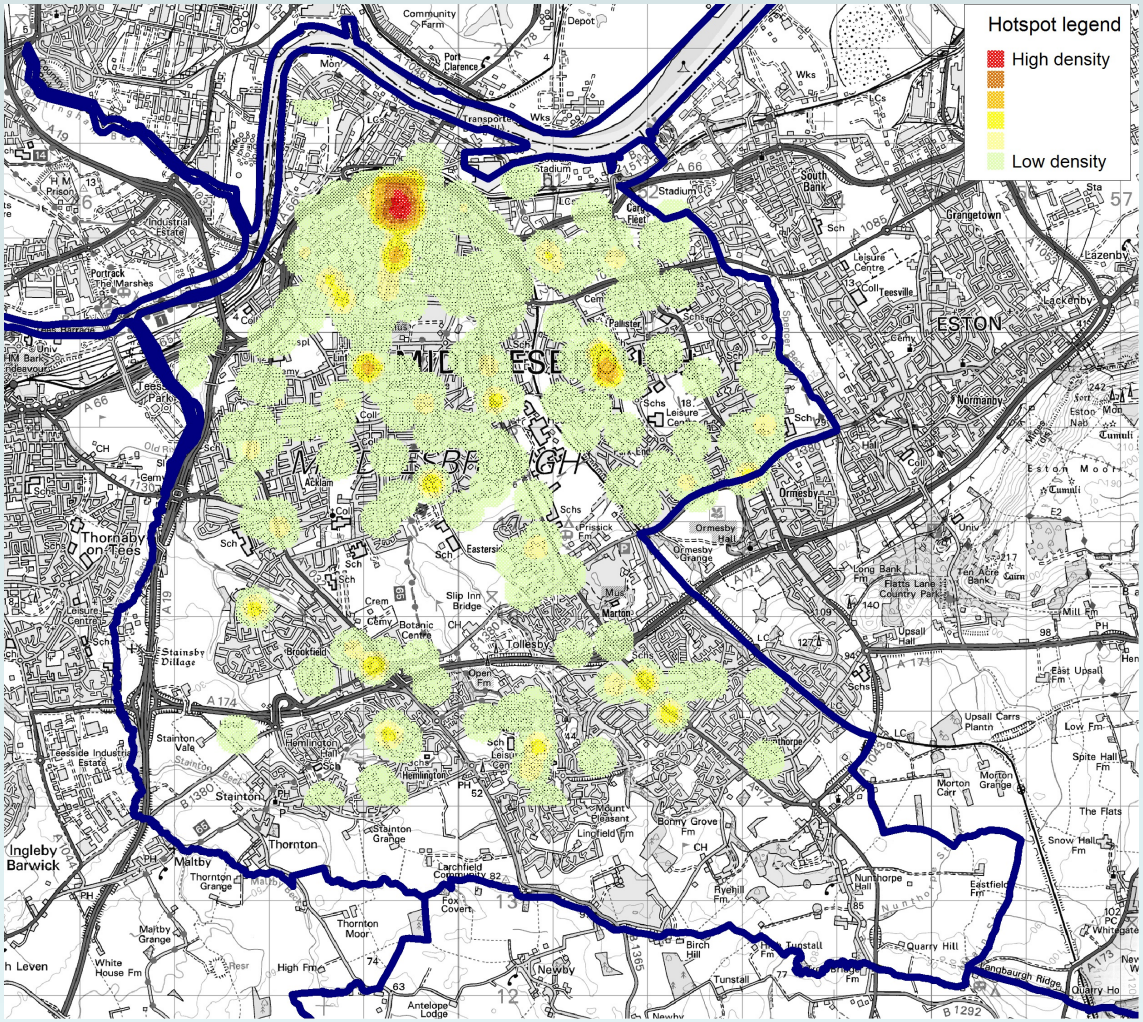
Scotland Yard: crime enabler



UCL Jill Dando Institute of Crime Science

Beyond blobology - defining hotspots

Middlesbrough - Theft from shops

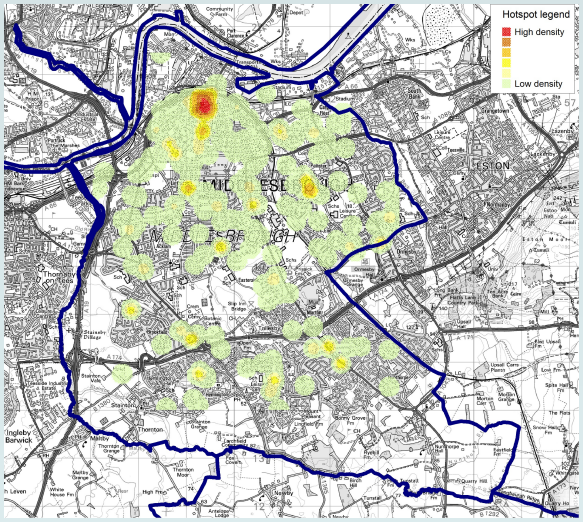


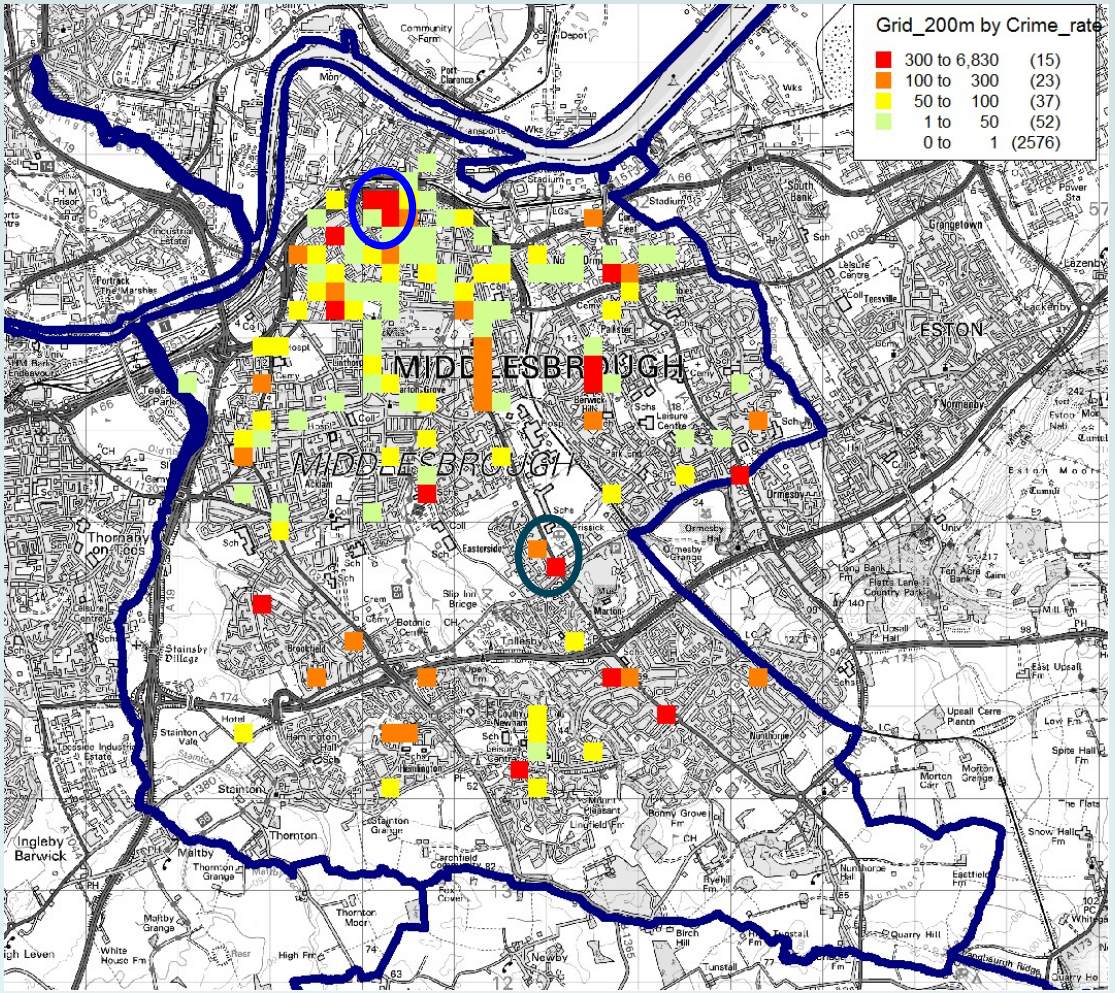
UCL Jill Dando Institute of Crime Science

Beyond blobology - defining hotspots

Middlesbrough - Theft from shops

OS Address Layer 'shops' as the denominator





Crime attractor

(high vol; high rate)

Cause: attracts offenders

Response: discourage offenders

Crime enabler

(low vol; high rate)

Cause: Erosion of controls

Response: restore guardianship handling and/or place management

UCL Jill Dando Institute of Crime Science

Neighbourhood crime stats for the public

- If we tell the public the facts about crime in their local area it will increase their fear of crime?

  "We don't get the true picture, we want to know what's really going on in our area, rather than just relying on stories from the press" West Yorkshire Resident
- The public perception of crime is often 10 to 100 times greater than actual crime levels
- Why is it important to provide the public with neighbourhood crime facts
  - support a positive reassurance message that addresses the public's fear, worries and perceptions of crime.
  - demonstrate how the police and partners are performing
  - promotes transparency and accountability
  - improves the credibility of crime statistics
  - manages and supports public and media enquiries on crime statistics
  - supports a Police force's and CDRP's freedom of information obligations
  - because the Home Office said you should (Independent Review of Crime Statistics, 2006)
- How do we provide them with the facts at the moment?

Essex, Gwent, Merseyside, North Wales, Nottinghamshire, Suffolk police forces

Durham police and South Wales police

- *Don't look at us – visit the Home Office website if you want crime stats ….*

Thames Valley

http://www.thamesvalley.police.uk/news_info/planning/performance/pf03-0

SUMMARY OF NOTIFIABLE OFFENCES IN OXFORD: 1 APRIL - 31 MARCH 2005

OFFENCES	FINALLY RECORDED				CRIMES PER 1000 POPULATION/HOUSEHOLD			CLEARED UP			CLEAR UP RATE		
	2002/2003	2003/2004	2004/2005	%CHANGE	2002/2003	2003/2004	2004/2005	2002/2003	2003/2004	2004/2005	2002/2003	2003/2004	2004/2005
Burglary Dwelling and Related Offences													
Burglary Dwelling (Households)	1,270	1,330	982	-26.2	24.55	25.71	18.42	352	241	349	27.7	18.1	35.5
Criminal Damage to Dwellings (Households)	847	936	904	-3.4	16.37	18.09	16.96	172	143	192	20.3	15.3	21.2
Burglary non Dwelling	1,237	950	943	-0.7	9.21	7.08	7.01	198	123	222	16.0	12.9	23.5
Criminal Damage to other Buildings	421	425	392	-7.8	3.14	3.17	2.91	86	89	76	20.4	20.9	19.4
Vehicle Crime and Related Offences													
Theft of Vehicle	795	791	744	-5.9	5.92	5.89	5.53	378	176	181	47.5	22.3	24.3
Theft from Vehicle	2,214	1,781	1,466	-17.7	16.49	13.27	10.89	350	311	189	15.8	17.5	12.9
(Total Theft of and From)	3,009	2,572	2,210	-14.1	22.41	19.16	16.42	728	487	370	24.2	18.9	16.7
Vehicle Interference	401	330	310	-6.1	2.99	2.46	2.30	34	28	18	8.5	8.5	5.8
Criminal Damage to Vehicles	1,039	1,165	1,095	-6.0	7.74	8.68	8.13	116	103	118	11.2	8.8	10.8
Violent Crime													
Violence Against the Person (excluding Disorder)	2,517	2,551	2,824	10.7	18.75	19.00	20.98	1,436	1,211	1,376	57.1	47.5	48.7
Disorder (Public Order,Violent Disorder,Riot and Affray)	321	329	510	55.0	2.39	2.45	3.79	287	287	446	89.4	87.2	87.5
Sexual Offences	166	166	205	23.5	1.24	1.24	1.52	54	47	64	32.5	28.3	31.2
Total Robbery	323	291	270	-7.2	2.41	2.17	2.01	106	81	71	32.8	27.8	26.3
Total Violent Crime	3,298	3,291	3,779	14.8	24.57	24.51	28.07	1,863	1,592	1,932	56.5	48.4	51.1
Street Crime													
Robbery Business	33	28	16	-42.9	0.25	0.21	0.12	14	10	12	42.4	35.7	75.0
Robbery Personal	290	263	254	-3.4	2.16	1.96	1.89	92	71	59	31.7	27.0	23.2
Snatch Theft	158	141	150	6.4	1.18	1.05	1.11	16	16	14	n/a	11.3	9.3
Drug Offences													
Drug Trafficking	56	48	59	22.9	0.42	0.36	0.44	50	46	44	89.3	95.8	74.6
Possession of Controlled Drugs (Excluding Cannabis)	0	0	137	n/a	0.00	0.00	1.02	0	0	115	n/a	n/a	83.9
Possession of Controlled Drugs (Cannabis)	0	0	469	n/a	0.00	0.00	3.48	0	0	380	n/a	n/a	81.0
Racially Aggravated Crime	81	99	143	44.4	0.60	0.74	1.06	29	30	50	35.8	30.3	35.0
TOTAL ALL CRIME	**22,564**	**21,504**	**21,646**	**0.7**	168.07	160.18	160.81	**6,516**	**5,246**	**6,487**	**28.9**	**24.4**	**30.0**
Other Incidents													
Domestic Incidents - Recorded Crime	851	966	1111	15.0	6.34	7.20	8.25						
Domestic Incidents - Non Recordable Crime	593	790	931	17.8	4.42	5.88	6.92						
Homophobic - Recorded Crime	13	16	21	31.3	0.10	0.12	0.16						
Homophobic - Non Recordable Crime	3	5	4	-20.0	0.02	0.04	0.03						
Racist - Recorded Crime	107	133	180	35.3	0.80	0.99	1.34						
Racist - Non Recordable Crime	33	41	45	9.8	0.25	0.31	0.33						

Force target achieved Force target not achieved

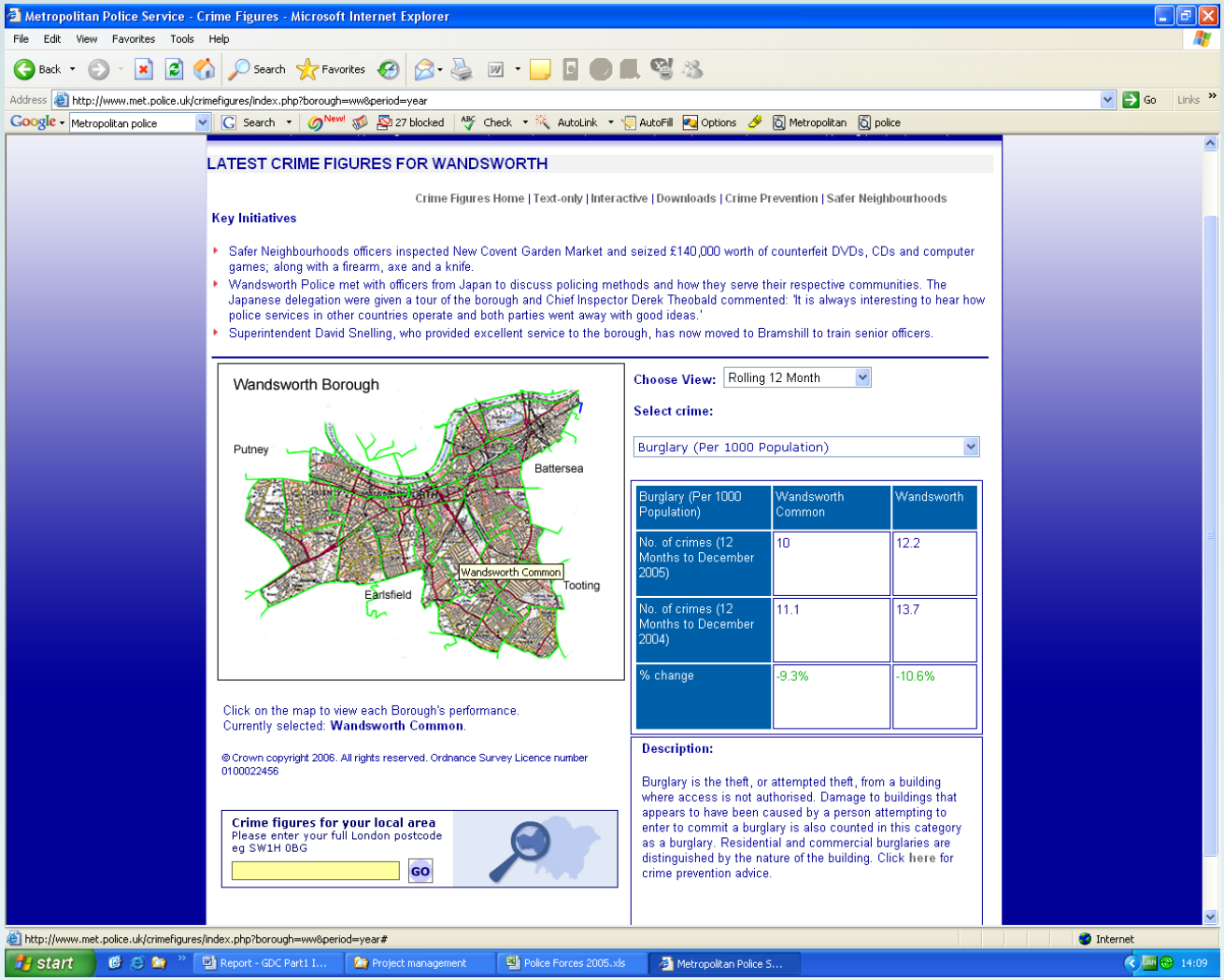
Local Reduction Targets: Robbery 5% Burglary Dwelling 5% Vehicle Crime 10%
Local Detection Targets: Robbery 30% Burglary Dwelling 25% Vehicle Crime 20%

From April 2003 crime recorded in previous years and no crimed in the current year is discounted from crime figures. This results in lower crime and higher detection rates. This does not apply to historic data.

Source: EIS & CEDAR Population is based on 2002 and 2003

London

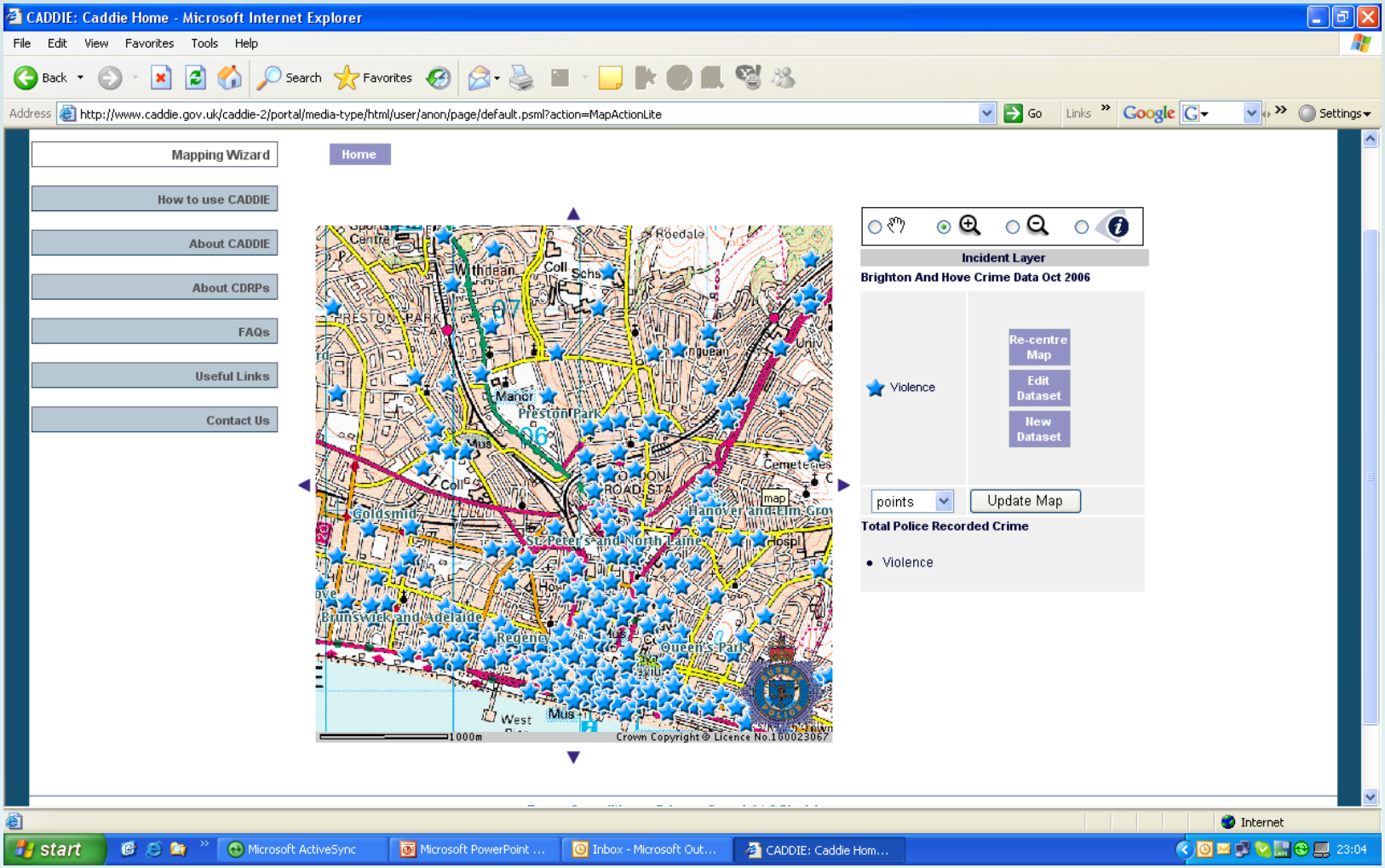
www.met.police.uk/crimefigures/index.php



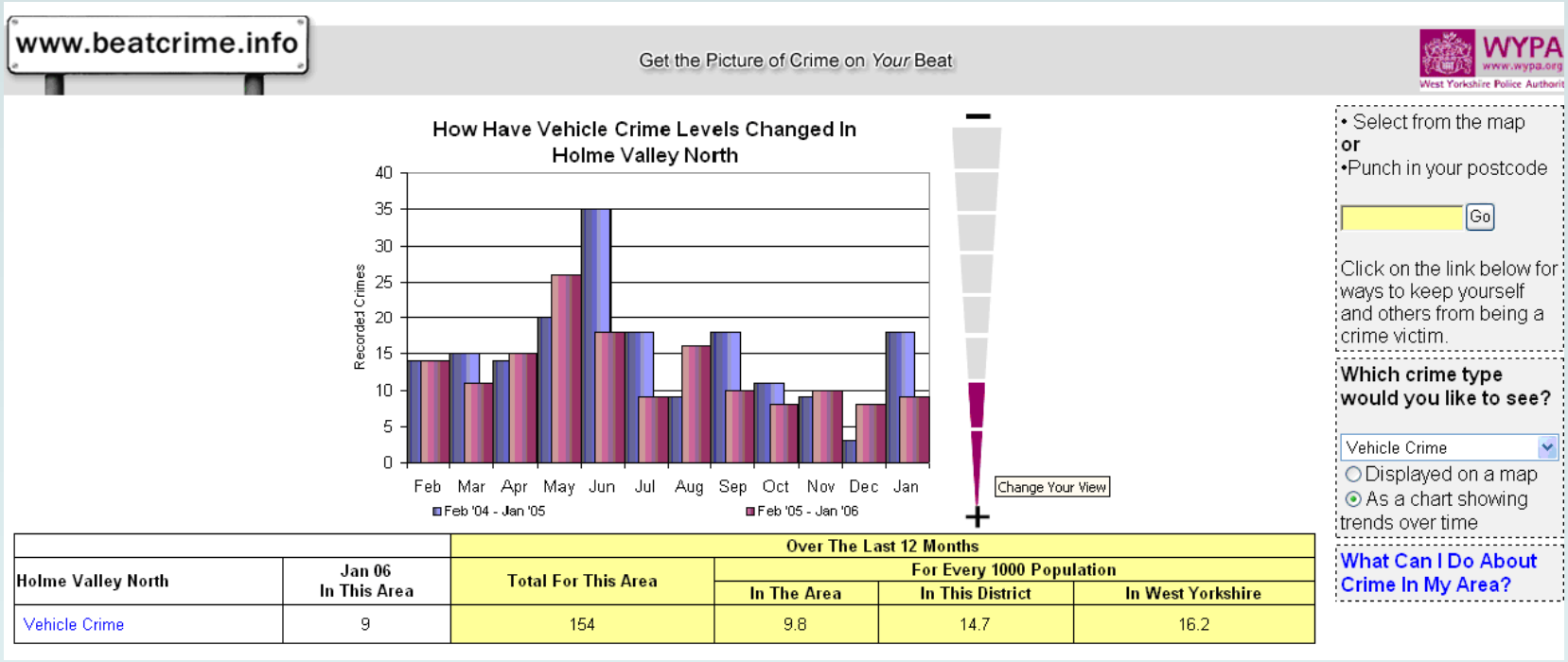
UCL Jill Dando Institute of Crime Science

Sussex

…15 clicks later



West Yorkshire



		Over The Last 12 Months			
Holme Valley North	Jan 06 In This Area	Total For This Area	For Every 1000 Population		
			In The Area	In This District	In West Yorkshire
Vehicle Crime	9	154	9.8	14.7	16.2

"It's easy to see what's going on by just looking at the maps, much better to look at a picture like this than a load of statistics which I won't understand"

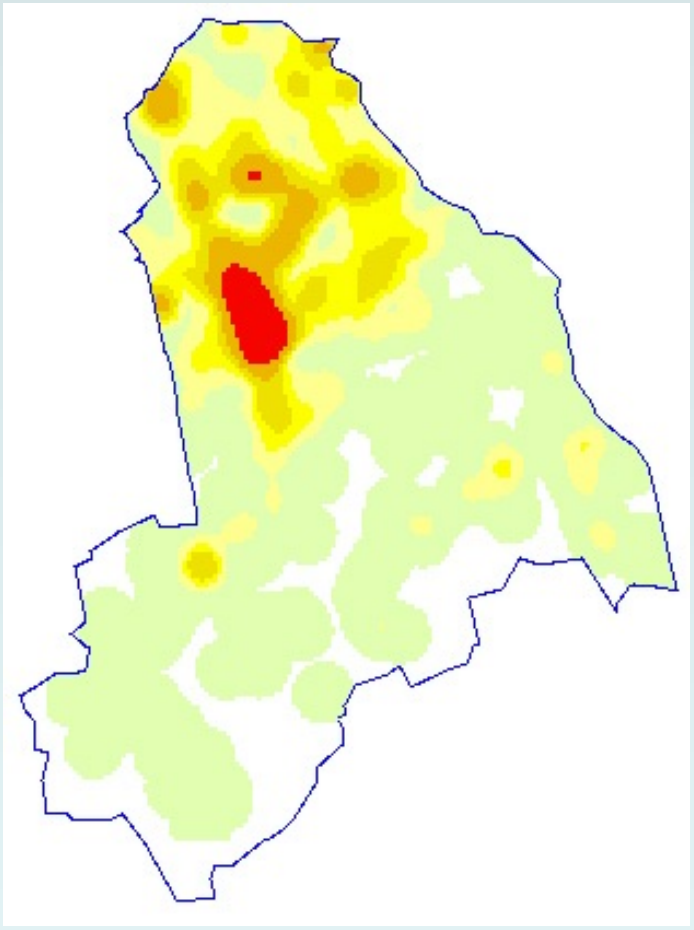
West Yorkshire Resident

"In most cases, the incidence of offending is lower than people perceive and the effect is to reassure, rather than alarm the viewer"

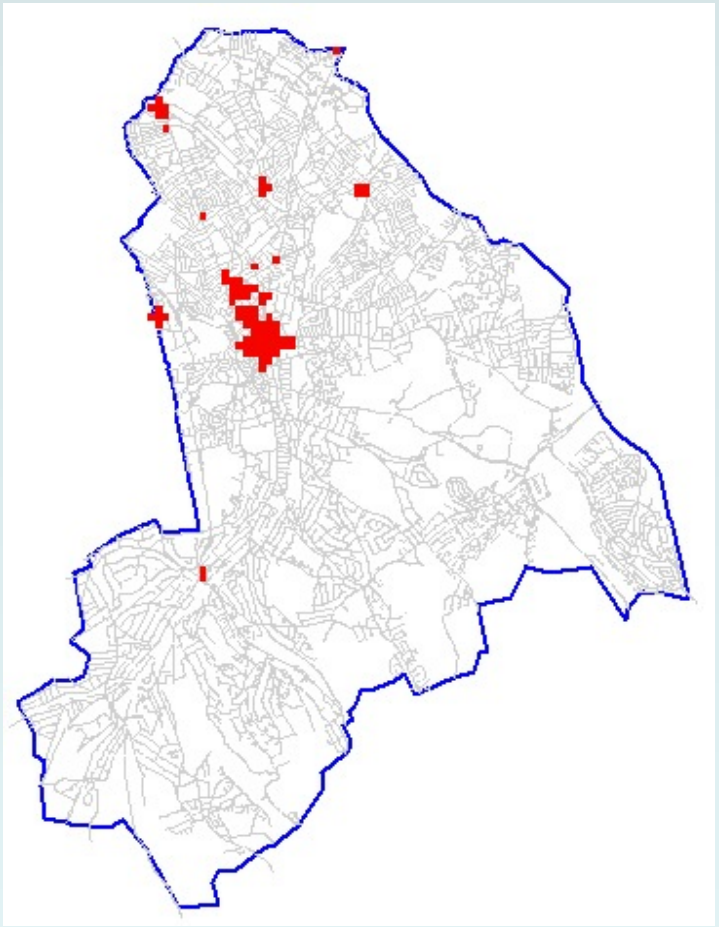
West Yorkshire Police Authority

Significance? Where is something really usual occurring?

KDE

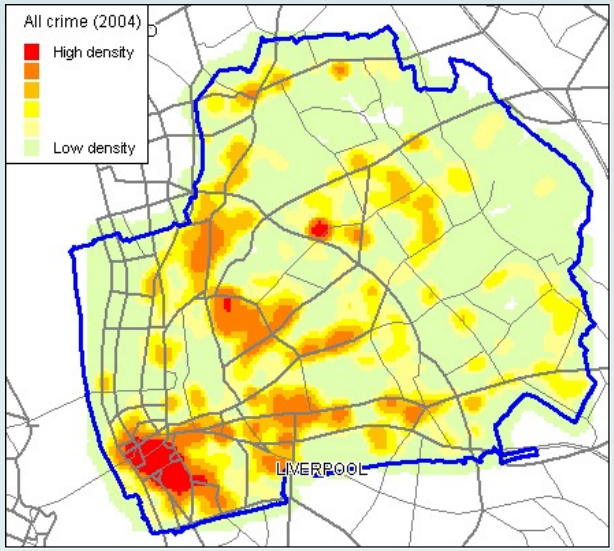


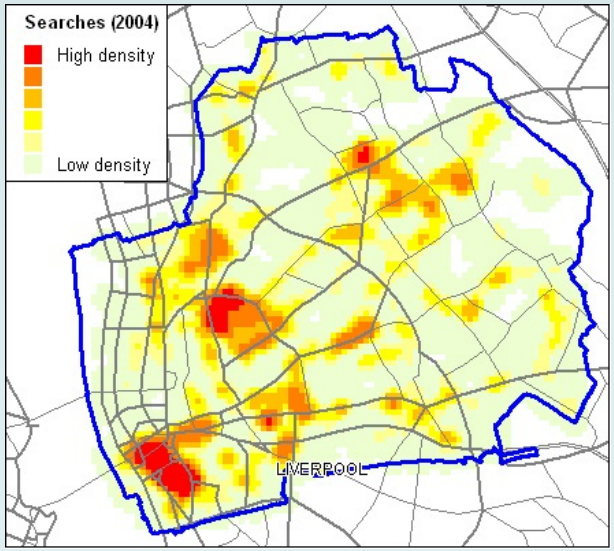
Gi*

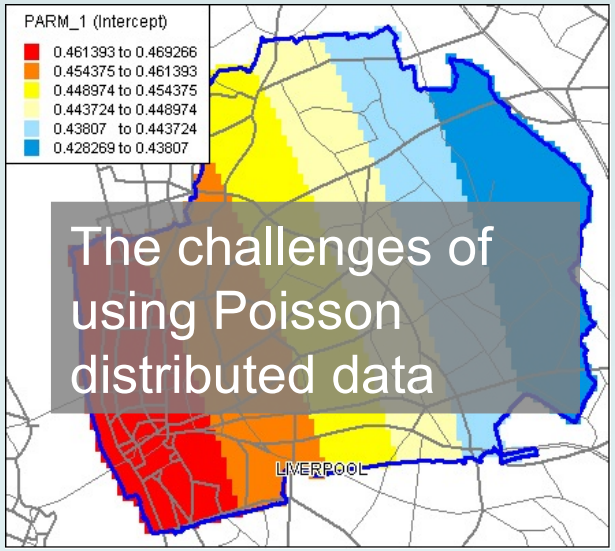


Why? Spatial regression

- Geographically Weighted Regression: to see how crime varies over space in relation to the spatial distribution of searches (i.e. where are there more (or less) searches than we would expect in relation to the distribution of crime?)



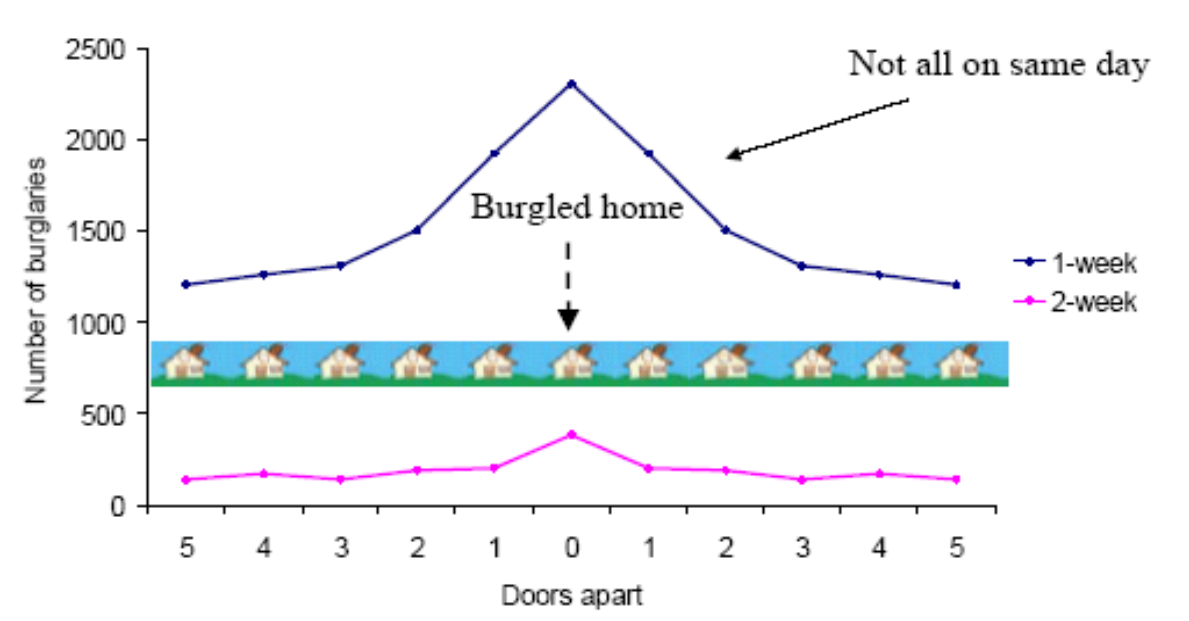




The challenges of using Poisson distributed data

Where is it going to happen next?

Prospective mapping



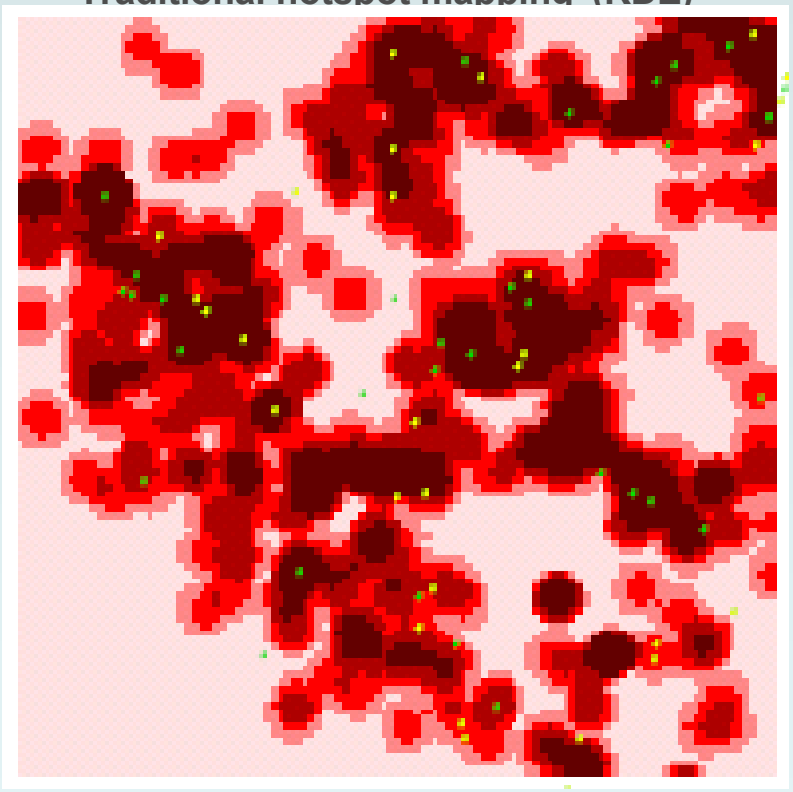
- Research: properties within 400m of a burgled house are at an elevated risk for upto one month – 'near repeats' (Bowers et al, 2004)
  - Burglary patterns were similar to those of communicable diseases
  - Were measured using techniques that were developed for epidemiology
  - Adapted these techniques for prospecting where burglary would spread to

Predicting the future

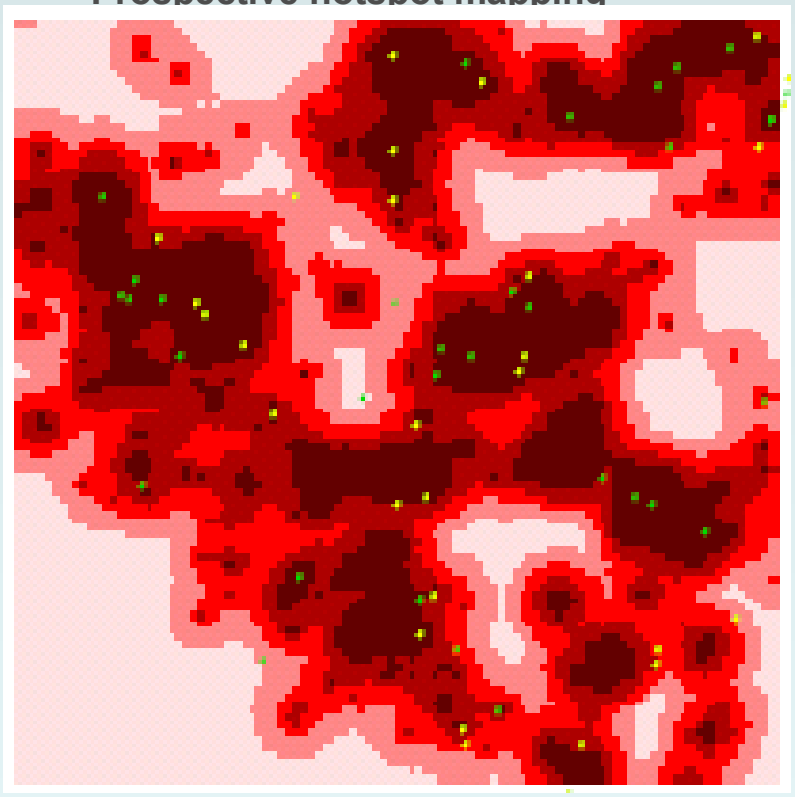
Prospective mapping

- 35% more accurate than common hotspot mapping techniques for showing where crime would happen next
  (accuracy measure does account for differences in hotspot area)

Traditional hotspot mapping (KDE)



Prospective hotspot mapping



Summary

- Place is important
  - Plays a key role for helping to understand and tackle crime problems
- Crime mapping supports many forms of operational, tactical, investigative and strategic policing and crime reduction activity
- Still only scratching the surface in how we exploit the place dimension of crime
- *"Crime mapping … has been fundamental in improving police performance in the West Midlands, and in recent months reducing all crime by 20%"*

Assistant Chief Constable Nick Tofiluk
West Midlands Police

UCL Jill Dando Institute of Crime Science

Thank you

Spencer Chainey

E: s.chainey@ucl.ac.uk

- My book …
- And my next book!
- Links to other publications