UK Research and Innovation
Missions Accelerator Programme

What are we measuring?

Modelling the consequences of key analytical choices in hotspot analysis

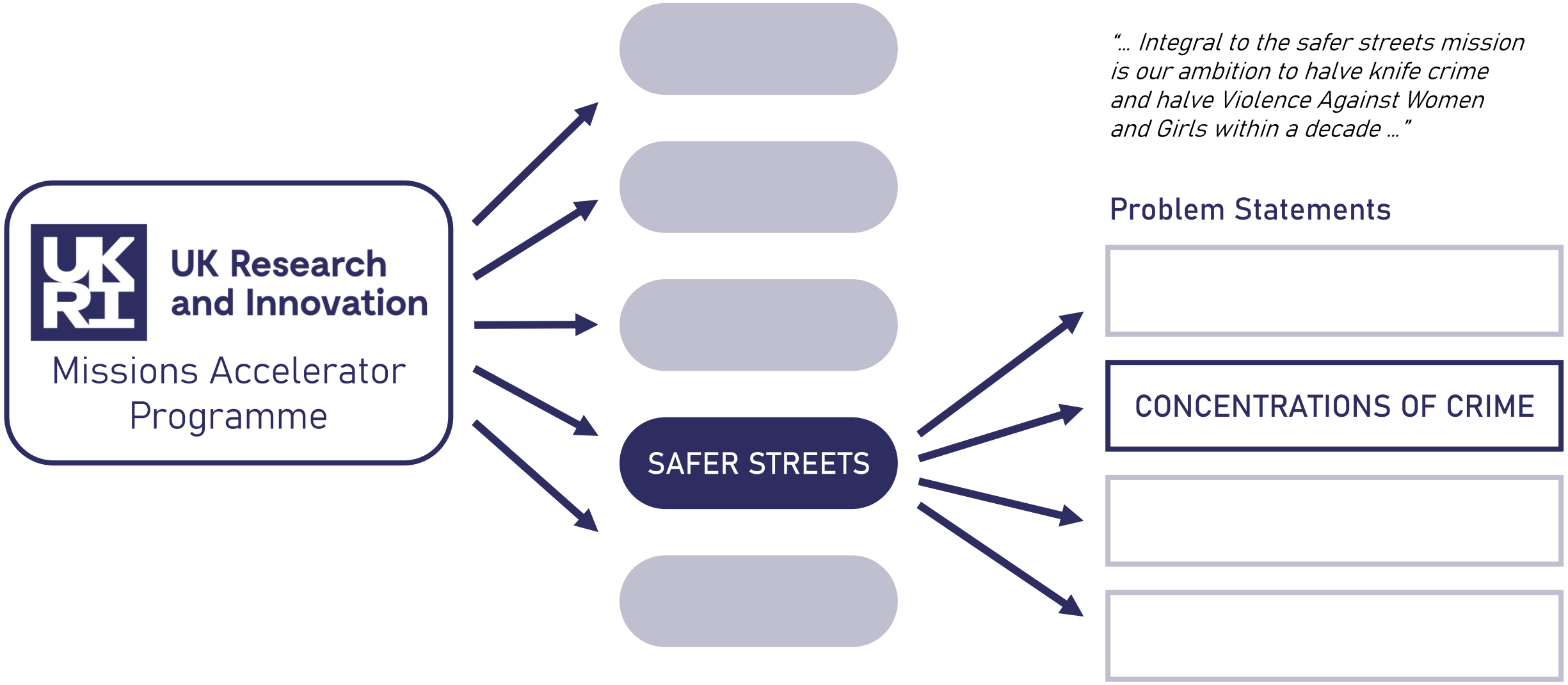
Toby Davies, Dan Birks & Andrew Smith

UNIVERSITY OF LEEDS

Vulnerability & Policing Futures Research Centre

typ-ace.
THE YORKSHIRE POLICING ACADEMIC CENTRE OF EXCELLENCE

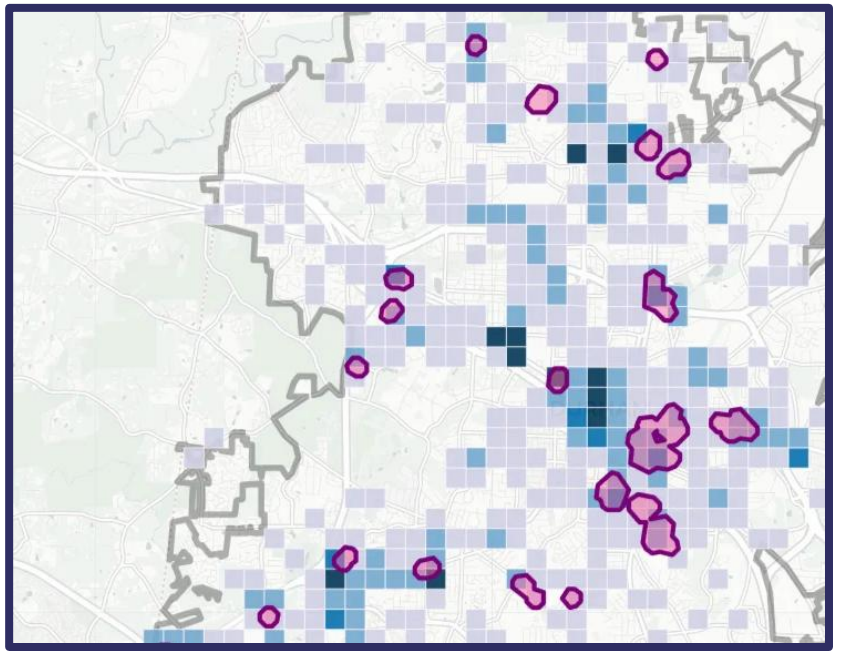
Context


UK Research and Innovation
Missions Accelerator Programme
SAFER STREETS
"... Integral to the safer streets mission is our ambition to halve knife crime and halve Violence Against Women and Girls within a decade ..."
Problem Statements
CONCENTRATIONS OF CRIME

Concentrations of Crime

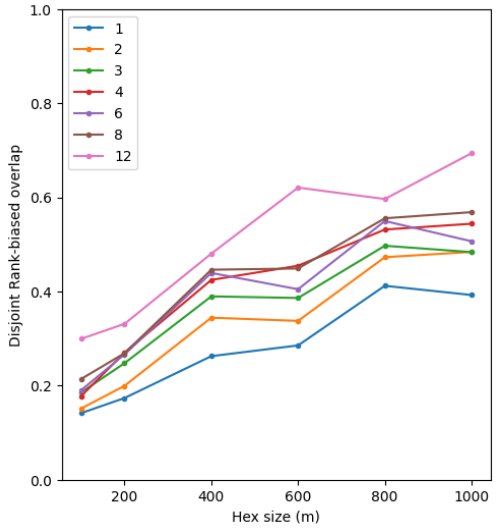
The Challenge:

- Systematise identification of **hyperlocal crime hotspots** to target crime prevention intervention.
- Develop approaches to better **match interventions to crime problems**
- Contribute to development of **national integrated mapping capability**

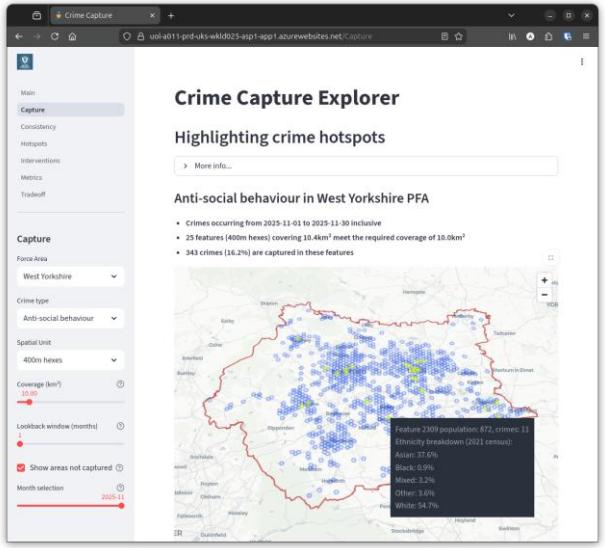


Key goals

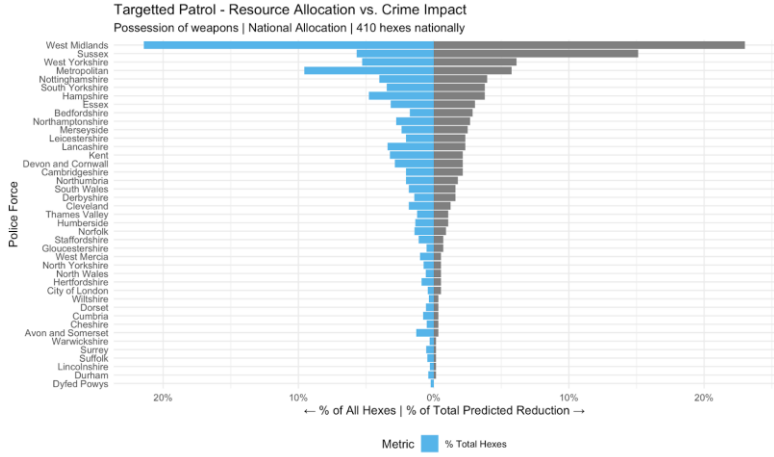
Quantify the effects of key analytical choices affecting the utility of hotspot maps.



Produce ‘explorable’ tools to allow experimentation and prototyping.



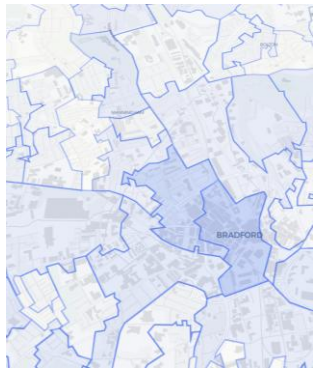
Estimate the preventative potential of interventions under different scenarios.



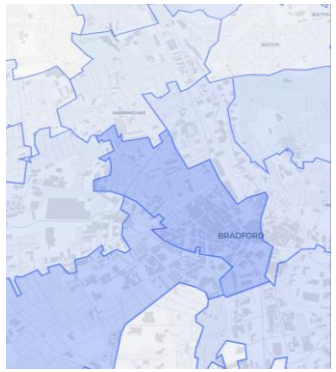
Analytic choices

A typical hotspot analysis scenario involves ‘hot’ areas being identified on the basis of data for some historical period. Three key choices:

- **Spatial unit**: What are the areas that can be identified?

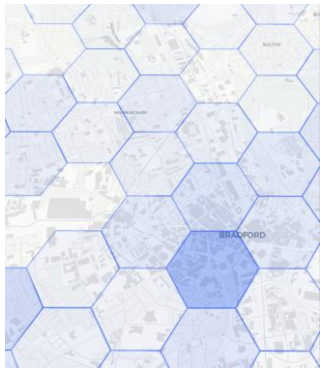


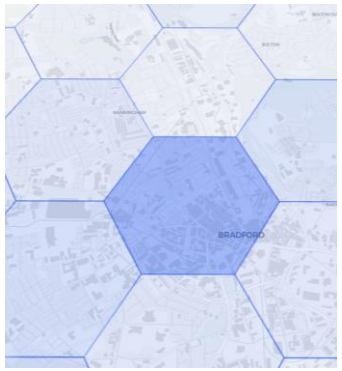
LSOA



MSOA

Grid



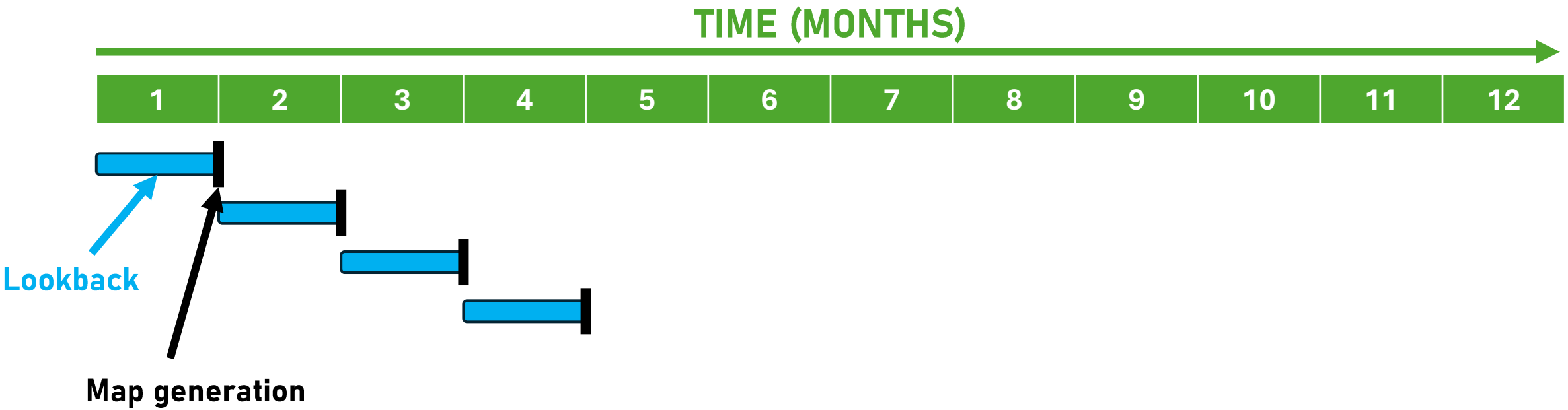


Hex

Analytic choices

A typical hotspot analysis scenario involves 'hot' areas being identified on the basis of data for some historical period. Three key choices:

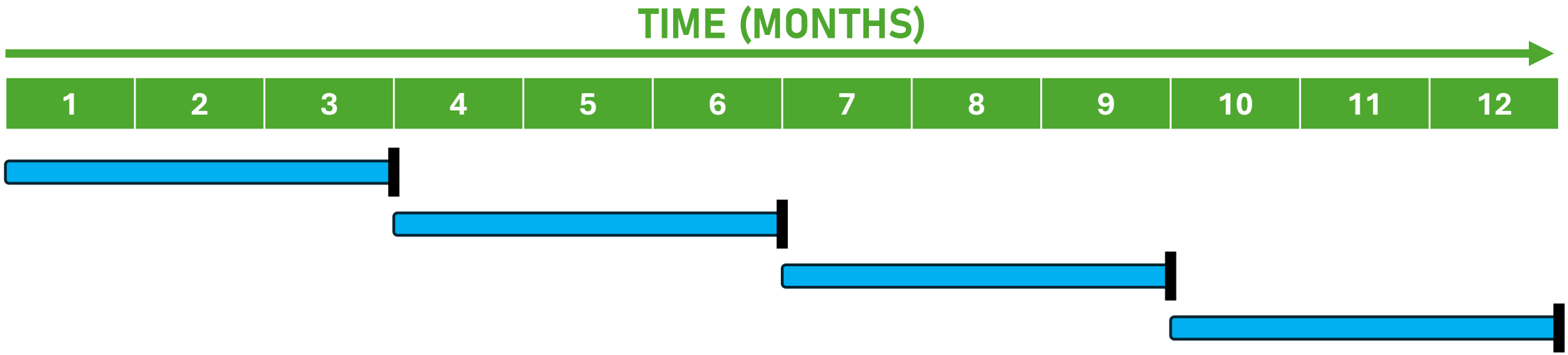
- **Spatial unit**: What are the areas that can be identified?
- **Lookback window**: What period of data is used to make the identification?



Analytic choices

A typical hotspot analysis scenario involves ‘hot’ areas being identified on the basis of data for some historical period. Three key choices:

- **Spatial unit**: What are the areas that can be identified?
- **Lookback window**: What period of data is used to make the identification?
- **Update frequency**: How often is the set of hotspots updated?



Outcomes

For any set of hotspot maps, can consider several key properties:

CONCENTRATION

The more pronounced the concentration, the greater the potential return from intervention

STABILITY

The more consistent the patterns identified, the greater the ability to address structural risks.

GEOMETRY

Pattern configuration (e.g. clumped/diffuse)

DEMOGRAPHICS

Proportionality of resident populations

COMPLEMENTARITY

Overlap between crime types

Results

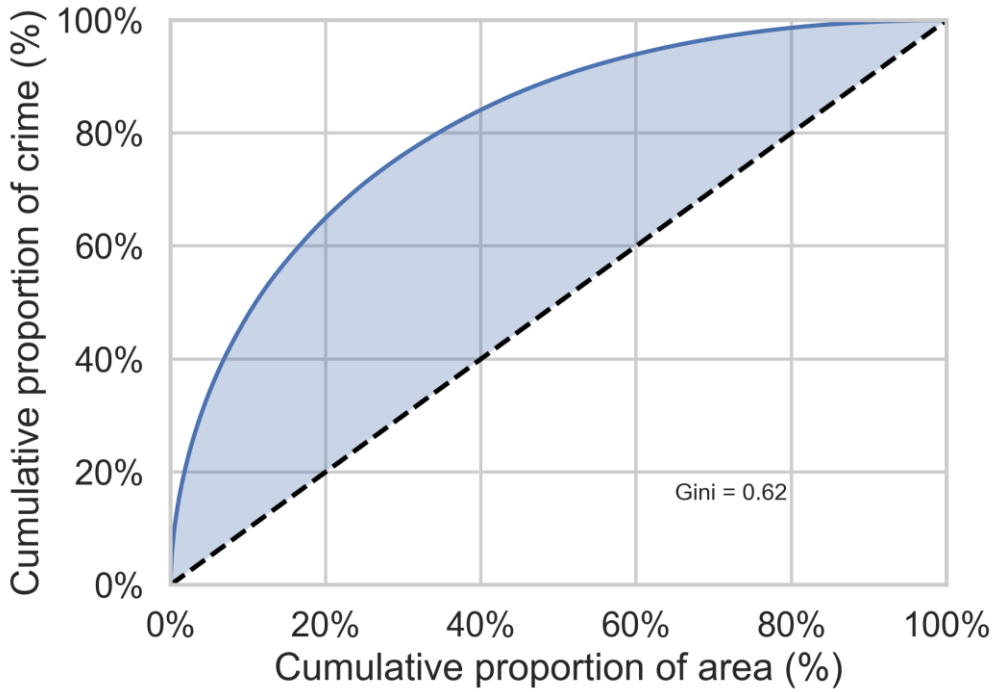
Findings shown for **Violence & Sexual Offences**
in **West Yorkshire**
using **open data**
for **3 years**

DATA.POLICE.UK

Concentration

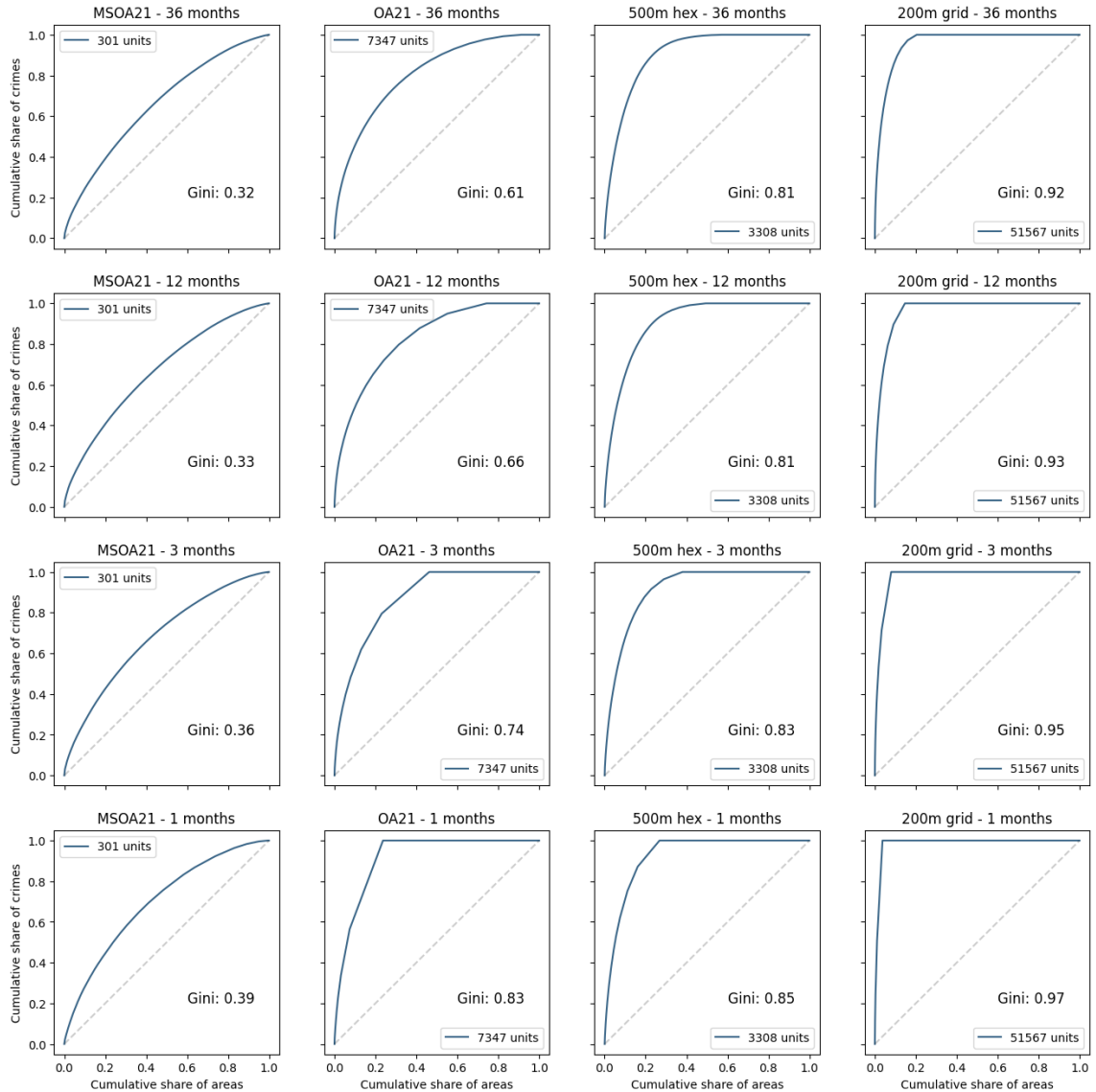
Concentration is the extent to which crime is unevenly distributed across units:

- Can be visualised via curve
- Straight line represents perfectly equal distribution
- The steeper the curve, the more concentrated
- Measured using area under the curve



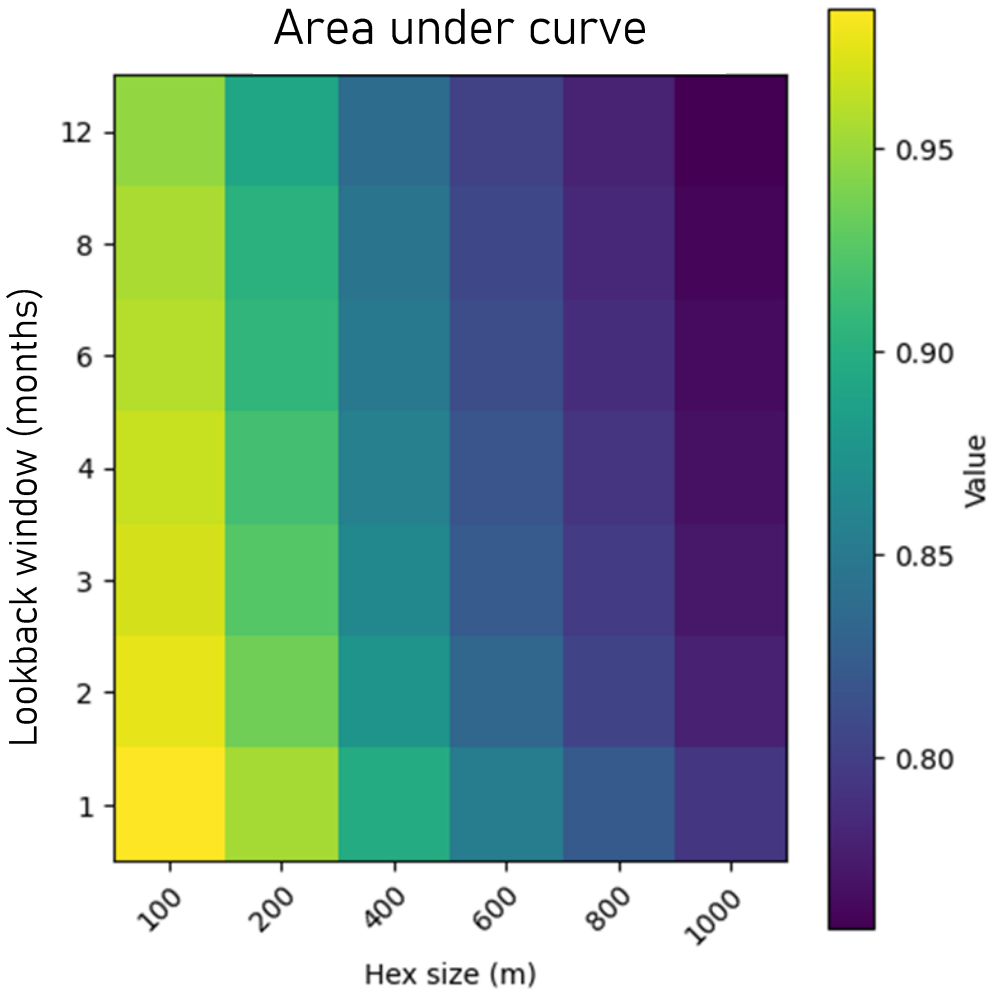
In general, higher concentration is desirable – greater potential reduction…

Concentration



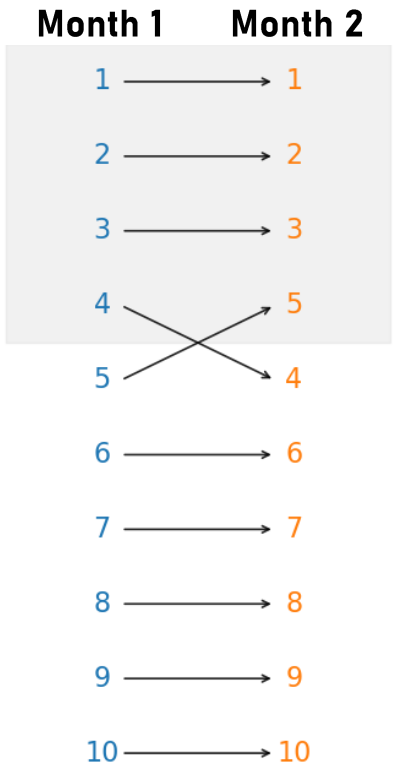
Concentration

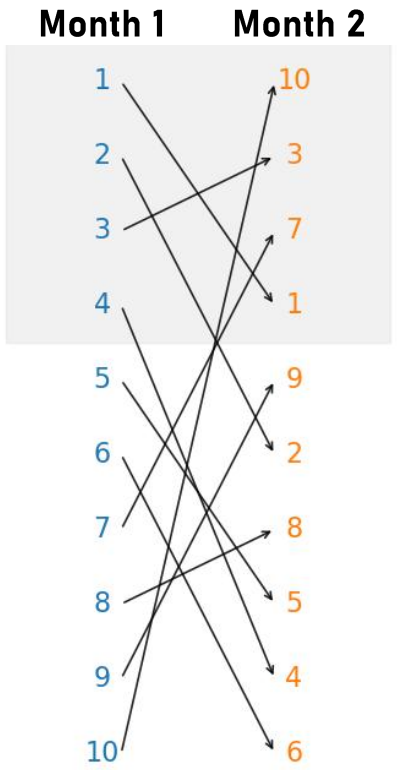
Finer scales – in both spatial and temporal units – lead to more pronounced concentration.



Stability

How similar are hotspot patterns from one timepoint to the next?

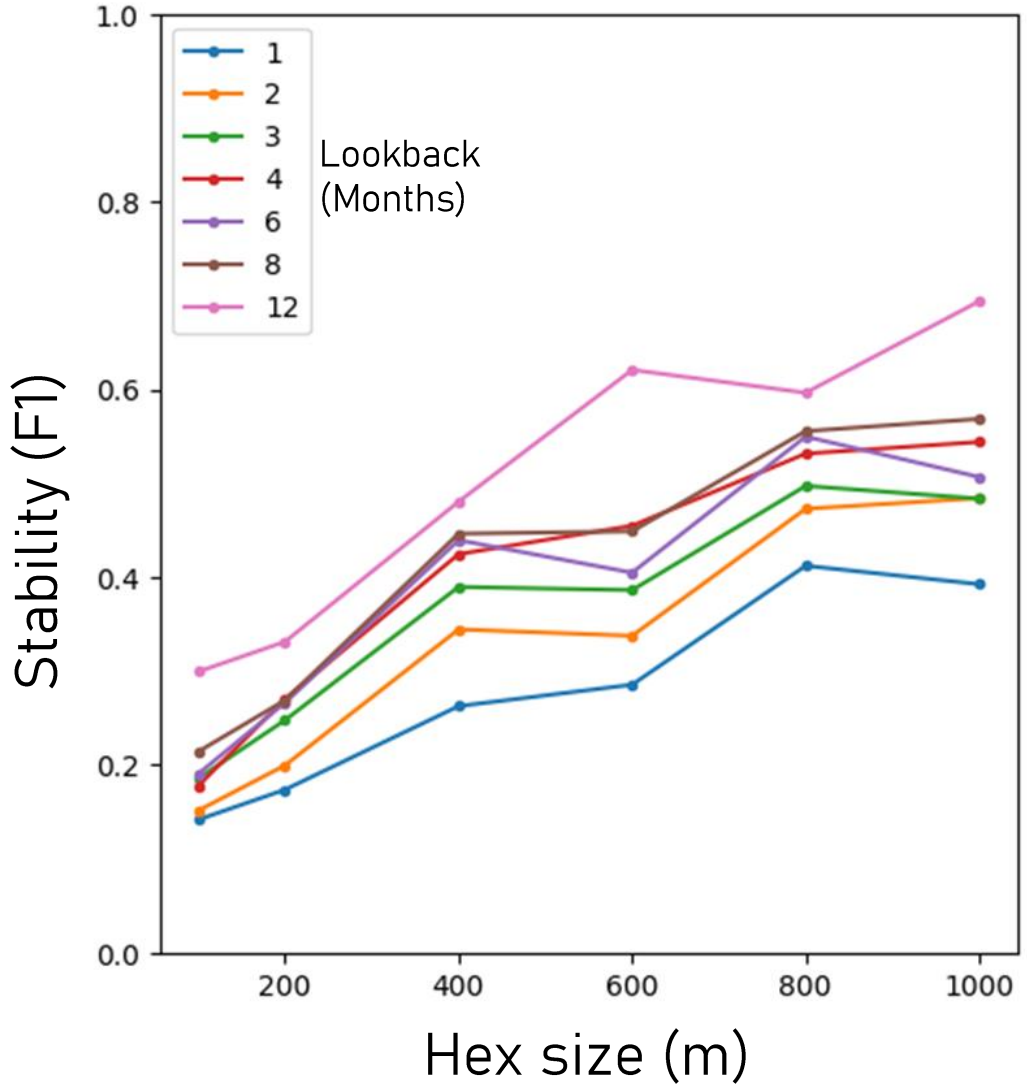




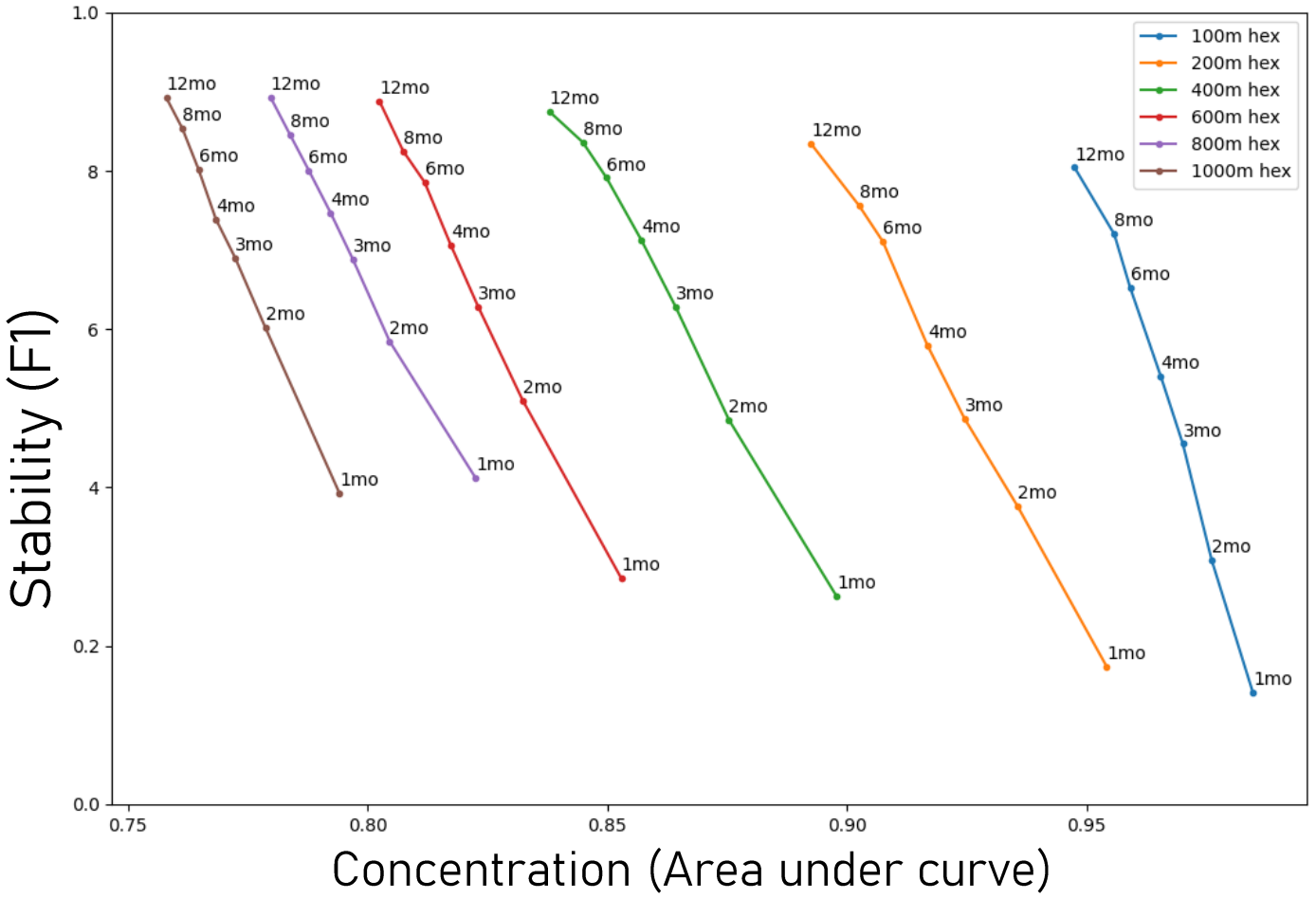
In general, higher stability is desirable, especially for long-term interventions.

Stability

Again consistent results – the finer the scale, the less stable the hotspot pattern will be – i.e. the more it will change from period to period.



Tradeoff



Key findings:

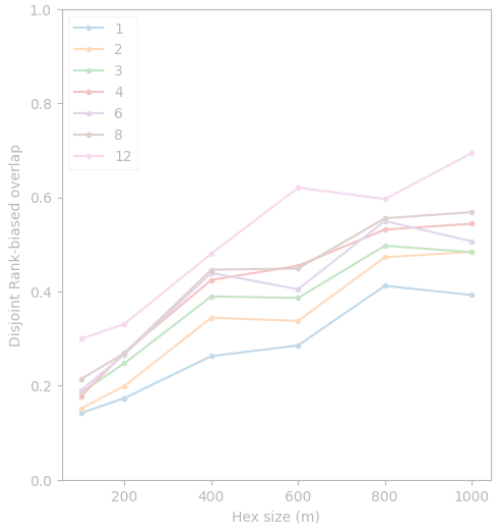
- Tradeoff between concentration and stability
- (...though details depend on how they are measured)
- Optimising for concentration (finer granularity) means hotspots may be volatile
- Optimising for stability (larger scales) does not maximise preventative potential
- How to choose depends on intervention...

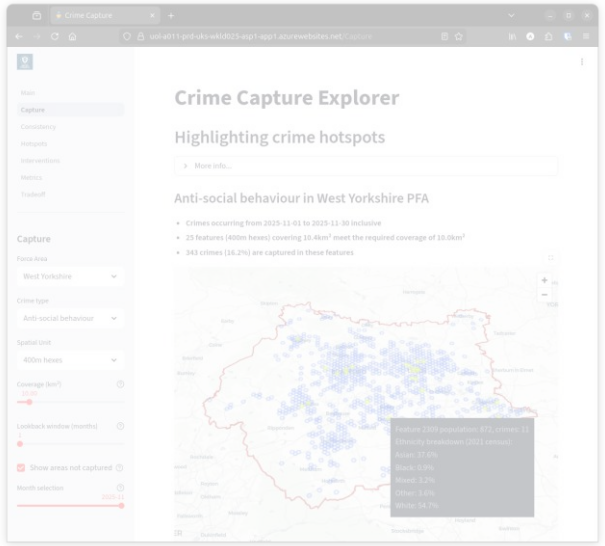
Key goals

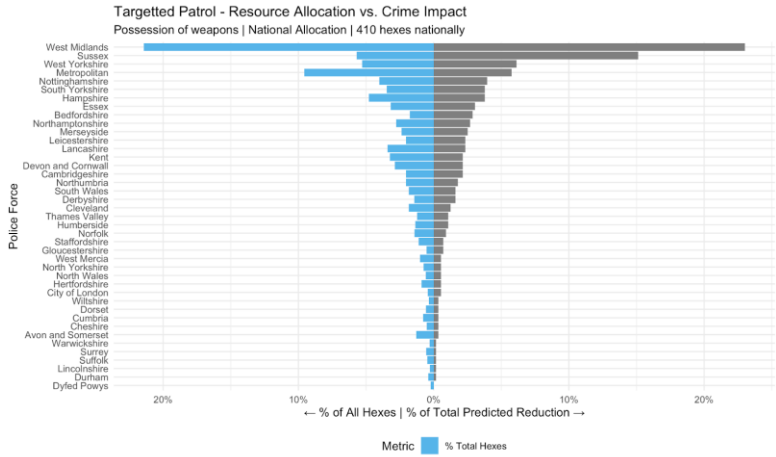
Quantify the effects of key analytical choices affecting the utility of hotspot maps.

Produce ‘explorable’ tools to allow experimentation and prototyping.

Estimate the preventative potential of interventions under different scenarios.







What are realistic levels of crime reduction that could be achieved via a hyperlocal approach?; and how do the number of hyperlocal areas targeted and the way you select those areas impact?

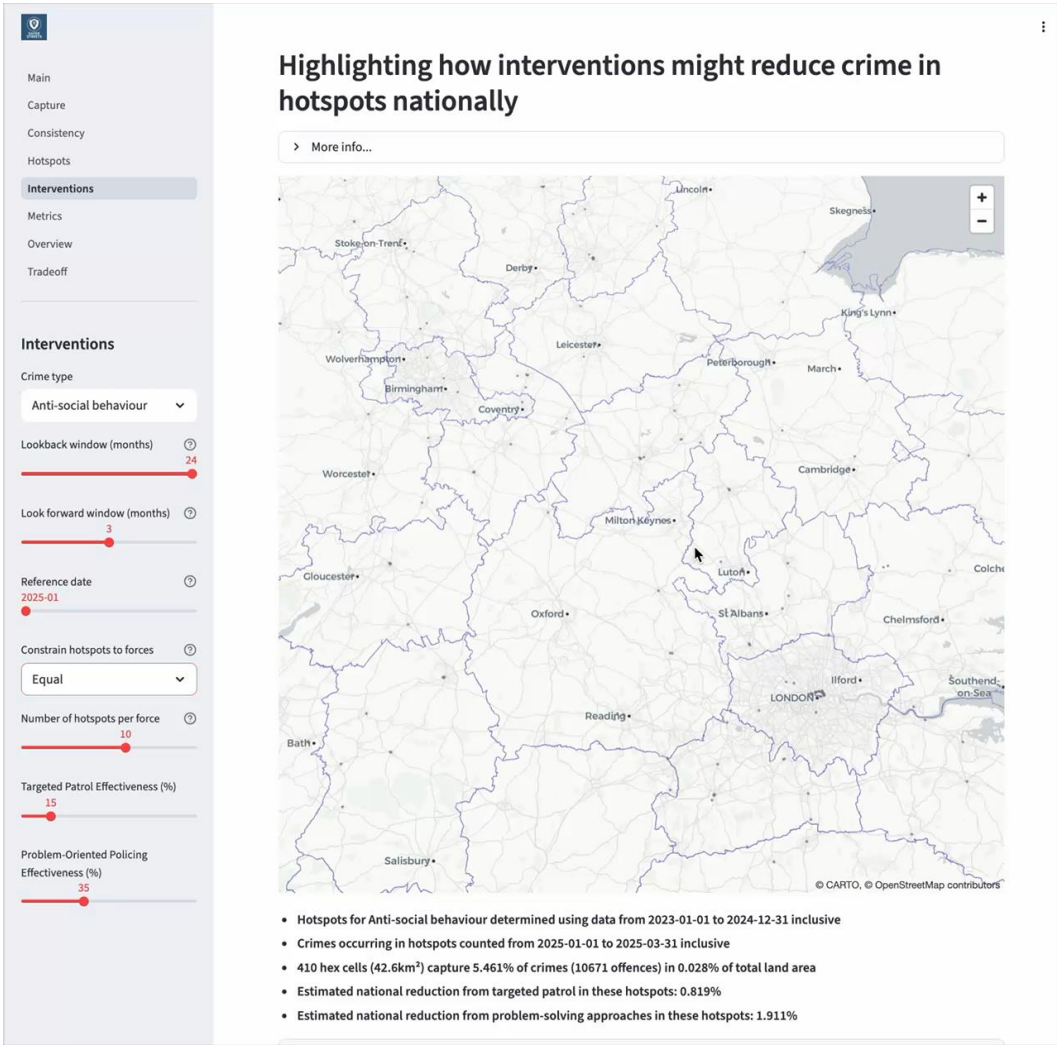
'Back-casting' exercise simulating the predictions that would have been made for the final year for which data is available:

Approach allows us to estimate (1) a ceiling on potential effect; (2) reductions that might reasonably be expected based on prior research

Simulating interventions

Each intervention scenario allows various features to be specified:

- **Number of hotpots** – number of hexes identified for intervention
- **Allocation strategy** – how hexes are allocated at the force/national level
- **Lookback window** – volume of historical data used for identification
- **Update frequency** – how often hotspots are re-identified
- **Intervention effectiveness** – expected reduction based on existing research



Key variations

Resource levels:
Nunber of hex cells identified for intervention

Hex Allocation Strategy:
National – *purely on count irrespective of force*
PFA – *equal number of hexes in each force*
Headcount – *proportionate to workforce size*
Proportion - *proportionate to crime problem (current H0 implementation)*

Modelled Interventions

 *Targeted Patrol* – 15% reduction, lookback = 6 months, update = 1 month

 *Problem-oriented Policing* – 35% reduction, lookback = 24 months, update = 12 months

Problem-oriented Policing

Based on assumption of **35% reduction**

Fixed:

- **Lookback period**: 24 months
- **Update frequency**: None

Varying:

- Number of hexes
- Allocation strategy

Problem-oriented Policing

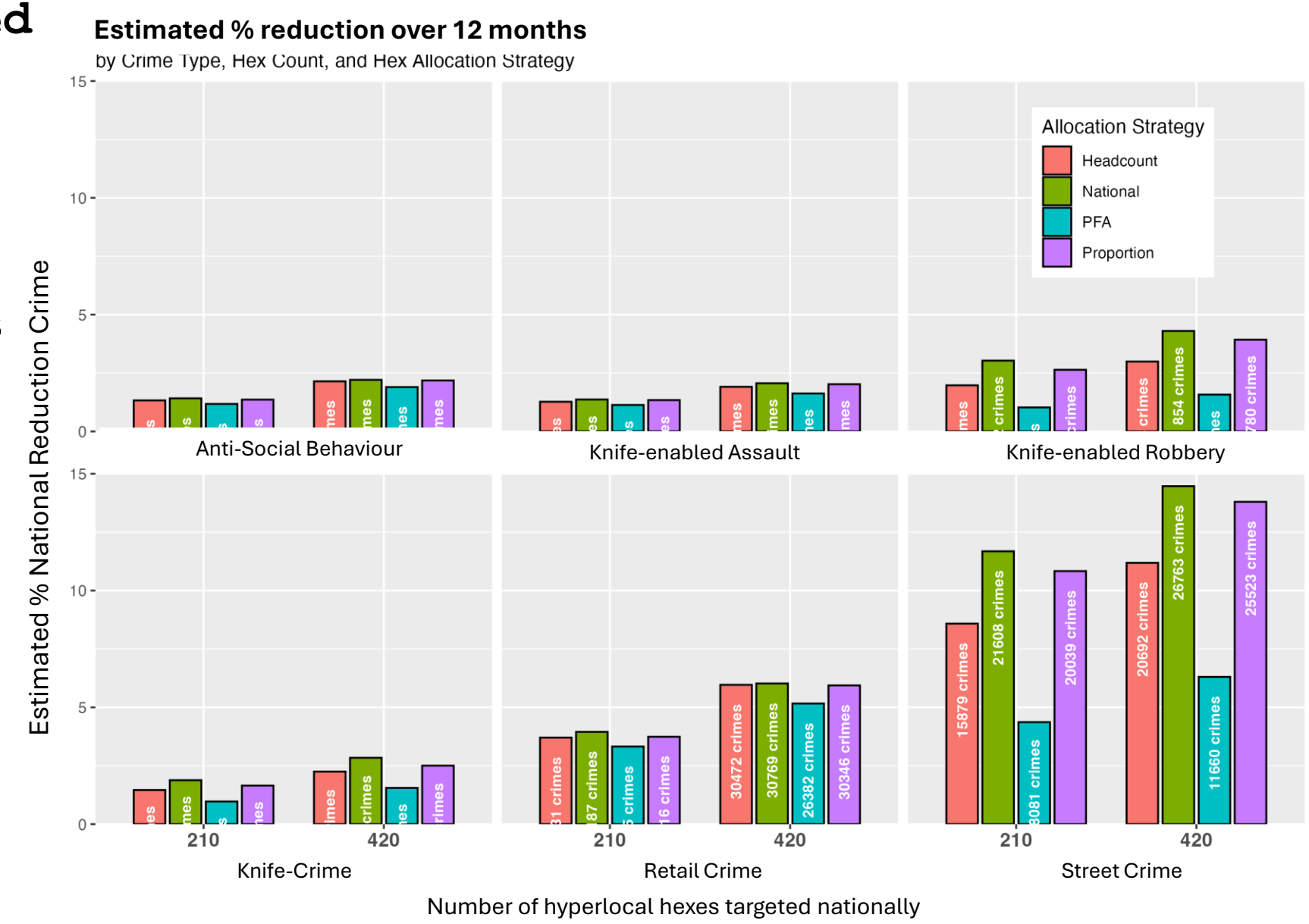
Based on assumption of **35% reduction**

Fixed:

- **Lookback period**: 24 months
- **Update frequency**: None

Varying:

- Number of hexes
- Allocation strategy



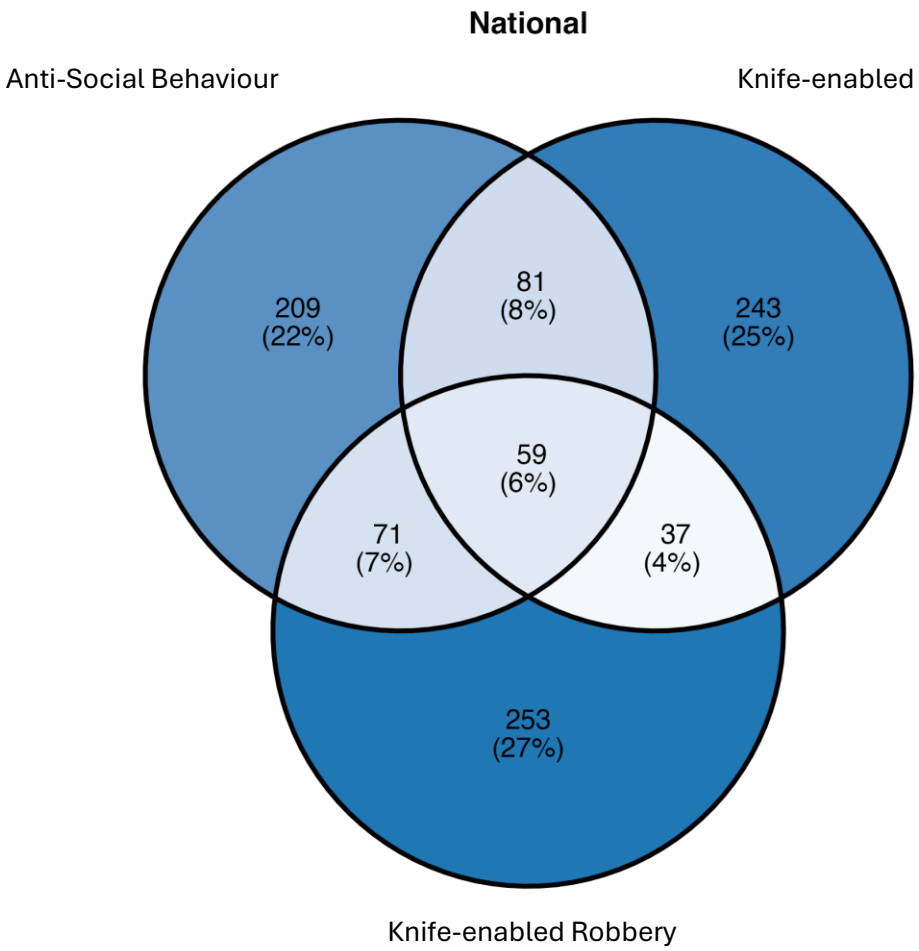
What is the overlap in priority offence hexes?

ASB, Knife Enabled Assault, Knife Enabled Robbery

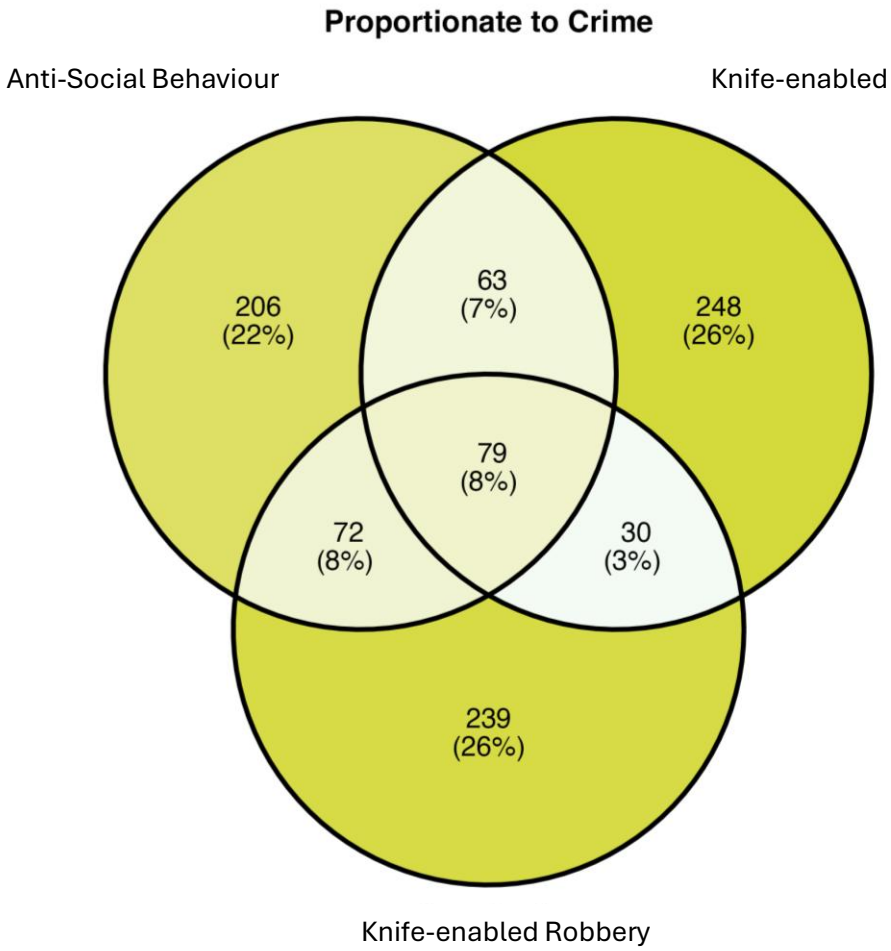
What is the overlap in priority offence hexes?

ASB, Knife Enabled Assault, Knife Enabled Robbery

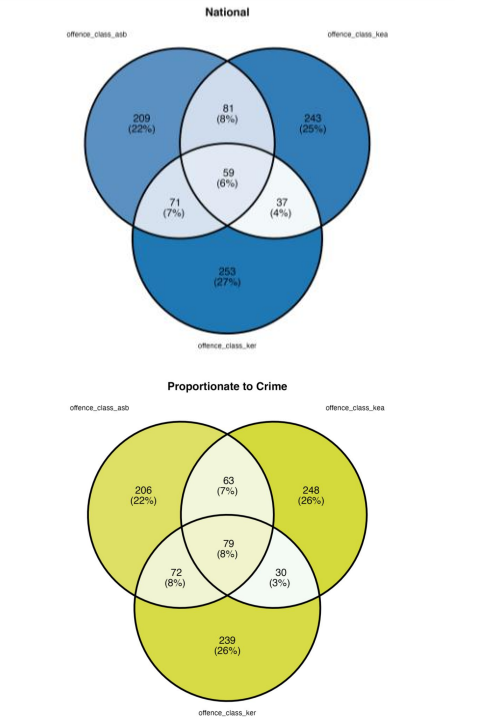
National



Proportionate to Crime



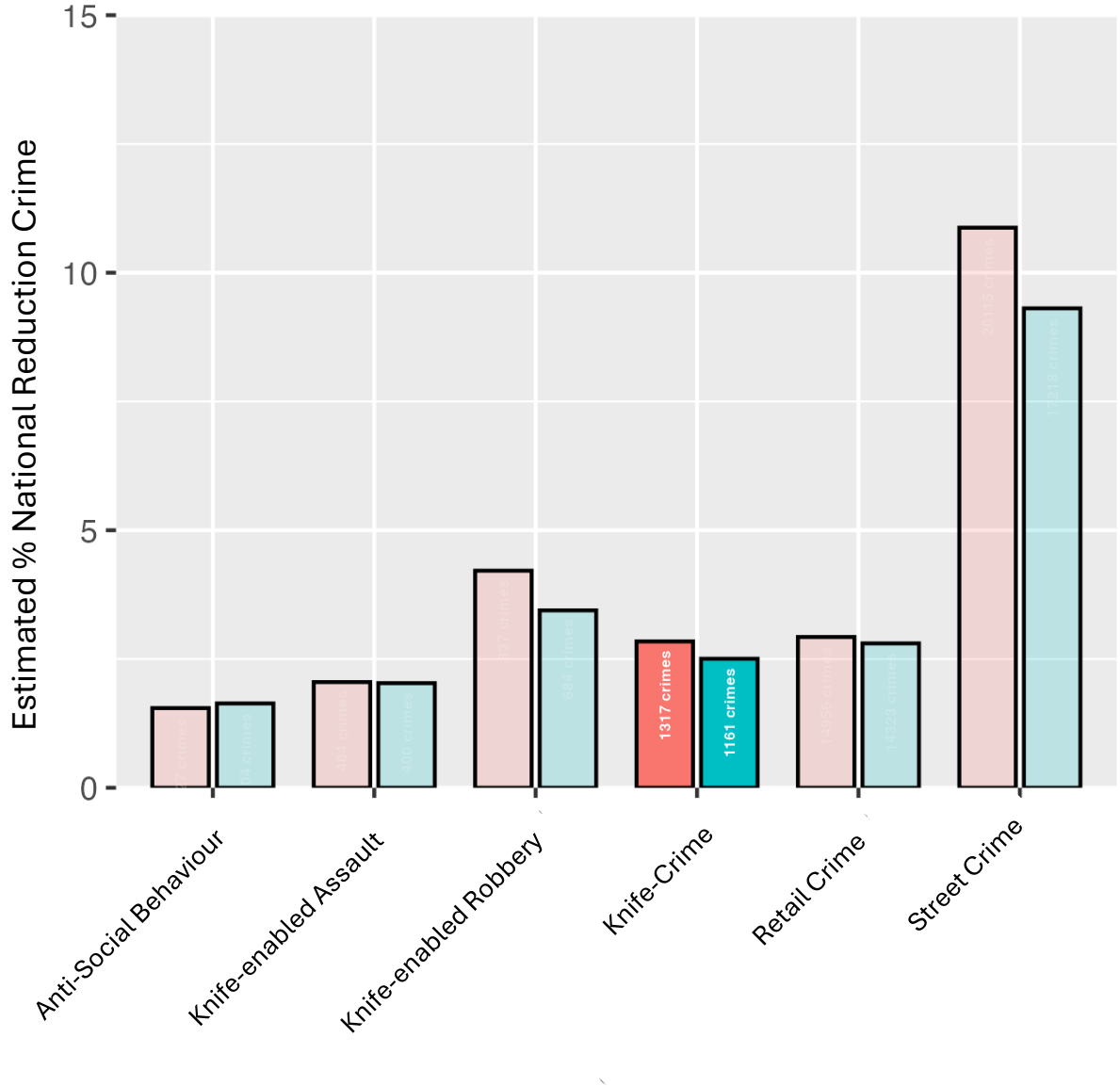
Offence Overlap



Estimated reductions based on:

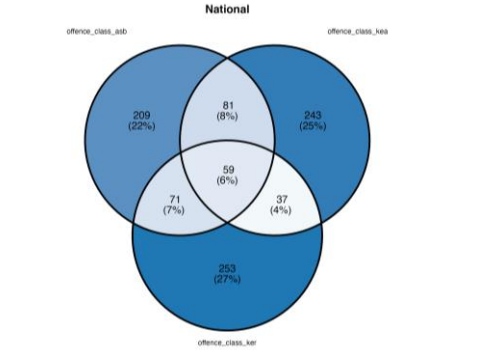
- One-off selection of top 420 priority hexes for intervention
- Assumes POP delivers ~35% reduction over 12 months in these areas
- Also (naively) assumes proportional reductions across other priority offences within the same hexes.

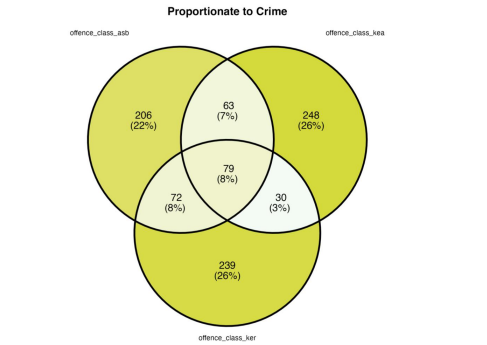
Targeting hyperlocal hexes based on Knife Crime



Impact on primary and secondary (shaded) offences

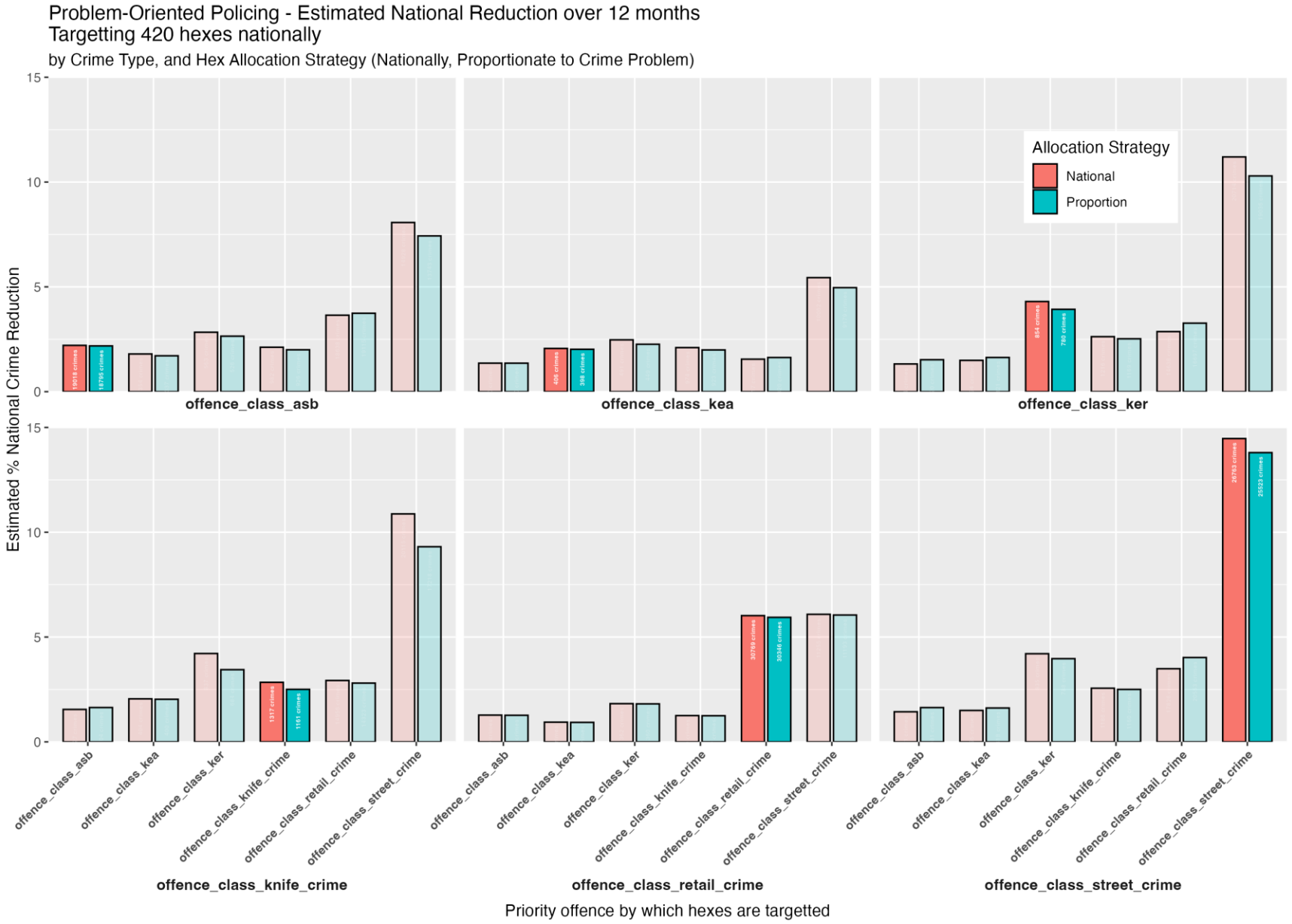
Offence Overlap





Estimated reductions based on:

- One-off selection of top 420 priority hexes for intervention
- Assumes POP delivers ~35% reduction over 12 months in these areas
- Also (naively) assumes proportional reductions across other priority offences within the same hexes.



Estimated reductions are based on:
1. Using 24 months of historic data to identify priority hexes
2. Selecting top 420 priority hexes once and deploying intervention in only those locations
3. POP producing a 35% reduction over 12 months in priority hexes
4. For each priority-targeted offence, we also estimate reductions in other priority offences within the same hexes, assuming (naively) that crime decreases by the same proportion (shown as translucent bars).

Key Takeaways:

1. At modelled levels of intervention, we estimate modest national reductions
   (ASB, Knife Crime ~2.5%; Retail Crime ~6%; Street Crime ~14% - @ 420 hyperlocal hexes targeted)

2. Increasing resources is subject to diminishing returns.

3. Current / national allocation strategy = greatest national reductions, but substantial implications for workload and equity of response

4. Effects all differ by crime type

5. There is utility to be derived from targeting locations WRT offence overlap
   (…but this will rely on careful selection of problems and intervention mechansims)

Safer Streets: Concentrations of Crime

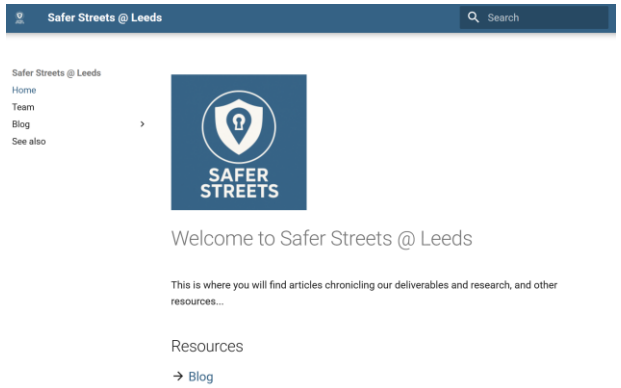
What are we measuring?

Modelling the consequences of key analytical choices in hotspot analysis

UK Research and Innovation
Missions Accelerator Programme

Thanks & Q&A

Toby Davies t.davies@leeds.ac.uk
Dan Birks d.birks@leeds.ac.uk
Andrew Smith a.p.smith@leeds.ac.uk



https://safer-streets.github.io/

UNIVERSITY OF LEEDS

Vulnerability & Policing Futures Research Centre

typ-ace.
THE YORKSHIRE POLICING ACADEMIC CENTRE OF EXCELLENCE