Butterflies, Bees & Burglars

The foraging behavior of contemporary criminal offenders

P. Jeffrey Brantingham¹
Maria-Rita D’Orsogna²
Jon Azose³
George Tita⁴
Andrea Bertozzi²
Lincoln Chayes²

¹ UCLA Anthropology, ² UCLA Mathematics, ³ Harvey Mudd College, ⁴ UC Irvine Criminology, Law and Society

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experiments in insect foraging

- **environment**: arrangement of patches
- **manipulation**: alter spacing and/or quality of patches
- **questions**: search for patches of different quality; residence time in patch; travel time between hosts
- **observations**: insects are able to quickly adjust foraging strategies to changed patch conditions
crime opportunities & motivated offenders → unevenly distributed

foraging strategies are what bring motivated offenders together with criminal opportunities

two low-level questions

- given a serial burglar...
  - how far away in space or time is a second burglary (or second series of burglaries) likely to be from a first burglary (or series)?
  - how long do we have to wait between repeat burglaries at the same residential location?
road map for this talk

1. crime as a foraging problem
2. Long Beach, CA residential burglary data
3. models of patch residence and return times
4. implications and future directions
optimal foraging theory and crime

- obligate resource acquisition
  - crime is a “boundedly rational” behavior

- behavioral options
  - strategies to find targets, victimize, and avoid detection

- selection
  - biased social or trial-and-error learning leads offenders to arrive at an optimal foraging pattern
Long Beach residential burglary

- CPC 459R & G
  - unlawful entry into a residence with the intent to commit larceny or any felony
  - 12,690 burglaries between Jan 2000 – Dec 2005
  - geocoded address locations and reporting date
  - 3,951 repeat burglaries at the same addresses
Repeat Victimization

Long Beach residential burglaries 2000-2005

most repeats very quick
patch foraging models

- **currency**
  - assume offender wants to maximize return or payoff per unit time spent in a patch OR minimize the travel times between patches

- **decision variables**
  - how long to remain in a patch
  - how much time to dedicate to travel between patches

- **constraints**
  - size and/or quality of patches
  - spatial distribution of patches
  - quality of information about the environment
marginal value theorem (MVT)

net gain

g'(t)
g(t)

travel time

\( t_{\text{tt}} \)

residence time

\( t_{\text{rt}}^* \)
optimal travel time

- $g'(t)$
- net gain
- $g(t_{rt})$
- $t_{rt}$

Travel time $t_{tt}$

Residence time $t_{rt}$
larger takes from burglaries in one patch may translate into a greater temporal (and/or spatial) lag to the next set of burglaries
anecdotal evidence

- Most burglaries produce only small economic gains/losses, but happen very often.
- Major gains/losses are very rare events.
- Burglars that travel further (between patches) tend to net greater returns.
33% fewer burglaries, but median take 1.8 times larger

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<th>burglaries per month</th>
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<tr>
<td></td>
<td>Median</td>
<td>Inter-quartile range</td>
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<td>Commercial</td>
<td>8.7</td>
<td>2-30.3</td>
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<tr>
<td>Residential</td>
<td>12.8</td>
<td>3-30</td>
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<tr>
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<th>burglary income per month (USD)</th>
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<tbody>
<tr>
<td></td>
<td>Median</td>
<td>Inter-quartile range</td>
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<tr>
<td>Commercial</td>
<td>6,522</td>
<td>3,261-13,044</td>
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<tr>
<td>Residential</td>
<td>3,586</td>
<td>1,467-13,044</td>
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</tbody>
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individual house as a patch
quantitative expectations?

waiting time to a burglary at an individual house = the sum of all the time spent traveling between other patches (houses) and time spent burglarizing those other patches.
2D lattice model – sites $r_{nm}$
simple random walk

\[ p_n = q_n = p_m = q_m = 0.25 \]
random walker will eventually visit every site in a 2D lattice an infinite number of times
burglary probabilities $b_r$
waiting time between burglaries
12 steps
probability distribution of first passage

\[ F(r, t) = \frac{1}{A_1 t \ln^2 t} \]

a very high baseline probability that that site will be re-victimized within a short period of time.
n = 3951
mean time = 297 days
stdev = 360 days
max = 2073 days
how does the model do?

The graph compares the observed number of returns over waiting/return time (days) with the theoretical model. The blue line represents the observed data, while the red line indicates the theoretical model. The graph shows a sharp decrease in returns initially, followed by a more gradual fluctuation over time.
biased random walk based on attractive & repulsive forces

Neighborhood Risk Levels $\rho$

$\rho = 1$

$\frac{1}{3} \quad \frac{2}{3} \quad \frac{2}{3} \quad \frac{1}{3}$

$b_{n-2} \quad b_{n-1} \quad b_n \quad b_{n+1} \quad b_{n+2}$

$d_{n-2} \quad d_{n-1} \quad d_n \quad d_{n+1} \quad d_{n+2}$
attractive force = $b_r e^{-t/T_1} + b_r$
repulsive force = $d_r e^{-t/T_2} + d_r$
burglary probability = \( b_r e^{-\frac{t}{r_1}} - d_r e^{-\frac{t}{r_2}} + b_r - d_r \)
emergent crime patterns
The deterrent effect has to be fairly large relative to the attractive effect immediate following a burglary.

analytical model $F(r,t)$

simulation
random walk model & the MVT

net gain

all travel times between patches are equally optimal!

return from crime is fixed & burglar is obliged to leave

g(t)

travel time $t_3^*$ $t_2^*$ $t_1^*$

residence time
biased walk model & the MVT

net gain

burglary probability

t_1^*

travel time

residence time
crime prevention implications

- Close attention to the spatial and temporal nature of repeat burglaries has been used successfully to apprehend serial burglars.

- The same ideas are also central to the operation of hotspot policing—targeting areas previously victimized for stepped-up police activity is premised on the fact that offenders will likely repeat (in the same places) what has worked for them in the past.
the causes of repeat victimization may be many, but foraging theory suggests that

- small gains or returns from burglaries or other crimes will tend to lead to repeat offenses that occur close in space and time

- the “decay-like” character of the distribution of burglary waiting times may reflect simple constraints on movement around in a 2D world with some contributions from deterrent & attractive effects