Chapter X
Offender Mobility and Crime Pattern Formation from First Principles

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ABSTRACT

Criminal opportunity in most cases is constrained by the fact that motivated offenders and potential targets or victims are not found at the same place at the same time. This ecological fact necessitates that offenders, potential victims, or both move into spatial positions that make crimes physically possible. This chapter develops a series of simple mathematical and agent-based models looking at the relationship between basic movement decisions and emergent crime patterns in two-dimensional environments. It is shown that there may be substantial regularities to crime patterns, including the tendency for crime to form discrete hotspots that arise solely from different movement strategies deployed by offenders.

INTRODUCTION

Foraging theory is the domain of ecology that seeks to model how organisms deploy alternative behavioral strategies to bring themselves into contact with the resources that they need for survival. For stationary organisms such as plants or sessile animals, foraging might mean attempting to establish and control a spatial position within the environment that ensures at least a minimum flow of nutrients past that location. For mobile animals such as large mammalian herbivores or carnivores seeking stationary or mobile prey, foraging may mean developing movement routines that ensure a certain rate of encounter and return from prey items. In exactly

the same way, criminal opportunity in most cases is constrained by the fact that motivated offenders and potential targets or victims are not found at the same place at the same time. This ecological fact necessitates that the foraging movements of offenders, potential victims, or both intersect in ways that make crimes physically possible (Cohen & Felson, 1979; Felson, 2006).

Although formal modeling of the foraging behaviors of nonhuman organisms is routine in ecology (see e.g., Altman, 1998; Stephens & Krebs, 1986; Turchin, 1998), much less attention has been directed at modeling the movement patterns of criminal offenders (but see Brantingham & Brantingham, 1981; Groff, in press; Rengert, Piquero, & Jones, 1999; Rossmo, 2000). What we do know is that offenders appear to concentrate their movement in the immediate vicinity of nodal activity points such as a residence, but they occasionally will travel much farther distances along heavily used pathways (Bernasco & Nieuwbeerta, 2005; Flemming, Brantingham, & Brantingham, 1994). While these observations are crucial to crime pattern studies in a general qualitative sense, a quantitative understanding of how individual level movement choices translate into emergent crime patterns is still lacking. If studies from the physical and biological sciences provide any guide (Camazine, 2001; Koch & Meinhardt, 1994; Topaz & Bertozzi, 2004), then there is a strong possibility that very complex spatio-temporal crime patterns may be the product of relatively simple behavioral processes operating at the individual level. Finding this to be true would be consistent with the perspectives of routine activity theory (Felson, 2002), situational crime prevention (Clarke, 1995) and environmental criminology (Brantingham & Brantingham, 1981).

This chapter develops a series of mathematical and agent-based models looking at the relationship between offender movement decisions and emergent crime patterns in two-dimensional environments. These models rely on the simplest behavioral components and represent a "bottom up" modeling strategy. Section 1 of the chapter examines the minimal behavioral elements necessary to model movement in two dimensions. In principle, all we need specify are the rules describing how offenders choose movement distances and movement directions. In some cases it may also necessary to specify the time intervals at which an offender must return to the origin of movement, generally understood to be an activity node such as a residential location (Brantingham & Brantingham, 1993). Section 2 uses these basic components to build a very general and flexible model of offender movement. The model may be used to describe a continuum of offender foraging strategies ranging from simple random walks (Brownian Motion) through to so-called Lévy flights (anomalous diffusion) (Brantingham, 2006). Section 3 examines the hypothetical crime patterns generated by these movement regimes. We address the possible quantitative regularities in crime patterns that may be linked to movement regimes. Finally, we consider the analytical utility of simulating the emergence of crime patterns from first principles.

A MINIMALIST MODEL OF OFFENDER MOVEMENT

Offenders move about their urban environments in response to a complex array of individual and environmental attributes. For instance, the foraging choices of a residential burglar might hinge upon access to private or public transportation, the accessibility of residences, and levels of informal social control or surveillance (Bernasco & Luykx, 2003; Bernasco & Nieuwbeerta, 2005). As demonstrated in ecological studies, however, the simplest possible model of forager movement need only consider two things: (1) the choice of a direction in which to move; and (2) a choice of a movement distance (Brantingham, 2003; Brantingham, 2006; Turchin, 1998). Figure 1 shows how these two essential behavioral variables fit