Remapping gang turf: Math model shows crimes cluster on borders between rivals

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A mathematical model that has been used for more than 80 years to determine the hunting range of animals in the wild holds promise for mapping the territories of street gangs, a UCLA-led team of social scientists reports in a new study.

"The way gangs break up their neighborhoods into unique territories is a lot like the way lions or honey bees break up space," said lead author P. Jeffrey Brantingham, a professor of anthropology at UCLA.

Further, the research demonstrates that the most dangerous place to be in a neighborhood packed with gangs is not deep within the territory of a specific gang, as one might suppose, but on the border between two rival gangs. In fact, the highest concentration of conflict occurs within less than two blocks of gang boundaries, the researchers discovered.

The findings appear online today in *Criminology*, a peer-reviewed scholarly journal published by the American Society of Criminology, the world's largest society of scholars conducting research on crime.

"Maps of gang territories provide police with a better understanding of how to allocate resources," said research co-author George E. Tita, an associate professor of criminology, law and society at UC Irvine. "So figuring out the most accurate approach is really important for effectively deploying law enforcement."

Currently, law enforcement agencies map gang territories based on

police observation of such clues as graffiti and where gang members hang out. In these maps, geographic features like streets, parks and schoolyards typically delineate gang territories.

For the Criminology study, the team used Lotka–Volterra equations, which were designed to model the population dynamics of species competing for common resources. Since the 1930s, ecologists have used the equations to study the relationships between competing groups as diverse as bee colonies, troops of chimpanzees and prides of lions.

The equations are based on the principle that competition between groups determines where the boundaries between rivals form, and even a tiny amount of competition is enough to cause territories to form.

"What's at work is a competitive balancing act where both gangs are trying to keep their rival as far away as possible," Brantingham said.

The model the researchers derived from the equation predicted that gang boundaries would form midway between the home bases of rivals and would run in a perpendicular line between them.

The team looked at 13 gangs in the 6.5-square-mile area of Boyle Heights, a densely populated neighborhood on Los Angeles' east side that is bounded by three freeways. Gang activity tends to be confined within the freeway-bounded area.

To determine the home bases for each gang, the researchers relied on a prior study by Tita and his UC Irvine colleagues. The locations of the home bases ranged from a specific street corner to someone's house, a neighborhood business or any other specific location where a gang gathers most frequently.

Using the Lotka–Volterra formula, Brantingham's team drew boundaries

between the known gangs. Unlike law enforcement's maps, the resulting effort did not produce gang boundaries that neatly followed streets. Instead, the boundaries ran through the yards of homes and businesses and through alleyways. When the boundaries did land on streets, they were as likely to crisscross them as follow them.

Using police records, the researchers then mapped 563 known gang crimes that occurred between 1999 and 2002 and have been attributed by police to at least one of the 13 gangs. To their surprise, most of the crimes fell on the borders that the model laid between gang territories. When crime locations did deviate from the borders, they did so in a configuration that was consistent with the model. For instance, the theory predicted that 58.8 percent of the crimes would occur within one-fifth of a mile of the border between two gangs — or just under two blocks — and 87.5 percent within two-fifths of a mile of the border — or just over three blocks. Overall, 99.8 percent of crimes could be expected to occur within one mile of the border, according to the theory.

In fact, the team found that 58.2 percent occurred within two blocks of the border and 83.1 percent within just over three blocks of the border; in total, 97.7 percent of the crimes took place within one mile of the border between gangs.

"You would think that we're more complicated than other animals, so a model this simplistic shouldn't work, but I was surprised that it fit as well as it did," said co-author Martin B. Short, an assistant adjunct professor of mathematics at UCLA.

It's no coincidence that Lotka–Volterra equations would have bearing on the configurations of gang territories: The same forces that define territories in the animal kingdom also are at work in all kinds of rivalries between groups of people, the researchers stress.

"The findings match up with what we know about any conflict," Tita said. "Skirmishes tend to occur on disputed boundaries on which individuals, organizations or nation-states seek control."

The researchers plan to compare their gang maps with those derived by law enforcement.

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