Spatial Analysis of Waterfowl-Predator Interactions

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Goals and Objectives:

- Review the statistical methods that have previously been used to describe and analyze spatial data, including Ripley's K (Dixon 2002) and kernel estimation (Berman and Diggle 1989).
- Apply those methods to existing data sets on nesting waterfowl, including Ducks Unlimited's PHJV Assessment data.
- Develop extensions of existing methods better suited to spatial questions relating to waterfowl nest data.
- Explore whether the spatial patterns of waterfowl nests and predation events are related to total density of nests and landscape context.

Progress:
We are studying the nest predation process, specifically how habitat fragmentation influences patterns of waterfowl nest initiation, predator movement patterns, and the interaction of predator movements and nest patterns in space and time using spatial point analyses. Nest initiation point patterns have been investigated using Ripley's K, and we are using space-time K functions to reveal the underlying processes in three dimensions. Our use of space-time K functions further generalizes our point pattern analyses through the use of a null model that is robust to habitat heterogeneity. Preliminary results show that when time (in 2 week intervals) is added to the model, patterns of nest distribution and nest predation cannot be distinguished from random patterns. Additionally, the nest initiation pattern tends to be overdispersed at small spatial scales, implying that hens select nest sites farther away from existing nests than would be expected by chance. Finally nests face a much greater risk of predation when they are located close to another nest in both space and time. This increased risk of predation extends to ~100m over short time intervals (up to 6 days) but only to ~50m over time intervals up to 15 days. Because our analyses reveal that clusters of nests apparently don't exist over short time intervals, analyses of space-only patterns accumulated across an entire season are somewhat misleading. But the analyses are consistent with predators displaying Area Restricted Search behaviors which result in a pattern of increased destruction risk at small spatial and temporal scales.

We are now using kernel density ratios to describe how the risk of nest destruction varies across observed nest point patterns. Risk surfaces are calculated as the ratio of the destroyed nest density surface over the initiated nest density surface and identify the nest destruction process conditional on observed nest locations.

Future Plans:
Our collaboration with Ducks Unlimited exploring the spatial processes that describe waterfowl nest initiation and nest success is nearing completion. We are now investigating the interaction of nest point patterns and predator movement behavior by simulating predator trajectories using data collected by Mike Phillips. Nest encounter rates for the observed nest initiation pattern will be compared with encounter rates for random and regularly spaced nest locations. This analysis will help us understand the predator foraging mechanism that leads to nest destruction and how habitat arrangements lead to areas of high and low nest success through their impacts on nesting spatial patterns. Additionally, Area Restricted Search modeling of predation events in space and time will allow quantification of the strength of this behavior.