Development of Techniques for Monitoring Mammalian Predator Distributions

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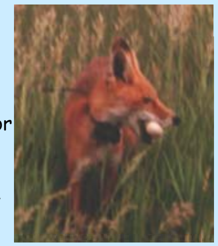
Background

Predation, primarily by mammals, is a major factor influencing waterfowl production in the Prairie Pothole Region (PPR). We know variation in predation rates can be caused by differences in predator species composition, especially differences in canid community composition. Estimates of predator distribution, when coupled with estimates of waterfowl breeding activity, could be used to prioritize management and maximize benefits achieved with limited resources.

Predator distribution: the problems & needs

Most predators are secretive and occur at low densities, and often focus activities on very large geographic areas. As a result, objective estimates of predator distribution are exceptionally difficult and costly to generate. An ideal method could be applied economically at sample sites distributed throughout a large area, would produce estimates for sites that were not sampled, would accommodate errors of omission (i.e., failing to detect species when they are present), and would produce accurate and precise results.



Objective

Develop and evaluate a protocol for using inexpensive presence/absence surveys and a Markov random-field detection-history model to estimate distributions of mammalian predator species in the Prairie Pothole Region (PPR) and prairie-hardwood transition zone of Minnesota and northern Iowa.

Study area and methods

Our study area encompassed 19,642 mi^2 and portions of all wetland management districts in Minnesota and Iowa. We partitioned the study area into a grid of 16-mi^2 blocks and selected a "checkerboard" sample of alternating blocks for surveys (right).

Each sample block was subjected to 2 time-constrained track searches ($\leq$75min) each year for up to 3 years. Observers recorded survey results as detection histories. For example, detection of foxes on the first, but not the second, of 2 search occasions would result in a history of {1,0}.

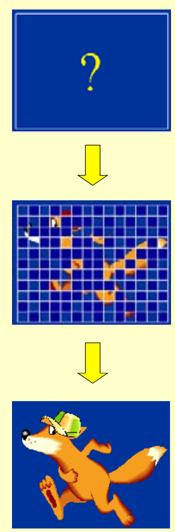
Data analysis

Species distributions have traditionally been portrayed by mapping detections (atlas maps), or by predicting detection rates from descriptors of habitats. However, such methods describe areas where species have been *detected*, not areas where they *occur*, and may be severely biased when detection is uncertain, as is the case for most predators.

Probabilities of *occurrence* can be estimated with detection-history models. In principle, relations between rates of occurrence and habitat characteristics can be used to prepare maps: most predators, unfortunately, are generalists with distributions that are not strongly associated with landscape features.

To resolve these issues, we used a Markov random field/detection history model originally developed to describe the distribution of swift foxes in Kansas. Our model adjusted for uncertain detection and used spatial relations among blocks to estimate probabilities of occurrence for both surveyed and unsurveyed blocks.

An intuitive understanding of our model can be gained by considering the box on the right. Let's say that it contains an unknown image, and we want to know what it is. To find out, we divide the box into blocks and sample some of them. Unfortunately, we can't afford to survey all of the blocks and we fail to detect the contents of others. As a result, we see only bits of the image… but we probably can do a pretty good job of filling in the blanks, based only on those bits and on our previous experience with similar images.

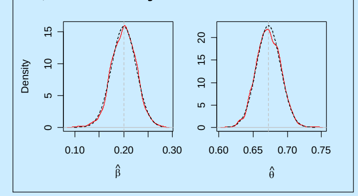


Our model was essentially a formal, mathematical description of this process. We observed "bits" when we detected species of interest. We made judgments for blocks without detections based on characteristics of neighboring blocks and, for cells that were surveyed, detection histories.

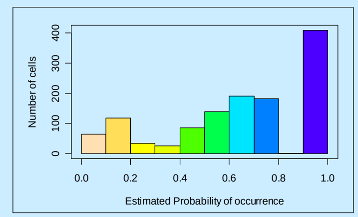
We used Markov chain Monte Carlo simulation (MCMC) to generate thousands of maps that were consistent with our model and our data. Each map classified each block as either "occupied" or "unoccupied." We used the proportion of times a particular block was occupied to estimate the probability of occupancy, conditional on our model and data.

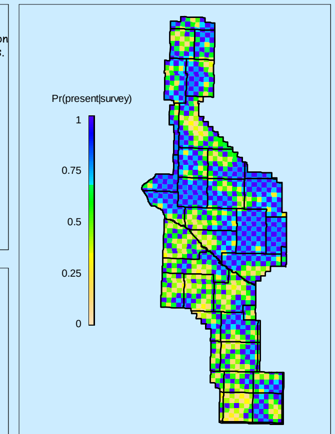
Sample results: Red foxes 2005

During 2005, we surveyed 619 sample blocks 2 times each. We detected red foxes on 588 occasions. Our model-fitting algorithm converged after approximately 2500 iterations and we used the next 2500 iterations to generate sample estimates of the detection rate and species distribution. The probability of detecting red foxes, when present, during a single search was approximately 0.67 (SE = 0.018).



Two parameters control the model. β determines the weight afforded to information from neighboring cells. Θ (the detection rate) determines the weight afforded to unsuccessful searches.





Estimated probabilities of occurrence for red foxes, based on data collected in 2005.

As one might expect, probabilities of occurrence were relatively high for red foxes throughout our survey area (lower left figure, above); however, probabilities of occurrence were considerably greater in some regions than in others. Variation in probabilities of occurrence is most likely to result from joint variation in predator density and detectability. The development of models for variable detectability, which should enhance understanding of variation in abundance, and methods for evaluating changes in distribution are promising topics for future research.

Conclusions

In the unstable and disturbed environment of the PPR, where wetland conditions change continually, the challenge is to know when, where, and how to apply existing options to manage nesting habitats. Adding to this challenge is consideration of the differences in predator community compositions when choosing appropriate management options. Clearly, different situations require different management approaches. Tools are available to assist in planning of management approaches based on habitats at the landscape habitat level (Reynolds et al. 1996). Complementing those tools with information on predator species distributions could augment success of the management process. Our survey method and the use of MCMC analyses provide efficient and cost effective methods to periodically estimate predator distributions. With the full complement of information, managers can direct both habitat and predation management activities to enhance waterfowl productivity.