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ESTIMATING ANIMAL ABUNDANCE WITH A HIERARCHICAL CATCH-EFFORT MODEL[1]

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SUMMARY OF FINDINGS

The primary objective of this paper is to compare methods for modeling the probability of removal when variable amounts of removal effort are present. A hierarchical modeling framework can produce estimates of animal abundance and detection from replicated removal counts taken at different locations in a region of interest. A common method of specifying variation in detection probabilities across locations or replicates is with a logistic model that incorporates relevant detection covariates. As an alternative to this logistic model, we propose using a catch-effort model to account for heterogeneity in detection when a measure of removal effort is available for each removal count. This method models the probability of detection as a nonlinear function of removal effort and a removal probability parameter that can vary spatially. Simulation results demonstrate that our model is effective in estimating abundance and removal probability. We also found that our catch-effort model fits better than logistic models when estimating wild turkey abundance using harvest and hunter counts collected by the Minnesota Department of Natural Resources during the spring turkey hunting season.

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PROBABILITY OF DETECTION IN CROWING SURVEYS OF RING-NECKED PHEASANTS[1]

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SUMMARY OF FINDINGS

There currently is no reliable and cost-effective population estimator for ring-necked pheasants (*Phasianus colchicus*). Consequently, most pheasant monitoring programs rely on population indices (e.g., roadside counts or crowing indices). The validity of using indices to make inferences about population size is based on the assumption that detection probability (*p*) is constant or, more realistically, variation in *p* among comparison groups is small relative to the variation in population size sought to be detected. We applied time-of-detection methods to replicate (within season) pheasant-crowing surveys conducted on 18 study sites in southern Minnesota in 2007 to estimate $\overline{p}$, $\mathrm{var}(\hat{\overline{p}})$, and σ^2 (random spatial variation). We also conducted a Monte Carlo simulation to examine the bias-variance tradeoff associated with using a time-of-detection model to estimate and adjust for non-response bias. More specifically, we used estimates of $\overline{p}$, $\mathrm{var}(\hat{\overline{p}})$, and σ^2 to simulate variation in replicated pheasant-crowing counts on 18 study sites where true population size was a positive function of percent undisturbed grasslands. Estimated mean detection probability in our study was 0.533 (SE = 0.030) and $\hat{\sigma}^2$ was 0.081 (95% CI: 0.057–0.126). On average, both adjusted (for $\hat{p}$) and unadjusted counts of crowing males qualitatively described the simulated relationship between pheasant abundance and grassland abundance. However, using a time-of-detection model to estimate and adjust for $\hat{p}$ produced, on average, nearly unbiased (0.008) estimates of β_1 (the slope of the simulated pheasant-grassland relationship). Conversely, using unadjusted counts tended to result in a negatively biased estimate of β_1 (–0.206). Adjusted counts were more variable than unadjusted counts (IQR = 2.8 vs. 1.8), but MSE (a measure of bias-variance tradeoff) was smaller for adjusted counts (MSE = 0.003 vs. 0.045). These findings support using time-of-detection methods to estimate and adjust for non-response bias in replicated pheasant crowing surveys.

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COMPARING STRATIFICATION SCHEMES FOR AERIAL MOOSE SURVEYS[1]

John R. Fieberg and **Mark S. Lenarz**

ABSTRACT

Stratification is generally used to improve the precision of aerial surveys. In Minnesota, moose (*Alces alces*) survey strata have been constructed using expert opinion, informed by moose density from previous surveys (if available) and recent disturbance and cover-type information. Stratum-specific distributions of observed moose from plots surveyed during 2005-2010 overlapped, suggesting some improvement in precision might be accomplished by using a different stratification scheme. We explored the feasibility of using remote-sensing data to define strata. Stratum boundaries were formed using a 2-step process: 1) we fit parametric and non-parametric regression models using land-cover data as predictors of observed moose numbers; 2) we formed strata by applying classical rules for determining stratum boundaries to the model-based predictions. Although land-cover data and moose numbers were correlated, we were unable to improve upon the current stratification scheme based on expert opinion.

[1] Abstract from paper accepted for publication in *Alces*.

COULD YOU PLEASE PHRASE "HOME RANGE" AS A QUESTION?[1]

John Fieberg and Luca Börger[2]

ABSTRACT

Statisticians frequently voice concern that their interactions with applied researchers start only after data have been collected. The same can be said for our experience with home-range studies. Too often, conversations about home range begin with questions concerning estimation methods, smoothing parameters, or the nature of autocorrelation. More productive efforts start by asking good (and interesting) research questions; once these questions are defined, it becomes possible to ask how various design and analysis strategies influence one's ability to answer these questions. With this process in mind, we address key sample design and data analysis issues related to the topic of home range. The impact of choosing a particular home-range estimator (e.g., minimum convex polygon, kernel density estimator, local convex hull) will be question dependent, and for some problems other movement or use-based metrics (e.g., mean step lengths, time spent in particular areas) may be worthy of consideration. Thus, we argue the need for more question-driven and focused research and for clearly distinguishing the biological concept of an animal's home range from the statistical quantities one uses to investigate this concept. For comparative studies, it is important to standardize sampling regimes and estimation methods as much as possible, and to pay close attention to missing data issues. More attention should also be given to temporally changing space-use patterns, with biologically meaningful time periods (e.g., life history stages) used to define sampling periods. Lastly, we argue the need for closer connections between theoretical and empirical researchers. Advances in ecological theory, and its application to natural resources management, will require carefully designed research studies to test theoretical predictions from more mechanistic modeling approaches.

[1] Abstract from paper accepted for publication in the *Journal of Mammalogy*

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UNDERSTANDING THE CAUSES AND CONSEQUENCES OF ANIMAL MOVEMENT: A CAUTIONARY NOTE ON FITTING AND INTERPRETING REGRESSION MODELS WITH TIME-DEPENDENT COVARIATES[1]

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Summary

1. New technologies have made it possible to simultaneously, and remotely, collect time series of animal location data along with indicators of individuals' physiological condition. These data, along with animal movement models that incorporate individual physiological and behavioral states, promise to offer new insights into determinants of animal behavior. Care must be taken, however, when attempting to infer causal relationships from biotelemetry data. The possibility of unmeasured confounders, responsible for driving both physiological measurements and animal movement, must be considered. Further, response values (y_t) may be predictive of future covariate values (x_{t+s}; $s > 1$). When this occurs, the covariate process is said to be endogenous with respect to the response variable, which has implications for both choosing statistical estimation targets and also estimators of these quantities.

2. We explore models that attempt to relate x_t = log(daily movement rate) to y_t = log(average daily heart rate) using data collected from a black bear (*Ursus americanus*) population in Minnesota. The regression parameter for x_t was 0.19 and statistically different from 0 ($P <$ 0:001) when daily measurements were assumed to be independent, but residuals were highly autocorrelated. Assuming an autoregressive model (ar(1)) for the residuals, however, resulted in a negative slope estimate (-0.001) that was not statistically different from 0.

3. The sensitivity of regression parameters to the assumed error structure can be explained by exploring relationships between lagged and current values of x and y and between parameters in the independence and ar(1) models. We hypothesize that an unmeasured confounder may be responsible for the behavior of the regression parameters. In addition, measurement error associated with daily movement rates may also play a role.

4. Similar issues often arise in epidemiological, biostatistical, and econometrics applications; directed acyclical graphs, representing causal pathways, are central to understanding potential problems (and their solutions) associated with modeling time-dependent covariates. In addition, we suggest that incorporating lagged responses and lagged predictors as covariates may prove useful for diagnosing when and explaining why some conclusions are sensitive to model assumptions.

[1] Abstract from paper accepted for publication in Methods in Ecology and Evolution
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RECENT POPULATION TRENDS OF MOUNTAIN GOATS IN THE OLYMPIC MOUNTAINS, WASHINGTON[1]

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ABSTRACT

Mountain goats (*Oreamnos americanus*) were introduced in Washington's Olympic Mountains during the 1920s. The population subsequently expanded and increased in numbers, leading to concerns by the 1970s over the potential effects of non-native mountain goats on high-elevation plant communities in Olympic National Park. The National Park Service (NPS) transplanted mountain goats from the Olympic Mountains to other ranges between 1981 and 1989 as a tool to manage overabundant populations, and began monitoring population trends of mountain goats in 1983. We estimated population abundance of mountain goats during 18-25 July 2011, the sixth survey of the time series, as a means to assess current population status and responses of the population to past management. We surveyed 39 sample units, comprising 39% of the 59,615-ha survey area. We estimated a population of 344±72 (90% confidence interval [CI]) mountain goats in the survey area. Retrospective analysis of the 2004 survey, accounting for differences in survey area boundaries and methods of estimating aerial detection biases, indicated that the population increased at an average annual rate of 4.9% since the last survey. That is the first population growth observed since the cessation of population control measures in 1990. We postulate that differences in population trends observed in western, eastern, and southern sections of the Olympic Mountains may reflect effects of climate variation across the pronounced precipitation gradient that exists.

[1] Abstract from paper accepted for publication in Northwest Science
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