Cogan and Diefenbach (1998)

keywords: elk, model selection, simulations, sightability, mHT.

Title. Effect of undercounting and model selection on a sightability-adjustment estimator for elk.

Introduction (Cogan and Diefenbach, 1998). Visibility bias should be corrected for to reduce abundance estimator bias, and sightability adjustment estimators have been applied to elk. Specifically, the sightability covariates have been identified to be group size and vegetative cover. However, this estimator and method assumes that group sizes have been counted accurately with no counting bias.

The authors used simulations to examine the error associated with counting group sizes, the effect of underestimating group sizes, the effect of model selection for the detection model, and then they also looked at model selection and population estimates for empirical elk data (Pennsylvania elk).

Methods (Cogan and Diefenbach, 1998). Sightability trials consisted of capturing and marking elk, using helicopter surveys and fixed-wing aircraft to determine elk locations, and then some groups were counted twice (with one measurement error free and another where count was associated with vegetative cover). Spatially, they sampled 100% of the sampling area.

They used several different population estimators, including the modified Horitz-Thompson estimator (mHT) whereby the detection model covariates were selected with AIC. They also calculated the 95% CIs with three methods, assuming asymptotic normality, log-normal distributions, and with a bootstrapping technique.

Secondly, they calculated the "minimal number alive," using basically raw counts.

Finally, they did an L-P estimate where $\hat{N} = [(n+1)(n_1+1)]/(m+1)-1$, where n is the number of radio-collared elk, n_1 is the number of elk observed, and m is the number of radio-collared elk observed. The variance of the L-P estimator was: $\hat{\text{var}}(\hat{N}) = [(n+1)(n_1+1)(n-m)(n_1-m)]/[(m+1)^2(m+2)]$.

Then, the authors assumed that under counting was due to vegetative cover and group sizes, and used the relationship to adjust the sightability models.

With the simulated study, the authors used the "true" model based on the sightability trials and four varying population sizes ($N = 250, 500, 750, 1000$) and three error sources, including incorrect sightability model, under counting group sizes, and including an ad hoc group size correction factor.

Results (Cogan and Diefenbach, 1998). As stated previously, the empirical elk sightability model included group size and percent canopy cover as its covariates. The mHT estimator seemed to give negatively biased population sizes because the $\hat{N}^{\text{mHT}}$ was less than the minimal number alive.

Undercounting did occur and was related to vegetative cover, so this is probably why $\hat{N}^{\mathrm{mHT}} <$ MNA.

With no errors introduced, the $\hat{N}^{\mathrm{mHT}}$ was unbiased but CIs were not nominal. Using the wrong sightability model introduced slight bias, but the bias introduced by undercounting was larger. Accounting for the undercounting was important but difficult to incorporate into the mHT variance estimator.

Discussion (Cogan and Diefenbach, 1998). In modeling elk populations in Pennsylvania, land managers must account for the uncertainty and visibility bias. This finding may apply elsewhere, but the same exact models from these elk may not apply to other situations/locations/species.

Based on the simulations, the authors identified three main areas of concern:

(1) Undercounting caused a negative bias whereby $\hat{N}^{\mathrm{mHT}} < MNA$; $\hat{\mathrm{var}}(\hat{N})$ was biased, too
(2) The sightability model selected affects both $\hat{N}^{\mathrm{mHT}}$ and $\hat{\mathrm{var}}(\hat{N})$
(3) CIs don't provide nominal coverage (less than nominal), the authors specifically recommend bootstrapping your CIs to get better coverage