

Comparing Camera-Based Ungulate Density Estimates: A Case Study Using an Island Population of Bighorn Sheep

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Camera-based abundance estimators are an alternative methodology of growing interest in both research and management applications. The statistical formulations of camera-based abundance estimators using time-lapse data should theoretically produce precise and unbiased estimates; however, production of unbiased results also requires meeting several important assumptions, and real-world case studies evaluating such results remain relatively few. We applied instantaneous sampling (IS) and space-to-event (STE) estimators to remote camera data collected in April 2021 via time-lapse sampling of closed populations of bighorn sheep (*Ovis canadensis*) and mule deer (*Odocoileus hemionus*) on Wild Horse Island in western Montana, USA, and compared results for bighorn sheep to aerial and ground-based counts. Point estimates from camera-based approaches underestimated bighorn sheep populations by 32–44% (IS estimator) and 62–69% (STE estimator) relative to aerial and ground counts. Patchy spatial distribution and group-living behavior of sheep resulted in a high degree of noise surrounding the IS estimate. In comparison, a low point estimate with relatively narrow confidence intervals suggested potential sensitivity of the STE estimator to violating assumptions of independence among individual animals and sampling occasions. Estimates of mule deer had improved precision over sheep estimates, as indicated by lower estimated coefficients of variation of the mean (CV_{mean}) derived from the analytic SE estimator. Using 15-m viewsheds and the IS estimators, mule deer density estimates came with a 26% CV_{mean} compared to 43% CV_{mean} for bighorn sheep. This discrepancy may be a result of differences in distribution, behavior, and relative abundance between the 2 species. Accounting for group size and increasing time between sampling may improve accuracy of density estimates and adhere better to model assumptions when estimating precision. In addition, factors influencing viewshed and resulting density extrapolations must be considered carefully. While camera-based methods theoretically provide an alternative way to estimate density when traditional methods are impractical, our results suggest that more work is needed to ensure density estimates are accurate and precise enough to inform population management.