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Validation of parameter estimates from camera trap photo-captures using calibration models

Camera traps are a well-established sampling tool to monitor wildlife over large areas. Several new approaches to estimate density of unmarked species using camera-traps require precise measurements of the distance of the animal from camera-trap units. This study presents a new method to estimate the angular and radial distances of animals from digitized pixel positions within the image. Given the complexity of camera trapping fieldwork in difficult terrain, we attempted to limit the technology required to construct pixel-to-ground-distance models ('calibration') to allow its application in a wide range of settings. We used two levels of calibration: (1) camera calibration, with poles of known height and distances away from the camera units, to establish a basic relationship between pixel length and ground distances; (2) site calibration to estimate sitewise distance and angle on a range of ground surfaces. We validated the accuracy of these calibration equations using two approaches. Firstly, we generated ground locations by extrapolating calibration poles placed at known distances away from the camera. Secondly, to approximate field conditions, we marked a random selection of points on the ground and measured ground distances to them on a range of surface types. Finally, we used simulations to understand how the deviation in model estimated distance can bias estimates of speed and density. The predictive accuracy of first approach was higher ($R^2 = 0.99$), whereas for field validation approach, the accuracy decreased to ($R^2 = 0.96$). There was a consistent overestimation between distance generated using the calibration model and distance calculated from field. Based on the difference between field and digital calibration, we infer that the deviation is caused primarily by errors in image digitization by users, and in the ground surface model. We believe the theoretical pixel-to-ground-distance models to be fairly accurate and robust. Simulations suggested that the error in ground distances is not amplified in either effective radius or speed estimates, rather passing through with the same absolute value. With the positive bias in radius and speed estimates, density estimates were negatively biased. We suggest more precise image digitization of animal locations to increase the accuracy of density estimates.