277

Multiple-observer protocol for drone-based abundance estimation: integrating counts from manual review and accessible deep learning algorithms

Reviewing large image sets remains a major challenge for wildlife abundance estimation from drone-based surveys, especially for rare and threatened species. Convolutional neural networks (CNNs) provide a straightforward framework to automatically detect wildlife in aerial imagery, although their implementation can be tricky for non-experts and small image sets. Motivated by the need to develop a pipeline for automated detection and abundance estimation of the threatened marsh deer, we i) explore deep learning techniques (convolutional neural networks) accessible to ecologists to detect rare wildlife species in drone imagery and ii) evaluate the incorporation of algorithm detections through a semiautomatic procedure in multiple-observer models for wildlife abundance estimation from drone-based surveys.

We trained two CNNs using transfer learning and fine-tuning to classify drone image tiles into "deer" or "background" (non-deer). We evaluated algorithm performance in a test set for each trained CNN and with a consensus method. A human observer checked algorithm detections to discard false positives (semiautomated review). Manual and semiautomated individual detections were integrated under detection histories and fitted using a multiple observer closed-population capture-recapture model.

The consensus classification approach produced a 3.5-fold increase in precision while reducing only 0.09 the proportion of deer samples detected, when compared to each algorithm independently. Compared to manual reviewing, the semiautomated procedure greatly reduced the time needed to review images (from two months to 66 hours) while providing a similar detection probability of deer individuals available in the imagery. Planning drone flights with frontal overlapping in the images can enlarge the number of samples for training and improve algorithm detection.

Deep learning has become increasingly accessible for ecologists and conservationists to develop their own detection algorithms. A multiple-observer approach including manual and semiautomated reviewing can be used to address algorithms' false-negative errors while avoiding false positives in abundance estimation. Monitoring programs of threatened species can greatly benefit from this to achieve timely assessments of abundance estimates from drone-based surveys in times of rapid environmental changes.