Simulations Inform Design of Regional Occupancy-Based Monitoring for a Sparsely Distributed, Territorial Species

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Sparsely distributed species attract management concern. Insufficient information on population trends, however, challenges conservation and funding prioritization. Occupancy-based methods are cost effective and therefore attractive for broad-scale trend monitoring, but appropriate sampling design and inference depend on particulars of the study system. We employed spatially explicit simulations to inform regional occupancy-based monitoring of white-headed woodpeckers (*Picoides albolvartus*), a sparsely distributed, territorial species threatened by habitat decline and degradation. We incorporated basic knowledge of species ecology into population simulations to compare statistical power and trend estimation error under alternative scenarios. Sampling effort needed to achieve adequate power to observe a long-term population trend (≥ 80% chance to observe a 2% yearly decline over 20 years) consisted of annually monitoring ≥ 120 transects using the single-survey approach or ≥ 90 transects using a repeat-survey approach. The single-survey approach, which employs occupancy as an index of abundance and requires auxiliary information to account for

detectability, provided more power for a given level of sampling effort than repeat-survey approaches. Alternate allocation schemes improved statistical power and trend estimates over the baseline (surveying 10 points within all transects annually), including surveying a subset (33%) of transects each year (i.e., a panel design) and surveying fewer points per transect in exchange for a larger spatial sample. Considering this case study, single-survey methods (with separate evaluation of detectability), panel designs, and aligning sampling resolution with home range size could likely benefit broad-scale occupancy-based monitoring of other sparsely distributed and mobile species.