Appendix 2. Using supplemental data from 2007 to evaluate survey sample completeness.

Background and Methods

Point samples of bird community richness are by nature assumed to be incomplete. Thus, the observed bird richness during a 5-minute point count is expected to be a fraction of the true species richness that occurs at a site, which is a fraction of the regional species pool (Hurlbert and White 2005). There are numerous reasons why a 5-minute sample of a community is expected to be incomplete, but with bird surveys, the main factors are considered to be imperfect detection of species present at the site, combined with species moving around such that some individuals that truly occupy a site are not available for sampling during the duration of the survey. The incomplete detection of species during surveys can result in richness estimates that produce biased patterns and inference (Tingley and Beissinger 2013).

Here, we use supplemental survey data collected at a subsample of sites in 2007 to evaluate the degree to which our 5-minute surveys conducted at all sites in 2006 either completely or incompletely sampled bird richness.

In 2007, one observer (MCM) returned to a 150 high-elevation sites along the PCT and conducted additional bird surveys. Revisited sites were distributed across all 5 regions of the PCT, but were concentrated in NoSN (92 sites) and SoSN (40 sites) where the PCT reaches its highest elevations. At each site, a single consecutive bird survey was conducted, totaling 120 minutes, divided into a 30, 60, and the full 120-minute increment. During the first 30-minutes, all bird species detected were recording. During the following 30- and 60-minute segments, only new species detections were recorded. During the full 120 minutes, the observer (MCM) was also collecting vegetation data, but as most bird detections are auditory, this is not expected to substantially bias species lists. Richness estimates derived from species lists during these supplemental, extended sampling visits were used to explore the extent to which species detected during 5-minute visits to sites in 2006 were complete or incomplete.

Results and Discussion

Species richness samples derived from 5-minute surveys showed varying degrees of completeness (Fig. A2). At 43% of survey locations, 5-minute surveys sampled 100% of species detected during 30-minute surveys. This percentage dropped to 20% for 60-minute surveys, and 4% for 120-minute surveys. The median percentage of species detected during 5-minute surveys was 75%, 58%, and 40%, compared to 30-, 60-, and 120-minute surveys, respectively.

Despite evidence that 5-minute surveys incompletely sampled the bird community, particularly when compared to 120-minute samples, we found strong relationships between the percentage of sample completeness and both the time-of-day and time-of-year of the 5-minute samples (Fig. A2). Across 30-, 60-, and 120-minute survey durations, the proportion of species detected during 5-minutes was near perfect early in the breeding season and early in the morning (Fig. A2), times when bird detectability is expected to be high. Put together in a generalized linear model (binomial error distribution with log link), the time-of-day was linearly significant ($p < 0.01$) in explaining richness proportions of all three extended durations, and the time-of-year had a significant positive quadratic (i.e., bowl-shaped) relationship for the proportion of species detected compared to 30- and 60-minute surveys.
While the analysis of supplemental extended surveys collected in 2007 indicates that 5-minute surveys conducted along the PCT incompletely sampled the bird community, this analysis also indicates that the potential for this “detection gap” to bias our main findings is minimal. First, the number of species detected during 5-minutes was significantly correlated with the number of species detected over 60- \( p = 0.002 \) and 120-minutes \( p < 0.001 \), and marginally correlated with the number of species detected over 30-minutes \( p = 0.075 \). Given this tight correlation (particularly with regard to a full 120-minute survey), the forms of statistical relationships derived from 5-minute survey data are not likely to significantly differ from those derived from 120-minute survey data. Second, as the degree to which 5-minute surveys incompletely sampled local bird richness was significantly related to time-of-year and time-of-day, adding these two variables into our models of local species richness should help correct for sampling bias. Indeed, the statistical relationships modeled for time-of-day and time-of-year based off of the full 2006 dataset (see main text, Fig. 2), closely match the proportional incompleteness relationships modeled here (Fig. A2).

**Literature Cited**


![Figure A2](image-url). The proportion of bird species richness detected during 5-minute survey, in relation to the time-of-day (a) and the day of year (b). Proportions are relative to 30-minute (light gray), 60-minute (medium gray), and 120-minute (dark gray) bird surveys at 150 sites. Loess curves for 30- (light blue), 60- (dark blue), and 120-minute (light green) surveys show trends in proportions in relation to time-of-day and day of year.