Burrowing Owl Study Design: sample and plot size determination

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Purpose. Determine an appropriate sample size and plot size to use in a burrowing owl (BUOW) study that would estimate the number of BUOW burrows throughout the Altamont.

General Approach. I used BUOW burrow count data obtained from Lee Neher that were collected at the East Bay Parks of the Altamont. These data inform us of the level of variation that might be anticipated in an Altamont-wide burrow count study. I used these data to define parameters for the distributions of BUOW burrow counts across survey plots. I used these distributions to conduct computer simulations that randomly simulate survey data over a range of hypothetical sample sizes, plot sizes and shapes. I calculated estimates and 90% confidence limits of burrow density for each of the simulated data sets, and defined the margin of error as the width of the confidence limit relative to the estimate. For example, for a confidence limit of 500±100 ha, then the margin of error is 100/500 or 20%. Finally I determined the sample size that will likely produce 10% and 20% margin of errors.

This report provides a recommendation on sample size for a given plot type and a specified margin of acceptable error. This report does not recommend a particular plot type. In general, larger plots take longer to sample but require fewer samples than smaller plots. A consideration of field-related factors can easily influence the choice of plot type, which is outside the scope of this report. A major assumption of the methods used here is that the intensity and variation in burrow counts in the East Bay Parks is representative of what will be found in the Altamont. Any large departures from this assumption could lead to large biases in the projections of sample size and error calculations in this report.

Details. There were three sources of BUOW census data: two performed by Albion in 2006 and 2007 and one by Shawn Smallwood in 2006. I repeated the analysis for each of the three sources of data.

In investigating plot sizes and shapes, Neher and Smallwood found that naturally shaped plots defined by watersheds could easily be defined in GIS prior to survey and easily identified and marked by technicians in the field. These watershed plots varied in size with a mean (± std. dev.) of 5.16 ± 2.61 ha and had a skewed distribution. For simulations, I selected the Gamma distribution that best approximated this shape. The numbers of burrows on these plots also varied, by survey and between plots (Albion 2006: 0.319 ± 0.990 burrows/plot; Albion 2007: 0.236 ± 0.796; Smallwood 2006: 1.792 ± 4.735). I modeled the burrow counts in relation to plot size and found that the data are consistent with the pattern of burrow numbers increasing in proportion to plot size. For purposes of simulating burrow counts, I assumed that mean counts were indeed proportional to plot size, and I selected the Poisson distribution with over-dispersion that best approximated the distribution of burrow counts in the three available data sets.

In addition to the watershed plots which are irregular in size and shape, I repeated the analysis for two different sizes of square plots (125m x 125m, or 6.25 ha; and 250m x

250m = 25 ha). This allows us to better understand the effect that plot size might have on our estimation error. Lee Neher simulated square plots by overlaying a fishnet grid across the East Bay Parks area. Although all squares in this grid are exactly 6.25 ha or 25 ha, depending on grid size, some plots could actually vary smaller than this because not all of the area in every grid can be surveyed (e.g. grids along the edge of Altamont, or intersected with roads or ponds). I call these smaller plots "partial plots."

Therefore, I simulated variable plot sizes as part of the grid design approach. To do this, I assumed that our random sample of grids would contain a mixture of full size plots (i.e. 6.25 or 25 ha) while the remaining proportion are partial and randomly vary in size up to the maximum 6.25 or 25 ha. In the East Bay Parks, approximately 50% of the 6.25 ha grids were partial; likewise for 90% of the 25 ha grids. Since the Altamont is a much larger area than East Bay Parks, then the edge to area ratio is much smaller and we could anticipate a much smaller proportion of edge or partial plots. For purposes of simulation, I arbitrarily set the proportion of partial plots in the Altamont to 5% for 6.25 ha grids and 10% for the 25 ha grids. Because of the large size of the Altamont, I believe that these proportions would probably be smaller, but I found that the results of the simulation did not change when I input smaller proportions.

For each of the simulated datasets, I estimated the burrow density (burrows/ha) by using the ratio estimator (Cochran, 1977)[1]. This estimator is essentially equal to the total number of burrows divided by the total ha sampled. The standard errors and confidence limits of this estimator are calculated following standard calculations for the ratio estimator, implemented in SAS software (version 9.1.3)[2]. I applied a finite population correction factor, which ensures that as the sample size approaches the maximum capacity of the Altamont, then the error of the estimate approaches zero. To apply the finite population correction factor, I assumed the Altamont to be 150 sq km, or 15000 ha. Since the average simulated plot sizes for 6.25-ha grids was 6.10 ha and 23.8 ha for 25-ha grids, then I assumed 2460 and 630 total plots respectively. The average watershed plot size was 5.16 ha so I assumed a total of 2910 of those irregular plots.

I performed the simulation over a range of 100 to 1000 plots, in increments of 50 plots. For each sample size, I conducted the simulation 100 times to smooth out the simulation variability.

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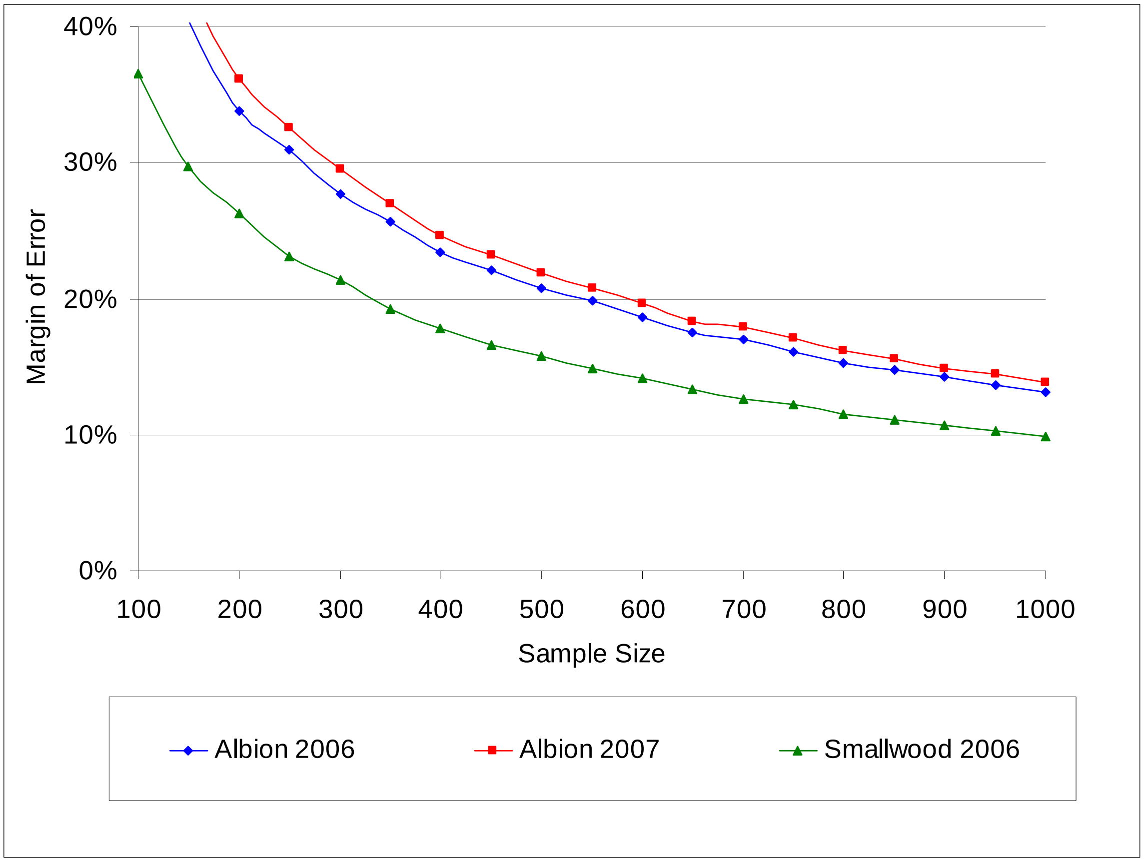
[1] Cochran, W.G. 1977. Sampling Techniques, Third Edition. John Wiley & Sons, Inc., New York, NY. 428 pp.
[2] SAS Institute. 2004. SAS OnlineDoc® 9.1.3. Cary, NC: SAS Institute Inc.

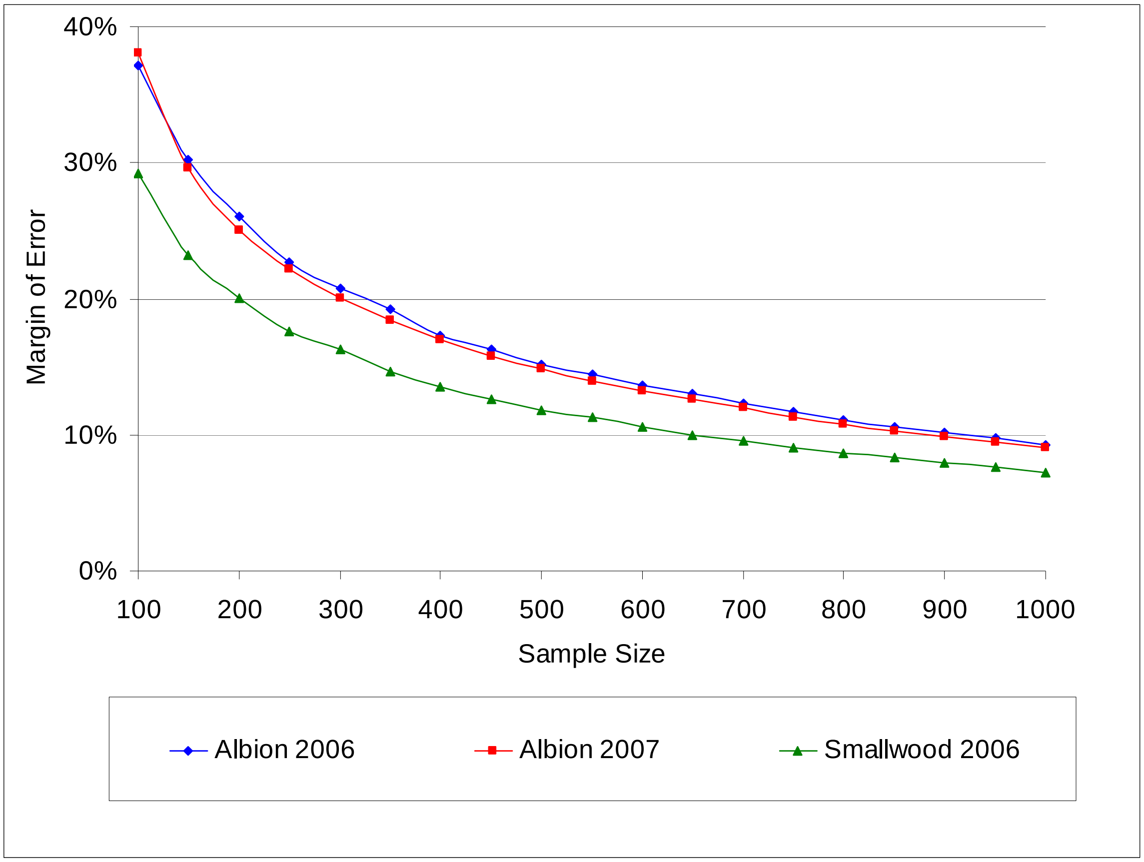
Results. For watershed plots, the sample size necessary to achieve a 20% margin of error varied by data sample (Albion 2006, Albion 2007, Smallwood 2006) and fell between 350 to 550 irregular watershed plots (Figure 1). Achieving 10% margin of error would take at least 1000 plots.

Figure 1. Margin of error versus sample size, based on three different samples of burrow counts collected on irregular watershed plots.



For 250m by 250m square plots, the sample size necessary to achieve a 20% margin of error also varied by data sample and fell between 200 to 300 plots (Figure 2). Achieving 10% margin of error would take 650 to 900 plots.

Figure 2. Margin of error versus sample size, based on three different samples of burrow count data collected on 250m square plots.



For 500m by 500m square plots, all data samples consistently indicated the sample size necessary to achieve 20% and 10% margins of error would be about 130 and 300 plots (Figure 3).

Figure 3. Margin of error versus sample size, based on three different samples of burrow count data collected on 500m square plots.