Top 10 Tips for Refuge Waterfowl Survey Design

For more on the rationale behind the tips, refer to the report *Migratory Waterfowl Monitoring Perspective from California Central Valley National Wildlife Refuges (ServCat 150122).*

Study Design

1. ***What to expect with average effort.*** Based on the dataset we analyzed, the average amount of sampling effort averaged 9.7 surveys per season. Refuges with that approximate level of effort (7-9 surveys September-April; ~monthly) were able to estimate peak waterfowl abundance with a 90% CI that averaged +/- 34-35% of the estimate (asymmetric in practice).
2. ***Timing—spread out counts.*** Modelling worked best when counts were evenly distributed before and after peak abundance. Try to do about half your counts before the peak, and half after. In much of California, the "peak" is often late-December or early-January.
3. ***Do whole surveys, not partial ones.*** It is difficult and requires a lot of assumptions to calculate "how many birds were in the portion of the refuge you didn't survey." In terms of making refuge-level estimates confidently, it's always better to have one full survey than multiple partial surveys—partial ones are mostly useful to subunit-scale inferences only. In other words, if you're going to reduce survey effort, it's often better to cut out every-other count instead of performing several short, incomplete surveys.

Data Management

4. ***Zero data is still data.*** There can be cases where it's not clear that if a "missing" subunit means that it wasn't surveyed, or rather that it was surveyed, but simply had zero birds. One way to clarify this situation is to make a habit of always counting and recording at least one species, for example, mallards. At every subunit, record mallards, writing zero if there are none present. In this way, you indicate a survey took place even if no waterfowl were detected, and analysis won't be affected.
5. ***One long datasheet is fine.*** Since waterfowl surveys often stretch between and among years, we suggest keeping one long dataset with "date" as a column.
6. ***I&M can help with data management.*** Whether you have specific questions or you're not sure where to begin with data management, you can set up a meeting with I&M anytime to discuss. Use of its BOMS (Biological Observation Minimum Standard) format will mean your dataset directly mirrors the datasets we used for the reference report.

Analysis

7. ***All indicators are highly correlated, so pick the one that meets refuge needs.*** For example, maximum bird abundance is easier to explain to non-waterfowl audiences than bird-use days, but the latter incorporates more information. Both are well-correlated, so choosing either can be fine. Avoid mean or median counts as indicators as they are highly influenced by sampling schedule.
8. ***It's important to consider precision and confidence in estimates***. The 90% confidence intervals we usually use as error bars may make your estimate seem less precise because it's a span representing where the true value is likely to fall--not a single point. We think the opposite; it tells your audience how certain you are, which is important information in decision-making. Calculate and include error bars to provide this important insight.

9. ***Consider the timescale of analysis.*** Looking at differences between year X and year X+1 may be possible, but not necessarily useful because there are too many environmental and other factors to explain the exact cause of year-to-year changes. Many analyses of waterfowl and other avian datasets look for trends at decadal rather than year-to-year scales. This is especially true for observational, low-sampling effort surveys (many/most may fall in this category).
10. ***There's an analytical script available to help.*** As part of this project, we generated an R Markdown file that generates reports with all the sorts of statistics you've seen in this document. See *ServCat* *150125*.