

An Example of Bias when using Separate Adjustment Factors

By Julie Yee, August 17, 2009

Proposal under consideration:

Estimate separate decay functions for Whole carcasses, Partial carcasses and Feather piles, and then apply adjustments based on these functions separately to the number of carcasses found according to their condition when found (Whole, Partial, Feather).

Example Case Study:

Although there are merits to separate adjustments, I believe the approach is subject to bias. To simplify concepts, assume 30-day intervals, searcher detection is perfect, and there are only Whole carcasses and Partial carcasses – this example can be extended to general situations if needed, including Feathers, imperfect detection...etc. Further, suppose we learn from the KB study the following parameters, which I will illustrate using made-up values:

- 1) Fatalities occur at a 40:60 ratio of Partial to Whole carcasses.
- 2) 50% of fatalities that start as Partial carcasses remain at 30 days.
- 3) 10% of fatalities that start as Whole carcasses remain at 30 days, but half of them will have transitioned to a Partial carcass and the other half will be Whole.

Bias is a problem when estimates are, on average, very different from what we want to estimate. In this case, we want to use an adjusted fatality number to estimate the number of carcasses deposited. Suppose 100 carcasses are deposited. On average, 40 of them start as Partial carcasses and the other 60 are Whole. At 30 days, 20 of the Partial carcasses and 6 of the Whole carcasses remain and are found. Out of the 6 Whole carcasses, only 3 of them remain Whole and the other 3 have transitioned to Partial carcasses. Thus, average data include 23 Partial carcasses and 3 Whole carcasses. Since the decay rates at 30 days for Partial and Whole carcasses suggest $R=0.5$ and 0.1 respectively, then the adjusted number of fatalities will be, on average, $(23/0.5) + (3/0.10) = 46 + 30 = 76$, which substantially underestimates the 100 carcasses that were deposited.

Recommendations:

A better approach is the original idea of applying a single decay function which includes all carcasses. For the example above, the combined decay rate is a weighted average of decay, $(0.4)(0.5) + (0.6)(0.1)$, because 40% and 60% of carcasses start as Partial and Whole, respectively. This rate calculates to 0.26 . The adjusted fatality estimate is, on average, $26/0.26 = 100$.

Another approach is to model the data using a multinomial distribution. The fate of carcasses fall into three categories: detected Partial, detected Whole, and disappeared. Our data includes carcasses in only the first two categories. Based on the proportions of carcasses falling into these categories (0.23 and 0.03 respectively), you can estimate the

number of total carcasses ($n=100$) by maximum likelihood. Or, since the proportions are themselves estimates from the KB study and subject to an error distribution, then a hierarchical modeling method or Bayesian approach would have the advantage of better capturing that additional error.