A Probability-Based Approach for Estimating Avian Mortality

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Model Characteristics

- Addresses the following key issues
  - Mortality is a function of string characteristics
  - Provides probability framework for adjusting for zero finds
  - Provides a probability framework for estimating survey error
  - Provides a probability framework for estimating the mortality at each string, adjusted for survey error and chance of a true zero
  - Generates string-specific outputs and graphics

Steps

- Generate Binomial data
- Generate Poisson data
- Run program (WinBugs or Jags in R)
- Calculate expected mortality / string using Likelihood equation
- Report results

Motivation

- Go to Excel statistics for RTHA, MAKE, GOEA, and BUOW

Term Definitions

- Psample = conditional probability of reporting a dead bird when the dead bird is present
- Pkill = probability of a bird being killed at string
- Pobs = probability of observing a bird at string
- Probability of observing y birds:

$$\Pr(Y = y) = \frac{e^{-\lambda}\lambda^{y}}{y!}$$

- λ is the expected value of the count variable, Y when there is a kill
- OBJECTIVE: Find λ – after adjusting for survey error and zeros

Models

- Possible models (we are currently evaluating)
  - Pkill = f(MW, No. of turbines, rotor swept area, geographic characteristics, etc.)
  - Psample = f(number of searches, etc.)
- For predicting those strings not surveyed:
  - λ= f(available co-variables at site)

- Pobs = Pkill * Psample

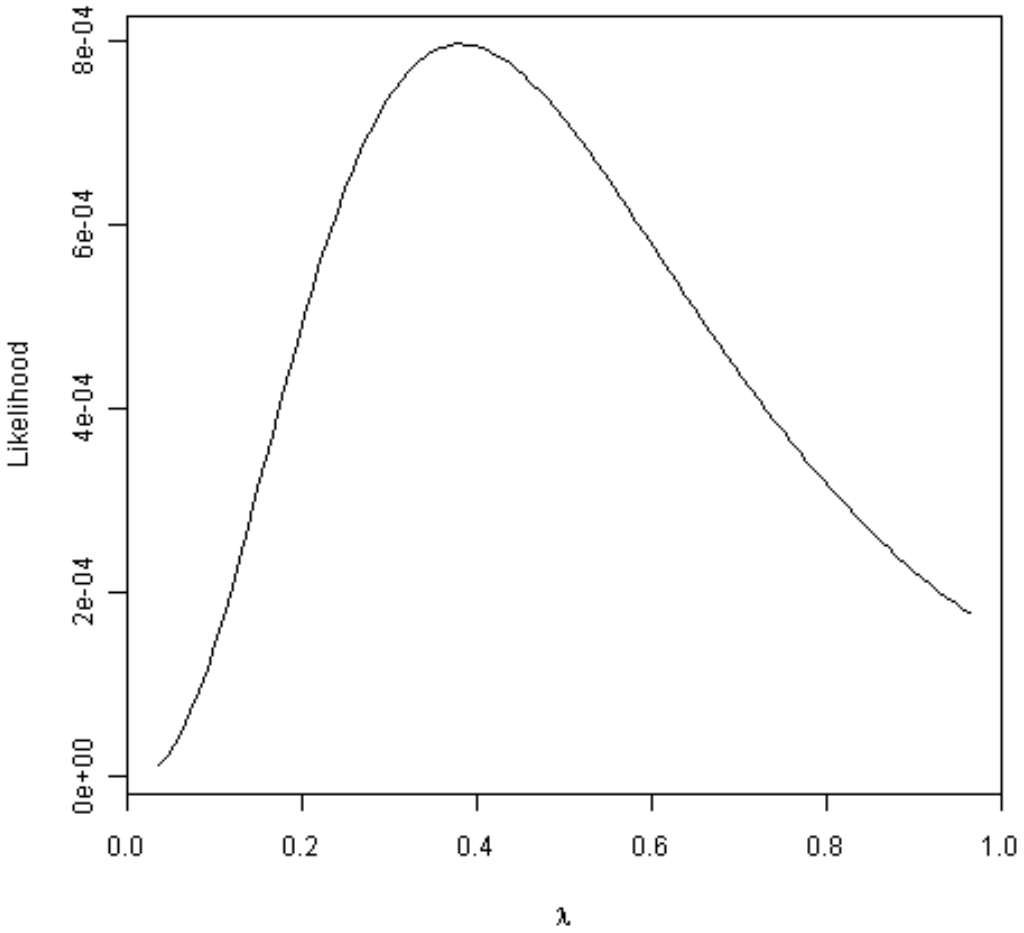
Maximum Likelihood Estimation

- Based on the zero-inflated Poisson model, the likelihood of observing, say, *k* 0s and *r* non-zero counts (y_i, i=1,…,r) is:

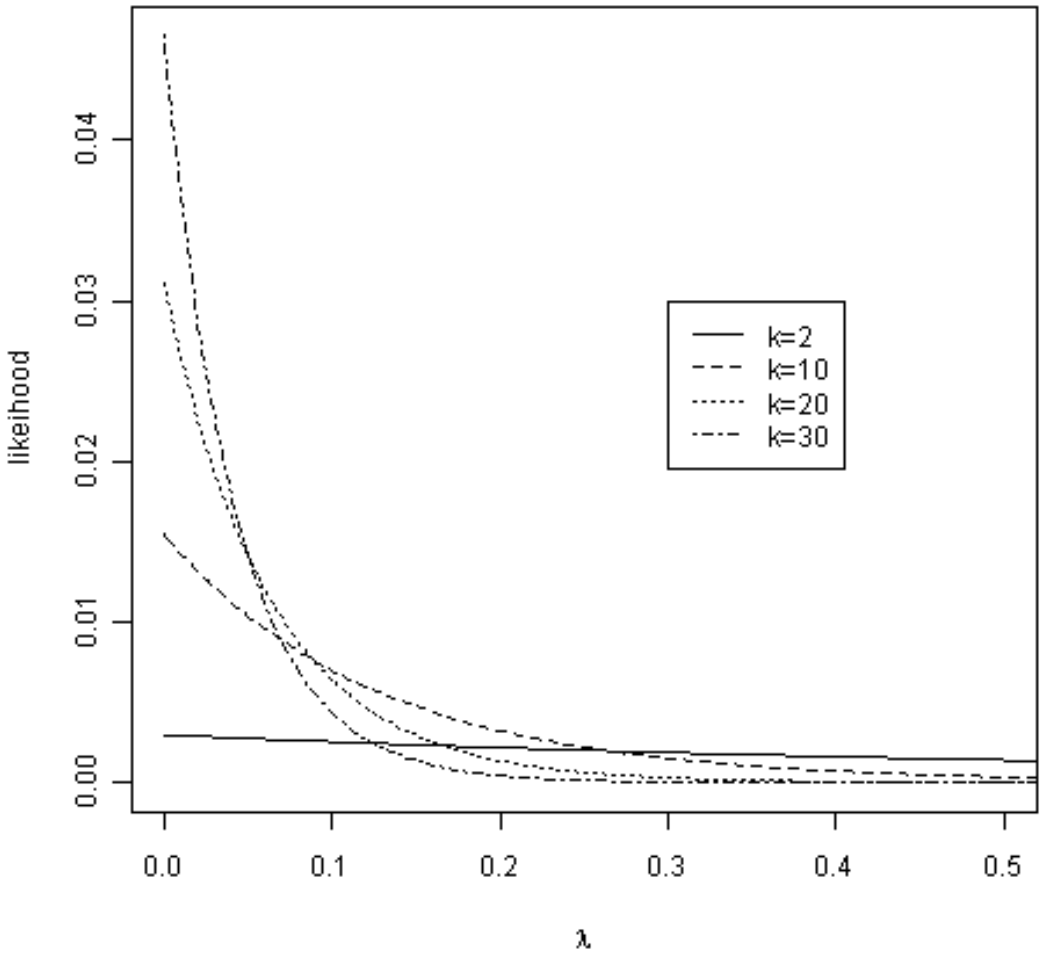
$$[1-p_{kill}+p_{kill}e^{-\lambda}]^{k}\prod_{i=1}^{r}(p_{kill}e^{-\lambda}\lambda^{yi}/y_i!)$$

- Estimated λ is the value that maximizes the likelihood function (using numerical analysis)

Likelihood of λ



Zeros



Advantages

- Rigorous probability framework
- Graphical analyses aid prediction
- Flexible, allows experimentation with models
- Probability-based outputs allows choice of λ from Likelihood function (MLE, expected value, or an upper bound)
- Reflects information content of data set

Possible Estimation Issues

- Few bird finds, leading to lack of information content in a specific data set (say, a specific year)
- Available co-variables not best predictors
- Individual years for some species may have less mortality leading to more difficult estimation issues

Example Outputs: RTHA, 2006