

## Simple SCR exercises

The code in the file `scr-11.r` creates a log-likelihood function, loads some example data, and fits the ‘binary proximity model’ described by Efford et al. (2009). The model makes the following assumptions:

- The number of animals’ activity centres in the survey region is a Poisson random variable, with expectation equal to animal density,  $D$ , multiplied by the area of the survey region.
- The activity centre locations are independent, and are uniformly distributed across the survey region.
- The probability that a detector detects an individual is given by the halfnormal detection function,

$$g(d) = g_0 \exp\left(\frac{-d^2}{2\sigma^2}\right),$$

where  $d$  is the distance between the animal’s activity centre and the detector.

Run the code in `scr-11.r` and answer the following questions.

### General questions

1. Create a plot of the detector locations. Their coordinates can be found in `test.data$traps`.
2. Inspect the capture histories in `test.data$bin.capt`. Describe what the first two rows represent.
3. The model has estimated animal density,  $D$ , and parameters of a halfnormal detection function,  $g_0$  and  $\sigma$ . Create a plot of the detection function estimated by the model.
4. Tricky question for STATS 730 graduates only:
  - (a) Compute standard errors for the transformed parameters,  $\log(D)$ ,  $\text{logit}(g_0)$ , and  $\log(\sigma)$ . The `optim()` argument `hessian` will be useful.
  - (b) Compute standard errors for the parameters themselves,  $D$ ,  $g_0$ , and  $\sigma$ .
  - (c) Compute confidence intervals for the three parameters.
5. Write some R code that simulates capture histories from a spatial capture-recapture model under the following conditions:
  - The survey region is a square, with x-coordinate limits  $(-500, 900)$  and y-coordinate limits also  $(-500, 900)$ . Note that these coordinates are given in metres.
  - Detectors are deployed on a three-by-three grid with a 100 m spacing between them, so that the columns are located at x-coordinates 100, 200, and 300, and the rows are located at y-coordinates 100, 200, and 300. Note that this is the configuration of the detectors in `test.data$traps`.
  - Animal density is  $D = 0.75$  animals per hectare. Note that 1 hectare is 10 000 m<sup>2</sup>.
  - Conditional on its activity centre location, an individual is detected by a detector with probability given by a halfnormal detection function with  $g_0 = 0.9$  and  $\sigma = 75$  m.

For bonus points, write your R code as a function, allowing the user to set their own detector locations and parameter values.

6. Fit a spatial capture-recapture model to your simulated data. Note that you can use the detector locations in `test.data$traps` and the mask in `test.data$mask`. How close are your estimates to the true parameter values?
7. For STATS 730 graduates only: Compute confidence intervals for the three parameters. Did they capture the true parameter values?
8. Run a simulation study, repeating Questions 5–7 a total of 100 times. This involves simulating 100 sets of capture histories, and generating estimates from each. Inspect your 100 sets of estimates.
  - (a) How close are the averages of your parameter estimates to the true parameter values?
  - (b) For STATS 730 graduates only: How often do your confidence intervals capture the true parameter values?

## Questions for ascr users

9. Fit the same model from `secr-11.r`, but using the `ascr` package. Verify that you get the same parameter estimates. For STATS 730 graduates, also verify that you get similar standard errors and confidence intervals.

## Questions for secr users

10. Fit the same model from `secr-11.r`, but using the `secr` package. Verify that you get the same parameter estimates. For STATS 730 graduates, also verify that you get similar standard errors and confidence intervals. This will require some data reformatting.

## References

- Efford, M. G., Dawson, D. K., & Borchers, D. L. (2009). Population density estimated from locations of individuals on a passive detector array. *Ecology*, *90*, 2676–2682.