Micro-level survey design for secr

Macro vs micro-level designs

Our approach breaks designing very large SECR surveys into two steps. First, we decide which areas to survey (macro). Then, we decide where to place cameras in each survey area (micro). This sheet covers micro-level survey design.

Micro-level survey design

SCR models need sufficient detections of individual animals and recaptures to reliably assess quantities like animal density. The goal of micro-level survey design is to place cameras so that we expect to get enough of each of these when we run the survey.

Set up and analyse data

Other sheets in this series cover steps involved in turning collected SECR data into estimates of animal abundance.

(1) Open the Shiny app

There are 3 ways to access the app, #1 is recommended.

#1 Run the app directly in a browser: https://www.stats.otago.ac.nz/secrdesignapp/

#2
```
library(shiny)
runGitHub("secrdesignapp", “MurrayEfford")
```

#3 Download or fork the GitHub repository at https://github.com/MurrayEfford/secrdesignapp

#2 and #3 require the R packages **shiny**, **shinyjs**, **secr**, **secrdesign**

Example datasets for steps below provided in repo link in #3

(2) Load a habitat mask

The required format is a **.txt file** with the first 2 columns giving the **x- and y-coordinates** of mask points. Mask covariates can be specified in additional columns.

Select the **Habitat mask** tab from the left-hand panel, click **File** and then **Browse** to the location of the mask txt file. If the mask is loaded correctly it will be displayed in the app.

A mask is a **set of square grid cells** representing habitat **in the vicinity of detectors** that is **potentially occupied**. See the *Setting up data* sheet for more details on mask setup. Masks in `secr` can be written to txt files using `write.mask`.

(3) Provide rough estimates of `secr` parameters

! Designing and checking survey designs needs preliminary estimates of animal density and movement. These can come from preliminary surveys or, where these are not available, from judgment. Being exactly correct is not important, but if guesses are far from the true values then the design may be poor.

Select the **Design** tab and, in the **Parameters** panel, specify expected animal density **D**, expected encounter rate at distance zero **lambda0**, and the movement parameter **sigma**. In most cases other settings can be left at their defaults; consult the `secr` help files or a statistician if in doubt.

Still in the **Design** tab, specify the number of survey **Occasions** (General) and **Detector type** (Detector array).

Default units in secr is “per hectare”. This can be changed to per km² using the **Options** tab (Area units)

Survey checklist

- ✔ 1 - 2 sigma spacing between most detectors
- ✔ Array covers > 1 home range
- ✔ n > 10, r > 15, m > 10, CV < 25%

(4) Specify layout of detectors

! SCR design is an evolving field. Best practice is a detector spacing of 1-2 sigma, and array coverage > 1 home range. Regular grids are a good, robust option. If there are not enough cameras to cover the survey area with a grid, cluster designs can be used. Other designs should be used with caution, in collaboration with a statistician.

Upload your own file with detector positions

Use this option if you have already chosen a potential set of detector locations. This also allows you complete control over locations. Locations should be recorded in a space-delimited **.txt file** with 3 columns: detector **ID**, **x** and **y** coords.

Select the **Design** tab, and click **File** in the **Detector Array** panel, and **Browse** to the location of your array .txt. If the file has column headings, enter `skip = 1` in the “Optional arguments” box.

Generate a regular grid design in the app

1 Select **Region** in the **Detector Array** tab. Click **Browse**, and upload a ‘boundary file’: a shape file demarcating all potential areas where cameras can be placed.

Required boundary file format is an ESRI polygon shapefile with the four component files (.shp, .dbf, .prj, and .shx), selected together. This can be the habitat mask in (2), minus the buffer area.

2 For a regular grid design, choose the **Systematic** tab. Specify a desired **Spacing** (between 1 and 2 sigma). Tick the **Random origin** box.

Generate a cluster design in the app

Do step 1 above, then select **Grid** in the Detector Array tab and specify the desired number of detector **rows**, **columns** and **spacing** *within each cluster*. From the **Region** tab, set the *between-cluster* **spacing**, choose **Cluster type** as “Grid” and tick the **Random origin** box.

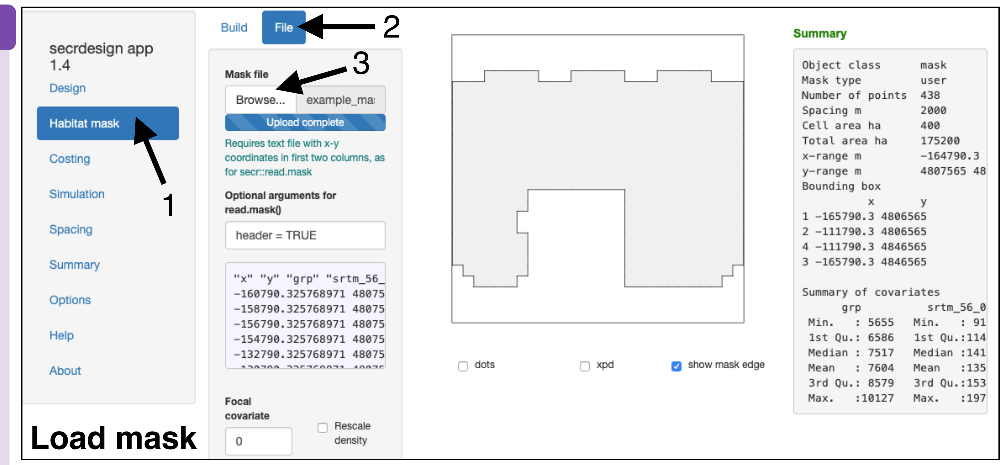
Use the **Array**, **Popn**, and **Pxy** tabs from the right hand **Results** panel to check that everything looks sensible. Save detector locations using the **Save** button visible after you click the **Array** tab.

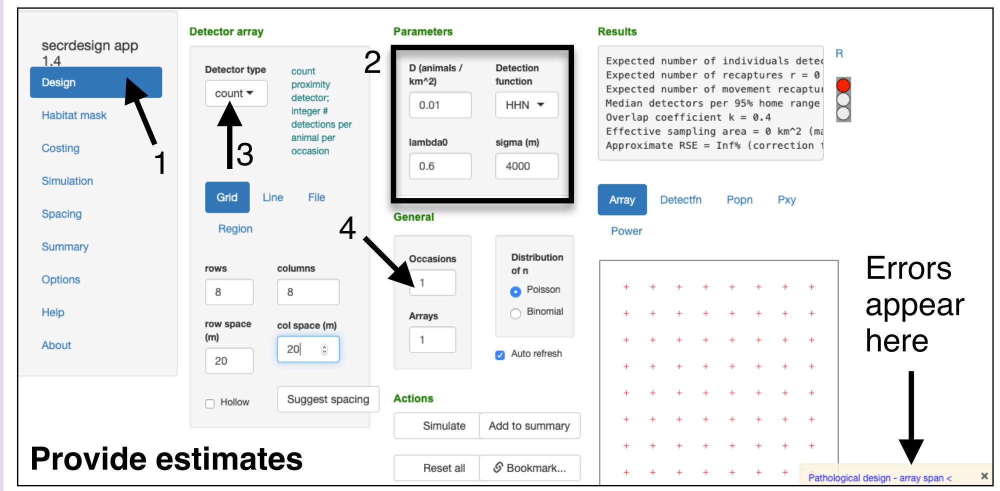
(5) Perform checks on survey

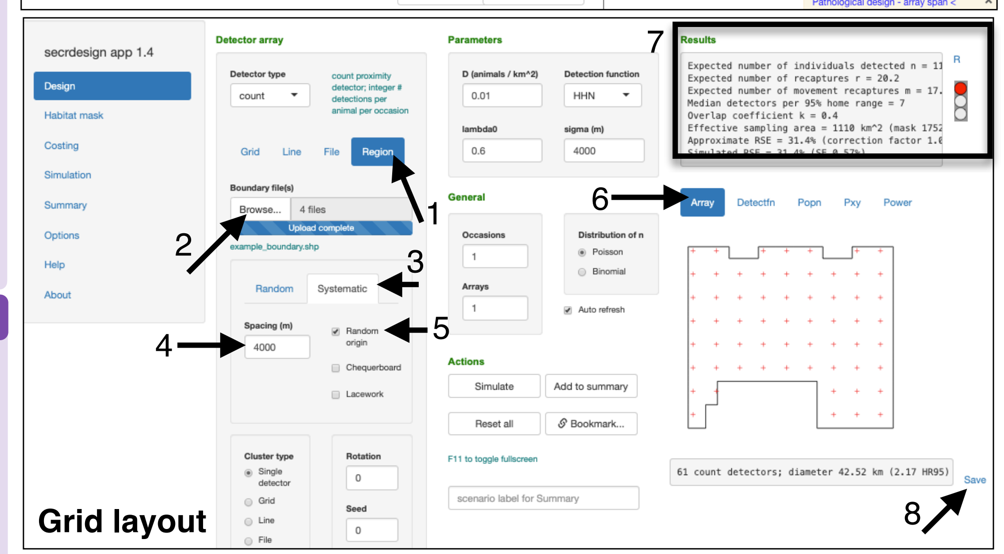
! The **Results** window (**Design** tab) automatically shows summary measures for a proposed design. These are useful checks on designs, but are calculated using approximations, and so must be checked with simulation as described below.

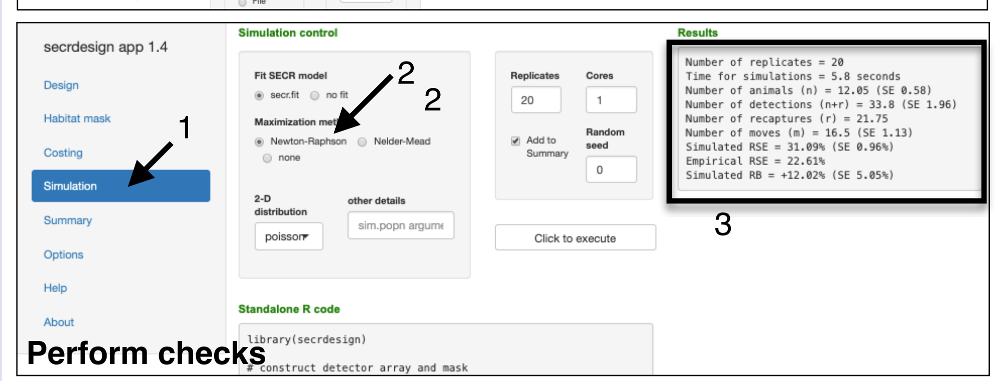
Select the **Simulation** tab and select **Newton-Raphson** as the **Maximization method**. Specify at least 20 in the **Replicates** box for final tests. Animal density is assumed uniform by default; these and other SCR parameters can be changed in the **other details** box, but require knowledge of `secr`. The **Click to execute** button runs the simulation and sends output to the adjacent window, and the **Summary** tab.

It is difficult to say when a design is “good enough”. Very few individuals (<5) or between-detector movements (<5) make it likely that SCR models fail. More animals and more recaptures (>15) make this unlikely, but borderline cases depend on many factors. Snow leopard studies are often at the limit of what is possible. If in doubt, consult a statistician.









secrdesignapp version 1.4 uses secr (v3.2.0 or later) and secrdesign (v2.5.7 or later). App and packages created by Murray Efford. Learn more about the material shown here from https://github.com/MurrayEfford/secrdesignapp and from the app’s help tab.