

# Macro-level survey design for secr

## (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://iandurbach.shinyapps.io/macro-design-app/>
- #2 `library(shiny)`  
`runGitHub("macro-design-app", "iandurbach")`
- #3 Download or fork the GitHub repository at <https://github.com/iandurbach/macro-design-app>

#2 and #3 require the R packages **shiny**, **dplyr**, **sf**, **leaflet**  
Example datasets for steps below provided in repo link in #3

## (2) Load a study area shape file

Input data for the app consists of a shape file demarcating the entire study area. This should encompass several future camera trap survey areas (usually > 10,000km<sup>2</sup>)

The required format is an ESRI polygon shapefile with at least four component files (.shp, .dbf, .prj, and .shx).

Click the **Browse** button located next to **Load new survey area** and select the four component files *together*.

The drop-down **Base map** menu allows different topographical aspects of the landscape to be shown.

## (3) Create new survey sites

- 1 Click **New seed** to randomize the design and record the survey ID in the **Seed/survey ID** box
- 2 Set the **Number of new survey points to generate** box to the desired number.
- 3 Click **Add surveys**. New survey points appear as red circles.

Each generated point is the rough centre of a future camera trap survey. Hover the mouse over any survey point to see the order of a survey, and its latitude and longitude

- ! To add additional points to an existing survey, enter your seed/survey ID in the box and generate the number of existing survey points. Then, use step 2 and 3 to add new survey points.

Click **Download survey points** to download a csv file with all generated points, existing and new.

You need the seed!

The seed/survey ID is the only way to reproduce your survey points. It is written into the csv download filename. Keep this number safe!

## 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 macro-level survey design.



## Macro-level survey design

Macro designs are only needed when the aim is to **extrapolate** the results of **several** camera trap surveys to a much larger area than covered by the surveys (usually > 10,000km<sup>2</sup>). If inferences are limited to survey areas, or enough surveys can be run to cover the whole region of interest, macro designs are not needed.

## Why use macro design?



Because it is impossible to survey the whole snow leopard range. Without statistical survey design there is no way to know if surveys are representative of the whole range, so extrapolation is impossible.

## Stratified designs

- ! Stratified design place more survey effort in certain areas than others. They should only be used with caution, in collaboration with a statistician.

For stratified designs, a variable called `stratum_id` must be added to the shape file prior to using the app, identifying the stratum that each polygon belongs to.

### Area-proportional stratified designs

By default, the number of points generated in each stratum is proportional to the area covered by the stratum. This means that a stratum covering twice the area of another will receive twice as many survey points.

### User-specified stratified designs

The desired **Sampling proportions per stratum** can be set in the box of the same name. Use R syntax here e.g. for 10% of points in stratum 1 and 2, and 80% stratum 3, enter `c(0.1, 0.1, 0.8)` and click **Update**. Use with caution!

Sampling proportions in each stratum are shown in brackets in the legend in the bottom-right corner of the screen.

## Excluding areas already surveyed

A shape file with polygons demarcating areas already surveyed can be uploaded with the **Browse** button located next to **Locations of existing surveys**. Polygons can be regions covered by habitat masks from existing SECR studies.

The file format is as for (2): an ESRI polygon shapefile with at least four component files (.shp, .dbf, .prj, and .shx), selected together.

Already-surveyed areas are indicated by grey regions. No survey points will be generated in these regions.

- ! Areas already covered by the habitat masks of existing surveys can also be removed from the shape file used in Step (2)

## A bit about BAS

Spatial survey designs often use a grid of regularly-spaced points, but this is not possible in irregularly shaped areas. We use a method called Balanced Acceptance Sampling (BAS) to generate survey points. BAS generates a sequence of points so that points from any part of the sequence are evenly distributed in space. This means we don't need to know the number of surveys in advance - surveys can always be added later, while preserving even spatial coverage. This is exactly what we need for most snow leopard surveys.

See: van Dam-Bates, P et al. (2018). [Using balanced acceptance sampling as a master sample for environmental surveys](#). MEE 9(7), 1718-1726.

