

# Wildlife Simulation Package



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# Concepts in animal abundance estimation

## State model

Describes the spatial distribution and characteristics of animals in a region

Who lives here and where are they?

Population: group size, composition (gender, type), position, exposure

## Survey design

Describes the covered region, survey units, effort (observers/traps)

Where, how, and how hard we look.

Survey design: plot sampling, removal methods, mark-recapture, distance sampling, etc.

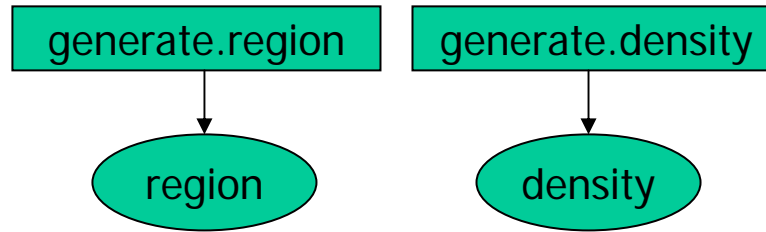
## Observation model

Describes the probability that animals with given characteristics are detected.

What we assume we are likely to see.

Detection probability: certain, constant, distance dependent, covariate-dependent

# Abundance estimation process in WiSP



1.) Define survey region  
& population density

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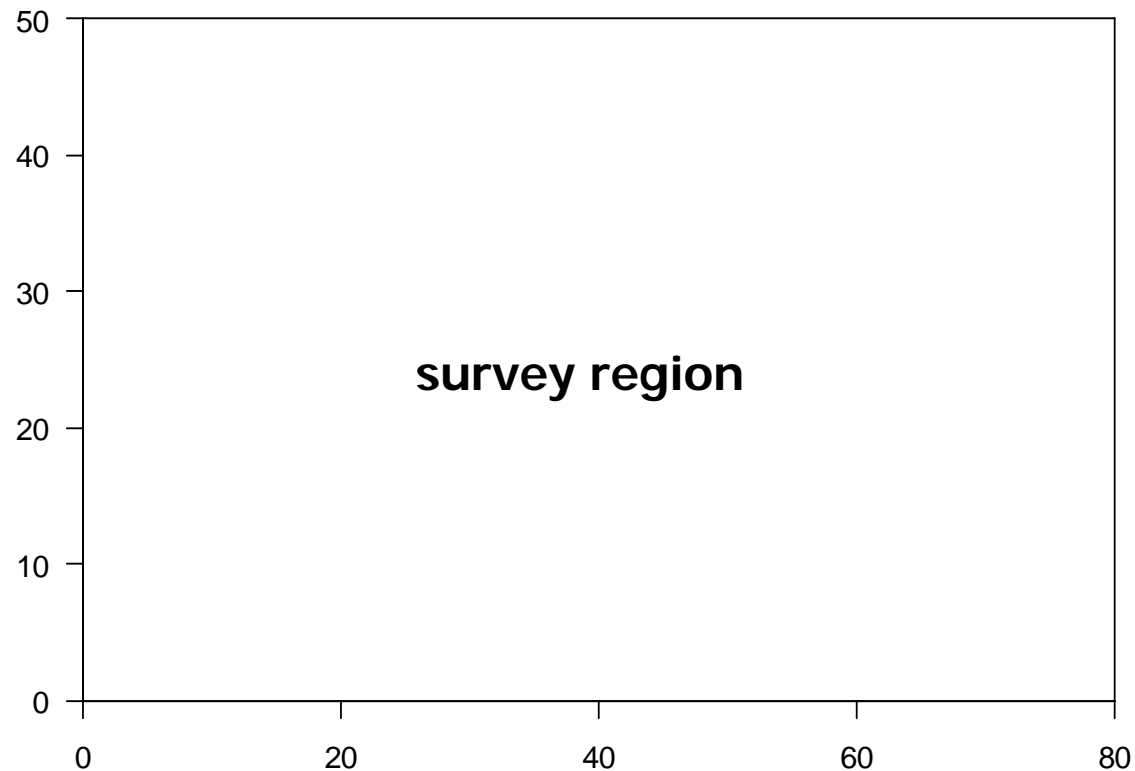
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functions

objects

# Generating a survey region

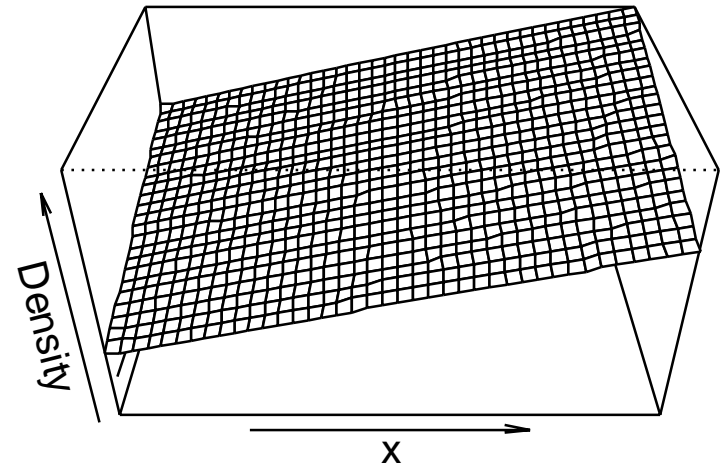
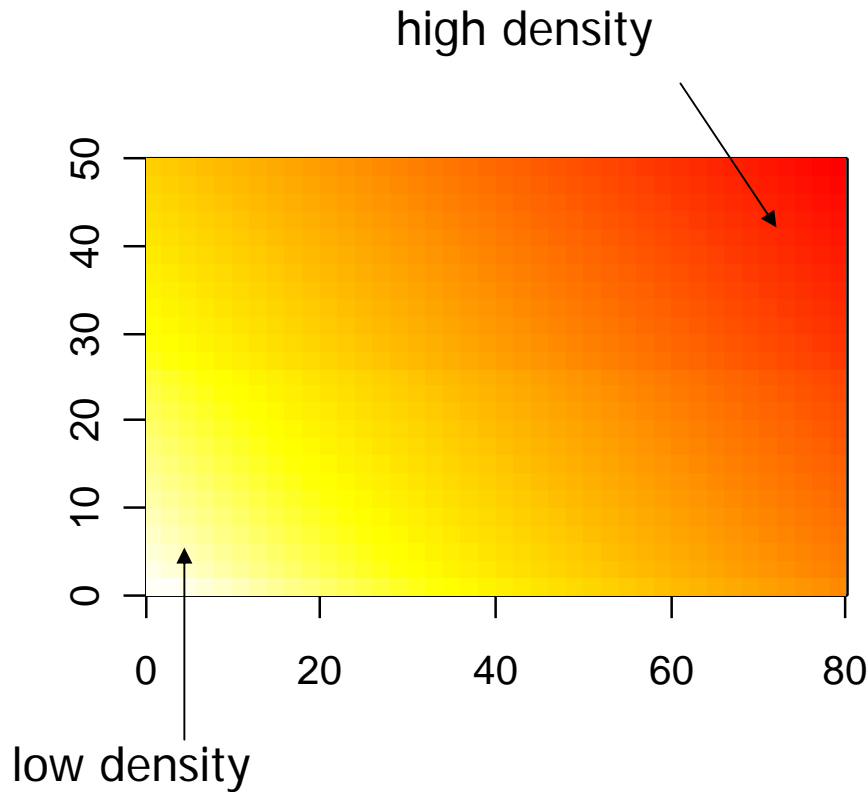
**Survey region = An area of given height and width**



# Generating a population density (1)

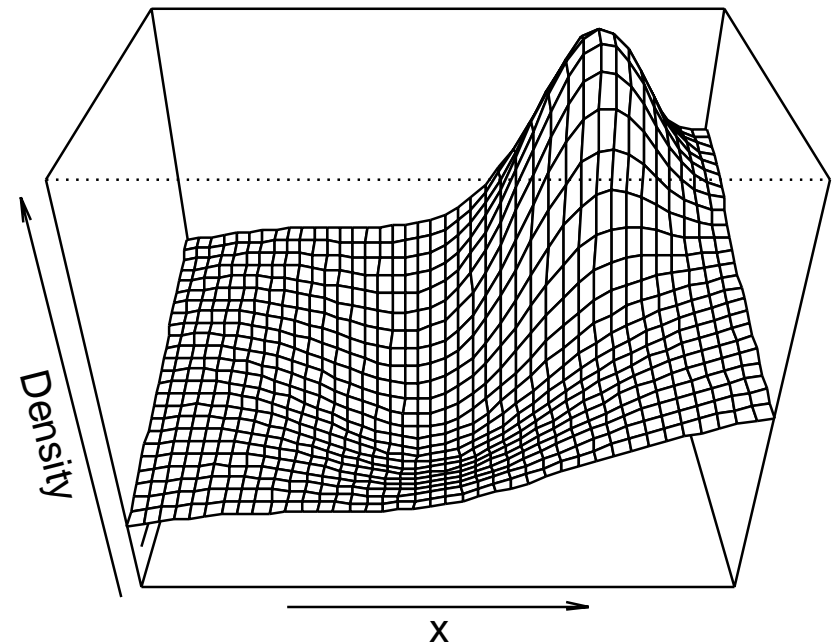
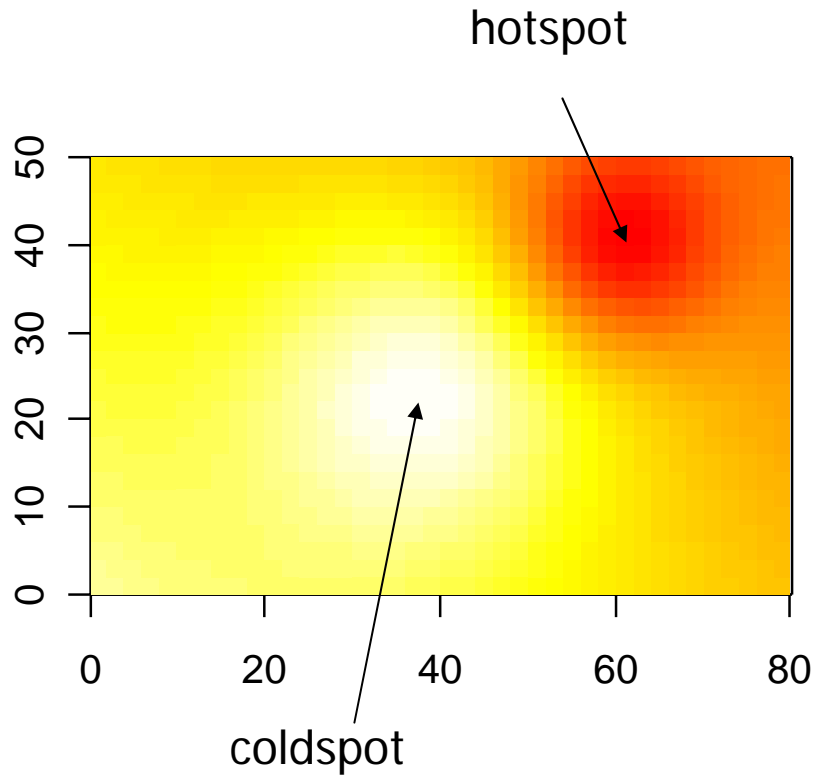
**The population density defines the spatial distribution of animals in the survey region.**

Simple density with linear trend:



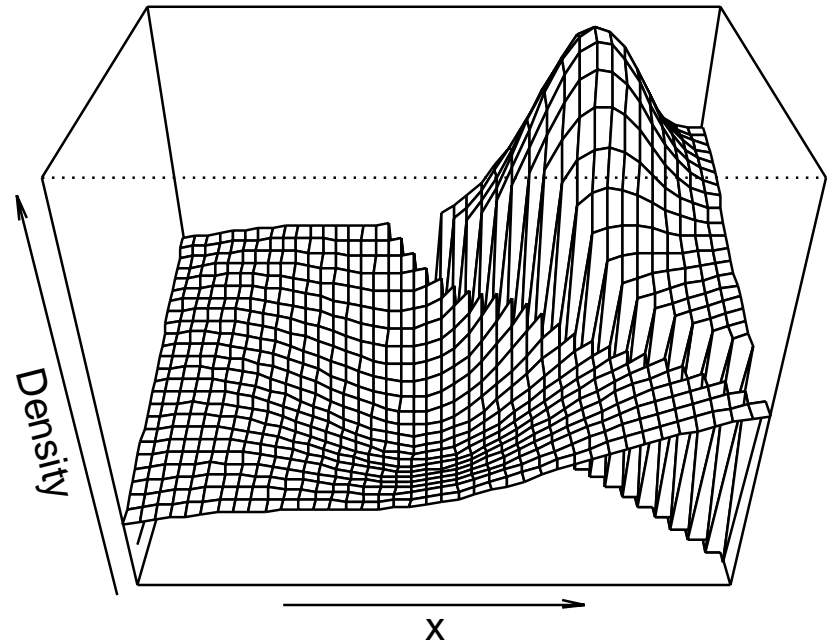
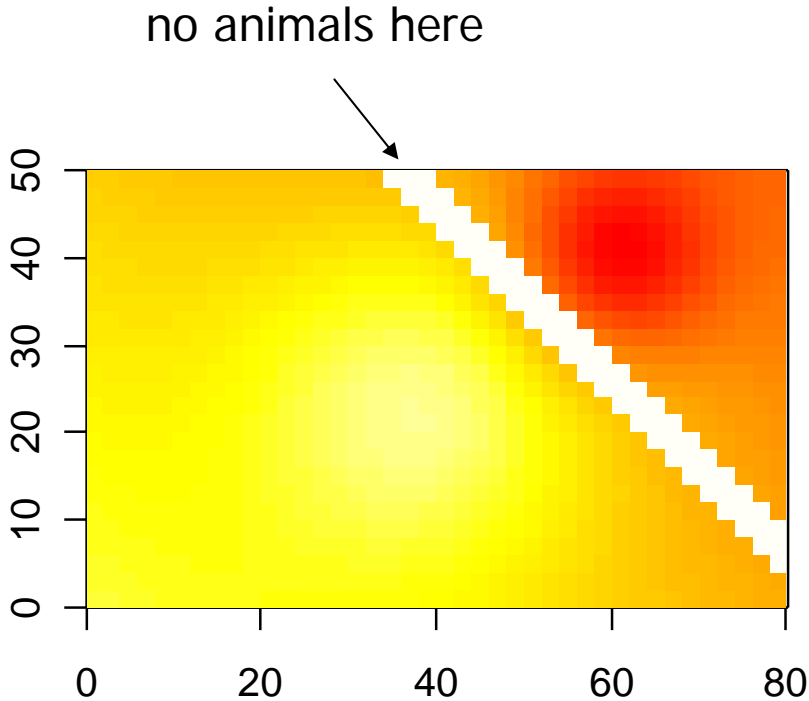
# Generating a population density (2)

Increase complexity by adding hotspots and coldspots:

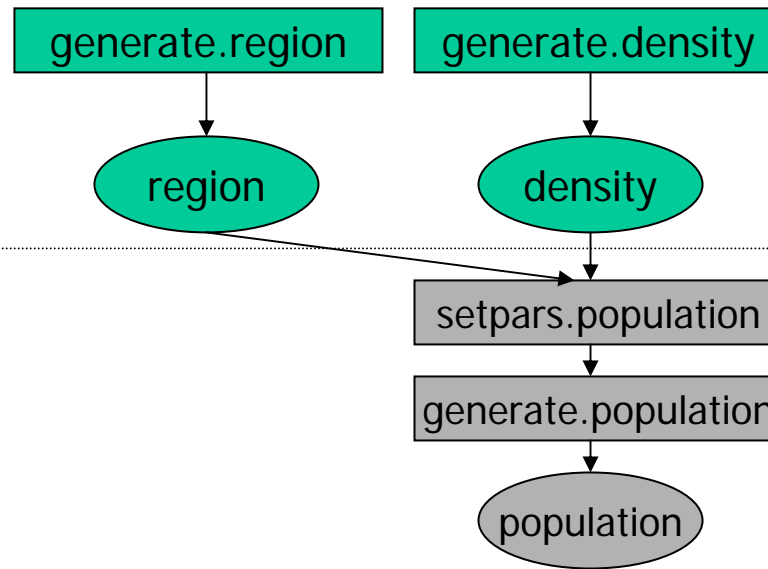


# Generating a population density (3)

**Add more complexity: Strips of constant density**



# Abundance estimation process



1.) Define survey region  
& population density

2.) Generate population

functions

objects



# Generating a population

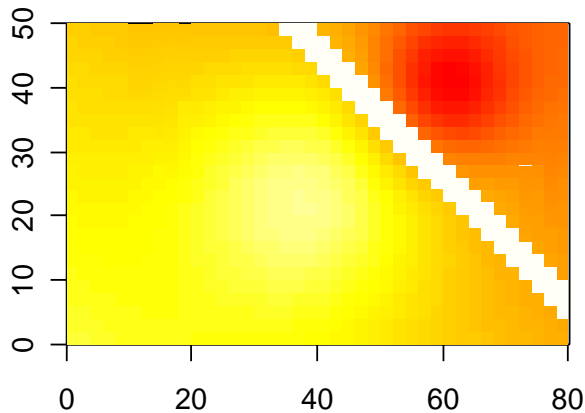
**The population specifies the positions and characteristics of groups and individuals**

## **Population parameters**

- region
- density
- probability distributions of group and individual characteristics (group sizes and exposures)
- number of groups

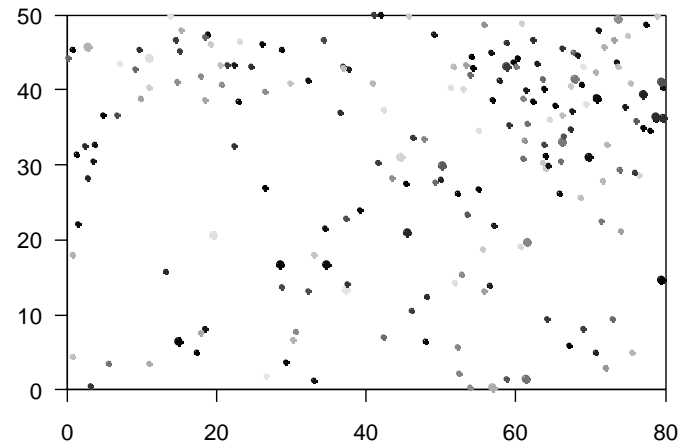
# Generating a population

Region, density and  $N$

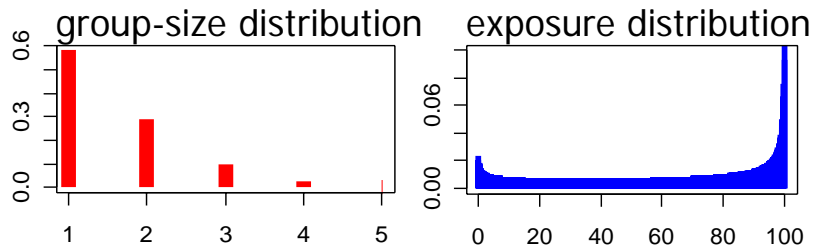


**Generate population**

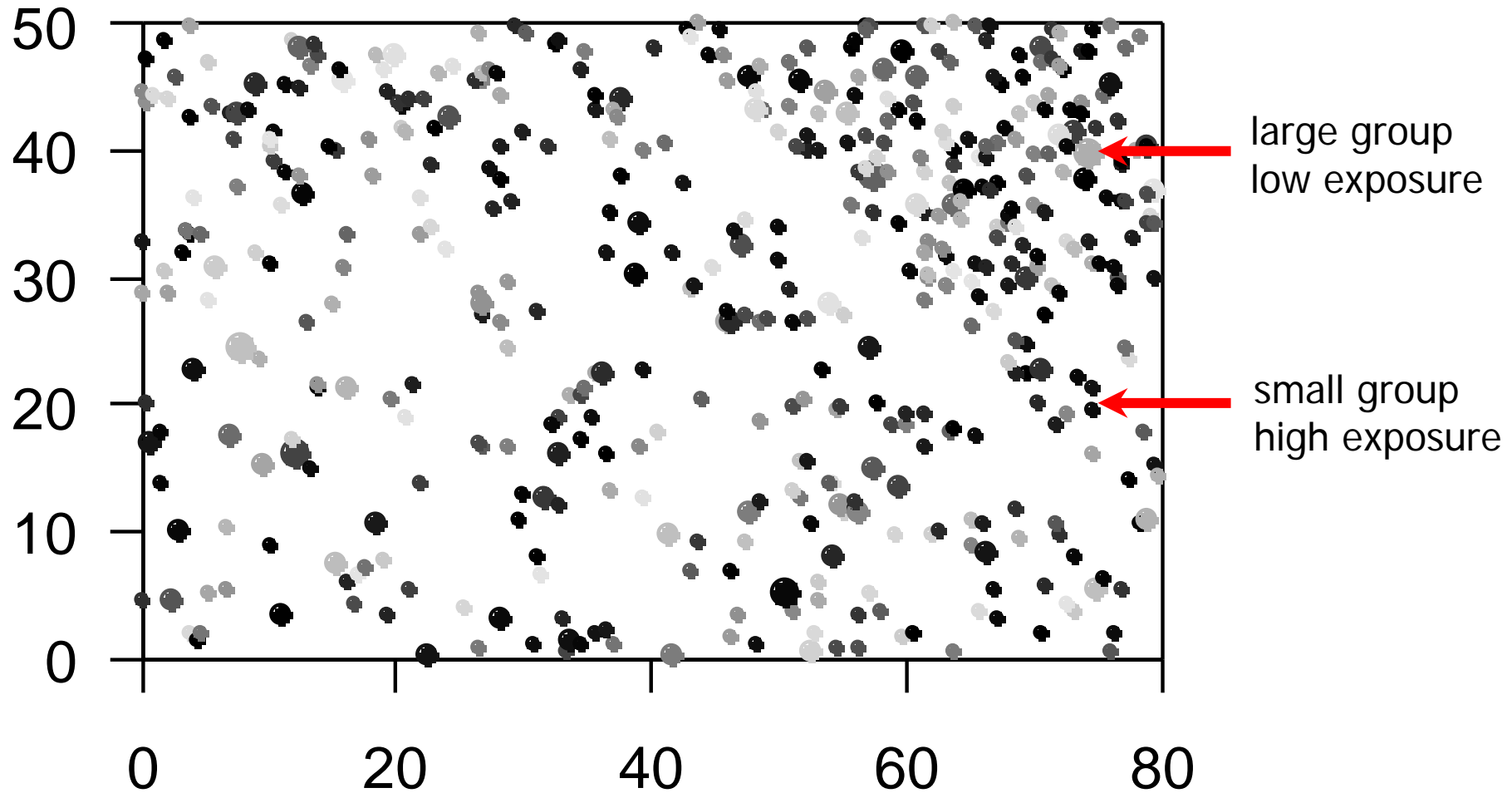
Population



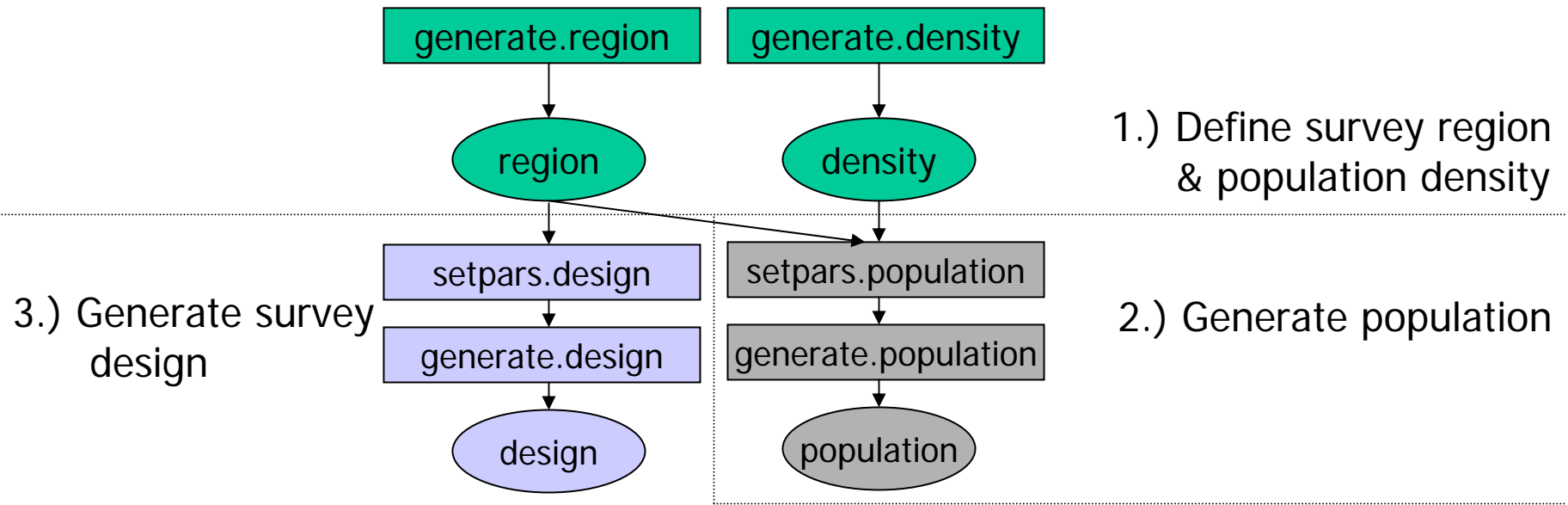
population parameters



# A population with 500 groups



# Abundance estimation process in WiSP

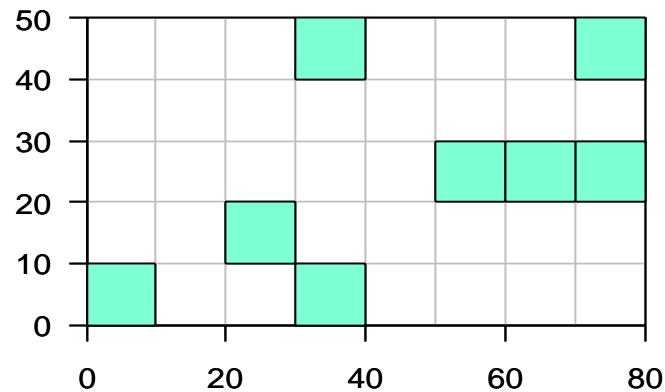


# Survey designs for closed populations

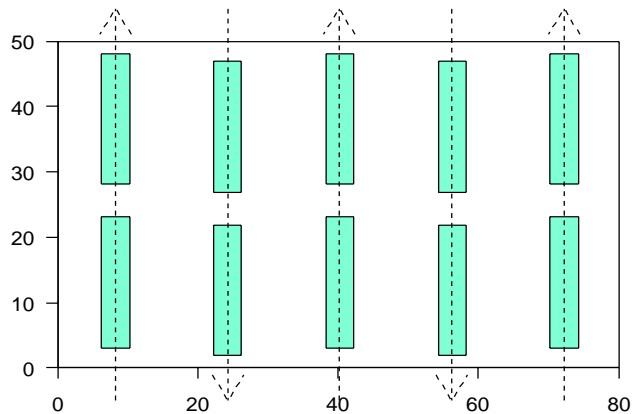
- **plot sampling** Count all animals in a selected sub-region
- **distance sampling**
  - line transect Count along a transect – record the distances
  - point transect Count within a circle – record the distances
- **removal methods** Repeatedly remove some
- **mark-recapture**
  - various Repeatedly capture, mark, return
- **nearest object**
  - single nearest object Measure distance to nearest object detected

# Survey designs with Incomplete Coverage

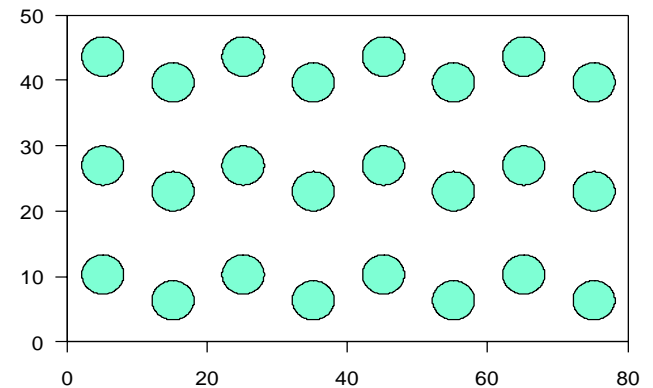
**plot sampling (random)**



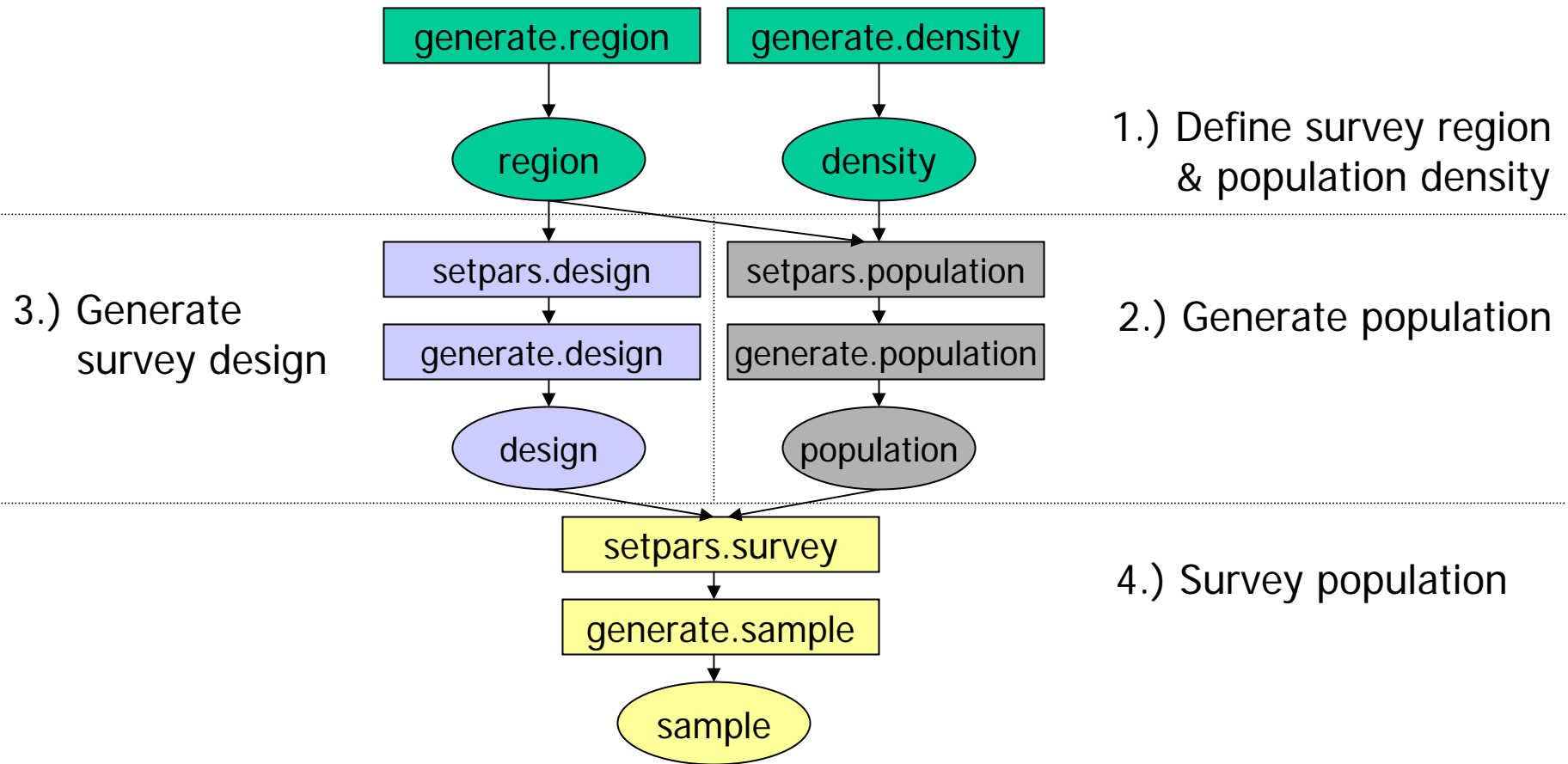
**line transect**



**point transect**



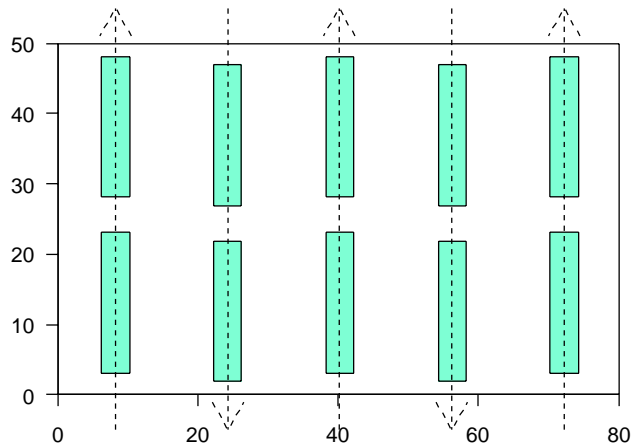
# Abundance estimation process in WiSP



# A line-transect survey

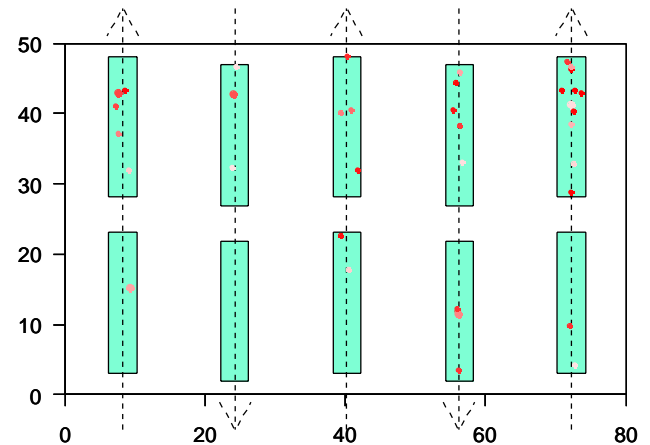
**Specify design pars**

**Generate design (random)**



**Specify survey pars**

**Do survey to generate ...**

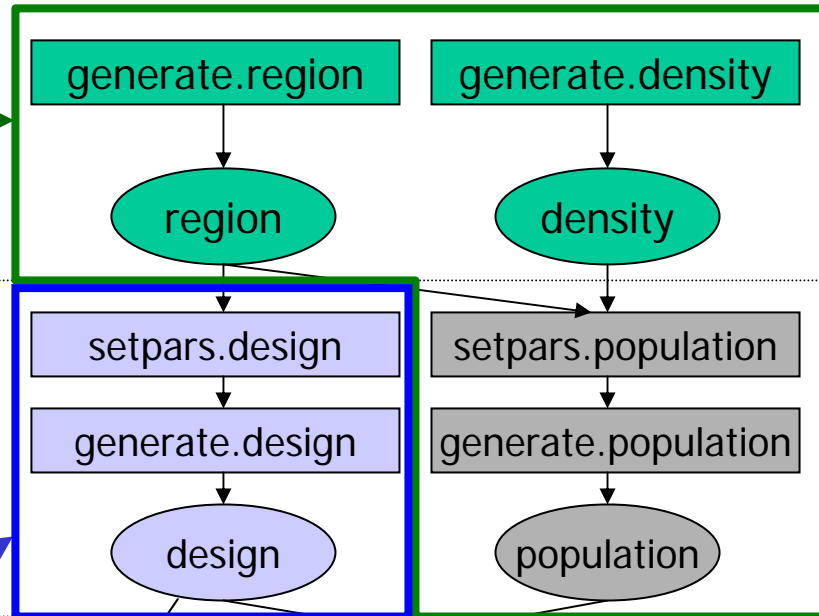


**... a sample**



# Abundance estimation process in WiSP

**State Model** →



1.) Define survey region & population density

3.) Generate survey design

2.) Generate population

**Design** →

4.) Survey population

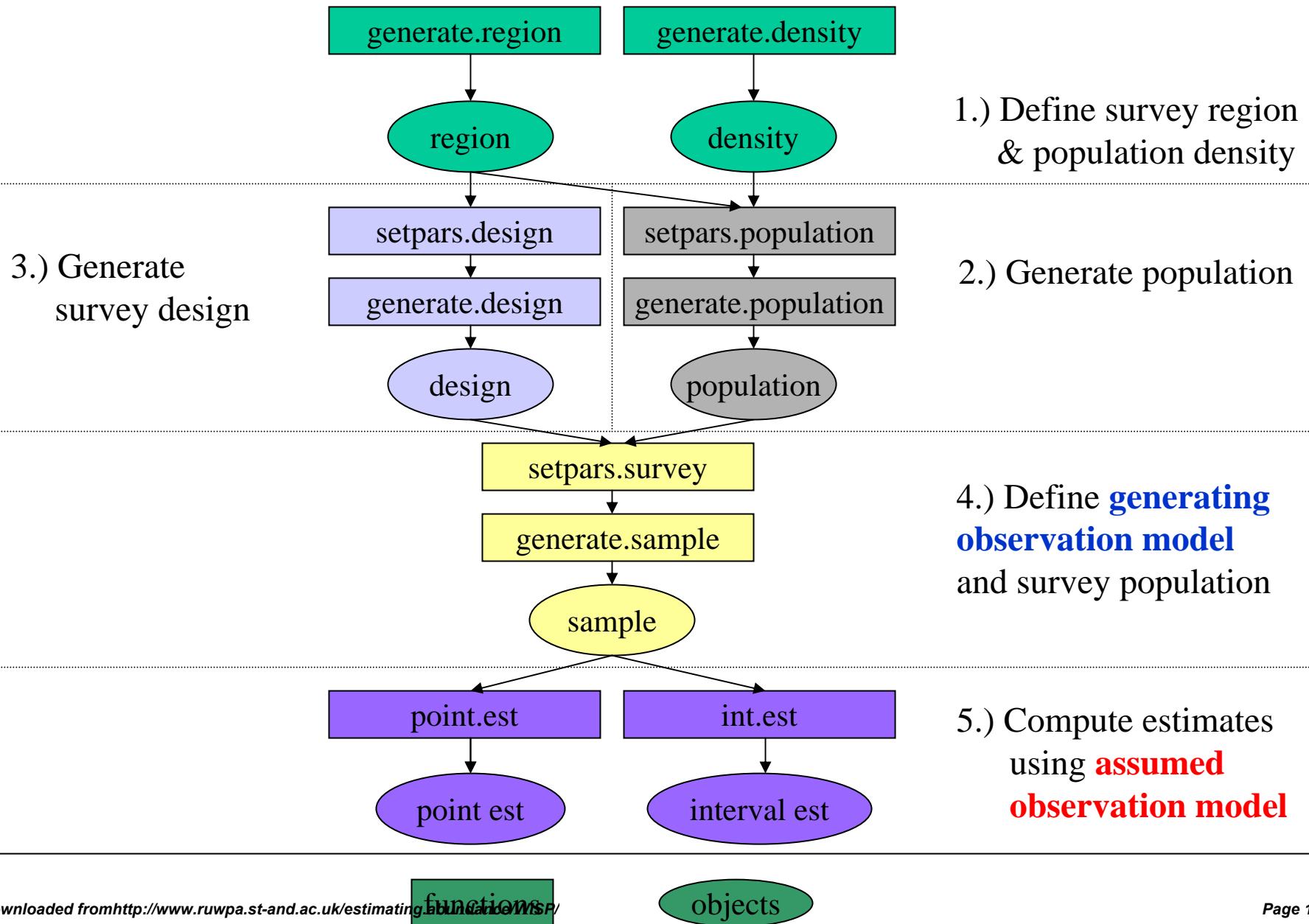
**Observation Model** →

5.) Compute estimates

functions

objects

# Assumed model vs reality

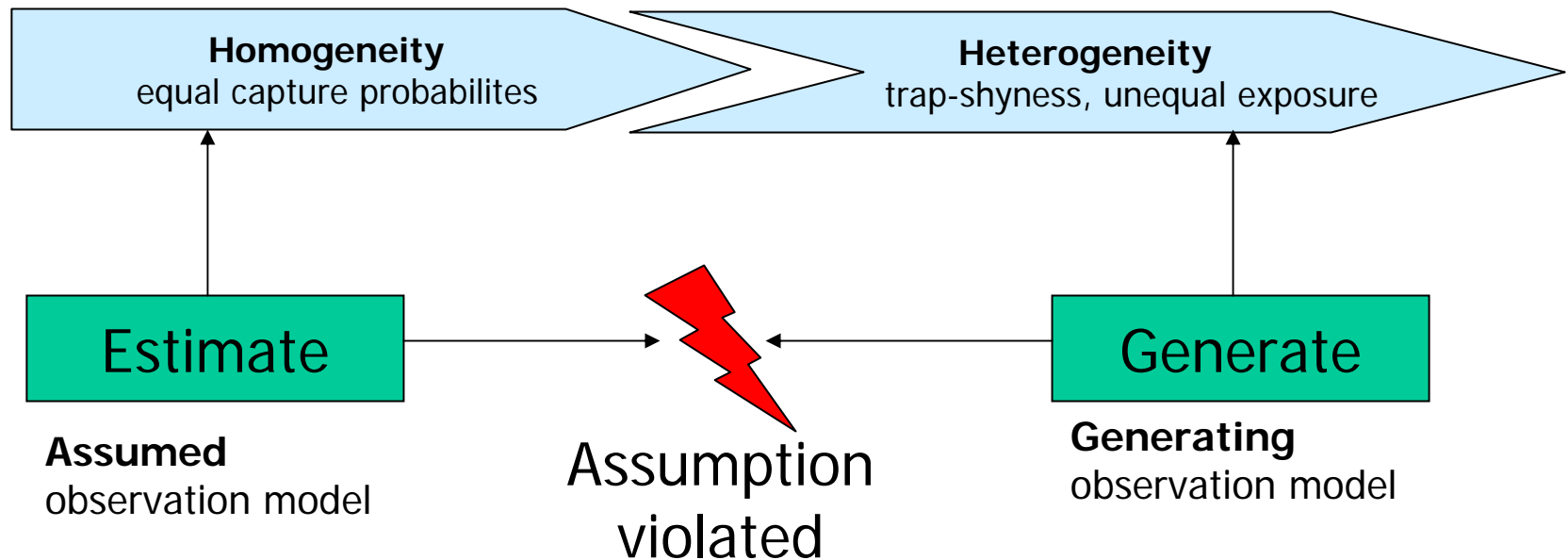


# Assessing sensitivity to assumptions

**Generating observation model** defines the **true** detection/capture probabilities for all animals

**Assumed observation model** is what we use to carry out the estimation

## Mark-recapture method



**Enables sensitivity analysis**

# Function and object names

## Prefix\* (action)

setpars.survey  
generate.design  
plot.design  
generate.sample  
summary.sample  
point.est  
interval.est  
point.sim  
etc.

\* incomplete list

## Suffix (method extension)

.cr <sup>1</sup>	capture-recapture
.dp	double-platform
.lt	line-transect
.no	nearest object
.pl	plot sampling
.pt	point-transect
.rm <sup>2</sup>	removal

+

## Example:

**setpars.survey.pt**      Set survey parameters for a **point** transect

<sup>1</sup> Estimation functions for .cr extension are .crM0, .crMt, crMb, crMh

<sup>2</sup> Estimation functions for .rm extension are .rm, .ce and .cir

**Also summary() and plot() functions for most objects**