

Acoustic Array Configuration Testing

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Set up and plot the detection functions from which to simulate:

```
# parameters for half-normal detection function
detfun = "HN"
g0 = 1
sigma = c(500,1000)

# parameters for hazard half-normal detection function
detfun = "HHN"
l0 = c(22,84)
sigma = c(350,500)

if(detfun=="HN") detpar = list(list(g0=g0, sigma=sigma[1]),list(g0=g0, sigma=sigma[2]))
if(detfun=="HHN") detpar = list(list(lambda0=l0[1], sigma=sigma[1]),list(lambda0=l0[2], sigma=sigma[2]))

nsigma = length(sigma)
```

In the absence of better information, density was chosen to give what looks like a believable number of calling groups per square kilometre.

Survey Simulation Setup

Let $\mathbf{s} = (x, y)$ be a generic activity centre location, (u, v) be a detector location and $p(d) = g_0 \frac{d^2}{2\sigma^2} = g_0 \frac{-((x-u)^2 + (y-v)^2)}{2\sigma^2}$ be the detection function evaluated at distance $d = \sqrt{(x-u)^2 + (y-v)^2}$ from the activity centre, where g_0 and σ are the detection function parameters.

The probability of detection at distance zero from a detector is assumed to be 1, i.e., we assume that $p(0) = g_0 = 1$.

We have N activity centres, in a region of area A that includes the trap array at its centre. Activity centres are assumed to be evenly distributed in the survey region (created with the `secr` function `sim.popn`, with argument `model2D="even"`).

Each activity centre is assumed to emit $n_c = 5$ calls.

We consider estimation with either arrays of 7 detectors or arrays of 5 detectors, with about the same total number of detectors in each case - see below for detector layouts.

We consider scenarios with either the half-normal detection function range parameter σ is either 350m or 500m, or the hazard half-normal detection function with parameters $(\lambda_0 = 22, \sigma = 350)$ or $(\lambda_0 = 84, \sigma = 500)$

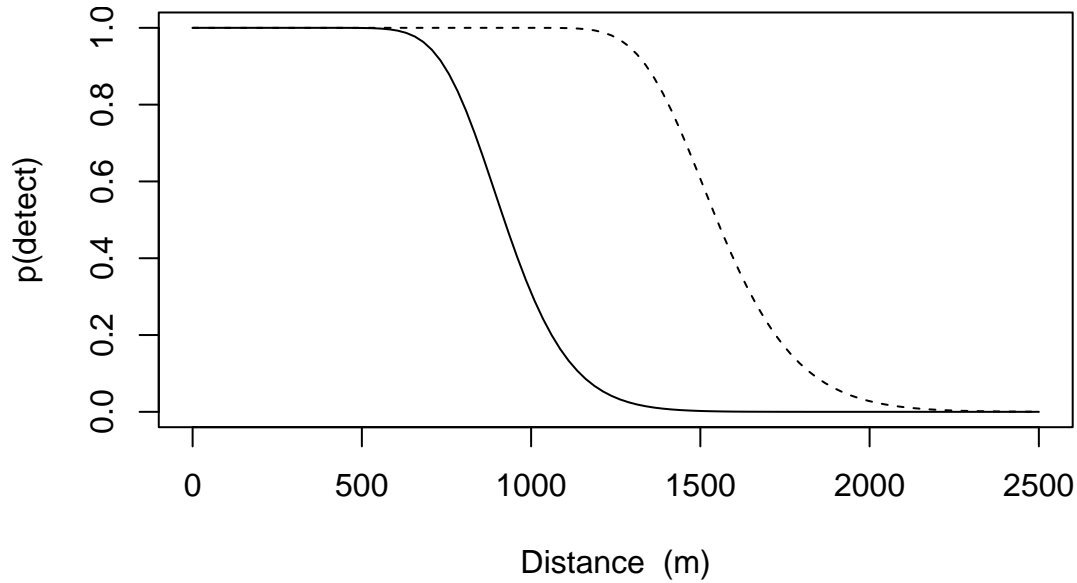
To evaluate the designs, we look at the bias and the std. deviation of estimates of density of calls and of σ .

7-array simulations

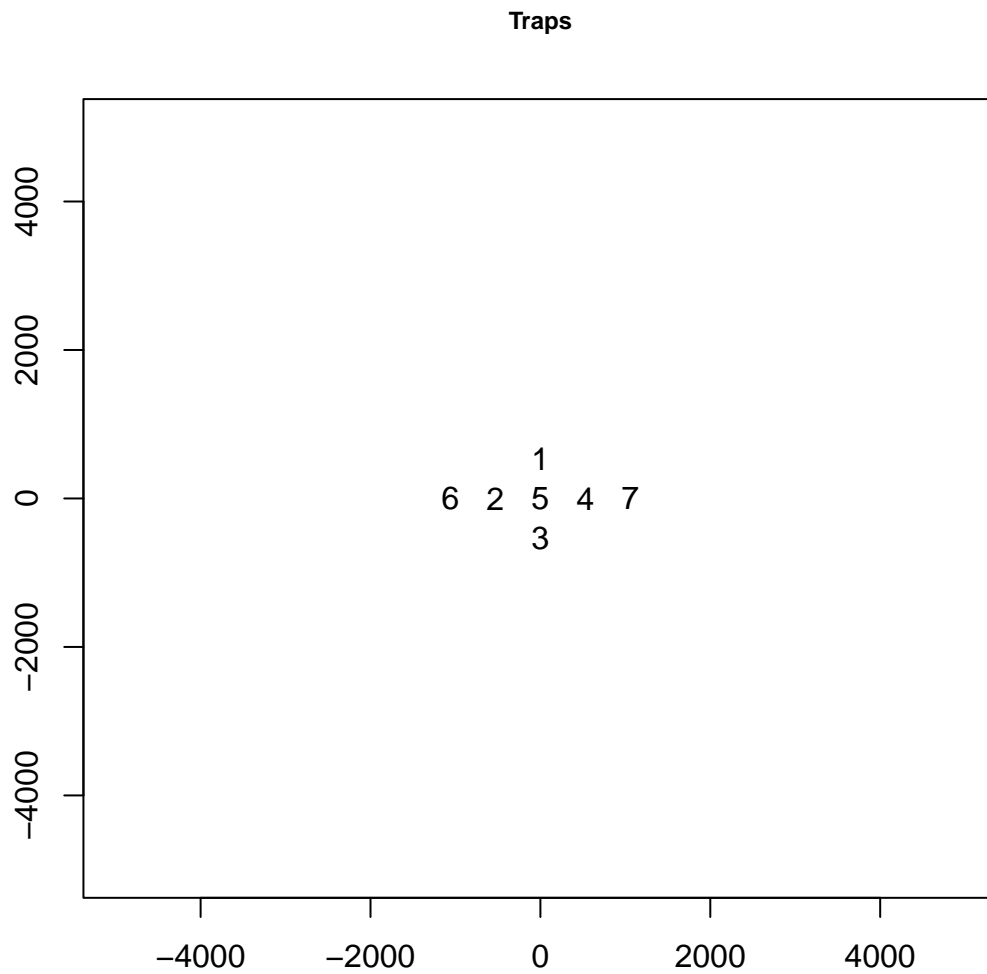
The key parameter values are as follows:

- $\sigma = 350$,
- $g_0 = 1$ (for half-normal) OR $\lambda_0 = 22$ (for hazard half-normal).
- The surface area of the area around a single array is 9121.2825,
- The number of 7-element arrays used is 11,
- The total number of animals across all arrays $N = 363$,
- The number of calls per animal is $n_c = 5$,
- True number of calls is $N_{call} = 1815$,
- The mask buffer is 4000,
- The number of simulations is 3.

Let's take a look at the detecton functions:



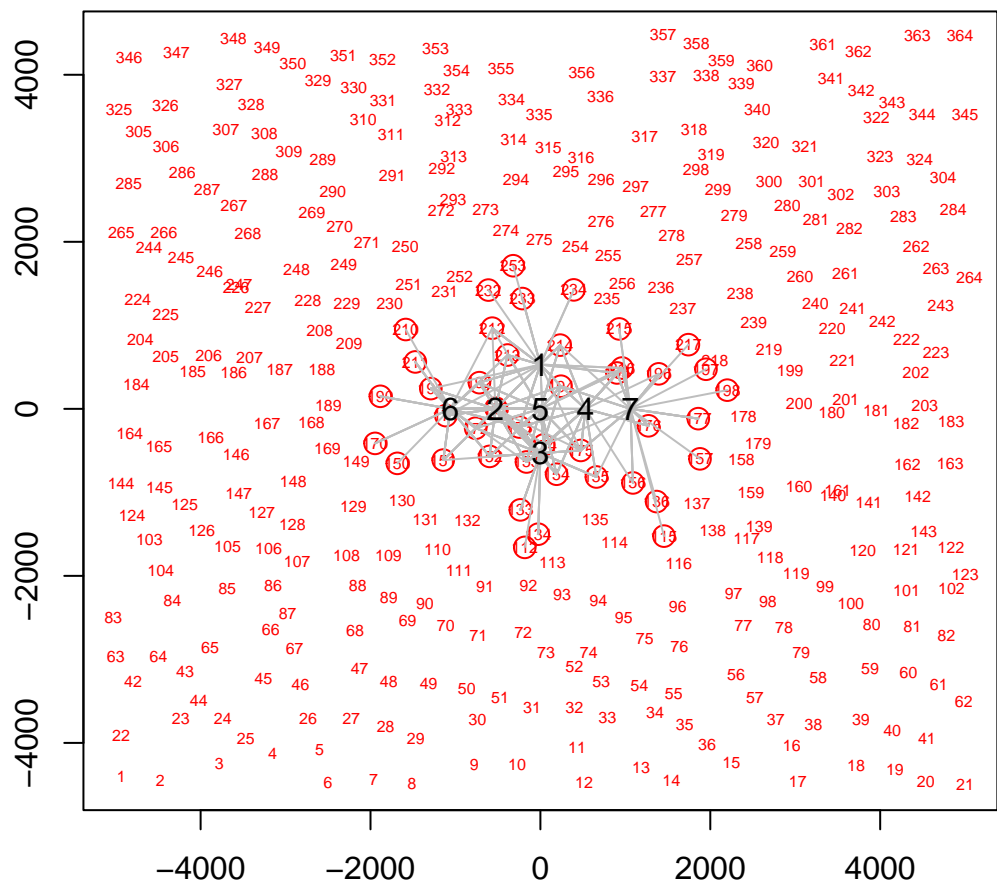
And take a look at the traps:



Now try simulate a single survey and plot the population and captures for a single array, to give a feel for what the simulation scenario looks like. We do this for each candidate σ .

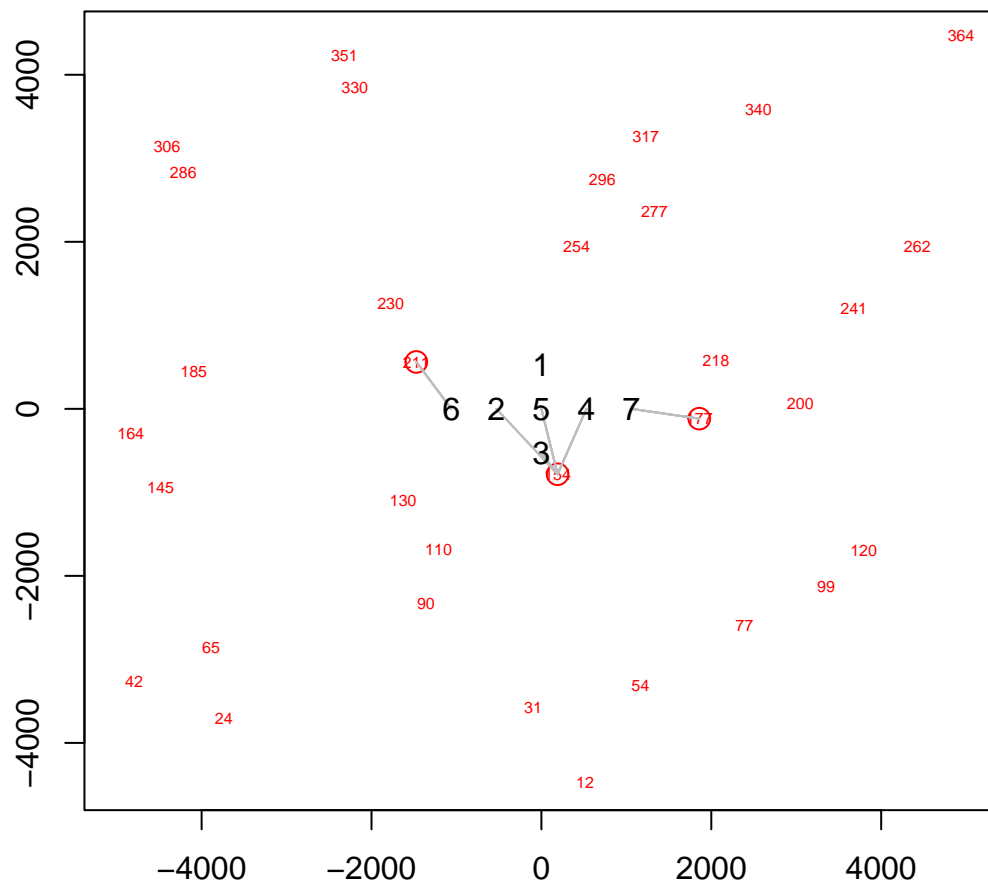
Captures for all arrays:

All arrays, 7-element array, sigma=350; 5 calls per animal.



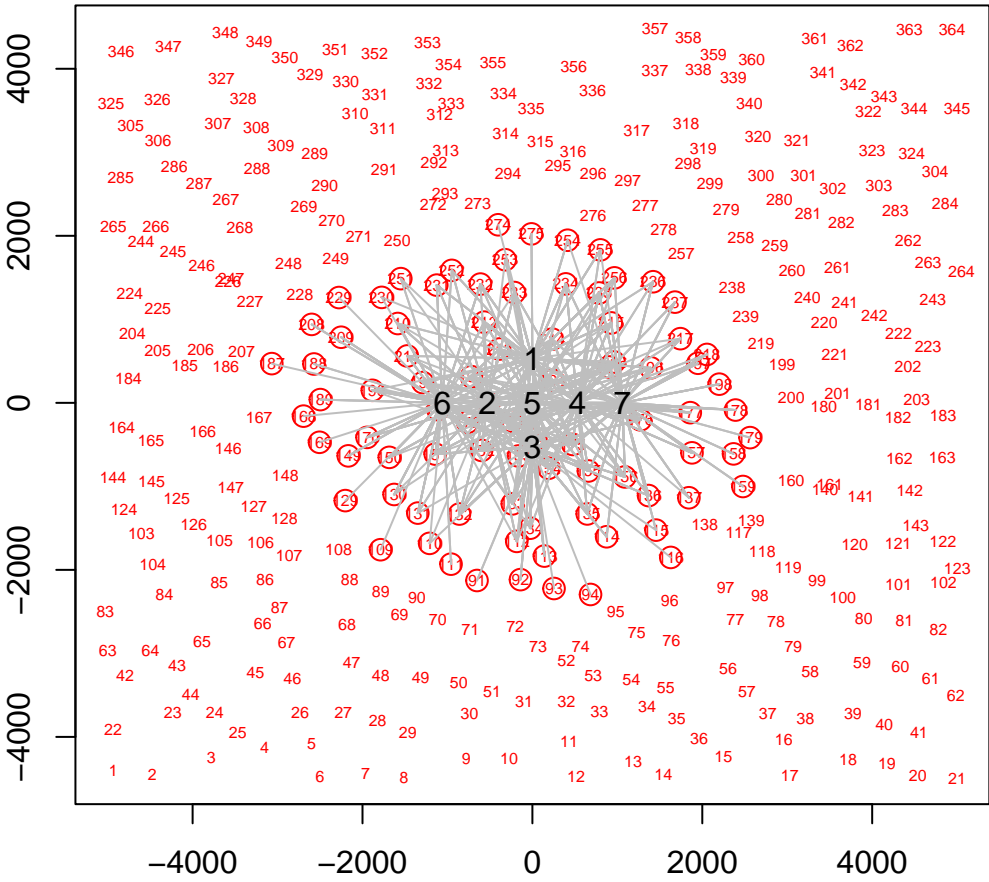
Example captures from a single array:

Single array, 7-element array, sigma=350; 5 calls per animal.



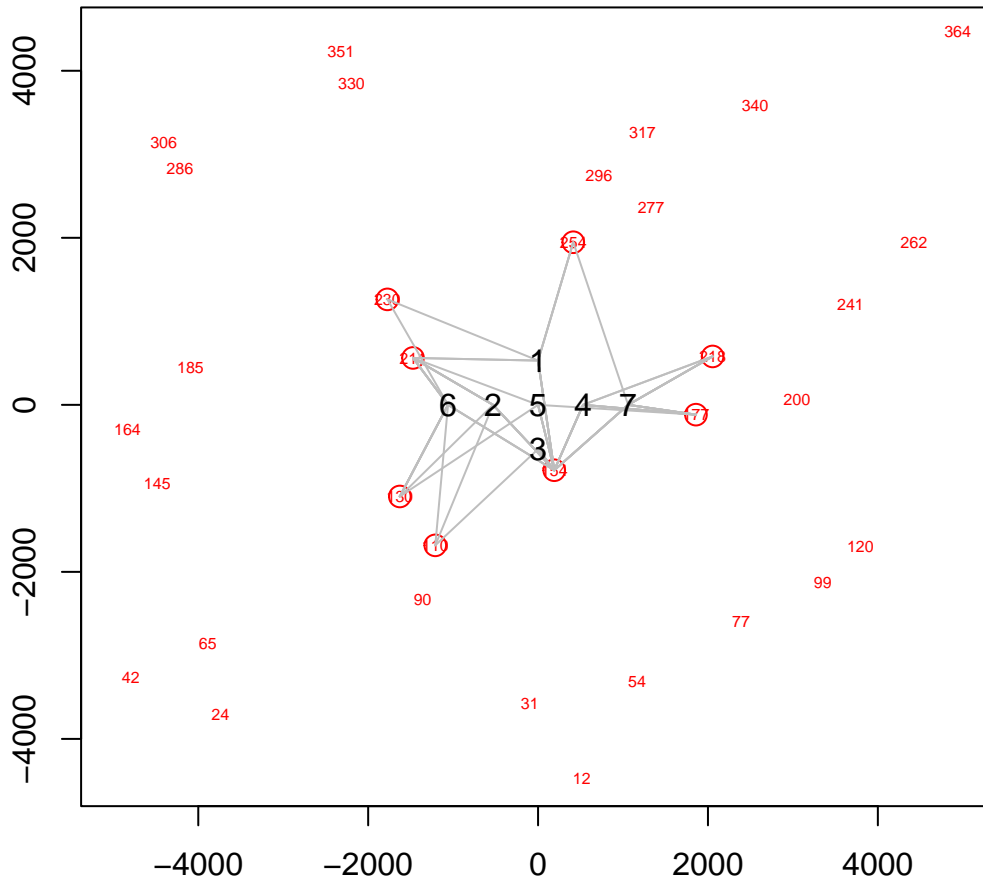
All arrays:

All arrays, 7-element array, sigma=500; 5 calls per animal.



Single array.

Single array, 7-element array, with sigma=500; 5 calls per animal



Simulate population and survey, and look at distribution of estimates of number of calls, number of groups detected, and number of calls detected, across all the arrays.

5-Element Array Simulations

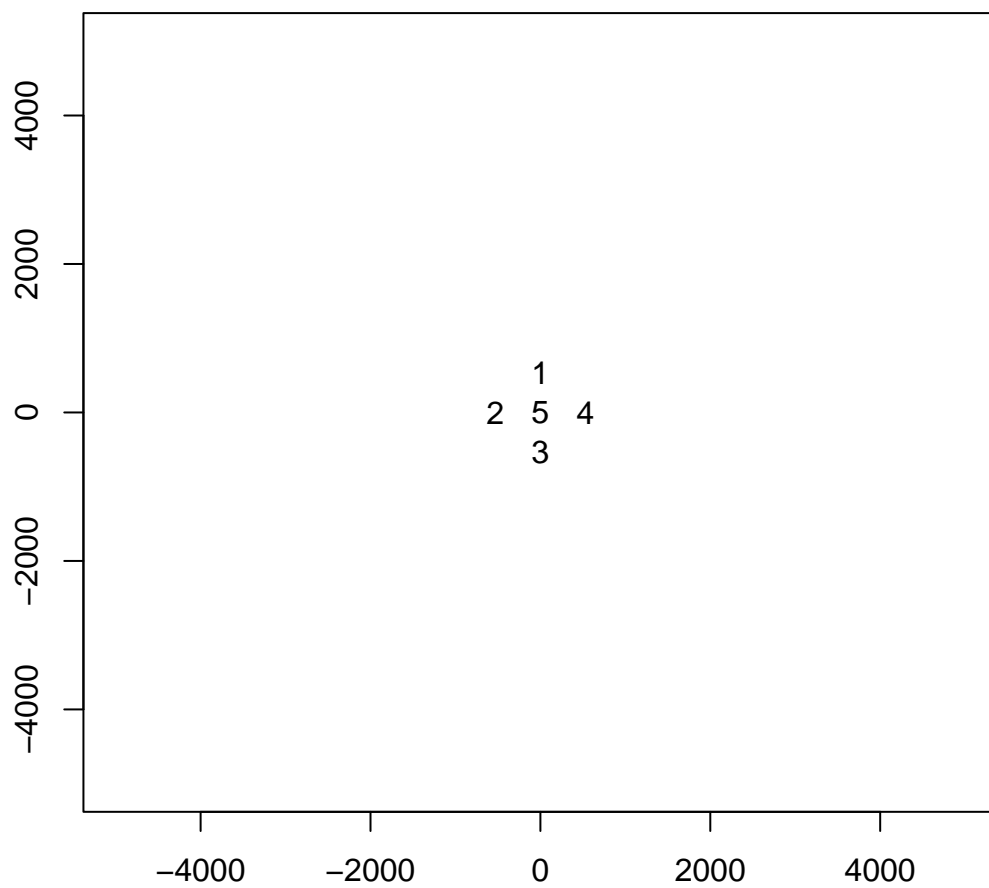
Now repeat with a 5-element trap array

The key parameter values are as follows:

- $\sigma = 500$,
- $g_0 = 1$ (for half-normal) OR $\lambda_0 = 84$ (for hazard half-normal).
- The surface area of the area around a single array is 9121.2825,
- The number of 5-element arrays used is 15,
- The total number of animals across all arrays $N = 495$,
- The number of calls per animal is $n_c = 5$,
- True number of calls is $N_{call} = 2475$,
- The mask buffer is 4000
- The number of simulations is 3

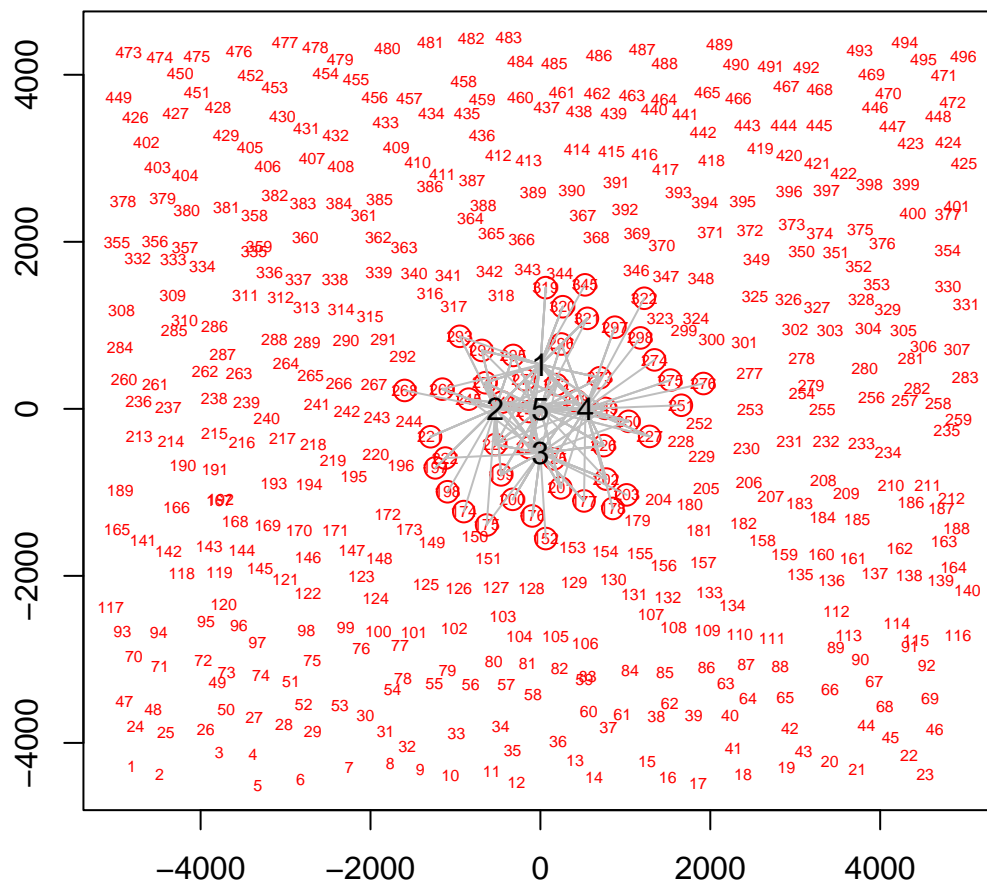
Let's take a look at the traps:

Traps



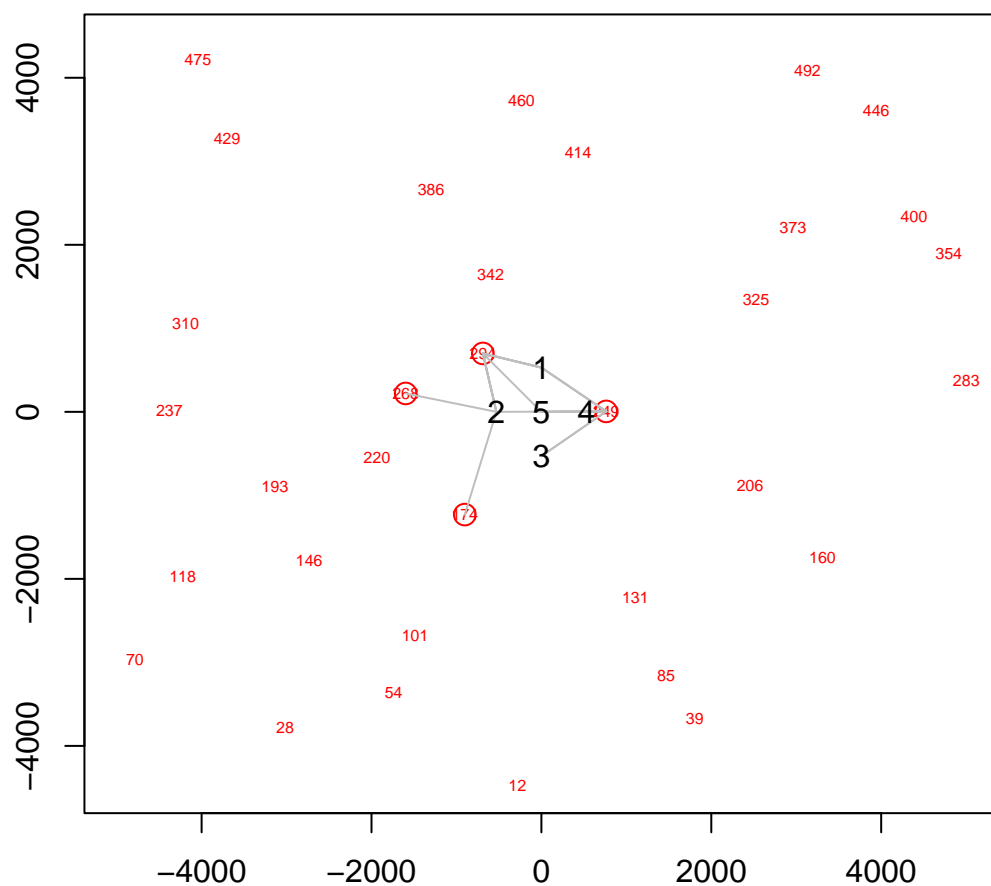
Look at captures over all arrays

All arrays, 5-element array, sigma=350; 5 calls per animal.



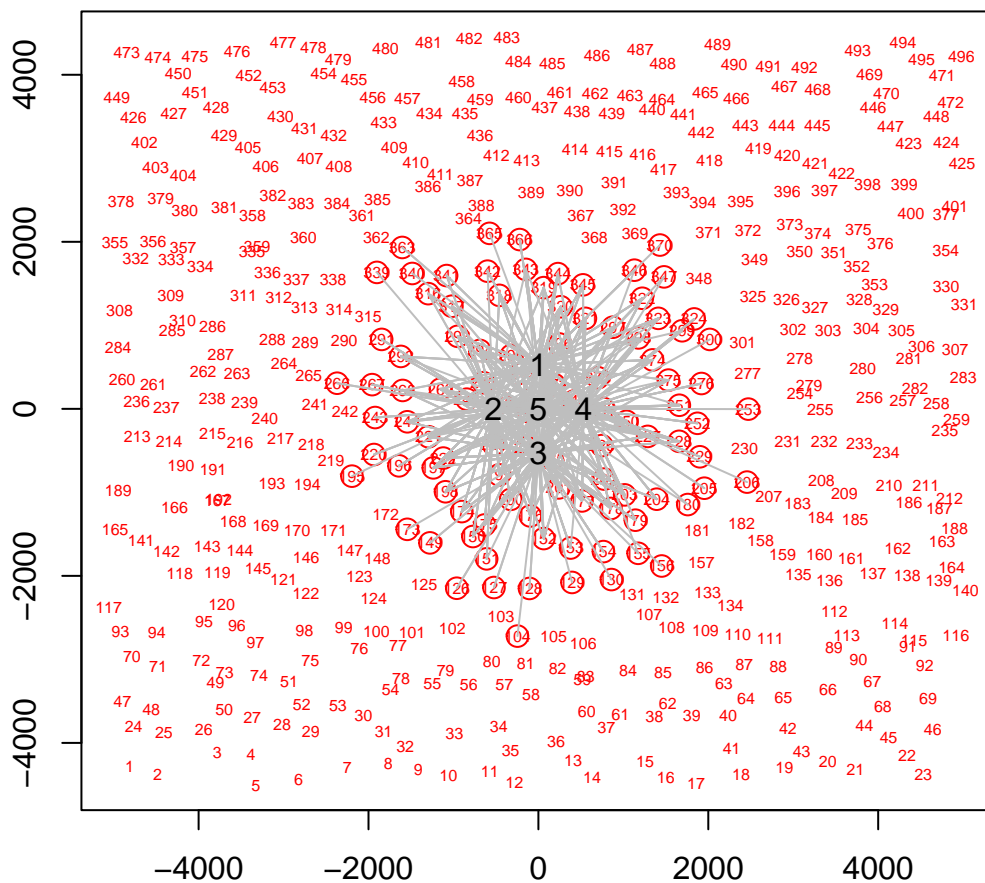
Then look at a single array captures:

Single array, 5-element array, sigma=350; 5 calls per animal.



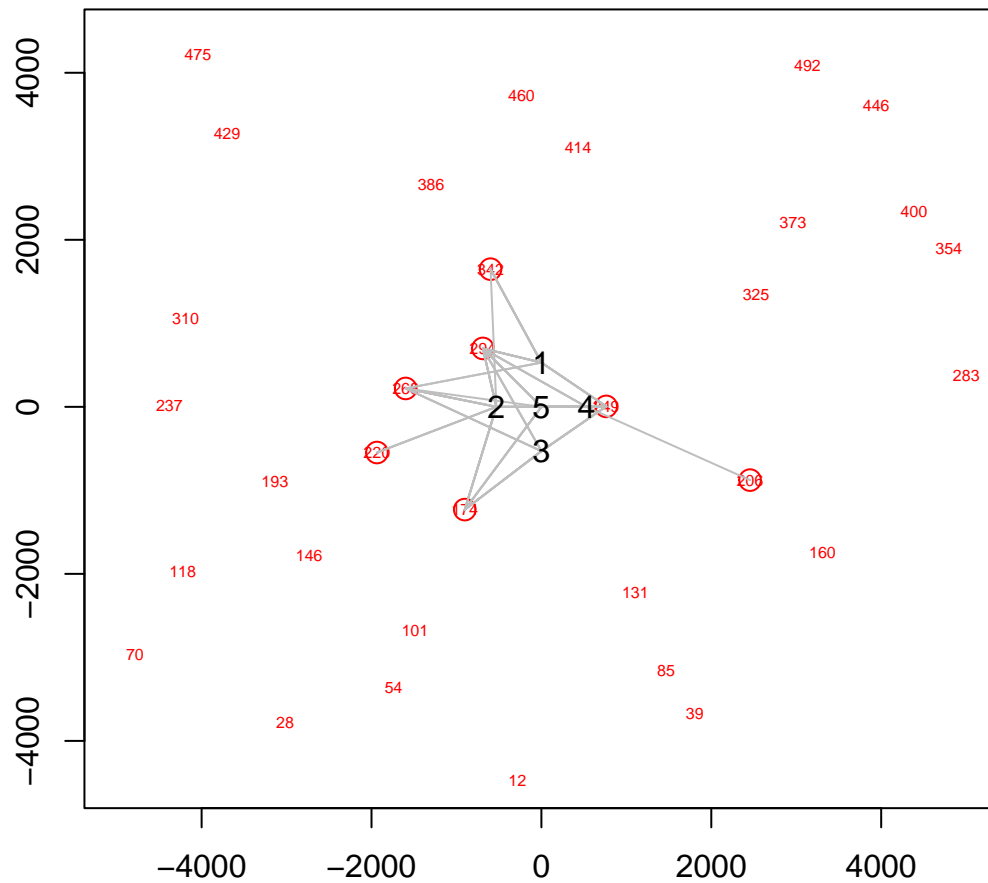
All arrays:

All arrays, 5-element array, sigma=500; 5 calls per animal.



Example single array:

Single array, 5-element array, sigma=500; 5 calls per animal.



Summary of estimates

Summary of mean and % bias of estimate of total number of calls made during the survey, across all detector arrays, and estimated σ , together with mean number of groups detected and mean number of calls detected, for each level of σ . Results are from 3 simulations.

Table 1: Mean and %bias of call density estimates and sigma, at each sigma level for 7-trap arrays, with associated %CV. Dcall 1000x is estimated call density, sigma is estimated sigma, Ngrpdet is number of groups detected, Ncalldet is number of calls detected. Extensions .sigma1 and .sigma2 indicate the two sigma levels.

	Mean.sigma1	pcBias.sigma1	pcCV.sigma1	Mean.sigma2	pcBias.sigma2	pcCV.sigma2
Dcall	15	-16.36	3	14	-25.07	12
sigma	588	68.00	2	925	85.00	4
Ngrpdet	167	NA	3	329	NA	4
Ncalldet	400	NA	5	1108	NA	3

Table 2: Mean and %bias of call density estimates and sigma, at each sigma level for 5-trap arrays, with associated %CV. Dcall 1000x is estimated call density, sigma is estimated sigma, Ngrpdet is number of groups detected, Ncalldet is number of calls detected. Extensions .sigma1 and .sigma2 indicate the two sigma levels.

	Mean.sigma1	pcBias.sigma1	pcCV.sigma1	Mean.sigma2	pcBias.sigma2	pcCV.sigma2
Dcall	15	-15.60	3	14	-21.33	9
sigma	575	64.29	4	913	82.60	4
Ngrpdet	229	NA	2	449	NA	1
Ncalldet	532	NA	4	1458	NA	2