SCR without "ghost" detections

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1 Tost example

Get libraries:

```
> library(secr)
> library(maptools)
> library(sp) # package to manipulate and plot spatial objects
```

1.1 Exploring ideas with Tost data

Get the Tost data:

```
> load(,file="../ghosts/data/Tostdata.Rdata") # Tostboundary,TostMask,Tost_ch,Tost_traps
```

Do some plotting to see what we have:

```
> pdf(h=5, w=12, file="../ghosts/figures/Tostplot.pdf")
> plot(TostMask)
> plot(Tostboundary,add=TRUE)
> plot(Tost_traps,add=TRUE)
> dev.off()

null device
          1
```

Fit a simple model and extract detection parameters:

```
> Tostfit.null <- secr.fit(Tost_ch, detectfn="HHN", mask=TostMask,model=list(D~1, lambda0~1, sigma~1),trace=0)
> detectpars = detectpar(Tostfit.null)
> l0 = detectpars$lambda0
> sig = detectpars$sigma
> tm = usage(Tost_traps) # usage
```

Now calculate the prob detected, prob detected only once, prob detected at least once for every mesh point, and the expected number of times an animal will be detected (just as a realioty check).

With the HHN model, the expected number of detections (assuming Poisson number of detections) of an animal at a trap with activity centre at $\mathbf{s}$ that is distance $d(\mathbf{s})$ from its activity centre is $\lambda(d(\mathbf{s})) = \lambda_0 \exp(-d(\mathbf{s})^2/\sigma^2)$ and the expected number of detections of an animal at *any* trap is $\lambda_. = \lambda_0 \exp(-\sum_j d_j(\mathbf{s})^2/\sigma^2)$, where the sum is over all traps $j = 1, \ldots, J$. It follows that the probabilities that an animal with activity centre at $\mathbf{s}$ is detected at all, the probability that it is detected exactly once, and the probability that it is detected at least twice, are

$$
\begin{align}
p_. &= 1 - e^{-\lambda_.} \tag{1}\\
p_1 &= \lambda_. e^{-\lambda_.} \quad \text{and} \tag{2}\\
p_{2+} &= 1 - e^{-\lambda_.} - \lambda_. e^{-\lambda_.}, \tag{3}
\end{align}
$$

respectively.

Here are a couple of functions needed to calculate prob detected only once and expected number of times an animal will be detected (only using the "hazard half normal" (HHN) model for simplicity for now).

```
> p.once.HHN = function(d,lambda0,sigma,tm) {
+    lambda = sum(tm*lambda0*exp(-d^2/sigma^2))
+    return(lambda*exp(-lambda))
+ }
> En.HHN = function(d,lambda0,sigma,tm) return(sum(tm*lambda0*exp(-d^2/sigma^2)))
```
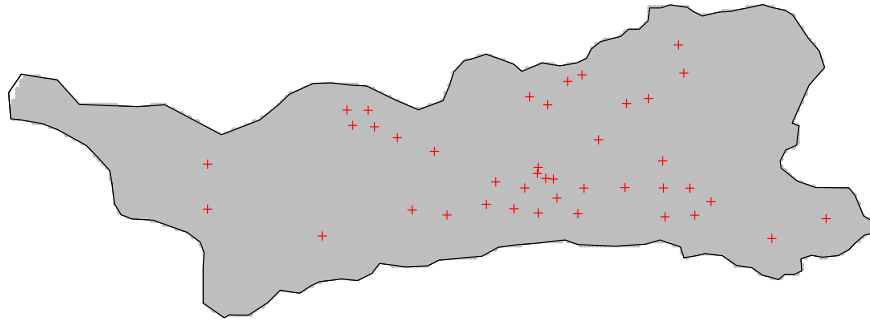
Figure 1: Tost survey mesh and traps

Using those functions, lets calculate $p_{\cdot}$, p_1, and p_{2+}, as well as the "coverage" (percentage of survey region effectively surveyed, or effective survey area divided by actual survey area) in each case.

```
> distmat =  edist(TostMask, Tost_traps) # all distances from traps to mesh points
> coords = as.data.frame(TostMask) # make coords of mesh a data frame for use below
> p. = pdot(TostMask, Tost_traps, detectfn="HHN", detectpar=list(lambda0=l0, sigma=sig), noccasions=1)
> p1 = apply(distmat,1,p.once.HHN,lambda0=l0,sigma=sig,tm=tm)
> Ens = apply(distmat,1,En.HHN,lambda0=l0,sigma=sig,tm=tm)
> p2plus = p. - p1
> coverage. = sum(p.)/length(p.)
> coverage2plus = sum(p2plus)/length(p.)
```

So with this detection function, we expect animals to be detected between 0 and 13.5 times, depending on where their activity centers are.

Lets have a look at plots of $p_{\cdot}$ and p_{2+}. We will do this by creating `SpatialPixelsDataFrames` and using the `sp` package to plot them:

```
> spts = SpatialPoints(coords=coords)
> sp. = SpatialPixelsDataFrame(spts, data=data.frame(p.=p.))
> sp2plus = SpatialPixelsDataFrame(spts, data=data.frame(p2plus=p2plus))
> pdf(h=8,w=10,file="../ghosts/figures/Tostprobplots.pdf")
> par(mfrow=c(2,1))
> plot(sp.,main=paste("p(det); coverage=",round(100*coverage.),"%",sep=""),what="image")
> plot(Tost_traps,add=TRUE)
> plot(sp2plus,main=paste("p(det at least twice); coverage=",round(100*coverage2plus),"%",sep=""),what="image")
> plot(Tost_traps,add=TRUE)
> dev.off()

null device
          1
```

It might also be useful to look at the ratio of the coverages, which would equal to the ratio of the expected number of animals that were detected and the expected number of animals that were detected at least twice if there were no ghost detections.

```
> coveratio = 100*(1-coverage2plus/coverage.)
```

From which we see that you'd expect to detect about 19% more animals than animals that were detected twice, if there were no ghosts.

p(det); coverage=89%
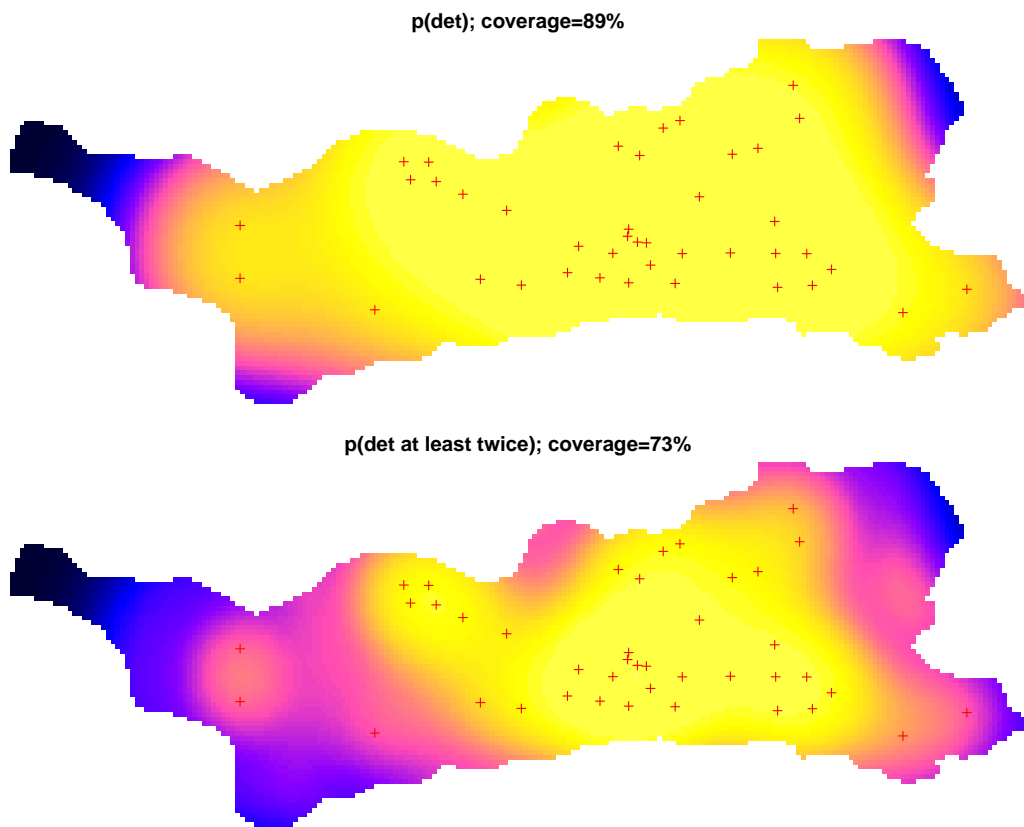
p(det at least twice); coverage=73%

Figure 2: Probabilities of detection and of detection at least twice.