Point Process Models

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Point Process Models in Ecology

- Resource Selection Functions: Telemetry data on individual locations
- Species Distribution Models: Presence-only data for locations of species

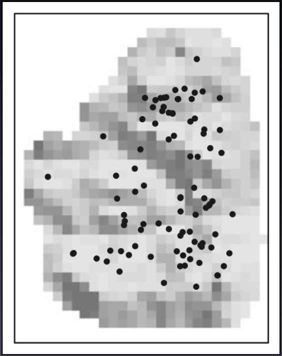
Point Process Models (RSF)

- Manly et al. (2002). Resource Selection by Animals, Second Edition. Kluwer Academic Publishers.
- Johnson, Hooten, and Kuhn. (2013). Estimating animal resource selection from telemetry data using point process models. Journal of Animal Ecology, 82: 1155-1164.
- Hooten, Hanks, Johnson, Alldredge. (2013). Reconciling resource utilization and resource selection functions. Journal of Animal Ecology, 82: 1146-1154.

Spatial Point Process

$$\mathbf{s}_i \sim [\mathbf{s}_i|\beta] \; , \; \mathbf{s}_i \in \mathcal{S}$$

$$i = 1, \ldots, n$$



Spatial Point Process

- Manly et al. (2002). Resource Selection by Animals, Second Edition. Kluwer Academic Publishers.
- Johnson, Hooten, and Kuhn. (2013). Estimating animal resource selection from telemetry data using point process models. Journal of Animal Ecology, 82: 1155-1164.
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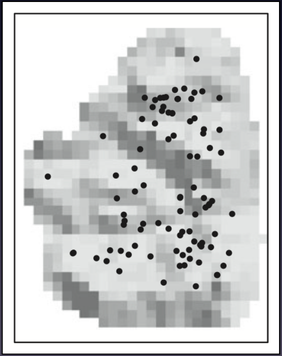
Data Model

$$\mathbf{s}_i \sim [\mathbf{s}_i|\boldsymbol{\beta}] \ , \ \mathbf{s}_i \in \mathcal{S}$$

$i = 1, \ldots, n$ (known)

Weighted Distribution Form

$$[\mathbf{s}_i|\boldsymbol{\beta}] = \frac{g(\mathbf{x}(\mathbf{s}_i), \boldsymbol{\beta})}{\int g(\mathbf{x}(\mathbf{s}), \boldsymbol{\beta}) d\mathbf{s}}$$



Implementing SPPs

- Aarts, G., J. Fieberg, and J. Matthiopoulos. 2012. Comparative interpretation of count, presence-absence, and point methods for species distribution models. Methods in Ecology and Evolution, 3: 177-187.
- Warton, D. and L. Shepherd. 2010. Poisson point process models solve the pseudo-absence problem for presence-only data in ecology. Annals of Applied Statistics, 4: 1383-1402.

Numerical Integration

Approximate integral with large sum, calculated on every step of optimization algorithm.

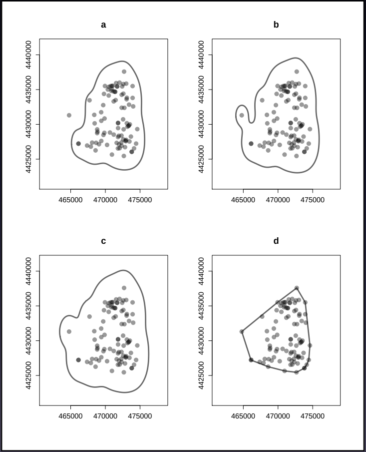
Logistic Regression

Observed points are ones, background points as zeros, regress binary data on covariates.

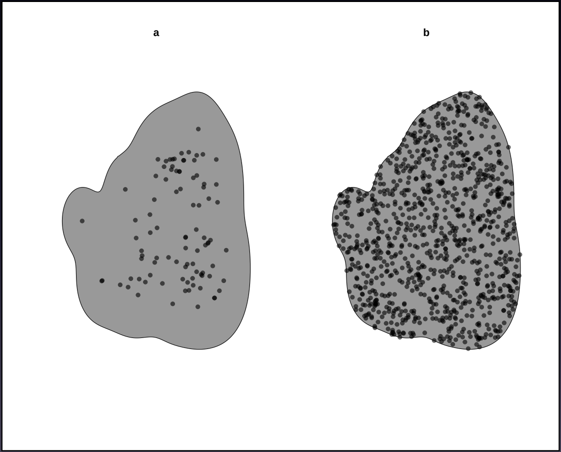
Poisson Regression

Grid $\mathcal{S}$, count points in grid cells, regress counts on gridded covariates.

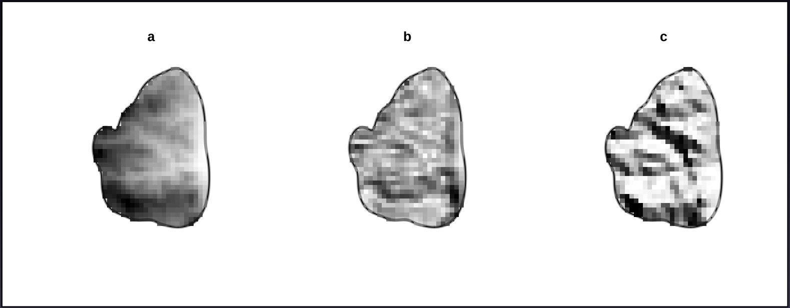
Specify Support



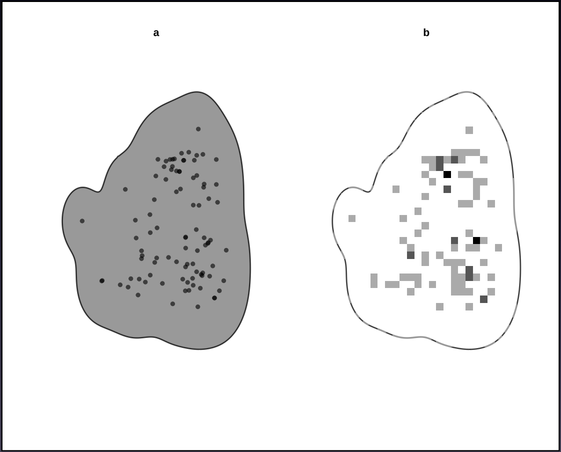
Background Sample



Obtain Covariate Values for Both



Obtain Grid Cell Counts



Fit Poisson GLM

```
> summary(glm(y~elev+slope+exposure,family=poisson(link="log"),data=rsf.1.df))

Call:
glm(formula = y ~ elev + slope + exposure, family = poisson(link = "log"),
    data = rsf.1.df)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-0.8486  -0.5696  -0.4847  -0.3989   3.5346

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -2.0524     0.1131 -18.152  < 2e-16 ***
elev         -0.2946     0.1116  -2.639  0.00832 **
slope         0.2148     0.1020   2.106  0.03519 *
exposure     -0.1306     0.1223  -1.068  0.28546
```

Fit Bernoulli GLM

```
> summary(glm(y~elev+slope+exposure,family=binomial(link="logit"),data=rsf.2.df))

Call:
glm(formula = y ~ elev + slope + exposure, family = binomial(link = "logit"),
    data = rsf.2.df)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-0.6941  -0.4604  -0.3975  -0.3239   2.4566

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -2.4506     0.1175 -20.861  < 2e-16 ***
elev         -0.3111     0.1180  -2.637  0.00836 **
slope         0.2437     0.1142   2.134  0.03287 *
exposure     -0.1396     0.1251  -1.116  0.26446
```

Bayesian SPP Model

Data Model

$$\mathbf{y}_i \sim \text{Bern}(p_i)$$

$$i = 1, \ldots, n, n+1, \ldots, m$$

Link Function

$$\text{logit}(p_i) = \mathbf{x}_i' \boldsymbol{\beta}$$

Parameter Model

$$\boldsymbol{\beta} \sim \text{N}(\boldsymbol{\mu}_\beta, \boldsymbol{\Sigma}_\beta)$$