LMM with Spatial data

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spatial distribution

```
Animals <- data(koalas)
```

explaining data

Var name	Detail
pprim ssite	Percentage of Primary trees in each sub-site
psec ssite	Percentage of Secondary trees in each sub-site
phss 1km	Percentage of the landscape within 1km respectively, of each subsite that is highly suitable
phss 2.5km	Percentage of the landscape within 2.5 KM , respectively, of each subsite that is highly suitable
phss 5km	Percentage of the landscape within 5km, respectively, of each subsite that is highly suitable
pm 1km	Percentage of the landscape within 1 KM respectively, of each subsite that is marginal suitable
pm 2.5km	Percentage of the landscape within 2.5 KM respectively, of each subsite that is marginal suitable
pm 5km	Percentage of the landscape within 5 KM respectively, of each subsite that is marginal suitable
pdens 1km	Density (patches/100 ha) of habitat at 1 KM
pdens 2.5km	Density (patches/100 ha) of habitat at 2.5 Km
pdens 5km	Density (patches/100 ha) of habitat
edens 1km	Density (m/ha) of habitat patch edges
edens 2.5km	Density (m/ha) of habitat patch edges
edens 5km	Density (m/ha) of habitat patch edges
rdens 1km	Density (m/ha) of paved roads
rdens 2.5km	Density (m/ha) of paved roads
rdens 5km	Density (m/ha) of paved roads

Data expolaration and discriptive

The can be two major issue

1. Col linearity and/or
2. Spatial auto correlation.

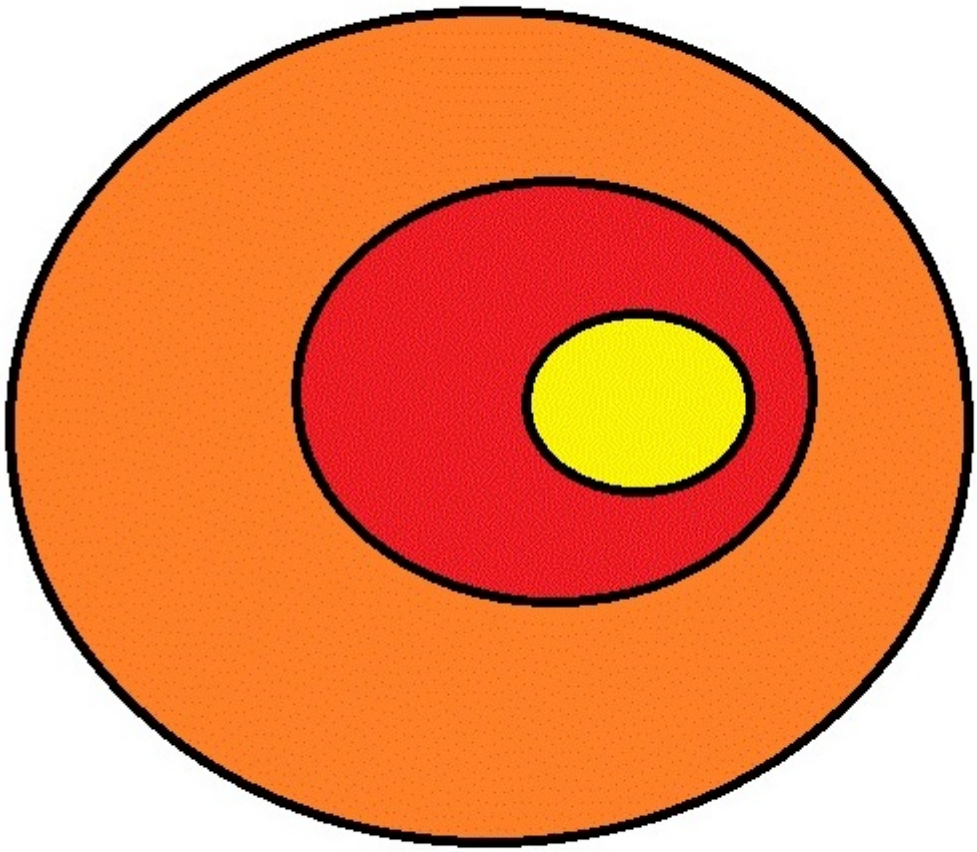
Collinear check

```
cor(Koalas[,6:22],method = "spearman")
```

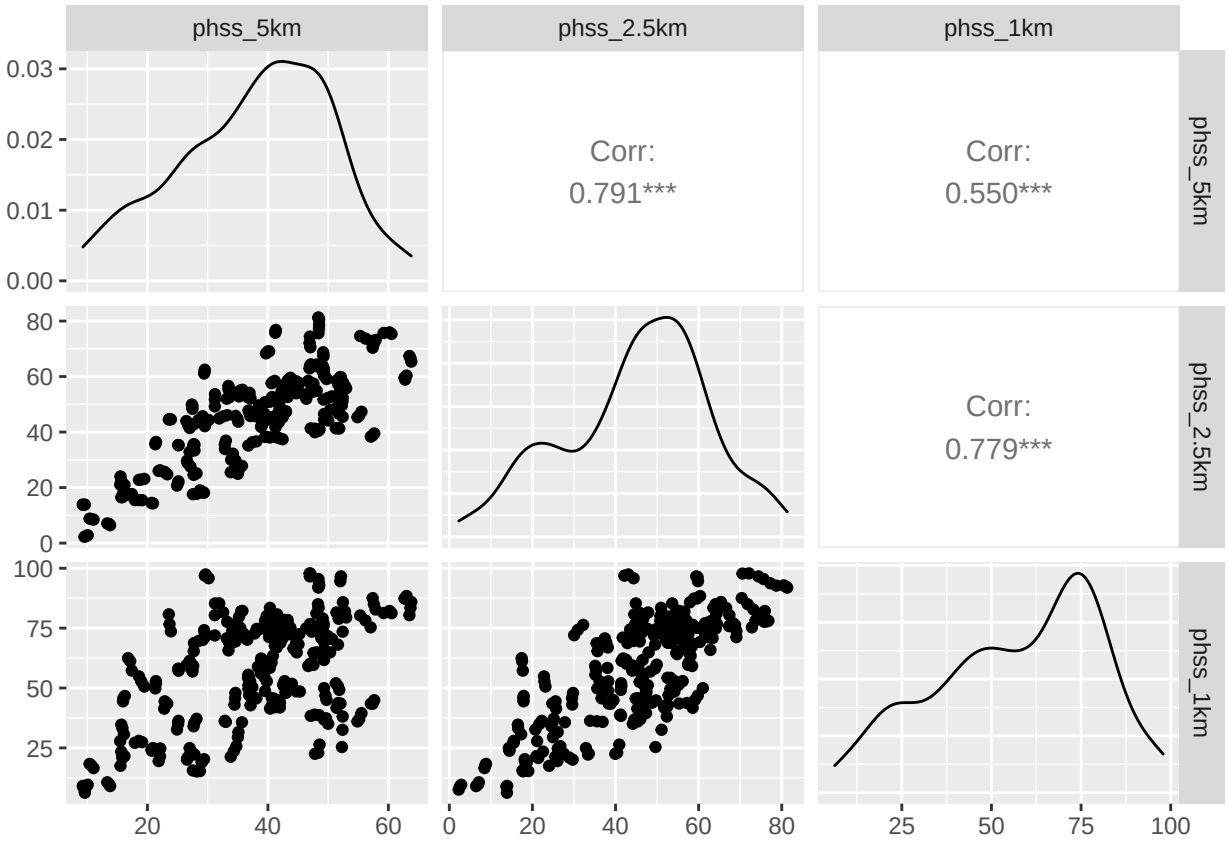
```
##              pprim_ssite  psec_ssite    phss_5km   phss_2.5km     phss_1km
## pprim_ssite  1.000000000 -0.19120803 -0.04760121 -0.032780836 -0.020417112
## psec_ssite  -0.191208029  1.00000000 -0.10343151 -0.019252137 -0.046502154
## phss_5km    -0.047601206 -0.10343151  1.00000000  0.737515050  0.486706375
## phss_2.5km  -0.032780836 -0.01925214  0.73751505  1.000000000  0.740403325
## phss_1km    -0.020417112 -0.04650215  0.48670638  0.740403325  1.000000000
## pm_5km      -0.048185804 -0.24744572  0.22134042  0.041048407  0.171687372
## pm_2.5km    -0.083671041 -0.11792741  0.07360133 -0.045715484  0.008264348
## pm_1km      -0.027104365 -0.08654332 -0.11759707 -0.150455940 -0.220801736
## pdens_5km   -0.056547930  0.29468090 -0.45449481 -0.236224263 -0.247857240
## pdens_2.5km -0.004534600  0.18902145 -0.44199460 -0.517430391 -0.501483157
## pdens_1km   -0.017110649  0.12294654 -0.18868017 -0.248650599 -0.453412507
## edens_5km   -0.159956521  0.30983775 -0.07457305 -0.007220872 -0.156310664
## edens_2.5km -0.084139125  0.22307477 -0.17463724 -0.233201476 -0.392934799
## edens_1km    0.003885453  0.18287617 -0.18796229 -0.331345942 -0.508636124
## rdens_5km   -0.136356838  0.10771090  0.33350215  0.177156570 -0.027465879
## rdens_2.5km -0.102642473  0.10068695  0.26134747  0.058231499 -0.074207327
## rdens_1km   -0.068976325  0.07343747  0.16980780  0.011513002 -0.023111583
##                  pm_5km     pm_2.5km      pm_1km   pdens_5km pdens_2.5km
## pprim_ssite -0.04818580 -0.083671041 -0.02710437 -0.05654793  -0.0045346
## psec_ssite  -0.24744572 -0.117927413 -0.08654332  0.29468090   0.1890214
## phss_5km     0.22134042  0.073601330 -0.11759707 -0.45449481  -0.4419946
## phss_2.5km   0.04104841 -0.045715484 -0.15045594 -0.23622426  -0.5174304
## phss_1km     0.17168737  0.008264348 -0.22080174 -0.24785724  -0.5014832
## pm_5km       1.00000000  0.587221746  0.24800403 -0.54598663  -0.3985728
## pm_2.5km     0.58722175  1.000000000  0.70879422 -0.35648307  -0.4194080
## pm_1km       0.24800403  0.708794217  1.00000000 -0.16858164  -0.1336637
## pdens_5km   -0.54598663 -0.356483070 -0.16858164  1.00000000   0.6214631
## pdens_2.5km -0.39857280 -0.419407988 -0.13366371  0.62146309   1.0000000
## pdens_1km   -0.29777420 -0.253385544 -0.09933685  0.31095338   0.5422206
## edens_5km   -0.53281446 -0.428602762 -0.30420165  0.80090144   0.5515174
## edens_2.5km -0.48947289 -0.402420683 -0.17982471  0.63474926   0.7377454
## edens_1km   -0.40283248 -0.285131240 -0.17488913  0.46422114   0.5964765
## rdens_5km   -0.24159421 -0.188272782 -0.09817424  0.17807288   0.1893438
## rdens_2.5km -0.20496093 -0.228624776 -0.13984237  0.12040573   0.2391663
## rdens_1km   -0.21807094 -0.148326315 -0.13816014  0.07683865   0.1916224
##               pdens_1km    edens_5km edens_2.5km    edens_1km   rdens_5km
## pprim_ssite -0.01711065 -0.159956521 -0.08413913  0.003885453 -0.13635684
## psec_ssite   0.12294654  0.309837751  0.22307477  0.182876165  0.10771090
## phss_5km    -0.18868017 -0.074573052 -0.17463724 -0.187962286  0.33350215
```

```
## phss_2.5km  -0.24865060 -0.007220872 -0.23320148 -0.331345942  0.17715657
## phss_1km    -0.45341251 -0.156310664 -0.39293480 -0.508636124 -0.02746588
## pm_5km      -0.29777420 -0.532814459 -0.48947289 -0.402832483 -0.24159421
## pm_2.5km    -0.25338554 -0.428602762 -0.40242068 -0.285131240 -0.18827278
## pm_1km      -0.09933685 -0.304201652 -0.17982471 -0.174889125 -0.09817424
## pdens_5km    0.31095338  0.800901439  0.63474926  0.464221138  0.17807288
## pdens_2.5km  0.54222060  0.551517412  0.73774543  0.596476539  0.18934379
## pdens_1km    1.00000000  0.280339181  0.63902867  0.651218075  0.17236583
## edens_5km    0.28033918  1.000000000  0.74136688  0.492520941  0.51399634
## edens_2.5km  0.63902867  0.741366885  1.00000000  0.748572437  0.40945149
## edens_1km    0.65121807  0.492520941  0.74857244  1.000000000  0.28424550
## rdens_5km    0.17236583  0.513996339  0.40945149  0.284245500  1.00000000
## rdens_2.5km  0.18495223  0.435460921  0.37415201  0.281746295  0.90979343
## rdens_1km    0.15363443  0.336397239  0.30444877  0.253466246  0.72157159
##             rdens_2.5km   rdens_1km
## pprim_ssite -0.10264247 -0.06897632
## psec_ssite   0.10068695  0.07343747
## phss_5km     0.26134747  0.16980780
## phss_2.5km   0.05823150  0.01151300
## phss_1km    -0.07420733 -0.02311158
## pm_5km      -0.20496093 -0.21807094
## pm_2.5km    -0.22862478 -0.14832632
## pm_1km      -0.13984237 -0.13816014
## pdens_5km    0.12040573  0.07683865
## pdens_2.5km  0.23916632  0.19162241
## pdens_1km    0.18495223  0.15363443
## edens_5km    0.43546092  0.33639724
## edens_2.5km  0.37415201  0.30444877
## edens_1km    0.28174630  0.25346625
## rdens_5km    0.90979343  0.72157159
## rdens_2.5km  1.00000000  0.80657941
## rdens_1km    0.80657941  1.00000000
```

```
## An example of spatial colinear variable.
knitr::include_graphics("./imp_image/nested_spatial.jpg")
```



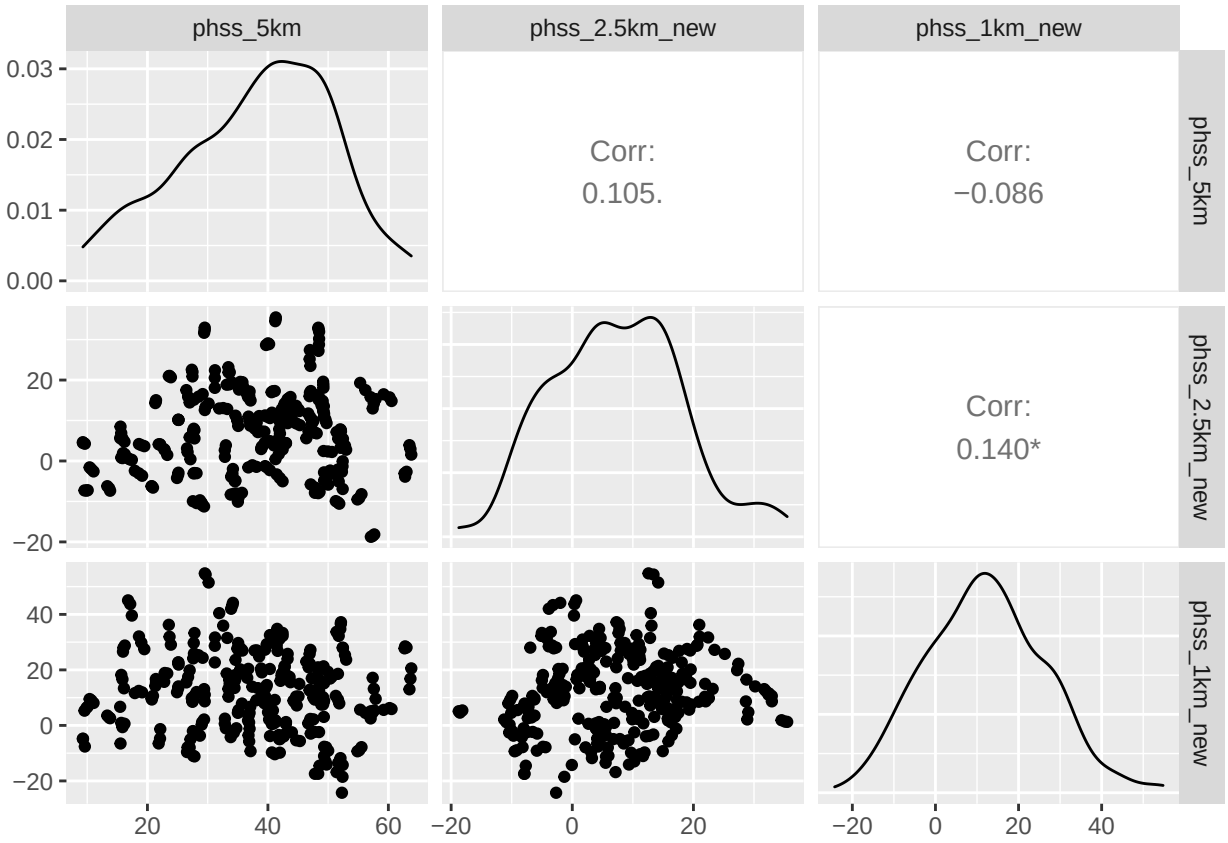
```
ggpairs(Koalas[,8:10])
```



We can see that similar variable at different distance are show co-linear behavior.This suggest that our data is spatial nested.

To overcome this variable we need to perform a calculation. This will divide out data such that new data will be 5 to 2.5 km, 2.5 to 1 KM

```
Koalas <- Koalas%>%mutate(phss_2.5km_new = phss_2.5km- phss_5km,
                 phss_1km_new = phss_1km-phss_2.5km,
                 pm_2.5km_new = pm_2.5km - pm_5km,
                 pm_1km_new = pm_1km - pm_2.5km,
                 pdens_2.5km_new = pdens_2.5km - pdens_5km,
                 pdens_1km_new = pdens_1km - pdens_2.5km,
                 edens_2.5km_new = edens_2.5km - edens_5km,
                 edens_1km_new = edens_1km - edens_2.5km,
                 rdens_2.5km_new = rdens_2.5km - rdens_5km,
                 rdens_1km_new = rdens_1km - rdens_5km)
ggpairs(Koalas[,c(8,23,24)])
```



We can also check if co-linearity is impacting the model by using package called car and function call VCF

```
glm0 <- glm(presence~pprim_ssite+psec_ssite+
              phss_5km+phss_2.5km_new+phss_1km_new+
              pm_5km + pm_2.5km_new+pm_1km_new+
              pdens_5km+pdens_2.5km_new+pdens_1km_new+
              rdens_5km + rdens_2.5km_new +rdens_1km_new,
            data = Koalas, family = "binomial")

vif(glm0)
```

```
##     pprim_ssite      psec_ssite        phss_5km  phss_2.5km_new    phss_1km_new
##        1.121726        1.099841        3.196495        1.584206        1.495203
##          pm_5km    pm_2.5km_new      pm_1km_new       pdens_5km pdens_2.5km_new
##        1.931660        1.575770        1.973593        2.474995        1.600666
##   pdens_1km_new       rdens_5km rdens_2.5km_new   rdens_1km_new
##        1.273422        2.130524        1.676686        1.419444
```

```
glm0.old <- glm(presence~pprim_ssite+psec_ssite+
              phss_5km+phss_2.5km+phss_1km+
              pm_5km + pm_2.5km+pm_1km+
              pdens_5km+pdens_2.5km+pdens_1km+
              rdens_5km + rdens_2.5km +rdens_1km,
            data = Koalas, family = "binomial")
vif(glm0.old)
```

```
## pprim_ssite  psec_ssite    phss_5km  phss_2.5km    phss_1km      pm_5km
##    1.121726    1.099841    5.725572    6.664211    3.872937    3.368125
##    pm_2.5km      pm_1km   pdens_5km pdens_2.5km   pdens_1km   rdens_5km
##    4.530706    3.410261    3.290377    3.339844    1.653424    8.832575
## rdens_2.5km   rdens_1km
##    9.329289    2.322678
```

```
glm0_2.5 <- glm(presence~pprim_ssite+psec_ssite+
              phss_2.5km_new+phss_1km_new+
              pm_2.5km_new+pm_1km_new+
              pdens_2.5km_new+pdens_1km_new+
             rdens_2.5km_new +rdens_1km_new,
            data = Koalas, family = "binomial")
vif(glm0_2.5)
```

```
##     pprim_ssite      psec_ssite  phss_2.5km_new    phss_1km_new    pm_2.5km_new
##        1.081343        1.058178        1.488893        1.341732        1.475352
##      pm_1km_new pdens_2.5km_new   pdens_1km_new rdens_2.5km_new   rdens_1km_new
##        1.459823        1.515581        1.240205        1.475457        1.387168
```

```
glm0_1 <- glm(presence~pprim_ssite+psec_ssite+
              phss_1km_new+
              pm_1km_new+
              pdens_1km_new+
             rdens_1km_new,
            data = Koalas, family = "binomial")
vif(glm0_1)
```

```
##   pprim_ssite    psec_ssite  phss_1km_new    pm_1km_new pdens_1km_new
##      1.053231      1.031041      1.341394      1.168002      1.202651
## rdens_1km_new
##      1.016711
```

```
## the value should be below 10, new study even less almost close to 1.5-2
```

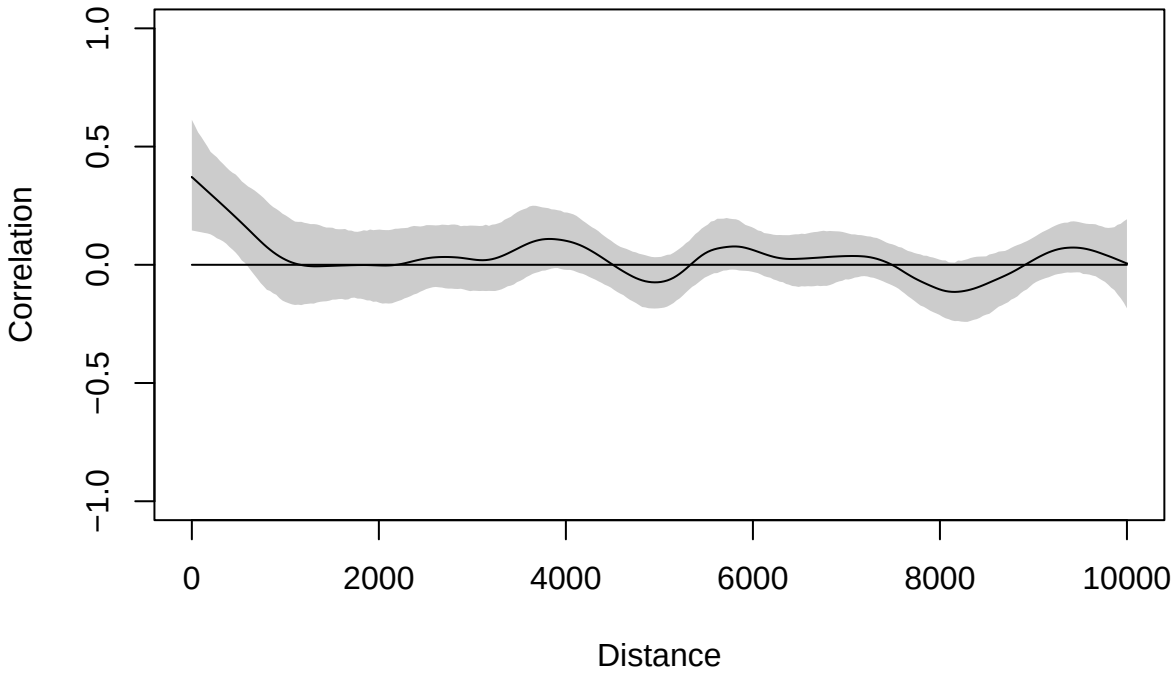
We can also test for data for 2.5 km and 1 km to check how co-linearity behave.

spatial auto correaltion.

```
library(ncf)
Correlog <- spline.correlog(x = Koalas[, "easting"],
y = Koalas[, "northing"],
z = Koalas[, "presence"], xmax = 10000)
```

```
## 100  of  1000 200  of  1000 300  of  1000 400  of  1000 500  of  1000 600  of  1000 700  of  1000 800
```

```
plot(Correlog)
```



Model selection

```
glm_sec <- glm(presence~.,
            data = Koalas[,c("presence","pprim_ssite","psec_ssite",
                             "phss_5km","phss_2.5km_new","phss_1km_new",
                             "pm_5km","pm_2.5km_new","pm_1km_new",
                             "pdens_5km","pdens_2.5km_new","pdens_1km_new",
                             "rdens_5km","rdens_2.5km_new","rdens_1km_new",
                             "edens_5km","edens_2.5km_new","edens_2.5km_new")]
            , family = "binomial")
Step_model <- stepAIC(glm_sec,trace = T,direction = "both")
```

```
## Start:  AIC=392.03
## presence ~ pprim_ssite + psec_ssite + phss_5km + phss_2.5km_new +
##     phss_1km_new + pm_5km + pm_2.5km_new + pm_1km_new + pdens_5km +
##     pdens_2.5km_new + pdens_1km_new + rdens_5km + rdens_2.5km_new +
##     rdens_1km_new + edens_5km + edens_2.5km_new + edens_2.5km_new.1
##
##
## Step:  AIC=392.03
## presence ~ pprim_ssite + psec_ssite + phss_5km + phss_2.5km_new +
##     phss_1km_new + pm_5km + pm_2.5km_new + pm_1km_new + pdens_5km +
##     pdens_2.5km_new + pdens_1km_new + rdens_5km + rdens_2.5km_new +
```

```
##     rdens_1km_new + edens_5km + edens_2.5km_new
##
##                   Df Deviance    AIC
## - rdens_1km_new    1   358.04 390.04
## - pm_5km           1   358.07 390.07
## - phss_5km         1   358.08 390.08
## - pdens_5km        1   358.19 390.19
## - psec_ssite       1   358.36 390.36
## - rdens_5km        1   358.54 390.54
## - pdens_2.5km_new  1   358.74 390.74
## - edens_5km        1   359.09 391.09
## - pdens_1km_new    1   359.20 391.20
## - phss_1km_new     1   359.22 391.22
## - rdens_2.5km_new  1   359.28 391.28
## - edens_2.5km_new  1   359.67 391.67
## <none>                 358.03 392.03
## - phss_2.5km_new   1   360.56 392.56
## - pm_2.5km_new     1   361.55 393.55
## - pm_1km_new       1   362.56 394.56
## - pprim_ssite      1   379.05 411.05
##
## Step:  AIC=390.04
## presence ~ pprim_ssite + psec_ssite + phss_5km + phss_2.5km_new +
##     phss_1km_new + pm_5km + pm_2.5km_new + pm_1km_new + pdens_5km +
##     pdens_2.5km_new + pdens_1km_new + rdens_5km + rdens_2.5km_new +
##     edens_5km + edens_2.5km_new
##
##                   Df Deviance    AIC
## - pm_5km           1   358.07 388.07
## - phss_5km         1   358.09 388.09
## - pdens_5km        1   358.19 388.19
## - psec_ssite       1   358.37 388.37
## - rdens_5km        1   358.54 388.54
## - pdens_2.5km_new  1   358.74 388.74
## - edens_5km        1   359.10 389.10
## - pdens_1km_new    1   359.20 389.20
## - phss_1km_new     1   359.22 389.22
## - edens_2.5km_new  1   359.67 389.67
## - rdens_2.5km_new  1   359.69 389.69
## <none>                 358.04 390.04
## - phss_2.5km_new   1   360.57 390.57
## - pm_2.5km_new     1   361.56 391.56
## + rdens_1km_new    1   358.03 392.03
## - pm_1km_new       1   362.79 392.79
## - pprim_ssite      1   379.15 409.15
##
## Step:  AIC=388.07
## presence ~ pprim_ssite + psec_ssite + phss_5km + phss_2.5km_new +
##     phss_1km_new + pm_2.5km_new + pm_1km_new + pdens_5km + pdens_2.5km_new +
##     pdens_1km_new + rdens_5km + rdens_2.5km_new + edens_5km +
##     edens_2.5km_new
##
##                   Df Deviance    AIC
## - phss_5km         1   358.10 386.10
```

```
## - pdens_5km        1   358.22 386.22
## - psec_ssite       1   358.43 386.43
## - rdens_5km        1   358.55 386.55
## - pdens_2.5km_new  1   358.77 386.77
## - phss_1km_new     1   359.24 387.24
## - edens_5km        1   359.27 387.27
## - pdens_1km_new    1   359.30 387.30
## - edens_2.5km_new  1   359.70 387.70
## - rdens_2.5km_new  1   359.73 387.73
## <none>                 358.07 388.07
## - phss_2.5km_new   1   360.89 388.89
## - pm_2.5km_new     1   361.56 389.56
## + pm_5km           1   358.04 390.04
## + rdens_1km_new    1   358.07 390.07
## - pm_1km_new       1   363.11 391.11
## - pprim_ssite      1   379.66 407.66
##
## Step:  AIC=386.1
## presence ~ pprim_ssite + psec_ssite + phss_2.5km_new + phss_1km_new +
##     pm_2.5km_new + pm_1km_new + pdens_5km + pdens_2.5km_new +
##     pdens_1km_new + rdens_5km + rdens_2.5km_new + edens_5km +
##     edens_2.5km_new
##
##                   Df Deviance    AIC
## - psec_ssite       1   358.45 384.45
## - pdens_5km        1   358.53 384.53
## - rdens_5km        1   358.55 384.55
## - pdens_2.5km_new  1   358.77 384.77
## - phss_1km_new     1   359.24 385.24
## - pdens_1km_new    1   359.36 385.36
## - edens_5km        1   359.52 385.52
## - rdens_2.5km_new  1   359.78 385.78
## - edens_2.5km_new  1   359.81 385.81
## <none>                 358.10 386.10
## - phss_2.5km_new   1   360.96 386.96
## - pm_2.5km_new     1   361.60 387.60
## + phss_5km         1   358.07 388.07
## + pm_5km           1   358.09 388.09
## + rdens_1km_new    1   358.09 388.09
## - pm_1km_new       1   363.84 389.84
## - pprim_ssite      1   379.66 405.66
##
## Step:  AIC=384.45
## presence ~ pprim_ssite + phss_2.5km_new + phss_1km_new + pm_2.5km_new +
##     pm_1km_new + pdens_5km + pdens_2.5km_new + pdens_1km_new +
##     rdens_5km + rdens_2.5km_new + edens_5km + edens_2.5km_new
##
##                   Df Deviance    AIC
## - pdens_5km        1   358.87 382.87
## - rdens_5km        1   358.91 382.91
## - pdens_2.5km_new  1   359.15 383.15
## - phss_1km_new     1   359.58 383.58
## - pdens_1km_new    1   359.66 383.66
## - edens_5km        1   359.96 383.96
```

```
## - rdens_2.5km_new  1   359.98 383.98
## - edens_2.5km_new  1   360.03 384.03
## <none>                 358.45 384.45
## - phss_2.5km_new   1   361.67 385.67
## - pm_2.5km_new     1   362.05 386.05
## + psec_ssite       1   358.10 386.10
## + pm_5km           1   358.41 386.41
## + phss_5km         1   358.43 386.43
## + rdens_1km_new    1   358.43 386.43
## - pm_1km_new       1   364.13 388.13
## - pprim_ssite      1   379.66 403.66
##
## Step:  AIC=382.87
## presence ~ pprim_ssite + phss_2.5km_new + phss_1km_new + pm_2.5km_new +
##     pm_1km_new + pdens_2.5km_new + pdens_1km_new + rdens_5km +
##     rdens_2.5km_new + edens_5km + edens_2.5km_new
##
##                   Df Deviance    AIC
## - rdens_5km        1   359.02 381.02
## - pdens_2.5km_new  1   359.76 381.76
## - phss_1km_new     1   359.79 381.79
## - pdens_1km_new    1   360.10 382.10
## - edens_5km        1   360.46 382.46
## - rdens_2.5km_new  1   360.71 382.71
## - edens_2.5km_new  1   360.84 382.84
## <none>                 358.87 382.87
## - phss_2.5km_new   1   361.93 383.93
## - pm_2.5km_new     1   362.33 384.33
## + pdens_5km        1   358.45 384.45
## + psec_ssite       1   358.53 384.53
## + phss_5km         1   358.60 384.60
## + pm_5km           1   358.86 384.86
## + rdens_1km_new    1   358.86 384.86
## - pm_1km_new       1   364.17 386.17
## - pprim_ssite      1   379.73 401.73
##
## Step:  AIC=381.02
## presence ~ pprim_ssite + phss_2.5km_new + phss_1km_new + pm_2.5km_new +
##     pm_1km_new + pdens_2.5km_new + pdens_1km_new + rdens_2.5km_new +
##     edens_5km + edens_2.5km_new
##
##                   Df Deviance    AIC
## - pdens_2.5km_new  1   359.93 379.93
## - phss_1km_new     1   360.02 380.02
## - pdens_1km_new    1   360.17 380.17
## - edens_5km        1   360.59 380.59
## - edens_2.5km_new  1   360.97 380.97
## <none>                 359.02 381.02
## - rdens_2.5km_new  1   362.01 382.01
## - phss_2.5km_new   1   362.05 382.05
## - pm_2.5km_new     1   362.54 382.54
## + psec_ssite       1   358.67 382.67
## + rdens_5km        1   358.87 382.87
## + pdens_5km        1   358.91 382.91
```

```
## + phss_5km         1   358.97 382.97
## + rdens_1km_new    1   359.01 383.01
## + pm_5km           1   359.02 383.02
## - pm_1km_new       1   364.21 384.21
## - pprim_ssite      1   379.87 399.87
##
## Step:  AIC=379.93
## presence ~ pprim_ssite + phss_2.5km_new + phss_1km_new + pm_2.5km_new +
##     pm_1km_new + pdens_1km_new + rdens_2.5km_new + edens_5km +
##     edens_2.5km_new
##
##                   Df Deviance    AIC
## - pdens_1km_new    1   360.71 378.71
## - phss_1km_new     1   360.80 378.80
## - edens_2.5km_new  1   361.03 379.03
## - edens_5km        1   361.90 379.90
## <none>                 359.93 379.93
## - phss_2.5km_new   1   362.22 380.22
## - rdens_2.5km_new  1   362.61 380.61
## - pm_2.5km_new     1   362.70 380.70
## + pdens_2.5km_new  1   359.02 381.02
## + psec_ssite       1   359.54 381.54
## + pdens_5km        1   359.73 381.73
## + rdens_5km        1   359.76 381.76
## + phss_5km         1   359.89 381.89
## + pm_5km           1   359.92 381.92
## + rdens_1km_new    1   359.92 381.92
## - pm_1km_new       1   365.38 383.38
## - pprim_ssite      1   380.53 398.53
##
## Step:  AIC=378.71
## presence ~ pprim_ssite + phss_2.5km_new + phss_1km_new + pm_2.5km_new +
##     pm_1km_new + rdens_2.5km_new + edens_5km + edens_2.5km_new
##
##                   Df Deviance    AIC
## - phss_1km_new     1   361.15 377.15
## - edens_2.5km_new  1   361.17 377.17
## <none>                 360.71 378.71
## - edens_5km        1   362.85 378.85
## - phss_2.5km_new   1   363.41 379.41
## - rdens_2.5km_new  1   363.60 379.60
## + pdens_1km_new    1   359.93 379.93
## - pm_2.5km_new     1   364.02 380.02
## + pdens_2.5km_new  1   360.17 380.17
## + psec_ssite       1   360.38 380.38
## + pdens_5km        1   360.48 380.48
## + rdens_5km        1   360.62 380.62
## + phss_5km         1   360.64 380.64
## + pm_5km           1   360.69 380.69
## + rdens_1km_new    1   360.71 380.71
## - pm_1km_new       1   365.54 381.54
## - pprim_ssite      1   380.87 396.87
##
## Step:  AIC=377.15
```

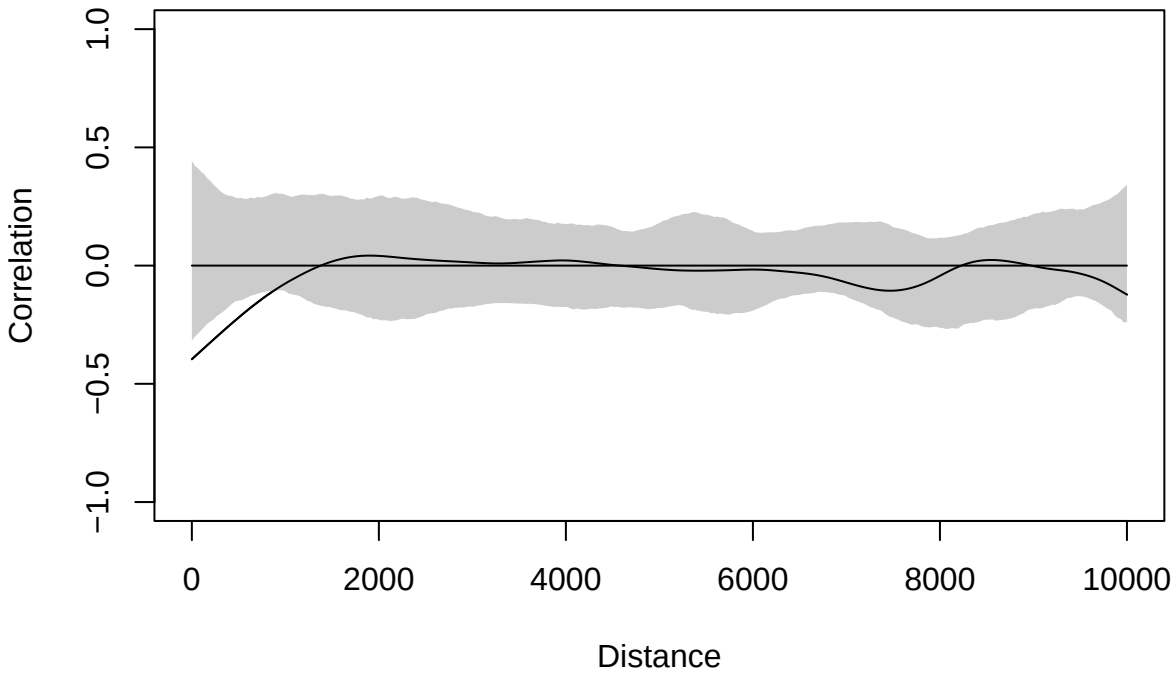
```
## presence ~ pprim_ssite + phss_2.5km_new + pm_2.5km_new + pm_1km_new +
##     rdens_2.5km_new + edens_5km + edens_2.5km_new
##
##                   Df Deviance    AIC
## - edens_2.5km_new  1   361.83 375.83
## - edens_5km        1   362.99 376.99
## <none>                 361.15 377.15
## - phss_2.5km_new   1   363.85 377.85
## - rdens_2.5km_new  1   364.06 378.06
## - pm_2.5km_new     1   364.30 378.30
## + pdens_2.5km_new  1   360.60 378.60
## + phss_1km_new     1   360.71 378.71
## + pdens_1km_new    1   360.80 378.80
## + psec_ssite       1   360.80 378.80
## + rdens_5km        1   361.00 379.00
## + pdens_5km        1   361.05 379.05
## + pm_5km           1   361.12 379.12
## + phss_5km         1   361.15 379.15
## + rdens_1km_new    1   361.15 379.15
## - pm_1km_new       1   365.57 379.57
## - pprim_ssite      1   380.99 394.99
##
## Step:  AIC=375.83
## presence ~ pprim_ssite + phss_2.5km_new + pm_2.5km_new + pm_1km_new +
##     rdens_2.5km_new + edens_5km
##
##                     Df Deviance    AIC
## <none>                  361.83 375.83
## - edens_5km          1   363.96 375.96
## - rdens_2.5km_new    1   364.60 376.60
## + edens_2.5km_new    1   361.15 377.15
## + edens_2.5km_new.1  1   361.15 377.15
## + phss_1km_new       1   361.17 377.17
## - pm_2.5km_new       1   365.54 377.54
## + psec_ssite         1   361.59 377.59
## + rdens_5km          1   361.64 377.64
## + pdens_5km          1   361.69 377.69
## + pdens_2.5km_new    1   361.79 377.79
## + phss_5km           1   361.80 377.80
## + rdens_1km_new      1   361.83 377.83
## + pm_5km             1   361.83 377.83
## + pdens_1km_new      1   361.83 377.83
## - pm_1km_new         1   365.89 377.89
## - phss_2.5km_new     1   366.02 378.02
## - pprim_ssite        1   381.18 393.18
```

```
Step_model
```

```
##
## Call:  glm(formula = presence ~ pprim_ssite + phss_2.5km_new + pm_2.5km_new +
##     pm_1km_new + rdens_2.5km_new + edens_5km, family = "binomial",
##     data = Koalas[, c("presence", "pprim_ssite", "psec_ssite",
##         "phss_5km", "phss_2.5km_new", "phss_1km_new", "pm_5km",
##         "pm_2.5km_new", "pm_1km_new", "pdens_5km", "pdens_2.5km_new",
```

```
##         "pdens_1km_new", "rdens_5km", "rdens_2.5km_new", "rdens_1km_new",
##         "edens_5km", "edens_2.5km_new", "edens_2.5km_new")])
##
## Coefficients:
##     (Intercept)      pprim_ssite   phss_2.5km_new     pm_2.5km_new
##      -1.6250136        0.0441092        0.0260414        0.0450319
##      pm_1km_new  rdens_2.5km_new        edens_5km
##       0.0235568       -0.0009315        0.0190902
##
## Degrees of Freedom: 299 Total (i.e. Null);  293 Residual
## Null Deviance:       398.4
## Residual Deviance: 361.8     AIC: 375.8
```

```
## 100  of  1000 200  of  1000 300  of  1000 400  of  1000 500  of  1000 600  of  1000 700  of  1000 800
```



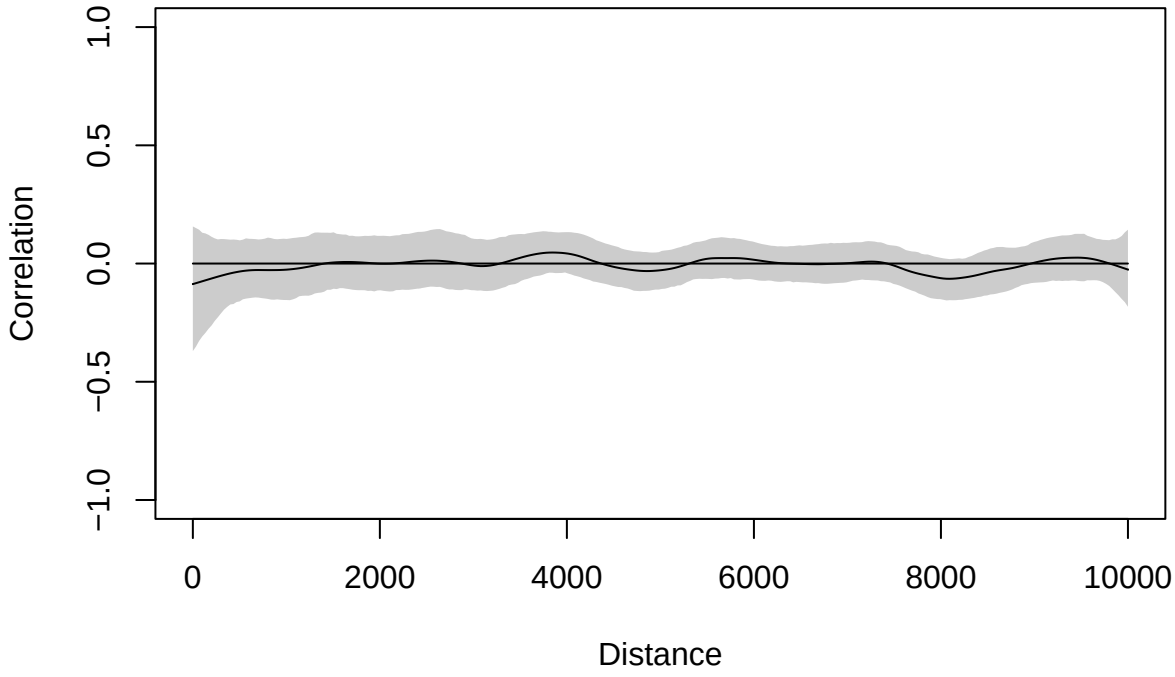

```
Best_model <- glmer(formula = presence ~ pprim_ssite + phss_2.5km_new + pm_2.5km_new +
    pm_1km_new + rdens_2.5km_new + edens_5km + (1|site), family = "binomial", data = Koalas)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, : Model is nearly unider
##  - Rescale variables?
```

```
Best_auto <- spline.correlog(x = Koalas[, "easting"],
y = Koalas[, "northing"],
z = residuals(Best_model), xmax = 10000)
```

```
## 100  of  1000 200  of  1000 300  of  1000 400  of  1000 500  of  1000 600  of  1000 700  of  1000 800
```

```
plot(Best_auto)
```

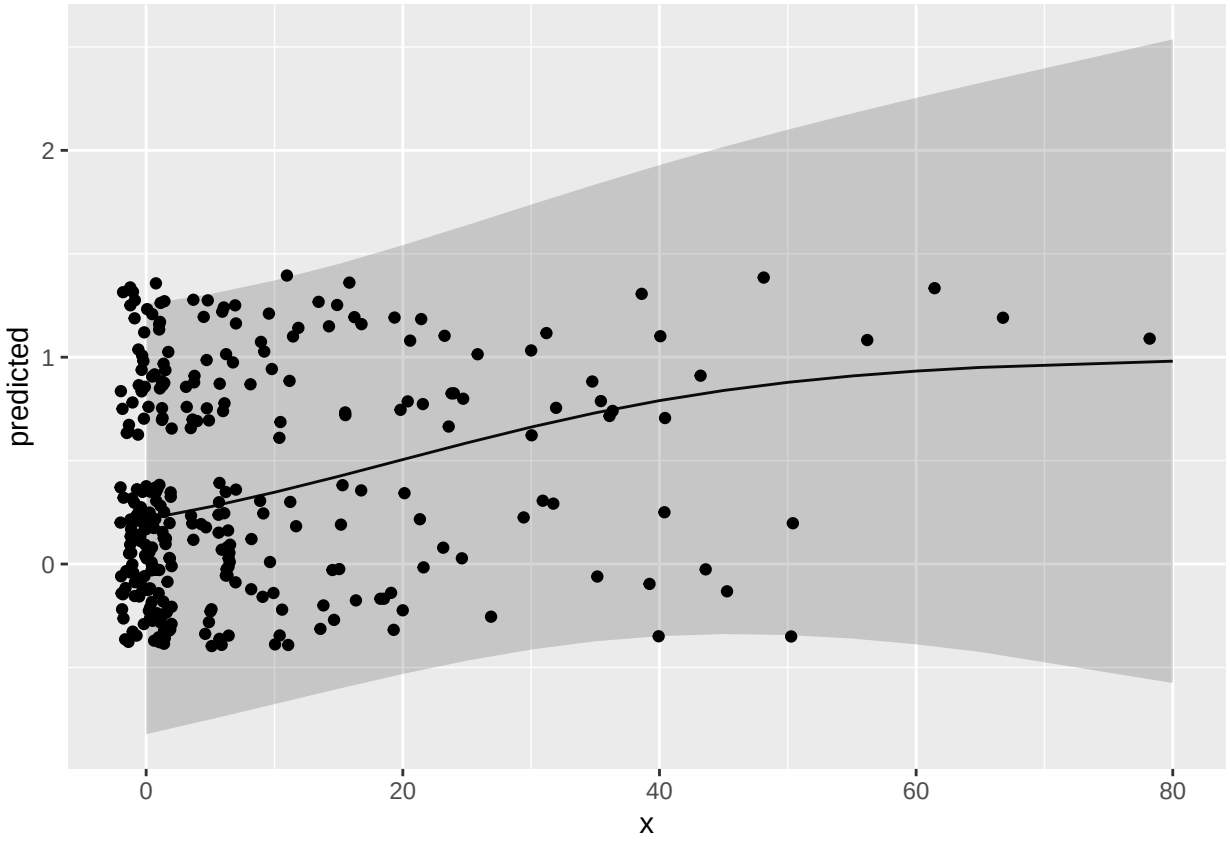



```
summary(Best_model)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: presence ~ pprim_ssite + phss_2.5km_new + pm_2.5km_new + pm_1km_new +
##     rdens_2.5km_new + edens_5km + (1 | site)
##    Data: Koalas
##
##      AIC      BIC   logLik deviance df.resid
##    361.3    391.0   -172.7    345.3      292
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.0124 -0.5170 -0.2981  0.6442  2.0660
##
## Random effects:
##  Groups Name        Variance Std.Dev.
##  site   (Intercept) 1.993    1.412
## Number of obs: 300, groups:  site, 100
##
```

```
## Fixed effects:
##                   Estimate Std. Error z value Pr(>|z|)
## (Intercept)     -2.3409900  0.7867039  -2.976 0.002923 **
## pprim_ssite      0.0652716  0.0168439   3.875 0.000107 ***
## phss_2.5km_new   0.0343386  0.0209165   1.642 0.100653
## pm_2.5km_new     0.0583297  0.0386688   1.508 0.131441
## pm_1km_new       0.0328777  0.0198924   1.653 0.098376 .
## rdens_2.5km_new -0.0013848  0.0009209  -1.504 0.132656
## edens_5km        0.0288996  0.0219133   1.319 0.187230
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) pprm_s ph_2.5_ pm_2.5_ pm_1k_ r_2.5_
## pprim_ssite -0.453
## phss_2.5km_ -0.274  0.169
## pm_2.5km_nw -0.202  0.083  0.138
## pm_1km_new  -0.113  0.169  0.149  -0.347
## rdns_2.5km_ -0.084 -0.073  0.237   0.120  -0.047
## edens_5km   -0.897  0.240  0.001   0.123   0.052 -0.007
## optimizer (Nelder_Mead) convergence code: 0 (OK)
## Model is nearly unidentifiable: very large eigenvalue
##  - Rescale variables?
```

```
pred_best <- ggpredict(Best_model,terms = "pprim_ssite",type = "re")
plot <- ggplot(data=pred_best,aes(x=x,y=predicted))
plot + geom_line() +
  geom_ribbon(aes(ymin=predicted-std.error,ymax=predicted+std.error),alpha=0.2)+
  geom_jitter(data = Koalas,aes(x=pprim_ssite,y=presence))
```


predicted
2
1
0
0
20
40
60
80
x