Spatial Modeling Assignment

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```
library(vegan)
```

```
## Warning: package 'vegan' was built under R version 3.5.3
```

```
## Loading required package: permute
```

```
## Warning: package 'permute' was built under R version 3.5.3
```

```
## Loading required package: lattice
```

```
## Warning: package 'lattice' was built under R version 3.5.3
```

```
## This is vegan 2.5-6
```

```
data(BCI)
## UTM Coordinates (in metres)
BCI_xy = data.frame(x = rep(seq(625754, 626654, by=100), each=5),
                    y = rep(seq(1011569,  1011969, by=100), len=50))
?BCI
```

```
## starting httpd help server ...
```

```
##  done
```

```
head(BCI)
```

```
##   Abarema.macradenia Vachellia.melanoceras Acalypha.diversifolia
## 1                  0                     0                     0
## 2                  0                     0                     0
## 3                  0                     0                     0
## 4                  0                     0                     0
## 5                  0                     0                     0
## 6                  0                     0                     0
##   Acalypha.macrostachya Adelia.triloba Aegiphila.panamensis
## 1                     0              0                    0
## 2                     0              0                    0
## 3                     0              0                    0
## 4                     0              3                    0
## 5                     0              1                    1
## 6                     0              0                    0
##   Alchornea.costaricensis Alchornea.latifolia Alibertia.edulis
## 1                       2                   0                0
## 2                       1                   0                0
## 3                       2                   0                0
## 4                      18                   0                0
## 5                       3                   0                0
## 6                       2                   1                0
##   Allophylus.psilospermus Alseis.blackiana Amaioua.corymbosa
## 1                       0               25                 0
## 2                       0               26                 0
## 3                       0               18                 0
## 4                       0               23                 0
## 5                       1               16                 0
## 6                       0               14                 0
##   Anacardium.excelsum Andira.inermis Annona.spraguei Apeiba.glabra
## 1                   0              0               1            13
## 2                   0              0               0            12
## 3                   0              0               1             6
## 4                   0              0               0             3
## 5                   0              1               0             4
## 6                   0              1               0            10
##   Apeiba.tibourbou Aspidosperma.desmanthum Astrocaryum.standleyanum
## 1                2                       0                        0
## 2                0                       0                        2
## 3                1                       0                        1
## 4                1                       1                        5
## 5                0                       1                        6
## 6                0                       1                        2
##   Astronium.graveolens Attalea.butyracea Banara.guianensis
## 1                    6                 0                 0
## 2                    0                 1                 0
## 3                    1                 0                 0
## 4                    3                 0                 0
## 5                    0                 0                 0
## 6                    1                 1                 0
##   Beilschmiedia.pendula Brosimum.alicastrum Brosimum.guianense
## 1                     4                   5                  0
## 2                     5                   2                  0
## 3                     7                   4                  0
```

```
## 4                     5                   3                   0
## 5                     8                   2                   0
## 6                     6                   2                   0
##   Calophyllum.longifolium Casearia.aculeata Casearia.arborea
## 1                       0                 0                1
## 2                       2                 0                1
## 3                       0                 0                3
## 4                       2                 0                2
## 5                       1                 0                4
## 6                       2                 0                1
##   Casearia.commersoniana Casearia.guianensis Casearia.sylvestris
## 1                      0                   0                   2
## 2                      0                   0                   1
## 3                      1                   0                   0
## 4                      0                   0                   0
## 5                      1                   0                   0
## 6                      0                   0                   3
##   Cassipourea.guianensis Cavanillesia.platanifolia Cecropia.insignis
## 1                      2                         0                12
## 2                      0                         0                 5
## 3                      1                         0                 7
## 4                      1                         0                17
## 5                      3                         0                21
## 6                      4                         0                 4
##   Cecropia.obtusifolia Cedrela.odorata Ceiba.pentandra Celtis.schippii
## 1                    0               0               0               0
## 2                    0               0               1               0
## 3                    0               0               1               0
## 4                    0               0               0               2
## 5                    1               0               1               2
## 6                    0               0               0               0
##   Cespedesia.spathulata Chamguava.schippii Chimarrhis.parviflora
## 1                     0                  0                     0
## 2                     0                  0                     0
## 3                     0                  0                     0
## 4                     0                  0                     0
## 5                     0                  0                     0
## 6                     0                  0                     0
##   Maclura.tinctoria Chrysochlamys.eclipes Chrysophyllum.argenteum
## 1                 0                     0                       4
## 2                 0                     0                       1
## 3                 0                     0                       2
## 4                 0                     0                       2
## 5                 0                     0                       6
## 6                 0                     0                       2
##   Chrysophyllum.cainito Coccoloba.coronata Coccoloba.manzinellensis
## 1                     0                  0                        0
## 2                     0                  0                        0
## 3                     0                  0                        0
## 4                     0                  1                        0
## 5                     0                  2                        0
## 6                     0                  0                        0
##   Colubrina.glandulosa Cordia.alliodora Cordia.bicolor Cordia.lasiocalyx
## 1                    0                2             12                 8
```

```
## 2                0            3         14             6
## 3                0            3         35             6
## 4                0            7         23            11
## 5                0            1         13             7
## 6                0            1          7             6
##   Coussarea.curvigemma Croton.billbergianus Cupania.cinerea
## 1                    0                    2               0
## 2                    0                    2               0
## 3                    0                    0               0
## 4                    1                   11               0
## 5                    0                    6               0
## 6                    2                    0               0
##   Cupania.latifolia Cupania.rufescens Cupania.seemannii
## 1                 0                 0                 2
## 2                 0                 0                 2
## 3                 0                 0                 1
## 4                 1                 0                 0
## 5                 0                 0                 3
## 6                 0                 0                 0
##   Dendropanax.arboreus Desmopsis.panamensis Diospyros.artanthifolia
## 1                    0                    0                       1
## 2                    3                    0                       1
## 3                    6                    4                       1
## 4                    0                    0                       1
## 5                    5                    0                       0
## 6                    2                    0                       0
##   Dipteryx.oleifera Drypetes.standleyi Elaeis.oleifera
## 1                 1                  2               0
## 2                 1                  1               0
## 3                 3                  2               0
## 4                 0                  0               0
## 5                 0                  0               0
## 6                 0                  0               0
##   Enterolobium.schomburgkii Erythrina.costaricensis
## 1                         0                       0
## 2                         0                       0
## 3                         0                       0
## 4                         0                       0
## 5                         0                       0
## 6                         0                       3
##   Erythroxylum.macrophyllum Eugenia.florida Eugenia.galalonensis
## 1                         0               0                    0
## 2                         1               1                    0
## 3                         0               0                    0
## 4                         0               7                    0
## 5                         0               2                    0
## 6                         0               0                    0
##   Eugenia.nesiotica Eugenia.oerstediana Faramea.occidentalis
## 1                 0                   3                   14
## 2                 0                   2                   36
## 3                 1                   5                   39
## 4                 0                   1                   39
## 5                 0                   5                   22
## 6                 0                   2                   16
```

```
##   Ficus.colubrinae Ficus.costaricana Ficus.insipida Ficus.maxima
## 1                0                 0              0            1
## 2                1                 0              0            0
## 3                0                 0              0            0
## 4                0                 0              0            0
## 5                0                 0              0            0
## 6                0                 0              0            0
##   Ficus.obtusifolia Ficus.popenoei Ficus.tonduzii Ficus.trigonata
## 1                 0              0              0               0
## 2                 0              0              0               0
## 3                 0              0              1               0
## 4                 0              0              2               0
## 5                 0              0              1               0
## 6                 0              0              0               0
##   Ficus.yoponensis Garcinia.intermedia Garcinia.madruno Genipa.americana
## 1                1                   0                4                0
## 2                0                   1                0                0
## 3                0                   1                0                1
## 4                0                   3                0                0
## 5                0                   2                1                0
## 6                1                   1                0                0
##   Guapira.myrtiflora Guarea.fuzzy Guarea.grandifolia Guarea.guidonia
## 1                  3            1                  0               2
## 2                  1            1                  0               6
## 3                  0            0                  0               2
## 4                  1            1                  0               5
## 5                  1            3                  0               3
## 6                  7            0                  0               4
##   Guatteria.dumetorum Guazuma.ulmifolia Guettarda.foliacea
## 1                   6                 0                  1
## 2                  16                 0                  5
## 3                   6                 0                  1
## 4                   3                 1                  2
## 5                   9                 0                  1
## 6                   7                 0                  0
##   Gustavia.superba Hampea.appendiculata Hasseltia.floribunda
## 1               10                    0                    5
## 2                5                    0                    9
## 3                0                    1                    4
## 4                1                    0                   11
## 5                3                    0                    9
## 6                1                    0                    2
##   Heisteria.acuminata Heisteria.concinna Hirtella.americana
## 1                   0                  4                  0
## 2                   0                  5                  0
## 3                   0                  4                  0
## 4                   0                  6                  0
## 5                   1                  4                  0
## 6                   1                  8                  0
##   Hirtella.triandra Hura.crepitans Hieronyma.alchorneoides Inga.acuminata
## 1                21              0                       0              0
## 2                14              0                       2              0
## 3                 5              0                       0              0
## 4                 4              0                       0              0
```

```
## 5              6             0                      0             0
## 6              6             2                      0             0
##   Inga.cocleensis Inga.goldmanii Inga.laurina Inga.semialata Inga.nobilis
## 1               2              0            0              0            0
## 2               4              0            0              0            0
## 3               4              1            0              2            1
## 4               6              0            0              4            3
## 5               0              2            1              0            1
## 6               0              1            0              0            0
##   Inga.oerstediana Inga.pezizifera Inga.punctata Inga.ruiziana
## 1                0               0             3             0
## 2                0               0             0             0
## 3                0               0             0             0
## 4                0               0             0             0
## 5                0               0             0             0
## 6                0               0             0             0
##   Inga.sapindoides Inga.spectabilis Inga.umbellifera Jacaranda.copaia
## 1                2                0                0                6
## 2                0                2                0               10
## 3                3                0                0                9
## 4                2                1                1                2
## 5                5                0                0                3
## 6                0                0                0                7
##   Lacistema.aggregatum Lacmellea.panamensis Laetia.procera Laetia.thamnia
## 1                    1                    1              0              0
## 2                    0                    0              1              1
## 3                    0                    0              1              1
## 4                    1                    2              0              0
## 5                    1                    2              1              0
## 6                    2                    1              0              0
##   Lafoensia.punicifolia Licania.hypoleuca Licania.platypus
## 1                     0                 0                0
## 2                     0                 0                0
## 3                     0                 0                0
## 4                     0                 0                0
## 5                     0                 1                0
## 6                     0                 0                0
##   Lindackeria.laurina Lonchocarpus.heptaphyllus Luehea.seemannii
## 1                   0                         7                1
## 2                   0                         7                0
## 3                   0                         3                0
## 4                   0                         9                0
## 5                   0                         2                1
## 6                   0                         1                1
##   Macrocnemum.roseum Maquira.guianensis.costaricana Margaritaria.nobilis
## 1                  0                              4                    0
## 2                  0                              3                    0
## 3                  0                              7                    0
## 4                  0                              7                    0
## 5                  0                             10                    1
## 6                  0                              4                    0
##   Marila.laxiflora Maytenus.schippii Miconia.affinis Miconia.argentea
## 1                1                 2               0                2
## 2                0                 0               0                0
```

```
## 3              0                 0               0                1
## 4              0                 1               1                0
## 5              0                 0               0                1
## 6              0                 1               0                0
##   Miconia.elata Miconia.hondurensis Mosannona.garwoodii Myrcia.gatunensis
## 1            0                   0                   1                 1
## 2            0                   0                   0                 0
## 3            0                   0                   0                 0
## 4            0                   0                   0                 0
## 5            0                   0                   1                 0
## 6            0                   0                   1                 0
##   Myrospermum.frutescens Nectandra.cissiflora Nectandra.lineata
## 1                      0                    0                 0
## 2                      0                    1                 0
## 3                      0                    2                 0
## 4                      0                    2                 0
## 5                      0                    2                 0
## 6                      2                    0                 0
##   Nectandra.purpurea Ochroma.pyramidale Ocotea.cernua Ocotea.oblonga
## 1                  1                  1             0              0
## 2                  0                  0             0              0
## 3                  0                  0             1              1
## 4                  0                  0             1              2
## 5                  0                  0             0              0
## 6                  1                  0             0              0
##   Ocotea.puberula Ocotea.whitei Oenocarpus.mapora Ormosia.amazonica
## 1               0             1                22                 0
## 2               0             0                21                 0
## 3               0             2                14                 0
## 4               2             3                23                 0
## 5               0            16                17                 0
## 6               1             3                19                 0
##   Ormosia.coccinea Ormosia.macrocalyx Pachira.quinata Pachira.sessilis
## 1                0                  0               0                0
## 2                0                  0               0                0
## 3                0                  0               0                0
## 4                0                  0               0                0
## 5                0                  0               0                0
## 6                0                  0               0                0
##   Perebea.xanthochyma Cinnamomum.triplinerve Picramnia.latifolia
## 1                   0                      0                   0
## 2                   1                      0                   0
## 3                   0                      1                   1
## 4                   0                      0                   0
## 5                   1                      1                   0
## 6                   0                      0                   0
##   Piper.reticulatum Platymiscium.pinnatum Platypodium.elegans
## 1                 0                     3                   2
## 2                 0                     3                   1
## 3                 0                     5                   3
## 4                 0                     1                   0
## 5                 2                     1                   0
## 6                 0                     1                   2
##   Posoqueria.latifolia Poulsenia.armata Pourouma.bicolor
```

```
## 1                   0               24                5
## 2                   1               16                3
## 3                   0               28                0
## 4                   0               15                0
## 5                   0               25                1
## 6                   0               15                0
##   Pouteria.fossicola Pouteria.reticulata Pouteria.stipitata
## 1                  0                   5                  0
## 2                  0                   7                  0
## 3                  0                   3                  1
## 4                  0                   6                  0
## 5                  0                   5                  0
## 6                  0                   4                  0
##   Prioria.copaifera Protium.costaricense Protium.panamense
## 1                13                    5                 2
## 2                12                    4                 0
## 3                12                    1                 2
## 4                 5                    3                 3
## 5                 3                    7                 2
## 6                26                    1                 1
##   Protium.tenuifolium Pseudobombax.septenatum Psidium.friedrichsthalianum
## 1                  11                       0                           0
## 2                   8                       0                           0
## 3                   3                       0                           0
## 4                   9                       0                           0
## 5                   3                       0                           0
## 6                   2                       0                           0
##   Psychotria.grandis Pterocarpus.rohrii Quararibea.asterolepis
## 1                  0                  1                     11
## 2                  0                  0                     12
## 3                  0                  0                     15
## 4                  0                  2                     14
## 5                  0                  1                      9
## 6                  0                  1                      3
##   Quassia.amara Randia.armata Sapium.broadleaf Sapium.glandulosum
## 1             0             3                0                  0
## 2             0             2                0                  0
## 3             0             1                0                  1
## 4             0             4                0                  0
## 5             0             2                0                  2
## 6             0             9                0                  0
##   Schizolobium.parahyba Senna.dariensis Simarouba.amara
## 1                     0               0              14
## 2                     0               0               6
## 3                     0               0              16
## 4                     0               0               8
## 5                     0               0               7
## 6                     1               0               7
##   Siparuna.guianensis Siparuna.pauciflora Sloanea.terniflora
## 1                   3                   0                  1
## 2                   2                   0                  0
## 3                   1                   1                  2
## 4                   2                   0                  2
## 5                   0                   3                  3
```

```
## 6                  1                 0                 2
##   Socratea.exorrhiza Solanum.hayesii Sorocea.affinis Spachea.membranacea
## 1                 15               0               1                   0
## 2                 22               0               1                   0
## 3                 31               0               1                   0
## 4                  9               0               1                   0
## 5                 55               1               0                   0
## 6                 44               0               1                   0
##   Spondias.mombin Spondias.radlkoferi Sterculia.apetala
## 1               1                   2                 1
## 2               1                   0                 2
## 3               0                   3                 0
## 4               1                   3                 0
## 5               1                   5                 0
## 6               0                   0                 1
##   Swartzia.simplex.var.grandiflora Swartzia.simplex.continentalis
## 1                                3                              1
## 2                                3                              4
## 3                                0                              2
## 4                                1                              2
## 5                                1                              1
## 6                                9                              5
##   Symphonia.globulifera Handroanthus.guayacan Tabebuia.rosea
## 1                     0                     1              1
## 2                     1                     0              2
## 3                     1                     1              1
## 4                     1                     0              2
## 5                     2                     0              3
## 6                     0                     1              0
##   Tabernaemontana.arborea Tachigali.versicolor Talisia.nervosa
## 1                       9                    6               0
## 2                       5                    1               0
## 3                       6                    3               0
## 4                      10                    3               0
## 5                      16                    0               0
## 6                      11                    1               0
##   Talisia.princeps Terminalia.amazonia Terminalia.oblonga
## 1                1                   1                  0
## 2                0                   0                  0
## 3                0                   0                  0
## 4                0                   0                  0
## 5                0                   1                  0
## 6                0                   1                  0
##   Tetragastris.panamensis Tetrathylacium.johansenii Theobroma.cacao
## 1                       5                         0               1
## 2                       7                         0               1
## 3                      10                         0               0
## 4                      10                         0               0
## 5                       7                         0               1
## 6                      17                         0               0
##   Thevetia.ahouai Tocoyena.pittieri Trattinnickia.aspera Trema.micrantha
## 1               0                 0                    3               0
## 2               0                 1                    1               0
## 3               0                 0                    1               0
```

```
## 4             0               0                0             2
## 5             0               0                2             1
## 6             0               0                0             0
##   Trichanthera.gigantea Trichilia.pallida Trichilia.tuberculata
## 1                     0                 0                    18
## 2                     0                 1                    27
## 3                     0                 0                    28
## 4                     0                 1                    35
## 5                     0                 0                    15
## 6                     0                 0                    31
##   Trichospermum.galeottii Triplaris.cumingiana Trophis.caucana
## 1                       0                    0               2
## 2                       0                    0               0
## 3                       0                    0               0
## 4                       0                    0               0
## 5                       0                    0               2
## 6                       0                    1               0
##   Trophis.racemosa Turpinia.occidentalis Unonopsis.pittieri
## 1                1                     0                  1
## 2                1                     1                  5
## 3                0                     1                 12
## 4                1                     4                  3
## 5                0                     2                  4
## 6                0                     1                  3
##   Virola.multiflora Virola.sebifera Virola.surinamensis Vismia.baccifera
## 1                 0              17                   4                0
## 2                 0              12                   3                0
## 3                 0              11                   2                0
## 4                 0              16                   2                0
## 5                 0              31                   6                0
## 6                 2              19                   1                0
##   Vochysia.ferruginea Xylopia.macrantha Zanthoxylum.ekmanii
## 1                   0                 1                   3
## 2                   0                 0                   4
## 3                   0                 0                   8
## 4                   0                 0                  13
## 5                   0                 0                   3
## 6                   0                 0                   1
##   Zanthoxylum.juniperinum Zanthoxylum.panamense Zanthoxylum.setulosum
## 1                       0                     2                     0
## 2                       0                     2                     0
## 3                       1                     2                     0
## 4                       1                     5                     0
## 5                       0                     5                     0
## 6                       0                     3                     0
##   Zuelania.guidonia
## 1                 0
## 2                 0
## 3                 0
## 4                 1
## 5                 0
## 6                 2
```

1. Examine if there is evidence of spatial dependence in a rare and a common species in the BCI tree dataset. Alesis.blackiana Cordia.bicolor. Pull a column or two and look etc.

```
colSums(BCI)
```

```
##             Abarema.macradenia            Vachellia.melanoceras
##                              1                                3
##          Acalypha.diversifolia            Acalypha.macrostachya
##                              2                                1
##                 Adelia.triloba              Aegiphila.panamensis
##                             92                               23
##        Alchornea.costaricensis              Alchornea.latifolia
##                            156                                1
##               Alibertia.edulis          Allophylus.psilospermus
##                              1                               27
##               Alseis.blackiana                Amaioua.corymbosa
##                            983                                3
##            Anacardium.excelsum                   Andira.inermis
##                             22                               28
##                Annona.spraguei                    Apeiba.glabra
##                             27                              236
##              Apeiba.tibourbou          Aspidosperma.desmanthum
##                             21                               52
##       Astrocaryum.standleyanum             Astronium.graveolens
##                            201                               39
##              Attalea.butyracea                Banara.guianensis
##                             33                                1
##          Beilschmiedia.pendula              Brosimum.alicastrum
##                            294                              188
##             Brosimum.guianense          Calophyllum.longifolium
##                              1                               55
##              Casearia.aculeata                Casearia.arborea
##                             23                              100
##        Casearia.commersoniana              Casearia.guianensis
##                              3                                2
##            Casearia.sylvestris           Cassipourea.guianensis
##                             54                               87
##      Cavanillesia.platanifolia                Cecropia.insignis
##                             19                              264
##          Cecropia.obtusifolia                  Cedrela.odorata
##                             25                                2
##                Ceiba.pentandra                 Celtis.schippii
##                             39                               38
##          Cespedesia.spathulata              Chamguava.schippii
##                              2                                3
##          Chimarrhis.parviflora               Maclura.tinctoria
##                              1                                1
##          Chrysochlamys.eclipes        Chrysophyllum.argenteum
##                              2                               85
##          Chrysophyllum.cainito              Coccoloba.coronata
##                             25                               22
##       Coccoloba.manzinellensis            Colubrina.glandulosa
##                             13                                1
##              Cordia.alliodora                   Cordia.bicolor
##                             63                              325
##             Cordia.lasiocalyx              Coussarea.curvigemma
##                            364                               55
##          Croton.billbergianus                  Cupania.cinerea
```

```
##                        98                           1
##          Cupania.latifolia          Cupania.rufescens
##                        12                           4
##          Cupania.seemannii      Dendropanax.arboreus
##                        47                          88
##       Desmopsis.panamensis     Diospyros.artanthifolia
##                        13                          16
##          Dipteryx.oleifera         Drypetes.standleyi
##                        33                         285
##            Elaeis.oleifera  Enterolobium.schomburgkii
##                        21                           2
##     Erythrina.costaricensis  Erythroxylum.macrophyllum
##                        26                          18
##            Eugenia.florida       Eugenia.galalonensis
##                        81                          12
##          Eugenia.nesiotica         Eugenia.oerstediana
##                        55                         177
##       Faramea.occidentalis          Ficus.colubrinae
##                      1717                           1
##          Ficus.costaricana             Ficus.insipida
##                         7                           3
##               Ficus.maxima          Ficus.obtusifolia
##                         4                           7
##            Ficus.popenoei             Ficus.tonduzii
##                         3                          23
##            Ficus.trigonata           Ficus.yoponensis
##                         5                           6
##        Garcinia.intermedia          Garcinia.madruno
##                        92                          12
##          Genipa.americana          Guapira.myrtiflora
##                        23                          99
##               Guarea.fuzzy         Guarea.grandifolia
##                        68                          10
##           Guarea.guidonia        Guatteria.dumetorum
##                       376                         244
##          Guazuma.ulmifolia         Guettarda.foliacea
##                        38                          85
##          Gustavia.superba       Hampea.appendiculata
##                       644                          13
##       Hasseltia.floribunda       Heisteria.acuminata
##                       229                           7
##        Heisteria.concinna         Hirtella.americana
##                       288                           5
##          Hirtella.triandra             Hura.crepitans
##                       681                         101
##    Hieronyma.alchorneoides            Inga.acuminata
##                        41                          26
##           Inga.cocleensis             Inga.goldmanii
##                        52                          49
##               Inga.laurina            Inga.semialata
##                        10                          98
##               Inga.nobilis           Inga.oerstediana
##                        67                           2
##           Inga.pezizifera             Inga.punctata
```

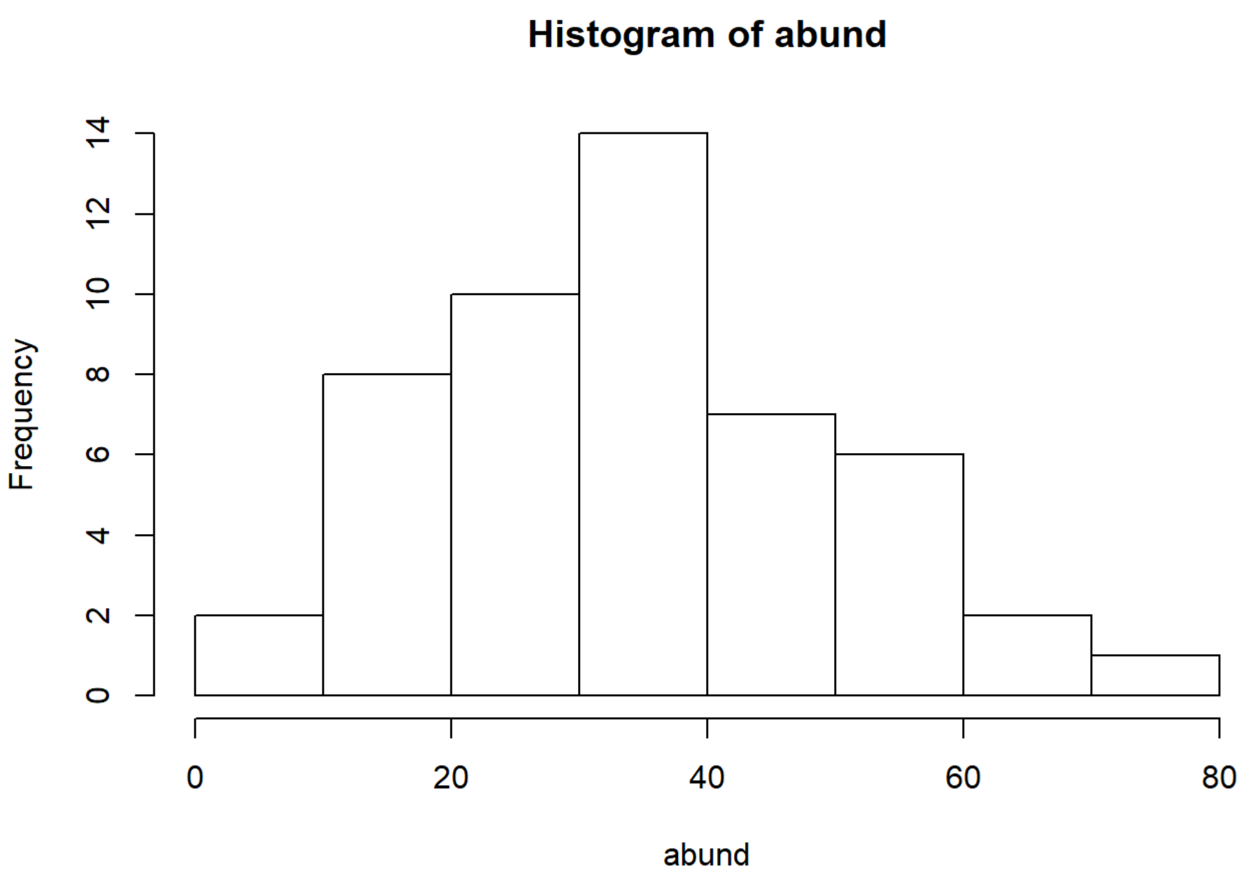
```
##                           20                           10
##                Inga.ruiziana             Inga.sapindoides
##                            5                           76
##             Inga.spectabilis             Inga.umbellifera
##                           14                           14
##             Jacaranda.copaia         Lacistema.aggregatum
##                          236                           33
##         Lacmellea.panamensis               Laetia.procera
##                           51                           12
##               Laetia.thamnia        Lafoensia.punicifolia
##                           27                            5
##            Licania.hypoleuca             Licania.platypus
##                           14                           10
##          Lindackeria.laurina    Lonchocarpus.heptaphyllus
##                           64                          121
##             Luehea.seemannii          Macrocnemum.roseum
##                           93                           25
##  Maquira.guianensis.costaricana       Margaritaria.nobilis
##                          167                            2
##             Marila.laxiflora            Maytenus.schippii
##                           10                           21
##              Miconia.affinis            Miconia.argentea
##                            8                           70
##                Miconia.elata          Miconia.hondurensis
##                            1                            7
##          Mosannona.garwoodii            Myrcia.gatunensis
##                           15                            5
##      Myrospermum.frutescens          Nectandra.cissiflora
##                            7                           33
##           Nectandra.lineata           Nectandra.purpurea
##                           10                            4
##          Ochroma.pyramidale               Ocotea.cernua
##                            5                           29
##              Ocotea.oblonga             Ocotea.puberula
##                           36                           22
##               Ocotea.whitei            Oenocarpus.mapora
##                          184                          788
##           Ormosia.amazonica            Ormosia.coccinea
##                            1                            5
##          Ormosia.macrocalyx              Pachira.quinata
##                            3                            1
##            Pachira.sessilis          Perebea.xanthochyma
##                            9                           21
##      Cinnamomum.triplinerve          Picramnia.latifolia
##                           16                           45
##           Piper.reticulatum        Platymiscium.pinnatum
##                            9                           61
##         Platypodium.elegans          Posoqueria.latifolia
##                           43                           15
##             Poulsenia.armata             Pourouma.bicolor
##                          755                           13
##          Pouteria.fossicola          Pouteria.reticulata
##                            2                          203
##          Pouteria.stipitata            Prioria.copaifera
```

```
##                               31                                345
##             Protium.costaricense                  Protium.panamense
##                              111                                 50
##              Protium.tenuifolium            Pseudobombax.septenatum
##                              381                                  8
##       Psidium.friedrichsthalianum                Psychotria.grandis
##                                4                                  2
##               Pterocarpus.rohrii             Quararibea.asterolepis
##                               80                                724
##                    Quassia.amara                      Randia.armata
##                                4                                248
##                 Sapium.broadleaf                 Sapium.glandulosum
##                                3                                 17
##            Schizolobium.parahyba                    Senna.dariensis
##                                2                                  1
##                  Simarouba.amara                Siparuna.guianensis
##                              289                                 13
##              Siparuna.pauciflora                 Sloanea.terniflora
##                               16                                 78
##               Socratea.exorrhiza                    Solanum.hayesii
##                              346                                 12
##                  Sorocea.affinis                Spachea.membranacea
##                               28                                  8
##                  Spondias.mombin                Spondias.radlkoferi
##                               29                                 63
##                Sterculia.apetala Swartzia.simplex.var.grandiflora
##                               26                                218
##   Swartzia.simplex.continentalis             Symphonia.globulifera
##                              118                                 26
##            Handroanthus.guayacan                     Tabebuia.rosea
##                               30                                 68
##           Tabernaemontana.arborea               Tachigali.versicolor
##                              322                                 98
##                 Talisia.nervosa                   Talisia.princeps
##                                1                                  3
##               Terminalia.amazonia                Terminalia.oblonga
##                               28                                 43
##           Tetragastris.panamensis          Tetrathylacium.johansenii
##                              379                                  7
##                  Theobroma.cacao                    Thevetia.ahouai
##                               12                                  2
##                Tocoyena.pittieri               Trattinnickia.aspera
##                                5                                 40
##                  Trema.micrantha              Trichanthera.gigantea
##                               15                                  2
##                Trichilia.pallida             Trichilia.tuberculata
##                               82                               1681
##           Trichospermum.galeottii               Triplaris.cumingiana
##                                1                                147
##                  Trophis.caucana                   Trophis.racemosa
##                               33                                 32
##            Turpinia.occidentalis                 Unonopsis.pittieri
##                               58                                163
##                 Virola.multiflora                    Virola.sebifera
```

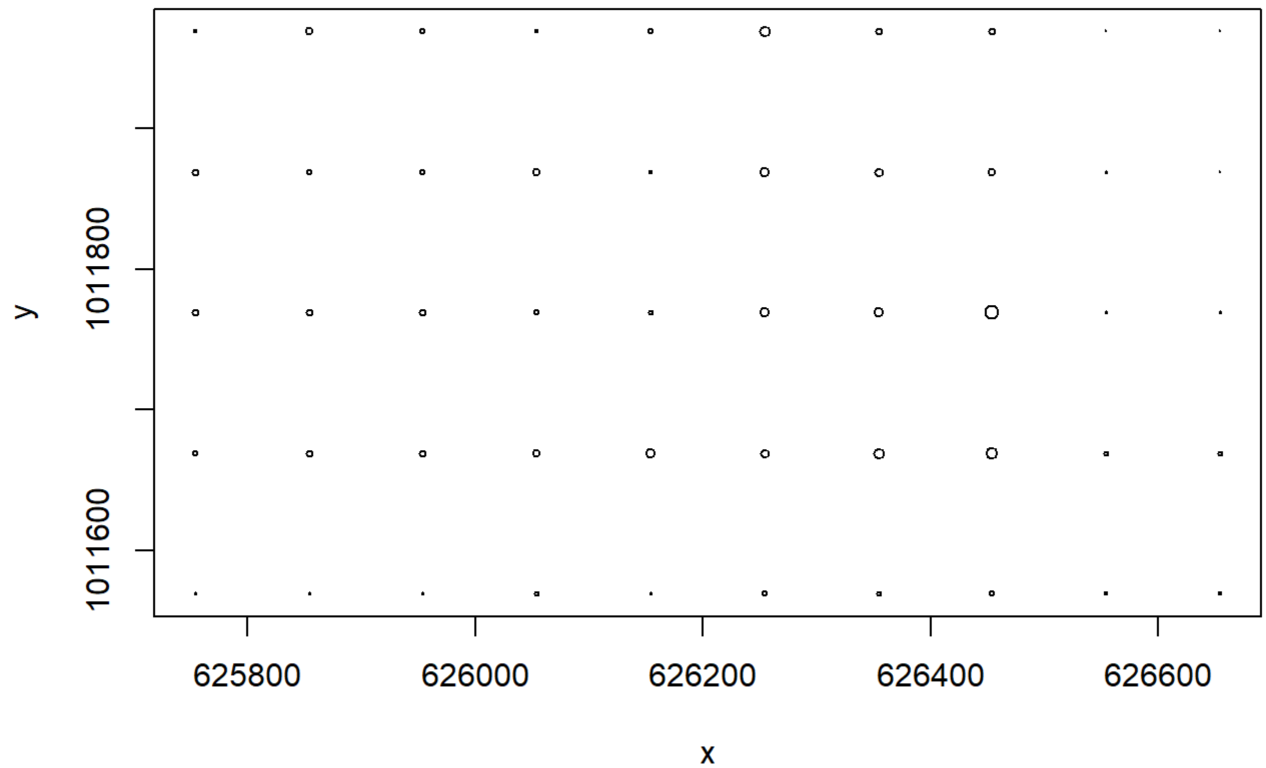
```
##                       25                          617
##      Virola.surinamensis            Vismia.baccifera
##                      164                            1
##      Vochysia.ferruginea           Xylopia.macrantha
##                       12                          143
##      Zanthoxylum.ekmanii      Zanthoxylum.juniperinum
##                      149                           45
##    Zanthoxylum.panamense       Zanthoxylum.setulosum
##                       67                            1
##        Zuelania.guidonia
##                       10
```

```
many <- BCI$Faramea.occidentalis
few <- BCI$Zanthoxylum.panamense
many <- data.frame(many)
few <- data.frame(few)
```

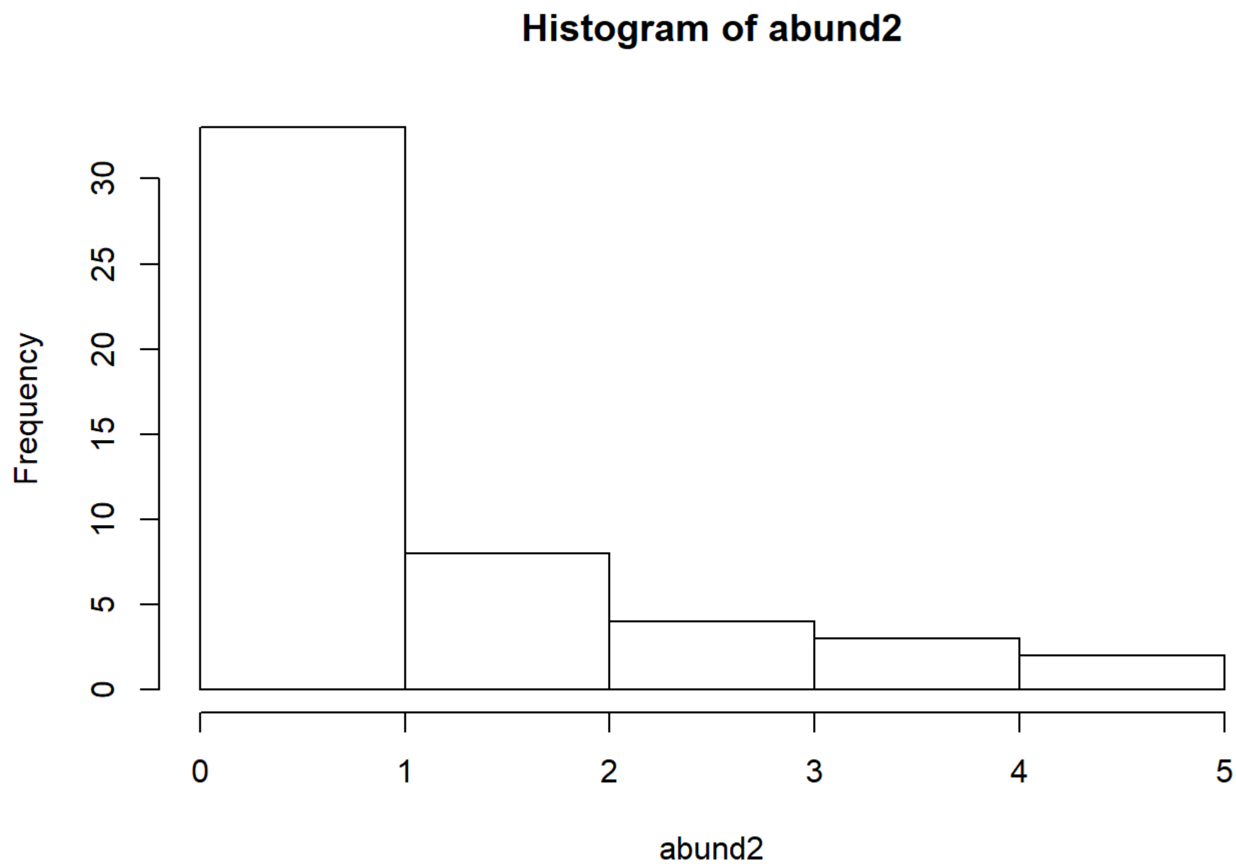
```
abund <- apply(many, 1, sum)
hist(abund)
```



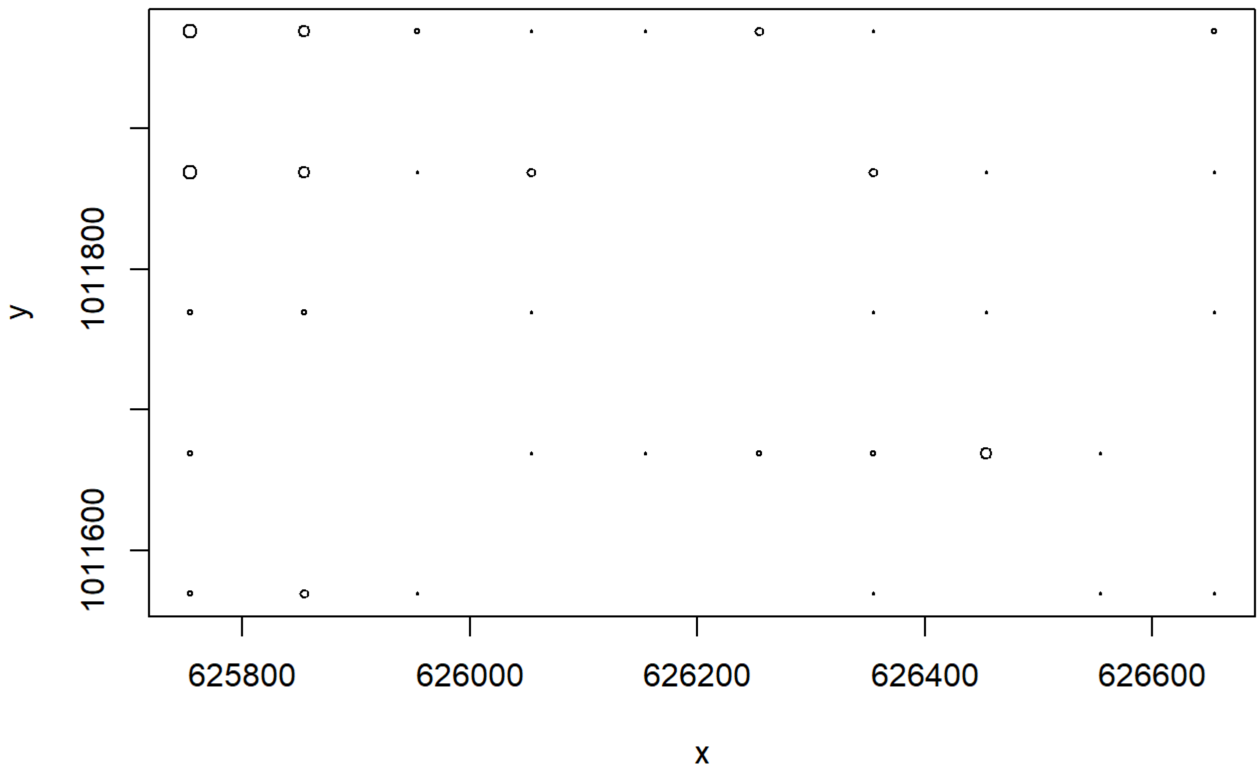

```
plot(BCI_xy, cex = abund/max(abund))
```



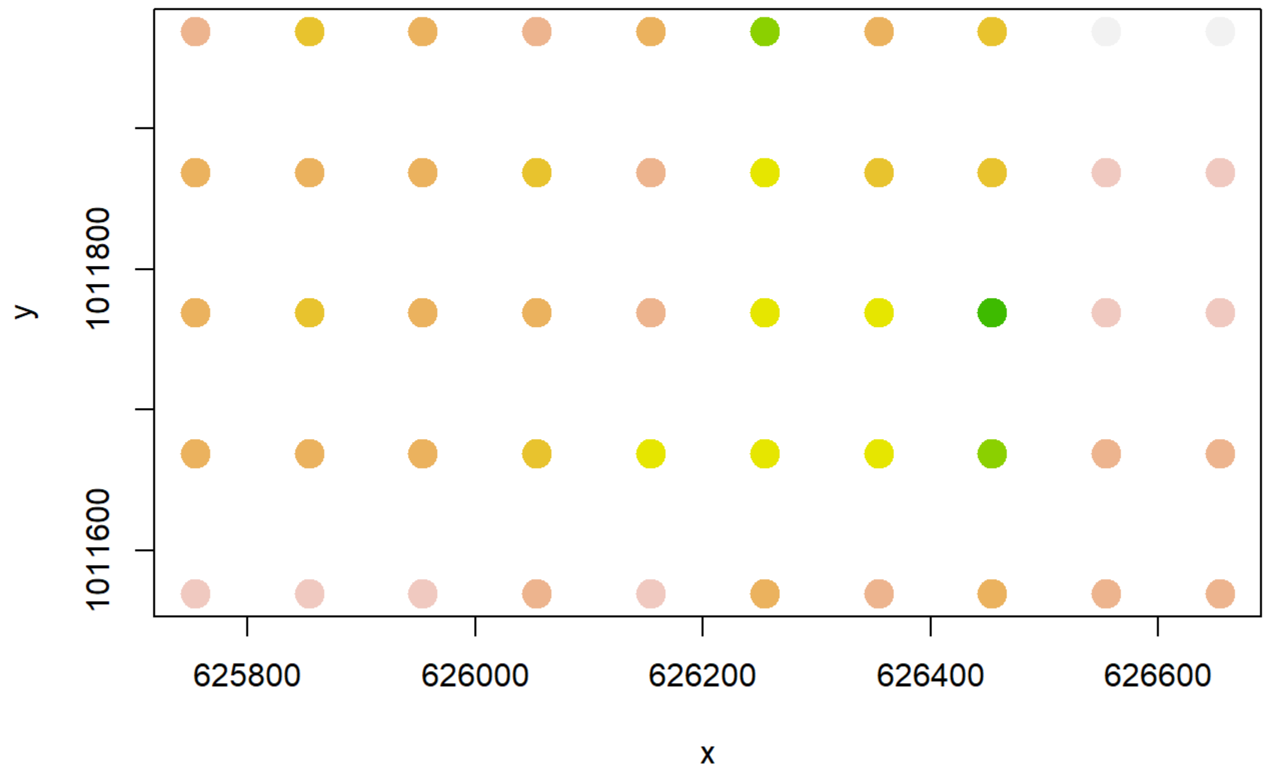

```
abund2 <- apply(few, 1, sum)

hist(abund2)
```



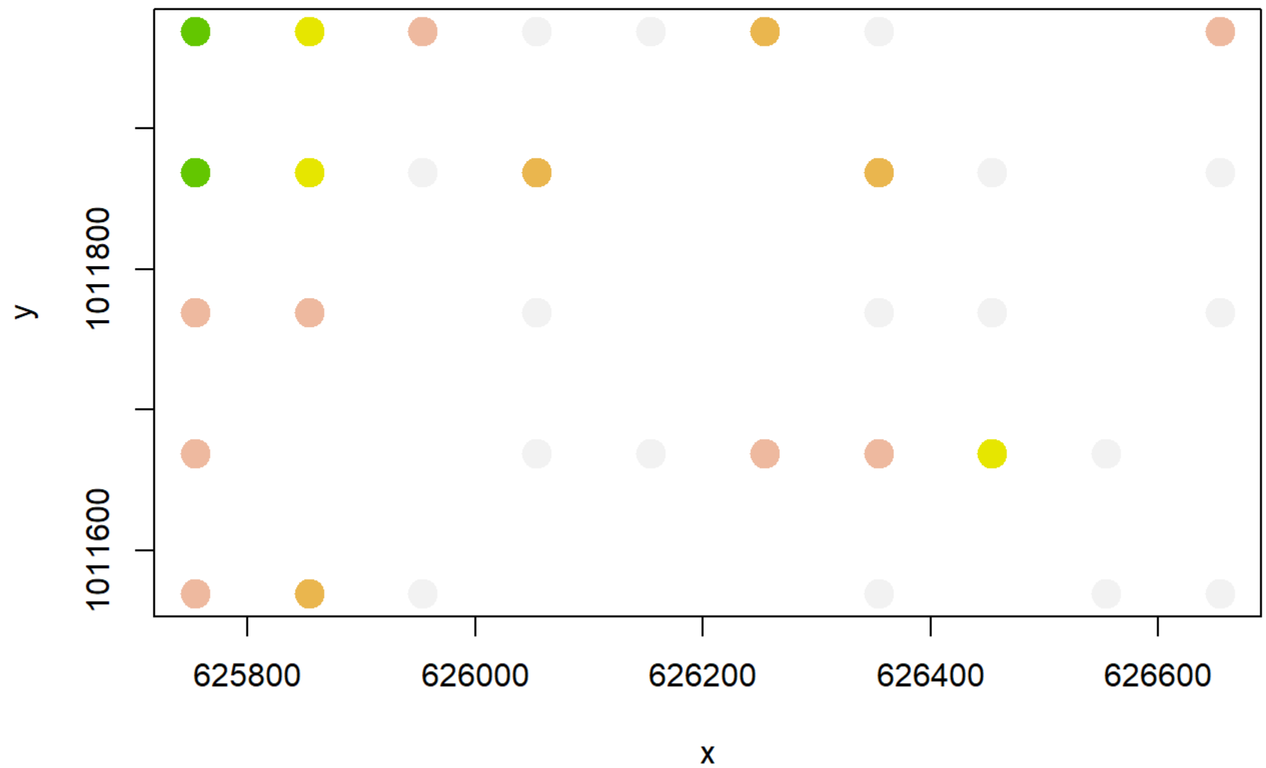

```
plot(BCI_xy, cex = abund2/max(abund2))
```




```
col_brks = hist(abund, plot=F)$breaks
col_indices = as.numeric(cut(abund, col_brks))
cols = rev(terrain.colors(length(col_brks)))
plot(BCI_xy, cex=2, pch=19, col=cols[col_indices])
```

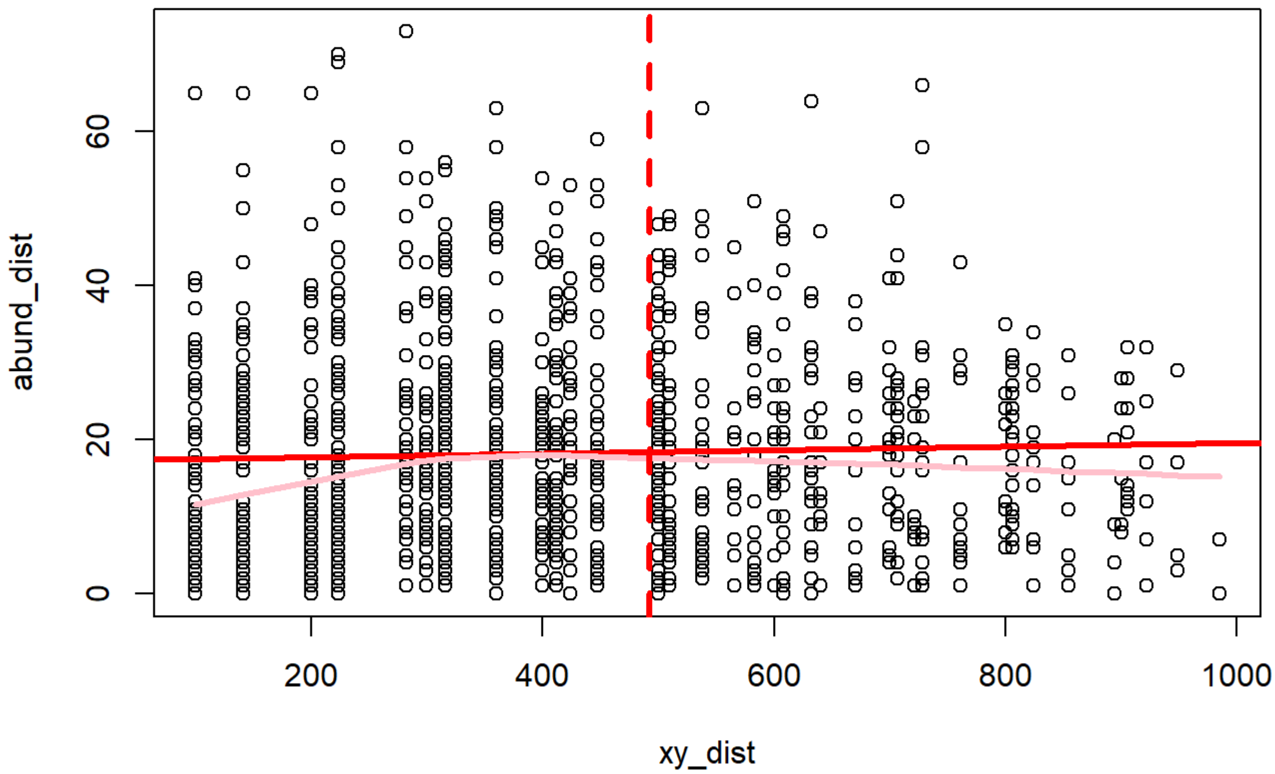



```
col_brks = hist(abund2, plot=F)$breaks
col_indices = as.numeric(cut(abund2, col_brks))
cols = rev(terrain.colors(length(col_brks)))
plot(BCI_xy, cex=2, pch=19, col=cols[col_indices])
```

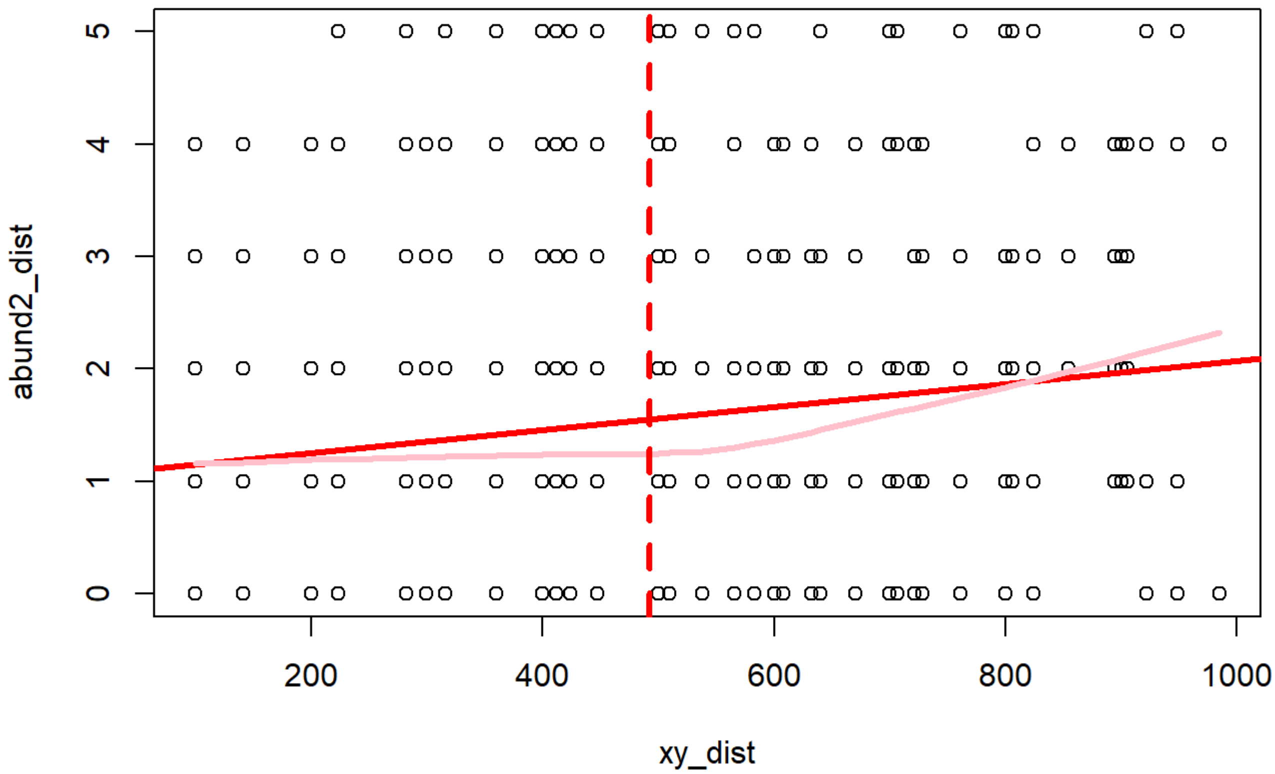



```
abund_dist <- dist(abund)
xy_dist <- dist(BCI_xy)
abund2_dist <- dist(abund2)
```

```
max_dist = max(xy_dist) / 2

# plot result
plot(xy_dist, abund_dist)
abline(lm(abund_dist ~ xy_dist), lwd=3, col='red')
lines(lowess(xy_dist, abund_dist), lwd=3, col='pink')
abline(v = max_dist, col='red', lwd=3, lty=2)
```




```
ax_dist = max(xy_dist) / 2

# plot result
plot(xy_dist, abund2_dist)
abline(lm(abund2_dist ~ xy_dist), lwd=3, col='red')
lines(lowess(xy_dist, abund2_dist), lwd=3, col='pink')
abline(v = max_dist, col='red', lwd=3, lty=2)
```




```
obs_cor <- cor(xy_dist, abund_dist)
obs_cor
```

```
## [1] 0.0355889
```

```
obs_cor2 <- cor(xy_dist, abund2_dist)
obs_cor2
```

```
## [1] 0.1656752
```

```
#measure of correlation between your distance and species matrix. Low is bad.
```

```
sr_mantel <- mantel(abund_dist, xy_dist)
sr_mantel
```

```
##
## Mantel statistic based on Pearson's product-moment correlation
##
## Call:
## mantel(xdis = abund_dist, ydis = xy_dist)
##
## Mantel statistic r: 0.03559
##       Significance: 0.237
##
## Upper quantiles of permutations (null model):
##    90%    95%  97.5%    99%
## 0.0645 0.0859 0.1050 0.1259
## Permutation: free
## Number of permutations: 999
```

This mantel statistic for the common species suggests there is a weak correlation between the species abundance matrix and the distance matrix. The p-value suggests this is not a statistically significant correlation

```
sr_mantel2 = mantel(abund2_dist, xy_dist)
sr_mantel2
```

```
##
## Mantel statistic based on Pearson's product-moment correlation
##
## Call:
## mantel(xdis = abund2_dist, ydis = xy_dist)
##
## Mantel statistic r: 0.1657
##       Significance: 0.005
##
## Upper quantiles of permutations (null model):
##    90%    95%  97.5%    99%
## 0.0641 0.0830 0.1018 0.1161
## Permutation: free
## Number of permutations: 999
```

The mantel statistic for the rare species suggests a low correlation between the apecies abundance matrix and the geographical distance matrix. However, the p-value of 0.003 suggests this is a statistically significant correlation.

```
corlog1 <- mantel.correlog(abund_dist, xy_dist)

corlog1
```

```
##
## Mantel Correlogram Analysis
##
## Call:
##
## mantel.correlog(D.eco = abund_dist, D.geo = xy_dist)
##
##         class.index     n.dist Mantel.cor Pr(Mantel) Pr(corrected)
## D.cl.1   136.870241 144.000000   0.041368      0.046         0.046 *
## D.cl.2   210.610723 376.000000   0.009563      0.349         0.349
## D.cl.3   284.351204 390.000000  -0.054005      0.024         0.072 .
## D.cl.4   358.091686 148.000000  -0.056782      0.010         0.040 *
## D.cl.5   431.832168 372.000000  -0.039064      0.115         0.230
## D.cl.6   505.572649 266.000000  -0.023481      0.143         0.345
## D.cl.7   579.313131 168.000000         NA         NA            NA
## D.cl.8   653.053613 100.000000         NA         NA            NA
## D.cl.9   726.794094 154.000000         NA         NA            NA
## D.cl.10  800.534576  88.000000         NA         NA            NA
## D.cl.11  874.275058  50.000000         NA         NA            NA
## D.cl.12  948.015539  24.000000         NA         NA            NA
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

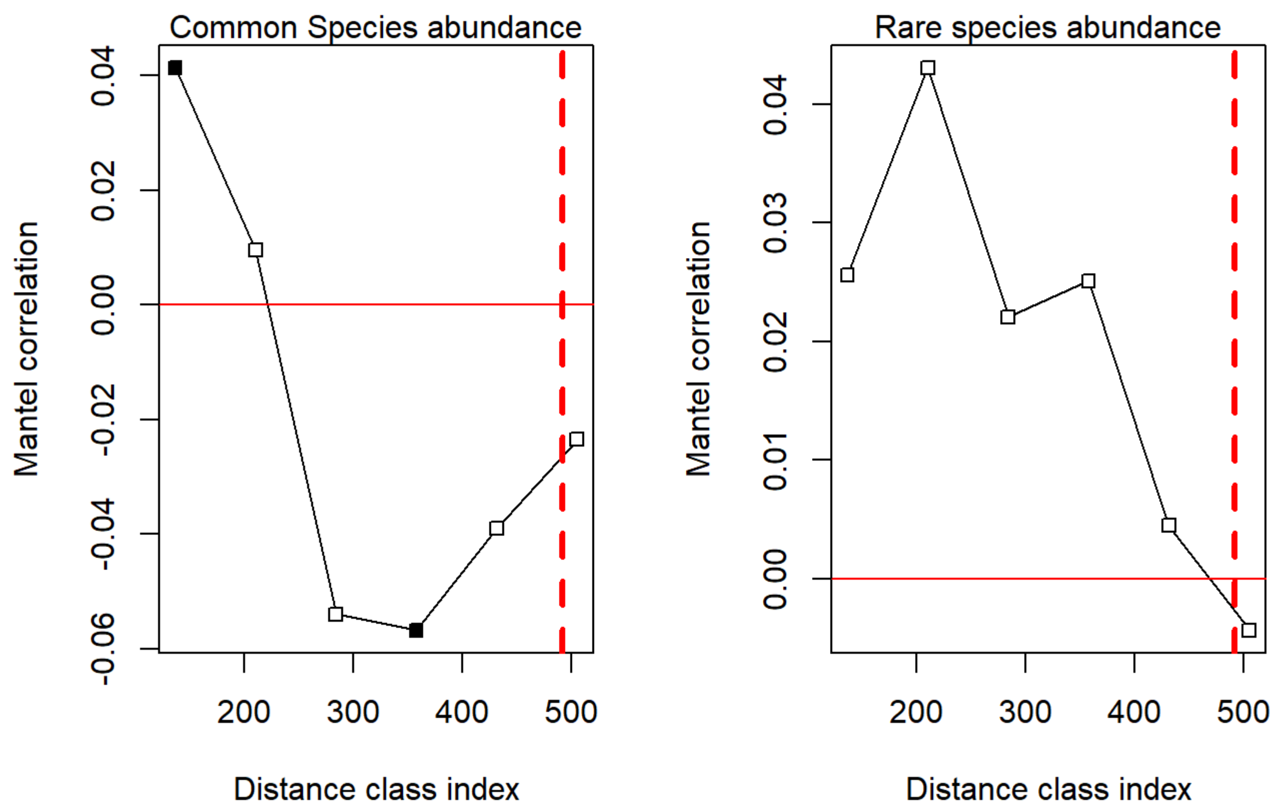
This indicates that for the common species, there are two distance classes at which there is a statistically significant correlation between the matrixes.

```
corlog2 <- mantel.correlog(abund2_dist, xy_dist)
corlog2
```

```
##
## Mantel Correlogram Analysis
##
## Call:
##
## mantel.correlog(D.eco = abund2_dist, D.geo = xy_dist)
##
##         class.index      n.dist  Mantel.cor Pr(Mantel) Pr(corrected)
## D.cl.1  136.8702408 144.0000000   0.0256137      0.160         0.160
## D.cl.2  210.6107225 376.0000000   0.0430563      0.058         0.116
## D.cl.3  284.3512042 390.0000000   0.0220694      0.202         0.320
## D.cl.4  358.0916859 148.0000000   0.0251025      0.149         0.447
## D.cl.5  431.8321676 372.0000000   0.0044998      0.458         0.596
## D.cl.6  505.5726492 266.0000000  -0.0043089      0.465         0.916
## D.cl.7  579.3131309 168.0000000          NA         NA            NA
## D.cl.8  653.0536126 100.0000000          NA         NA            NA
## D.cl.9  726.7940943 154.0000000          NA         NA            NA
## D.cl.10 800.5345760  88.0000000          NA         NA            NA
## D.cl.11 874.2750577  50.0000000          NA         NA            NA
## D.cl.12 948.0155393  24.0000000          NA         NA            NA
```

For the rare species, it appears that no statistically significant correlation is found for any of the distances classes.

```
par(mfrow=c(1,2))
plot(corlog1)
mtext(side=3, 'Common Species abundance')
abline(v=max_dist, col='red', lwd=3, lty=2)
plot(corlog2)
mtext(side=3, 'Rare species abundance')
abline(v= max_dist, col='red', lwd=3, lty=2)
```



It appears there may be evidence of spatial dependance in the common species. According to the mantel correlation values a statistically significant relationship was found at a distance class of about 100, indicating a positive correlation between abundance and smaller distances. Also, there is a statistically significant relationship seen at a distance class of about 280, indicating a negative correlation between species abundance and larger distances.

However, for the rare species, no statistically significant correlations were found at any of the distance classes.

2. Build two generalized linear models to predict the abundance of the species Drypetes standleyi using the abundance of other tree species in the study site. Specifically examine the following species as predictor variables:

```
library(nlme)
```

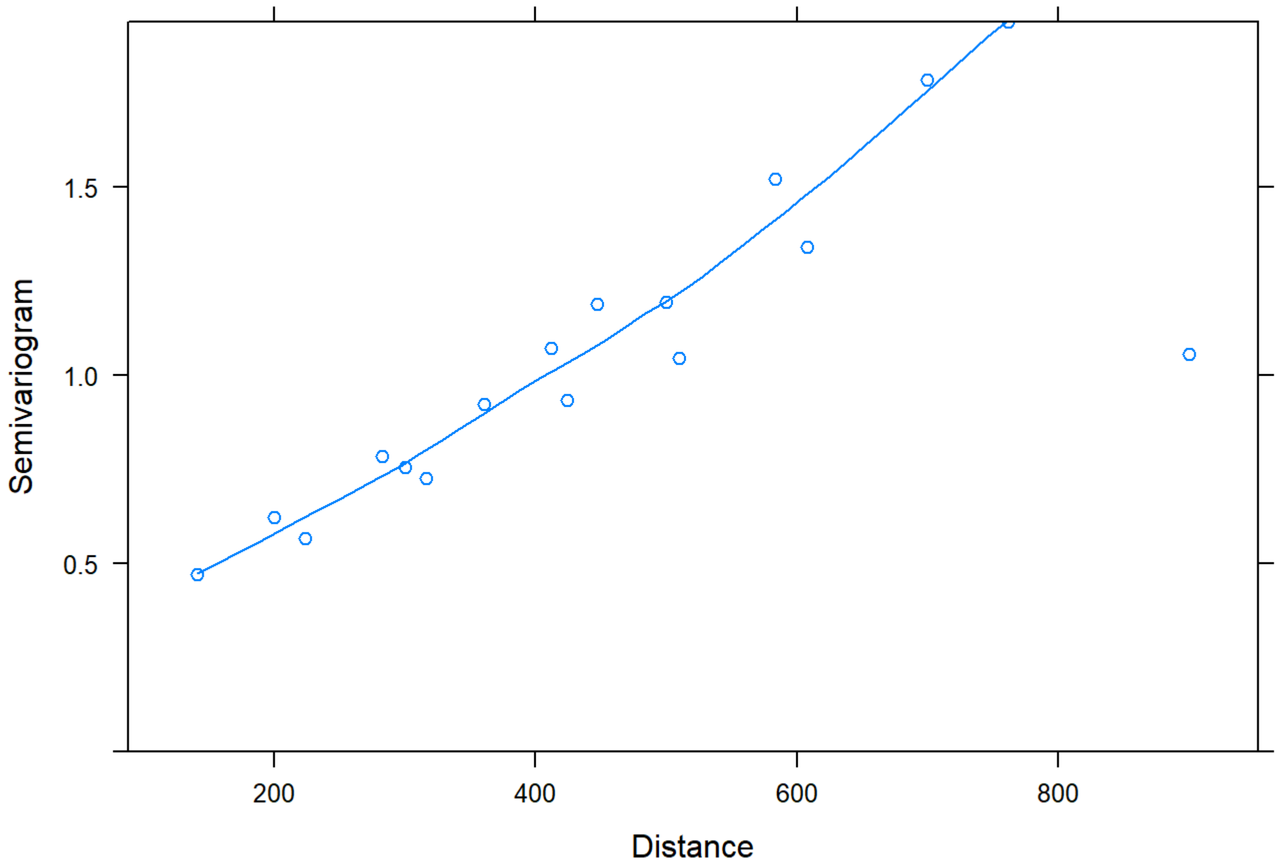
```
all.dat <- data.frame(BCI, BCI_xy)
```

Model 1: only include a single species as a predictor variable

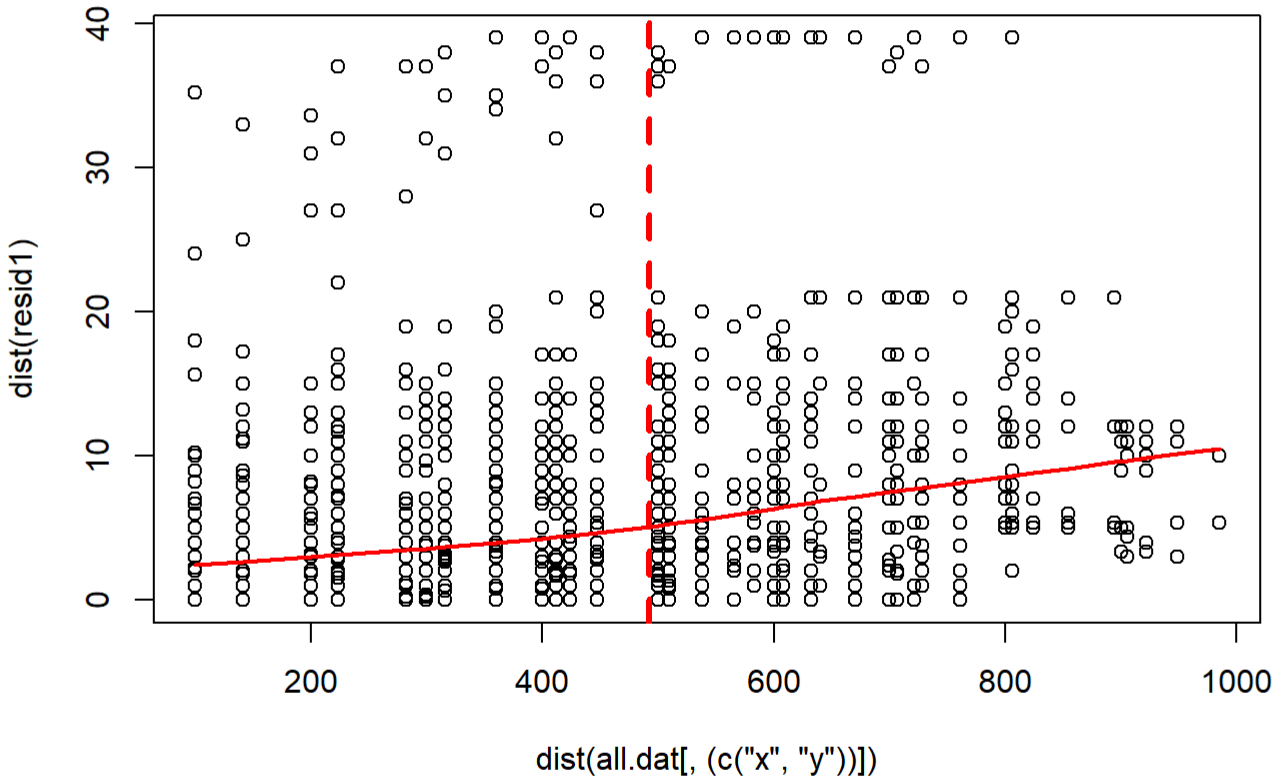
```
glm1 <- gls(Drypetes.standleyi~Quassia.amara, data=all.dat)

summary(glm1)
```

```
## Generalized least squares fit by REML
##   Model: Drypetes.standleyi ~ Quassia.amara
##   Data: all.dat
##        AIC      BIC    logLik
##   337.5287 343.1423 -165.7644
##
## Coefficients:
##                  Value Std.Error  t-value p-value
## (Intercept)   4.962810  1.030804 4.814503   0e+00
## Quassia.amara 9.214876  2.304948 3.997867   2e-04
##
##  Correlation:
##               (Intr)
## Quassia.amara -0.179
##
## Standardized residuals:
##        Min         Q1        Med         Q3        Max
## -0.6920362 -0.6920362 -0.4131473  0.2840748  4.7462963
##
## Residual standard error: 7.171316
## Degrees of freedom: 50 total; 48 residual
```

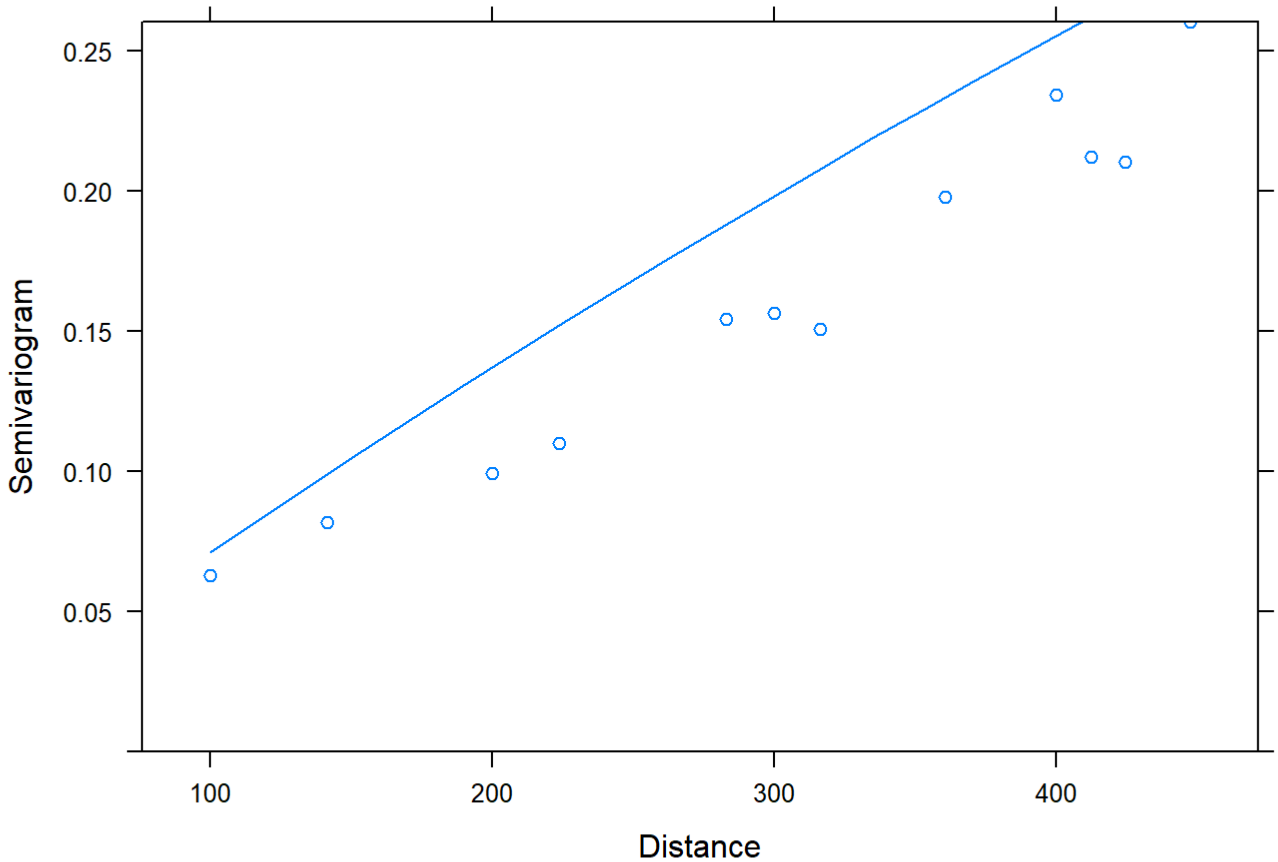
```
plot(Variogram(glm1, form= ~ x+y))
```




```
resid1 <- residuals(glm1)
plot(dist(all.dat[, (c('x', 'y'))]), dist(resid1))
lines(lowess(dist(all.dat[, c('x', 'y')]), dist(resid1)), col='red', lwd=2)
abline(v = max_dist, col='red', lwd=3, lty=2)
```

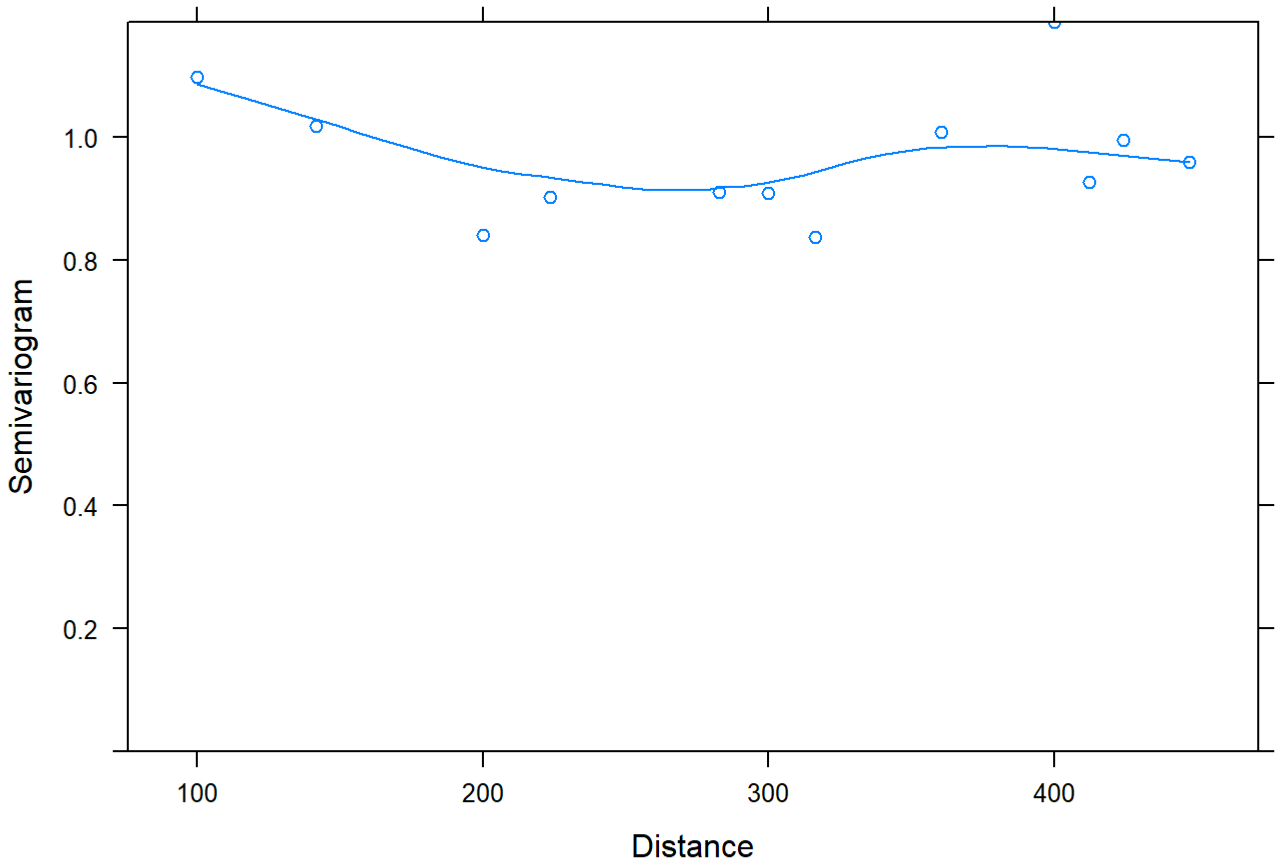



```
glm1.exp <- update(glm1, corr=corExp(form=~x + y))
plot(Variogram(glm1.exp, maxDist = max_dist))
```



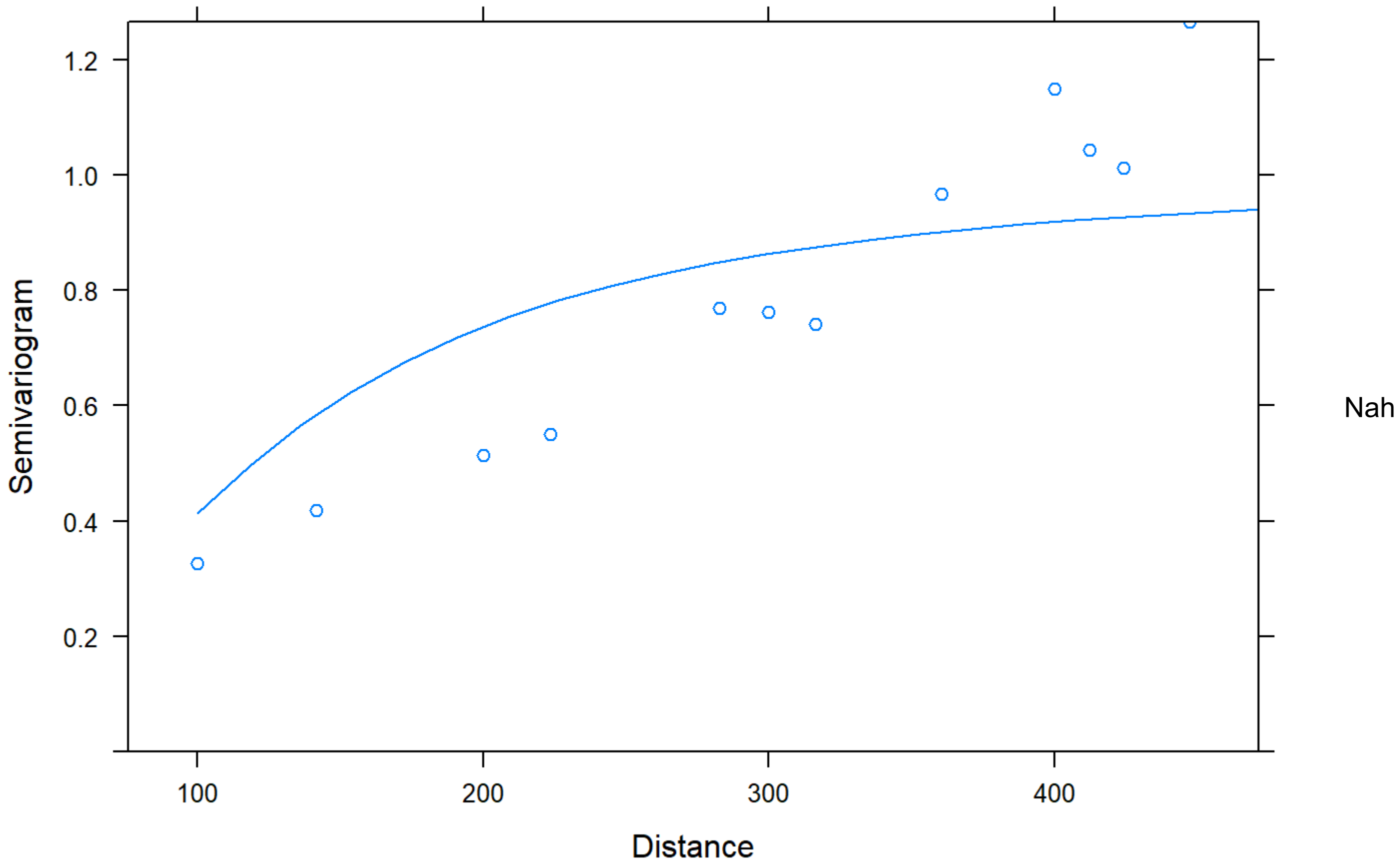
Not terrible. . .

```
plot(Variogram(glm1.exp, resType='normalized', maxDist = max_dist))
```



Some trend here

```
glm1.rat <- update(glm1, corr=corRatio(form=~x + y))
plot(Variogram(glm1.rat, maxDist = max_dist))
```




```r
anova(glm1, glm1.exp)
```

```
##          Model df      AIC      BIC    logLik   Test  L.Ratio p-value
## glm1         1  3 337.5287 343.1423 -165.7644
## glm1.exp     2  4 301.4029 308.8877 -146.7014 1 vs 2 38.12584  <.0001
```

So both models with the spacial error term fits better than the one without. However, the exponential model fits the best. It appears there is a significant difference between the models

```r
summary(glm1)
```

```
## Generalized least squares fit by REML
##   Model: Drypetes.standleyi ~ Quassia.amara
##   Data: all.dat
##        AIC      BIC    logLik
##   337.5287 343.1423 -165.7644
##
## Coefficients:
##                  Value Std.Error  t-value p-value
## (Intercept)   4.962810  1.030804 4.814503   0e+00
## Quassia.amara 9.214876  2.304948 3.997867   2e-04
##
##  Correlation:
##               (Intr)
## Quassia.amara -0.179
##
## Standardized residuals:
##        Min         Q1        Med         Q3        Max
## -0.6920362 -0.6920362 -0.4131473  0.2840748  4.7462963
##
## Residual standard error: 7.171316
## Degrees of freedom: 50 total; 48 residual
```

```
summary(glm1.exp)
```

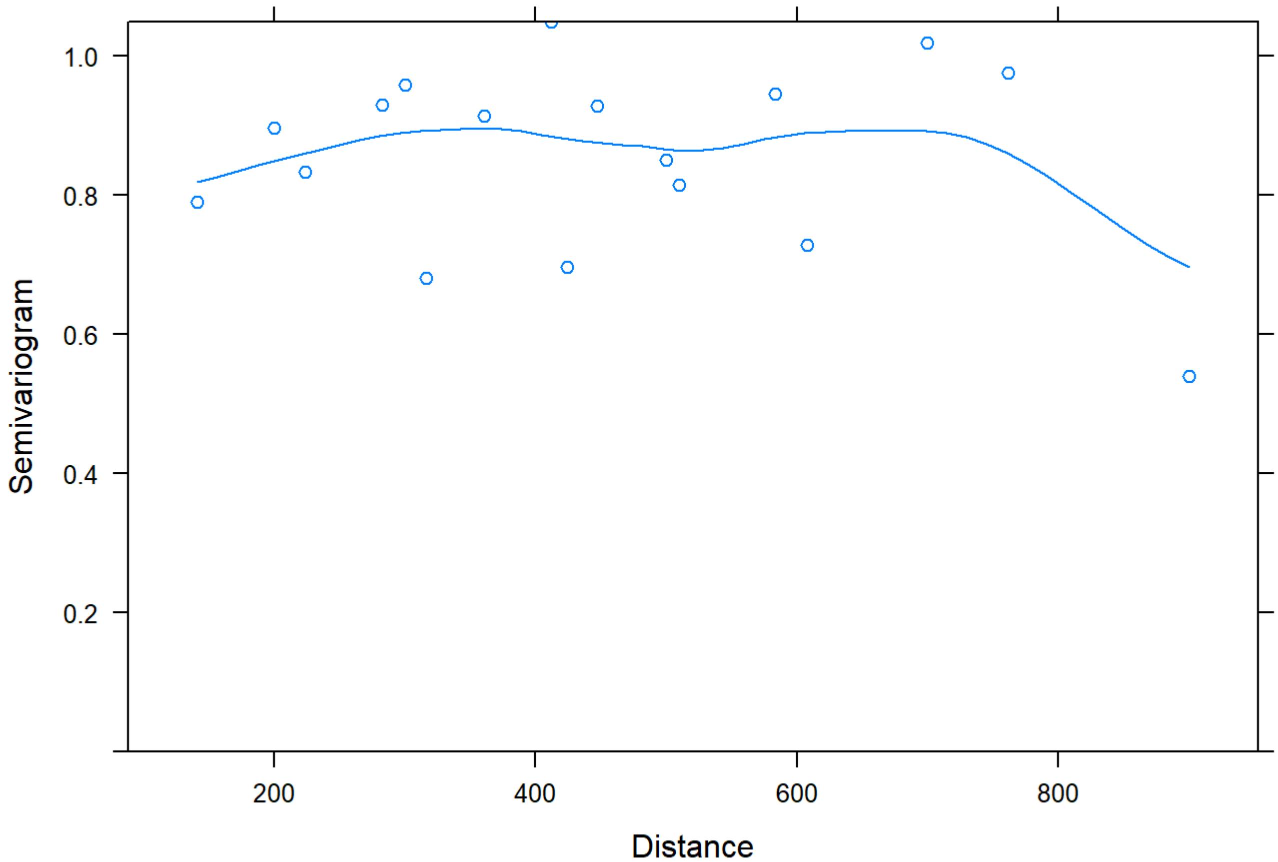
```
## Generalized least squares fit by REML
##   Model: Drypetes.standleyi ~ Quassia.amara
##   Data: all.dat
##        AIC      BIC    logLik
##   301.4029 308.8877 -146.7015
##
## Correlation Structure: Exponential spatial correlation
##  Formula: ~x + y
##  Parameter estimate(s):
##   range
## 1356.62
##
## Coefficients:
##                  Value Std.Error   t-value p-value
## (Intercept)   9.794547 13.486551 0.7262455  0.4712
## Quassia.amara 3.763073  1.495159 2.5168384  0.0152
##
##  Correlation:
##               (Intr)
## Quassia.amara -0.069
##
## Standardized residuals:
##        Min         Q1        Med         Q3        Max
## -0.5991027 -0.5991027 -0.4767688 -0.1250587  1.7864089
##
## Residual standard error: 16.34869
## Degrees of freedom: 50 total; 48 residual
```

Model 2: include all of the species as predictor variables

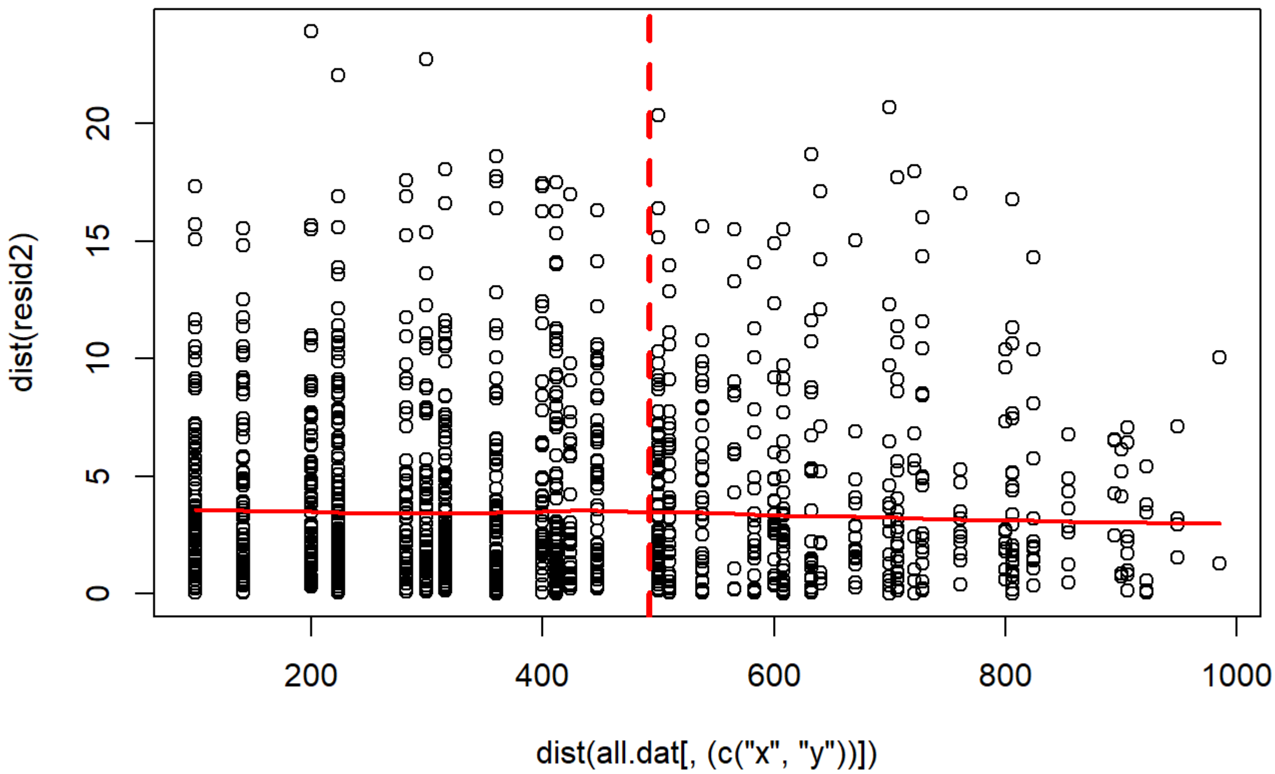
```
glm2 <- gls(Drypetes.standleyi~Cordia.lasiocalyx + Hirtella.triandra + Picramnia.latifolia + Qua
ssia.amara + Tabernaemontana.arborea + Trattinnickia.aspera + Xylopia.macrantha, data=all.dat)

summary(glm2)
```

```
## Generalized least squares fit by REML
##   Model: Drypetes.standleyi ~ Cordia.lasiocalyx + Hirtella.triandra +      Picramnia.latifoli
a + Quassia.amara + Tabernaemontana.arborea +      Trattinnickia.aspera + Xylopia.macrantha
##   Data: all.dat
##        AIC      BIC    logLik
##   307.1163 322.7554 -144.5582
##
## Coefficients:
##                             Value Std.Error   t-value p-value
## (Intercept)             -1.051752 2.1175346 -0.496687  0.6220
## Cordia.lasiocalyx        0.428920 0.2039316  2.103255  0.0415
## Hirtella.triandra        0.122279 0.0802638  1.523462  0.1351
## Picramnia.latifolia      0.662259 0.6358905  1.041468  0.3036
## Quassia.amara            4.085661 2.2842770  1.788602  0.0809
## Tabernaemontana.arborea -0.249725 0.1491192 -1.674667  0.1014
## Trattinnickia.aspera     1.349323 0.7147412  1.887848  0.0660
## Xylopia.macrantha        0.548832 0.1468772  3.736672  0.0006
##
##  Correlation:
##                         (Intr) Crd.ls Hrtll. Pcrmn. Qss.mr Tbrnm. Trttn.
## Cordia.lasiocalyx       -0.618
## Hirtella.triandra       -0.212 -0.354
## Picramnia.latifolia      0.025 -0.019 -0.381
## Quassia.amara            0.163 -0.378  0.307 -0.302
## Tabernaemontana.arborea -0.708  0.245  0.163 -0.113  0.148
## Trattinnickia.aspera    -0.139  0.187 -0.311  0.308 -0.708 -0.144
## Xylopia.macrantha       -0.140 -0.125  0.156 -0.463  0.314  0.279 -0.294
##
## Standardized residuals:
##         Min          Q1         Med          Q3         Max
## -1.87708765 -0.42701500 -0.04032793  0.23615609  3.38768871
##
## Residual standard error: 4.539713
## Degrees of freedom: 50 total; 42 residual
```

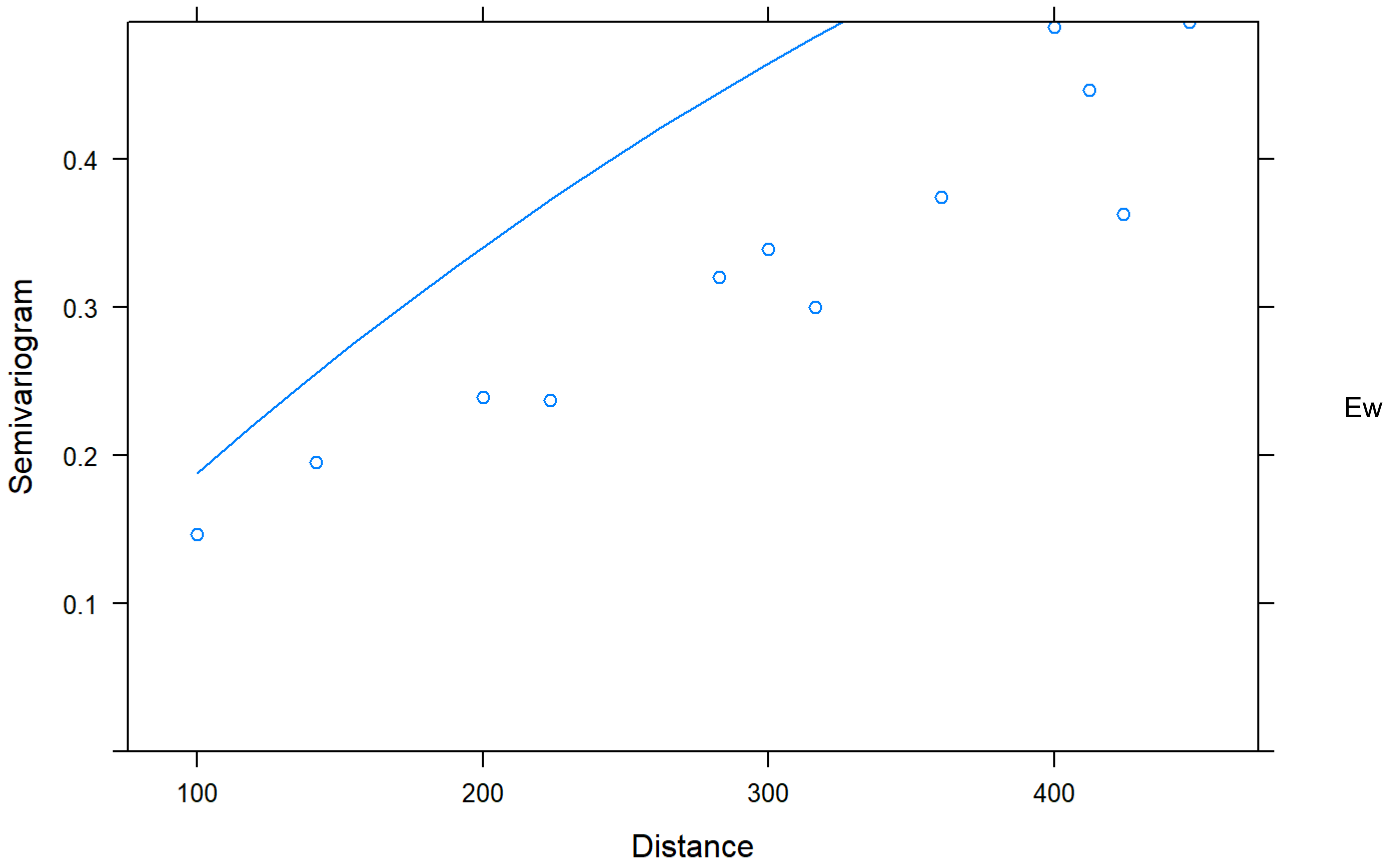
```
plot(Variogram(glm2, form =  ~ x+y))
```



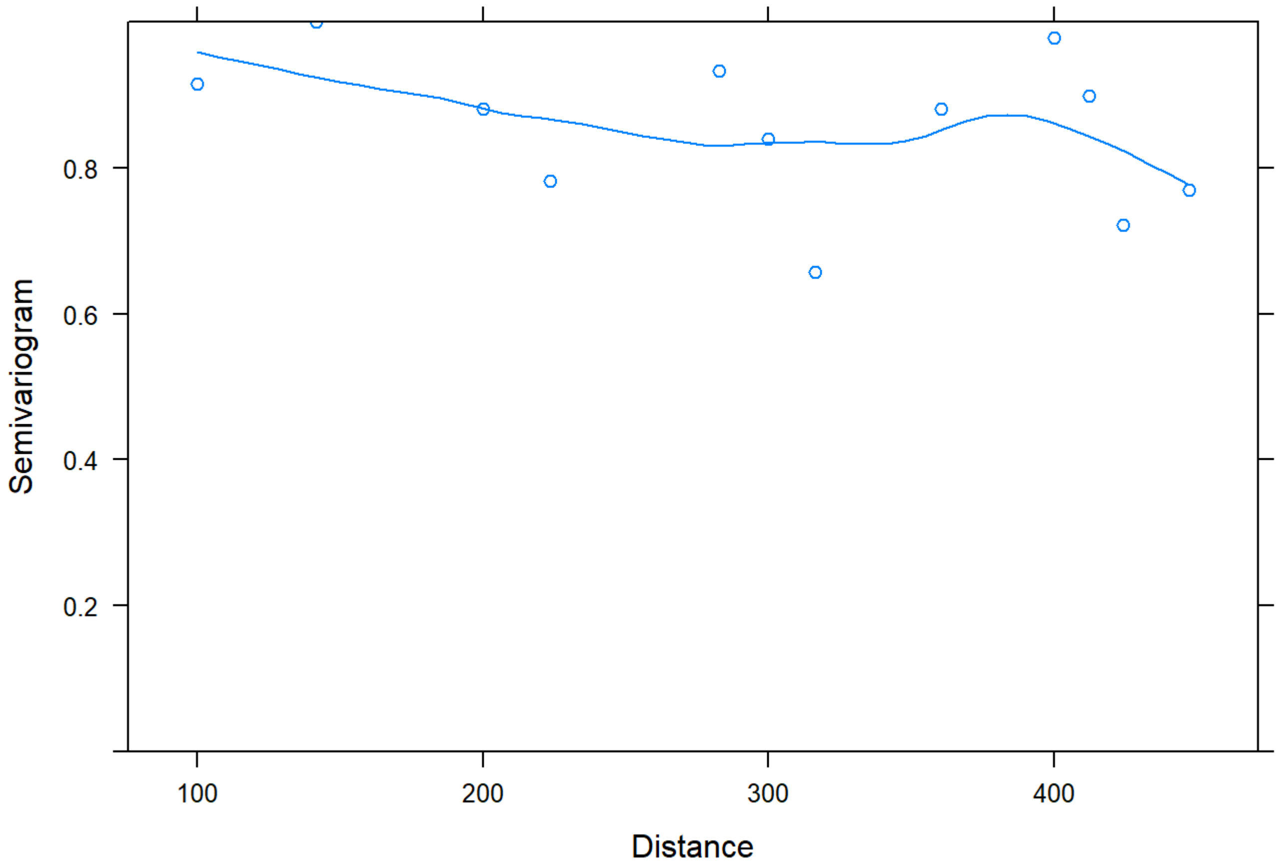

```
resid2 <- residuals(glm2)
plot(dist(all.dat[, (c('x', 'y'))]), dist(resid2))
lines(lowess(dist(all.dat[, c('x', 'y')]), dist(resid2)), col='red', lwd=2)
abline(v = max_dist, col='red', lwd=3, lty=2)
```




```
glm2.exp <- update(glm2, corr=corExp(form=~x + y))
plot(Variogram(glm2.exp, maxDist = max_dist))
```




```
plot(Variogram(glm2.exp, resType='normalized', maxDist = max_dist))
```



slightly better. suggests resids are kinda normal . . . .

```
anova(glm2, glm2.exp)
```

```
##          Model df      AIC      BIC    logLik   Test  L.Ratio p-value
## glm2         1  9 307.1163 322.7554 -144.5582
## glm2.exp     2 10 301.6062 318.9829 -140.8031 1 vs 2 7.510175  0.0061
```

Anova indicates a significant difference between the models, and the spacial error term appears to have improved the model somewhat.

```
summary(glm2)
```

```
## Generalized least squares fit by REML
##   Model: Drypetes.standleyi ~ Cordia.lasiocalyx + Hirtella.triandra +      Picramnia.latifoli
a + Quassia.amara + Tabernaemontana.arborea +      Trattinnickia.aspera + Xylopia.macrantha
##   Data: all.dat
##        AIC      BIC    logLik
##   307.1163 322.7554 -144.5582
##
## Coefficients:
##                             Value Std.Error   t-value p-value
## (Intercept)             -1.051752 2.1175346 -0.496687  0.6220
## Cordia.lasiocalyx        0.428920 0.2039316  2.103255  0.0415
## Hirtella.triandra        0.122279 0.0802638  1.523462  0.1351
## Picramnia.latifolia      0.662259 0.6358905  1.041468  0.3036
## Quassia.amara            4.085661 2.2842770  1.788602  0.0809
## Tabernaemontana.arborea -0.249725 0.1491192 -1.674667  0.1014
## Trattinnickia.aspera     1.349323 0.7147412  1.887848  0.0660
## Xylopia.macrantha        0.548832 0.1468772  3.736672  0.0006
##
##  Correlation:
##                         (Intr) Crd.ls Hrtll. Pcrmn. Qss.mr Tbrnm. Trttn.
## Cordia.lasiocalyx       -0.618
## Hirtella.triandra       -0.212 -0.354
## Picramnia.latifolia      0.025 -0.019 -0.381
## Quassia.amara            0.163 -0.378  0.307 -0.302
## Tabernaemontana.arborea -0.708  0.245  0.163 -0.113  0.148
## Trattinnickia.aspera    -0.139  0.187 -0.311  0.308 -0.708 -0.144
## Xylopia.macrantha       -0.140 -0.125  0.156 -0.463  0.314  0.279 -0.294
##
## Standardized residuals:
##         Min          Q1         Med          Q3         Max
## -1.87708765 -0.42701500 -0.04032793  0.23615609  3.38768871
##
## Residual standard error: 4.539713
## Degrees of freedom: 50 total; 42 residual
```

```
summary(glm2.exp)
```

```
## Generalized least squares fit by REML
##   Model: Drypetes.standleyi ~ Cordia.lasiocalyx + Hirtella.triandra +      Picramnia.latifoli
a + Quassia.amara + Tabernaemontana.arborea +      Trattinnickia.aspera + Xylopia.macrantha
##   Data: all.dat
##        AIC      BIC    logLik
##   301.6062 318.9829 -140.8031
##
## Correlation Structure: Exponential spatial correlation
##  Formula: ~x + y
##  Parameter estimate(s):
##    range
## 480.0567
##
## Coefficients:
##                             Value Std.Error  t-value p-value
## (Intercept)             2.3485197  6.154919 0.381568  0.7047
## Cordia.lasiocalyx       0.1208390  0.179811 0.672033  0.5052
## Hirtella.triandra       0.0191759  0.098501 0.194677  0.8466
## Picramnia.latifolia     0.2014516  0.509196 0.395627  0.6944
## Quassia.amara           1.2792289  1.847570 0.692385  0.4925
## Tabernaemontana.arborea 0.0674943  0.133782 0.504511  0.6165
## Trattinnickia.aspera    1.8115374  0.525147 3.449582  0.0013
## Xylopia.macrantha       0.3388574  0.156874 2.160064  0.0365
##
##  Correlation:
##                         (Intr) Crd.ls Hrtll. Pcrmn. Qss.mr Tbrnm. Trttn.
## Cordia.lasiocalyx       -0.226
## Hirtella.triandra       -0.309 -0.022
## Picramnia.latifolia      0.045 -0.066 -0.369
## Quassia.amara           -0.059 -0.304  0.321 -0.142
## Tabernaemontana.arborea -0.240 -0.016  0.288 -0.221  0.112
## Trattinnickia.aspera    -0.069  0.168 -0.237  0.212 -0.633 -0.041
## Xylopia.macrantha       -0.056 -0.137 -0.063  0.109  0.290  0.102 -0.186
##
## Standardized residuals:
##        Min         Q1        Med         Q3        Max
## -1.0051632 -0.5235683 -0.3176178  0.2208753  2.3746027
##
## Residual standard error: 8.628464
## Degrees of freedom: 50 total; 42 residual
```

The exponential spacial error model also seemed to improve this model somewhat.

Model 1: only include a single species as a predictor variable

Model 2: include all of the species as predictor variables

Did including the spatial error term have a large impact on the coefficients of the model?

```
coef(summary(glm1))
```

```
##                   Value Std.Error  t-value      p-value
## (Intercept)   4.962810  1.030804 4.814503 1.511773e-05
## Quassia.amara 9.214876  2.304948 3.997867 2.194886e-04
```

```
coef(summary(glm1.exp))
```

```
##                   Value Std.Error   t-value    p-value
## (Intercept)   9.794547 13.486551 0.7262455 0.47121500
## Quassia.amara 3.763073  1.495159 2.5168384 0.01523603
```

For th model testing only one predictor variable, addition of the spacial error term appeared to have an effect on the intercept, however it improved the std error and t-value, and still indicates a significant relationship (p-value) although perhaps not as stong as before.

```
coef(summary(glm2))
```

```
##                             Value  Std.Error    t-value      p-value
## (Intercept)             -1.0517523 2.11753456 -0.4966872 0.6219995234
## Cordia.lasiocalyx        0.4289202 0.20393162  2.1032551 0.0414742065
## Hirtella.triandra        0.1222789 0.08026383  1.5234616 0.1351381124
## Picramnia.latifolia      0.6622595 0.63589053  1.0414677 0.3036166790
## Quassia.amara            4.0856614 2.28427702  1.7886015 0.0808936542
## Tabernaemontana.arborea -0.2497250 0.14911920 -1.6746671 0.1014312033
## Trattinnickia.aspera     1.3493226 0.71474122  1.8878478 0.0659680951
## Xylopia.macrantha        0.5488320 0.14687723  3.7366715 0.0005567007
```

```
coef(summary(glm2.exp))
```

```
##                             Value  Std.Error   t-value     p-value
## (Intercept)             2.34851969 6.15491875 0.3815679 0.704705521
## Cordia.lasiocalyx       0.12083904 0.17981117 0.6720330 0.505242933
## Hirtella.triandra       0.01917586 0.09850099 0.1946768 0.846584598
## Picramnia.latifolia     0.20145161 0.50919625 0.3956267 0.694382984
## Quassia.amara           1.27922893 1.84756977 0.6923846 0.492506385
## Tabernaemontana.arborea 0.06749426 0.13378153 0.5045110 0.616539081
## Trattinnickia.aspera    1.81153745 0.52514691 3.4495822 0.001290775
## Xylopia.macrantha       0.33885742 0.15687377 2.1600643 0.036522530
```

In the model testing multiple species effects, we see some changes in the coefficients indicating far fewer species have a significat effect on the response variable.

Did including the spatial error terms significantly improve model fit (use function anova to carry out model comparison)?

Yes, p-values indicated significance. Including the spacial error terms did improve the model fit.

Explain why you did or did not observe a difference in the influence of adding the spatial error term between the two models.

Adding the spacial error term had an influence on the model, indicating that spacial dependance should be taken into consideration when building a model to predict the abundance of Drypetes standleyi. In this case, the model improved, indicating that the addition of a spacial error term fitted the model closer to the algorithm matching the relationship between the possible predictor variables in the dataset for D. standleyi abundance. In otherwords, it improved the model because spacial dependance likely has an effect on the abundance of Drypetes standleyi.