Main Project Analysis Part 1

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Introduction

In this RMarkdown document I will be doing the analysis of the "Full Rabbit Dataset.csv" constituting the main focus of the project. This data set contains point occurrence counts of invasive European rabbits (*Oryctolagus cuniculus*) in Australia. These point counts were collated from various direct and indirect studies as well as citizen science observations during the time frame 1760 to 2015 and form part of the long term rabbit data set (*Roy-Dufresne et al 2019*). The data set also contained a suit of environmental variables as well as the presence-absence data from the "Species Pseudoabsence Generation.Rmd" document. Finally, various abundance estimates were derived from the data provided by the data base and from the "Estimating Rabbit Abundance.Rmd" document.

Variable names:

- **Occurrence.ID**: unique data identifier, numeric
- **Lat**: decimal latitude, numeric
- **Long**: decimal longitude, numeric
- **Occurrences**: number of rabbit occurrences for a given sampling unit, integer
- **Abund1**: estimated rabbit abundance from "Estimating Rabbit Abundance.Rmd", numeric
- **Abund2**: estimated rabbit abundance from the "S12_DataAbundance" file in "European Rabbit Dataset.zip", numeric
- **Abund3**: estimated rabbit abundance derived from **Occurrences** and **No.of.10km.cells**, numeric
- **Year**: year the observations were recorded, integer/numeric
- **Day**: day of the year the observations were recorded, integer/numeric
- **A__Prec__Avg30Yr**: 30 year average of average precipitation, numeric
- **A__Psea__Avg30Yr**: 30 year average of average precipitation seasonality, numeric
- **A__TAvg__Avg30Yr**: 30 year average of average temperature, numeric
- **A__TMax__Avg30Yr**: 30 year average of average maximum temperature, numeric
- **A__TMin__Avg30Yr**: 30 year average of average minimum temperature, numeric
- **A__TSea__Avg30Yr**: 30 year average of average temperature seasonality, numeric
- **A__TWet__Avg30Yr**: 30 year average of average temperature in the wettest quarter of the year, numeric
- **A__TWrm__Avg30Yr**: 30 year average of average temperature in the warmest quarter of the year, numeric
- **A__Prec__AvgAutumn30Yr**: 30 year average of average precipitation in Autumn, numeric
- **A__Prec__AvgSummer30Yr**: 30 year average of average precipitation in Summer, numeric
- **A__Prec__AvgSpring30Yr**: 30 year average of average precipitation in Spring, numeric
- **A__Prec__AvgWinter30Yr**: 30 year average of average precipitation in Winter, numeric
- **DistPermWater**: euclidean distance in metres to the nearest permanent water feature, numeric
- **DistAgriLand**: euclidean distance in metres to the nearest agricultural land margins, numeric
- **PercSoilClay**: the percentage of estimated clay in the soil, numeric
- **MinDayLength**: minimum day length in hours, numeric
- **VarDayLength**: variation in day length in hours, numeric

- **VegeType**: vegetation type, factor with 13 levels
- **Season**: meterological season according to the Australian calendar, factor with 4 levels
- **Month**: month of the year, factor with 12 levels
- **Diseases**: the number of introduced diseases as biological control for rabbits in a given year, factor with 4 levels
- **Red.Fox**: presence/absence of red foxes, factor with 2 levels
- **Dingo**: presence/absence of dingoes , factor with 2 levels
- **Feral.Cat**: presence/absence of feral cats, factor with 2 levels
- **Whistling.Kite**: presence/absence of whistling kites, factor with 2 levels
- **Wallaby.Sp** :presence/absence of a wallaby species, factor with 2 levels

The 13 vegetation types were a re-classification of all the vegetation types in Australia as described by the Environment Department of the Australian Government classification scheme and the original classes can be found at "https://www.awe.gov.au/agriculture-land/land/native-vegetation/national-vegetation-information-system/data-products". The re-classifications used in the data set are found below:

- 1 = Rainforest and vine thickets
- 2 = Eucalyptus forest
- 3 = Eucalyptus woodland
- 4 = Woodlands
- 5 = Seasonal inundated swamps, salt marches and mangroves
- 6 = Low closed forests and tall closed shrublands
- 7 = Shrublands
- 8 = Tussock grasslands
- 9 = Hummock grasslands
- 10 = Saltbushes
- 11 = Cleared vegetation, naturally bare
- 12 = Water
- 13 = Unclassified/Unknown/Other

The factor levels in **Disease** are coded 0-3 with what each number corresponds to below:

- 0 = no diseases introduced as biological control
- 1 = only myxomatosis is the introduced disease
- 2 = myxomatosis and rabbit hemorrhagic disease virus 1 (RHDV1) are the only introduced diseases
- 3 = myxomatosis, RHDV1 and RHDV2 are the only introduced diseases

As **Season** is coded according to the Australian calender the numeric coding of 1-4 represents different seasons than would be the case for a Northern hemisphere nation:

- 1 = Summer
- 2 = Autumn
- 3 = Winter
- 4 = Spring

The state variable refers to the 8 states/territories of Australia coded with their 2/3-letter coding with the full names of each state/territory given below:

- ACT = Australian Capital Territory
- NSW = New South Wales
- NT = Northern Territory
- QLD = Queensland

- SA = South Australia
- TAS = Tasmania
- VIC = Victoria
- Western Australia

Finally, in all the animal presence/absence factors 1 represents presences and 0 represents absences.

The aim of the project is to determine the drivers of rabbit occurrence patterns, given the variables in the data set, at different spatial scales and compare the variables that are in each final model. The scales will be on the country scale, state/territory scale and transect scale. The transect scale will consist of random transects sampled from the data on a North-South axis and a East-West axis.

R Environment Set Up and Importing the Data

I will start by loading the R packages that I will be using for this analysis.

```
library(mgcv)
```

```
## Loading required package: nlme
```

```
## This is mgcv 1.8-36. For overview type 'help("mgcv-package")'.
```

```
library(ggplot2)
library(ggcleveland)
```

```
## Warning: package 'ggcleveland' was built under R version 4.1.2
```

```
library(GGally)
```

```
## Registered S3 method overwritten by 'GGally':
##   method from
##   +.gg   ggplot2
```

```
library(patchwork)
library(tidyverse)
```

```
## Warning: package 'tidyverse' was built under R version 4.1.2
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.1 --
```

```
## v tibble  3.1.6     v dplyr   1.0.7
## v tidyr   1.1.4     v stringr 1.4.0
## v readr   2.1.1     v forcats 0.5.1
## v purrr   0.3.4
```

```
## Warning: package 'tibble' was built under R version 4.1.2
```

```
## Warning: package 'readr' was built under R version 4.1.2
```

```
## -- Conflicts ---------------------------------------- tidyverse_conflicts() --
## x dplyr::collapse() masks nlme::collapse()
## x dplyr::filter()   masks stats::filter()
## x dplyr::lag()      masks stats::lag()
```

```
library(effects)
```

```
## Warning: package 'effects' was built under R version 4.1.2
```

```
## Loading required package: carData
```

```
## Warning: package 'carData' was built under R version 4.1.2
```

```
## lattice theme set by effectsTheme()
## See ?effectsTheme for details.
```

```
library(AICcmodavg)
```

```
## Warning: package 'AICcmodavg' was built under R version 4.1.2
```

```
library(emmeans)
```

```
## Warning: package 'emmeans' was built under R version 4.1.2
```

```
##
## Attaching package: 'emmeans'
```

```
## The following object is masked from 'package:GGally':
##
##     pigs
```

```
library(car)
```

```
## Warning: package 'car' was built under R version 4.1.2
```

```
##
## Attaching package: 'car'
```

```
## The following object is masked from 'package:dplyr':
##
##     recode
```

```
## The following object is masked from 'package:purrr':
##
##     some
```

There are also some custom functions that I want to create that will be helpful for graphical data analysis and plotting with **ggplot2**

```
#Augmented pairs plot
panel.hist = function(x, ...) {
  usr = par("usr"); on.exit(par(usr))
  par(usr = c(usr[1:2], 0, 2.5))
  hist(x, freq = FALSE, col="cyan", add=TRUE)
  lines(density(x))
}
panel.cor = function(x, y, digits = 2, prefix = "", cex.cor, ...){
  usr = par("usr"); on.exit(par(usr))
  par(usr = c(0, 1, 0, 1))
  r = abs(cor(x, y))
  txt = format(c(r, 0.123456789), digits = digits)[1]
  txt = paste0(prefix, txt)
  if(missing(cex.cor)) cex.cor <- 0.8/strwidth(txt)
  text(0.5, 0.5, txt, cex = cex.cor * r)
}
pairs2 = function (x) {
  pairs(x, lower.panel = panel.smooth, upper.panel = panel.cor, diag.panel = panel.hist)
}

#Co-plot panel function
coplot.ablines = function(x, y, ...){
  tmp = lm(y ~ x, na.action = na.omit)
  abline(tmp)
  points(x, y)
}

#Custom ggplot theme
theme_customized = function(base_size = 13, base_family = "", base_line_size = base_size/22, base_rect_
  theme(
    axis.title = element_text(size = 13),
    axis.text.x = element_text(size = 10),
    axis.text.y = element_text(size = 10),
    plot.caption = element_text(size = 10, face = "italic"),
    panel.background = element_rect(fill = "white"),
    axis.line = element_line(size = 1, colour = "black"),
    strip.background = element_rect(fill = "#cddcdd"),
    panel.border = element_rect(colour = "black", fill = NA, size = 0.5),
    strip.text = element_text(colour = "black"),
    legend.key = element_blank()
  )
}
```

I would also like to note that the custom R functions above were provided to me during statistics courses run by Dr Alex Douglas and Dr Thomas Cornulier at the University of Aberdeen.

Now lets finally import the data

```
Rabbit = read.table("E:/Masters Project/BI5002 (Masters Project)/Invasive European Rabbit Data/Full Rabb
                    header = TRUE, stringsAsFactors = TRUE, sep = ",")
str(Rabbit)
```

```
## 'data.frame':    689265 obs. of  37 variables:
##  $ Occurrence_ID       : int  683808 683809 684986 684987 684988 686921 686922 686923 686924 686925
```

```
##  $ Lat                : num  -37.1 -38.4 -36.8 -36.5 -36.6 ...
##  $ Long               : num  148 145 147 145 147 ...
##  $ Occurences         : int  33 24 5 2 7 159 7 57 57 111 ...
##  $ Abund.1            : int  33 24 5 2 7 159 7 57 57 111 ...
##  $ Abund.2            : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ Abund.3            : num  5.14e-04 3.74e-04 7.78e-05 3.11e-05 1.09e-04 ...
##  $ No.of.10km.cells   : int  6425 6425 6425 6425 6425 6425 6425 6425 6425 6425 ...
##  $ Year               : int  1760 1760 1760 1760 1760 1760 1760 1760 1760 1760 ...
##  $ Day                : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_Prec_Avg30Yr     : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_Psea_Avg30Yr     : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_TAvg_Avg30Yr     : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_TMax_Avg30Yr     : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_TMin_Avg30Yr     : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_TSea_Avg30Yr     : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_TWet_Avg30Yr     : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_TWrm_Avg30Yr     : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_Prec_AvgAutumn30Yr: num  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_Prec_AvgSummer30Yr: num  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_Prec_AvgSpring30Yr: num  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_Prec_AvgWinter30Yr: num  NA NA NA NA NA NA NA NA NA NA ...
##  $ DistPermWater      : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ DistAgriLand       : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ PercSoilClay       : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ MinDayLength       : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ VarDayLength       : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ State              : Factor w/ 8 levels "ACT","NSW","NT",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ VegeType           : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ Season             : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ Month              : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ Diseases           : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ Red.Fox            : int  1 1 1 1 1 1 0 0 0 0 ...
##  $ Dingo              : int  1 1 1 1 1 1 0 0 0 0 ...
##  $ Feral.Cat          : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ Whistling.Kite     : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ Wallaby.Sp         : int  1 1 1 1 1 1 1 1 1 1 ...
```

```
head(Rabbit, n = 10)
```

```
##    Occurrence_ID    Lat   Long Occurences Abund.1 Abund.2     Abund.3
## 1         683808 -37.15 148.25         33      33      NA 0.000513619
## 2         683809 -38.35 145.35         24      24      NA 0.000373541
## 3         684986 -36.75 146.65          5       5      NA 0.000077800
## 4         684987 -36.45 145.05          2       2      NA 0.000031100
## 5         684988 -36.65 146.65          7       7      NA 0.000108949
## 6         686921 -37.95 145.15        159     159      NA 0.002474708
## 7         686922 -37.95 145.55          7       7      NA 0.000108949
## 8         686923 -37.85 145.35         57      57      NA 0.000887160
## 9         686924 -38.15 145.25         57      57      NA 0.000887160
## 10        686925 -37.65 145.15        111     111      NA 0.001727626
##    No.of.10km.cells Year Day A_Prec_Avg30Yr A_Psea_Avg30Yr A_TAvg_Avg30Yr
## 1              6425 1760  NA             NA             NA             NA
## 2              6425 1760  NA             NA             NA             NA
## 3              6425 1760  NA             NA             NA             NA
```

```
## 4              6425 1760  NA             NA             NA             NA
## 5              6425 1760  NA             NA             NA             NA
## 6              6425 1760  NA             NA             NA             NA
## 7              6425 1760  NA             NA             NA             NA
## 8              6425 1760  NA             NA             NA             NA
## 9              6425 1760  NA             NA             NA             NA
## 10             6425 1760  NA             NA             NA             NA
##    A_TMax_Avg30Yr A_TMin_Avg30Yr A_TSea_Avg30Yr A_TWet_Avg30Yr A_TWrm_Avg30Yr
## 1              NA             NA             NA             NA             NA
## 2              NA             NA             NA             NA             NA
## 3              NA             NA             NA             NA             NA
## 4              NA             NA             NA             NA             NA
## 5              NA             NA             NA             NA             NA
## 6              NA             NA             NA             NA             NA
## 7              NA             NA             NA             NA             NA
## 8              NA             NA             NA             NA             NA
## 9              NA             NA             NA             NA             NA
## 10             NA             NA             NA             NA             NA
##    A_Prec_AvgAutumn30Yr A_Prec_AvgSummer30Yr A_Prec_AvgSpring30Yr
## 1                    NA                   NA                   NA
## 2                    NA                   NA                   NA
## 3                    NA                   NA                   NA
## 4                    NA                   NA                   NA
## 5                    NA                   NA                   NA
## 6                    NA                   NA                   NA
## 7                    NA                   NA                   NA
## 8                    NA                   NA                   NA
## 9                    NA                   NA                   NA
## 10                   NA                   NA                   NA
##    A_Prec_AvgWinter30Yr DistPermWater DistAgriLand PercSoilClay MinDayLength
## 1                    NA            NA           NA           NA           NA
## 2                    NA            NA           NA           NA           NA
## 3                    NA            NA           NA           NA           NA
## 4                    NA            NA           NA           NA           NA
## 5                    NA            NA           NA           NA           NA
## 6                    NA            NA           NA           NA           NA
## 7                    NA            NA           NA           NA           NA
## 8                    NA            NA           NA           NA           NA
## 9                    NA            NA           NA           NA           NA
## 10                   NA            NA           NA           NA           NA
##    VarDayLength State VegeType Season Month Diseases Red.Fox Dingo Feral.Cat
## 1            NA   ACT       NA      1     1        0       1     1         1
## 2            NA   ACT       NA      1     1        0       1     1         1
## 3            NA   ACT       NA      1     1        0       1     1         1
## 4            NA   ACT       NA      1     1        0       1     1         1
## 5            NA   ACT       NA      1     1        0       1     1         1
## 6            NA   ACT       NA      1     1        0       1     1         1
## 7            NA   ACT       NA      1     1        0       0     0         1
## 8            NA   ACT       NA      1     1        0       0     0         1
## 9            NA   ACT       NA      1     1        0       0     0         1
## 10           NA   ACT       NA      1     1        0       0     0         1
##    Whistling.Kite Wallaby.Sp
## 1               1          1
## 2               1          1
```

```
## 3               1          1
## 4               1          1
## 5               1          1
## 6               1          1
## 7               1          1
## 8               1          1
## 9               1          1
## 10              1          1
```

```
tail(Rabbit, n = 10)
```

```
##        Occurrence_ID    Lat   Long Occurences Abund.1 Abund.2     Abund.3
## 689256        682523 -23.85 134.45          2      NA      NA 0.000031100
## 689257        682524 -25.05 129.35          2      NA      NA 0.000031100
## 689258        682525 -23.25 133.65          4      NA      NA 0.000062300
## 689259        682526 -23.65 133.85         24      NA      NA 0.000373541
## 689260        682527 -22.55 137.05         10      NA      NA 0.000155642
## 689261        682528 -22.55 137.05         10      NA      NA 0.000155642
## 689262        682529 -22.55 137.05         10      NA      NA 0.000155642
## 689263        682530 -22.55 137.05         10      NA      NA 0.000155642
## 689264        682531 -22.55 137.05         10      NA      NA 0.000155642
## 689265        682532 -12.55 131.35          2      NA      NA 0.000031100
##        No.of.10km.cells Year Day A_Prec_Avg30Yr A_Psea_Avg30Yr A_TAvg_Avg30Yr
## 689256             6425   NA  NA             NA             NA             NA
## 689257             6425   NA  NA             NA             NA             NA
## 689258             6425   NA  NA             NA             NA             NA
## 689259             6425   NA  NA             NA             NA             NA
## 689260             6425   NA  NA             NA             NA             NA
## 689261             6425   NA  NA             NA             NA             NA
## 689262             6425   NA  NA             NA             NA             NA
## 689263             6425   NA  NA             NA             NA             NA
## 689264             6425   NA  NA             NA             NA             NA
## 689265             6425   NA  NA             NA             NA             NA
##        A_TMax_Avg30Yr A_TMin_Avg30Yr A_TSea_Avg30Yr A_TWet_Avg30Yr
## 689256             NA             NA             NA             NA
## 689257             NA             NA             NA             NA
## 689258             NA             NA             NA             NA
## 689259             NA             NA             NA             NA
## 689260             NA             NA             NA             NA
## 689261             NA             NA             NA             NA
## 689262             NA             NA             NA             NA
## 689263             NA             NA             NA             NA
## 689264             NA             NA             NA             NA
## 689265             NA             NA             NA             NA
##        A_TWrm_Avg30Yr A_Prec_AvgAutumn30Yr A_Prec_AvgSummer30Yr
## 689256             NA                   NA                   NA
## 689257             NA                   NA                   NA
## 689258             NA                   NA                   NA
## 689259             NA                   NA                   NA
## 689260             NA                   NA                   NA
## 689261             NA                   NA                   NA
## 689262             NA                   NA                   NA
## 689263             NA                   NA                   NA
## 689264             NA                   NA                   NA
```

```
## 689265             NA                   NA                   NA
##        A_Prec_AvgSpring30Yr A_Prec_AvgWinter30Yr DistPermWater DistAgriLand
## 689256                   NA                   NA          5.78       569.24
## 689257                   NA                   NA         33.59       783.73
## 689258                   NA                   NA          7.63       532.17
## 689259                   NA                   NA          2.98       566.36
## 689260                   NA                   NA         10.97       295.79
## 689261                   NA                   NA         10.97       295.79
## 689262                   NA                   NA         10.97       295.79
## 689263                   NA                   NA         10.97       295.79
## 689264                   NA                   NA         10.97       295.79
## 689265                   NA                   NA          1.45         3.03
##        PercSoilClay MinDayLength VarDayLength State VegeType Season Month
## 689256         5.03        10.66         1.04    WA        7     NA    NA
## 689257         7.51        10.58         1.16    WA        8     NA    NA
## 689258        34.24        10.70         0.98    WA        7     NA    NA
## 689259         6.06        10.67         1.02    WA        7     NA    NA
## 689260        24.32        10.75         0.91    WA        9     NA    NA
## 689261        24.32        10.75         0.91    WA        9     NA    NA
## 689262        24.32        10.75         0.91    WA        9     NA    NA
## 689263        24.32        10.75         0.91    WA        9     NA    NA
## 689264        24.32        10.75         0.91    WA        9     NA    NA
## 689265        43.30        11.39         0.26    WA        5     NA    NA
##        Diseases Red.Fox Dingo Feral.Cat Whistling.Kite Wallaby.Sp
## 689256       NA      NA    NA        NA             NA         NA
## 689257       NA      NA    NA        NA             NA         NA
## 689258       NA      NA    NA        NA             NA         NA
## 689259       NA      NA    NA        NA             NA         NA
## 689260       NA      NA    NA        NA             NA         NA
## 689261       NA      NA    NA        NA             NA         NA
## 689262       NA      NA    NA        NA             NA         NA
## 689263       NA      NA    NA        NA             NA         NA
## 689264       NA      NA    NA        NA             NA         NA
## 689265       NA      NA    NA        NA             NA         NA
```

The factors have not been coded as factors, as such I will need to factorise them but everything else looks okay with the data frame.

```
#Factorise the factor
Rabbit$VegeType = factor(Rabbit$VegeType)
Rabbit$Season = factor(Rabbit$Season)
Rabbit$Month = factor(Rabbit$Month, levels = c("1", "2", "3", "4", "5", "6", "7", "8", "9", "10", "11",
Rabbit$Diseases = factor(Rabbit$Diseases)
Rabbit$Red.Fox = factor(Rabbit$Red.Fox)
Rabbit$Dingo = factor(Rabbit$Dingo)
Rabbit$Feral.Cat = factor(Rabbit$Feral.Cat)
Rabbit$Whistling.Kite = factor(Rabbit$Whistling.Kite)
Rabbit$Wallaby.Sp = factor(Rabbit$Wallaby.Sp)

#Re-check the data set
str(Rabbit)
```

```
## 'data.frame':    689265 obs. of  37 variables:
##  $ Occurrence_ID       : int  683808 683809 684986 684987 684988 686921 686922 686923 686924 686925
```

```
##  $ Lat                : num  -37.1 -38.4 -36.8 -36.5 -36.6 ...
##  $ Long               : num  148 145 147 145 147 ...
##  $ Occurences         : int  33 24 5 2 7 159 7 57 57 111 ...
##  $ Abund.1            : int  33 24 5 2 7 159 7 57 57 111 ...
##  $ Abund.2            : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ Abund.3            : num  5.14e-04 3.74e-04 7.78e-05 3.11e-05 1.09e-04 ...
##  $ No.of.10km.cells   : int  6425 6425 6425 6425 6425 6425 6425 6425 6425 6425 ...
##  $ Year               : int  1760 1760 1760 1760 1760 1760 1760 1760 1760 1760 ...
##  $ Day                : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_Prec_Avg30Yr     : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_Psea_Avg30Yr     : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_TAvg_Avg30Yr     : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_TMax_Avg30Yr     : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_TMin_Avg30Yr     : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_TSea_Avg30Yr     : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_TWet_Avg30Yr     : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_TWrm_Avg30Yr     : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_Prec_AvgAutumn30Yr: num  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_Prec_AvgSummer30Yr: num  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_Prec_AvgSpring30Yr: num  NA NA NA NA NA NA NA NA NA NA ...
##  $ A_Prec_AvgWinter30Yr: num  NA NA NA NA NA NA NA NA NA NA ...
##  $ DistPermWater      : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ DistAgriLand       : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ PercSoilClay       : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ MinDayLength       : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ VarDayLength       : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ State              : Factor w/ 8 levels "ACT","NSW","NT",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ VegeType           : Factor w/ 13 levels "1","2","3","4",..: NA NA NA NA NA NA NA NA NA NA ...
##  $ Season             : Factor w/ 4 levels "1","2","3","4": 1 1 1 1 1 1 1 1 1 1 ...
##  $ Month              : Factor w/ 12 levels "1","2","3","4",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ Diseases           : Factor w/ 4 levels "0","1","2","3": 1 1 1 1 1 1 1 1 1 1 ...
##  $ Red.Fox            : Factor w/ 2 levels "0","1": 2 2 2 2 2 2 1 1 1 1 ...
##  $ Dingo              : Factor w/ 2 levels "0","1": 2 2 2 2 2 2 1 1 1 1 ...
##  $ Feral.Cat          : Factor w/ 2 levels "0","1": 2 2 2 2 2 2 2 2 2 2 ...
##  $ Whistling.Kite     : Factor w/ 2 levels "0","1": 2 2 2 2 2 2 2 2 2 2 ...
##  $ Wallaby.Sp         : Factor w/ 2 levels "0","1": 2 2 2 2 2 2 2 2 2 2 ...
```

```
summary(Rabbit)
```

```
##  Occurrence_ID         Lat              Long         Occurences
##  Min.   :     1   Min.   :-43.49   Min.   :113.0   Min.   :     1
##  1st Qu.:172317   1st Qu.:-34.15   1st Qu.:139.1   1st Qu.:  5779
##  Median :344633   Median :-34.15   Median :139.2   Median : 45089
##  Mean   :344634   Mean   :-34.02   Mean   :140.1   Mean   : 44618
##  3rd Qu.:516949   3rd Qu.:-33.25   3rd Qu.:139.4   3rd Qu.: 69866
##  Max.   :689285   Max.   :-12.35   Max.   :153.7   Max.   :104045
##
##     Abund.1          Abund.2          Abund.3       No.of.10km.cells
##  Min.   :     1   Min.   :  0.0    Min.   :   0.0   Min.   :   1.0
##  1st Qu.:  8072   1st Qu.:  0.0    1st Qu.: 216.7   1st Qu.:   2.0
##  Median : 45089   Median :  1.0    Median :2254.4   Median :   2.0
##  Mean   : 45553   Mean   :  7.0    Mean   :2202.2   Mean   : 444.2
##  3rd Qu.: 69866   3rd Qu.:  6.0    3rd Qu.:3493.3   3rd Qu.:   2.0
##  Max.   :104045   Max.   :546.7    Max.   :5202.2   Max.   :6425.0
```

```
##  NA's   :16774    NA's   :638089
##       Year            Day        A_Prec_Avg30Yr   A_Psea_Avg30Yr
##  Min.   :1760    Min.   : 1.00   Min.   : 135.5   Min.   :  9.73
##  1st Qu.:2007    1st Qu.: 9.00   1st Qu.: 262.6   1st Qu.: 23.40
##  Median :2009    Median :13.00   Median : 336.8   Median : 27.34
##  Mean   :2007    Mean   :16.06   Mean   : 379.9   Mean   : 29.87
##  3rd Qu.:2009    3rd Qu.:24.00   3rd Qu.: 423.0   3rd Qu.: 36.36
##  Max.   :2015    Max.   :31.00   Max.   :3270.0   Max.   :137.75
##  NA's   :16774   NA's   :70248   NA's   :39295    NA's   :39295
##  A_TAvg_Avg30Yr  A_TMax_Avg30Yr  A_TMin_Avg30Yr  A_TSea_Avg30Yr
##  Min.   : 4.83   Min.   :15.15   Min.   :-4.95   Min.   :158.7
##  1st Qu.:14.78   1st Qu.:29.55   1st Qu.: 3.04   1st Qu.:472.2
##  Median :15.66   Median :30.38   Median : 4.13   Median :478.1
##  Mean   :15.52   Mean   :30.28   Mean   : 3.83   Mean   :491.1
##  3rd Qu.:16.14   3rd Qu.:31.36   3rd Qu.: 4.61   3rd Qu.:527.7
##  Max.   :28.21   Max.   :41.84   Max.   :18.46   Max.   :676.2
##  NA's   :39295   NA's   :39295   NA's   :39295   NA's   :39295
##  A_TWet_Avg30Yr  A_TWrm_Avg30Yr  A_Prec_AvgAutumn30Yr A_Prec_AvgSummer30Yr
##  Min.   : 1.06   Min.   : 9.80   Min.   :  8.11       Min.   :  5.31
##  1st Qu.: 9.82   1st Qu.:20.88   1st Qu.: 18.71       1st Qu.: 22.25
##  Median :12.01   Median :21.69   Median : 22.84       Median : 23.52
##  Mean   :12.24   Mean   :21.66   Mean   : 26.84       Mean   : 27.84
##  3rd Qu.:13.72   3rd Qu.:22.36   3rd Qu.: 29.75       3rd Qu.: 24.23
##  Max.   :32.50   Max.   :33.11   Max.   :447.45       Max.   :474.84
##  NA's   :39295   NA's   :39295   NA's   :39295        NA's   :39295
##  A_Prec_AvgSpring30Yr A_Prec_AvgWinter30Yr DistPermWater      DistAgriLand
##  Min.   :  0.85       Min.   :  1.23       Min.   :  0.000   Min.   :  0.00
##  1st Qu.: 27.68       1st Qu.: 24.45       1st Qu.:  1.780   1st Qu.:  1.57
##  Median : 32.78       Median : 35.97       Median :  3.360   Median :  6.76
##  Mean   : 37.35       Mean   : 38.33       Mean   :  3.897   Mean   : 21.99
##  3rd Qu.: 42.73       3rd Qu.: 48.52       3rd Qu.:  4.010   3rd Qu.: 20.24
##  Max.   :251.57       Max.   :286.80       Max.   :170.370   Max.   :915.02
##  NA's   :39295        NA's   :39295        NA's   :1073      NA's   :1073
##   PercSoilClay    MinDayLength     VarDayLength       State
##  Min.   : 5.00   Min.   : 8.950   Min.   :0.250   QLD    :543602
##  1st Qu.:20.90   1st Qu.: 9.870   1st Qu.:2.310   VIC    :105780
##  Median :28.10   Median : 9.870   Median :2.480   WA     : 18385
##  Mean   :25.29   Mean   : 9.878   Mean   :2.478   ACT    :  8644
##  3rd Qu.:29.99   3rd Qu.: 9.950   3rd Qu.:2.480   SA     :  6394
##  Max.   :57.55   Max.   :11.400   Max.   :4.940   NT     :  3498
##  NA's   :1078    NA's   :1047     NA's   :1047    (Other):  2962
##     VegeType       Season           Month        Diseases      Red.Fox
##  11     :413419   1   :142960   4      :155686   0   :   278   0   :   121
##  10     :113955   2   :289616   3      :113069   1   : 26021   1   : 66993
##  3      :113598   3   :160038   7      :110078   2   :643287   NA's:622151
##  4      : 13507   4   : 69582   1      : 92315   3   :  2905
##  2      : 11864   NA's: 27069   2      : 39119   NA's: 16774
##  (Other): 21795                (Other):151929
##  NA's   :  1127                NA's   : 27069
##   Dingo        Feral.Cat     Whistling.Kite Wallaby.Sp
##  0   :   121   0   :   121   0   :   121    0   :   121
##  1   : 13871   1   : 13816   1   :144911    1   : 73930
##  NA's:675273   NA's:675328   NA's:544233    NA's:615214
##
```

```
##
##
##
```

In order to look at the drivers of rabbit occurrences at different scales I need to sub set the data to make new data frames based on these scales. First I will create a subset data frame for each Australian state/territory. I will then name each data frame "Rabbit_state/territory"

```
Rabbit_ACT = Rabbit[Rabbit$State == "ACT", ]
Rabbit_NSW = Rabbit[Rabbit$State == "NSW", ]
Rabbit_NT = Rabbit[Rabbit$State == "NT", ]
Rabbit_QLD = Rabbit[Rabbit$State == "QLD", ]
Rabbit_SA = Rabbit[Rabbit$State == "SA", ]
Rabbit_TAS = Rabbit[Rabbit$State == "TAS", ]
Rabbit_VIC = Rabbit[Rabbit$State == "VIC", ]
Rabbit_WA = Rabbit[Rabbit$State == "WA", ]
```

A point of note to myself, the Tasmania data set only has 365 observations whilst the other 7 data sets have thousands of observations. This may limit the number of parameters that can be potentially fitted to statistical models for the Tasmania given the number of potential predictors, whereas there should not be any such limitations for the other state/ territory specific data sets.

Creating the transect-scale data sets will be more tricky. To create the North-South transects I need to randomly sample longitudes given a fixed latitude and to create the East-West transects I need to randomly sample latitudes given a fixed longitude. To create transects of equal sizes the fixed longitudes and fixed latitudes can be within a range that corresponds to a set physical distance measured in metres.

First, some starting longitudes and latitudes to make the transects from.

```
#Most Northern and Southern Points
Long_max = max(Rabbit$Long, na.rm = TRUE)
Long_min = min(Rabbit$Long, na.rm = TRUE)
Long_max
```

```
## [1] 153.65
```

```
Long_min
```

```
## [1] 113.05
```

```
#Most Eastern and Western Points
Lat_min = min(Rabbit$Lat, na.rm = TRUE)
Lat_max = max(Rabbit$Lat, na.rm = TRUE)
Lat_min
```

```
## [1] -43.49
```

```
Lat_max
```

```
## [1] -12.35
```

As there is only a difference of approximately 40 units between **Long_max** and **Long_min** I will make 8 North-South transects with a difference in longitude of approximately 5 units. As for latitude there is only a difference of approximately 32 units between **Lat_max** and **Lat_min**, as such I will make 6 East-West transects with a difference in latitude of approximately 5 units.

Now we can make the transect-level data sets.

```
#North-South Transects
NS1 = Rabbit[Rabbit$Long == 153.65, ]
NS2 = Rabbit[Rabbit$Long == 153.65 - 5.00, ]
NS3 = Rabbit[Rabbit$Long == 153.65 - 10.00, ]
NS4 = Rabbit[Rabbit$Long == 153.65 - 15.00, ]
NS5 = Rabbit[Rabbit$Long == 153.65 - 20.00, ]
NS6 = Rabbit[Rabbit$Long == 153.65 - 25.00, ]
NS7 = Rabbit[Rabbit$Long == 153.65 - 30.00, ]
NS8 = Rabbit[Rabbit$Long == 153.65 - 35.00, ]
NS9 = Rabbit[Rabbit$Long == 113.05, ]

NS = rbind(NS1, NS2, NS3, NS4, NS5, NS6, NS7, NS8, NS9)
NS = as.data.frame(NS)

#East-West Transects
EW1 = Rabbit[Rabbit$Lat == -12.35, ]
EW2 = Rabbit[Rabbit$Lat == -12.35 - 5.00, ]
EW3 = Rabbit[Rabbit$Lat == -12.35 - 10.00, ]
EW4 = Rabbit[Rabbit$Lat == -12.35 - 15.00, ]
EW5 = Rabbit[Rabbit$Lat == -12.35 - 20.00, ]
EW6 = Rabbit[Rabbit$Lat == -12.35 - 25.00, ]
EW7 = Rabbit[Rabbit$Lat == -43.49, ]

EW = rbind(EW1, EW2, EW3, EW4, EW5, EW6, EW7)
EW = as.data.frame(EW)
```

The transects created about have variable sample sizes with **EW7** only having one observation, regardless we now need to add a **Transect** variable to **NS** and **EW**. Then I will check the data and remove the individual transect data sets to save memory.

```
#Add Transect Variables
x = factor(rep(c("a", "b", "c", "d", "e", "f", "g", "h", "i"),
               times = c(4, 272, 235, 1511, 282, 12, 7, 28, 2)))
y = factor(rep(c("a", "b", "c", "d", "e", "f", "g"),
               times = c(2, 17, 34, 97, 277, 6322, 1)))
NS$Transect = x
EW$Transect = y
str(NS)
```

```
## 'data.frame':    2353 obs. of  38 variables:
##  $ Occurrence_ID       : int  647256 676312 619050 619051 646031 679518 646475 646480 646484 659105
##  $ Lat                 : num  -28.6 -28.6 -28.8 -28.6 -35.6 ...
##  $ Long                : num  154 154 154 154 149 ...
##  $ Occurences          : int  3 3 1 3 8 8 18 6 8 3 ...
##  $ Abund.1             : int  3 3 1 3 8 8 18 6 8 3 ...
##  $ Abund.2             : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ Abund.3             : num  4.67e-05 4.67e-05 4.22e-05 1.27e-04 1.25e-04 ...
```

```
##  $ No.of.10km.cells    : int  6425 6425 2371 2371 6425 6425 6425 6425 6425 6425 ...
##  $ Year                : int  2008 2008 2011 2011 1964 1964 1974 1974 1974 1974 ...
##  $ Day                 : int  NA NA 4 7 NA NA NA NA NA NA ...
##  $ A_Prec_Avg30Yr      : num  1789 1789 1726 1789 NA ...
##  $ A_Psea_Avg30Yr      : num  39.1 39.1 38.4 39.1 NA ...
##  $ A_TAvg_Avg30Yr      : num  20.3 20.3 19.6 20.3 NA ...
##  $ A_TMax_Avg30Yr      : num  27.8 27.8 28.3 27.8 NA ...
##  $ A_TMin_Avg30Yr      : num  11.4 11.4 9.05 11.4 NA NA -3.41 -2.83 -2.58 -3.18 ...
##  $ A_TSea_Avg30Yr      : num  319 319 345 319 NA ...
##  $ A_TWet_Avg30Yr      : num  21.1 21.1 20.5 21.1 NA ...
##  $ A_TWrm_Avg30Yr      : num  24 24 23.6 24 NA ...
##  $ A_Prec_AvgAutumn30Yr: num  214 214 213 214 NA ...
##  $ A_Prec_AvgSummer30Yr: num  186 186 184 186 NA ...
##  $ A_Prec_AvgSpring30Yr: num  106 106 106 106 NA ...
##  $ A_Prec_AvgWinter30Yr: num  119 119 126 119 NA ...
##  $ DistPermWater       : num  1.08 1.08 0.67 1.08 NA NA 2.73 1.38 2.06 1.7 ...
##  $ DistAgriLand        : num  3.87 3.87 1.85 3.87 NA ...
##  $ PercSoilClay        : num  NA NA NA NA NA ...
##  $ MinDayLength        : num  10.3 10.3 10.3 10.3 NA ...
##  $ VarDayLength        : num  1.6 1.6 1.6 1.6 NA NA 2.82 2.8 2.78 2.86 ...
##  $ State               : Factor w/ 8 levels "ACT","NSW","NT",..: 4 4 7 7 1 1 1 1 1 1 ...
##  $ VegeType            : Factor w/ 13 levels "1","2","3","4",..: 11 11 11 11 NA NA 2 3 2 2 ...
##  $ Season              : Factor w/ 4 levels "1","2","3","4": 1 2 1 1 1 1 2 2 2 4 ...
##  $ Month               : Factor w/ 12 levels "1","2","3","4",..: 2 3 1 1 1 12 3 3 3 10 ...
##  $ Diseases            : Factor w/ 4 levels "0","1","2","3": 3 3 3 3 2 2 2 2 2 2 ...
##  $ Red.Fox             : Factor w/ 2 levels "0","1": NA NA NA NA 2 2 2 2 2 2 ...
##  $ Dingo               : Factor w/ 2 levels "0","1": NA NA NA NA 1 2 1 2 2 2 ...
##  $ Feral.Cat           : Factor w/ 2 levels "0","1": NA NA NA NA 2 2 2 2 2 2 ...
##  $ Whistling.Kite      : Factor w/ 2 levels "0","1": NA NA NA NA 2 2 2 2 2 2 ...
##  $ Wallaby.Sp          : Factor w/ 2 levels "0","1": NA NA NA NA 2 2 2 2 2 2 ...
##  $ Transect            : Factor w/ 9 levels "a","b","c","d",..: 1 1 1 1 2 2 2 2 2 2 ...
```

```
str(EW)
```

```
## 'data.frame':    6750 obs. of  38 variables:
##  $ Occurrence_ID       : int  656794 672615 624773 620875 618928 618929 618930 618931 618932 618955
##  $ Lat                 : num  -12.3 -12.3 -17.4 -17.4 -17.4 ...
##  $ Long                : num  131 131 145 145 146 ...
##  $ Occurences          : int  2 2 3 3 8 8 8 5 5 3 ...
##  $ Abund.1             : int  2 2 3 3 8 8 8 5 5 3 ...
##  $ Abund.2             : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ Abund.3             : num  3.11e-05 3.11e-05 2.65e-04 1.27e-04 3.37e-04 ...
##  $ No.of.10km.cells    : int  6425 6425 1132 2371 2371 2371 2371 2371 2371 2371 ...
##  $ Year                : int  2010 2010 1995 2009 2010 2010 2010 2010 2010 2011 ...
##  $ Day                 : int  NA NA 1 20 10 13 6 20 20 26 ...
##  $ A_Prec_Avg30Yr      : num  1747 1747 1104 1104 2736 ...
##  $ A_Psea_Avg30Yr      : num  112.3 112.3 88.6 88.6 67.1 ...
##  $ A_TAvg_Avg30Yr      : num  27.4 27.4 20 20 20.8 ...
##  $ A_TMax_Avg30Yr      : num  33.7 33.7 28.7 28.7 28.6 ...
##  $ A_TMin_Avg30Yr      : num  18.5 18.5 10.2 10.2 11.6 ...
##  $ A_TSea_Avg30Yr      : num  159 159 294 294 286 ...
##  $ A_TWet_Avg30Yr      : num  28.1 28.1 22.7 22.7 23.1 ...
##  $ A_TWrm_Avg30Yr      : num  29.1 29.1 23.2 23.2 23.9 ...
##  $ A_Prec_AvgAutumn30Yr: num  151.8 151.8 98.9 98.9 307.2 ...
```

```
##  $ A_Prec_AvgSummer30Yr: num  364 364 203 203 329 ...
##  $ A_Prec_AvgSpring30Yr: num  68.8 68.8 42.1 42.1 86.2 ...
##  $ A_Prec_AvgWinter30Yr: num  2.37 2.37 18.47 18.47 88.32 ...
##  $ DistPermWater       : num  1.44 1.44 1.73 1.73 1.25 1.25 1.25 1.11 1.11 1.73 ...
##  $ DistAgriLand        : num  7.21 7.21 10.65 10.65 2.81 ...
##  $ PercSoilClay        : num  20.3 20.3 29.4 29.4 50 ...
##  $ MinDayLength        : num  11.4 11.4 11.1 11.1 11.1 ...
##  $ VarDayLength        : num  0.25 0.25 0.52 0.52 0.52 0.52 0.52 0.52 0.52 0.52 ...
##  $ State               : Factor w/ 8 levels "ACT","NSW","NT",..: 7 7 4 7 7 7 7 7 7 7 ...
##  $ VegeType            : Factor w/ 13 levels "1","2","3","4",..: 11 11 3 3 11 11 11 11 11 3 ...
##  $ Season              : Factor w/ 4 levels "1","2","3","4": 4 4 4 4 4 4 4 4 4 1 ...
##  $ Month               : Factor w/ 12 levels "1","2","3","4",..: 10 10 9 10 9 9 10 10 10 1 ...
##  $ Diseases            : Factor w/ 4 levels "0","1","2","3": 3 3 3 3 3 3 3 3 3 3 ...
##  $ Red.Fox             : Factor w/ 2 levels "0","1": NA NA 2 NA NA NA NA NA NA NA ...
##  $ Dingo               : Factor w/ 2 levels "0","1": NA NA NA NA NA NA NA NA NA NA ...
##  $ Feral.Cat           : Factor w/ 2 levels "0","1": NA NA NA NA NA NA NA NA NA NA ...
##  $ Whistling.Kite      : Factor w/ 2 levels "0","1": NA NA 2 NA NA NA NA NA NA NA ...
##  $ Wallaby.Sp          : Factor w/ 2 levels "0","1": NA NA 2 NA NA NA NA NA NA NA ...
##  $ Transect            : Factor w/ 7 levels "a","b","c","d",..: 1 1 2 2 2 2 2 2 2 2 ...
```

```
#Check the Data
summary(NS)
```

```
##  Occurrence_ID         Lat              Long         Occurences
##  Min.   :    95   Min.   :-38.75   Min.   :113.0   Min.   :  1.0
##  1st Qu.: 53717   1st Qu.:-33.65   1st Qu.:138.7   1st Qu.: 14.0
##  Median :642512   Median :-31.35   Median :138.7   Median : 92.0
##  Mean   :468320   Mean   :-31.29   Mean   :139.4   Mean   :231.4
##  3rd Qu.:653628   3rd Qu.:-31.25   3rd Qu.:138.7   3rd Qu.:370.0
##  Max.   :689243   Max.   :-19.25   Max.   :153.7   Max.   :574.0
##
##     Abund.1          Abund.2          Abund.3         No.of.10km.cells
##  Min.   :  1.0   Min.   : 0.000   Min.   :0.000016   Min.   :   1
##  1st Qu.:  8.0   1st Qu.: 0.000   1st Qu.:0.000374   1st Qu.:  13
##  Median : 24.0   Median : 0.000   Median :0.468354   Median :  79
##  Mean   :124.1   Mean   : 2.834   Mean   :0.912715   Mean   :2344
##  3rd Qu.: 92.0   3rd Qu.: 2.000   3rd Qu.:1.738462   3rd Qu.:6425
##  Max.   :574.0   Max.   :46.000   Max.   :9.200000   Max.   :6425
##  NA's   :799     NA's   :1991
##       Year           Day         A_Prec_Avg30Yr   A_Psea_Avg30Yr
##  Min.   :1837   Min.   : 1.00   Min.   : 144.4   Min.   :12.32
##  1st Qu.:1993   1st Qu.: 9.00   1st Qu.: 241.0   1st Qu.:23.55
##  Median :2001   Median :13.00   Median : 326.1   Median :28.80
##  Mean   :1999   Mean   :15.23   Mean   : 419.1   Mean   :34.78
##  3rd Qu.:2007   3rd Qu.:21.00   3rd Qu.: 507.5   3rd Qu.:48.40
##  Max.   :2014   Max.   :31.00   Max.   :1788.9   Max.   :91.06
##  NA's   :799    NA's   :1680    NA's   :947      NA's   :947
##  A_TAvg_Avg30Yr  A_TMax_Avg30Yr  A_TMin_Avg30Yr   A_TSea_Avg30Yr
##  Min.   : 7.89   Min.   :21.50   Min.   :-3.410   Min.   :291.5
##  1st Qu.:14.84   1st Qu.:29.22   1st Qu.: 3.360   1st Qu.:505.2
##  Median :17.05   Median :32.16   Median : 3.680   Median :587.0
##  Mean   :17.47   Mean   :32.35   Mean   : 3.717   Mean   :565.1
##  3rd Qu.:21.23   3rd Qu.:36.92   3rd Qu.: 4.490   3rd Qu.:640.8
##  Max.   :25.44   Max.   :39.62   Max.   :12.430   Max.   :665.5
```

```
##  NA's   :947     NA's   :947     NA's   :947      NA's   :947
##  A_TWet_Avg30Yr  A_TWrm_Avg30Yr  A_Prec_AvgAutumn30Yr A_Prec_AvgSummer30Yr
##  Min.   : 3.33   Min.   :14.05   Min.   : 10.73       Min.   :  6.24
##  1st Qu.: 9.35   1st Qu.:20.72   1st Qu.: 19.36       1st Qu.: 27.24
##  Median :10.46   Median :23.91   Median : 22.46       Median : 28.11
##  Mean   :16.61   Mean   :24.32   Mean   : 31.44       Mean   : 35.32
##  3rd Qu.:27.82   3rd Qu.:28.77   3rd Qu.: 38.33       3rd Qu.: 34.24
##  Max.   :32.00   Max.   :32.00   Max.   :213.58       Max.   :309.07
##  NA's   :947     NA's   :947     NA's   :947          NA's   :947
##  A_Prec_AvgSpring30Yr A_Prec_AvgWinter30Yr DistPermWater     DistAgriLand
##  Min.   :  5.44       Min.   :  6.61       Min.   :  0.00   Min.   :  0.02
##  1st Qu.: 18.29       1st Qu.: 11.29       1st Qu.:  2.43   1st Qu.: 24.69
##  Median : 29.25       Median : 33.25       Median :  2.98   Median : 65.98
##  Mean   : 36.96       Mean   : 39.33       Mean   :  4.35   Mean   :154.93
##  3rd Qu.: 47.81       3rd Qu.: 42.75       3rd Qu.:  6.07   3rd Qu.: 76.26
##  Max.   :151.87       Max.   :199.60       Max.   :111.42   Max.   :870.94
##  NA's   :947          NA's   :947          NA's   :11       NA's   :11
##   PercSoilClay    MinDayLength    VarDayLength       State         VegeType
##  Min.   : 5.00   Min.   : 9.45   Min.   :0.650   QLD    :1067   4      :765
##  1st Qu.:20.14   1st Qu.: 9.92   1st Qu.:1.970   WA     : 799   8      :682
##  Median :29.86   Median :10.10   Median :1.990   VIC    : 270   11     :341
##  Mean   :26.09   Mean   :10.10   Mean   :2.039   ACT    : 187   2      :202
##  3rd Qu.:29.86   3rd Qu.:10.11   3rd Qu.:2.360   NT     :  16   9      :172
##  Max.   :50.00   Max.   :10.97   Max.   :3.500   NSW    :  14   (Other):180
##  NA's   :15      NA's   :11      NA's   :11      (Other):   0   NA's   : 11
##   Season        Month     Diseases    Red.Fox      Dingo      Feral.Cat
##  1   :369   11     :199   0   :   6   0   :   1   0   :   5   0   :   6
##  2   :370   7      :183   1   : 405   1   : 843   1   : 210   1   : 209
##  3   :355   4      :180   2   :1143   NA's:1509   NA's:2138   NA's:2138
##  4   :364   2      :170   3   :   0
##  NA's:895   1      :160   NA's: 799
##             (Other):566
##             NA's   :895
##  Whistling.Kite Wallaby.Sp     Transect
##  0   :   2      0   :   3   d      :1511
##  1   :1133      1   : 880   e      : 282
##  NA's:1218      NA's:1470   b      : 272
##                             c      : 235
##                             h      :  28
##                             f      :  12
##                             (Other):  13
```

```
summary(EW)
```

```
##  Occurrence_ID         Lat              Long         Occurences
##  Min.   :   133   Min.   :-43.49   Min.   :113.8   Min.   :   1
##  1st Qu.:  8187   1st Qu.:-37.35   1st Qu.:142.8   1st Qu.:5779
##  Median :575601   Median :-37.35   Median :142.8   Median :5779
##  Mean   :343227   Mean   :-36.87   Mean   :143.1   Mean   :4950
##  3rd Qu.:577288   3rd Qu.:-37.35   3rd Qu.:142.8   3rd Qu.:5779
##  Max.   :689173   Max.   :-12.35   Max.   :152.9   Max.   :5779
##
##     Abund.1        Abund.2           Abund.3          No.of.10km.cells
##  Min.   :   1   Min.   :  0.000   Min.   :  0.00002   Min.   :   2.0
```

```
##  1st Qu.:5779   1st Qu.:  0.000   1st Qu.: 30.41579   1st Qu.:   2.0
##  Median :5779   Median :  0.200   Median : 30.41579   Median :  19.0
##  Mean   :4955   Mean   :  8.316   Mean   :136.68868   Mean   : 792.4
##  3rd Qu.:5779   3rd Qu.:  6.000   3rd Qu.:288.95000   3rd Qu.:  19.0
##  Max.   :5779   Max.   :456.364   Max.   :288.95000   Max.   :6425.0
##  NA's   :7      NA's   :3033
##       Year           Day         A_Prec_Avg30Yr   A_Psea_Avg30Yr
##  Min.   :1760   Min.   : 1.00   Min.   : 154.3   Min.   : 12.59
##  1st Qu.:2001   1st Qu.: 9.00   1st Qu.: 593.2   1st Qu.: 28.44
##  Median :2004   Median :15.00   Median : 593.2   Median : 28.44
##  Mean   :2003   Mean   :15.77   Mean   : 621.6   Mean   : 28.90
##  3rd Qu.:2007   3rd Qu.:22.00   3rd Qu.: 593.2   3rd Qu.: 28.44
##  Max.   :2014   Max.   :31.00   Max.   :2735.9   Max.   :112.34
##  NA's   :7      NA's   :784     NA's   :272      NA's   :272
##  A_TAvg_Avg30Yr  A_TMax_Avg30Yr  A_TMin_Avg30Yr   A_TSea_Avg30Yr
##  Min.   : 8.00   Min.   :18.67   Min.   :-0.980   Min.   :158.7
##  1st Qu.:13.12   1st Qu.:27.04   1st Qu.: 3.560   1st Qu.:424.4
##  Median :13.12   Median :27.04   Median : 3.560   Median :424.4
##  Mean   :13.39   Mean   :27.19   Mean   : 3.574   Mean   :429.5
##  3rd Qu.:13.12   3rd Qu.:27.04   3rd Qu.: 3.560   3rd Qu.:424.4
##  Max.   :27.44   Max.   :40.09   Max.   :18.460   Max.   :665.6
##  NA's   :272     NA's   :272     NA's   :272      NA's   :272
##  A_TWet_Avg30Yr  A_TWrm_Avg30Yr  A_Prec_AvgAutumn30Yr A_Prec_AvgSummer30Yr
##  Min.   : 5.20   Min.   :13.56   Min.   : 10.45       Min.   : 13.03
##  1st Qu.: 9.41   1st Qu.:18.42   1st Qu.: 43.93       1st Qu.: 37.83
##  Median : 9.41   Median :18.42   Median : 43.93       Median : 37.83
##  Mean   :10.21   Mean   :18.73   Mean   : 46.22       Mean   : 41.69
##  3rd Qu.: 9.41   3rd Qu.:18.42   3rd Qu.: 43.93       3rd Qu.: 37.83
##  Max.   :32.25   Max.   :32.25   Max.   :307.20       Max.   :364.33
##  NA's   :272     NA's   :272     NA's   :272          NA's   :272
##  A_Prec_AvgSpring30Yr A_Prec_AvgWinter30Yr DistPermWater      DistAgriLand
##  Min.   :  2.00       Min.   :  2.37       Min.   : 0.0300   Min.   :  0.37
##  1st Qu.: 57.42       1st Qu.: 64.37       1st Qu.: 0.0500   1st Qu.:  2.97
##  Median : 57.42       Median : 64.37       Median : 0.0500   Median :  2.97
##  Mean   : 58.95       Mean   : 65.23       Mean   : 0.5413   Mean   :  9.30
##  3rd Qu.: 57.42       3rd Qu.: 64.37       3rd Qu.: 0.0500   3rd Qu.:  2.97
##  Max.   :159.44       Max.   :186.02       Max.   :47.3700   Max.   :719.33
##  NA's   :272          NA's   :272          NA's   :24        NA's   :24
##   PercSoilClay    MinDayLength    VarDayLength       State          VegeType
##  Min.   : 5.00   Min.   : 8.95   Min.   :0.250   QLD    :5405   11     :6079
##  1st Qu.:14.91   1st Qu.: 9.58   1st Qu.:3.150   VIC    :1054   2      : 357
##  Median :14.91   Median : 9.58   Median :3.150   ACT    : 208   3      : 163
##  Mean   :16.07   Mean   : 9.62   Mean   :3.066   NSW    :  42   10     :  50
##  3rd Qu.:14.91   3rd Qu.: 9.58   3rd Qu.:3.150   NT     :  34   7      :  25
##  Max.   :53.11   Max.   :11.40   Max.   :4.930   WA     :   7   (Other):  52
##  NA's   :24      NA's   :24      NA's   :24      (Other):   0   NA's   :  24
##   Season         Month      Diseases    Red.Fox      Dingo      Feral.Cat
##  1   :1663   5      :1099   0   :  10   0   :   2   0   :   3   0   :   3
##  2   :1941   11     : 859   1   : 477   1   :2283   1   : 278   1   : 277
##  3   :1181   12     : 827   2   :6256   NA's:4465   NA's:6469   NA's:6470
##  4   :1760   10     : 606   3   :   0
##  NA's: 205   2      : 577   NA's:   7
##              (Other):2577
##              NA's   : 205
```

```
##  Whistling.Kite Wallaby.Sp  Transect
##  0   :   2      0   :   0   a:   2
##  1   :5223      1   :2292   b:  17
##  NA's:1525      NA's:4458   c:  34
##                             d:  97
##                             e: 277
##                             f:6322
##                             g:   1
```

```
#Remove the transect specific data sets
rm(EW1, EW2, EW3, EW4, EW5, EW6, EW7)
rm(NS1, NS2, NS3, NS4, NS5, NS6, NS7, NS8, NS9)
```

This concludes the "R Environment Set Up and Importing the Data section". Next, we move on to "Initial Graphical Data Exploration and Research Questions".