Introduction

Alpine ecosystems are those which are located at high altitudes but below the snowline of the mountains.In this assignment we are going to look into the degree of effects of various environmental factors affecting the growth of two alpine plant species Carex.bigelowii and Thalictrum.alpinum by looking into a dataset containing 10 factors and the plant density data collected by using the Pin-point method.

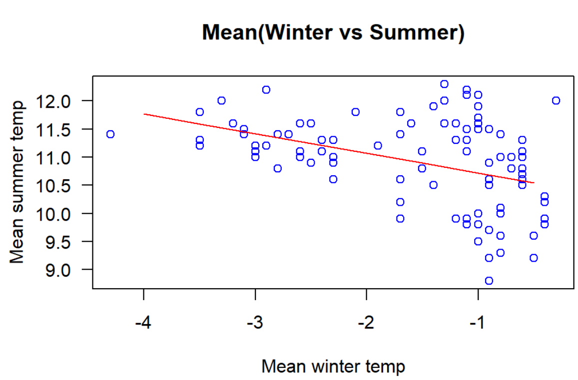
The factors in the dataset are ,mean winter temperature,maximum and minimum winter temperature,mean summer temperature, maximum and minimum summer temperature,sunlight,snow,soil moisture and altitude.The factors considered in the dataset are logical and have varying degree of effects on the growth of plants and their pollinators in the alpine ecosystem..

Analysis Methods

We first analyse the given dataset to find possible groups of factors that could significantly affect the growth of Carex.bigelowii and Thalictrum.alpinum.

Temperatures

We first analyse the mean temperatures to identify whether they are dependent on each other. We calculate the Variance Inflation Factor(VIF) for the pair which is 1.2021 which signifies for poor correlation.



All the other possible correlations were analysed and were found to have no to poor correlation.This signifies that all the predictors which might affect the growth of Carex.bigelowii and Thalictrum.alpinum are independent of each other.

Data Transformations

Cube roots were taken for all the factors to normalise the data.The density of the plants have also been rounded off to the nearest whole number.

Finally,The Poisson Regression model was used to fit the data and 2 models were generated to analyse the effect of factors on Carex.bigelowii and Thalictrum.alpinum independently and a third model which looked into the factors affecting the growth of both the species.

Results

Model1-Carex.bigelowii

A backward selection was performed on the factors and p value was used as a criterion for elimination.Finally the mean temperature during summer, mean temperature during winter and the altitude were chosen as they were the most influential factors.

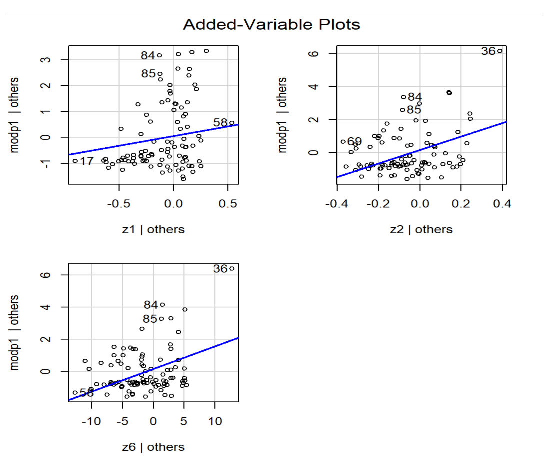
From the summary we can see that the slopes of all the predictor variables are positive indicating a positive correlation between the factors and the growth of Carex.bigelowii.The standard errors are smaller than the estimates and the P-value for all three variables are highly significant.

MODEL INFO:
Observations: 95 (1 missing obs. deleted)
Dependent Variable: modp1
Type: Generalized linear model
Family: poisson
Link function: log

MODEL FIT:
$\chi^2(3) = 52.13$, $p = 0.00$
Pseudo-R^2 (Cragg-Uhler) = 0.43
Pseudo-R^2 (McFadden) = 0.15
AIC = 298.45, *BIC* = 308.66

Standard errors: MLE

	Est.	S.E.	z val.	p
(Intercept)	-35.56	9.28	-3.83	0.00
z1	1.54	0.45	3.40	0.00
z2	2.22	0.55	4.02	0.00
z6	0.07	0.02	3.79	0.00

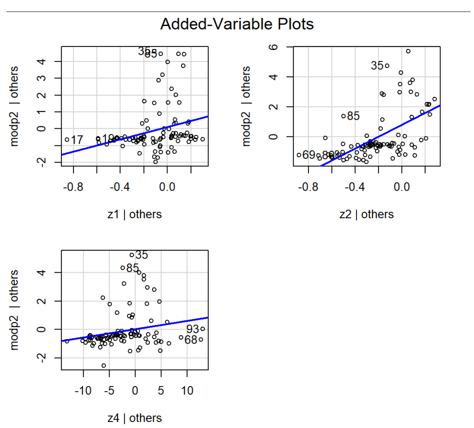


There is a positive correlation between the factors and the factors to the growth of Carex.bigelowii.

Model 2-Thalictrum.alpinum

A backward selection was performed on the factors and p value was used as a criterion for elimination.Finally the mean temperature during summer, mean temperature during winter and the snow were chosen as they were the most influential factors.From the summary we can see that the slopes of all the predictor variables are positive indicating a positive correlation between the factors and the growth of Thalictrum.alpinum.The standard errors are smaller than the estimates and the P-value for all three variables are highly significant.

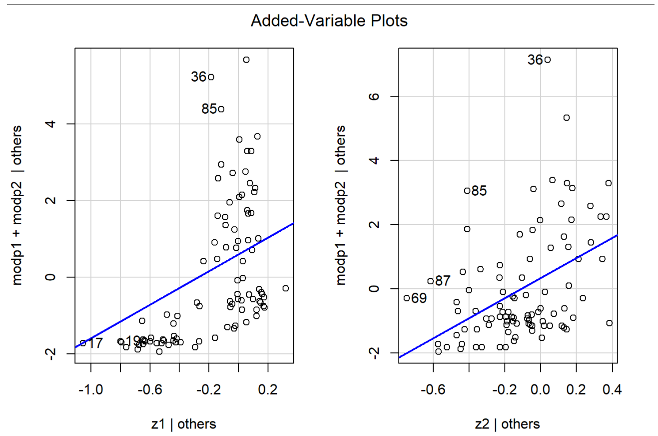
```
MODEL INFO:
Observations: 95 (1 missing obs. deleted)
Dependent Variable: modp2
Type: Generalized linear model
  Family: poisson
  Link function: log

MODEL FIT:
χ²(3) = 131.88, p = 0.00
Pseudo-R² (Cragg-Uhler) = 0.76
Pseudo-R² (McFadden) = 0.34
AIC = 259.63, BIC = 269.85

Standard errors: MLE
--------------------------------------------------
                      Est.   S.E.   z val.      p
----------------- -------- ------ -------- ------
(Intercept)         -12.09   1.68    -7.19   0.00
z1                    2.55   0.62     4.13   0.00
z2                    3.41   0.42     8.19   0.00
z4                    0.06   0.02     3.14   0.00
--------------------------------------------------
```



Model 3-Combined model

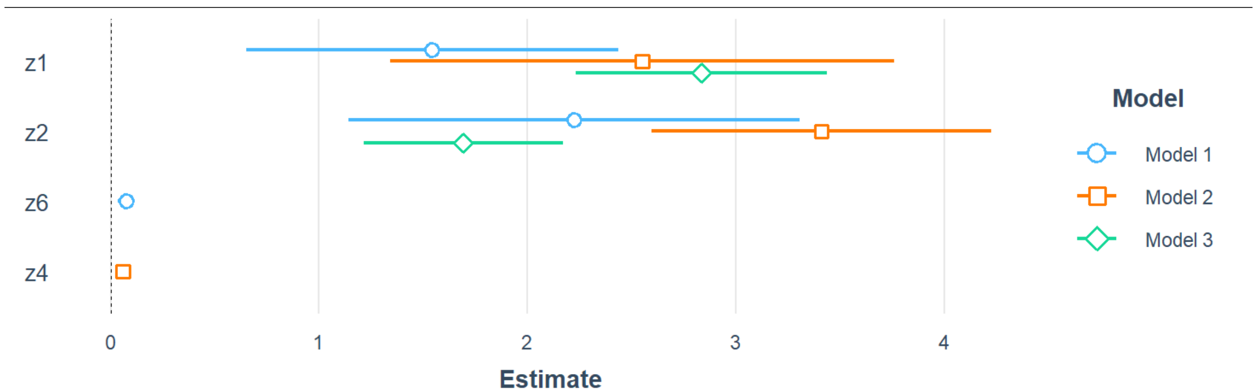
A linear model was fitted to the count data of both Carex.bigelowii and Thalictrum.alpinum.The factors were selected based on backwards selection to give the best possible fit.Mean temperature in the winter and mean temperature in the summer were the two parameters that affect the growth of both the species significantly.From the summary we can see that the slopes of all the predictor variables are positive indicating a positive correlation between the mean temperatures and the growth of Thalictrum.alpinum and Carex.bigelowii.The standard errors are smaller than the estimates and the P-value for all three variables are highly significant.

```
MODEL INFO:
Observations: 95 (1 missing obs. deleted)
Dependent Variable: modp1 + modp2
Type: Generalized linear model
  Family: poisson
  Link function: log

MODEL FIT:
χ²(2) = 129.77, p = 0.00
Pseudo-R² (Cragg-Uhler) = 0.75
Pseudo-R² (McFadden) = 0.24
AIC = 406.26, BIC = 413.92

Standard errors: MLE
------------------------------------------------
                      Est.    S.E.    z val.     p
----------------- ------- ------ -------- ------
(Intercept)          -4.00    0.88     -4.54   0.00
z1                    2.84    0.31      9.22   0.00
z2                    1.69    0.24      6.96   0.00
------------------------------------------------
```



Conclusion

The factors considered in the models affect both the species on different levels.When the temperature increases by 1 the logodds for Carex.bigelowii to take the value 1 is 1.54 in the winter and 2.22 in the summer whereas it is 2.55 and 3.41 for Thalictrum.alpinum.There is a small but significant effect of snow on the growth of Carex.bigelowii with a logodds value of 0.07 and altitude on the growth of Thalictrum.alpinum with a logodds value of 0.06.The combined model shows that the most influential effect on the growth of both alpine species is the mean temperatures during the summer and winter seasons with a log odds score of 2.84 and 1.69 respectively. Finally, we can conclude that temperature is the most influential factor affecting the alpine species of Carex.bigelowii and Thalictrum.alpinum.



References

- Inouye, D. W. (2020). Effects of climate change on alpine plants and their pollinators. *Annals of the New York Academy of Sciences*, *1469*(1), 26-37.

Appendix R-code

```
library(jtools) #Used in summ() function
library(sjPlot) #Used in plot_sums()
library(car) #Used in avPlots()
plants = read.csv("alpineplants.csv")

x1=(plants$mean_T_winter)
z1=x1^1/3 #Normalizing the mean winter temperature.

x2=(plants$mean_T_summer)
z2=x2^1/3 #Normalizing the mean summer temperature.

x3=(plants$light)
z3=x3^1/3 #Normalizing the light received.

x4=(plants$snow)
z4=x4^1/3 #Normalizing the amount of snow fall.

x5=(plants$soil_moist)
z5=x5^1/3 #Normalizing the amount of soil moisture.

x6=(plants$altitude)
z6=x6^1/3 # Normalizing the altitude.

modp1=plants$Carex.bigelowii #Getting the count data of Carex.bigelowii
modp2=plants$Thalictrum.alpinum # Getting the count data of Thalictrum.alpinum

for (index in 1:length(plants$Carex.bigelowii)){
  if (modp1[index]==0.5){
        modp1[index]=modp1[index]+0.5
  }                         #Rounding off the count data to 1 incase of 0.5 plants.
  if (modp2[index]==0.5){
        modp2[index]=modp2[index]+0.5
  }
```

```
}

#Data Analysis #Analysing the dependence of the factors in the data
a<-lm(x2~x1)
plot(x=x1,y=x2,col="blue",las=1,xlab="Mean winter temp",ylab="Mean summer temp")
xx=seq(-4,-0.1,by=0.5)
yhat=summary(a)$coef[1,1]+summary(a)$coef[2,1]*xx
lines(x=xx,y=yhat,col="red")

#VIF calculation
r2 = summary(a)$r.squared
cat(1/(1-r2)) #1.2021

#Models
model1=glm(modp1~z1+z2+z6,family='poisson')
summary(model1)
summ(model1)
avPlots(model1,ylab="Carex.bigelowii | others")

model2=glm(modp2~z1+z2+z4,family='poisson')
summary(model2)
summ(model2)
avPlots(model2,ylab="Thalictrum.alpinum  | others")

modelc=glm(modp1+modp2~z1+z2,family ='poisson' )
summary(modelc)
summ(modelc)
avPlots(modelc,ylab="Carex.bigelowii+Thalictrum.alpinum | others")

plot_summs(model1,model2,modelc)
```