Report for 02935 Introduction to applied statistics and R for PhD students, Winter 2025

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Summary

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Introduction

Description of data

The data process in the following report was collected in Kangerluasunnguaq (Kobbefjord, Nuuk) in Southeast Greenland in 2024. The data was collected in 100 plots placed in an area of interest of aproxemately 12 km^2 by randomised stratified sampling. Stratification was based on elevation (5 bins) and NDVI (4 bins).

Within each circular plot of 1 m^2 the abundance and maximum height of all vascular plant species was recorded. Abundance was assessed by means of the well known Braun-Blanquet scale (8 step version). Abundance was assessed for bryophytes and lichens collectively as well.

In all plots soil temperature, soil moisture, and general vegetation height, was measured as well. Soil temperature was measured with a generic thermometer (°C, 4 measurements, mean calculated). Soil moisture was measured with a ThetaProbe (% water content, 4 measurements, mean calculated). General vegetation height was measured with a generic ruler (cm, 4 measurements, mean calculated)

The final processed data contains data from 100 plots and 72 species of vascular plants.

```
'data.frame':   961 obs. of  11 variables:
 $ plot_name            : chr  "MP002" "MP003" "MP004" "MP005" ...
 $ taxon                : Factor w/ 77 levels "Agrostis mertensii",..: 68 64 26 6 64 6 6 26 64 65 ...
 $ height               : int  15 14 7 6 23 37 23 9 35 2 ...
 $ bb                   : Factor w/ 8 levels "0.5","2.5","12.5",..: 3 4 3 4 3 5 3 4 6 3 ...
 $ bb_num               : chr  "12.5" "37.5" "12.5" "37.5" ...
 $ mean_soil_moisture   : num  95.42 3.22 25.23 35.2 28.3 ...
 $ mean_soil_temp       : num  7.05 6.5 4 6.9 4.58 ...
 $ mean_veg_height      : num  9.25 2.25 10.75 3 6.25 ...
 $ rowid                : int  1 2 3 4 5 6 7 9 10 11 ...
 $ position             : chr  "taxon_1" "taxon_1" "taxon_1" "taxon_1" ...
 $ other_vegetation_type: logi  NA NA NA NA NA NA ...
```

Scientific question

- Does the most common species have different preferences (= abundance) for soil moisture and/or temperature?
  - *
- What model can describe the relationship between the abundance of the most common species (> 10 observations in plots) and soil moisture?
- Can PCA reveal any kind of structure in the collected data based the abundance of different species?
  - If so, what do these structures indicate?

Statistical analyses

The relationship between soil moisture and abundance of a given species cannot be assumed to be linear. Any given species of plants will have a preference for soil moisture (a wide or narrow interval) where frequency is highest. Abundance of said species will decrease with higher or lower soil moisture than this optimum. Hence, the relation could be considered to have somewhat a bell shape, but uncertain whether this would be symmetrical.

Thus, for the purpose of the analysis a generalized additive model (GAM) have been chosen. This choise was made with emphasis on the fact that this model does not make any assumptions about the relationship of the explanatory and response variable.

- Estimation: Which parameter values t the observations best? How certain are we of our estimates?
- Model check : Are the assumptions on the underlying model fullfilled? Logically this should come rst, but for practical reasons it comes after estimation.
- Simplifying the model (te

Model choise (expected relation ship, data types)

results

Discussion

PCA is a commonly used method in ecology and vegetation science to aid in classification of vegetation structures. This is due to the advantages of

Assumed model

assumption

evaluation

- Statistical analyses
- results

GAM for soilmoisture

Sal gla

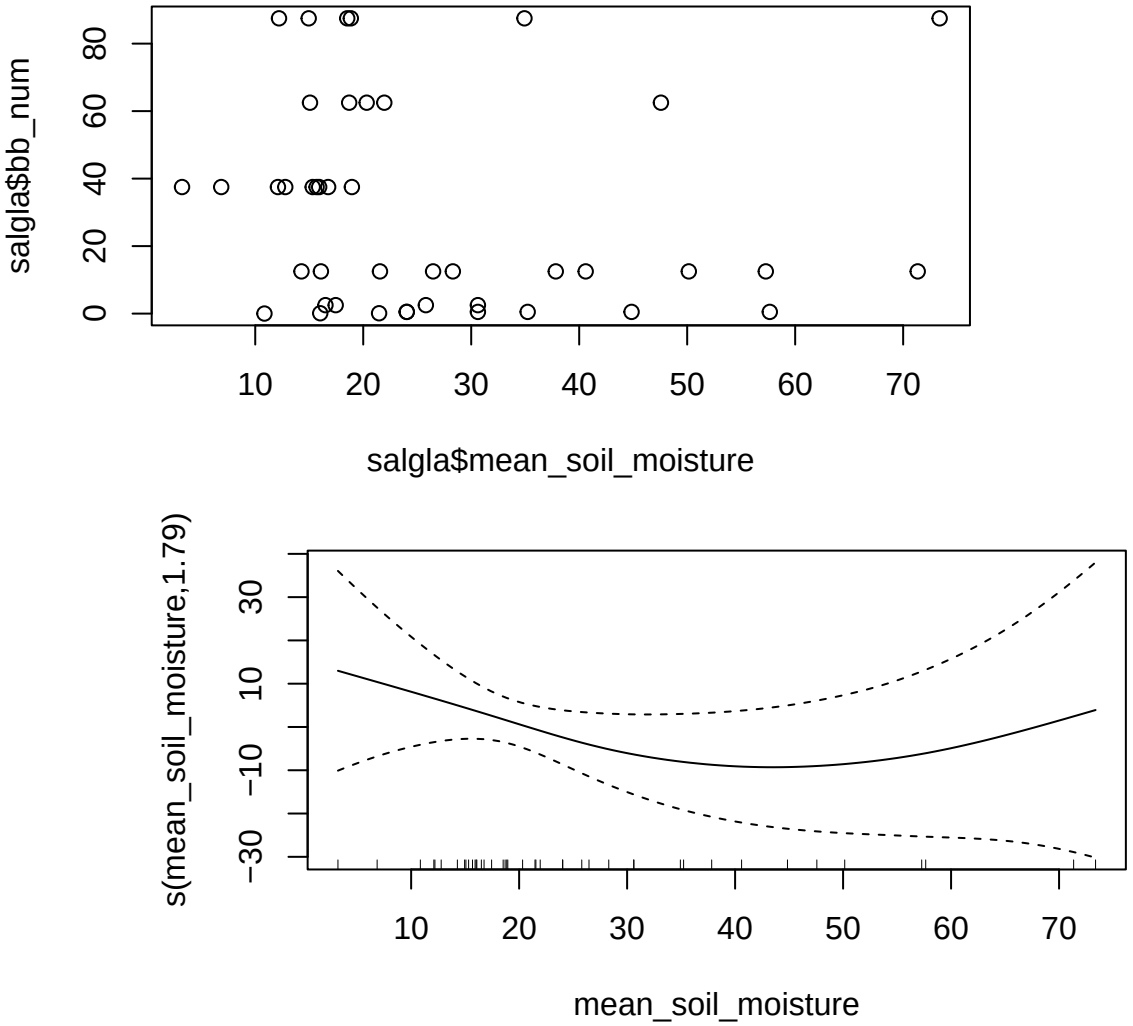


Figure 1: Plot of GAM model for soil moisture and abundance of Salix glauca. P-value is 0.366 at 95 % level.

```
Call:
lm(formula = bb_num ~ I(mean_soil_moisture^2), data = salgla)

Residuals:
   Min     1Q Median     3Q    Max
-31.46 -28.21 -15.46  18.72  61.88

Coefficients:
                         Estimate Std. Error t value Pr(>|t|)
(Intercept)             31.606223   5.977427   5.288 4.43e-06 ***
I(mean_soil_moisture^2) -0.001112   0.003805  -0.292    0.772
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 31.05 on 41 degrees of freedom
Multiple R-squared:  0.00208,   Adjusted R-squared:  -0.02226
F-statistic: 0.08545 on 1 and 41 DF,  p-value: 0.7715
```

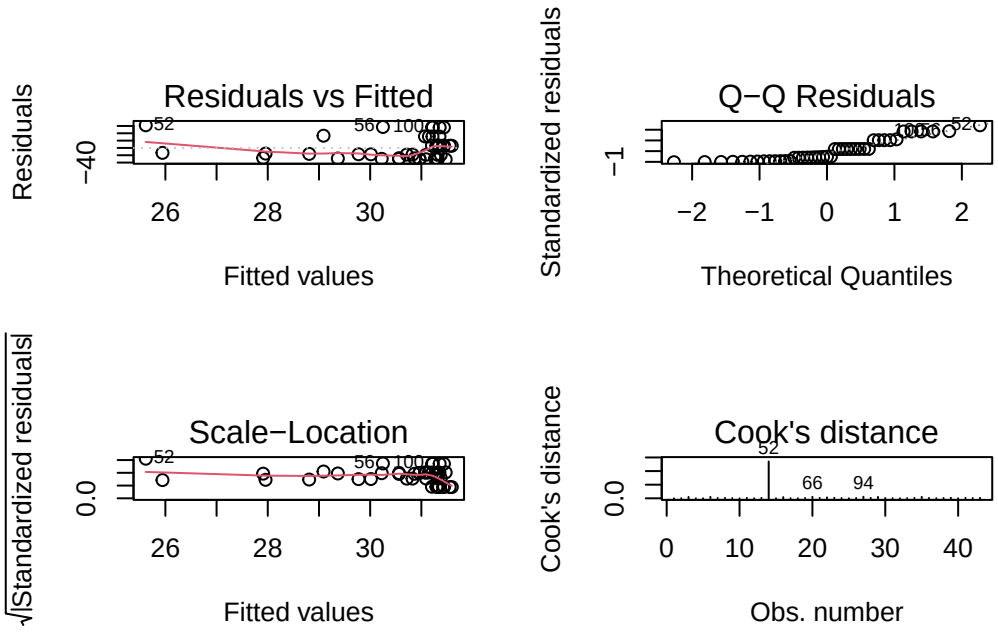


Figure 2: Diagnosticsplot of

Des fle

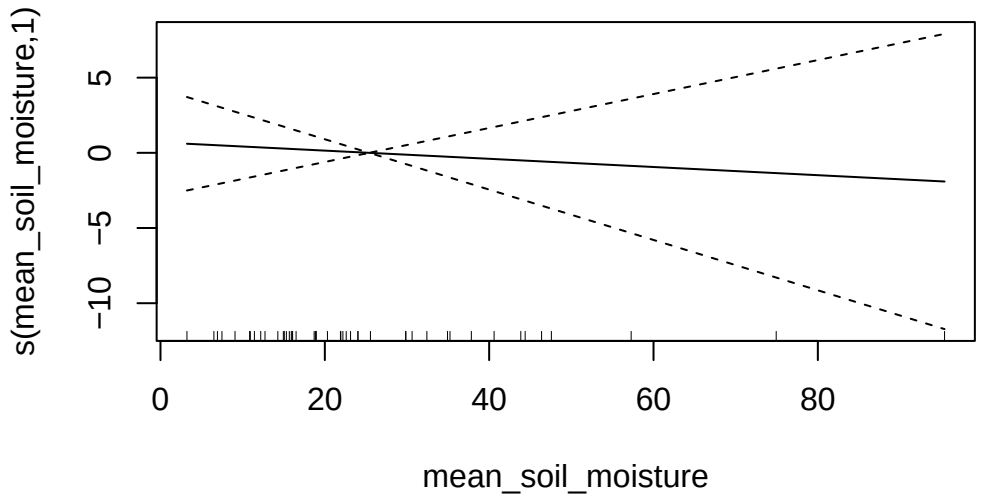


Figure 3: Plot of GAM model for soil moisture and abundance of Deschampsia flexuosa. P-value is 0.699 at 95 % level.

PCA all data

Can causes the plots to be most different? With 73 taxa and the abundance of bare ground, bryophytes and lichen, what abundances are most nessesary to describe the differences of the plots. Some occurrences might be redundant in eplaining the variation between plots.

If the combination of characteristics

What causes wines to be different? • With the 13 characteristics, we can distinguish wines through differences in the charateristics. But are all 13 characteristics necessary? Some may be redundant. • If we can identify scales (linear combinations of the characteristics) where the characteristics vary the most, we can also find a scale that differentiates optimally between the wines.

```
library(remotes)
#install_github("rwehrens/ChemometricsWithR")
library(ChemometricsWithR)
```

```
Attaching package: 'ChemometricsWithR'

The following objects are masked from 'package:stats':

    loadings, screeplot
```

```
mp.PC<- PCA(scale(pca_stat))
names(mp.PC)
```

```
[1] "scores"       "loadings"     "var"          "totalvar"
[5] "centered.data"
```

```
summary(mp.PC)
```

```
PCA model of a mean-centered matrix of 100 by 76
Number of PCs to cover 90 percent of the variance: 37

          Var Cumul. var.
PC 1  6.834400     6.83440
PC 2  6.073946    12.90835
PC 3  5.068934    17.97728
PC 4  4.840477    22.81776
PC 5  4.163365    26.98112
PC 10 2.822849    43.38922
```

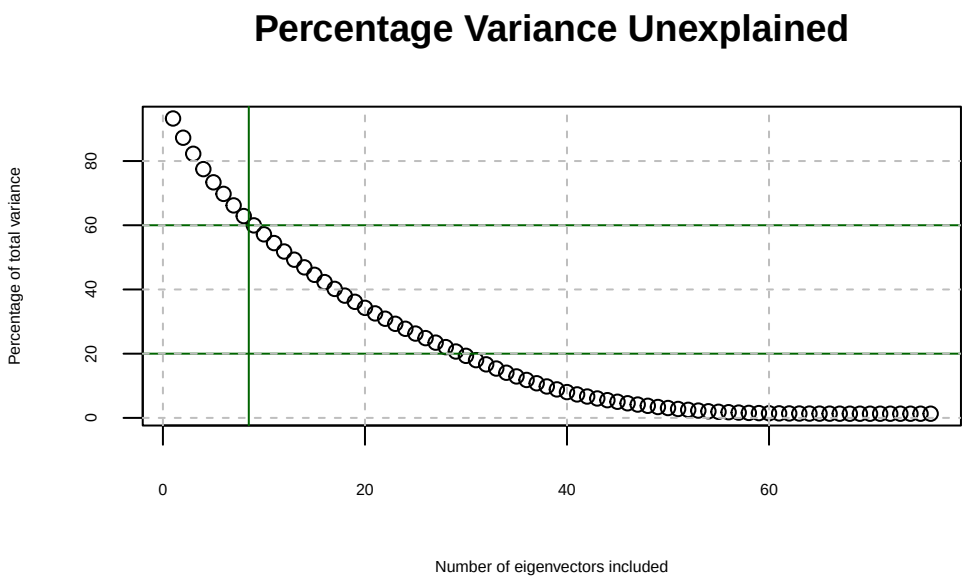
```
head(mp.PC$loadings,n=3)
```

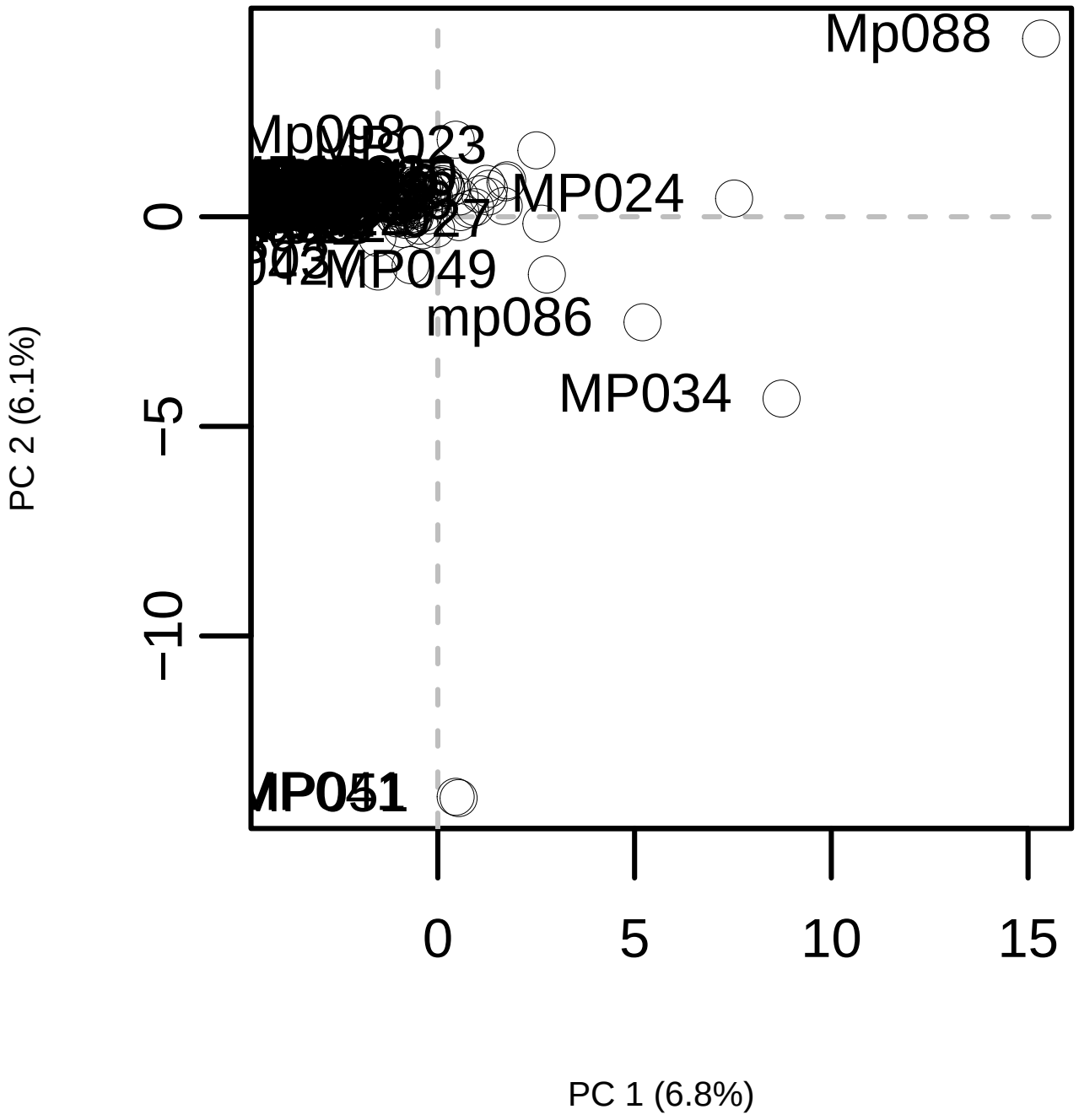
```
                          PC 1          PC 2        PC 3        PC 4
scirpus_caespitosus -0.02379151  0.0002786357 -0.02915946 -0.01321870
salix_glauca        -0.13993305 -0.0066342397  0.30125279  0.03762653
empetrum_nigrum     -0.11550968  0.0642820311 -0.07727665 -0.02161595
                           PC 5        PC 6         PC 7        PC 8       PC 9
scirpus_caespitosus  0.04257509 -0.04575855  0.016432593 -0.03762496 0.08254694
salix_glauca        -0.02042728 -0.05851153 -0.039278744  0.02001079 0.04712893
empetrum_nigrum      0.13115038 -0.05850372 -0.001136057 -0.15122685 0.12824624
                          PC 10       PC 11       PC 12       PC 13       PC 14
scirpus_caespitosus -0.23692846  0.07849664 -0.08862788  0.05318152 -0.19908100
salix_glauca         0.07408672  0.05266168  0.05789762 -0.02524768  0.06867752
empetrum_nigrum      0.06436084 -0.01469251 -0.11630637  0.23551154 -0.03877864
                          PC 15        PC 16       PC 17      PC 18       PC 19
scirpus_caespitosus  0.37349004 -0.072123167  0.35881616 -0.1301318 -0.04458802
salix_glauca        -0.03004669 -0.003994224  0.08604947  0.1621147 -0.32050032
empetrum_nigrum     -0.06142780  0.144779168 -0.01675500  0.2780506  0.10421265
                          PC 20       PC 21        PC 22       PC 23      PC 24
scirpus_caespitosus  0.22176634 -0.08660349 -0.001123991  0.05652370 0.03515630
salix_glauca        -0.08557510  0.10030238  0.007940519  0.10162646 0.16675243
empetrum_nigrum     -0.04258597 -0.22503363 -0.266103595 -0.06709857 0.02671033
                          PC 25        PC 26        PC 27        PC 28
scirpus_caespitosus -0.02262733 -0.005142075 -0.001449962 -0.005948812
salix_glauca        -0.07222090  0.067558690 -0.025919178 -0.043869272
empetrum_nigrum      0.08047646 -0.028741651  0.093663947  0.010941079
                           PC 29         PC 30       PC 31        PC 32
scirpus_caespitosus  0.001028597  0.0004828267 0.002920071  0.004146281
salix_glauca        -0.040172805 -0.0287644746 0.046955796  0.006608961
empetrum_nigrum     -0.015297020 -0.0376444308 0.002533122 -0.002096815
                          PC 33       PC 34        PC 35        PC 36
```

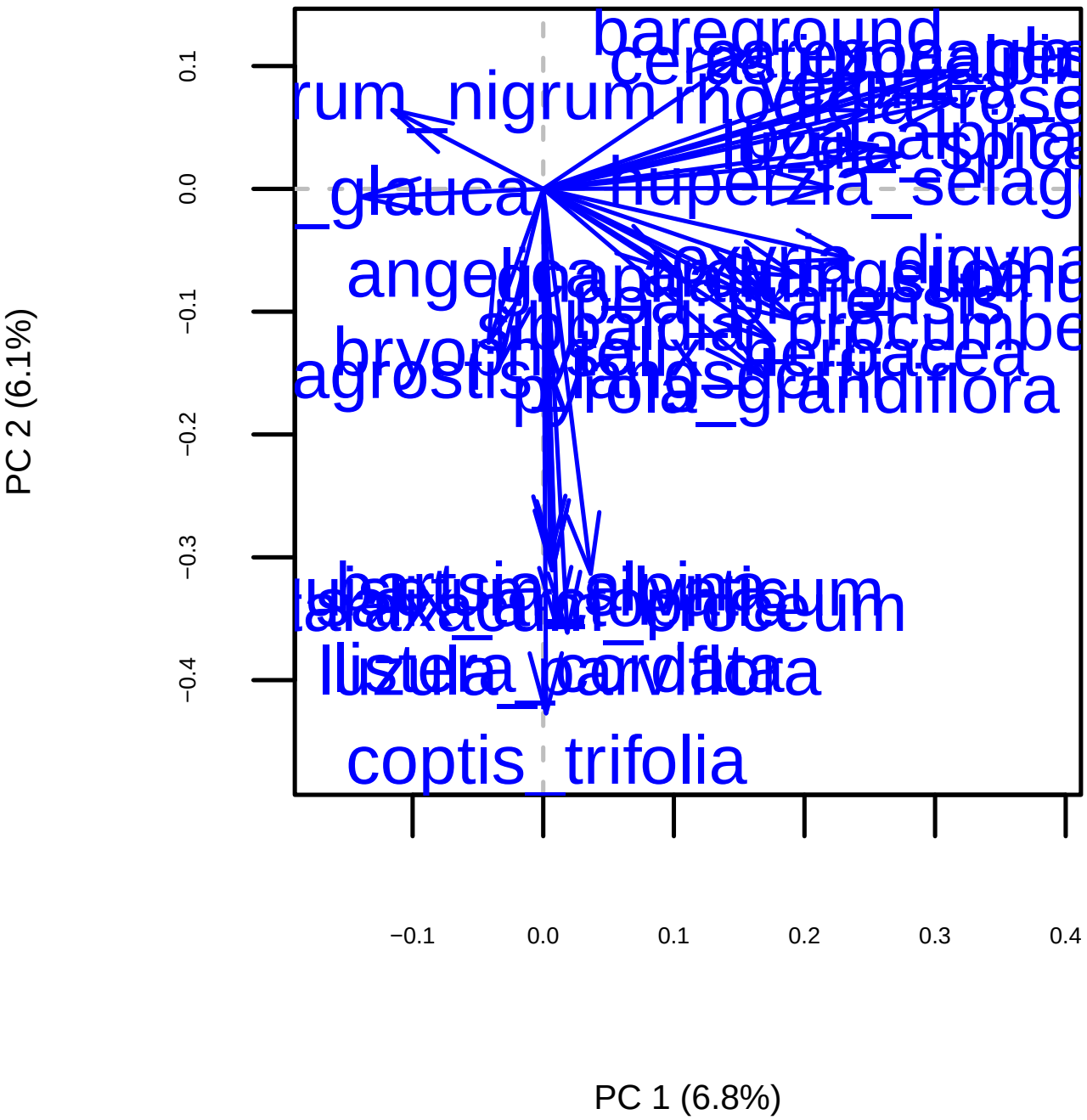
```
scirpus_caespitosus  0.004111769 0.003558343  0.003401163 -0.030120357
salix_glauca         0.026392798 0.021818894 -0.005471512 -0.003555740
empetrum_nigrum     -0.009586569 0.025056143  0.015555584 -0.009012015
                            PC 37         PC 38       PC 39       PC 40
scirpus_caespitosus -0.004345183 -0.0210863272  0.02676775 -0.04851726
salix_glauca         0.081860202  0.0003150324 -0.01410896  0.01194866
empetrum_nigrum      0.195484110  0.1266890769 -0.11602912  0.04361899
                           PC 41       PC 42       PC 43       PC 44       PC 45
scirpus_caespitosus  0.10265984  0.03533248 -0.04250135 -0.22244679  0.01966824
salix_glauca        -0.01827668  0.01774871 -0.39848282 -0.09454788 -0.19566519
empetrum_nigrum     -0.34532044 -0.03100345  0.21885931  0.12377472 -0.05838907
                           PC 46       PC 47       PC 48      PC 49     PC 50
scirpus_caespitosus  0.01787691  0.01933158  0.43735187 -0.2332758 0.3292791
salix_glauca        -0.21670535  0.02515220 -0.31668906 -0.1228940 0.1863840
empetrum_nigrum      0.10171339 -0.08973389  0.04898743  0.1862022 0.0885980
                          PC 51     PC 52       PC 53      PC 54       PC 55
scirpus_caespitosus 0.03253064 0.2004875 -0.16108044 0.15035201  0.07016883
salix_glauca        0.08428987 0.2855922  0.04960067 0.06951756 -0.02347552
empetrum_nigrum     0.04044612 0.2986558 -0.23138054 0.08918307 -0.02218976
                           PC 56       PC 57        PC 58        PC 59
scirpus_caespitosus -0.01430575 -0.01215051 -0.003881416  0.002995895
salix_glauca         0.10317242  0.24815821  0.262690303 -0.001208050
empetrum_nigrum      0.06435506  0.30438071 -0.069513559  0.012796508
                           PC 60        PC 61      PC 62        PC 63
scirpus_caespitosus 0.006429032  0.005282158 0.02953841 -0.001755620
salix_glauca        0.003885018 -0.028060309 0.03138839  0.002979555
empetrum_nigrum     0.022429641  0.051423893 0.01303850  0.017818231
                           PC 64         PC 65        PC 66        PC 67
scirpus_caespitosus -0.01863068 -0.0005312578  0.008031640  0.005287108
salix_glauca        -0.01900699 -0.0001926705 -0.013403964 -0.003641698
empetrum_nigrum      0.02278277  0.0400219889  0.003070548  0.017190797
                            PC 68        PC 69         PC 70         PC 71
scirpus_caespitosus 0.0020057887  0.007297768  0.0002603157  9.512622e-05
salix_glauca        0.0145075311  0.017454714 -0.0001072518 -1.367580e-04
empetrum_nigrum     0.0009543681 -0.016645871  0.0004053946  3.376961e-04
                            PC 72         PC 73        PC 74         PC 75
scirpus_caespitosus  3.550208e-06  1.851124e-16 0.000000e+00  0.000000e+00
salix_glauca         5.569003e-06  7.549419e-17 3.589501e-17 -1.341151e-16
empetrum_nigrum     -2.072272e-05 -1.189144e-16 2.918691e-16 -5.831357e-17
                            PC 76
scirpus_caespitosus  0.000000e+00
salix_glauca         9.622918e-17
empetrum_nigrum     -3.057764e-16
```

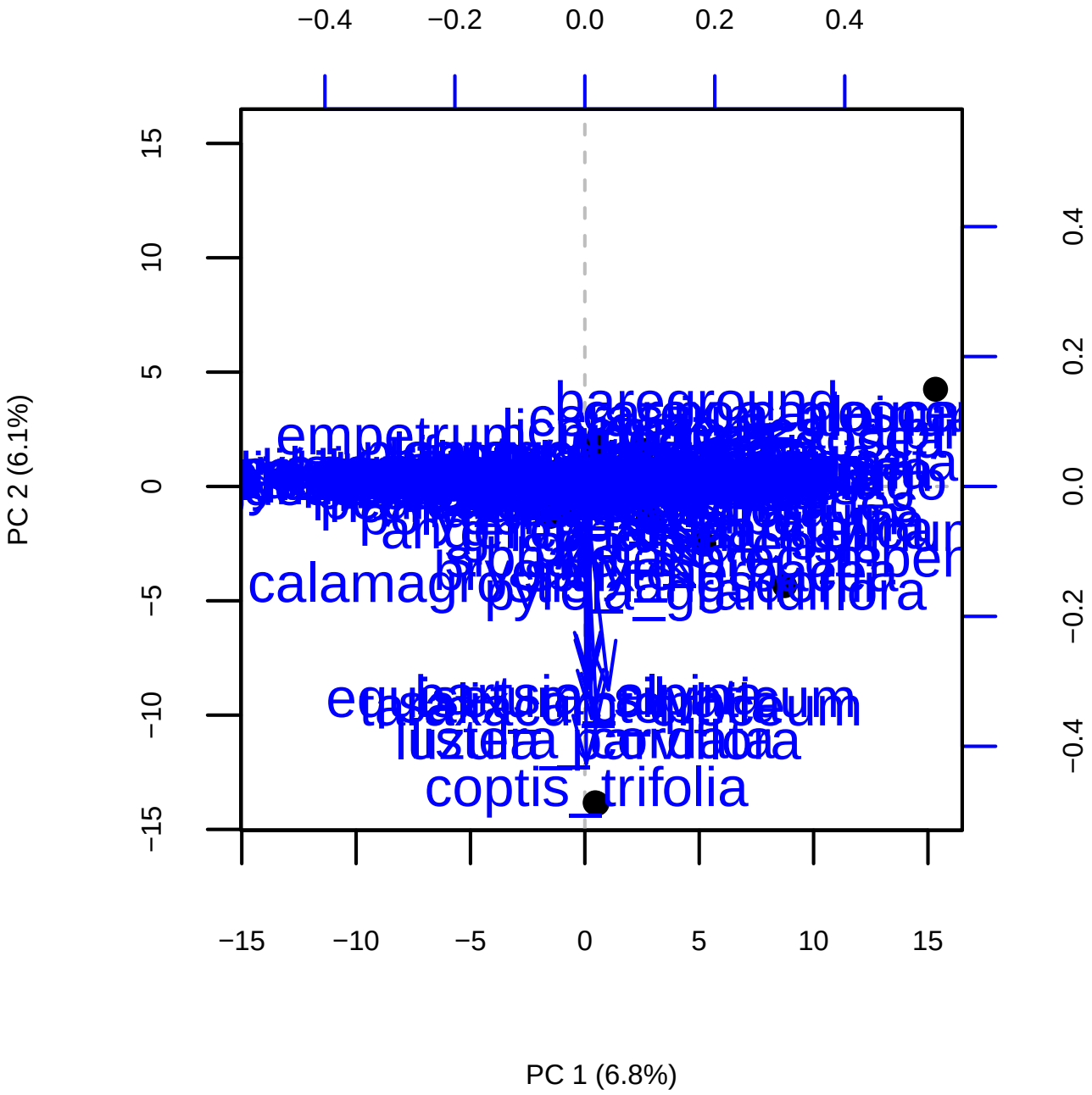
```
#| label: plot-percentage-variance-unexplained
#| echo: false
#| out-width: 100%

par(cex.axis = 0.5, cex.lab = 0.5)
plot(100*(77-cumsum(diag(Lambda)))/77,type="b",
main="Percentage Variance Unexplained",
xlab='Number of eigenvectors included',
ylab='Percentage of total variance',
 cex.axis = 0.5) # Reduce size of axis text)
abline(h = 20, col = "darkgreen")
abline(h = 60, col = "darkgreen")
abline(v = 8.5, col = "darkgreen")
grid(nx = NULL, ny = NULL,
```

```
      lty = 2,       # Grid line type
      col = "gray", # Grid line color
      lwd = 1)       # Grid line width
```

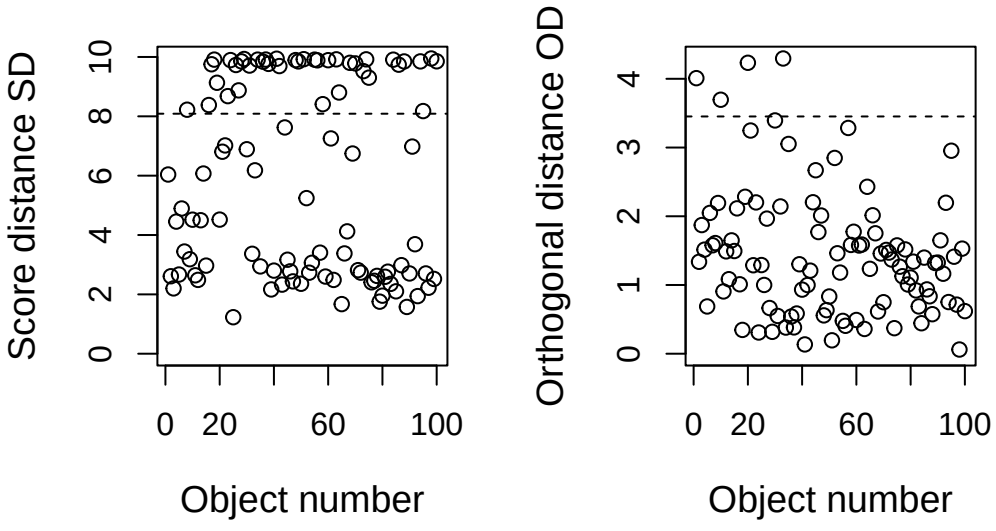


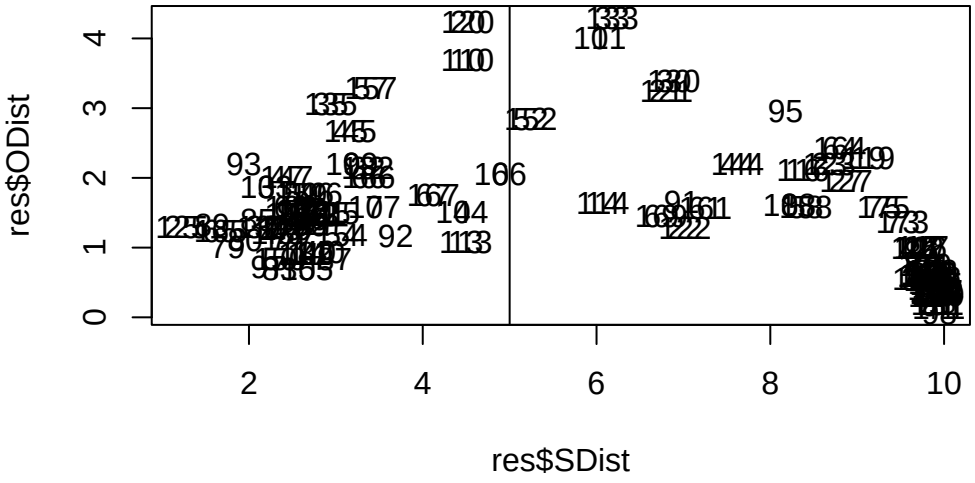

Mp088
MP024
MP049
mp086
MP034
0
−5
−10
0
5
10
15
PC 2 (6.1%)
PC 1 (6.8%)


bareground
glauca
hupeerzia_selag
coptis_trifolia
PC 1 (6.8%)
PC 2 (6.1%)
−0.1
0.0
0.1
0.2
0.3
0.4
−0.4
−0.3
−0.2
−0.1
0.0
0.1




```
Loading required package: rpart
```





PCA only vegetated data

```
#| label: pca-data-prepping-veg
#| echo: false
#| output: false
#|

wide_data <- stat_mappingplants[-c(590, 288), ] |>
  filter(rowid < 102) |>
  pivot_wider(id_cols = plot_name, names_from = taxon, values_from = bb_num) |>
  clean_names()
```

```
Warning: Values from `bb_num` are not uniquely identified; output will contain
list-cols.
* Use `values_fn = list` to suppress this warning.
* Use `values_fn = {summary_fun}` to summarise duplicates.
* Use the following dplyr code to identify duplicates.
  {data} |>
  dplyr::summarise(n = dplyr::n(), .by = c(plot_name, taxon)) |>
  dplyr::filter(n > 1L)
```

```
wide_data2_veg <- wide_data |>
  mutate(across(-1, ~ as.numeric(as.character(.)))) |>
  mutate(across(-1, ~ replace_na(., 0))) |>
  filter(plot_name != "",
         bareground < 50)
```

```
Warning: There were 74 warnings in `mutate()`.
The first warning was:
i In argument: `across(-1, ~as.numeric(as.character(.)))`.
Caused by warning:
! NAs introduced by coercion
i Run `dplyr::last_dplyr_warnings()` to see the 73 remaining warnings.
```

```
row.names(wide_data2_veg) <- wide_data2_veg$plot_name
```

```
Warning: Setting row names on a tibble is deprecated.
```

```r
pca_stat_veg <- wide_data2_veg[, !(names(wide_data2_veg) %in% c("plot_name", "phleum_commutatum"))]

row.names(pca_stat_veg) <- wide_data2_veg$plot_name
```

```
Warning: Setting row names on a tibble is deprecated.
```

```r
pca_stat_veg <- pca_stat_veg[, colSums(pca_stat_veg) != 0]
str(pca_stat_veg)
```

```
tibble [82 x 70] (S3: tbl_df/tbl/data.frame)
 $ scirpus_caespitosus           : num [1:82] 12.5 0 0 0 0 0 0 0 0 0 ...
 $ salix_glauca                  : num [1:82] 0 37.5 0 0 12.5 0 0 0 87.5 0.1 ...
 $ empetrum_nigrum               : num [1:82] 0.5 37.5 12.5 0.5 62.5 87.5 87.5 37.5 62.5 87.5 ...
 $ betula_nana                   : num [1:82] 0 0 37.5 37.5 0 62.5 12.5 0.1 0 0.1 ...
 $ salix_herbacea                : num [1:82] 0 0 0 0 0 0 0 0.5 0 0 ...
 $ carex_bigelowii               : num [1:82] 12.5 0 2.5 0.1 0 0.1 2.5 2.5 0.5 0.1 ...
 $ vaccinium_uliginosum          : num [1:82] 37.5 0 0 12.5 37.5 0 37.5 2.5 12.5 62.5 ...
 $ oxyria_digyna                 : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ huperzia_selago               : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ gnaphalium_supinum            : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ poa_alpina                    : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ poa_glauca                    : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ saxifraga_oppositifolia       : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ juncus_trifidus               : num [1:82] 0 0.5 0 0 0 0 0 0 0 0 ...
 $ angelica_archangelica         : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ luzula_spicata                : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ deschampsia_flexuosa          : num [1:82] 0.1 2.5 0 0 0 0 0.5 0.1 0 0 ...
 $ polygonum_viviparum           : num [1:82] 0 0 0 0 0 0 0 0 0.01 0 ...
 $ phyllodoce_coerulea           : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ luzula_multiflora             : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ luzula_confusa                : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ silene_acaulis                : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ carex_rariflora               : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ loiseleuria_procumbens        : num [1:82] 0 0 0 0.1 0 0 0 0.5 0 0 ...
 $ salix_arctophila              : num [1:82] 0 0 0 0 0 0 0 0 0.1 0 ...
 $ festuca_brachyphylla          : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ ledum_groenlandicum           : num [1:82] 0 0 0 0 0 0 2.5 0 0.1 0 ...
 $ lycopodium_annotinum          : num [1:82] 0 0 0 0 0 12.5 12.5 0 0 0 ...
 $ eriophorum_angustifolium      : num [1:82] 0.5 0 0 0 0 0 0 0 0 0 ...
 $ chamaenerion_latifolium       : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ rhodiola_rosea                : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ calamagrostis_langsdorfii     : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ juniperus_communis            : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ diphasiastrum_complanatum     : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ campanula_gieseckiana         : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ luzula_parviflora             : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ gymnocarpium_dryopteris       : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ taraxacum_croceum             : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ linnaea_borealis_ssp_americana: num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ deschampsia_alpina            : num [1:82] 0 0 0 0 0 2.5 0 0 0 0 ...
 $ sibbaldia_procumbens          : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ listera_cordata               : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ potentilla_tridentata         : num [1:82] 0 0 0 0 0 0 0 0.1 0 0 ...
 $ carex_brunnescens             : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ tofieldia_pusilla             : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ dryopteris_assimilis          : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ diphasiastrum_alpinum         : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ pyrola_grandiflora            : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
 $ potentilla_crantzii           : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
```

```
$ poa_pratensis                : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
$ carex_scirpoidea             : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
$ bartsia_alpina               : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
$ coptis_trifolia              : num [1:82] 0.1 0 0 0 0 0 0 0 0 0 ...
$ veronica_wormskjoldii        : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
$ agrostis_mertensii           : num [1:82] 0 0 0 0 0 0 0 0.1 0 0 ...
$ harrimanella_hypnoides       : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
$ diapensia_lapponica          : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
$ stellaria_calycantha         : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
$ scirpis_caespitosus          : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
$ chamaenerion_angustifolium   : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
$ alchemilla_alpina            : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
$ pedicularis_lapponica        : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
$ viscaria_alpina              : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
$ pedicularis_flammea          : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
$ equisetum_silvaticum         : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
$ hieracium_hyparcticum        : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
$ poa_nemoralis                : num [1:82] 0 0 0 0 0 0 0 0 0 0 ...
$ bryophyte                    : num [1:82] 87.5 12.5 87.5 87.5 37.5 12.5 62.5 0 2.5 62.5 ...
$ lichen                       : num [1:82] 0 62.5 12.5 87.5 12.5 2.5 0 12.5 0 0 ...
$ bareground                   : num [1:82] 0 37.5 0.01 0 0 0 0 12.5 12.5 0 ...
```

```
summary(pca_stat_veg)
```

```
 scirpus_caespitosus  salix_glauca    empetrum_nigrum  betula_nana
 Min.   : 0.000      Min.   : 0.000   Min.   : 0.00   Min.   : 0.000
 1st Qu.: 0.000      1st Qu.: 0.000   1st Qu.: 0.50   1st Qu.: 0.000
 Median : 0.000      Median : 0.005   Median :25.00   Median : 0.000
 Mean   : 0.305      Mean   :16.003   Mean   :31.12   Mean   : 6.478
 3rd Qu.: 0.000      3rd Qu.:12.500   3rd Qu.:62.50   3rd Qu.: 0.100
 Max.   :12.500      Max.   :87.500   Max.   :87.50   Max.   :87.500
 salix_herbacea   carex_bigelowii  vaccinium_uliginosum oxyria_digyna
 Min.   : 0.000   Min.   : 0.000   Min.   : 0.000       Min.   :0.00000
 1st Qu.: 0.000   1st Qu.: 0.000   1st Qu.: 0.000       1st Qu.:0.00000
 Median : 0.000   Median : 0.100   Median : 0.050       Median :0.00000
 Mean   : 2.555   Mean   : 2.526   Mean   : 7.294       Mean   :0.03793
 3rd Qu.: 0.000   3rd Qu.: 0.500   3rd Qu.:10.000       3rd Qu.:0.00000
 Max.   :87.500   Max.   :62.500   Max.   :87.500       Max.   :2.50000
 huperzia_selago    gnaphalium_supinum   poa_alpina        poa_glauca
 Min.   :0.000000   Min.   :0.000000   Min.   :0.00000   Min.   :0.000000
 1st Qu.:0.000000   1st Qu.:0.000000   1st Qu.:0.00000   1st Qu.:0.000000
 Median :0.000000   Median :0.000000   Median :0.00000   Median :0.000000
 Mean   :0.008902   Mean   :0.007317   Mean   :0.00122   Mean   :0.002439
 3rd Qu.:0.000000   3rd Qu.:0.000000   3rd Qu.:0.00000   3rd Qu.:0.000000
 Max.   :0.100000   Max.   :0.100000   Max.   :0.10000   Max.   :0.100000
 saxifraga_oppositifolia juncus_trifidus   angelica_archangelica
 Min.   :0.00000         Min.   : 0.0000   Min.   :0.00000
 1st Qu.:0.00000         1st Qu.: 0.0000   1st Qu.:0.00000
 Median :0.00000         Median : 0.0000   Median :0.00000
 Mean   :0.00122         Mean   : 0.3817   Mean   :0.03171
 3rd Qu.:0.00000         3rd Qu.: 0.0000   3rd Qu.:0.00000
 Max.   :0.10000         Max.   :12.5000   Max.   :2.50000
 luzula_spicata     deschampsia_flexuosa polygonum_viviparum
 Min.   :0.000000   Min.   : 0.000       Min.   :0.0000
 1st Qu.:0.000000   1st Qu.: 0.000       1st Qu.:0.0000
 Median :0.000000   Median : 0.000       Median :0.0000
 Mean   :0.004878   Mean   : 2.779       Mean   :0.1015
 3rd Qu.:0.000000   3rd Qu.: 2.500       3rd Qu.:0.0000
 Max.   :0.100000   Max.   :37.500       Max.   :2.5000
 phyllodoce_coerulea luzula_multiflora  luzula_confusa    silene_acaulis
```

```
Min.   : 0.0000     Min.   :0.000000   Min.   :0.00000   Min.   : 0.0000
1st Qu.: 0.0000     1st Qu.:0.000000   1st Qu.:0.00000   1st Qu.: 0.0000
Median : 0.0000     Median :0.000000   Median :0.00000   Median : 0.0000
Mean   : 0.3416     Mean   :0.003659   Mean   :0.00122   Mean   : 0.1537
3rd Qu.: 0.0000     3rd Qu.:0.000000   3rd Qu.:0.00000   3rd Qu.: 0.0000
Max.   :12.5000     Max.   :0.100000   Max.   :0.10000   Max.   :12.5000
carex_rariflora   loiseleuria_procumbens salix_arctophila festuca_brachyphylla
Min.   : 0.0000   Min.   :0.00000        Min.   : 0.000   Min.   :0.000000
1st Qu.: 0.0000   1st Qu.:0.00000        1st Qu.: 0.000   1st Qu.:0.000000
Median : 0.0000   Median :0.00000        Median : 0.000   Median :0.000000
Mean   : 0.9207   Mean   :0.06098        Mean   : 1.155   Mean   :0.002561
3rd Qu.: 0.0000   3rd Qu.:0.00000        3rd Qu.: 0.000   3rd Qu.:0.000000
Max.   :62.5000   Max.   :2.50000        Max.   :62.500   Max.   :0.100000
ledum_groenlandicum lycopodium_annotinum eriophorum_angustifolium
Min.   : 0.0000     Min.   : 0.000       Min.   :0.00000
1st Qu.: 0.0000     1st Qu.: 0.000       1st Qu.:0.00000
Median : 0.0000     Median : 0.000       Median :0.00000
Mean   : 0.3976     Mean   : 1.824       Mean   :0.07927
3rd Qu.: 0.0000     3rd Qu.: 0.100       3rd Qu.:0.00000
Max.   :12.5000     Max.   :62.500       Max.   :2.50000
chamaenerion_latifolium rhodiola_rosea    calamagrostis_langsdorfii
Min.   :0.00000         Min.   :0.00000   Min.   : 0.0000
1st Qu.:0.00000         1st Qu.:0.00000   1st Qu.: 0.0000
Median :0.00000         Median :0.00000   Median : 0.0000
Mean   :0.00122         Mean   :0.00122   Mean   : 0.7756
3rd Qu.:0.00000         3rd Qu.:0.00000   3rd Qu.: 0.0000
Max.   :0.10000         Max.   :0.10000   Max.   :37.5000
juniperus_communis diphasiastrum_complanatum campanula_gieseckiana
Min.   :0.00000    Min.   :0.00000           Min.   :0.0000
1st Qu.:0.00000    1st Qu.:0.00000           1st Qu.:0.0000
Median :0.00000    Median :0.00000           Median :0.0000
Mean   :0.00122    Mean   :0.03049           Mean   :0.0122
3rd Qu.:0.00000    3rd Qu.:0.00000           3rd Qu.:0.0000
Max.   :0.10000    Max.   :2.50000           Max.   :0.5000
luzula_parviflora gymnocarpium_dryopteris taraxacum_croceum
Min.   :0.0000    Min.   :0.00000         Min.   :0.00000
1st Qu.:0.0000    1st Qu.:0.00000         1st Qu.:0.00000
Median :0.0000    Median :0.00000         Median :0.00000
Mean   :0.0378    Mean   :0.06951         Mean   :0.04049
3rd Qu.:0.0000    3rd Qu.:0.00000         3rd Qu.:0.00000
Max.   :2.5000    Max.   :2.50000         Max.   :2.50000
linnaea_borealis_ssp_americana deschampsia_alpina sibbaldia_procumbens
Min.   :0.00000                Min.   : 0.0000    Min.   :0.0000
1st Qu.:0.00000                1st Qu.: 0.0000    1st Qu.:0.0000
Median :0.00000                Median : 0.0000    Median :0.0000
Mean   :0.01354                Mean   : 0.1829    Mean   :0.0122
3rd Qu.:0.00000                3rd Qu.: 0.0000    3rd Qu.:0.0000
Max.   :0.50000                Max.   :12.5000    Max.   :0.5000
listera_cordata   potentilla_tridentata carex_brunnescens  tofieldia_pusilla
Min.   :0.00000   Min.   :0.000000      Min.   :0.000000   Min.   :0.00000
1st Qu.:0.00000   1st Qu.:0.000000      1st Qu.:0.000000   1st Qu.:0.00000
Median :0.00000   Median :0.000000      Median :0.000000   Median :0.00000
Mean   :0.03659   Mean   :0.002561      Mean   :0.006098   Mean   :0.00122
3rd Qu.:0.00000   3rd Qu.:0.000000      3rd Qu.:0.000000   3rd Qu.:0.00000
Max.   :2.50000   Max.   :0.100000      Max.   :0.500000   Max.   :0.10000
dryopteris_assimilis diphasiastrum_alpinum pyrola_grandiflora
Min.   :0.000000     Min.   :0.00000       Min.   :0.000000
1st Qu.:0.000000     1st Qu.:0.00000       1st Qu.:0.000000
Median :0.000000     Median :0.00000       Median :0.000000
Mean   :0.006098     Mean   :0.03659       Mean   :0.007317
3rd Qu.:0.000000     3rd Qu.:0.00000       3rd Qu.:0.000000
```

```
 Max.   :0.500000     Max.   :2.50000       Max.   :0.500000
 potentilla_crantzii poa_pratensis      carex_scirpoidea   bartsia_alpina
 Min.   :0.00000     Min.   :0.000000   Min.   :0.000000   Min.   :0.000000
 1st Qu.:0.00000     1st Qu.:0.000000   1st Qu.:0.000000   1st Qu.:0.000000
 Median :0.00000     Median :0.000000   Median :0.000000   Median :0.000000
 Mean   :0.00122     Mean   :0.006098   Mean   :0.007317   Mean   :0.008537
 3rd Qu.:0.00000     3rd Qu.:0.000000   3rd Qu.:0.000000   3rd Qu.:0.000000
 Max.   :0.10000     Max.   :0.100000   Max.   :0.500000   Max.   :0.500000
 coptis_trifolia   veronica_wormskjoldii agrostis_mertensii
 Min.   :0.00000   Min.   :0.000000      Min.   :0.000000
 1st Qu.:0.00000   1st Qu.:0.000000      1st Qu.:0.000000
 Median :0.00000   Median :0.000000      Median :0.000000
 Mean   :0.08171   Mean   :0.009756      Mean   :0.002439
 3rd Qu.:0.00000   3rd Qu.:0.000000      3rd Qu.:0.000000
 Max.   :2.50000   Max.   :0.500000      Max.   :0.100000
 harrimanella_hypnoides diapensia_lapponica stellaria_calycantha
 Min.   :0.00000        Min.   :0.00000     Min.   :0.00000
 1st Qu.:0.00000        1st Qu.:0.00000     1st Qu.:0.00000
 Median :0.00000        Median :0.00000     Median :0.00000
 Mean   :0.00122        Mean   :0.03049     Mean   :0.00622
 3rd Qu.:0.00000        3rd Qu.:0.00000     3rd Qu.:0.00000
 Max.   :0.10000        Max.   :2.50000     Max.   :0.50000
 scirpis_caespitosus chamaenerion_angustifolium alchemilla_alpina
 Min.   :0.00000     Min.   :0.000000           Min.   :0.00000
 1st Qu.:0.00000     1st Qu.:0.000000           1st Qu.:0.00000
 Median :0.00000     Median :0.000000           Median :0.00000
 Mean   :0.00122     Mean   :0.001341           Mean   :0.03049
 3rd Qu.:0.00000     3rd Qu.:0.000000           3rd Qu.:0.00000
 Max.   :0.10000     Max.   :0.100000           Max.   :2.50000
 pedicularis_lapponica viscaria_alpina   pedicularis_flammea
 Min.   :0.00000       Min.   :0.00000   Min.   :0.00000
 1st Qu.:0.00000       1st Qu.:0.00000   1st Qu.:0.00000
 Median :0.00000       Median :0.00000   Median :0.00000
 Mean   :0.00122       Mean   :0.00122   Mean   :0.00122
 3rd Qu.:0.00000       3rd Qu.:0.00000   3rd Qu.:0.00000
 Max.   :0.10000       Max.   :0.10000   Max.   :0.10000
 equisetum_silvaticum hieracium_hyparcticum poa_nemoralis       bryophyte
 Min.   :0.00000      Min.   :0.000000      Min.   :0.00000   Min.   : 0.00
 1st Qu.:0.00000      1st Qu.:0.000000      1st Qu.:0.00000   1st Qu.:37.50
 Median :0.00000      Median :0.000000      Median :0.00000   Median :62.50
 Mean   :0.00122      Mean   :0.002561      Mean   :0.00122   Mean   :54.97
 3rd Qu.:0.00000      3rd Qu.:0.000000      3rd Qu.:0.00000   3rd Qu.:87.50
 Max.   :0.10000      Max.   :0.100000      Max.   :0.10000   Max.   :87.50
     lichen        bareground
 Min.   : 0.00   Min.   : 0.000
 1st Qu.: 0.00   1st Qu.: 0.000
 Median : 2.50   Median : 0.000
 Mean   :15.18   Mean   : 4.019
 3rd Qu.:12.50   3rd Qu.: 2.000
 Max.   :87.50   Max.   :37.500
```

```
sum(is.na(pca_stat_veg))
```

```
[1] 0
```

```
library(remotes)
#install_github("rwehrens/ChemometricsWithR")
library(ChemometricsWithR)
mp.PC.veg<- PCA(scale(pca_stat_veg))
names(mp.PC.veg)
```

```
[1] "scores"        "loadings"      "var"           "totalvar"
[5] "centered.data"
```

```
summary(mp.PC.veg)
```

```
PCA model of a mean-centered matrix of 82 by 70
Number of PCs to cover 90 percent of the variance: 34

           Var Cumul. var.
PC 1  7.550717    7.550717
PC 2  6.314912   13.865630
PC 3  5.575033   19.440663
PC 4  4.601075   24.041738
PC 5  4.179206   28.220943
PC 10 3.050795   45.216020
```

```
summary(pca_stat_veg)
```

```
 scirpus_caespitosus  salix_glauca    empetrum_nigrum  betula_nana
 Min.   : 0.000      Min.   : 0.000   Min.   : 0.00   Min.   : 0.000
 1st Qu.: 0.000      1st Qu.: 0.000   1st Qu.: 0.50   1st Qu.: 0.000
 Median : 0.000      Median : 0.005   Median :25.00   Median : 0.000
 Mean   : 0.305      Mean   :16.003   Mean   :31.12   Mean   : 6.478
 3rd Qu.: 0.000      3rd Qu.:12.500   3rd Qu.:62.50   3rd Qu.: 0.100
 Max.   :12.500      Max.   :87.500   Max.   :87.50   Max.   :87.500
 salix_herbacea   carex_bigelowii  vaccinium_uliginosum oxyria_digyna
 Min.   : 0.000   Min.   : 0.000   Min.   : 0.000       Min.   :0.00000
 1st Qu.: 0.000   1st Qu.: 0.000   1st Qu.: 0.000       1st Qu.:0.00000
 Median : 0.000   Median : 0.100   Median : 0.050       Median :0.00000
 Mean   : 2.555   Mean   : 2.526   Mean   : 7.294       Mean   :0.03793
 3rd Qu.: 0.000   3rd Qu.: 0.500   3rd Qu.:10.000       3rd Qu.:0.00000
 Max.   :87.500   Max.   :62.500   Max.   :87.500       Max.   :2.50000
 huperzia_selago    gnaphalium_supinum   poa_alpina        poa_glauca
 Min.   :0.000000   Min.   :0.000000   Min.   :0.00000   Min.   :0.000000
 1st Qu.:0.000000   1st Qu.:0.000000   1st Qu.:0.00000   1st Qu.:0.000000
 Median :0.000000   Median :0.000000   Median :0.00000   Median :0.000000
 Mean   :0.008902   Mean   :0.007317   Mean   :0.00122   Mean   :0.002439
 3rd Qu.:0.000000   3rd Qu.:0.000000   3rd Qu.:0.00000   3rd Qu.:0.000000
 Max.   :0.100000   Max.   :0.100000   Max.   :0.10000   Max.   :0.100000
 saxifraga_oppositifolia juncus_trifidus   angelica_archangelica
 Min.   :0.00000         Min.   : 0.0000   Min.   :0.00000
 1st Qu.:0.00000         1st Qu.: 0.0000   1st Qu.:0.00000
 Median :0.00000         Median : 0.0000   Median :0.00000
 Mean   :0.00122         Mean   : 0.3817   Mean   :0.03171
 3rd Qu.:0.00000         3rd Qu.: 0.0000   3rd Qu.:0.00000
 Max.   :0.10000         Max.   :12.5000   Max.   :2.50000
 luzula_spicata     deschampsia_flexuosa polygonum_viviparum
 Min.   :0.000000   Min.   : 0.000       Min.   :0.0000
 1st Qu.:0.000000   1st Qu.: 0.000       1st Qu.:0.0000
 Median :0.000000   Median : 0.000       Median :0.0000
 Mean   :0.004878   Mean   : 2.779       Mean   :0.1015
 3rd Qu.:0.000000   3rd Qu.: 2.500       3rd Qu.:0.0000
 Max.   :0.100000   Max.   :37.500       Max.   :2.5000
 phyllodoce_coerulea luzula_multiflora  luzula_confusa    silene_acaulis
 Min.   : 0.0000     Min.   :0.000000   Min.   :0.00000   Min.   : 0.0000
 1st Qu.: 0.0000     1st Qu.:0.000000   1st Qu.:0.00000   1st Qu.: 0.0000
 Median : 0.0000     Median :0.000000   Median :0.00000   Median : 0.0000
 Mean   : 0.3416     Mean   :0.003659   Mean   :0.00122   Mean   : 0.1537
```

```
3rd Qu.: 0.0000     3rd Qu.:0.000000   3rd Qu.:0.00000   3rd Qu.: 0.0000
Max.   :12.5000     Max.   :0.100000   Max.   :0.10000   Max.   :12.5000
carex_rariflora   loiseleuria_procumbens salix_arctophila festuca_brachyphylla
Min.   : 0.0000   Min.   :0.00000        Min.   : 0.000   Min.   :0.000000
1st Qu.: 0.0000   1st Qu.:0.00000        1st Qu.: 0.000   1st Qu.:0.000000
Median : 0.0000   Median :0.00000        Median : 0.000   Median :0.000000
Mean   : 0.9207   Mean   :0.06098        Mean   : 1.155   Mean   :0.002561
3rd Qu.: 0.0000   3rd Qu.:0.00000        3rd Qu.: 0.000   3rd Qu.:0.000000
Max.   :62.5000   Max.   :2.50000        Max.   :62.500   Max.   :0.100000
ledum_groenlandicum lycopodium_annotinum eriophorum_angustifolium
Min.   : 0.0000     Min.   : 0.000       Min.   :0.00000
1st Qu.: 0.0000     1st Qu.: 0.000       1st Qu.:0.00000
Median : 0.0000     Median : 0.000       Median :0.00000
Mean   : 0.3976     Mean   : 1.824       Mean   :0.07927
3rd Qu.: 0.0000     3rd Qu.: 0.100       3rd Qu.:0.00000
Max.   :12.5000     Max.   :62.500       Max.   :2.50000
chamaenerion_latifolium rhodiola_rosea    calamagrostis_langsdorfii
Min.   :0.00000         Min.   :0.00000   Min.   : 0.0000
1st Qu.:0.00000         1st Qu.:0.00000   1st Qu.: 0.0000
Median :0.00000         Median :0.00000   Median : 0.0000
Mean   :0.00122         Mean   :0.00122   Mean   : 0.7756
3rd Qu.:0.00000         3rd Qu.:0.00000   3rd Qu.: 0.0000
Max.   :0.10000         Max.   :0.10000   Max.   :37.5000
juniperus_communis diphasiastrum_complanatum campanula_gieseckiana
Min.   :0.00000    Min.   :0.00000           Min.   :0.0000
1st Qu.:0.00000    1st Qu.:0.00000           1st Qu.:0.0000
Median :0.00000    Median :0.00000           Median :0.0000
Mean   :0.00122    Mean   :0.03049           Mean   :0.0122
3rd Qu.:0.00000    3rd Qu.:0.00000           3rd Qu.:0.0000
Max.   :0.10000    Max.   :2.50000           Max.   :0.5000
luzula_parviflora gymnocarpium_dryopteris taraxacum_croceum
Min.   :0.0000    Min.   :0.00000         Min.   :0.00000
1st Qu.:0.0000    1st Qu.:0.00000         1st Qu.:0.00000
Median :0.0000    Median :0.00000         Median :0.00000
Mean   :0.0378    Mean   :0.06951         Mean   :0.04049
3rd Qu.:0.0000    3rd Qu.:0.00000         3rd Qu.:0.00000
Max.   :2.5000    Max.   :2.50000         Max.   :2.50000
linnaea_borealis_ssp_americana deschampsia_alpina sibbaldia_procumbens
Min.   :0.00000                Min.   : 0.0000    Min.   :0.0000
1st Qu.:0.00000                1st Qu.: 0.0000    1st Qu.:0.0000
Median :0.00000                Median : 0.0000    Median :0.0000
Mean   :0.01354                Mean   : 0.1829    Mean   :0.0122
3rd Qu.:0.00000                3rd Qu.: 0.0000    3rd Qu.:0.0000
Max.   :0.50000                Max.   :12.5000    Max.   :0.5000
listera_cordata   potentilla_tridentata carex_brunnescens  tofieldia_pusilla
Min.   :0.00000   Min.   :0.000000      Min.   :0.000000   Min.   :0.00000
1st Qu.:0.00000   1st Qu.:0.000000      1st Qu.:0.000000   1st Qu.:0.00000
Median :0.00000   Median :0.000000      Median :0.000000   Median :0.00000
Mean   :0.03659   Mean   :0.002561      Mean   :0.006098   Mean   :0.00122
3rd Qu.:0.00000   3rd Qu.:0.000000      3rd Qu.:0.000000   3rd Qu.:0.00000
Max.   :2.50000   Max.   :0.100000      Max.   :0.500000   Max.   :0.10000
dryopteris_assimilis diphasiastrum_alpinum pyrola_grandiflora
Min.   :0.000000     Min.   :0.00000       Min.   :0.000000
1st Qu.:0.000000     1st Qu.:0.00000       1st Qu.:0.000000
Median :0.000000     Median :0.00000       Median :0.000000
Mean   :0.006098     Mean   :0.03659       Mean   :0.007317
3rd Qu.:0.000000     3rd Qu.:0.00000       3rd Qu.:0.000000
Max.   :0.500000     Max.   :2.50000       Max.   :0.500000
potentilla_crantzii poa_pratensis      carex_scirpoidea   bartsia_alpina
Min.   :0.00000     Min.   :0.000000   Min.   :0.000000   Min.   :0.000000
1st Qu.:0.00000     1st Qu.:0.000000   1st Qu.:0.000000   1st Qu.:0.000000
```

```
 Median :0.00000     Median :0.000000   Median :0.000000   Median :0.000000
 Mean   :0.00122     Mean   :0.006098   Mean   :0.007317   Mean   :0.008537
 3rd Qu.:0.00000     3rd Qu.:0.000000   3rd Qu.:0.000000   3rd Qu.:0.000000
 Max.   :0.10000     Max.   :0.100000   Max.   :0.500000   Max.   :0.500000
 coptis_trifolia   veronica_wormskjoldii agrostis_mertensii
 Min.   :0.00000   Min.   :0.000000      Min.   :0.000000
 1st Qu.:0.00000   1st Qu.:0.000000      1st Qu.:0.000000
 Median :0.00000   Median :0.000000      Median :0.000000
 Mean   :0.08171   Mean   :0.009756      Mean   :0.002439
 3rd Qu.:0.00000   3rd Qu.:0.000000      3rd Qu.:0.000000
 Max.   :2.50000   Max.   :0.500000      Max.   :0.100000
 harrimanella_hypnoides diapensia_lapponica stellaria_calycantha
 Min.   :0.00000        Min.   :0.00000     Min.   :0.00000
 1st Qu.:0.00000        1st Qu.:0.00000     1st Qu.:0.00000
 Median :0.00000        Median :0.00000     Median :0.00000
 Mean   :0.00122        Mean   :0.03049     Mean   :0.00622
 3rd Qu.:0.00000        3rd Qu.:0.00000     3rd Qu.:0.00000
 Max.   :0.10000        Max.   :2.50000     Max.   :0.50000
 scirpis_caespitosus chamaenerion_angustifolium alchemilla_alpina
 Min.   :0.00000     Min.   :0.000000           Min.   :0.00000
 1st Qu.:0.00000     1st Qu.:0.000000           1st Qu.:0.00000
 Median :0.00000     Median :0.000000           Median :0.00000
 Mean   :0.00122     Mean   :0.001341           Mean   :0.03049
 3rd Qu.:0.00000     3rd Qu.:0.000000           3rd Qu.:0.00000
 Max.   :0.10000     Max.   :0.100000           Max.   :2.50000
 pedicularis_lapponica viscaria_alpina   pedicularis_flammea
 Min.   :0.00000       Min.   :0.00000   Min.   :0.00000
 1st Qu.:0.00000       1st Qu.:0.00000   1st Qu.:0.00000
 Median :0.00000       Median :0.00000   Median :0.00000
 Mean   :0.00122       Mean   :0.00122   Mean   :0.00122
 3rd Qu.:0.00000       3rd Qu.:0.00000   3rd Qu.:0.00000
 Max.   :0.10000       Max.   :0.10000   Max.   :0.10000
 equisetum_silvaticum hieracium_hyparcticum poa_nemoralis       bryophyte
 Min.   :0.00000      Min.   :0.000000      Min.   :0.00000   Min.   : 0.00
 1st Qu.:0.00000      1st Qu.:0.000000      1st Qu.:0.00000   1st Qu.:37.50
 Median :0.00000      Median :0.000000      Median :0.00000   Median :62.50
 Mean   :0.00122      Mean   :0.002561      Mean   :0.00122   Mean   :54.97
 3rd Qu.:0.00000      3rd Qu.:0.000000      3rd Qu.:0.00000   3rd Qu.:87.50
 Max.   :0.10000      Max.   :0.100000      Max.   :0.10000   Max.   :87.50
     lichen        bareground
 Min.   : 0.00   Min.   : 0.000
 1st Qu.: 0.00   1st Qu.: 0.000
 Median : 2.50   Median : 0.000
 Mean   :15.18   Mean   : 4.019
 3rd Qu.:12.50   3rd Qu.: 2.000
 Max.   :87.50   Max.   :37.500
```

```
head(pca_stat_veg)
```

```
# A tibble: 6 x 70
  scirpus_caespitosus salix_glauca empetrum_nigrum betula_nana salix_herbacea
                <dbl>        <dbl>           <dbl>       <dbl>          <dbl>
1                12.5          0              0.5         0                 0
2                 0           37.5            37.5         0                 0
3                 0            0              12.5        37.5               0
4                 0            0               0.5        37.5               0
5                 0           12.5            62.5         0                 0
6                 0            0              87.5        62.5               0
# i 65 more variables: carex_bigelowii <dbl>, vaccinium_uliginosum <dbl>,
#   oxyria_digyna <dbl>, huperzia_selago <dbl>, gnaphalium_supinum <dbl>,
```

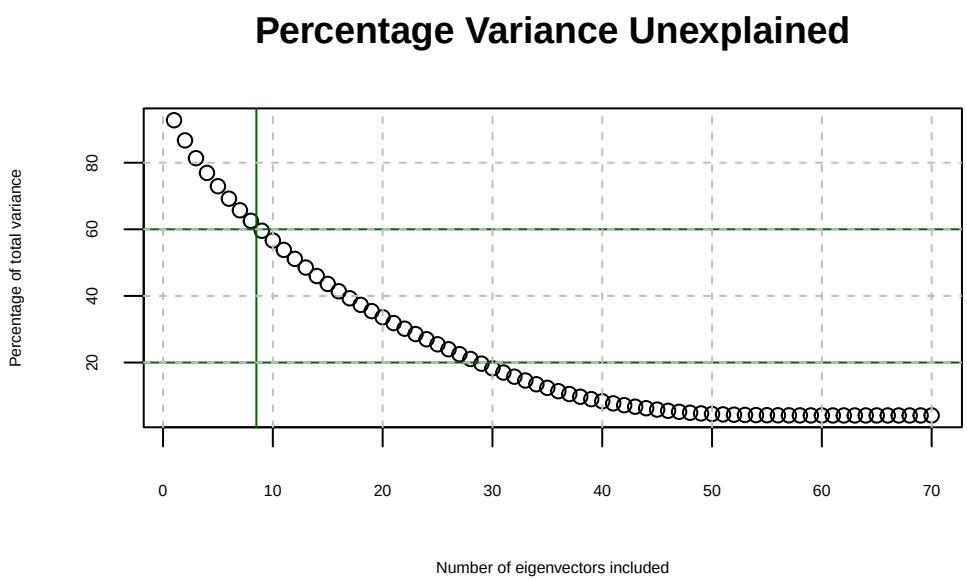
```
#   poa_alpina <dbl>, poa_glauca <dbl>, saxifraga_oppositifolia <dbl>,
#   juncus_trifidus <dbl>, angelica_archangelica <dbl>, luzula_spicata <dbl>,
#   deschampsia_flexuosa <dbl>, polygonum_viviparum <dbl>,
#   phyllodoce_coerulea <dbl>, luzula_multiflora <dbl>, luzula_confusa <dbl>,
#   silene_acaulis <dbl>, carex_rariflora <dbl>, ...
```

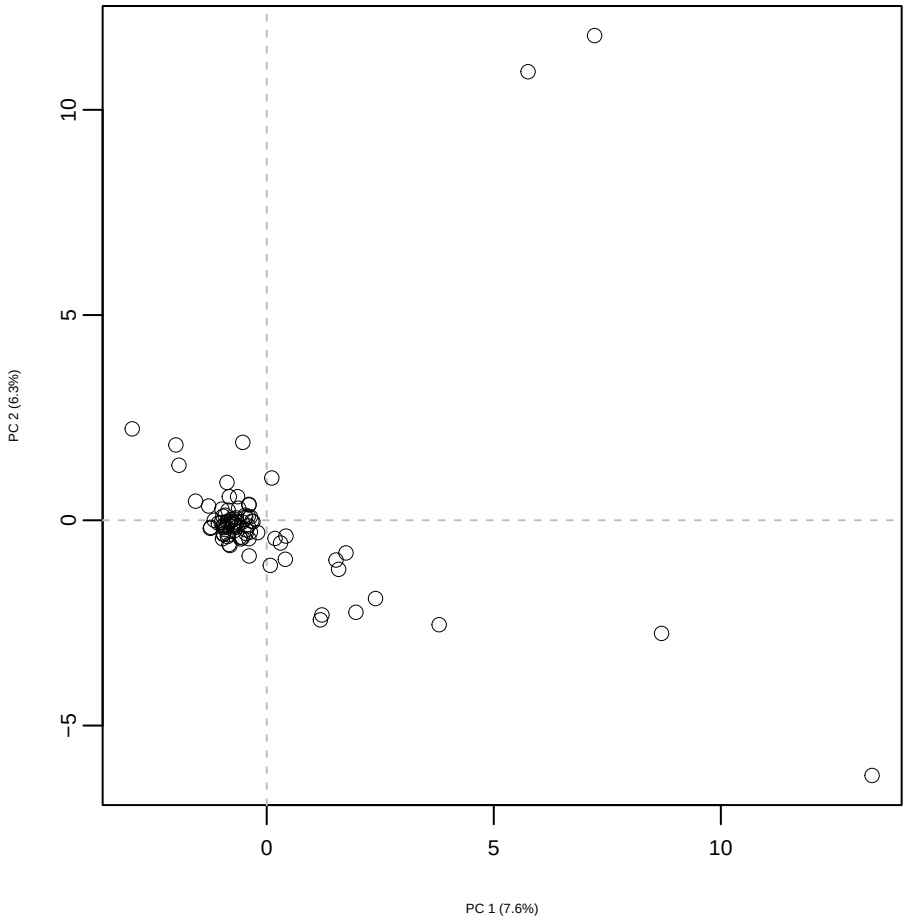
```
head(mp.PC.veg$loadings,n=3)
```

```
                          PC 1         PC 2        PC 3         PC 4
scirpus_caespitosus -0.01777596  0.001930689  0.03366522 -0.012228935
salix_glauca        -0.10844366  0.088700969 -0.30371207 -0.003266266
empetrum_nigrum     -0.13971239 -0.039741263  0.12052723 -0.103977033
                          PC 5        PC 6         PC 7        PC 8
scirpus_caespitosus 0.059963421 -0.01255231  0.007047585 -0.16416675
salix_glauca        0.002489245 -0.05845279 -0.055607414  0.00154211
empetrum_nigrum     0.131615094  0.09541861 -0.130288505  0.10400621
                          PC 9       PC 10       PC 11       PC 12       PC 13
scirpus_caespitosus  0.08666394 -0.15322789  0.08303443 -0.04819266  0.18987740
salix_glauca        -0.03563689  0.09168562 -0.07877487  0.01406448 -0.01045454
empetrum_nigrum     -0.08637798 -0.07086811  0.09153534 -0.23335654 -0.14297846
                         PC 14      PC 15      PC 16      PC 17     PC 18
scirpus_caespitosus -0.316210294 0.25089163  0.3700718 -0.1788046 0.1504676
salix_glauca         0.092512159 0.05641348  0.1059259  0.3053403 0.1455673
empetrum_nigrum     -0.004019566 0.04697129 -0.1961241  0.0119629 0.1842251
                          PC 19       PC 20        PC 21      PC 22       PC 23
scirpus_caespitosus -0.04241585 -0.08898912  0.062586913 0.01016234  0.04259817
salix_glauca         0.15821781  0.03490987  0.047036850 0.12288715  0.11882021
empetrum_nigrum     -0.29181119  0.09384167 -0.001332588 0.03848413 -0.01864729
                          PC 24        PC 25        PC 26        PC 27
scirpus_caespitosus -0.01855799 -0.006387973 -0.001452882 -0.002048265
salix_glauca        -0.04652944 -0.025410511 -0.098319324  0.042537189
empetrum_nigrum      0.06617746 -0.092229669  0.066758040 -0.047029046
                           PC 28        PC 29        PC 30        PC 31
scirpus_caespitosus -0.0006551481 -0.002315081 -0.003666406  0.005936386
salix_glauca         0.0194383658 -0.046355614 -0.010003626 -0.005014321
empetrum_nigrum      0.0483169640 -0.019579450 -0.011848178 -0.071782670
                         PC 32       PC 33       PC 34        PC 35       PC 36
scirpus_caespitosus 0.01204488  0.04825840 -0.01377625 -0.001942682 -0.02815833
salix_glauca        0.03428257 -0.03323756 -0.04261381 -0.075833375 -0.01891926
empetrum_nigrum     0.07877633 -0.08570779 -0.03206182 -0.147810379  0.01827638
                          PC 37       PC 38       PC 39       PC 40       PC 41
scirpus_caespitosus  0.03205584  0.01327067 -0.09871165 0.057852591  0.06993483
salix_glauca        -0.09982908 -0.04345207 -0.13270127 0.004897766  0.35374354
empetrum_nigrum      0.03863635 -0.02560902  0.32332442 0.193597539 -0.15466935
                          PC 42      PC 43       PC 44       PC 45       PC 46
scirpus_caespitosus  0.16626584 -0.1105789 -0.12902179  0.51103357  0.12831814
salix_glauca         0.03608272 -0.2353430 -0.01037426 -0.32905151  0.22264549
empetrum_nigrum     -0.12173946  0.1602991  0.04405002 -0.07389471 -0.06396656
                          PC 47      PC 48      PC 49       PC 50       PC 51
scirpus_caespitosus -0.09406194 -0.3774287 0.07974512 -0.06599237 -0.01557471
salix_glauca        -0.15824561 -0.2871817 0.09223065  0.16943127  0.34023802
empetrum_nigrum     -0.03198759 -0.4197614 0.26230861  0.30059551 -0.03866576
                          PC 52        PC 53        PC 54       PC 55
scirpus_caespitosus  0.008774034  0.022082715  0.003733800 -0.01121612
salix_glauca         0.054580548 -0.083966480 -0.008173121  0.02478228
empetrum_nigrum     -0.028705471  0.003989776 -0.044270842 -0.04915442
                          PC 56       PC 57       PC 58        PC 59
scirpus_caespitosus -0.026158742  0.01828231 0.007674634  0.002221215
salix_glauca        -0.040602483  0.01587486 0.006699653  0.008261292
empetrum_nigrum     -0.005652732 -0.03250632 0.049361703 -0.013646935
```

```
                          PC 60        PC 61         PC 62         PC 63
scirpus_caespitosus  0.001366782  0.004369205  0.0058528418  0.0001668317
salix_glauca        -0.014504074  0.022686148 -0.0003160379  0.0000881175
empetrum_nigrum     -0.028496789 -0.029858189  0.0092594428 -0.0001673844
                          PC 64        PC 65         PC 66        PC 67
scirpus_caespitosus  4.597649e-16 0.000000e+00  0.000000e+00 0.000000e+00
salix_glauca         1.818237e-16 1.173670e-16 -1.191142e-16 3.632569e-17
empetrum_nigrum     -1.783275e-16 2.645788e-16 -1.738992e-16 1.380965e-16
                          PC 68         PC 69        PC 70
scirpus_caespitosus  0.000000e+00  0.000000e+00 0.000000e+00
salix_glauca        -2.621512e-18 -1.332308e-16 9.675125e-17
empetrum_nigrum     -7.795603e-18 -1.957626e-16 1.440473e-16
```

```
#| label: plot-percentage-variance-unexplained-veg
#| echo: false
#| out-width: 100%

par(cex.axis = 0.5, cex.lab = 0.5)
plot(100*(73-cumsum(diag(Lambda.veg)))/73,type="b",
main="Percentage Variance Unexplained",
xlab='Number of eigenvectors included',
ylab='Percentage of total variance',
 cex.axis = 0.5) # Reduce size of axis text)
abline(h = 20, col = "darkgreen")
abline(h = 60, col = "darkgreen")
abline(v = 8.5, col = "darkgreen")
grid(nx = NULL, ny = NULL,
     lty = 2,      # Grid line type
     col = "gray", # Grid line color
     lwd = 1)      # Grid line width
```





PCA only veg with ggplot

```
#| label: pca-plotting-ggplot
#| code-fold: true
#| echo: false
#| output: true
#| include: true
#| out-width: 100%


# X <- scale(pca_stat_veg)
# pca_stat_veg_ggplot <- PCA(X)
#
# pca_stat_veg_ggplot
#
# # Extract scores
# scores <- as.data.frame(pca_stat_veg_ggplot$scores)
# scores$plots <- row.names(pca_stat_veg)
#
# # Extract loadings
# loadings <- as.data.frame(pca_stat_veg_ggplot$loadings)
# loadings$taxon <- rownames(loadings)
#
# pca_summary_veg <- as.data.frame(summary(pca_stat_veg_ggplot))
#
#
# #library("devtools")
# #install_github("kassambara/factoextra")
```

```
#
# library("factoextra")
# get_pca(res.pca, element = c("var", "ind"))
#
# # Calculate variance explained
# eigenvals <- pca_stat_veg_ggplot@var
# var_percent <- (eigenvals/sum(eigenvals)) * 100
#
# # Score plot showing plot distribution
# ggplot(scores, aes(x = `PC 1`, y = `PC2`)) +
#   geom_point(size = 3) +
#   geom_text(aes(label = Plot_ID), vjust = -0.5, size = 3) +
#   theme_minimal() +
#   labs(title = "PCA Score Plot of Vegetation Plots",
#        x = paste0("PC1 (", round(pca_stat_veg_ggplot@R2[1]*100, 1), "%)"),
#        y = paste0("PC2 (", round(pca_stat_veg_ggplot@R2[2]*100, 1), "%)"))
#
# # Species loading plot
# ggplot(loadings, aes(x = PC1, y = PC2)) +
#   geom_segment(aes(x = 0, y = 0, xend = PC1, yend = PC2),
#                arrow = arrow(length = unit(0.2, "cm"))) +
#   geom_text(aes(label = Species), size = 3, vjust = 1) +
#   coord_fixed() +
#   theme_minimal() +
#   labs(title = "Species Contributions to PCA Components")
```

Conclusion

Appendix

```
taxon_counts <- table(stat_mappingplants$taxon)

# Convert to a data frame for easier manipulation
taxon_summary <- data.frame(
  Taxon = names(taxon_counts),
  Count = as.vector(taxon_counts)
)

taxon_summary <- taxon_summary[order(-taxon_summary$Count), ]
```

The client

The client, i.e. the receiver, of this report is my future self. I have basic understanding of statistics, statistical methods, and want to further my expertise in this areas both to explore the data I collect and have available as well as to document known phenomena of this same data. I have advance knowledge in biology and ecology. I do not have extensive of intuitive understanding of statistics and this report is aimed at document the learning outcomes of the data processing with the purpose of statistical reporting.

It is my interest to gain an applied and hand on approach to statistics, answer the reserach question at hand, explore the data I have collected

- What does the client already know? (basic/advanced science on the subject, statistical methods, project circumstances)
- What does the client not know? (basic/advanced science on the subject, statistical methods, project circumstances)
- What is the interest of the Client? (research question, p-values, effect parameters, issues with data handling)
- What is NOT the interest of the Client? (R code, issues with data handling, intermediate analyses)
- Adapt the contents and structure (not the results though) to fit the knowledge and interests of the Client.