

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

Ida Bomholt Dyrholm Jacobsen

Summary

Table of contents

| | |
|------------------------------------|-----------|
| Summary | 1 |
| Introduction | 3 |
| Description of data | 4 |
| Scientific question | 5 |
| Statistical analyses | 6 |
| results | 6 |
| Discussion | 6 |
| GAM for soilmoisture | 7 |
| Sal gla | 7 |
| Des fle | 8 |
| PCA all data | 8 |
| PCA only vegetated data | 15 |
| PCA only veg with ggplot | 25 |
| Conclusion | 27 |
| Appendix | 28 |
| The client | 28 |

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 approximately 12 km² by randomised stratified sampling. Stratification was based on elevation (5 bins) and NDVI (4 bins).

Within each circular plot of 1 m² 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 choice 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 fulfilled? 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

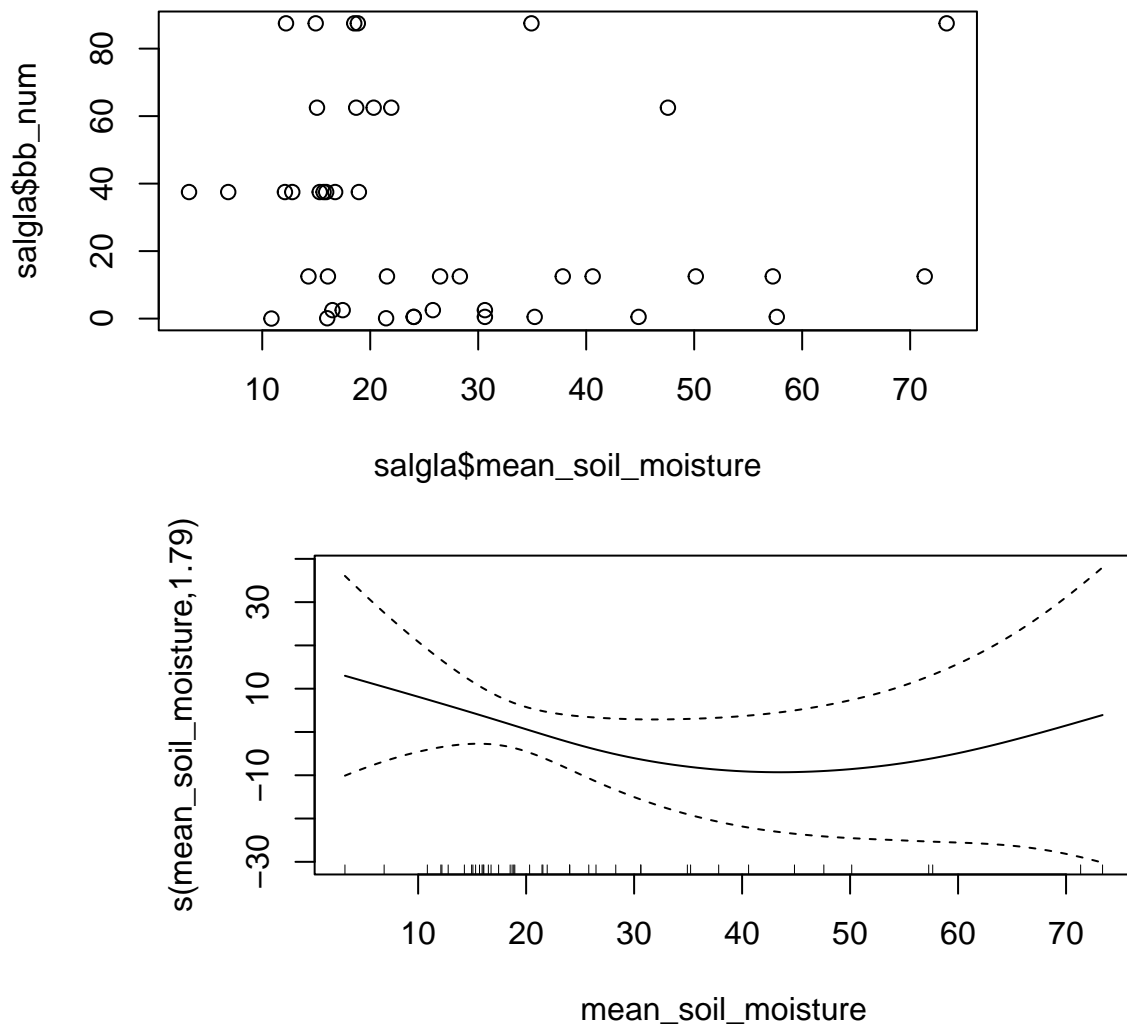


Figure 1: Plot of GAM model for soil moisture and abundance of *Salix glauca*. P-value is 0.366 at 95 % level.

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

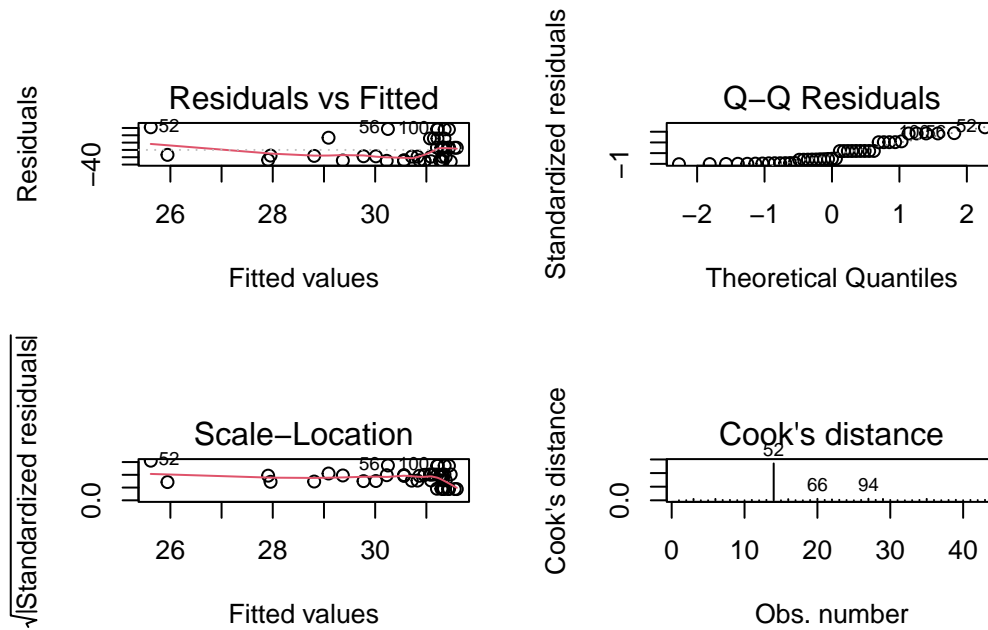


Figure 2: Diagnosticsplot of

Des fle

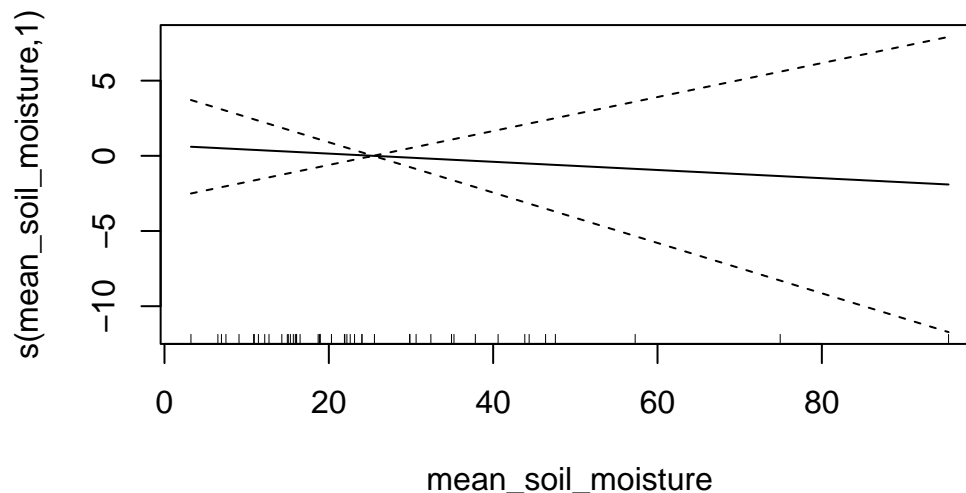


Figure 3: Plot of GAM model for soil moisture and abundance of *Deschampsia flexuosa*. P-value is 0.699 at 95 % level.

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 necessary to describe the differences of the plots. Some occurrences might be redundant in explaining 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 characteristics. 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 | |

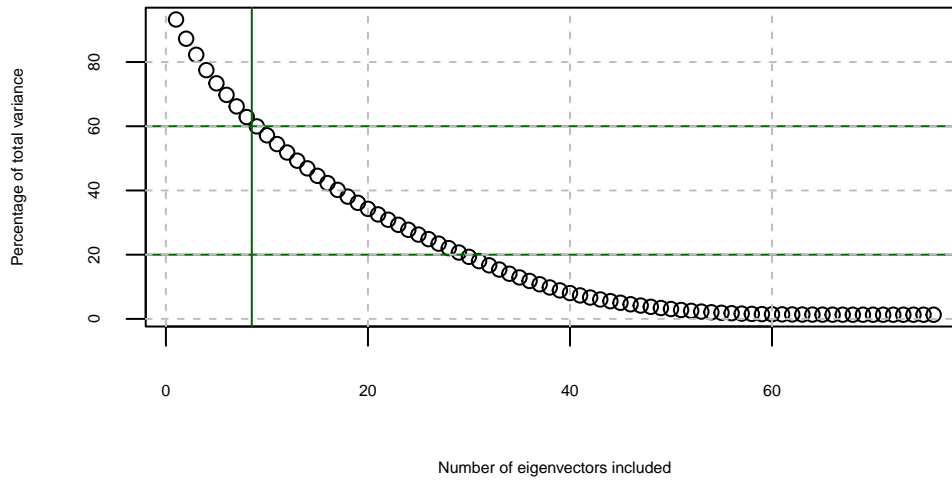
| | | | | | |
|---------------------|---------------|---------------|---------------|---------------|-------------|
| scirpus_caespitosus | 0.004111769 | 0.003558343 | 0.003401163 | -0.030120357 | |
| salix_glauca | 0.026392798 | 0.021818894 | -0.005471512 | -0.003555740 | |
| empetrum_nigrum | -0.009586569 | 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 | | | | |

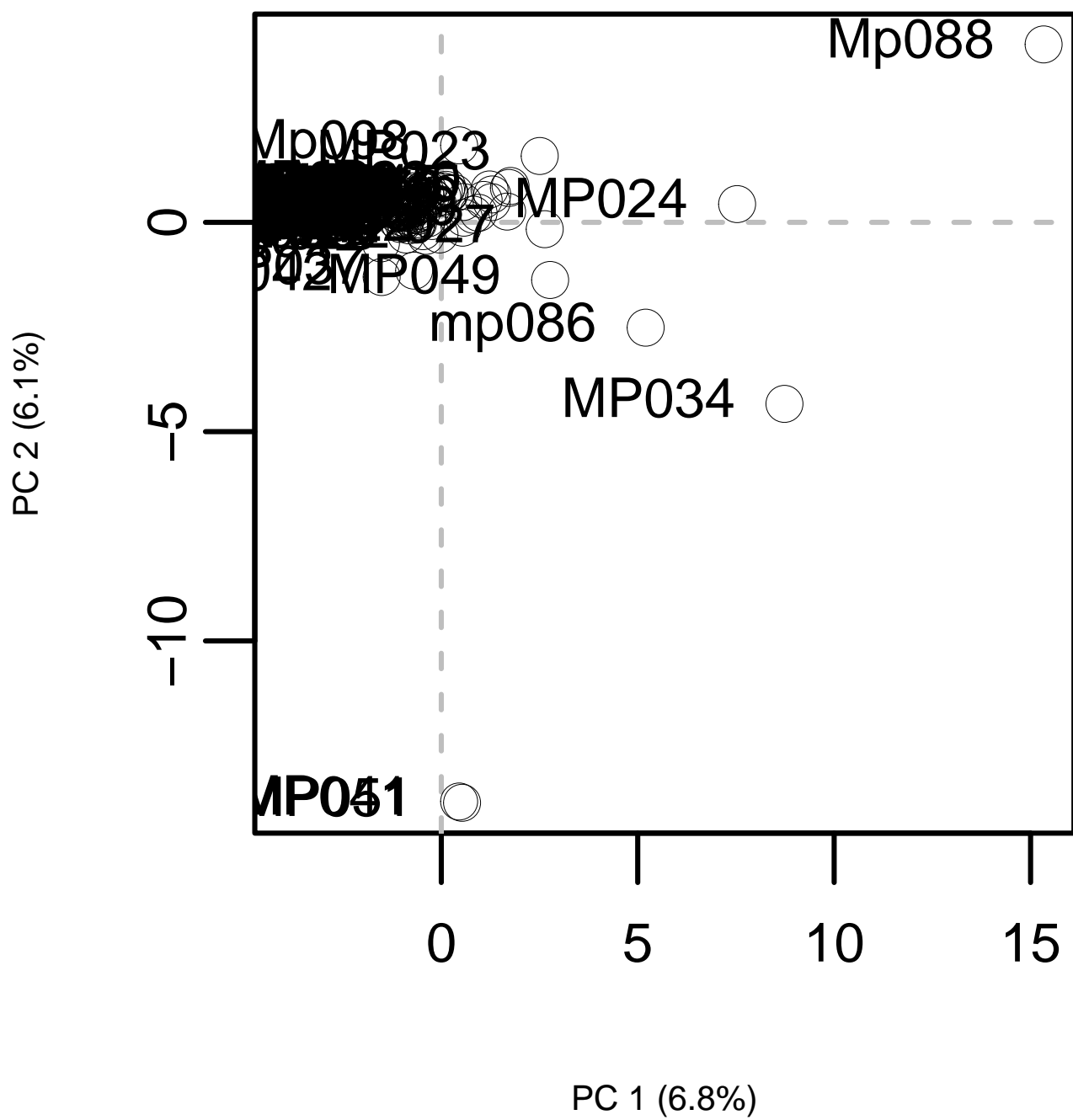
```
#| label: plot-percentage-variance-unexplained
#| echo: false
#| out-width: 100%
```

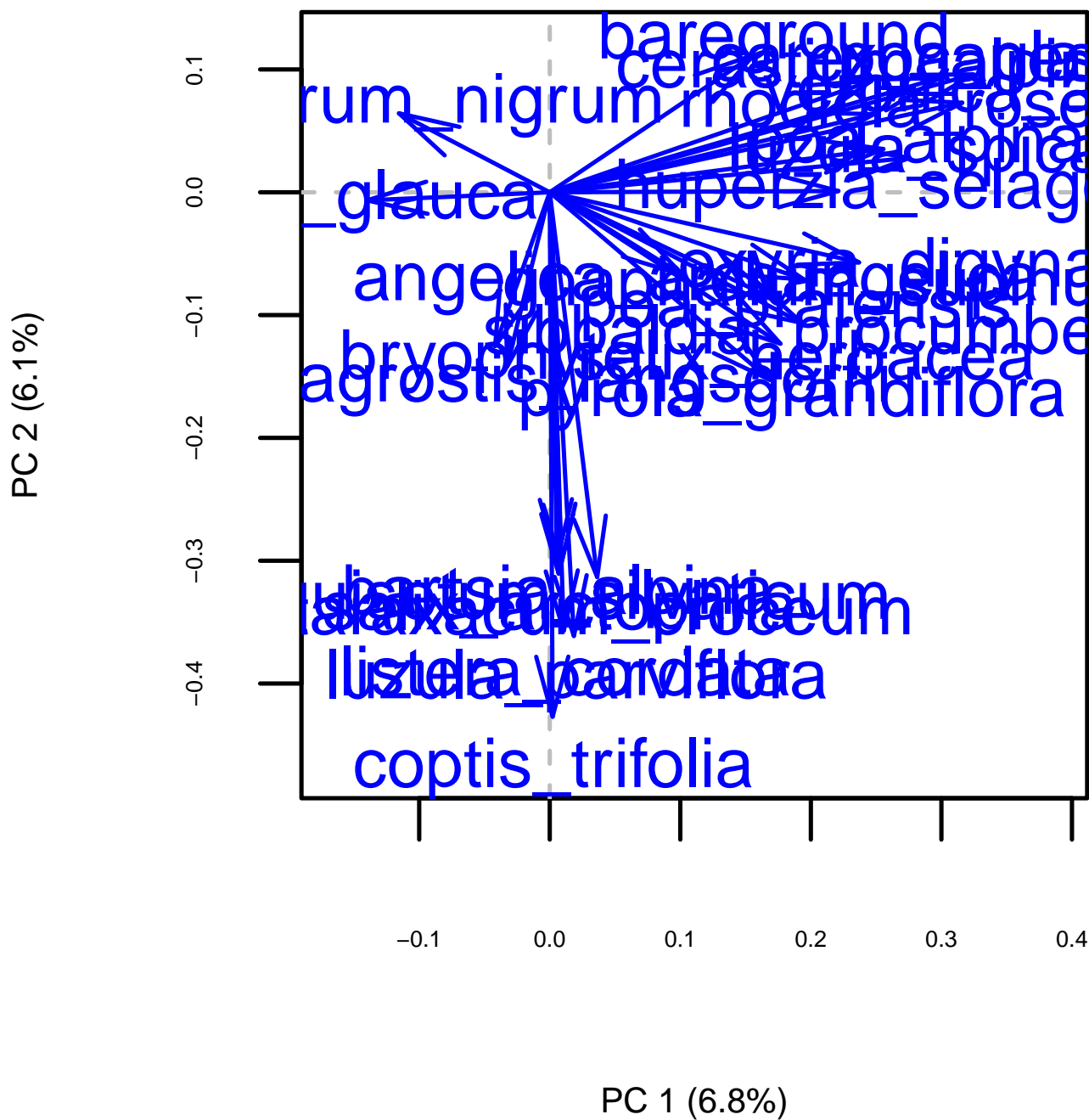
```
par(cex.axis = 0.5, cex.lab = 0.5)
plot(100*(77-cumsum(diag(Lambda)))/77,type="b",
main="Percentage Variance Unexplained",
xlab='Number of eigenvectors included',
ylab='Percentage of total variance',
cex.axis = 0.5) # Reduce size of axis text)
abline(h = 20, col = "darkgreen")
abline(h = 60, col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

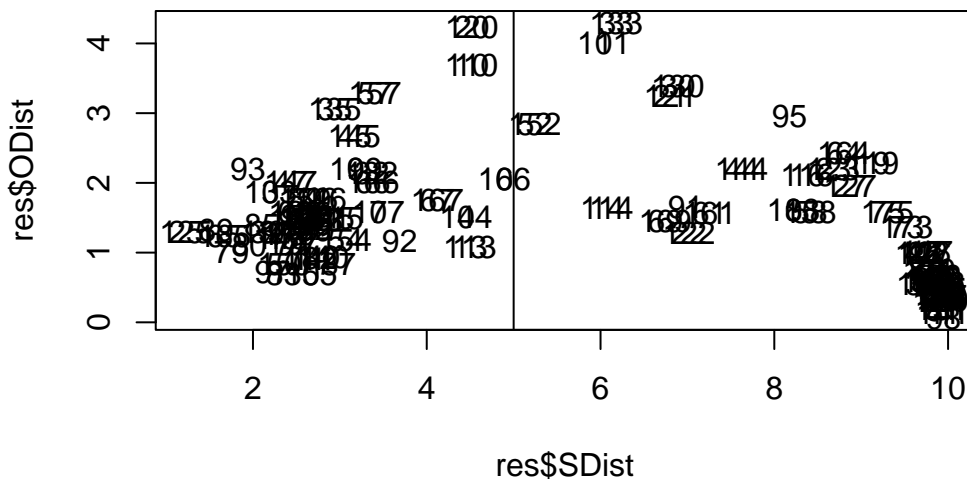
```
lty = 2,      # Grid line type
col = "gray", # Grid line color
lwd = 1)      # Grid line width
```

Percentage Variance Unexplained









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.

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

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_aucaulis         : 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 ...
$ diphasiastrium_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 ...
$ diphasiastrium_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 0 ...
$ viscaria_alpina           : num [1:82] 0 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 0 ...
$ equisetum_silvaticum      : num [1:82] 0 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 0 ...
$ poa_nemoralis             : num [1:82] 0 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.   :0.000000
1st Qu.: 0.000      1st Qu.: 0.000    1st Qu.: 0.000    1st Qu.:0.000000
Median : 0.000      Median : 0.100    Median : 0.050    Median :0.000000
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.:0.000000
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_aucaulis
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.   :0.000000   Min.   : 0.000     Min.   :0.000000
1st Qu.: 0.0000      1st Qu.:0.000000   1st Qu.: 0.000     1st Qu.:0.000000
Median : 0.0000      Median :0.000000   Median : 0.000     Median :0.000000
Mean   : 0.9207      Mean   :0.06098     Mean   : 1.155     Mean   :0.002561
3rd Qu.: 0.0000      3rd Qu.:0.000000   3rd Qu.: 0.000     3rd Qu.:0.000000

```

| | | | |
|--------------------------------|---------------------------|---------------------------|-------------------|
| Max. :62.5000 | Max. :2.50000 | Max. :62.500 | Max. :0.100000 |
| ledum_groenlandicum | lycopodium_annotinum | eriphorum_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 | |
| <i>harrimanella_hypnoides</i> | <i>diapensia_lapponica</i> | <i>stellaria_calycantha</i> | |
| 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 | |
| <i>scirpis_caespitosus</i> | <i>chamaenerion_angustifolium</i> | <i>alchemilla_alpina</i> | |
| 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 | |
| <i>pedicularis_lapponica</i> | <i>viscaria_alpina</i> | <i>pedicularis_flammea</i> | |
| 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 | |
| <i>equisetum_silvaticum</i> | <i>hieracium_hyparcticum</i> | <i>poa_nemoralis</i> | <i>bryophyte</i> |
| 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 |
| <i>lichen</i> | <i>bareground</i> | | |
| 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_aucaulis |
| 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 | eriphorum_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

```

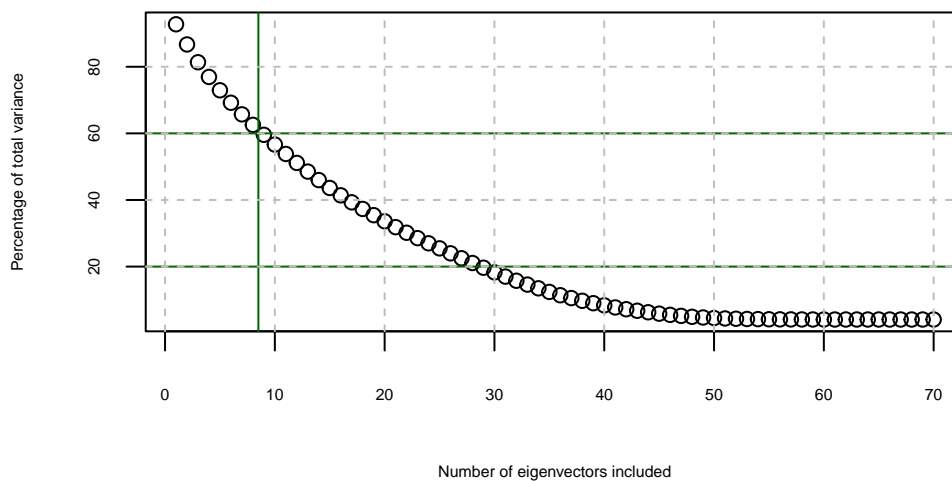
```

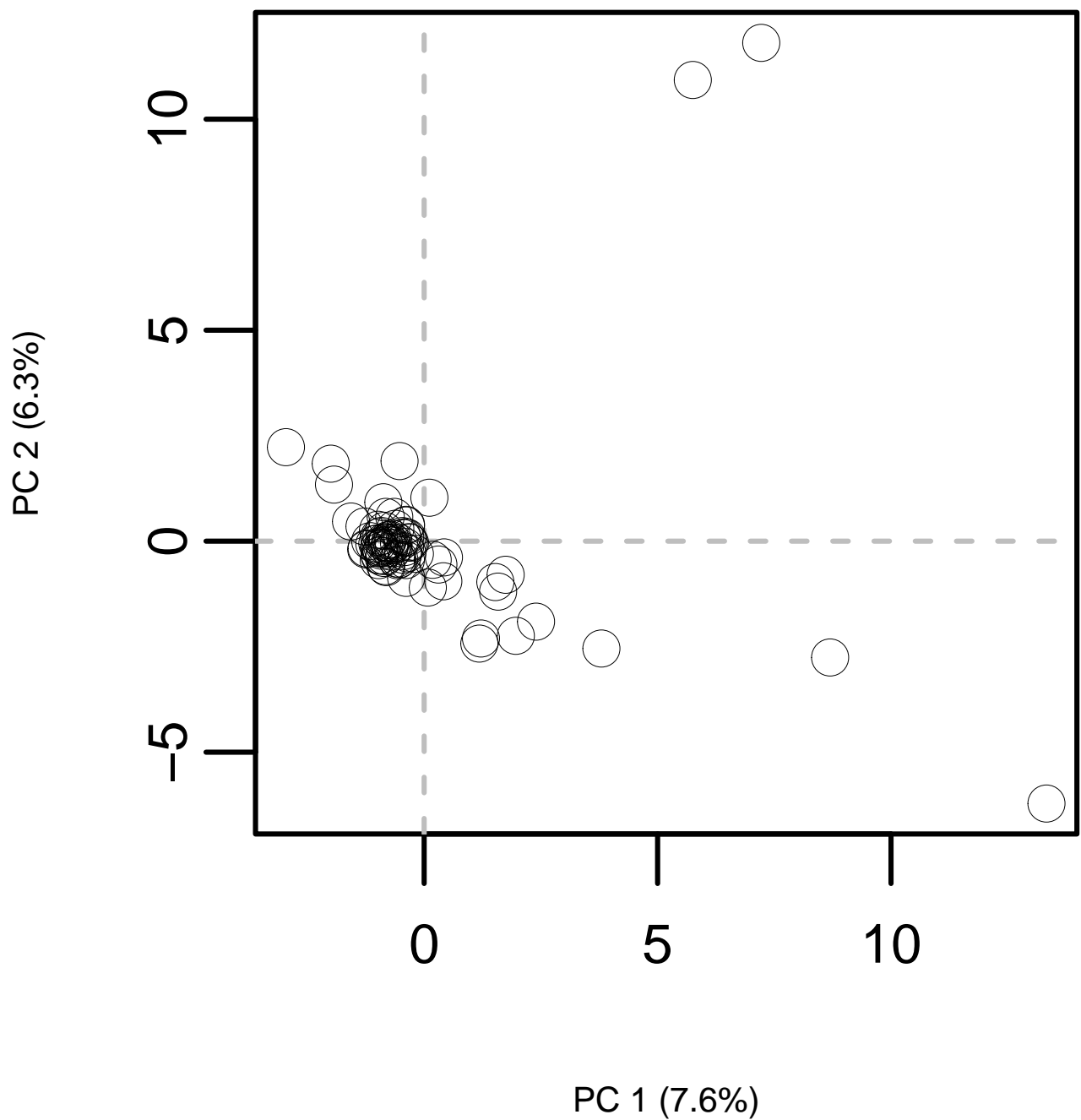
#| label: plot-percentage-variance-unexplained-veg
#| echo: false
#| out-width: 100%

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

```

Percentage Variance Unexplained





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)

# Extract scores
scores <- as.data.frame(pca_stat_veg_ggplot$scores)
```

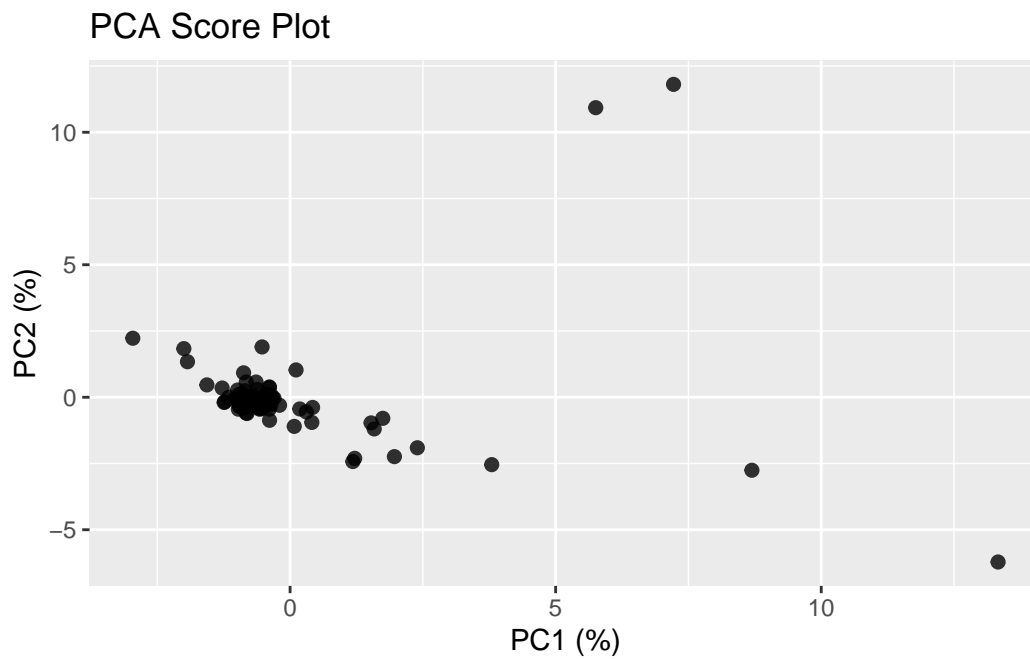
```

scores$Species <- pca_stat_veg_ggplot$Species

# Extract loadings
loadings <- as.data.frame(pca_stat_veg_ggplot$loadings)
loadings$Variable <- rownames(loadings)

ggplot(scores, aes(x = `PC 1`, y = `PC 2`)) +
  geom_point(size = 2, alpha = 0.8) +
  #theme_minimal() +
  labs(title = "PCA Score Plot",
       x = paste0("PC1 (", round(pca_stat_veg_ggplot$R2[1]*100, 1), "%)"),
       y = paste0("PC2 (", round(pca_stat_veg_ggplot$R2[2]*100, 1), "%)"))

```



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.