Laboratory 4: Reineke Line Graph in R

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In this Lab we will learn how to:

- Graph the Reineke line
- Add the lines of self-thinning and full site occupancy limits and the on-set competition
- Add a grid and text inside the plot
- Fit a Reineke line

We will use also the knowledge we acquire in our previous labs and the Reineke line fitted for *Pinus halepensis* Mill plantations in Aragon (Spain) by Hernández and Arrechea (2010) As usual, first we must define our working directory. In this lab we do not need any data set.

```
# establishing the working directory

setwd('C:/your_desired_working_directoryR')
```

Now we should define the variables and the maximum density line and the associated limits defined by Long (1985) by using this code:

```
# Variables and selfthinning line

Dg<-c(1:60)
Nmax <-(1:2500)
Nmax <-exp(11.9358)*Dg^(-1.605) #maximun density line

N60<-0.60*Nmax #lower limit or self-thinning
N35<-0.35*Nmax #lower limit of 'full site occupancy'
N25<-0.25*Nmax #On-set of competition (initial crown closure)
```

Basic graph

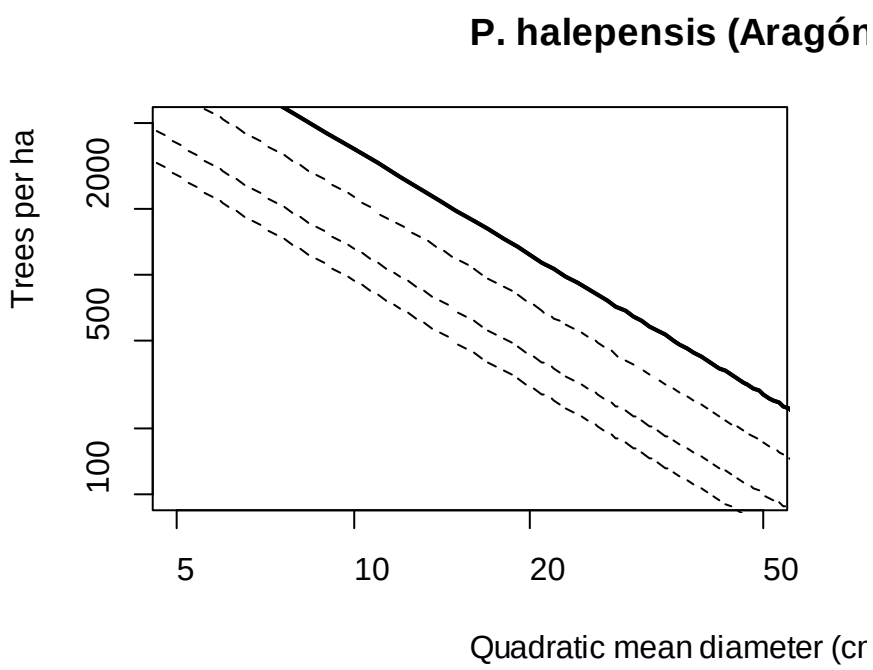
In our previous labs we have knew how to draw different plot types. Now we will draw a maximum density line graph by using the previous defined objects (Dg, Nmax, N60, N35 and N25) and a log transformation of the variables. The script to do that is the following:

```
# Graphing a maximum line density line

plot (Dg, Nmax, log=("xy"), type="l", lwd=2, col="black"
    ,ylab="Trees per ha"
```

```
    ,xlab="Quadratic mean diameter (cm)"
    ,main="P. halepensis (Aragón, Spain)"
    ,ylim= c(100,5000)
    ,xlim= c (5, 50)
    )
lines(Dg,Nmax,type="l",lwd=2, col="black")
lines(Dg,N60, type="l",lty=2, col="black")
lines(Dg,N35, type="l", lty=2, col="black")
lines (Dg,N25, type="l", lty=2, col="black")
```

To obtain the following plot:



Adding a grid

Now we have a maximum line density graph with log scales both for the x-axes (Quadratic mean diameter) and y-axes (trees per ha). If we want to add a grid on this graph we should use the instruction *abline* that will allow us to draw lines superimposed on the graph. The script is the following

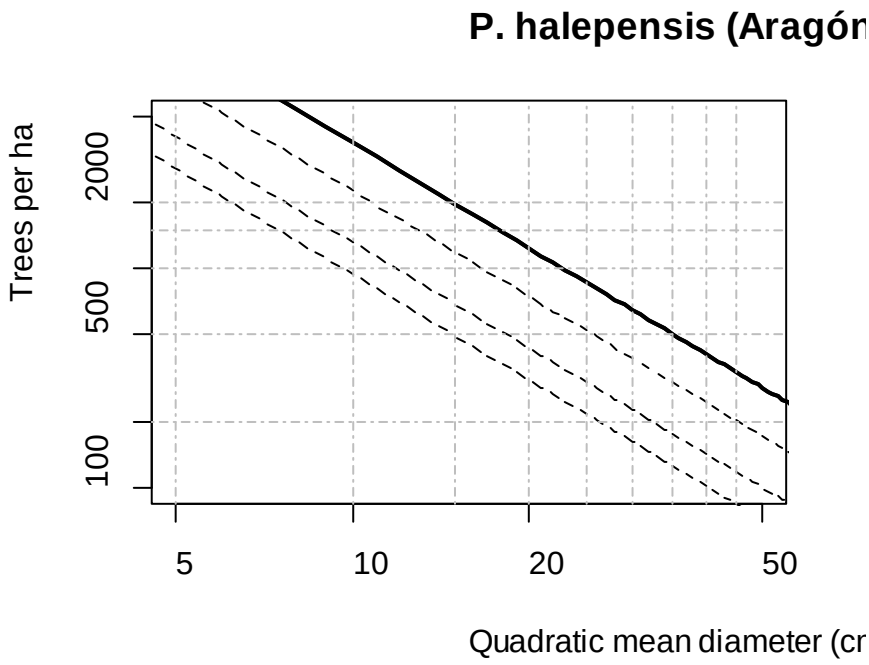
```
# adding a grid

#vertical lines
abline(v=5, lty=4, col="grey")
abline(v=10, lty=4, col="grey")
abline(v=15, lty=4, col="grey")
abline(v=20, lty=4, col="grey")
abline(v=25, lty=4, col="grey")
abline(v=30, lty=4, col="grey")
abline(v=35, lty=4, col="grey")
```

```
abline(v=40, lty=4, col="grey")
abline(v=45, lty=4, col="grey")

#horizontal lines
abline(h=200, lty=4, col="grey")
abline(h=500, lty=4, col="grey")
abline(h=1000, lty=4, col="grey")
abline(h=1500, lty=4, col="grey")
abline(h=2000, lty=4, col="grey")
```

to obtain:



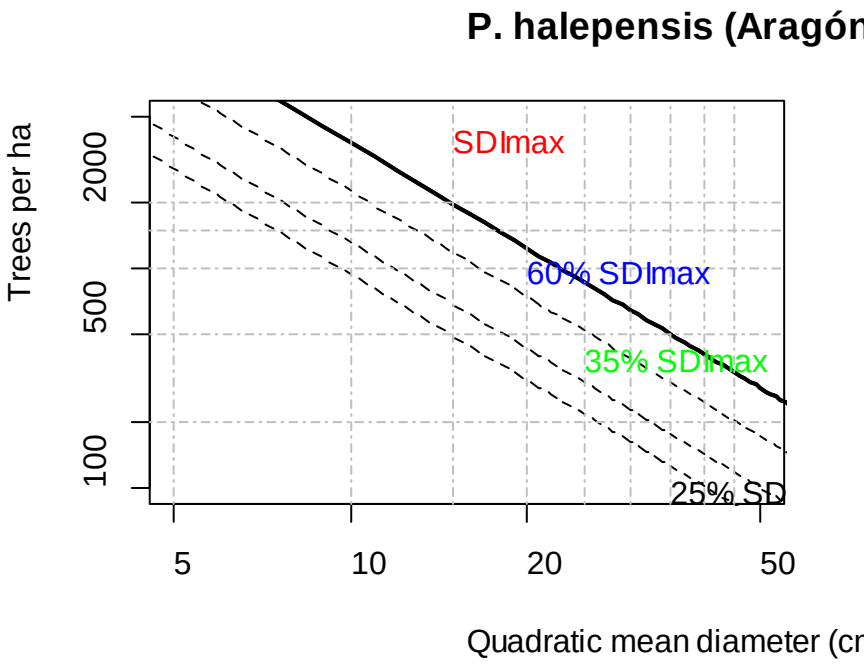
Writing a text on the grpah

Sometimes, you would like to include inside the graph some explanatory text to facilitate the readers to understand the output. In R you can include text inside the graph as follow:

```
# Adding explanatory text
# the first two digit in each text instruction indicate the position of the text

text(15,4000,"SDImax", col="red")
text(25,400, "35% SDImax", col="green")
text(20,1000,"60% SDImax", col="blue")
text(35, 100, "25% SDImax", clo="black")
```

to obtain:



Exporting the graph

Finally, you can export your graph to your desired path and in your preferred format by using the code line we can write before the graph instruction and finally close the script with instruction dev.off()

```
# Decide where and how you want to export your graph

# png format and indicate size (width and height)

png('C:/your_desired_ouptut_directoryR/filename.png', width = 683, height = 495)

# write the line above before the plot statement

######

# closing the device
# write this line after the plot statment

dev.off()
```

Fitting a Reineke line

We will use the Pnig_34_en_noSDI.csv dataset. This dataset comes from the Spanish National Forest Inventory and content *Pinus nigra* plots in the province of Palencia (northern Spain).

This dataset is available at this GitHub path: https://raw.githubusercontent.com/Felipe-Bravo/BioEcon.AdaptiveManagement/master/data/Pnig_34_eng_noSDI.csv

Follow this script to insight on the Reineke line fitting.

```
# Fitting a Reineke line

# establish the working directory
setwd("C://datosR")

# import data sets

newdata <- read.csv2("Pnig_34_eng_noSDI.csv")

# you can import the data directly from internet by using this code

# newdata <- read.csv2("copy_here_the_github_path_written_above", #header=TRUE)

# Remember to delete the # before the code lines above

# check data structure

names(newdata)

head(newdata)
tail(newdata)
View (newdata)

# we will use newdata dataset
# calculate SDI and its maximum

newdata$SDI <- newdata$N*(25/newdata$DG)**(-1.605)

names(newdata)

max(newdata$SDI)

# subsetting newdata to create newdata2 with only
# the 80% upper SDI observations

newdata2 <- subset(newdata, SDI >= 0.8*889.8126)

# creating new variables, logarithm transformations,
# in newdata2

newdata2$LOGN <- log(newdata2$N)
newdata2$LOGDG <- log(newdata2$DG)

# checking if variables are created

names(newdata2)

#plotting the logarithm transformated variables
```

```
plot(newdata2$LOGN, newdata2$LOGDG)

# fitting the straight line by simple regression

model <- lm(newdata2$LOGN~ newdata2$LOGDG)
summary(model)

#plotting the line over the scatterplot
plot(newdata2$LOGDG, newdata2$LOGN)
abline(model, col= "olivegreendark2",
       lty = 2, lwd =1)
# forcing the line to pass through
# the maximum SDI point
View(newdata2) # to identify max SDI point

# with this max SDI point we calculate the new b0
# create a new object to draw the maximum line

abline(a=11.8077, b=-1.5512, col="red", lty=2, lwd=1)
```

References

Hernández, A. and Arrechea, E. 2010 *Ensayo de claras en el M.U.P. nº 250 "El Cierzo" de Tarazona (Zaragoza). El tratamiento de las masas repobladas de pino carrasco (Pinus halepensis Mill.) en el Sistema Ibérico aragonés.* Internal report 28 pages

Long, J.N. 1985 A practical approach to density management *The Forestry Chronicle* 61:23-27