```
#Table of Contents-----------------

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# BL-02 starts on line 192
# BH-02 start on line ...


#---------------------------------
#Set working directory to ensure R can find the files we wish to import.

setwd("C:/Users/aalda/Desktop/All plots 2018")

#Installing and Loading all packages-------------

#install.packages("RStoolbox")
#install.packages("rasterVis")
#install.packages('raster')
#install.packages('gdalUtils')
#install.packages('tidyverse')
#install.packages('rgr')
#install.packages('uavRst')
#install.packages('rgdal') -Alex

library('gdalUtils')
library('RStoolbox')
library('rasterVis')
library('raster')
library('ggplot2')
library('rgr')
library('tidyverse')
library('rgdal') #alex wrote this.
#library('uavRst') #may not have been used.

# Load Data ---------------------------------------------------------------
#Raster

# We will create a character vector list of raster files using the list.files() function in the directory named "All plots 2018".
This list will be used to generate a Rasterstack.
files <- list.files()
files              #See the list of all files in the directory named "All plots 2018".
dbf.files <- files[grep(".tif", files, fixed=T)]        #Creates a file that is list of names only having .tif extensions. Grep
function finds ".tiff" pattern in the created "files" and fixed=T means pattern is a text string.
for(i in dbf.files) { assign(unlist(strsplit(i, "[.]"))[1], raster(i)) }    #

BH1_RGB<-stack("BH-01 RGB_modified.tif") # Import multi-band raster data, using the stack() function.
BH1_IR<-raster('BH-01 IR_modified.tif')   # Import and create a Rasterlayer file using the raster function.
BL2_RGB<-stack("BL-02 RGB.tif")
BL2_IR<-raster('BL-02 IR.tif')


# BH-01 -------------------------------------------------------------------


#align extent

BH1_IR_proj<-projectRaster(BH1_IR, BH1_RGB) #Alex: Project the data of a Raster object to a new RAster object with another
projection (crs). projectRaster(from, to).


#Shapefile
plot(BH1_IR_proj)                    #alex+ani: line 58-Error-plot.new has not been called yet, occured becuase plot name has not
been called.
polygon<-shapefile("Polygons.shp")   #Alex: File format for storing geospatial data in polygon.shp.
plot(polygon, add=TRUE)              #Alex: This adds another raster ontop of another. This draws the boundary of the two
exclosures over the [BH1_IR_proj] image
BH1_shp_ug<-subset(polygon, PlotID=='BH-01 UG') #Ungrazed  #Alex: Returns (selected variables) subsets of vectors, matirces or
dataframes which meet conditions. Subset(object to be subsetted, logical expression indicating elements or rows to keep).
BH1_shp_g<-subset(polygon, PlotID=='BH-01 G')#Grazed

# Mask and clip rasters to polygon ----------------------------------------------

#Ungrazed

BH1_RGB_mask<-mask(BH1_RGB, BH1_shp_ug)
BH1_IR_mask<-mask(BH1_IR_proj, BH1_shp_ug)


BH1RGB_crop<- crop(BH1_RGB_mask, BH1_shp_ug)
plot(BH1RGB_crop)             #Alex: four images produced.(#1-image)
ex<-extent(BH1RGB_crop)

BH1IR_crop<- crop(BH1_IR_mask, ex)
plot(BH1IR_crop)              #Alex: one image produced.(#2-image)


# Stack and Brick IR and RGB ----------------------------------------------------

BH1_stack<-stack(BH1RGB_crop, BH1IR_crop)
nlayers(BH1_stack)
BH1_stack<-writeRaster(BH1_stack, filename="C:/Users/aalda/Desktop/All plots 2018/BH1_Stack.tif", format="GTiff", overwrite=TRUE)




# Calculate NDVI ----------------------------------------------------------

BH1_ndvi_ungrazed<-((BH1_stack[[5]]-BH1_stack[[1]])/(BH1_stack[[5]]+BH1_stack[[1]]))
```

```
plot(BH1_ndvi_ungrazed)         #Alex: one image produced.(#3-image)
hist(BH1_ndvi_ungrazed)         #Alex: histogram produced. (#4-image)



# Do it all again for BH1 Grazed ----------------------------------------

# Mask and clip rasters to polygon ------------------------------------------------

#Grazed

BH1_RGB_mask<-mask(BH1_RGB, BH1_shp_g)
BH1_IR_mask<-mask(BH1_IR_proj, BH1_shp_g)


BH1RGB_crop<- crop(BH1_RGB_mask, BH1_shp_g)
plot(BH1RGB_crop)          #Alex: four images produced. (#5-image)
ex<-extent(BH1RGB_crop)

BH1IR_crop<- crop(BH1_IR_mask, ex)
plot(BH1IR_crop)           #Alex: one image produced.(#6-image)


# Stack and Brick IR and RGB ----------------------------------------------------

BH1_stack<-stack(BH1RGB_crop, BH1IR_crop)
nlayers(BH1_stack)          #Alex: there are 5 layers.

# Calculate NDVI ----------------------------------------------------------

BH1_ndvi_grazed<-((BH1_stack[[5]]-BH1_stack[[1]])/(BH1_stack[[5]]+BH1_stack[[1]]))
plot(BH1_ndvi_grazed)           #Alex: one image produced. (#7-image)

# REmoved bl2 here.

BH_01_g<-tibble(
  Value=BH1_ndvi_grazed$layer,
  Treatment="Grazed"
)

BH_01_ug<-tibble(
  Value=BL2_ndvi_ungrazed$layer,
  Treatment="Ungrazed"
)

BH_01<-rbind(BH_01_g, BH_01_ug)
ggplot(data=BH_01, aes(x=Treatment, y=Value))+
  geom_violin(scale='area')                     #Alex: two images produced.(#12 image)
hist(BH1_ndvi_grazed)                           #Alex: histogram produced. (#13 image)

#compare to ungrazed

BH1_ndvi_ungrazed<-as.data.frame(BH1_ndvi_ungrazed)
BH1_ndvi_grazed<-as.data.frame(BH1_ndvi_grazed)

BH_01_g<-tibble(
  Value=BH1_ndvi_grazed$layer,
  Treatment="Grazed"
)

BH_01_ug<-tibble(
  Value=BH1_ndvi_ungrazed$layer,
  Treatment="Ungrazed"
)

BH_01<-rbind(BH_01_g, BH_01_ug)
ggplot(data=BH_01, aes(x=Treatment, y=Value))+
  geom_violin(scale='area')                       #Alex: two images produced. (#14 image)




# BL-02 ----------------------------------------------------------------------


#align extent

BL2_IR_proj<-projectRaster(BL2_IR, BL2_RGB)    #Alex: two images produced. (#15 image)
BL2_IR_proj


#Shapefile

plot(BL2_IR_proj)                          #Alex created this line.
polygon<-shapefile("Polygons.shp")
plot(polygon, add=TRUE)
BL2_shp_ug<-subset(polygon, PlotID=='BL-02 UG') #Ungrazed
BL2_shp_g<-subset(polygon, PlotID=='BL-02 G') #Grazed


# Wrong: BL2_shp_ug<-subset(polygon, PlotID=='BH-01 UG') #Ungrazed     #Alex: warming messages.
#wrong: BL2_shp_g<-subset(polygon, PlotID=='BH-01 G')#Grazed

# Mask and clip rasters to polygon ------------------------------------------------

#Ungrazed
```

```
BL2_RGB_mask<-mask(BL2_RGB, BL2_shp_ug)
BL2_IR_mask<-mask(BL2_IR_proj, BL2_shp_ug)


BL2RGB_crop<- crop(BL2_RGB_mask, BL2_shp_ug)    #Alex: first run line 191 for BL2_shp_ug. Problem: Error in .local(x, y, ...) :
extents do not overlap
plot(BL2RGB_crop)                #Alex: four images produced in shape of parallelgrams. (#16 image)
ex<-extent(BL2RGB_crop)

BL2IR_crop<- crop(BL2_IR_mask, ex)
plot(BL2IR_crop)                    #Alex: (check) one image not produced. (#17 image)


# Stack and Brick IR and RGB ------------------------------------------------------

BL2_stack<-stack(BL2RGB_crop, BL2IR_crop)
nlayers(BL2_stack)                           #Alex: 5 layers.

# Calculate NDVI ------------------------------------------------------------

BL2_ndvi_ungrazed<-((BL2_stack[[5]]-BL2_stack[[1]])/(BL2_stack[[5]]+BL2_stack[[1]]))
plot(BL2_ndvi_ungrazed)                 #Alex: (check) one image produced. (#18 image)
hist(BL2_ndvi_ungrazed)                 #Alex: (check) histogram produced. (#19 image)



# Do it all again for BL2 Grazed ----------------------------------------

# Mask and clip rasters to polygon ------------------------------------------------

#Grazed

BL2_RGB_mask<-mask(BL2_RGB, BL2_shp_g)
BL2_IR_mask<-mask(BL2_IR_proj, BL2_shp_g)     #Ales wrote this line.

# pasted here


BL2RGB_crop<- crop(BL2_RGB_mask, BL2_shp_g)   #Alex: first run line 229 (BL2_RGB_mask<-mask(BL2_RGB, BL2_shp_g). Problem: Error
in file(fn, "rb") : cannot open the connection. Solution: run line 72 and line 16 (library (raster)).
plot(BL2RGB_crop)                              #Alex: four images in the shape of parallelgrams.(#8 image)
ex<-extent(BL2RGB_crop)

BL2IR_crop<- crop(BL2_IR_mask, ex)
plot(BL2IR_crop)                              #Alex: one image produce in the shape of parallelgram. (#9-image)


# Stack and Brick IR and RGB ------------------------------------------------------

BL2_stack<-stack(BL2RGB_crop, BL2IR_crop)
nlayers(BL2_stack)

# Calculate NDVI ------------------------------------------------------------

BL2_ndvi_grazed<-((BL2_stack[[5]]-BL2_stack[[1]])/(BL2_stack[[5]]+BL2_stack[[1]]))
plot(BL2_ndvi_grazed)                           #Alex: one image produced in the shape of a parallelgram.(#10 image)
hist(BL2_ndvi_grazed)                           #Alex: histogram produced. (#11 image)

#compare to ungrazed
BL2_ndvi_ungrazed<-((BL2_stack[[5]]-BL2_stack[[1]])/(BL2_stack[[5]]+BL2_stack[[1]]))  #alex:copied/pasted here.
BL2_ndvi_ungrazed<-as.data.frame(BL2_ndvi_ungrazed) #Alex: First run line 217 for BL2_ndvi_ungrazed which is (
BL2_ndvi_ungrazed<-((BL2_stack[[5]]-BL2_stack[[1]])/(BL2_stack[[5]]+BL2_stack[[1]])) .
BL2_ndvi_grazed<-as.data.frame(BL2_ndvi_grazed)

#alex wrote this
BL_02_ug<-tibble(
  Value= BH2_ndvi_ungrazed$layer,
  Treatment-"Grazed"
)

BH_02_ug<-tibble(
  Value=BH2_ndvi_ungrazed$layer,
  Treatment= "Ungrazed"
)
```