Experimental Design

Adriana Souza

June 15, 2018

1 Goals

1. Constrain treatment number, size and distribution in the context of permitting requirements and logistical matters
2. Conduct power analysis for deliverables based on proposed experimental design, inventory practices and preliminary data.
3. Do both 1 & 2 using annotated code in a version controlled format

2 Objectives

2.1 Constrain experimental design based on expected mulch volume, permit limits for fill and effective mulch depths

a. Estimate total volume of invasive plant biomass on spoil ridges
b. Estimate area corresponding to 25 cubic yards of fill in treatment ditch
c. Estimate depth of remaining mulch spread onto ridges
d. Propose scenarios for removal

```
## Reading data
all_plots <- read.csv("plots.csv")
trees <- read.csv("trees.csv")

## Subsetting
# Subsetting trees to only Australian Pine
ap <- trees %>% filter(Species == "AP")
# Getting rid of weird formatting error, disregard
names(ap)[1] <- "PlotID"
names(all_plots)[1] <- "PlotID"

# Subsetting Plots to exclude controls
plots <- subset(all_plots, (PlotID!=c("7", "8","9")))

# Aggregating invasive biomass per plot (note, there is no info for plots 7,8,9)
# ap_agg <- aggregate(ap[, 11], list(ap$PlotID), mean)
#The functions that race used were not precise and difficult to connect to volume
# new approach: calculate biomass of trunk, branch and leaves
# scaling equations following https://doi.org/10.1371/journal.pone.0151858

ap_DBH<-as.numeric(as.character(ap$Width.cm))

#mature forest: most similar based on age table 4 eq. 7
#ap_trunk_kg<-exp(-0.963+2.032*log(ap_DBH))
#ap_branch_kg<-exp(-3.945+2.349*log(ap_DBH))
#ap_leaf_kg<-exp(-4.108+2.270*log(ap_DBH))
```

```
#middle forest: most similar based on DBH distribution
#NOTE: understimate because of missing correction factor
ap_trunk_kg<-exp(-2.108+2.354*log(ap_DBH))
ap_branch_kg<-exp(-4.222+2.538*log(ap_DBH))
ap_leaf_kg<-exp(-3.164+1.996*log(ap_DBH))

# convert wood (trunk and branch) to volume based on standard wood density.
# http://www.wood-database.com/sheoak/
ap_wood_vol_cu_m<-c(ap_trunk_kg+ap_branch_kg) / 800
# 800 kg / cubic meter:
#https://www.researchgate.net/publication/230701880_Effects_of_height_on_physical_properties_of_wood_of_

# convert leaf  to volume based on scaling of Specific Leaf Area Table 1 N2 average
# drought and control https://onlinelibrary.wiley.com/doi/pdf/10.1046/j.1365-3040.1998.00302.x
# SLA = 20 sq cm / g ;
# area of a cylinder / volume of a cylinder = r/2 leaf diameter = 0.75

ap_leaf_vol_cu_m<-ap_leaf_kg * 1000 * 20 * (.75 / 4) / 1000000
# 1000 g / kg * 20 sq_cm / g, (0.75 cm / 4 ) cu_cm / sq_cm  / 10^6 cu_cm / cu_m

ap_vol_cu_m<-ap_leaf_vol_cu_m+ap_wood_vol_cu_m

ap_agg <- aggregate(ap_vol_cu_m, list(ap$PlotID), sum)

names(ap_agg)[1] <- "PlotID"
names(ap_agg)[2] <- "PlotVolume"
#head(ap_agg) # Table

## Defining variables

# Plot Area
#sm_length_m <- plots$SpoilMoundWidth # Spoil Mound Lenght
trans_len_m <- plots$SpoilMoundTransectLength # Transect Length
sm_area_sq_m <- trans_len_m * 4 # Spoil Mound Area

# Invasive Biomass original guess
# ap_density <- 475 # ?? http://www.wood-database.com/austrian-pine/

# Target: cubic meters of invasive per meter squared of spoil mound
ap_vol_cu_m_per_sq_m_spoil_mound <- ap_agg[,2]/sm_area_sq_m

#area of all spoil ridge as per Scheda map * sq_m / acre
spoil_ridge_area_sq_m<-(3.74+7.56+.17)*4046.86

total_invasive_volume_cu_yd<-spoil_ridge_area_sq_m*ap_vol_cu_m_per_sq_m_spoil_mound*1.30795

# New table
target_table <- data.frame(ap_agg, sm_area_sq_m, ap_vol_cu_m_per_sq_m_spoil_mound,
                           total_invasive_volume_cu_yd)
# target_table %>%
#   kable("latex", booktabs = TRUE) %>%
#   kable_styling(latex_options = "striped", "scale_down")
```

```r
# Calculations using Simple formula for difference in means
# https://web.stanford.edu/~kcobb/hrp259/lecture11.ppt

#Ratio of larger group to smaller group
r = 3/1

#Calculating effect size: difference in means
d <- 0 - mean(ap_vol_cu_m_per_sq_m_spoil_mound)

#Desired power (typically .84 for 80% power)
Zb <- 0.84

#Desired level of statistical significance (typically 1.96 for alpha = 0.05)
Za <- 1.96

# Estimate for sigma^2?
sigma_sq <- var(ap_vol_cu_m_per_sq_m_spoil_mound)

#Sample size calculation
(sample_size <- ((r+1)/r)*(sigma_sq*(Zb+Za)^2)/d^2)
```

```
## [1] 2.550197
```

2.2 Assess adequacy of proposed vegetation inventory elements:

1. Element 1: plot size

- Impact on biomass estimation error
- Impact on seedling diversity estimation error

2. Element 2: plot distribution per treatment

- Impact on removal / mulch treatment effect estimation error