

Growth_mort

Carmen

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Define parameters

```
years <- 15
iterations <- 100
max_shrub_ht_cm <- 250
max_shrub_ht_years <- 15
n_seedlings <- 100
length_m <- 20
height_m <- 20
```

Load functions

Normalize function

```
source("functions/normalize.R")
```

Initialization function

```
source("functions/initialize.R")
```

Height growth functions

```
source("functions/abcgrowth.R")
source("functions/pipogrowth.R")
```

Diameter growth functions

```
source("functions/abcodia.R")
source("functions/pipodia.R")
```

Mortality functions

```
source("functions/abcomort.R")
source("functions/pipomort.R")
```

Shrub growth function

```
source("functions/shrubgrowth.R")
```

Simulation function

```
source("functions/sim.R")
```

Iteration function

```
source("functions/iterate.R")
```

Initialize

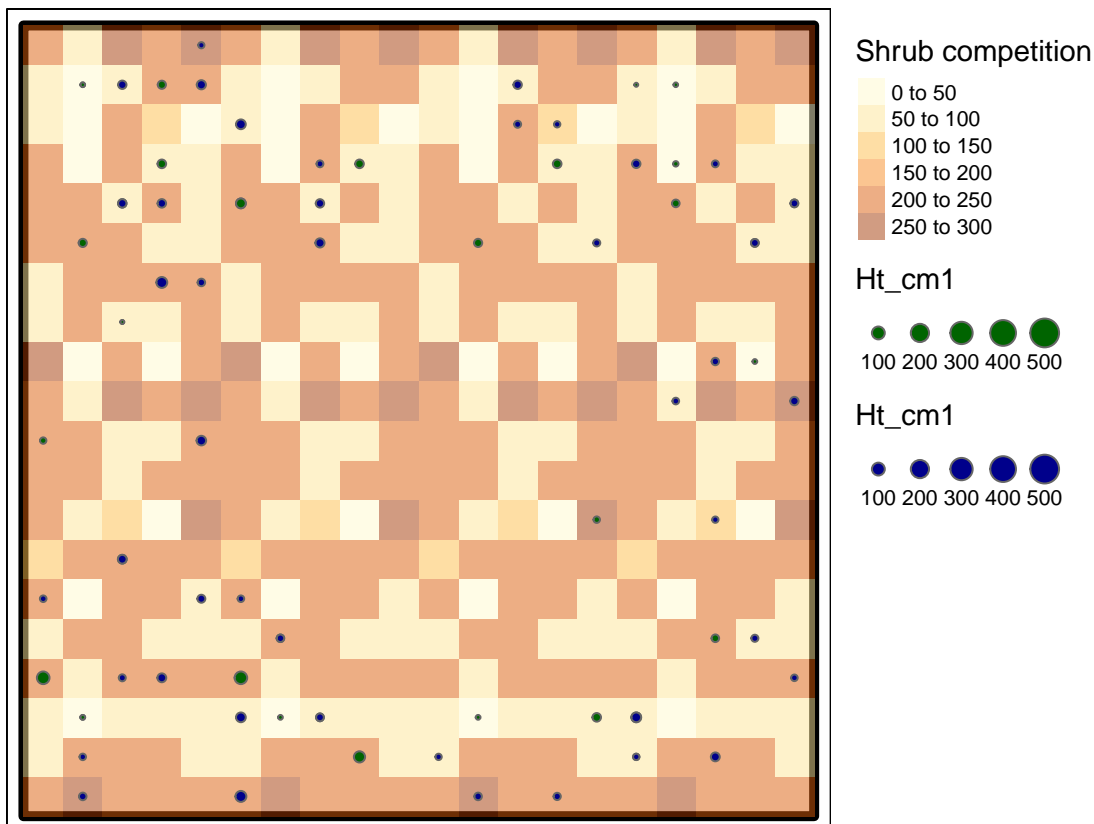
```
initialize()

## Joining, by = "Sd1g"

## Warning: Column `Sd1g` joining factors with different levels, coercing to
## character vector
```

Plot patch before simulation

```
tm_shape(p)+
  tm_borders(col = "black", lwd= 5)+
tm_shape(r)+
  tm_raster(alpha = .5, title = "Shrub competition")+
  tm_layout(asp=1:1, legend.outside = T)+
tm_shape(pts.sf.pipo)+
  tm_symbols(size = "Ht_cm1", col = "darkgreen", size.max = 500)+
tm_shape(pts.sf.abco)+
  tm_symbols(size = "Ht_cm1", col = "darkblue", size.max = 500)
```

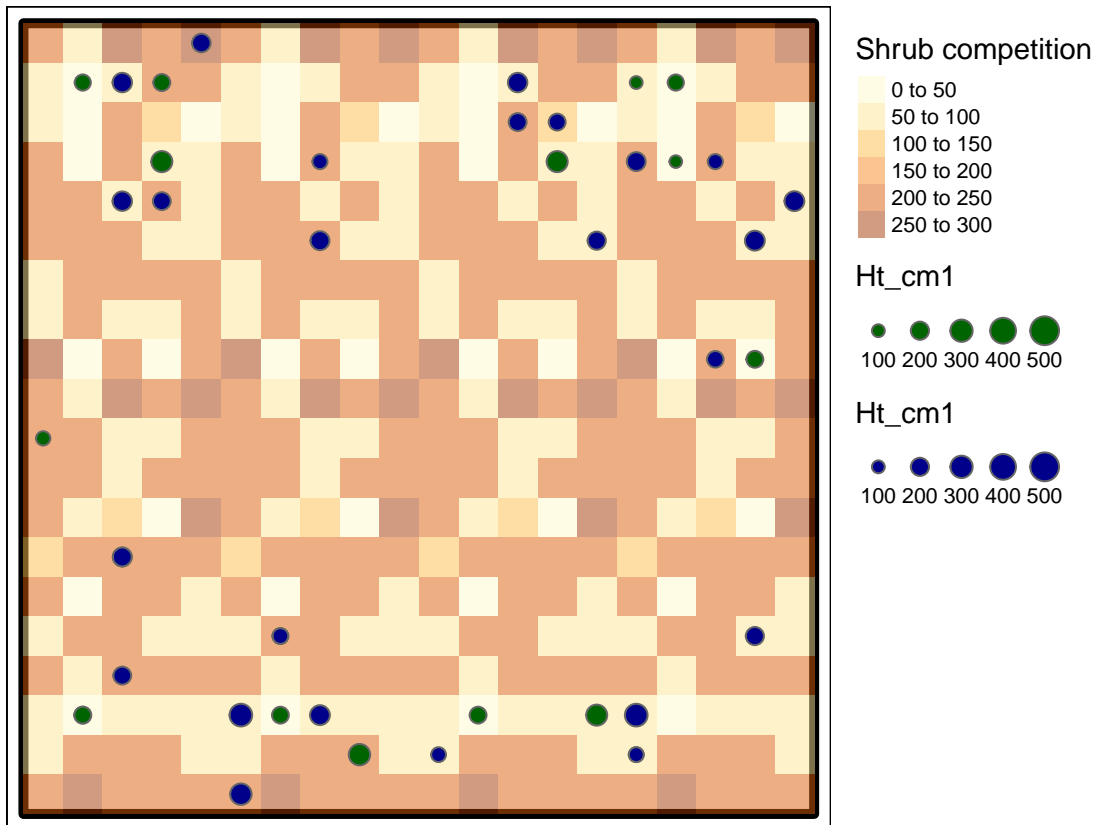


Simulate across years

```
suppressMessages(sim(years))
```

Plot patch after simulation

```
tm_shape(p)+
  tm_borders(col = "black", lwd= 5)+
tm_shape(r)+
  tm_raster(alpha = .5, title = "Shrub competition")+
  tm_layout(asp=1:1, legend.outside = T)+
tm_shape(pts.sf.pipo)+
  tm_symbols(size = "Ht_cm1", col = "darkgreen", size.max = 500)+
tm_shape(pts.sf.abco)+
  tm_symbols(size = "Ht_cm1", col = "darkblue", size.max = 500)
```



Iterate

```
iterate(iterations)
dfsimallreps %>%
  group_by(rep) %>%
  summarize(mean(Ht_cm1))
```

```
## # A tibble: 100 x 2
##   rep `mean(Ht_cm1)`
##   <int>     <dbl>
## 1     1      130.
## 2     2      136.
## 3     3      119.
```

```
## 4      4      127.
## 5      5      130.
## 6      6      124.
## 7      7      124.
## 8      8      119.
## 9      9      137.
## 10     10     118.
## # ... with 90 more rows
```

Summarize

Height by year

```
dfsimplereps_summary <- dfsimplereps %>%
  ungroup() %>%
  mutate(rep = as.factor(paste(rep))) %>%
  group_by(rep, Years, Species) %>%
  mutate(mean_ht_years = mean(Ht_cm1))
dfsimplereps_summary %>% dplyr::select(rep, Years, mean_ht_years) %>% summary()
```

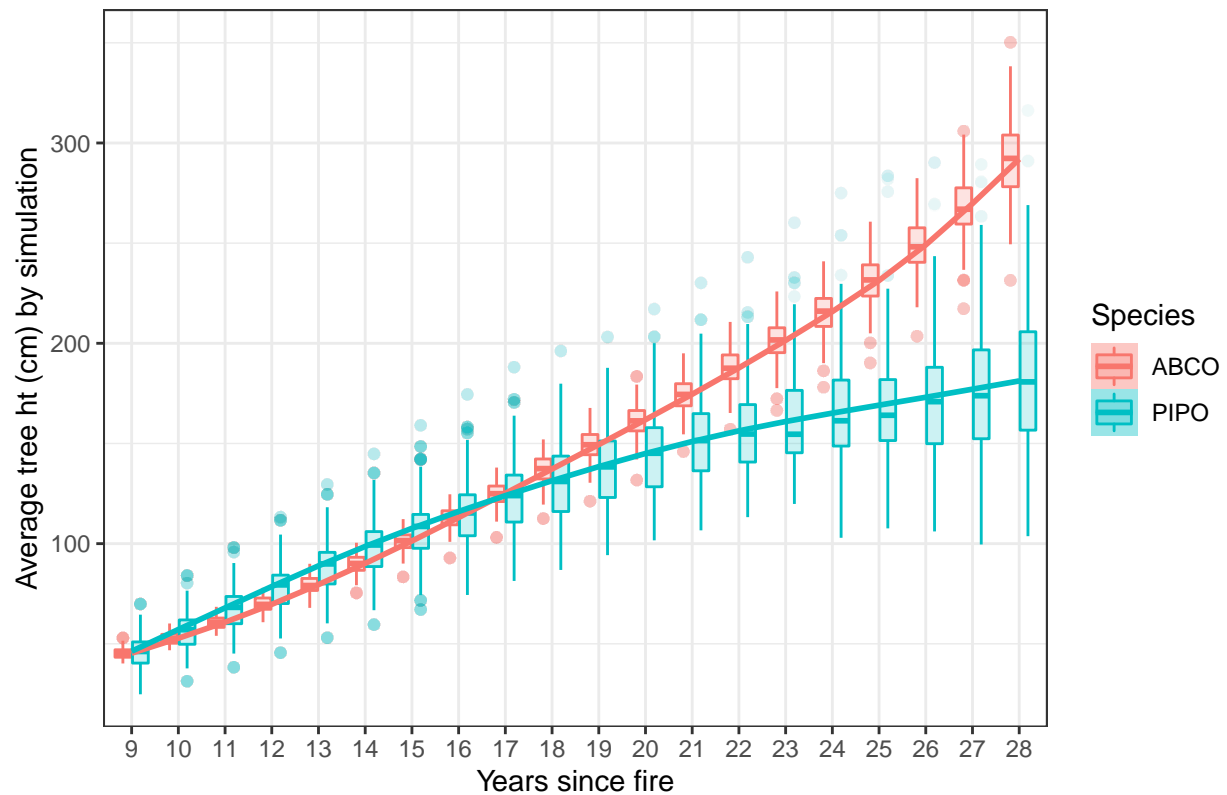
```
## Adding missing grouping variables: `Species`
```

```
## Species      rep      Years      mean_ht_years
## ABC0:76085    66      : 1285    Min.      : 9.0      Min.      : 24.80
## PIP0:38591    34      : 1282    1st Qu.:12.0    1st Qu.: 74.59
##              11      : 1255    Median :16.0    Median :115.58
##              93      : 1251    Mean    :16.9    Mean    :126.65
##              44      : 1241    3rd Qu.:21.0    3rd Qu.:164.82
##              10      : 1237    Max.     :28.0    Max.     :350.24
##              (Other):107125
```

```
ggplot(dfsimplereps_summary, aes(x = as.factor(Years), y = mean_ht_years, fill = Species, col = Species)) +
  geom_boxplot(alpha = .2, outlier.alpha = .02) +
  geom_smooth(aes(x = as.factor(Years), y = mean_ht_years, group = Species, col = Species), size = 1) +
  ggtitle("Results for 100 simulations") +
  xlab("Years since fire") +
  ylab("Average tree ht (cm) by simulation") +
  theme_bw()
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```

Results for 100 simulations



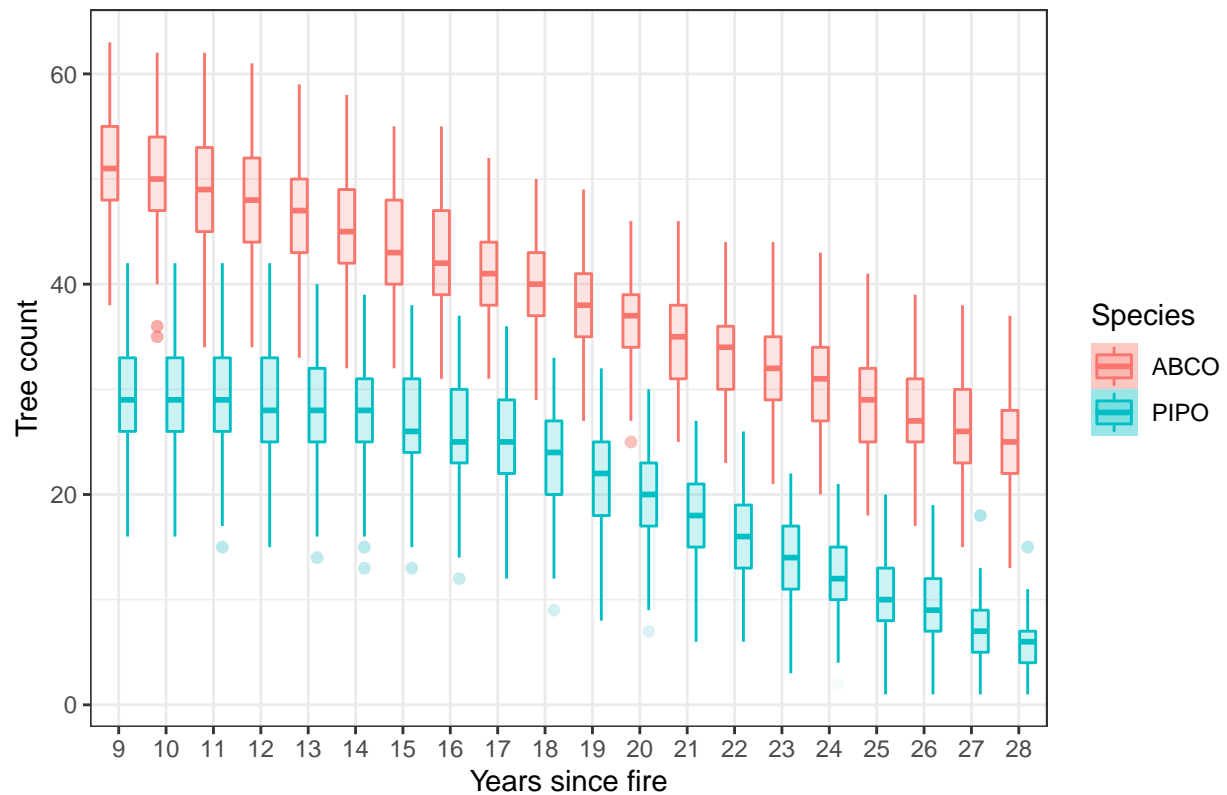
Counts by year

```
dfsimallreps_summary <- dfsimallreps %>%
  ungroup() %>%
  group_by(rep, Years, Species) %>%
  mutate(count = n()) %>%
  mutate(count = as.numeric(count))

ggplot(dfsimallreps_summary, aes(x = as.factor(Years), y = count, fill = Species, col = Species))+
  geom_boxplot(alpha = .2, outlier.alpha = .02)+
  geom_smooth(aes(x = as.factor(Years), y = count, fill = Species, col = Species), size = 1)+
  ggtitle("Results for 100 simulations")+
  xlab("Years since fire")+
  ylab("Tree count")+
  theme_bw()

## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```

Results for 100 simulations

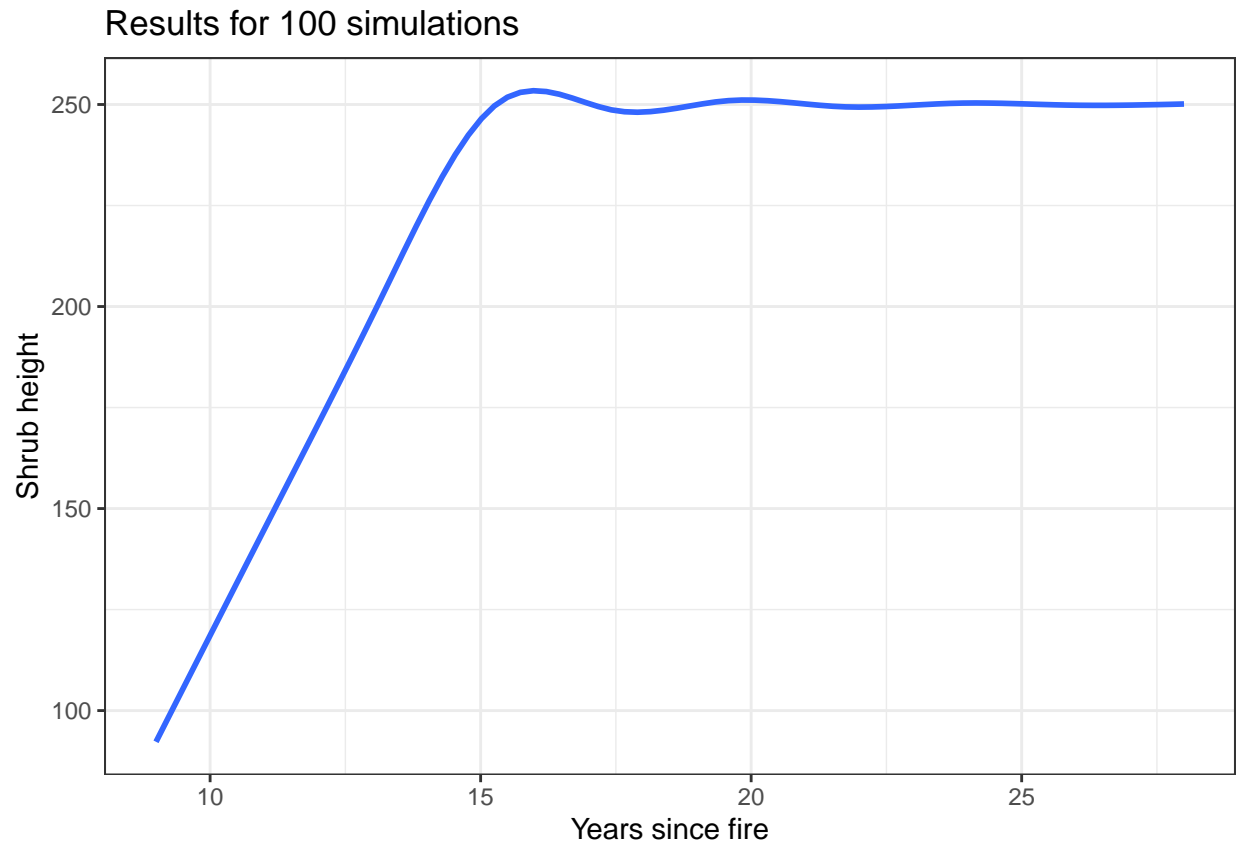


Shrub height by year

```
dfsimplereps_summary <- dfsimplereps %>%
  ungroup() %>%
  group_by(rep, Years, Ht1.3) %>%
  mutate(mean_shrub_ht = mean(Ht1.3))
```

```
ggplot(dfsimplereps_summary, aes(x = as.factor(Years), y = mean_shrub_ht)) +
  geom_smooth(aes(x = Years, y = mean_shrub_ht)) +
  ggtitle("Results for 100 simulations") +
  xlab("Years since fire") +
  ylab("Shrub height") +
  theme_bw()
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```



Next steps to improve the model

1. Use Kristen's data or Hugh's data for initial conditions
2. Improve dispersal kernel based on Kristen/Hugh's data
3. Improve shrub growth based on data
4. Include residual surviving trees and their seed dispersal
5. Include seed dispersal of post-fire regen once it reaches reproductive age
6. Add customization of patch size and shape
7. Add customization of whether the conditions reflect those of 2015, 2016, or 2017
8. Change sapling growth equations once they emerge from the shrub canopy