Declining_population_simulation

```
library(ggplot2)
library(dplyr)
```

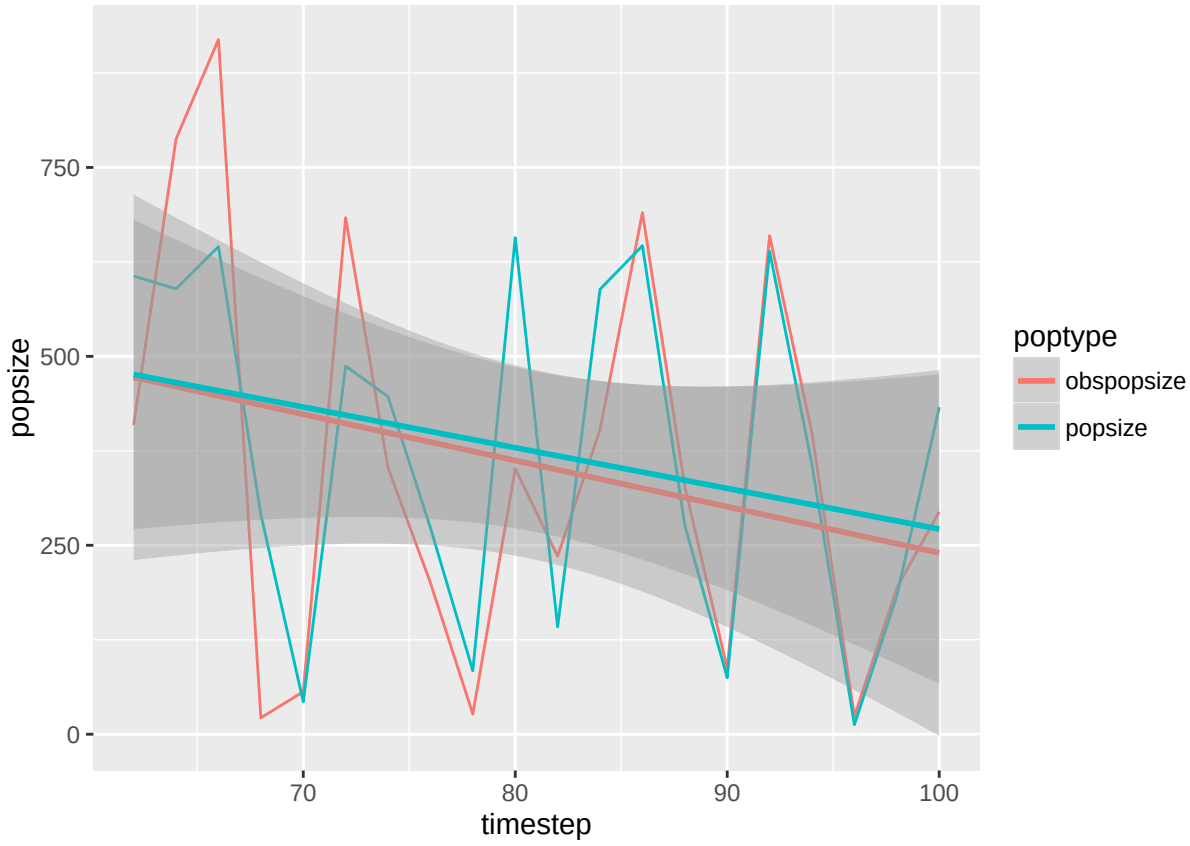
```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(tidyr)
simulations = 1000

compare <- data.frame(simulations=1:simulations,allyears=NA, surveyeddata=NA, startyear=NA, negwhennot=

for(sims in 1:simulations){

N0 <- 550#runif(1, 1,100)
R <- 3
K <- 500

maxtimesteps = 100

dat <- data.frame(timestep=1:maxtimesteps,popsize=c(N0, rep(NA, 99)))

PopNow <- N0

for(i in 2:nrow(dat)) {
  dat[i,"popsize"] <- dat[(i-1),"popsize"] + dat[(i-1),"popsize"]*R*(1-dat[(i-1),"popsize"]/K)
}

allyears <- lm(data=dat, popsize ~ timestep)

compare[sims,"allyears"] <- allyears$coefficients[2]

startdate <- round(runif(1, 1, 80))

compare[sims,"startyear"] <- 100 - startdate

surveytimesteps <- seq(startdate, maxtimesteps, by=2)

surveyed_data <- dat[surveytimesteps,]

for(row in 1:nrow(surveyed_data)){
  surveyed_data[row,"obspopsize"] <- rnorm(1, mean=surveyed_data[row,"popsize"], sd=0.6*surveyed_data[r
}

surveyedyears <- lm(data=surveyed_data, obspopsize ~ timestep)
```

```
compare[sims,"surveyeddata"] <- surveyedyears$coefficients[2]

compare[sims,"negwhennot"] <- ifelse(compare[sims,"surveyeddata"]<0&compare[sims,"allyears"]>0,"yes","n
}

sdat <- surveyed_data %>% gather("poptype","popsize",-timestep)

ggplot(data=sdat, aes(x=timestep, y=popsize, color=poptype))+geom_line()+geom_smooth(method="lm")
```

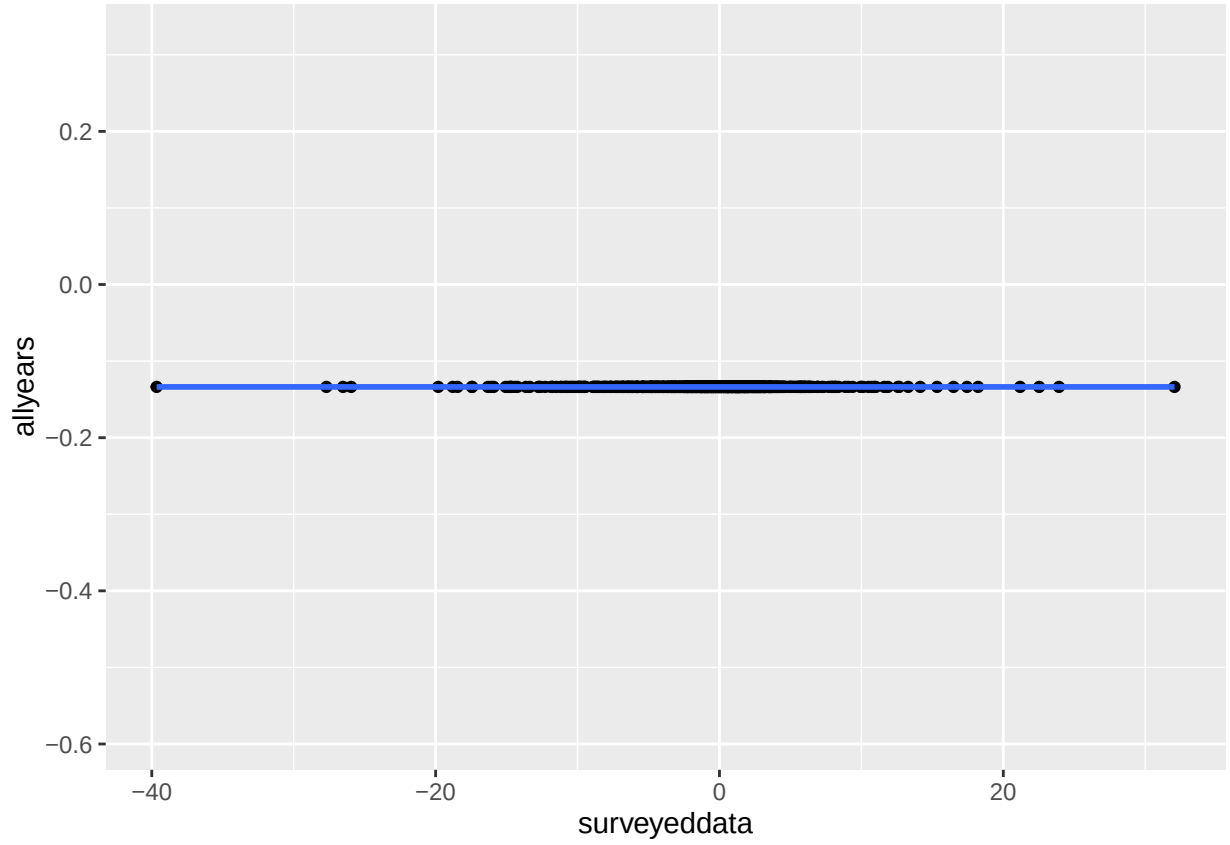



```
summary(lm(data=compare, surveyeddata ~ allyears))
```

```
##
## Call:
## lm(formula = surveyeddata ~ allyears, data = compare)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -39.277  -1.845   0.589   2.409  32.444
##
## Coefficients: (1 not defined because of singularities)
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -0.3817     0.1627  -2.346   0.0192 *
## allyears          NA         NA      NA       NA
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
## Residual standard error: 5.146 on 999 degrees of freedom
```

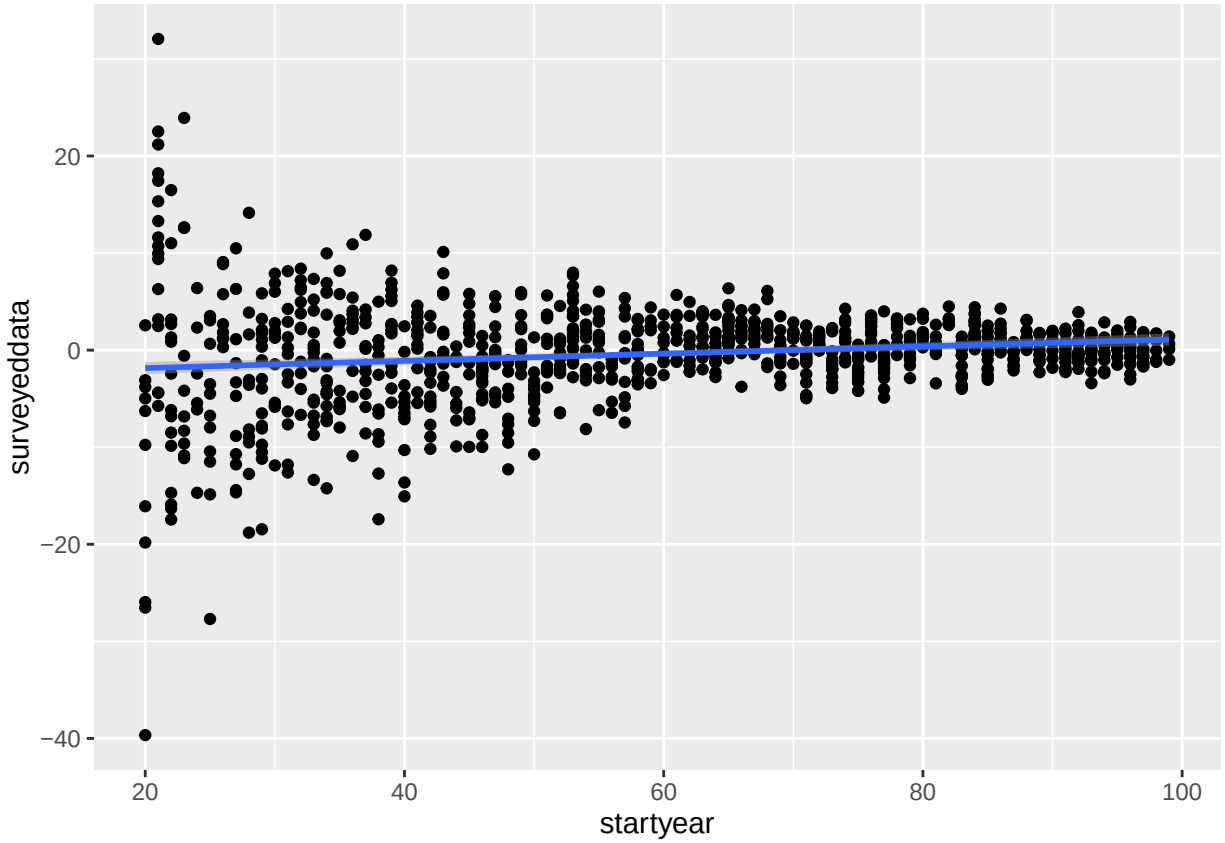
```
ggplot(data=compare, aes(x=surveyeddata, y=allyears))+geom_point()+geom_smooth(method="lm")
```



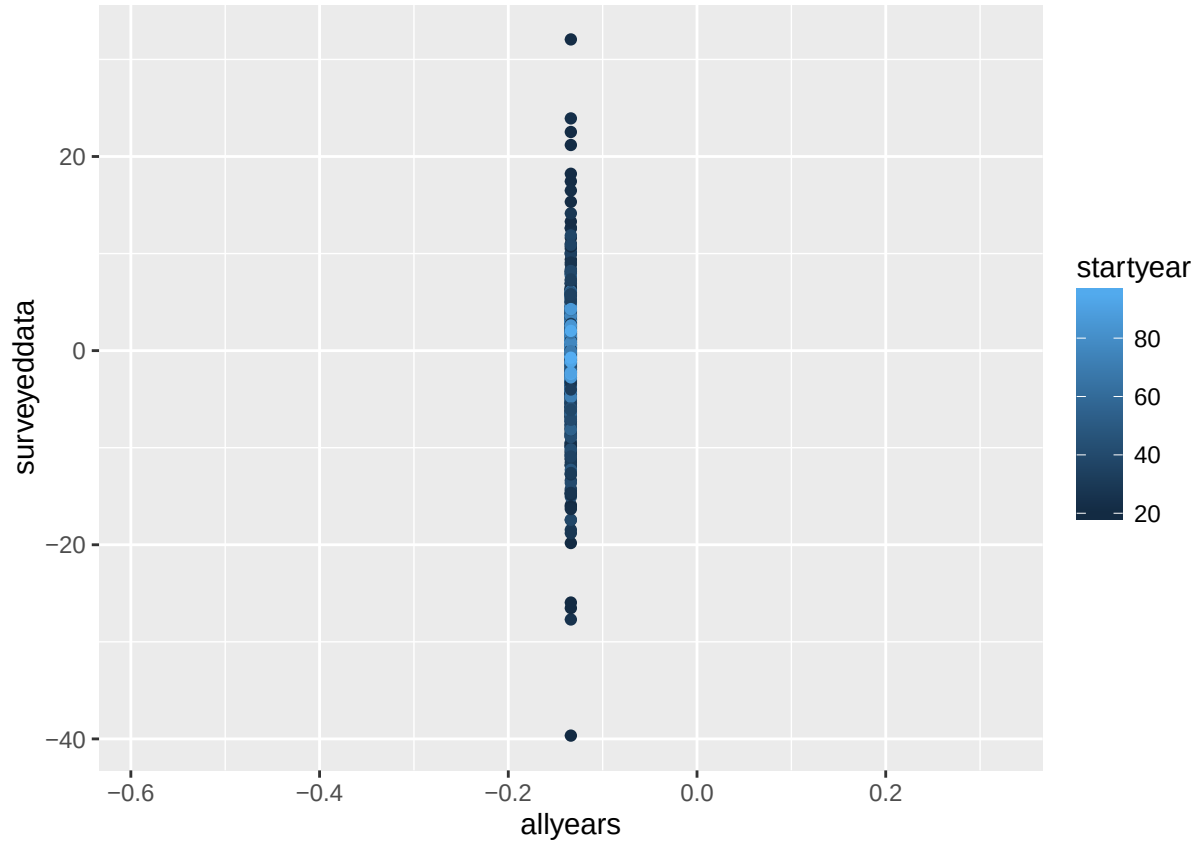

```
summary(lm(data=compare, surveyeddata ~ startyear))
```

```
##
## Call:
## lm(formula = surveyeddata ~ startyear, data = compare)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -37.814  -2.035   0.069   2.372  33.870
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -2.587259   0.451613  -5.729 1.34e-08 ***
## startyear    0.037120   0.007104   5.225 2.12e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 5.079 on 998 degrees of freedom
## Multiple R-squared:  0.02663,    Adjusted R-squared:  0.02566
## F-statistic:  27.3 on 1 and 998 DF,  p-value: 2.116e-07
```

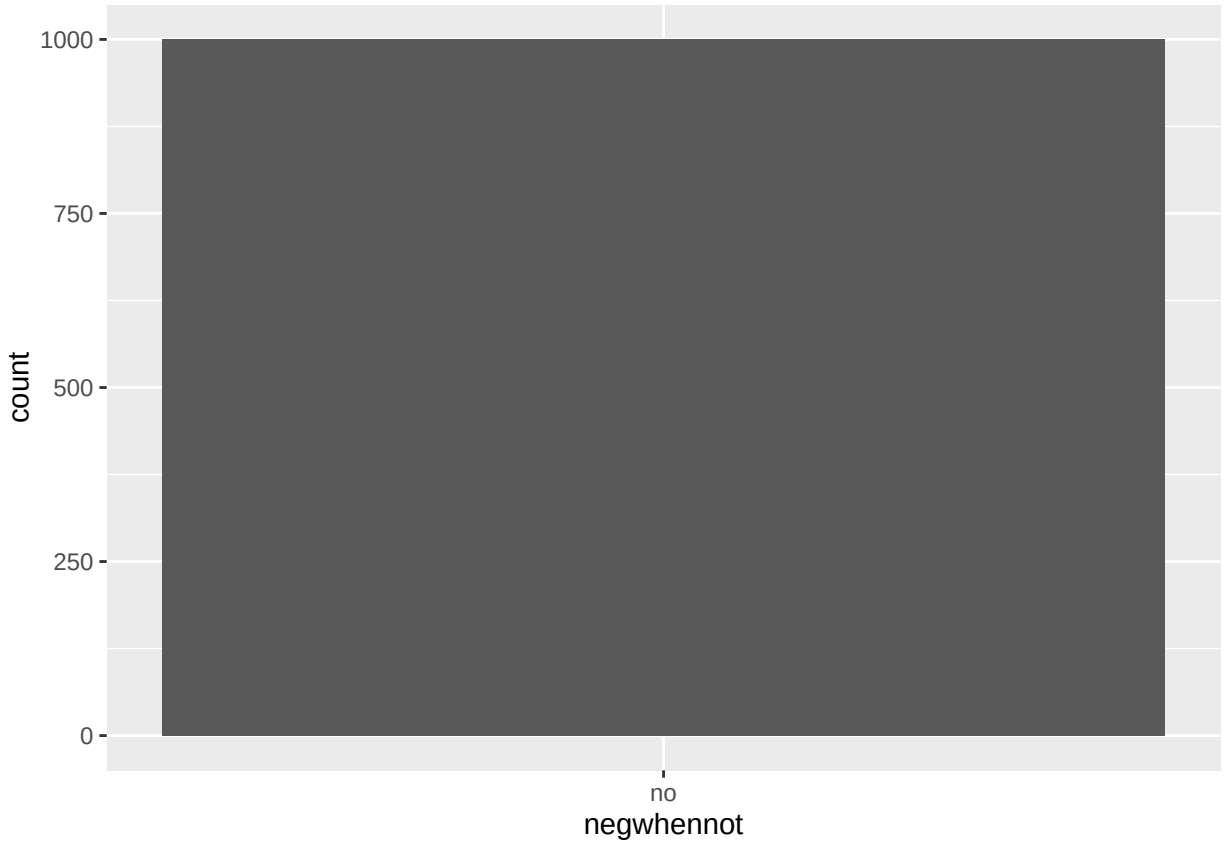
```
ggplot(data=compare, aes(x=startyear, y=surveyeddata))+geom_point()+geom_smooth(method="lm")
```



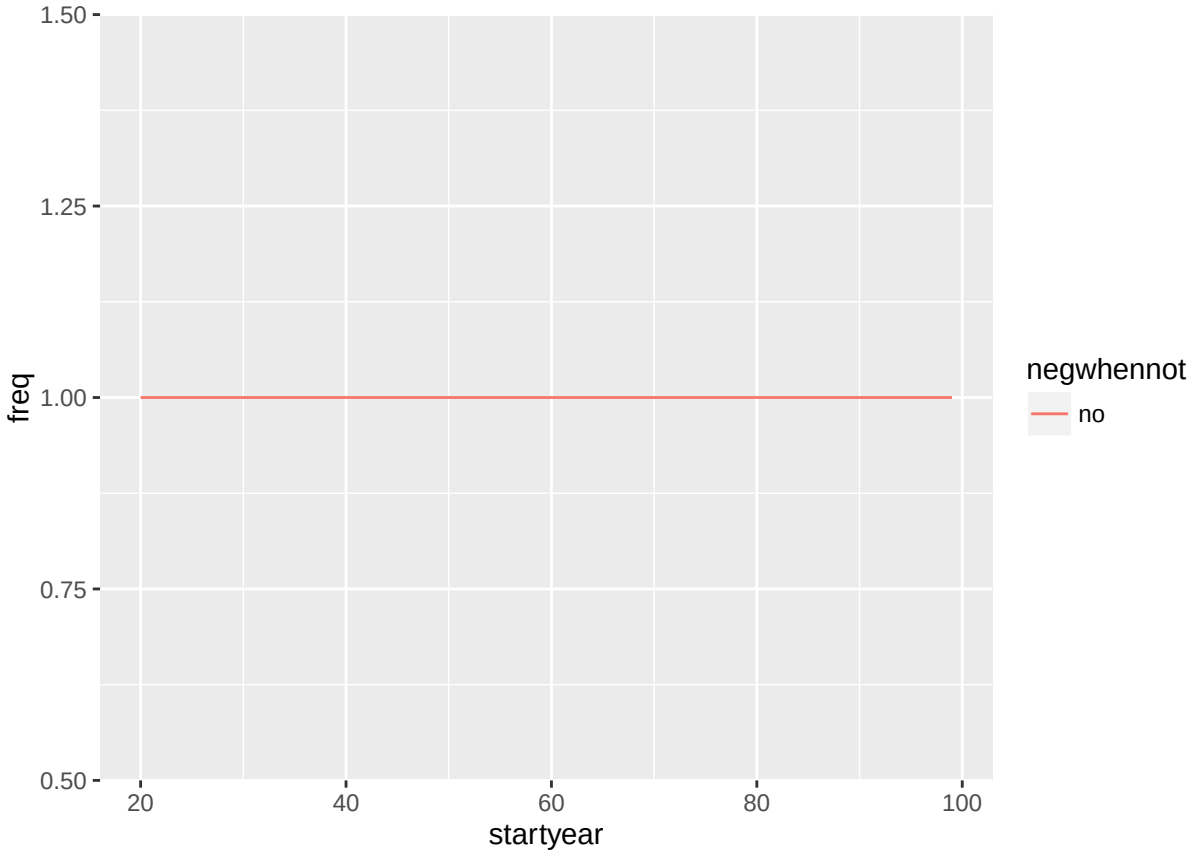

```
ggplot(data=compare, aes(x=allyears, y=surveyeddata, color=startyear))+geom_point()+geom_smooth(method=
```




```
ggplot(data=compare, aes(x=negwhennot)) +
        geom_bar()
```




```
compare %>% group_by(startyear, negwhennot) %>% summarize(count=n()) %>% mutate(freq = count / sum(coun
ggplot(aes(x=startyear, y=freq, color=negwhennot))+geom_line()
```


1.50
1.25
1.00
0.75
0.50
freq
20
40
60
80
100
startyear
negwhennot
no