Declining_population_simulation

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

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

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

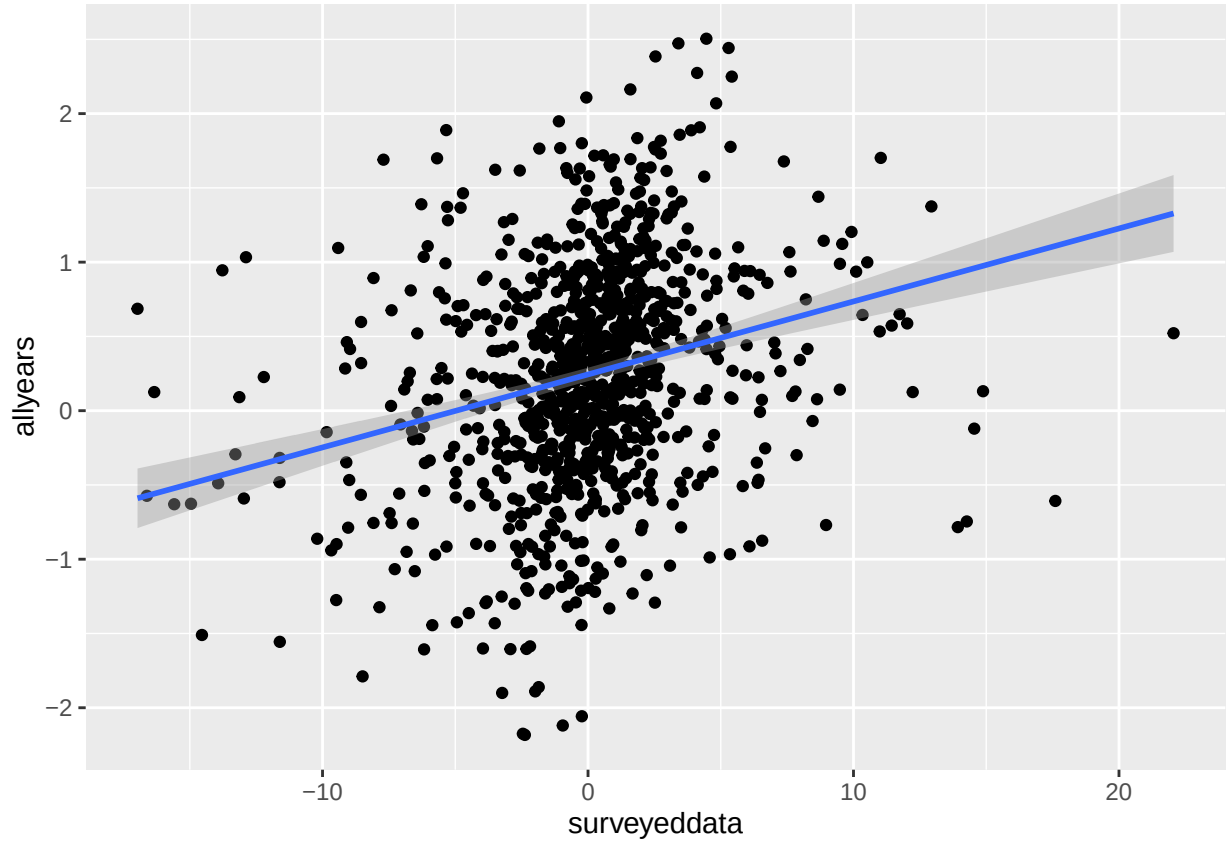
```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
simulations = 1000

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

for(sims in 1:simulations){

N0 <- 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"] <- startdate

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

surveyed_data <- dat[surveytimesteps,]

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

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

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

```
}

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

```
##
## Call:
## lm(formula = surveyeddata ~ allyears, data = compare)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -17.5254  -1.3879   0.1282   1.5001  21.7204
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -0.3594     0.1263  -2.846  0.00451 **
## allyears      1.3340     0.1594   8.367  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.801 on 998 degrees of freedom
## Multiple R-squared:  0.06555,    Adjusted R-squared:  0.06462
## F-statistic: 70.01 on 1 and 998 DF,  p-value: < 2.2e-16
```

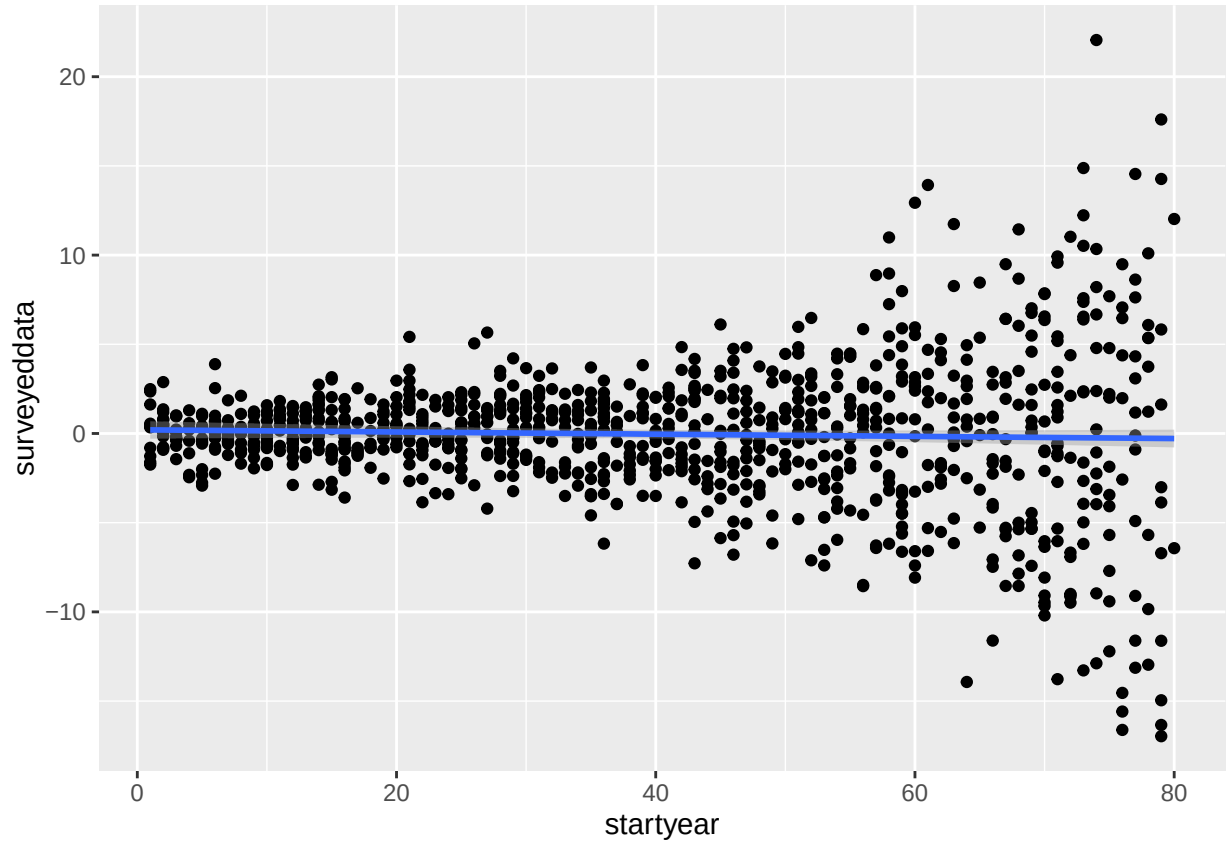
```
ggplot(data=compare, aes(x=surveyeddata, y=allyears))+geom_point()+geom_smooth(method="lm")
```



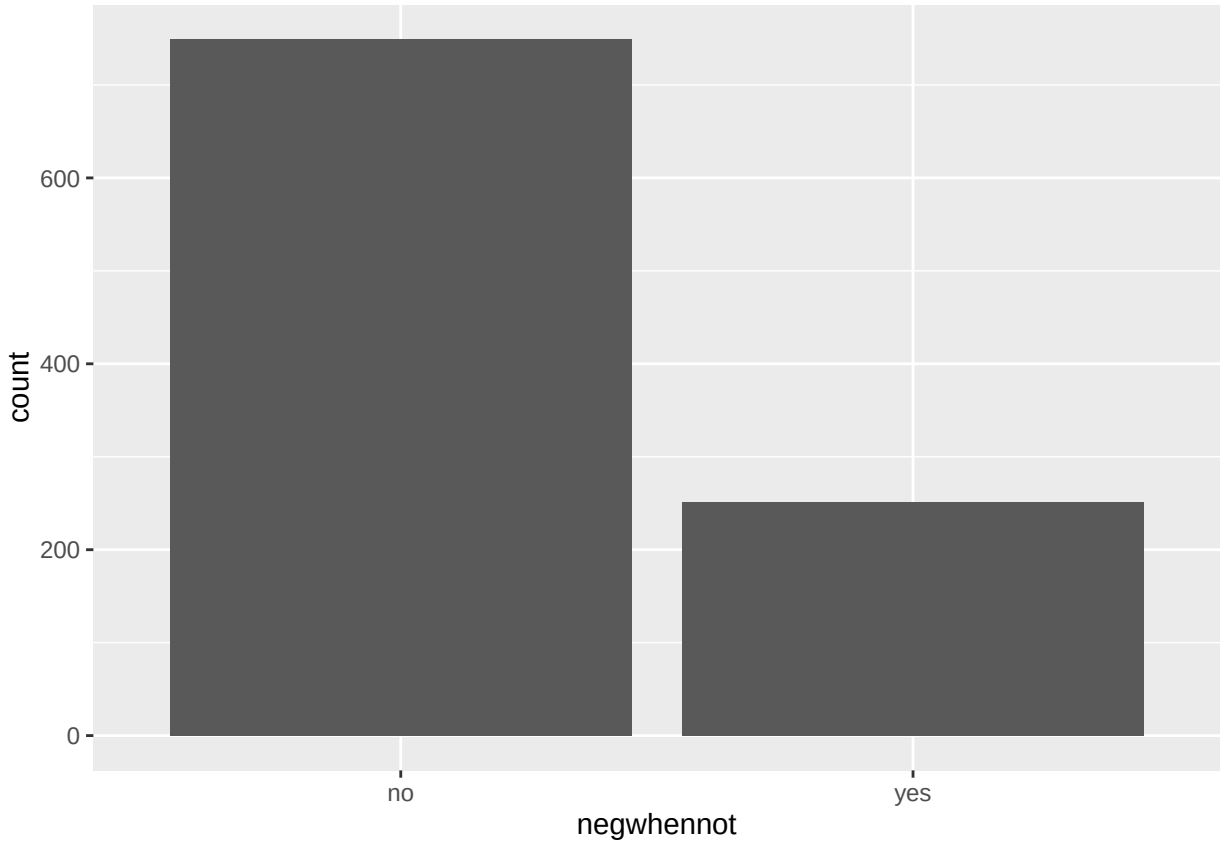

```
summary(lm(data=compare, surveyeddata ~ startyear))
```

```
##
## Call:
## lm(formula = surveyeddata ~ startyear, data = compare)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -16.6922  -1.6107   0.0914   1.6746  22.3033
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.207288   0.250671   0.827    0.408
## startyear   -0.006133   0.005485  -1.118    0.264
##
## Residual standard error: 3.93 on 998 degrees of freedom
## Multiple R-squared:  0.001251,   Adjusted R-squared:  0.0002505
## F-statistic:  1.25 on 1 and 998 DF,  p-value: 0.2638
```

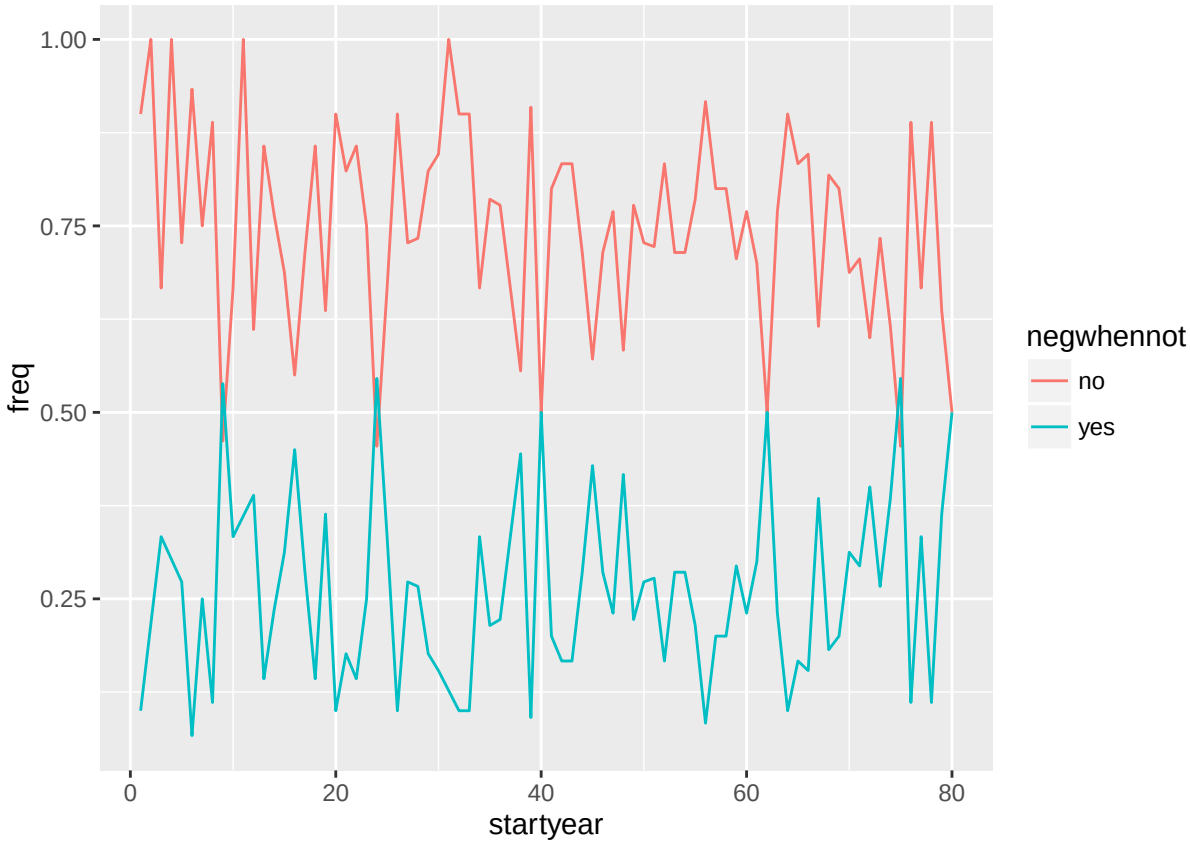
```
ggplot(data=compare, aes(x=startyear, y=surveyeddata))+geom_point()+geom_smooth(method="lm")
```




```
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()
```


1.00
0.75
0.50
0.25
freq
0
20
40
60
80
startyear
negwhennot
no
yes