Influences of Temperature and Salinity on Seagrass Linear Growth

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EDA Final Project - Fall 2023

R Markdown

This is an R Markdown document for the final project in EDA. This document explores the relationship between temperature and linear growth rates of seagrass.

Notes

For temp/salinity, readings were taken on the same day for either summer/reference or winter/reference. We decided to only use the reference measurements to keep the data uniform.

Linear growth readings were not taken the same days as the temp/salinity. They were usually taken the following day.

ex_week (experiment week) is the consistent variable across all the data collected. We used this to join the data frames.

Set up

```
# import libraries
library(tidyverse)
```

```
## -- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
## v dplyr     1.1.3     v readr     2.1.4
## v forcats   1.0.0     v stringr   1.5.0
## v ggplot2   3.4.3     v tibble    3.2.1
## v lubridate 1.9.2     v tidyr     1.3.0
## v purrr     1.0.2
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors
```

```
library(lubridate)
library(here)
```

```
## here() starts at /home/guest/R/EDA_Final_Project/BeyerBolgerNoor_Env872_EDA_FinalProject
```

```r
# check that here points to the project folder
here()
```

```
## [1] "/home/guest/R/EDA_Final_Project/BeyerBolgerNoor_Env872_EDA_FinalProject"
```

```r
# setting plot theme
mytheme <- theme_classic(base_size = 14) +
  theme(axis.text = element_text(color = "darkblue"),
        title = element_text(color='darkgreen'),
        panel.grid.major = element_line(color = "gray", linetype = "solid"))
# set theme
theme_set(mytheme)
```

Cleaning Data

You can also embed plots, for example:

```r
# import temperature data
temp <-  read.csv("Data/Raw/Temperature-Salinity.csv")

# import salinity data
salinity <-  read.csv("Data/Raw/Temperature-Salinity.csv")

# import linear growth data
linear_growth <- read.csv("Data/Raw/Seagrass-linear-growth-rates.csv")
```

```r
# change temp date column
temp$date <- as.Date(temp$date)

# change salinity date column
salinity$date <- as.Date(salinity$date)

# change dat column
linear_growth$date <- as.Date(linear_growth$date)
# creating a month column
```

```r
# filtering for only reference data (represents whole experiment time)
# creating a mean temp column
# selecting needed columns
# getting rid of possible NAs
temp_processed <- temp %>%
  filter(treatment == "reference") %>%
  mutate(mean_temp = (min_temp + max_temp) / 2) %>%
  select(date, mean_temp, exp_week) %>%
  na.omit()

# filtering for only reference data (represents whole experiment time)
# selecting needed columns
# getting rid of possible NAs
salinity_processed <- salinity %>%
  filter(treatment == "reference") %>%
```

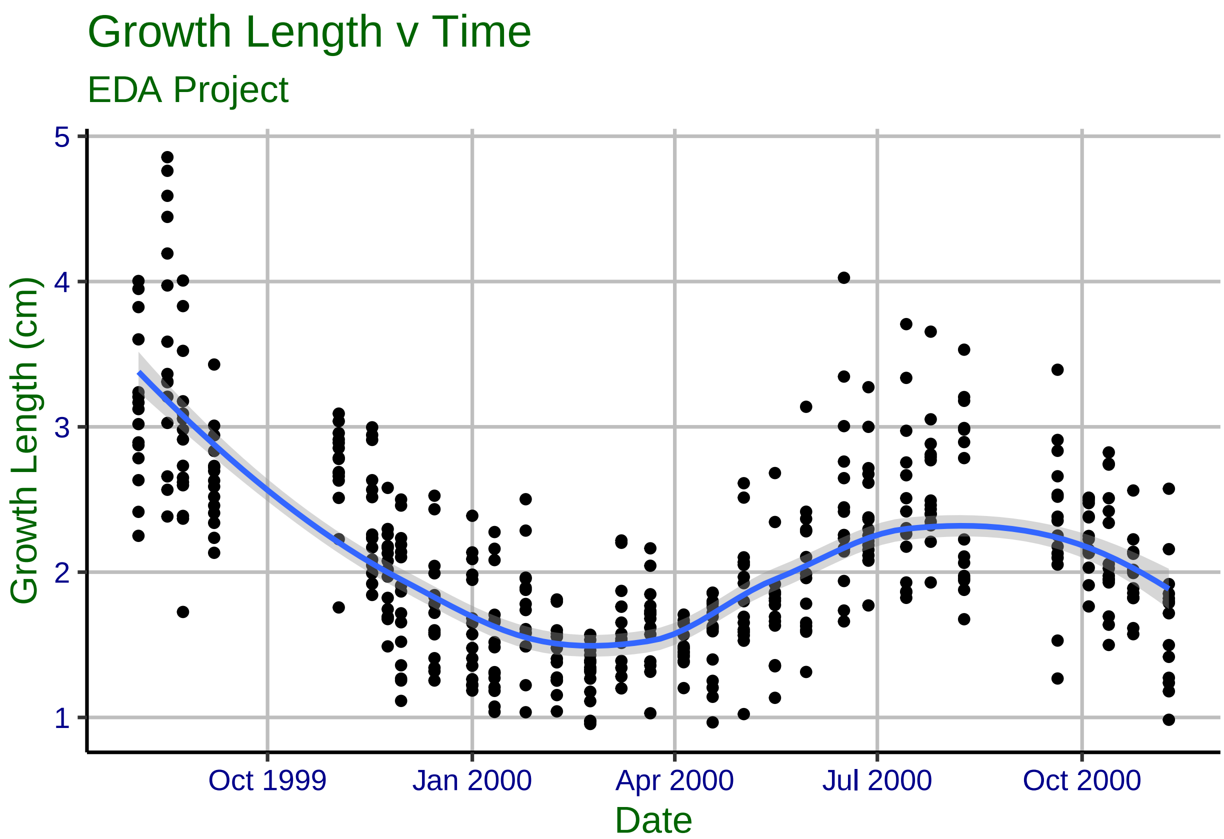
```r
  select(date, salinity, exp_week) %>%
  na.omit()


# filtering for only reference data (represents whole experiment time)
# selecting needed columns
linear_growth_processed <- linear_growth %>%
  filter(treatment == "reference") %>%
  select(date, gr_length, exp_week)
```

```r
# joining temp data and linear growth by using experiment week
temp_lineargrowth <- full_join(temp_processed,
                               linear_growth_processed,
                               by = "exp_week")

# selecting the full date column and removing NAs
temp_lineargrowth_processed <- temp_lineargrowth %>%
  select(date.x, mean_temp, gr_length) %>%
  na.omit()

# joining salinity data and linear growth by using experiment week
salinity_lineargrowth <- full_join(salinity_processed,
                                   linear_growth_processed,
                                   by = "exp_week")

# selecting the full date column and removing NAs
salinity_lineargrowth_processed <- salinity_lineargrowth %>%
  select(date.x, salinity, gr_length) %>%
  na.omit()
```

Plotting Temperature

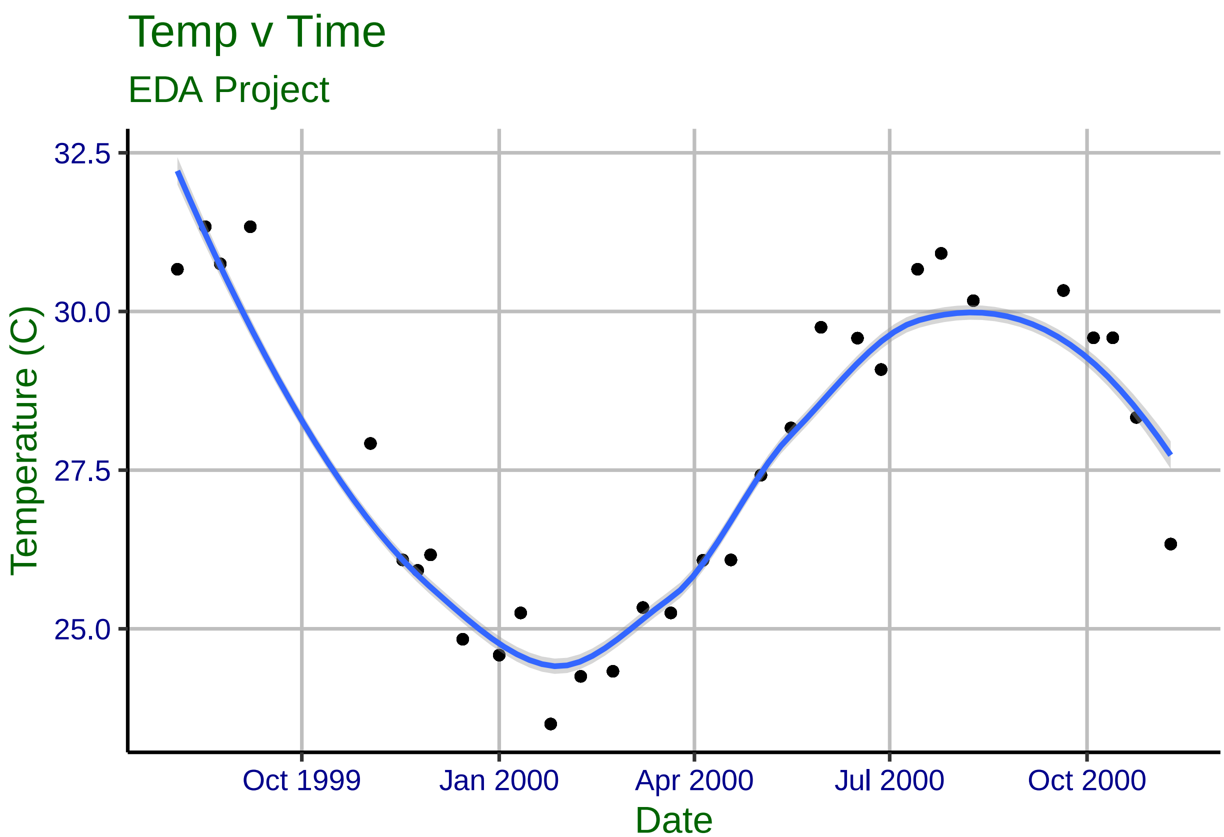
```r
# plot of linear growth over time
growth_time_plot <-
ggplot(temp_lineargrowth_processed,aes(x=date.x,y=gr_length)) +
  geom_point() +
  geom_smooth(method = 'loess') +
  labs(title = "Growth Length v Time",
       subtitle = "EDA Project",
       y="Growth Length (cm)",
       x="Date")
plot(growth_time_plot)
```

```
## `geom_smooth()` using formula = 'y ~ x'
```



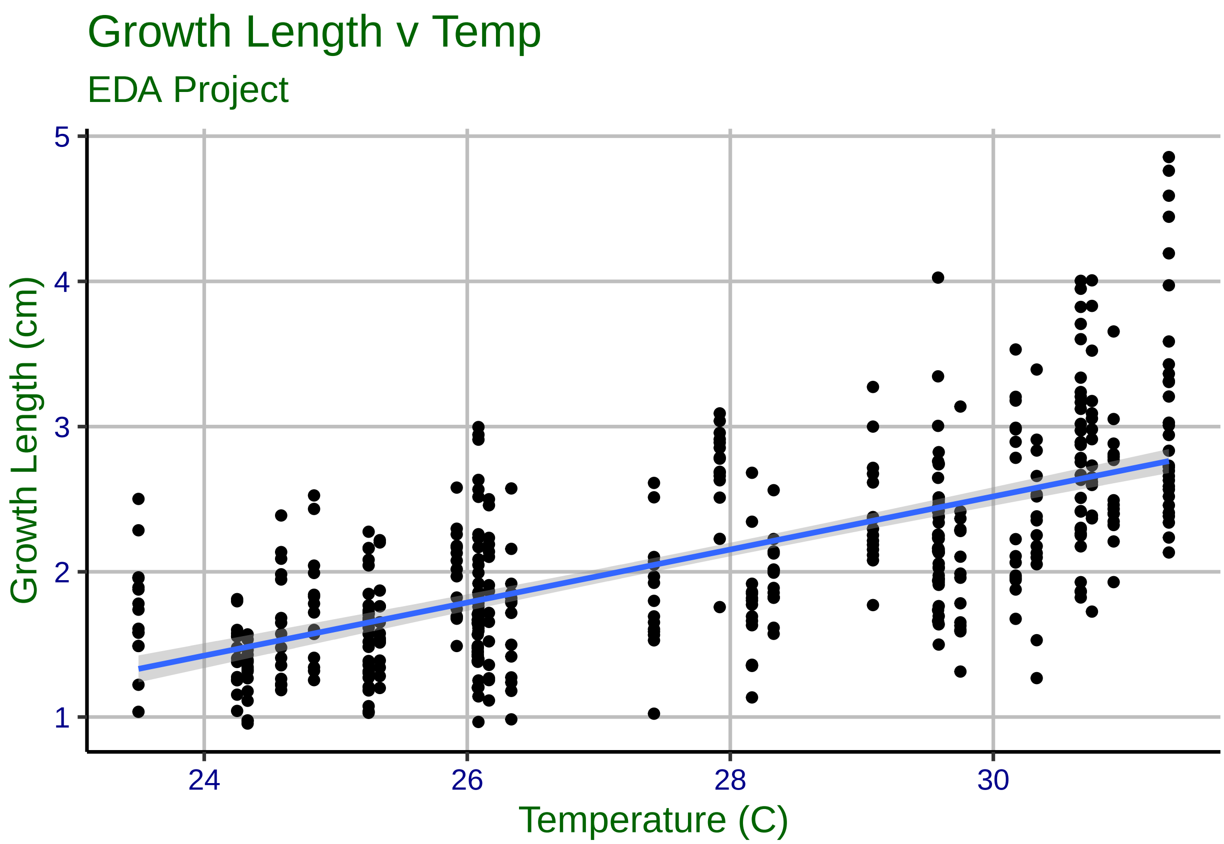

```r
# plot of temperature over time
temp_time_plot <-
ggplot(temp_lineargrowth_processed,aes(x=date.x,y=mean_temp)) +
  geom_point() +
  geom_smooth(method = 'loess') +
  labs(title = "Temp v Time",
       subtitle = "EDA Project",
       y="Temperature (C)",
       x="Date")
plot(temp_time_plot)
```

```
## `geom_smooth()` using formula = 'y ~ x'
```




```
# plot comparing linear growth to temperature
growth_temp_plot <-
ggplot(temp_lineargrowth_processed,aes(x=mean_temp,y=gr_length)) +
  geom_point() +
  geom_smooth(method = "lm") +
  labs(title = "Growth Length v Temp",
       subtitle = "EDA Project",
       y="Growth Length (cm)",
       x="Temperature (C)")
plot(growth_temp_plot)
```

```
## `geom_smooth()` using formula = 'y ~ x'
```



> Results: The first graph suggest that seagrass linear growth fluctuated over time seemingly with the seasons. The second graph demonstrations the seasonal shift in temperature. The third graph suggests a positive relationship between seagrass linear growth and temperature.

Temperature Analysis

```r
temp_growth_regression <-
  lm(data = temp_lineargrowth_processed,
     mean_temp ~ gr_length)
summary(temp_growth_regression)
```

```
##
## Call:
## lm(formula = mean_temp ~ gr_length, data = temp_lineargrowth_processed)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -5.1758 -1.4607 -0.1001  1.4551  4.5908
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  22.7217     0.2788   81.50   <2e-16 ***
## gr_length     2.3797     0.1261   18.87   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

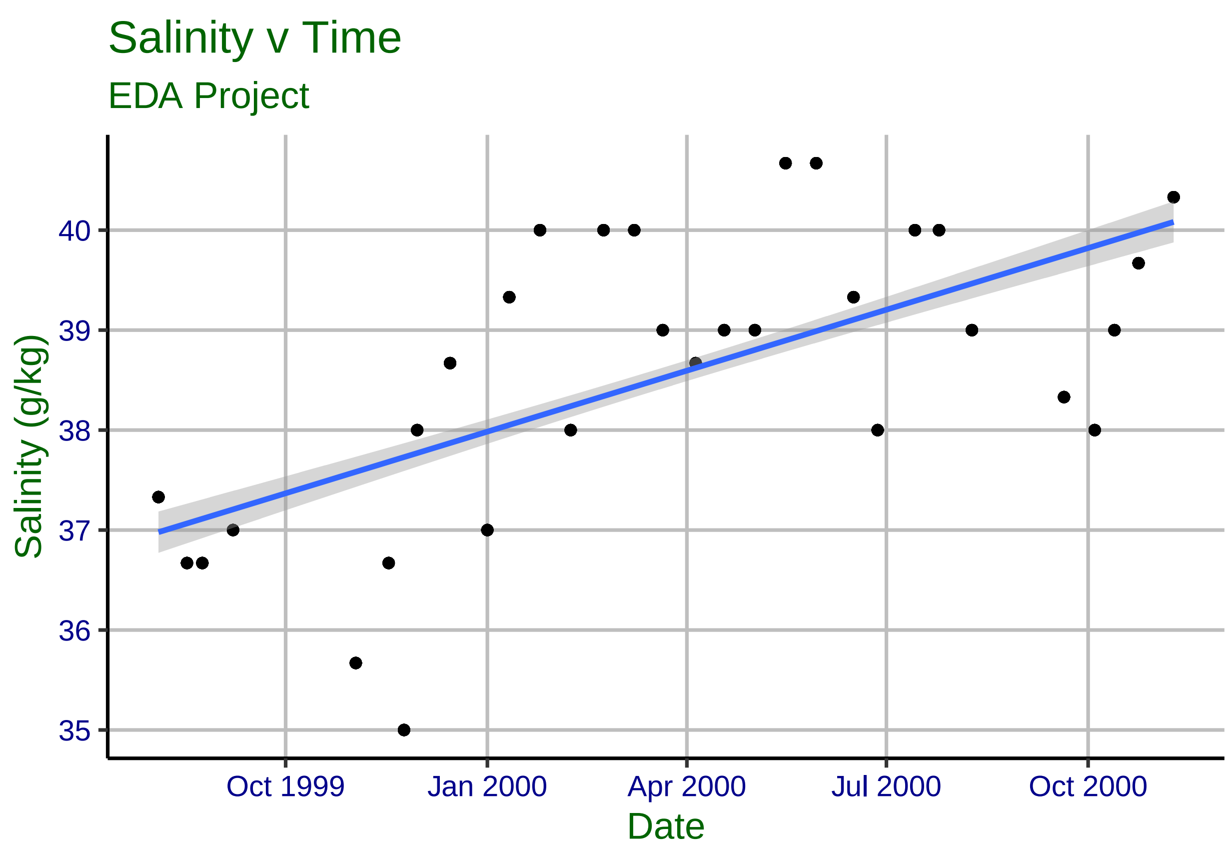
```
##
## Residual standard error: 1.844 on 463 degrees of freedom
## Multiple R-squared:  0.4347, Adjusted R-squared:  0.4335
## F-statistic: 356.1 on 1 and 463 DF,  p-value: < 2.2e-16
```

Results: p-value = < 2.2e-16, r-squared = 0.4335. This confirms a significant positive relationship between temperature and seagrass linear growth. This means that seagrass linear growth increases as the temperature increses.

Plotting Salinity

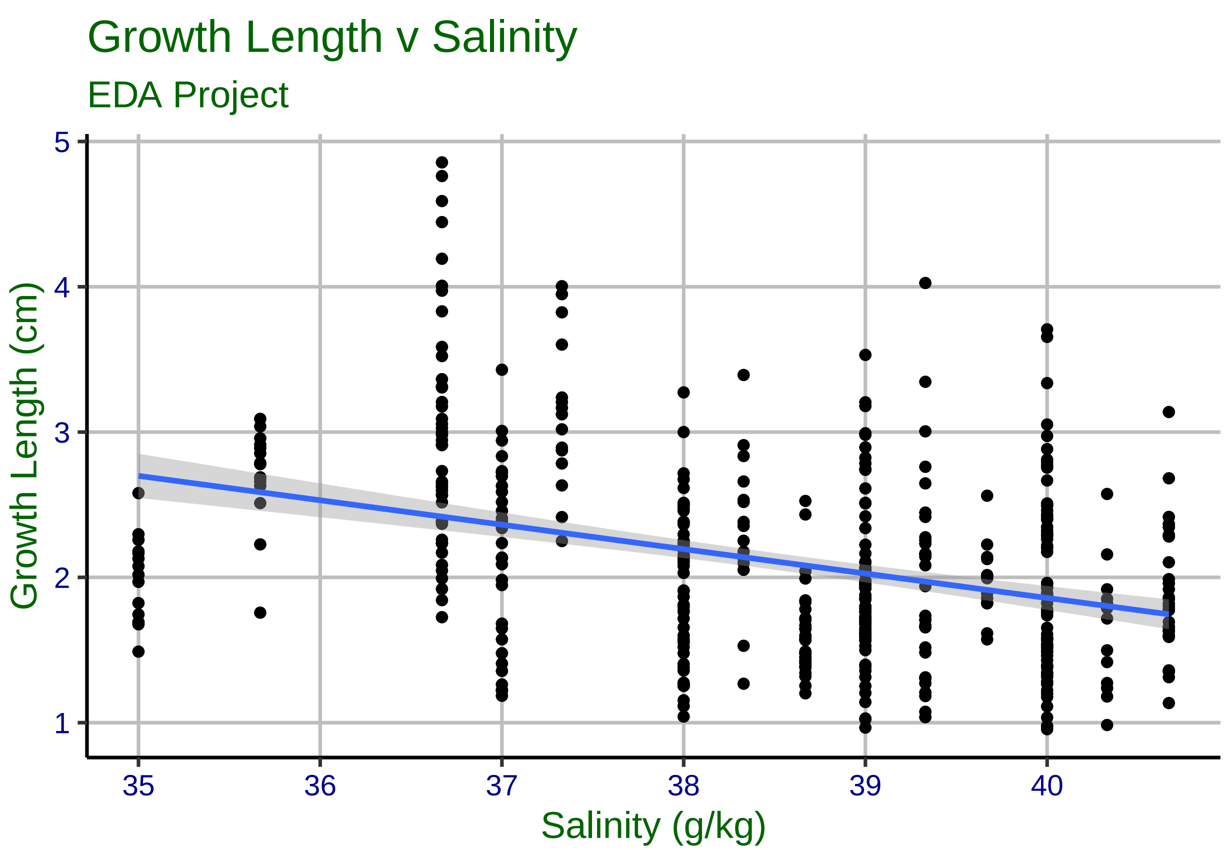
```
# plot of salinity over time
salinity_time_plot <-
ggplot(salinity_lineargrowth_processed,aes(x=date.x,y=salinity)) +
  geom_point() +
  geom_smooth(method = 'lm') +
  labs(title = "Salinity v Time",
       subtitle = "EDA Project",
       y="Salinity (g/kg)",
       x="Date")
plot(salinity_time_plot)
```

```
## `geom_smooth()` using formula = 'y ~ x'
```



```r
# plot comparing linear growth to salinity
growth_salinity_plot <-
ggplot(salinity_lineargrowth_processed,aes(x=salinity,y=gr_length)) +
  geom_point() +
  geom_smooth(method = "lm") +
  labs(title = "Growth Length v Salinity",
       subtitle = "EDA Project",
       y="Growth Length (cm)",
       x="Salinity (g/kg)")
plot(growth_salinity_plot)
```

```
## `geom_smooth()` using formula = 'y ~ x'
```



Results: The first graph suggests that salinity is increasing over time. The second graph suggests a negative relationship between salinity and seagrass linear growth.

Salinity Analysis

```r
# linear regression of salinity and linear growth
salinity_growth_regression <-
  lm(data = salinity_lineargrowth_processed,
     salinity ~ gr_length)
summary(salinity_growth_regression)
```

```
##
## Call:
## lm(formula = salinity ~ gr_length, data = salinity_lineargrowth_processed)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -4.0108 -0.8356  0.0906  1.0184  2.9268
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 40.15543    0.20503 195.848  < 2e-16 ***
## gr_length   -0.76870    0.09275  -8.288 1.26e-15 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.357 on 463 degrees of freedom
## Multiple R-squared:  0.1292, Adjusted R-squared:  0.1273
## F-statistic: 68.69 on 1 and 463 DF,  p-value: 1.256e-15
```

```
# linear regression of salinity and time
salinity_time_regression <-
  lm(data = salinity_lineargrowth_processed,
     salinity ~ date.x)
summary(salinity_time_regression)
```

```
##
## Call:
## lm(formula = salinity ~ date.x, data = salinity_lineargrowth_processed)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2.7296 -0.9014  0.1979  0.7086  1.8548
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -3.546e+01  4.318e+00  -8.213 2.17e-15 ***
## date.x       6.703e-03  3.911e-04  17.140  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.137 on 463 degrees of freedom
## Multiple R-squared:  0.3882, Adjusted R-squared:  0.3869
## F-statistic: 293.8 on 1 and 463 DF,  p-value: < 2.2e-16
```

Results: For salinity and linear growth the p-value 1.256e-15 and r-squared = 0.1273. This confirms a significant negative relationship between salinity and seagrass linear growth. This means that as salinity increases, seagrass seagrass linear growth decreases.

Results: For salinity over time the p-value < 2.2e-16 and r-squared = 0.3869. This confirms a significant positive relationship between salinity over time. This means that salinity was increasing over the time of the experiment.