



**NORTHEASTERN UNIVERSITY**

Toronto, Canada

## **Executive Summary of Module 2**

Introduction to Data Analysis  
(ALY6000)

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## Key Findings:

- In the following report, the analysis of data is of BullTroutRML2 in which assigned ages and fork lengths of Bull Trout from two Rocky Mountain (Harrison and Osprey) lakes in Alberta, CAN before and after a regulation change.

- For narrowing the analysis of Harrison Lake, we need to filter out other data except for Harrison Lake. So, the program to perform

Input:

```
Harrisonlake<-filter(BullTroutRML2, lake=="Harrison")
```

Harrisonlake

- If there is a specific sort of data which you want to do analysis of other than the whole data, it is also done by creating a object in which we can load data.

For example, I want to make different set of data for first and last 3 records of main data then an object is created and that records are inserted in the object.

Input:

```
tmp <- headtail(Harrisonlake,3)
```

```
> tmp
  age  fl    lake era
1  14 459 Harrison  1
2  12 449 Harrison  1
3  10 471 Harrison  1
59   7 245 Harrison  2
60   7 279 Harrison  2
61   5 245 Harrison  2
```

where tmp is the new object.

- To access one variable from a particular set of data, we can get it with the \$ symbol.

```
> tmp$era
[1] 1 1 1 2 2 2
>
```

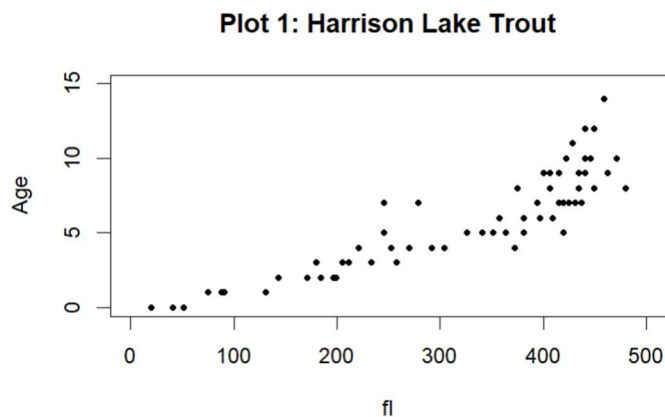
- Different kind of vectors are also created, and those vectors can also be initiated into the values of the data.

```
> #14. Create pchs vector
> pchs <- c("+", "x")
> pchs
[1] "+" "x"
> #15. Create cols vector
> cols<-c("red", "gray60")
> cols
[1] "red" "gray60"
> #17. Combine cols vector to tmp era values
> cols[tmp$era]
[1] "red" "red" "red" "gray60" "gray60" "gray60"
>
```

- To understand the data properly, graphs are plotted to visualize the data clearly and have a better acknowledgement of the data.  
The different types of graphs are shown below:

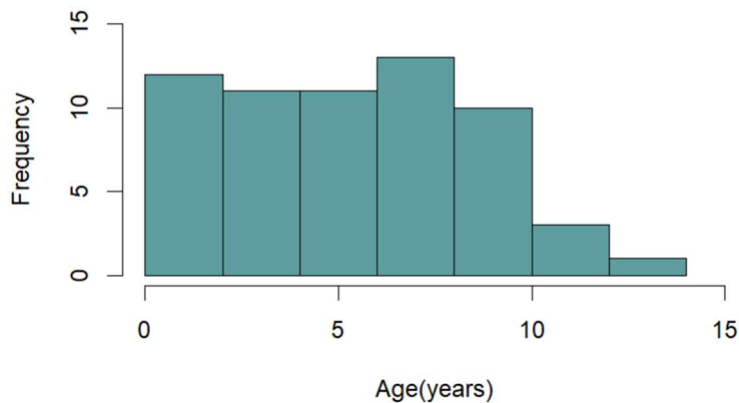
Plot 1:

The following scatterplot depicts the graph between age and fork length of the distinct fishes over the years in Harrison Lake Trout.

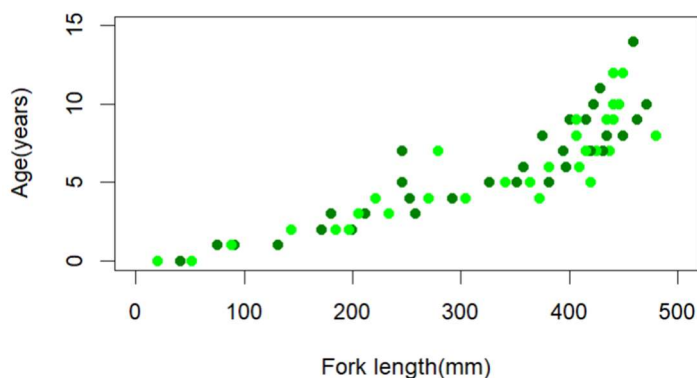


Plot 2:

This is a histogram of the age of the fish over the years with the frequency.

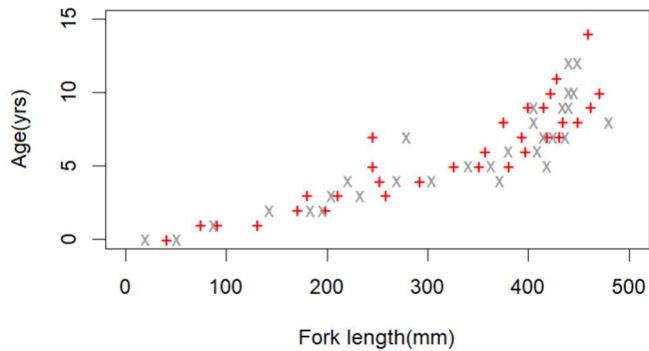
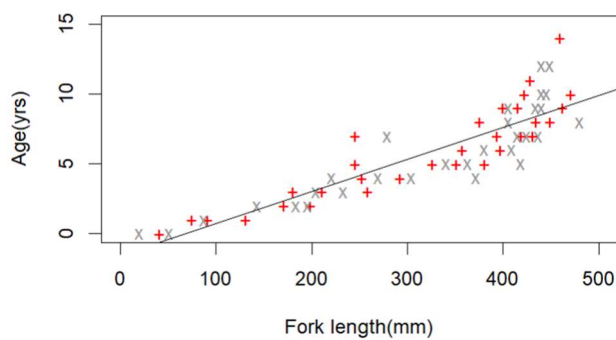
**Plot 2: Harrison Fish Age Distribution****Plot 3:**

This graph is same as the first graph except for the colours by which the graph is shaded. There are two different shades to understand the two different eras.

**Plot 3: Harrison Density Shaded by era****Plot 4 and 5:**

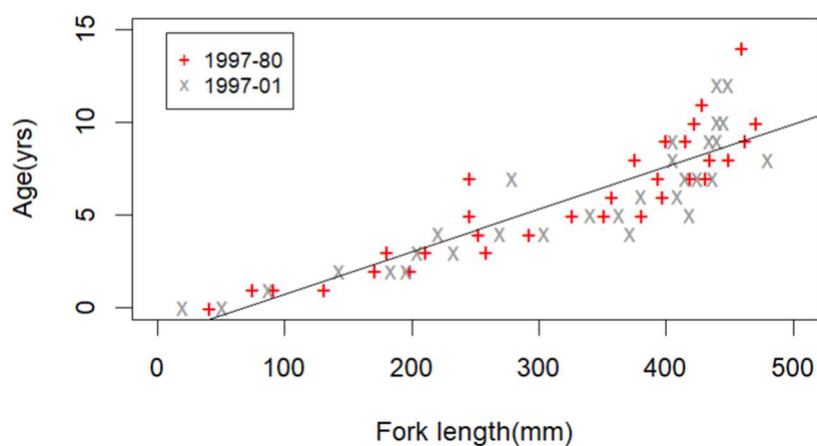
In 4<sup>th</sup> graph different values are assigned to different eras for much better understanding and in 5<sup>th</sup> one, a regression line is added which gives comprehensive analysis of the graph.

A regression line is used to predict the value of  $y$  for a given value of  $x$ .

**Plot 4: Symbol and Color by Era****Plot 5: Regression Overlay**

## ➤ Plot 6:

This is the final graph from which we can have the full understanding from the graph that fork length of fish increases with their age and even in different time era. Here we have mentioned the value of the dots which are plotted in the graph which are different timeframes.

**Plot 6: Legend overlay**

### Summary

- All the descriptive statistics which includes mean, median, variance etc are key findings in recognizing the pattern of the dataset.
- Scatterplots, histograms, frequency and probability distributions, bar plots (bar charts) are different types of graphs taken into consideration for explaining the visuals thoroughly.
- Visualization of data through R makes it so easy for analysts to get the clear picture of the dataset.
- In this assignment, the graphical representation of dataset gives a clear and proper understanding of the data.

### Bibliography

- <https://www.rdocumentation.org/packages/dplyr/versions/0.7.8/topics/filter>
- <https://libraryguides.mcgill.ca/c.php?g=699776&p=4968546>
- <https://www.statmethods.net/graphs/scatterplot.html>
- <https://www.datacamp.com/community/tutorials/make-histogram-basic-r>
- <https://www.geeksforgeeks.org/how-to-create-a-scatterplot-with-a-regression-line-in-r/>
- <http://www.sthda.com/english/wiki/add-legends-to-plots-in-r-software-the-easiest-way>

My GitHub repository : <https://github.com/dhruvang186/Module2>

# DhruvangPatel\_M2\_Project2.R

dhruvang

2022-01-25

```
#name  
print("Plotting Basics:Dhruvang Patel")
```

```
## [1] "Plotting Basics:Dhruvang Patel"
```

```
r=getOption("repos")  
r["CRAN"]="http://cran.us.r-project.org"  
options(repos=r)  
install.packages("vcd")
```

```
## Installing package into 'C:/Users/dhruvang/Documents/R/win-library/4.1'  
## (as 'lib' is unspecified)
```

```
## package 'vcd' successfully unpacked and MD5 sums checked  
##
```

```
## The downloaded binary packages are in  
## C:\Users\dhruvang\AppData\Local\Temp\RtmpYvAedw\downloaded_packages
```

```
library(vcd)
```

```
## Loading required package: grid
```

```
#install plyr package  
install.packages("plyr")
```

```
## Installing package into 'C:/Users/dhruvang/Documents/R/win-library/4.1'  
## (as 'lib' is unspecified)
```

```
## package 'plyr' successfully unpacked and MD5 sums checked
```

```
## Warning: cannot remove prior installation of package 'plyr'
```

```
## Warning in file.copy(savedcopy, lib, recursive = TRUE): problem copying C:  
## \Users\dhruvang\Documents\R\win-library\4.1\00LOCK\plyr\libs\x64\plyr.dll to C:  
## \Users\dhruvang\Documents\R\win-library\4.1\plyr\libs\x64\plyr.dll: Permission  
## denied
```

```
## Warning: restored 'plyr'
```



```
##  
## The downloaded binary packages are in  
## C:\Users\dhruvang\AppData\Local\Temp\RtmpYvAedw\downloaded_packages
```

```
library(plyr)  
  
#install FSA package  
install.packages("FSA")
```

```
## Installing package into 'C:/Users/dhruvang/Documents/R/win-library/4.1'  
## (as 'lib' is unspecified)
```

```
## package 'FSA' successfully unpacked and MD5 sums checked  
##
```

```
## The downloaded binary packages are in  
## C:\Users\dhruvang\AppData\Local\Temp\RtmpYvAedw\downloaded_packages
```

```
library(FSA)
```

```
## ## FSA v0.9.1. See citation('FSA') if used in publication.  
## ## Run fishR() for related website and fishR('IFAR') for related book.
```

```
##  
## Attaching package: 'FSA'
```

```
## The following object is masked from 'package:plyr':  
##  
## mapvalues
```

```
#install FSAdata package  
install.packages("FSAdata")
```

```
## Installing package into 'C:/Users/dhruvang/Documents/R/win-library/4.1'  
## (as 'lib' is unspecified)
```

```
## package 'FSAdata' successfully unpacked and MD5 sums checked  
##
```

```
## The downloaded binary packages are in  
## C:\Users\dhruvang\AppData\Local\Temp\RtmpYvAedw\downloaded_packages
```

```
library(FSAdata)
```

```
## ## FSAdata v0.3.8. See ?FSAdata to find data for specific fisheries analyses.
```

```
#install magrittr package  
install.packages("magrittr")
```

```
## Installing package into 'C:/Users/dhruvang/Documents/R/win-library/4.1'  
## (as 'lib' is unspecified)
```

```
## package 'magrittr' successfully unpacked and MD5 sums checked

## Warning: cannot remove prior installation of package 'magrittr'

## Warning in file.copy(savedcopy, lib, recursive = TRUE):
## problem copying C:\Users\dhruvang\Documents\R\win-
## library\4.1\00LOCK\magrittr\libs\x64\magrittr.dll to C:
## \Users\dhruvang\Documents\R\win-library\4.1\magrittr\libs\x64\magrittr.dll:
## Permission denied

## Warning: restored 'magrittr'

##
## The downloaded binary packages are in
## C:\Users\dhruvang\AppData\Local\Temp\RtmpYvAedw\downloaded_packages

library(magrittr)

#install dplyr package
install.packages("dplyr")

## Installing package into 'C:/Users/dhruvang/Documents/R/win-library/4.1'
## (as 'lib' is unspecified)

## package 'dplyr' successfully unpacked and MD5 sums checked

## Warning: cannot remove prior installation of package 'dplyr'

## Warning in file.copy(savedcopy, lib, recursive = TRUE): problem copying C:
## \Users\dhruvang\Documents\R\win-library\4.1\00LOCK\dplyr\libs\x64\dplyr.dll
## to C:\Users\dhruvang\Documents\R\win-library\4.1\dplyr\libs\x64\dplyr.dll:
## Permission denied

## Warning: restored 'dplyr'

##
## The downloaded binary packages are in
## C:\Users\dhruvang\AppData\Local\Temp\RtmpYvAedw\downloaded_packages

library(dplyr)

##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:plyr':
##
##   arrange, count, desc, failwith, id, mutate, rename, summarise,
##   summarize
```

```

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

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

#install plotrix package
install.packages("plotrix")

## Installing package into 'C:/Users/dhruvang/Documents/R/win-library/4.1'
## (as 'lib' is unspecified)

## package 'plotrix' successfully unpacked and MD5 sums checked
##
## The downloaded binary packages are in
## C:\Users\dhruvang\AppData\Local\Temp\RtmpYvAedw\downloaded_packages

library(plotrix)

#install ggplot2 package
install.packages("ggplot2")

## Installing package into 'C:/Users/dhruvang/Documents/R/win-library/4.1'
## (as 'lib' is unspecified)

## package 'ggplot2' successfully unpacked and MD5 sums checked
##
## The downloaded binary packages are in
## C:\Users\dhruvang\AppData\Local\Temp\RtmpYvAedw\downloaded_packages

library(ggplot2)

#install moments package
install.packages("moments")

## Installing package into 'C:/Users/dhruvang/Documents/R/win-library/4.1'
## (as 'lib' is unspecified)

## package 'moments' successfully unpacked and MD5 sums checked
##
## The downloaded binary packages are in
## C:\Users\dhruvang\AppData\Local\Temp\RtmpYvAedw\downloaded_packages

library(moments)

#Load the dataset
data(BullTroutRML2)
BullTroutRML2

```

##	age	fl	lake	era
## 1	14	459	Harrison	1977-80
## 2	12	449	Harrison	1977-80
## 3	10	471	Harrison	1977-80
## 4	10	446	Harrison	1977-80
## 5	9	400	Harrison	1977-80
## 6	9	440	Harrison	1977-80
## 7	9	462	Harrison	1977-80
## 8	8	480	Harrison	1977-80
## 9	8	449	Harrison	1977-80
## 10	7	437	Harrison	1977-80
## 11	7	431	Harrison	1977-80
## 12	7	425	Harrison	1977-80
## 13	7	419	Harrison	1977-80
## 14	6	409	Harrison	1977-80
## 15	6	397	Harrison	1977-80
## 16	5	419	Harrison	1977-80
## 17	5	381	Harrison	1977-80
## 18	5	363	Harrison	1977-80
## 19	5	351	Harrison	1977-80
## 20	4	372	Harrison	1977-80
## 21	2	199	Harrison	1977-80
## 22	2	184	Harrison	1977-80
## 23	1	91	Harrison	1977-80
## 24	12	440	Harrison	1997-01
## 25	11	428	Harrison	1997-01
## 26	10	440	Harrison	1997-01
## 27	10	422	Harrison	1997-01
## 28	9	434	Harrison	1997-01
## 29	9	415	Harrison	1997-01
## 30	9	406	Harrison	1997-01
## 31	8	434	Harrison	1997-01
## 32	8	406	Harrison	1997-01
## 33	8	375	Harrison	1997-01
## 34	7	415	Harrison	1997-01
## 35	7	394	Harrison	1997-01
## 36	6	381	Harrison	1997-01
## 37	6	357	Harrison	1997-01
## 38	5	341	Harrison	1997-01
## 39	5	326	Harrison	1997-01
## 40	4	304	Harrison	1997-01
## 41	4	292	Harrison	1997-01
## 42	4	270	Harrison	1997-01
## 43	4	252	Harrison	1997-01
## 44	4	221	Harrison	1997-01
## 45	3	258	Harrison	1997-01
## 46	3	233	Harrison	1997-01
## 47	3	211	Harrison	1997-01
## 48	3	205	Harrison	1997-01
## 49	3	180	Harrison	1997-01
## 50	2	196	Harrison	1997-01
## 51	2	171	Harrison	1997-01
## 52	2	143	Harrison	1997-01
## 53	1	131	Harrison	1997-01

```
## 54 1 88 Harrison 1997-01
## 55 1 75 Harrison 1997-01
## 56 0 51 Harrison 1997-01
## 57 0 41 Harrison 1997-01
## 58 0 20 Harrison 1997-01
## 59 7 245 Harrison 1997-01
## 60 7 279 Harrison 1997-01
## 61 5 245 Harrison 1997-01
## 62 8 360 Osprey 1977-80
## 63 8 357 Osprey 1977-80
## 64 7 357 Osprey 1977-80
## 65 7 329 Osprey 1977-80
## 66 6 385 Osprey 1977-80
## 67 6 323 Osprey 1977-80
## 68 5 369 Osprey 1977-80
## 69 5 326 Osprey 1977-80
## 70 4 357 Osprey 1977-80
## 71 4 326 Osprey 1977-80
## 72 4 258 Osprey 1977-80
## 73 4 239 Osprey 1977-80
## 74 3 221 Osprey 1977-80
## 75 3 258 Osprey 1977-80
## 76 3 276 Osprey 1977-80
## 77 11 688 Osprey 1997-01
## 78 10 369 Osprey 1997-01
## 79 9 400 Osprey 1997-01
## 80 8 381 Osprey 1997-01
## 81 8 332 Osprey 1997-01
## 82 7 394 Osprey 1997-01
## 83 7 388 Osprey 1997-01
## 84 7 354 Osprey 1997-01
## 85 7 320 Osprey 1997-01
## 86 6 320 Osprey 1997-01
## 87 6 347 Osprey 1997-01
## 88 6 360 Osprey 1997-01
## 89 5 354 Osprey 1997-01
## 90 5 335 Osprey 1997-01
## 91 5 313 Osprey 1997-01
## 92 5 289 Osprey 1997-01
## 93 4 313 Osprey 1997-01
## 94 4 298 Osprey 1997-01
## 95 3 279 Osprey 1997-01
## 96 3 273 Osprey 1997-01
```

```
#4. Print first and last three records
head(BullTroutRML2,3)
```

```
##   age fl   lake   era
## 1  14 459 Harrison 1977-80
## 2  12 449 Harrison 1977-80
## 3  10 471 Harrison 1977-80
```

```
tail(BullTroutRML2,3)
```

```
##    age  fl   lake    era
## 94   4 298 Osprey 1997-01
## 95   3 279 Osprey 1997-01
## 96   3 273 Osprey 1997-01
```

*#5. Remove all except Harrison Lake*

```
Harrisonlake<-filter(BullTroutRML2, lake=="Harrison")
Harrisonlake
```

```
##    age  fl   lake    era
## 1   14 459 Harrison 1977-80
## 2   12 449 Harrison 1977-80
## 3   10 471 Harrison 1977-80
## 4   10 446 Harrison 1977-80
## 5    9 400 Harrison 1977-80
## 6    9 440 Harrison 1977-80
## 7    9 462 Harrison 1977-80
## 8    8 480 Harrison 1977-80
## 9    8 449 Harrison 1977-80
## 10   7 437 Harrison 1977-80
## 11   7 431 Harrison 1977-80
## 12   7 425 Harrison 1977-80
## 13   7 419 Harrison 1977-80
## 14   6 409 Harrison 1977-80
## 15   6 397 Harrison 1977-80
## 16   5 419 Harrison 1977-80
## 17   5 381 Harrison 1977-80
## 18   5 363 Harrison 1977-80
## 19   5 351 Harrison 1977-80
## 20   4 372 Harrison 1977-80
## 21   2 199 Harrison 1977-80
## 22   2 184 Harrison 1977-80
## 23    1  91 Harrison 1977-80
## 24  12 440 Harrison 1997-01
## 25  11 428 Harrison 1997-01
## 26  10 440 Harrison 1997-01
## 27  10 422 Harrison 1997-01
## 28   9 434 Harrison 1997-01
## 29   9 415 Harrison 1997-01
## 30   9 406 Harrison 1997-01
## 31   8 434 Harrison 1997-01
## 32   8 406 Harrison 1997-01
## 33   8 375 Harrison 1997-01
## 34   7 415 Harrison 1997-01
## 35   7 394 Harrison 1997-01
## 36   6 381 Harrison 1997-01
## 37   6 357 Harrison 1997-01
## 38   5 341 Harrison 1997-01
## 39   5 326 Harrison 1997-01
## 40   4 304 Harrison 1997-01
## 41   4 292 Harrison 1997-01
```

```
## 42  4 270 Harrison 1997-01
## 43  4 252 Harrison 1997-01
## 44  4 221 Harrison 1997-01
## 45  3 258 Harrison 1997-01
## 46  3 233 Harrison 1997-01
## 47  3 211 Harrison 1997-01
## 48  3 205 Harrison 1997-01
## 49  3 180 Harrison 1997-01
## 50  2 196 Harrison 1997-01
## 51  2 171 Harrison 1997-01
## 52  2 143 Harrison 1997-01
## 53  1 131 Harrison 1997-01
## 54  1  88 Harrison 1997-01
## 55  1  75 Harrison 1997-01
## 56  0  51 Harrison 1997-01
## 57  0  41 Harrison 1997-01
## 58  0  20 Harrison 1997-01
## 59  7 245 Harrison 1997-01
## 60  7 279 Harrison 1997-01
## 61  5 245 Harrison 1997-01
```

```
#6. Display first and last 5 records of new dataset
#first 5
head(Harrisonlake,5)
```

```
##   age  fl    lake    era
## 1  14 459 Harrison 1977-80
## 2  12 449 Harrison 1977-80
## 3  10 471 Harrison 1977-80
## 4  10 446 Harrison 1977-80
## 5   9 400 Harrison 1977-80
```

```
#last 5
tail(Harrisonlake,5)
```

```
##   age  fl    lake    era
## 57  0  41 Harrison 1997-01
## 58  0  20 Harrison 1997-01
## 59  7 245 Harrison 1997-01
## 60  7 279 Harrison 1997-01
## 61  5 245 Harrison 1997-01
```

```
#7. Structure of a dataset
structure(Harrisonlake)
```

```
##   age  fl    lake    era
## 1  14 459 Harrison 1977-80
## 2  12 449 Harrison 1977-80
## 3  10 471 Harrison 1977-80
## 4  10 446 Harrison 1977-80
## 5   9 400 Harrison 1977-80
## 6   9 440 Harrison 1977-80
```

## 7	9	462	Harrison	1977-80
## 8	8	480	Harrison	1977-80
## 9	8	449	Harrison	1977-80
## 10	7	437	Harrison	1977-80
## 11	7	431	Harrison	1977-80
## 12	7	425	Harrison	1977-80
## 13	7	419	Harrison	1977-80
## 14	6	409	Harrison	1977-80
## 15	6	397	Harrison	1977-80
## 16	5	419	Harrison	1977-80
## 17	5	381	Harrison	1977-80
## 18	5	363	Harrison	1977-80
## 19	5	351	Harrison	1977-80
## 20	4	372	Harrison	1977-80
## 21	2	199	Harrison	1977-80
## 22	2	184	Harrison	1977-80
## 23	1	91	Harrison	1977-80
## 24	12	440	Harrison	1997-01
## 25	11	428	Harrison	1997-01
## 26	10	440	Harrison	1997-01
## 27	10	422	Harrison	1997-01
## 28	9	434	Harrison	1997-01
## 29	9	415	Harrison	1997-01
## 30	9	406	Harrison	1997-01
## 31	8	434	Harrison	1997-01
## 32	8	406	Harrison	1997-01
## 33	8	375	Harrison	1997-01
## 34	7	415	Harrison	1997-01
## 35	7	394	Harrison	1997-01
## 36	6	381	Harrison	1997-01
## 37	6	357	Harrison	1997-01
## 38	5	341	Harrison	1997-01
## 39	5	326	Harrison	1997-01
## 40	4	304	Harrison	1997-01
## 41	4	292	Harrison	1997-01
## 42	4	270	Harrison	1997-01
## 43	4	252	Harrison	1997-01
## 44	4	221	Harrison	1997-01
## 45	3	258	Harrison	1997-01
## 46	3	233	Harrison	1997-01
## 47	3	211	Harrison	1997-01
## 48	3	205	Harrison	1997-01
## 49	3	180	Harrison	1997-01
## 50	2	196	Harrison	1997-01
## 51	2	171	Harrison	1997-01
## 52	2	143	Harrison	1997-01
## 53	1	131	Harrison	1997-01
## 54	1	88	Harrison	1997-01
## 55	1	75	Harrison	1997-01
## 56	0	51	Harrison	1997-01
## 57	0	41	Harrison	1997-01
## 58	0	20	Harrison	1997-01
## 59	7	245	Harrison	1997-01
## 60	7	279	Harrison	1997-01



```
## 61 5 245 Harrison 1997-01
```

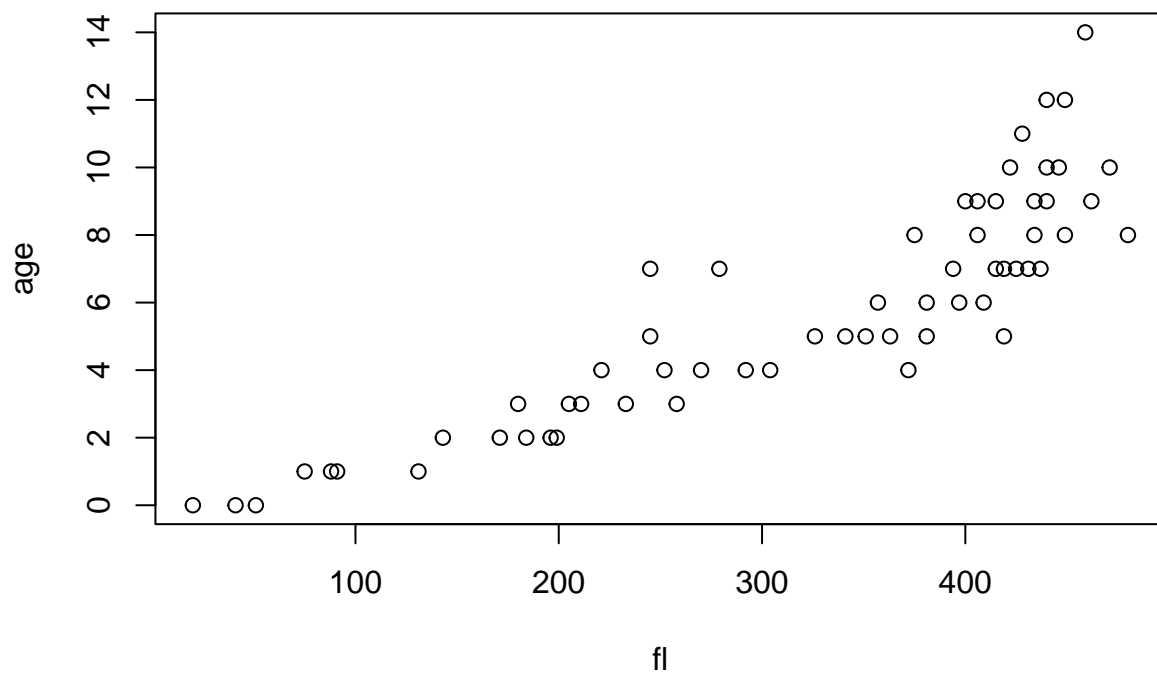
```
#8. Summary of a dataset  
summary(Harrisonlake)
```

```
##      age      fl      lake      era  
## Min.   : 0.000   Min.   : 20   Harrison:61   1977-80:23  
## 1st Qu.: 3.000   1st Qu.:221   Osprey  : 0   1997-01:38  
## Median : 6.000   Median :372  
## Mean   : 5.754   Mean   :319  
## 3rd Qu.: 8.000   3rd Qu.:425  
## Max.   :14.000   Max.   :480
```

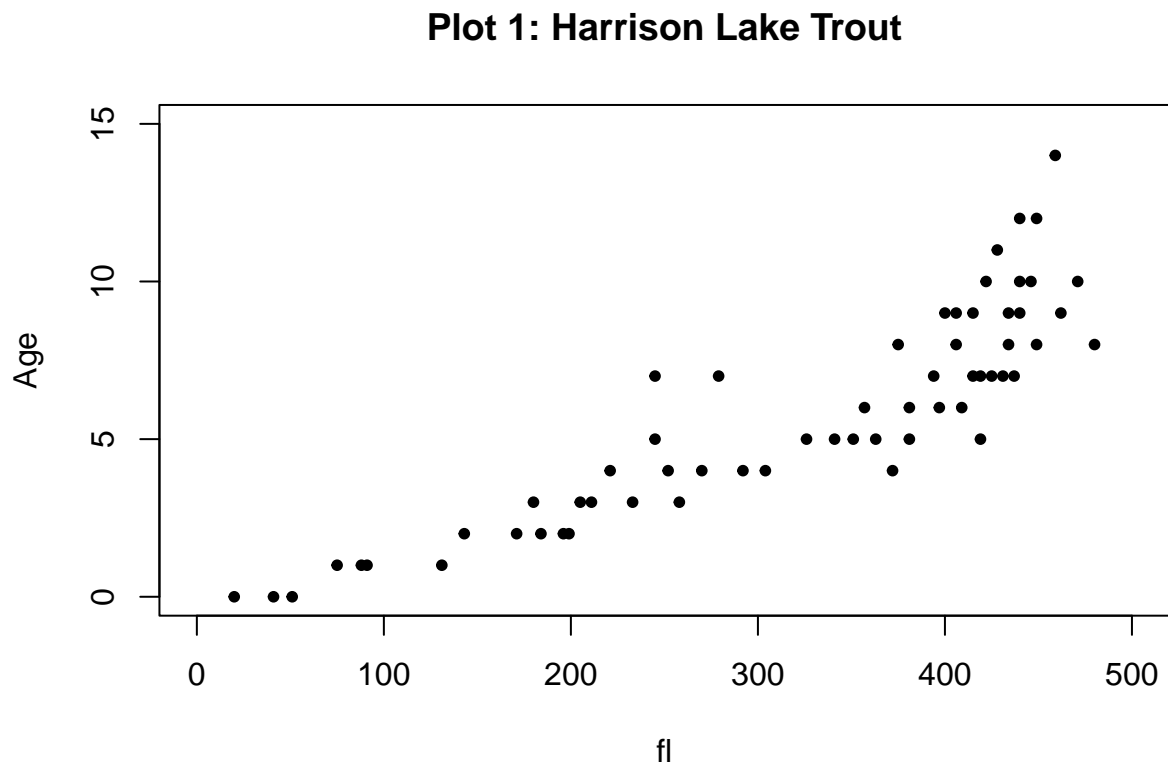
```
#9. Create a scatterplot with specifications  
#assign values  
fl<-Harrisonlake$fl  
age<-Harrisonlake$age  
#plot the data  
par("mar")
```

```
## [1] 5.1 4.1 4.1 2.1
```

```
par(mar=c(5.1,4.1,4.1,2.1))  
plot(age~fl)
```

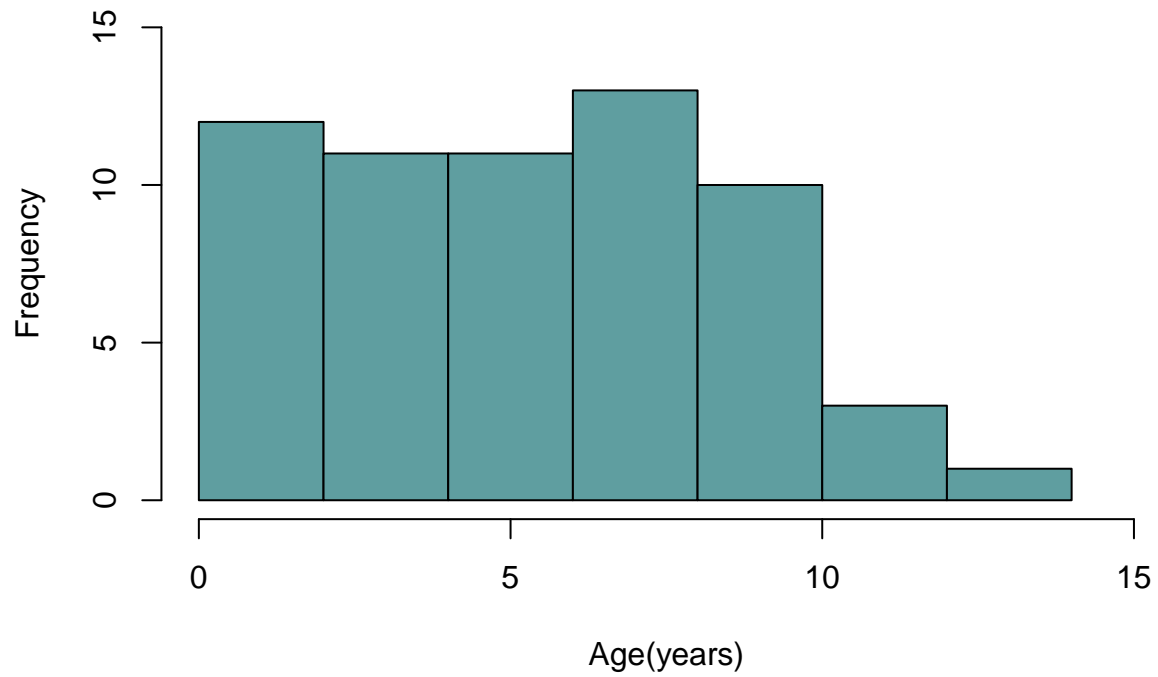


```
#plot with specifications
plot(age~fl,
      data = Harrisonlake,
      xlim=c(0,500), ylim=c(0,15),
      main="Plot 1: Harrison Lake Trout",
      xlab="fl", ylab="Age",
      pch=20)
```



```
#10. Plot a Histogram
hist(Harrisonlake$age,
      xlab = "Age(years)",
      ylab = "Frequency",
      main = "Plot 2: Harrison Fish Age Distribution",
      xlim=c(0,15),
      ylim=c(0,15),
      col = "cadetblue",
      col.main="cadetblue")
```

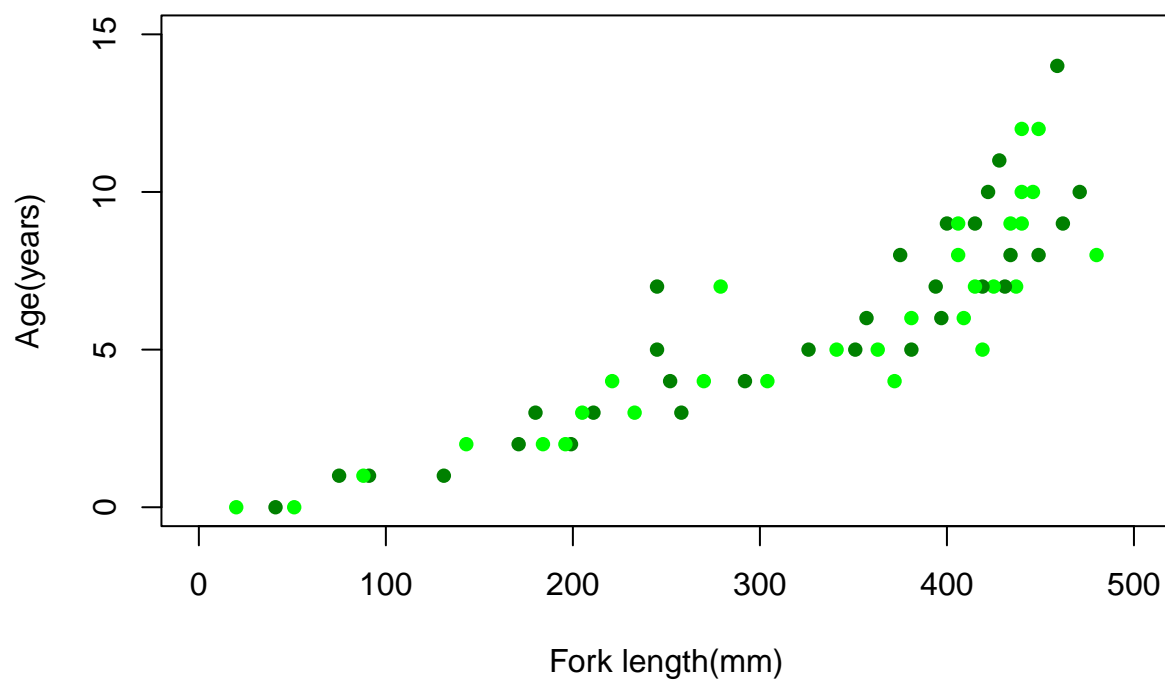
Plot 2: Harrison Fish Age Distribution



*#11. Overdense plot with specifications*

```
plot(age~fl,  
      main="Plot 3: Harrison Density Shaded by era",  
      ylab = "Age(years)",  
      ylim=c(0,15),  
      xlab="Fork length(mm)",  
      xlim=c(0,500),  
      pch = 16,  
      col=rgb(0,(1:2)/2,0))
```

**Plot 3: Harrison Density Shaded by era**



*#12. New object tmp for first and last 3 records*

```
tmp <- headtail(Harrisonlake,3)
tmp
```

```
##   age  fl   lake   era
## 1   14 459 Harrison 1977-80
## 2   12 449 Harrison 1977-80
## 3   10 471 Harrison 1977-80
## 59    7 245 Harrison 1997-01
## 60    7 279 Harrison 1997-01
## 61    5 245 Harrison 1997-01
```

*#13. Display era column from tmp*

```
tmp$era
```

```
## [1] 1977-80 1977-80 1977-80 1997-01 1997-01 1997-01
## Levels: 1977-80 1997-01
```

*#14. Create pchs vector*

```
pchs <- c("+", "x")
pchs
```

```
## [1] "+" "x"
```

```
#15. Create cols vector  
cols<-c("red", "gray60")  
cols
```

```
## [1] "red"    "gray60"
```

```
#16. Convert era to numeric  
tmp$era <- as.numeric(tmp$era)  
tmp$era
```

```
## [1] 1 1 1 2 2 2
```

```
is.numeric(tmp$era)
```

```
## [1] TRUE
```

```
#17. Combine cols vector to tmp era values  
cols[tmp$era]
```

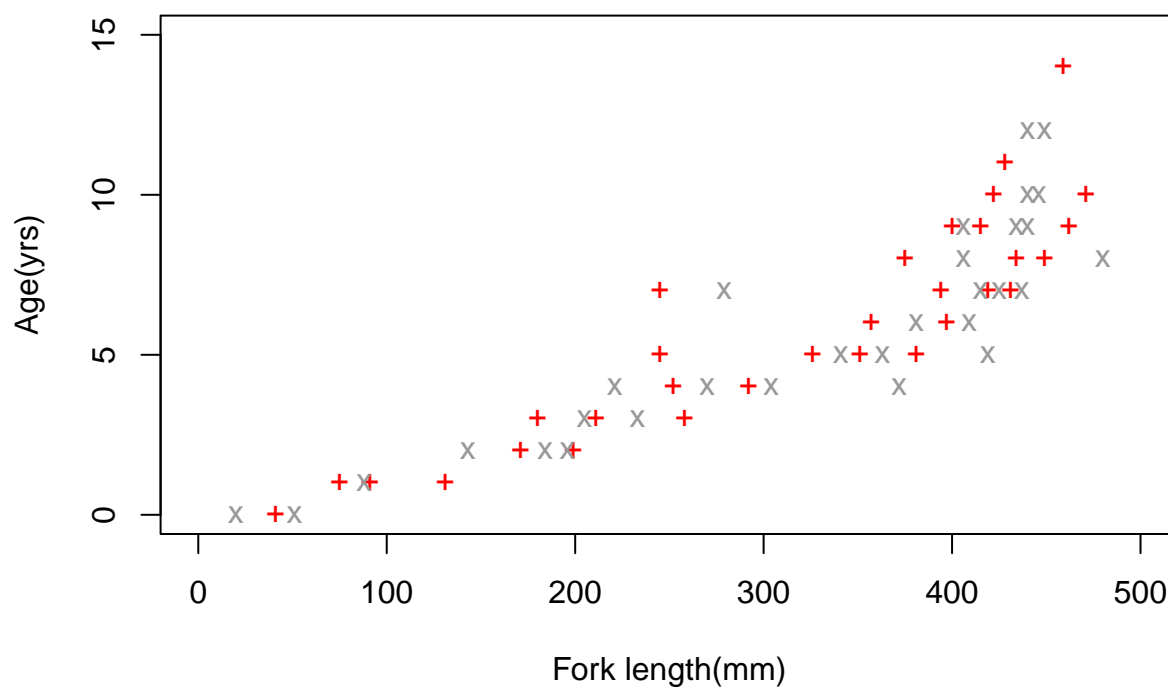
```
## [1] "red"    "red"    "red"    "gray60" "gray60" "gray60"
```

```
#18. Create plot with specifications  
par("mar")
```

```
## [1] 5.1 4.1 4.1 2.1
```

```
par(mar=c(5,4,4,2))  
plot(age~fl,  
      data = Harrisonlake,  
      main="Plot 4:Symbol and Color by Era",  
      xlim=c(0,500),  
      ylim=c(0,15),  
      ylab="Age(yrs)",  
      xlab = "Fork length(mm)",  
      pch=pchs,  
      col=cols)
```

**Plot 4: Symbol and Color by Era**



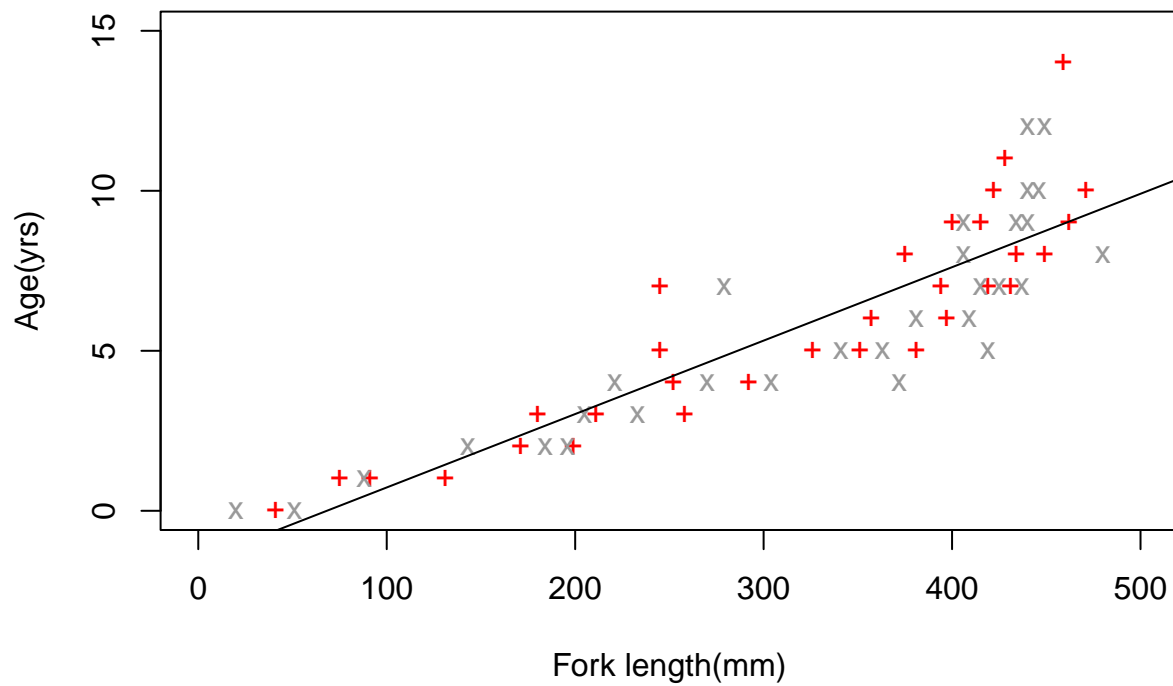
*#19. Plot regression line*

```
lm(age~fl, data = Harrisonlake)
```

```
##
## Call:
## lm(formula = age ~ fl, data = Harrisonlake)
##
## Coefficients:
## (Intercept)          fl
##    -1.56505      0.02294
```

```
plot(age~fl,
      data = Harrisonlake,
      main="Plot 5: Regression Overlay",
      xlim=c(0,500),
      ylim=c(0,15),
      ylab="Age(yrs)",
      xlab = "Fork length(mm)",
      pch=pchs,
      col=cols)
abline(lm(age~fl, data = Harrisonlake))
```

**Plot 5: Regression Overlay**



```
#20. Placing a legend
plot(age~fl,
     data = Harrisonlake,
     main="Plot 6: Legend overlay",
     xlim=c(0,500),
     ylim=c(0,15),
     ylab="Age(yrs)",
     xlab = "Fork length(mm)",
     pch=pchs,
     col=cols)
abline(lm(age~fl, data = Harrisonlake))
legend("topleft", inset = 0.05,
     legend = c("1997-80","1997-01"),
     bty = "n",
     cex = 0.8,
     pch = pchs,
     col = cols)
```

**Plot 6: Legend overlay**

