Notes and Figures

https://www.ppic.org/data-set/ppic-sacramento-valley-and-delta-surface-water-availability/

chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://ucanr.edu/sites/RiceTestSite/files/328501.pdf

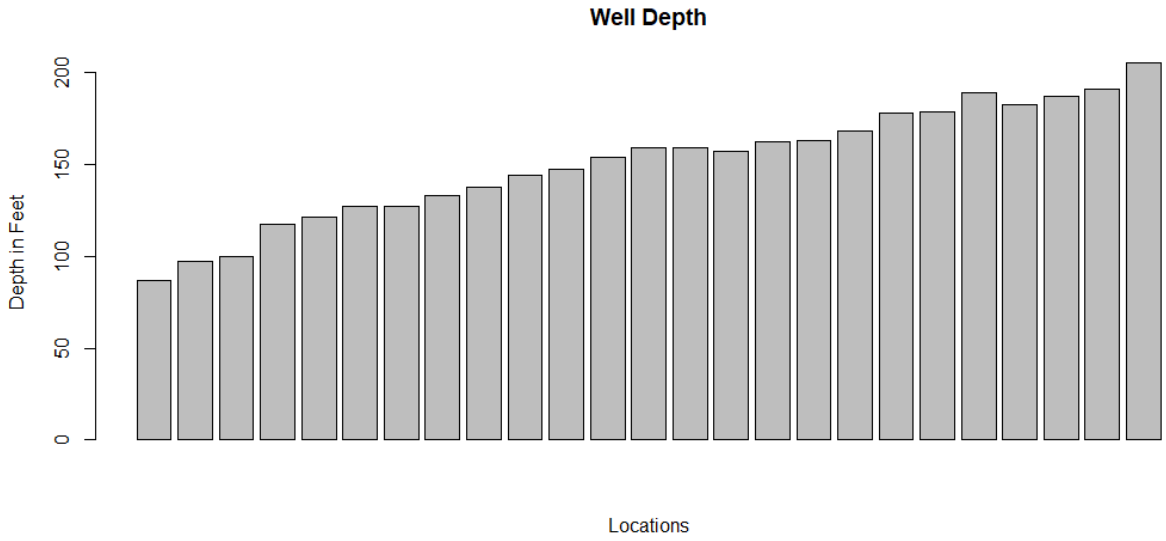
https://ca.water.usgs.gov/projects/central-valley/sacramento-valley.html#:~:text=Valley%20Facts&text=The%20predominate%20crop%20types%20are,table%20grapes%2C%20and%20wine%20grapes.

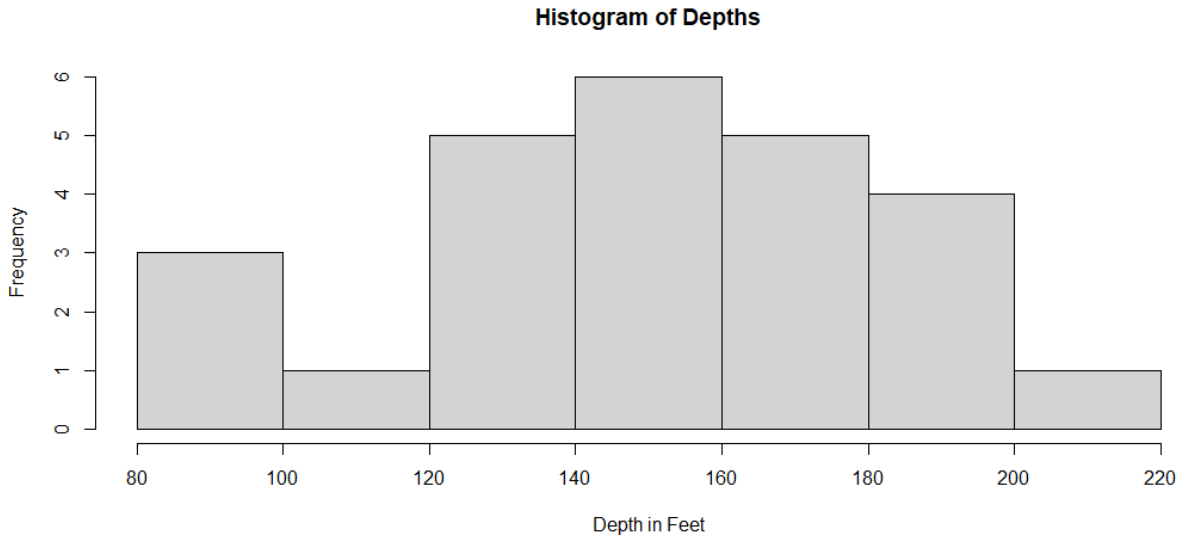
Well_Max = total well (subsurface + surface)

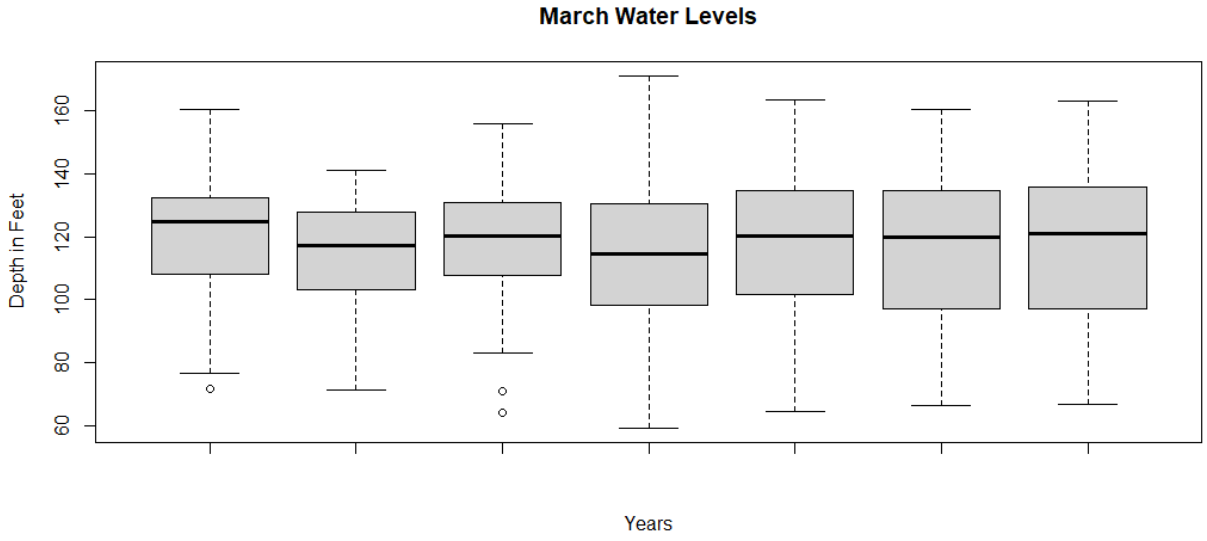
Well_sur = distance subsurface

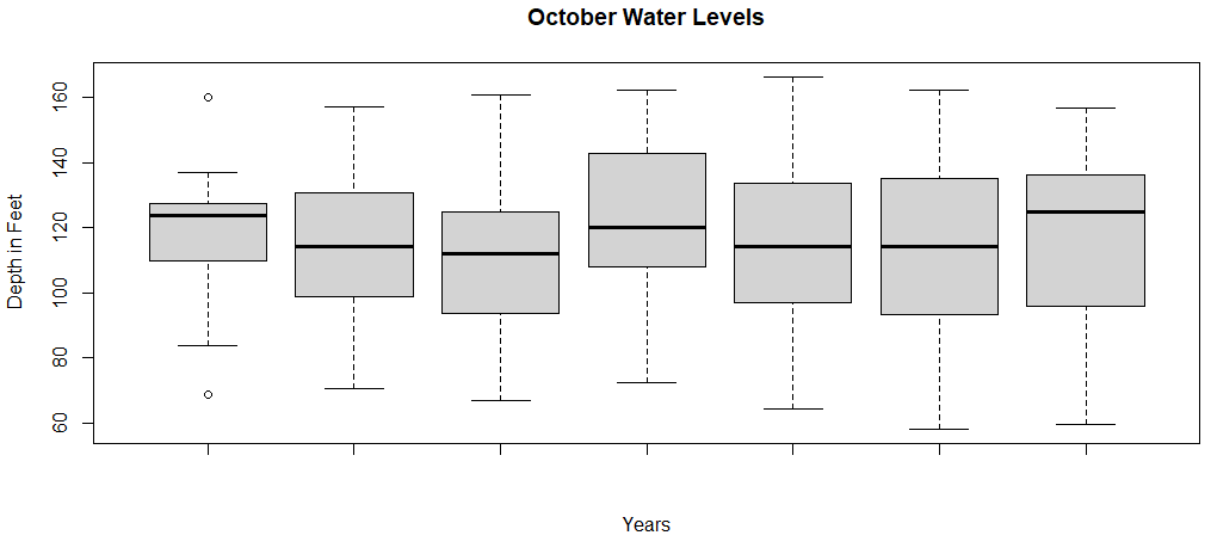
CWL = Current water level

ROOM = Distance till top of well from current surface of water.




Histogram of Depths
Frequency
0
1
2
3
4
5
6
80
100
120
140
160
180
200
220
Depth in Feet


March Water Levels
Depth in Feet
60
80
100
120
140
160
Years




```
> summary(water_level_mar_97)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  71.47  108.16  124.89  119.69  132.32  160.43
> summary(water_level_mar_98)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  71.36  103.13  117.10  113.16  127.64  141.00
> summary(water_level_mar_99)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  63.87  107.76  120.28  115.09  130.91  156.00
> summary(water_level_mar_10)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  59.16   98.30  114.67  113.47  130.50  171.06
> summary(water_level_mar_11)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  64.46  101.55  120.34  117.73  134.70  163.29
> summary(water_level_mar_15)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  66.36   97.14  119.98  115.08  134.44  160.36
> summary(water_level_mar_16)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  66.76   97.03  120.89  118.85  135.83  163.09
```

```
> summary(water_level_oct_97)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  68.46  109.62  123.63  115.73  127.60  160.00
> summary(water_level_oct_98)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  70.36   98.93  114.04  114.06  130.91  157.24
> summary(water_level_oct_99)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  66.96   93.73  112.08  110.82  124.80  161.00
> summary(water_level_oct_10)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
   72.3   107.8   120.0   120.2   142.8   162.3
> summary(water_level_oct_11)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  64.06   96.94  114.14  114.54  133.57  166.36
> summary(water_level_oct_15)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  58.06   93.16  114.34  115.60  135.00  162.46
> summary(water_level_oct_16)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  59.56   95.93  125.03  116.63  136.20  156.76
```

```
> describe(water_level_mar_97)
   vars  n   mean    sd median trimmed   mad   min    max range  skew kurtosis   se
X1    1 25 119.69 22.34 124.89  120.28 16.18 71.47 160.43 88.96 -0.45    -0.29 4.47
> describe(water_level_mar_98)
   vars  n   mean    sd median trimmed   mad   min max range  skew kurtosis   se
X1    1 25 113.16 19.31  117.1  114.48 18.89 71.36 141 69.64 -0.58    -0.52 3.86
> describe(water_level_mar_99)
   vars  n   mean    sd median trimmed   mad   min max range  skew kurtosis   se
X1    1 25 115.09 22.64 120.28  116.34 17.11 63.87 156 92.13 -0.56    -0.39 4.53
> describe(water_level_mar_10)
   vars  n   mean   sd median trimmed   mad   min    max range  skew kurtosis   se
X1    1 25 113.47 26.1 114.67  113.34 23.57 59.16 171.06 111.9 -0.06    -0.19 5.22
> describe(water_level_mar_11)
   vars  n   mean    sd median trimmed   mad   min    max range  skew kurtosis   se
X1    1 25 117.73 26.62 120.34  118.24 22.06 64.46 163.29 98.83 -0.12    -0.73 5.32
> describe(water_level_mar_15)
   vars  n   mean   sd median trimmed  mad   min    max range  skew kurtosis   se
X1    1 25 115.08 25.3 119.98  115.61 32.8 66.36 160.36    94 -0.05    -1.08 5.06
> describe(water_level_mar_16)
   vars  n   mean    sd median trimmed   mad   min    max range  skew kurtosis   se
X1    1 25 118.85 27.09 120.89  119.52 28.67 66.76 163.09 96.33 -0.16       -1 5.42
```

```
> describe(water_level_oct_97)
   vars  n   mean    sd median trimmed   mad   min max range  skew kurtosis   se
X1    1 25 115.73 21.64 123.63  117.11 15.58 68.46 160 91.54 -0.58    -0.07 4.33
> describe(water_level_oct_98)
   vars  n   mean    sd median trimmed   mad   min    max range  skew kurtosis   se
X1    1 25 114.06 23.22 114.04  113.94 25.01 70.36 157.24 86.88 -0.07    -0.79 4.64
> describe(water_level_oct_99)
   vars  n   mean    sd median trimmed   mad   min max range skew kurtosis   se
X1    1 25 110.82 22.65 112.08  110.62 25.19 66.96 161 94.04 0.02    -0.47 4.53
> describe(water_level_oct_10)
   vars  n   mean   sd median trimmed   mad  min    max range  skew kurtosis   se
X1    1 25 120.22 26.6    120  121.05 30.94 72.3 162.29 89.99 -0.24    -0.97 5.32
> describe(water_level_oct_11)
   vars  n   mean    sd median trimmed   mad   min    max range skew kurtosis   se
X1    1 25 114.54 26.57 114.14  114.69 28.81 64.06 166.36 102.3 0.03       -1 5.31
> describe(water_level_oct_15)
   vars  n  mean    sd median trimmed   mad   min    max range  skew kurtosis   se
X1    1 25 115.6 28.24 114.34  116.19 30.63 58.06 162.46 104.4 -0.17    -0.95 5.65
> describe(water_level_oct_16)
   vars  n   mean   sd median trimmed   mad   min    max range skew kurtosis   se
X1    1 25 116.63 26.2 125.03  117.95 20.02 59.56 156.76  97.2 -0.5    -0.91 5.24
```

If Skewness value is less than 1 we consider that normally distributed.

```
> summary(precip97)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
  0.070   0.650   1.395   4.260   3.475  19.150      13
> summary(precip98)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
  0.000   1.157   4.425   6.273   7.803  20.260      13
> summary(precip99)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
 0.0000  0.3425  2.2500  3.3267  4.3100 11.2000      13
> summary(precip10)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
 0.0100  0.1275  2.8800  3.6642  5.3575 12.9900      13
> summary(precip11)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
 0.0000  0.9725  3.7650  4.7658  6.6275 13.3400      13
> summary(precip15)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
 0.0600  0.2175  0.4350  2.4325  2.7700 14.4300      13
> summary(precip16)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
 0.0000  0.3925  1.4550  3.7483  4.7950 14.4600      13
>
```

```
> describe(precip97)
   vars  n mean   sd median trimmed  mad  min   max range skew kurtosis   se
X1    1 12 4.26 6.43    1.4    3.19 1.53 0.07 19.15 19.08 1.46     0.42 1.86
> describe(precip98)
   vars  n mean   sd median trimmed  mad min   max range skew kurtosis   se
X1    1 12 6.27 6.66   4.42     5.5 5.14   0 20.26 20.26 0.95    -0.49 1.92
> describe(precip99)
   vars  n mean   sd median trimmed  mad min  max range skew kurtosis   se
X1    1 12 3.33 3.86   2.25    2.87 2.91   0 11.2  11.2 0.95    -0.58 1.11
> describe(precip10)
   vars  n mean  sd median trimmed  mad  min   max range skew kurtosis   se
X1    1 12 3.66 3.9   2.88     3.1 4.08 0.01 12.99 12.98 0.99     0.08 1.13
> describe(precip11)
   vars  n mean   sd median trimmed  mad min   max range skew kurtosis   se
X1    1 12 4.77 4.77   3.76    4.38 4.55   0 13.34 13.34  0.7    -0.97 1.38
> describe(precip15)
   vars  n mean   sd median trimmed  mad  min   max range skew kurtosis   se
X1    1 12 2.43 4.12   0.43    1.47 0.55 0.06 14.43 14.37 1.99     3.07 1.19
> describe(precip16)
   vars  n mean   sd median trimmed  mad min   max range skew kurtosis   se
X1    1 12 3.75 5.15   1.46    3.05 2.15   0 14.46 14.46 1.11    -0.46 1.49
```

```
> cor(gwl)
          March_97    Oct_97  March_98    Oct_98  March_99    Oct_99  March_10    Oct_10  March_11
March_97 1.0000000 0.7684619 0.6659873 0.5856544 0.5669540 0.6012102 0.7809213 0.7258342 0.7451502
Oct_97   0.7684619 1.0000000 0.9001366 0.7821654 0.7595780 0.8174010 0.7634573 0.7492179 0.6973472
March_98 0.6659873 0.9001366 1.0000000 0.7777213 0.8378430 0.7967124 0.6499932 0.7155325 0.6544115
Oct_98   0.5856544 0.7821654 0.7777213 1.0000000 0.8819601 0.9402639 0.7471893 0.7813265 0.7197675
March_99 0.5669540 0.7595780 0.8378430 0.8819601 1.0000000 0.9175293 0.6724849 0.7172499 0.6872854
Oct_99   0.6012102 0.8174010 0.7967124 0.9402639 0.9175293 1.0000000 0.7587878 0.7647254 0.6932866
March_10 0.7809213 0.7634573 0.6499932 0.7471893 0.6724849 0.7587878 1.0000000 0.8483341 0.8808278
Oct_10   0.7258342 0.7492179 0.7155325 0.7813265 0.7172499 0.7647254 0.8483341 1.0000000 0.9570507
March_11 0.7451502 0.6973472 0.6544115 0.7197675 0.6872854 0.6932866 0.8808278 0.9570507 1.0000000
Oct_11   0.7087145 0.6865254 0.5892041 0.6755065 0.6137088 0.7185055 0.9228470 0.9210947 0.9299042
March_15 0.7043236 0.7136305 0.6578237 0.7138706 0.6340533 0.7065163 0.8928159 0.9495017 0.9641773
Oct_15   0.8091875 0.6323111 0.5224327 0.5540871 0.5385325 0.6204439 0.7915785 0.8213027 0.8551652
March_16 0.8111423 0.6327650 0.5475119 0.5679249 0.5583724 0.6196303 0.7877910 0.8275327 0.8591288
Oct_16   0.8430806 0.6502131 0.5870017 0.6122179 0.5778715 0.6274769 0.7871333 0.7880276 0.7988948
WELL_MAX 0.7500755 0.6013243 0.5575997 0.6630375 0.6153032 0.6537806 0.7505393 0.7866604 0.7864109
WELL_SUR 0.7455629 0.5986209 0.5561778 0.6631379 0.6160090 0.6500174 0.7421918 0.7904500 0.7928619
```

```
        Pearson's product-moment correlation

data:  gwl$March_97 and gwl$WY_97
t = -1.9924, df = 10, p-value = 0.07432
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.84765327  0.05881841
sample estimates:
       cor
-0.5330778

> cor.test(gwl$Oct_97,gwl$WY_97)

        Pearson's product-moment correlation

data:  gwl$Oct_97 and gwl$WY_97
t = -1.3201, df = 10, p-value = 0.2162
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.7854824  0.2422063
sample estimates:
       cor
-0.3852454

> cor.test(gwl$March_98,gwl$WY_98)

        Pearson's product-moment correlation

data:  gwl$March_98 and gwl$WY_98
t = -0.64216, df = 10, p-value = 0.5352
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.6936827  0.4232322
sample estimates:
       cor
-0.1990069

> cor.test(gwl$Oct_98,gwl$WY_98)

        Pearson's product-moment correlation

data:  gwl$Oct_98 and gwl$WY_98
t = -1.3659, df = 10, p-value = 0.2019
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.7905330  0.2296231
sample estimates:
       cor
-0.3965343
```

```
> cor.test(gwl$March_99,gwl$WY_99)

        Pearson's product-moment correlation

data:  gwl$March_99 and gwl$WY_99
t = -1.9781, df = 10, p-value = 0.07612
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.84656640  0.06265282
sample estimates:
       cor
-0.5303172

> cor.test(gwl$Oct_99,gwl$WY_99)

        Pearson's product-moment correlation

data:  gwl$Oct_99 and gwl$WY_99
t = -1.6237, df = 10, p-value = 0.1355
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.8166021  0.1587559
sample estimates:
       cor
-0.4567614

> cor.test(gwl$March_10,gwl$WY_2010)

        Pearson's product-moment correlation

data:  gwl$March_10 and gwl$WY_2010
t = -0.75403, df = 10, p-value = 0.4682
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.7111781  0.3944669
sample estimates:
       cor
-0.2319432

> cor.test(gwl$Oct_10,gwl$WY_2010)

        Pearson's product-moment correlation

data:  gwl$Oct_10 and gwl$WY_2010
t = -1.0673, df = 10, p-value = 0.3109
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.7551074  0.3112328
sample estimates:
       cor
-0.3197884
```

```
> cor.test(gwl$March_11,gwl$WY_2011)

        Pearson's product-moment correlation

data:  gwl$March_11 and gwl$WY_2011
t = -2.9073, df = 10, p-value = 0.01564
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.9008126 -0.1682547
sample estimates:
       cor
-0.6768031

> cor.test(gwl$Oct_11,gwl$WY_2011)

        Pearson's product-moment correlation

data:  gwl$Oct_11 and gwl$WY_2011
t = -2.3176, df = 10, p-value = 0.04295
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.86991156 -0.02606737
sample estimates:
       cor
-0.5911257

> cor.test(gwl$March_15,gwl$WY_2015)

        Pearson's product-moment correlation

data:  gwl$March_15 and gwl$WY_2015
t = -0.60885, df = 10, p-value = 0.5562
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.6882841  0.4316761
sample estimates:
       cor
-0.1890643

> cor.test(gwl$Oct_15,gwl$WY_2015)

        Pearson's product-moment correlation

data:  gwl$Oct_15 and gwl$WY_2015
t = -0.46853, df = 10, p-value = 0.6495
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.6645655  0.4665852
sample estimates:
       cor
-0.1465618
```

```
> cor.test(gwl$March_16,gwl$WY_2016)

        Pearson's product-moment correlation

data:  gwl$March_16 and gwl$WY_2016
t = -1.4146, df = 10, p-value = 0.1876
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.7957617  0.2162265
sample estimates:
       cor
-0.4083482

> cor.test(gwl$Oct_16,gwl$WY_2016)

        Pearson's product-moment correlation

data:  gwl$Oct_16 and gwl$WY_2016
t = -1.835, df = 10, p-value = 0.09639
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.8352200  0.1011413
sample estimates:
       cor
-0.5018928
```

```
> gwlreg

Call:
lm(formula = gwl$March_97 ~ gwl$WY_97)

Coefficients:
(Intercept)    gwl$WY_97
    112.752       -1.722

> gwlreg1

Call:
lm(formula = gwl$Oct_97 ~ gwl$WY_97)

Coefficients:
(Intercept)    gwl$WY_97
    110.216       -1.353

> gwlreg2

Call:
lm(formula = gwl$March_98 ~ gwl$WY_98)

Coefficients:
(Intercept)    gwl$WY_98
   108.3258      -0.6318

> gwlreg3

Call:
lm(formula = gwl$Oct_98 ~ gwl$WY_98)

Coefficients:
(Intercept)    gwl$WY_98
     111.42        -1.33

> gwlreg4

Call:
lm(formula = gwl$March_99 ~ gwl$WY_99)

Coefficients:
(Intercept)    gwl$WY_99
    116.485       -3.221

> gwlreg5

Call:
lm(formula = gwl$Oct_99 ~ gwl$WY_99)

Coefficients:
(Intercept)    gwl$WY_99
    107.471       -2.458
```

```
> gwlreg6

Call:
lm(formula = gwl$March_10 ~ gwl$WY_2010)

Coefficients:
(Intercept)  gwl$WY_2010
    103.058       -1.312

> gwlreg7

Call:
lm(formula = gwl$Oct_10 ~ gwl$WY_2010)

Coefficients:
(Intercept)  gwl$WY_2010
    110.969       -1.915

> gwlreg8

Call:
lm(formula = gwl$March_11 ~ gwl$WY_2011)

Coefficients:
(Intercept)  gwl$WY_2011
    114.326       -2.909

> gwlreg9

Call:
lm(formula = gwl$Oct_11 ~ gwl$WY_2011)

Coefficients:
(Intercept)  gwl$WY_2011
    109.303       -2.432
```

```
> gwlreg10

Call:
lm(formula = gwl$March_15 ~ gwl$WY_2015)

Coefficients:
(Intercept)  gwl$WY_2015
    99.2008      -0.7821

> gwlreg11

Call:
lm(formula = gwl$Oct_15 ~ gwl$WY_2015)

Coefficients:
(Intercept)  gwl$WY_2015
    94.9992      -0.6849

> gwlreg12

Call:
lm(formula = gwl$March_16 ~ gwl$WY_2016)

Coefficients:
(Intercept)  gwl$WY_2016
    102.187       -1.348

> gwlreg13

Call:
lm(formula = gwl$Oct_16 ~ gwl$WY_2016)

Coefficients:
(Intercept)  gwl$WY_2016
    105.232       -2.136
```

```
> summary(gwlreg)

Call:
lm(formula = gwl$March_97 ~ gwl$WY_97)

Residuals:
    Min      1Q  Median      3Q     Max
-31.948  -9.835   1.807  12.950  21.154

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 112.7519     6.4686  17.431 8.19e-09 ***
gwl$WY_97    -1.7223     0.8644  -1.992   0.0743 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 18.42 on 10 degrees of freedom
  (13 observations deleted due to missingness)
Multiple R-squared:  0.2842,    Adjusted R-squared:  0.2126
F-statistic:  3.97 on 1 and 10 DF,  p-value: 0.07432

> summary(gwlreg1)

Call:
lm(formula = gwl$Oct_97 ~ gwl$WY_97)

Residuals:
    Min      1Q  Median      3Q     Max
-38.265  -4.948   6.466  11.733  26.792

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  110.216      7.670   14.37 5.28e-08 ***
gwl$WY_97     -1.353      1.025   -1.32    0.216
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 21.84 on 10 degrees of freedom
  (13 observations deleted due to missingness)
Multiple R-squared:  0.1484,    Adjusted R-squared:  0.06326
F-statistic: 1.743 on 1 and 10 DF,  p-value: 0.2162
```

```
> summary(gwlreg2)

Call:
lm(formula = gwl$March_98 ~ gwl$WY_98)

Residuals:
    Min      1Q  Median      3Q     Max
-33.150 -15.593   9.302  15.048  26.294

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 108.3258     8.7995  12.310  2.3e-07 ***
gwl$WY_98    -0.6318     0.9838  -0.642    0.535
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 21.73 on 10 degrees of freedom
  (13 observations deleted due to missingness)
Multiple R-squared:  0.0396,    Adjusted R-squared:  -0.05644
F-statistic: 0.4124 on 1 and 10 DF,  p-value: 0.5352

> summary(gwlreg3)

Call:
lm(formula = gwl$Oct_98 ~ gwl$WY_98)

Residuals:
   Min     1Q Median     3Q    Max
-33.03 -16.24  -0.74  14.97  28.98

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 111.4225     8.7078  12.796 1.59e-07 ***
gwl$WY_98    -1.3298     0.9736  -1.366    0.202
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 21.5 on 10 degrees of freedom
  (13 observations deleted due to missingness)
Multiple R-squared:  0.1572,    Adjusted R-squared:  0.07296
F-statistic: 1.866 on 1 and 10 DF,  p-value: 0.2019
```

```
> summary(gwlreg4)

Call:
lm(formula = gwl$March_99 ~ gwl$WY_99)

Residuals:
    Min      1Q  Median      3Q     Max
-32.930 -12.552   4.239  11.595  32.553

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  116.485      8.099  14.382 5.23e-08 ***
gwl$WY_99     -3.221      1.628  -1.978   0.0761 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 20.86 on 10 degrees of freedom
  (13 observations deleted due to missingness)
Multiple R-squared:  0.2812,    Adjusted R-squared:  0.2094
F-statistic: 3.913 on 1 and 10 DF,  p-value: 0.07612

> summary(gwlreg5)

Call:
lm(formula = gwl$Oct_99 ~ gwl$WY_99)

Residuals:
    Min      1Q  Median      3Q     Max
-30.900 -10.805  -0.050   7.954  32.419

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  107.471      7.530  14.273 5.63e-08 ***
gwl$WY_99     -2.458      1.514  -1.624    0.136
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 19.39 on 10 degrees of freedom
  (13 observations deleted due to missingness)
Multiple R-squared:  0.2086,    Adjusted R-squared:  0.1295
F-statistic: 2.636 on 1 and 10 DF,  p-value: 0.1355
```

```
> summary(gwlreg6)

Call:
lm(formula = gwl$March_10 ~ gwl$WY_2010)

Residuals:
    Min      1Q  Median      3Q     Max
-38.705 -10.102   7.968  14.620  28.017

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  103.058      9.102  11.322 5.04e-07 ***
gwl$WY_2010   -1.312      1.739  -0.754    0.468
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 22.51 on 10 degrees of freedom
  (13 observations deleted due to missingness)
Multiple R-squared:  0.0538,    Adjusted R-squared:  -0.04082
F-statistic: 0.5686 on 1 and 10 DF,  p-value: 0.4682

> summary(gwlreg7)

Call:
lm(formula = gwl$Oct_10 ~ gwl$WY_2010)

Residuals:
    Min      1Q  Median      3Q     Max
-34.623 -14.305   3.831  15.355  32.050

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  110.969      9.391  11.817 3.38e-07 ***
gwl$WY_2010   -1.915      1.794  -1.067    0.311
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 23.23 on 10 degrees of freedom
  (13 observations deleted due to missingness)
Multiple R-squared:  0.1023,    Adjusted R-squared:  0.01249
F-statistic: 1.139 on 1 and 10 DF,  p-value: 0.3109
```

```
> summary(gwlreg8)

Call:
lm(formula = gwl$March_11 ~ gwl$WY_2011)

Residuals:
    Min      1Q  Median      3Q     Max
-26.885  -9.643  -2.175  14.855  20.574

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  114.326      6.601  17.320 8.72e-09 ***
gwl$WY_2011   -2.909      1.000  -2.907   0.0156 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 15.81 on 10 degrees of freedom
  (13 observations deleted due to missingness)
Multiple R-squared:  0.4581,    Adjusted R-squared:  0.4039
F-statistic: 8.452 on 1 and 10 DF,  p-value: 0.01564

> summary(gwlreg9)

Call:
lm(formula = gwl$Oct_11 ~ gwl$WY_2011)

Residuals:
    Min      1Q  Median      3Q     Max
-21.873 -13.805  -2.165  14.814  19.018

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  109.303      6.924  15.787 2.14e-08 ***
gwl$WY_2011   -2.432      1.049  -2.318    0.043 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 16.59 on 10 degrees of freedom
  (13 observations deleted due to missingness)
Multiple R-squared:  0.3494,    Adjusted R-squared:  0.2844
F-statistic: 5.371 on 1 and 10 DF,  p-value: 0.04295
```

```
> summary(gwlreg10)

Call:
lm(formula = gwl$March_15 ~ gwl$WY_2015)

Residuals:
    Min      1Q  Median      3Q     Max
-32.387  -5.071   2.651   6.899  25.790

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  99.2008     5.9487  16.676 1.26e-08 ***
gwl$WY_2015  -0.7821     1.2845  -0.609    0.556
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 17.54 on 10 degrees of freedom
  (13 observations deleted due to missingness)
Multiple R-squared:  0.03575,   Adjusted R-squared:  -0.06068
F-statistic: 0.3707 on 1 and 10 DF,  p-value: 0.5562

> summary(gwlreg11)

Call:
lm(formula = gwl$Oct_15 ~ gwl$WY_2015)

Residuals:
    Min      1Q  Median      3Q     Max
-36.542 -11.361   0.144  17.007  27.449

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  94.9992     6.7692  14.034 6.62e-08 ***
gwl$WY_2015  -0.6849     1.4617  -0.469    0.649
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 19.95 on 10 degrees of freedom
  (13 observations deleted due to missingness)
Multiple R-squared:  0.02148,   Adjusted R-squared:  -0.07637
F-statistic: 0.2195 on 1 and 10 DF,  p-value: 0.6495
```

```
> summary(gwlreg12)

Call:
lm(formula = gwl$March_16 ~ gwl$WY_2016)

Residuals:
    Min      1Q  Median      3Q     Max
-27.294 -11.553   2.177  10.593  21.569

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 102.1872     5.9017  17.315 8.74e-09 ***
gwl$WY_2016  -1.3483     0.9531  -1.415    0.188
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 16.27 on 10 degrees of freedom
  (13 observations deleted due to missingness)
Multiple R-squared:  0.1667,    Adjusted R-squared:  0.08342
F-statistic: 2.001 on 1 and 10 DF,  p-value: 0.1876

> summary(gwlreg13)

Call:
lm(formula = gwl$Oct_16 ~ gwl$WY_2016)

Residuals:
    Min      1Q  Median      3Q     Max
-26.895 -18.302   3.652  15.267  29.388

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  105.232      7.207  14.600 4.53e-08 ***
gwl$WY_2016   -2.136      1.164  -1.835   0.0964 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 19.87 on 10 degrees of freedom
  (13 observations deleted due to missingness)
Multiple R-squared:  0.2519,    Adjusted R-squared:  0.1771
F-statistic: 3.367 on 1 and 10 DF,  p-value: 0.09639
```

```
> stat.desc(gwl$March_97,basic=F)
      median         mean      SE.mean CI.mean.0.95          var      std.dev     coef.var
 124.8900000  119.6896000    4.4683921    9.2223081  499.1632040   22.3419606    0.1866658
> stat.desc(gwl$Oct_97,basic=F)
      median         mean      SE.mean CI.mean.0.95          var      std.dev     coef.var
 123.6300000  115.7300000    4.3289589    8.9345321  468.4971333   21.6447946    0.1870284
> stat.desc(gwl$March_98,basic=F)
      median         mean      SE.mean CI.mean.0.95          var      std.dev     coef.var
 117.1000000  113.1576000    3.8627759    7.9723776  373.0259357   19.3138794    0.1706812
> stat.desc(gwl$Oct_98,basic=F)
      median         mean      SE.mean CI.mean.0.95          var      std.dev     coef.var
 114.0400000  114.0624000    4.6431309    9.5829512  538.9666190   23.2156546    0.2035347
> stat.desc(gwl$March_99,basic=F)
      median         mean      SE.mean CI.mean.0.95          var      std.dev     coef.var
 120.2800000  115.0920000    4.5270859    9.3434460  512.3626583   22.6354293    0.1966725
> stat.desc(gwl$Oct_99,basic=F)
      median         mean      SE.mean CI.mean.0.95          var      std.dev     coef.var
 112.0800000  110.8244000    4.5306834    9.3508710  513.1773090   22.6534172    0.2044082
> stat.desc(gwl$March_10,basic=F)
      median         mean      SE.mean CI.mean.0.95          var      std.dev     coef.var
 114.6700000  113.4676000    5.2200850   10.7737259  681.2321773   26.1004248    0.2300254
> stat.desc(gwl$Oct_10,basic=F)
      median         mean      SE.mean CI.mean.0.95          var      std.dev     coef.var
 120.0000000  120.2212000    5.3203026   10.9805650  707.6405027   26.6015132    0.2212714
> stat.desc(gwl$March_11,basic=F)
      median         mean      SE.mean CI.mean.0.95          var      std.dev     coef.var
 120.3400000  117.7337200    5.3241888   10.9885857  708.6746718   26.6209442    0.2261115
> stat.desc(gwl$Oct_11,basic=F)
      median         mean      SE.mean CI.mean.0.95          var      std.dev     coef.var
 114.1400000  114.5424000    5.3130160   10.9655260  705.7034690   26.5650799    0.2319235
> stat.desc(gwl$March_15,basic=F)
      median         mean      SE.mean CI.mean.0.95          var      std.dev     coef.var
 119.9800000  115.0756000    5.0606712   10.4447119  640.2598173   25.3033559    0.2198846
> stat.desc(gwl$Oct_15,basic=F)
      median         mean      SE.mean CI.mean.0.95          var      std.dev     coef.var
 114.3400000  115.6032000    5.6481055   11.6571168  797.5273977   28.2405276    0.2442885
> stat.desc(gwl$March_16,basic=F)
      median         mean      SE.mean CI.mean.0.95          var      std.dev     coef.var
 120.8900000  118.8472000    5.4170689   11.1802807  733.6158793   27.0853444    0.2279006
> stat.desc(gwl$Oct_16,basic=F)
      median         mean      SE.mean CI.mean.0.95          var      std.dev     coef.var
 125.0300000  116.6284000    5.2402010   10.8152434  686.4926723   26.2010052    0.2246537
> stat.desc(gwl$WY_97,basic=F)
      median         mean      SE.mean CI.mean.0.95          var      std.dev     coef.var
    1.395000     4.260000     1.855005     4.082839    41.292527     6.425926     1.508433
> stat.desc(gwl$WY_98,basic=F)
      median         mean      SE.mean CI.mean.0.95          var      std.dev     coef.var
    4.425000     6.273333     1.922198     4.230729    44.338133     6.658689     1.061428
> stat.desc(gwl$WY_99,basic=F)
      median         mean      SE.mean CI.mean.0.95          var      std.dev     coef.var
    2.250000     3.326667     1.114798     2.453654    14.913297     3.861774     1.160854
> stat.desc(gwl$WY_2010,basic=F)
      median         mean      SE.mean CI.mean.0.95          var      std.dev     coef.var
    2.880000     3.664167     1.126569     2.479561    15.229881     3.902548     1.065057
> stat.desc(gwl$WY_2011,basic=F)
      median         mean      SE.mean CI.mean.0.95          var      std.dev     coef.var
    3.765000     4.765833     1.375790     3.028093    22.713572     4.765876     1.000009

> stat.desc(gwl$WY_2015,basic=F)
      median         mean      SE.mean CI.mean.0.95          var      std.dev     coef.var
    0.435000     2.432500     1.188176     2.615158    16.941148     4.115963     1.692071
> stat.desc(gwl$WY_2016,basic=F)
      median         mean      SE.mean CI.mean.0.95          var      std.dev     coef.var
    1.455000     3.748333     1.486037     3.270746    26.499688     5.147785     1.373353
```

```
> t.test(gwl$March_97,gwl$WY_97)

        Welch Two Sample t-test

data:  gwl$March_97 and gwl$WY_97
t = 23.858, df = 30.978, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 105.5619 125.2973
sample estimates:
mean of x mean of y
 119.6896    4.2600

> t.test(gwl$Oct_97,gwl$WY_97)

        Welch Two Sample t-test

data:  gwl$Oct_97 and gwl$WY_97
t = 23.668, df = 31.319, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 101.8685 121.0715
sample estimates:
mean of x mean of y
   115.73      4.26

> t.test(gwl$March_98,gwl$WY_98)

        Welch Two Sample t-test

data:  gwl$March_98 and gwl$WY_98
t = 24.773, df = 32.95, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
  98.10561 115.66292
sample estimates:
 mean of x  mean of y
113.157600   6.273333

> t.test(gwl$Oct_98,gwl$WY_98)

        Welch Two Sample t-test

data:  gwl$Oct_98 and gwl$WY_98
t = 21.449, df = 30.948, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
  97.53923 118.03890
sample estimates:
 mean of x  mean of y
114.062400   6.273333
```

```
> t.test(gwl$March_99,gwl$WY_99)

        Welch Two Sample t-test

data:  gwl$March_99 and gwl$WY_99
t = 23.972, df = 26.784, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 102.1954 121.3352
sample estimates:
 mean of x  mean of y
115.092000   3.326667

> t.test(gwl$Oct_99,gwl$WY_99)

        Welch Two Sample t-test

data:  gwl$Oct_99 and gwl$WY_99
t = 23.039, df = 26.78, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
  97.92058 117.07489
sample estimates:
 mean of x  mean of y
110.824400   3.326667

> t.test(gwl$March_10,gwl$WY_2010)

        Welch Two Sample t-test

data:  gwl$March_10 and gwl$WY_2010
t = 20.561, df = 26.164, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
  98.8297 120.7772
sample estimates:
 mean of x  mean of y
113.467600   3.664167

> t.test(gwl$Oct_10,gwl$WY_2010)

        Welch Two Sample t-test

data:  gwl$Oct_10 and gwl$WY_2010
t = 21.433, df = 26.086, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 105.3803 127.7338
sample estimates:
 mean of x  mean of y
120.221200   3.664167
```

```
> t.test(gwl$March_11,gwl$WY_2011)

        Welch Two Sample t-test

data:  gwl$March_11 and gwl$WY_2011
t = 20.543, df = 27.049, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 101.6857 124.2501
sample estimates:
 mean of x  mean of y
117.733720   4.765833

> t.test(gwl$Oct_11,gwl$WY_2011)

        Welch Two Sample t-test

data:  gwl$Oct_11 and gwl$WY_2011
t = 20.002, df = 27.061, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
  98.51679 121.03635
sample estimates:
 mean of x  mean of y
114.542400   4.765833

> t.test(gwl$March_15,gwl$WY_2015)

        Welch Two Sample t-test

data:  gwl$March_15 and gwl$WY_2015
t = 21.669, df = 26.543, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 101.9685 123.3177
sample estimates:
mean of x mean of y
 115.0756    2.4325

> t.test(gwl$Oct_15,gwl$WY_2015)

        Welch Two Sample t-test

data:  gwl$Oct_15 and gwl$WY_2015
t = 19.608, df = 26.06, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 101.3081 125.0333
sample estimates:
mean of x mean of y
 115.6032    2.4325
```

```
> t.test(gwl$March_16,gwl$WY_2016)

        Welch Two Sample t-test

data:  gwl$March_16 and gwl$WY_2016
t = 20.49, df = 27.409, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 103.5814 126.6164
sample estimates:
 mean of x  mean of y
118.847200   3.748333

> t.test(gwl$Oct_16,gwl$WY_2016)

        Welch Two Sample t-test

data:  gwl$Oct_16 and gwl$WY_2016
t = 20.724, df = 27.626, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 101.7159 124.0442
sample estimates:
 mean of x  mean of y
116.628400   3.748333
```