Size structure and sex ratio

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Structure and Condition of an Established Round Goby Population in the Thousand Islands Region, St. Lawrence River

Size structure and sex ratio

Contents of Rmarkdown:

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1. Summary tables of lengths by sex, site, and month

Characteristic	May	June	July	August	September	October
Male						
Total.Length						
N	241	29	56	46	13	0
Range	55, 237	53, 224	54, 114	57, 130	51, 135	Inf, -Inf
Mean(SD)	185(21)	175(49)	81(16)	86(17)	83(23)	NA(NA)
Female						
Total.Length						
N	20	2	86	66	11	0
Range	56, 137	57, 65	54, 114	51, 105	43, 105	Inf, -Inf
Mean(SD)	102(27)	61(6)	79(14)	81(11)	75(23)	NA(NA)
Immature						
Total.Length						
N	28	5	132	34	5	1
Range	29, 63	60, 65	42, 92	47, 82	56, 79	67, 67
Mean(SD)	49(9)	63(2)	58(10)	64(8)	69(10)	67(NA)

Characteristic	May	June	July	August	September	October
Total.Length						
N	508	57	80	163	0	24
Range	49, 230	65, 221	48, 146	57, 112	Inf, -Inf	47, 152

Characteristic	May	June	July	August	September	October
Mean(SD)	168(36)	152(38)	95(21)	79(11)	NA(NA)	86(27)

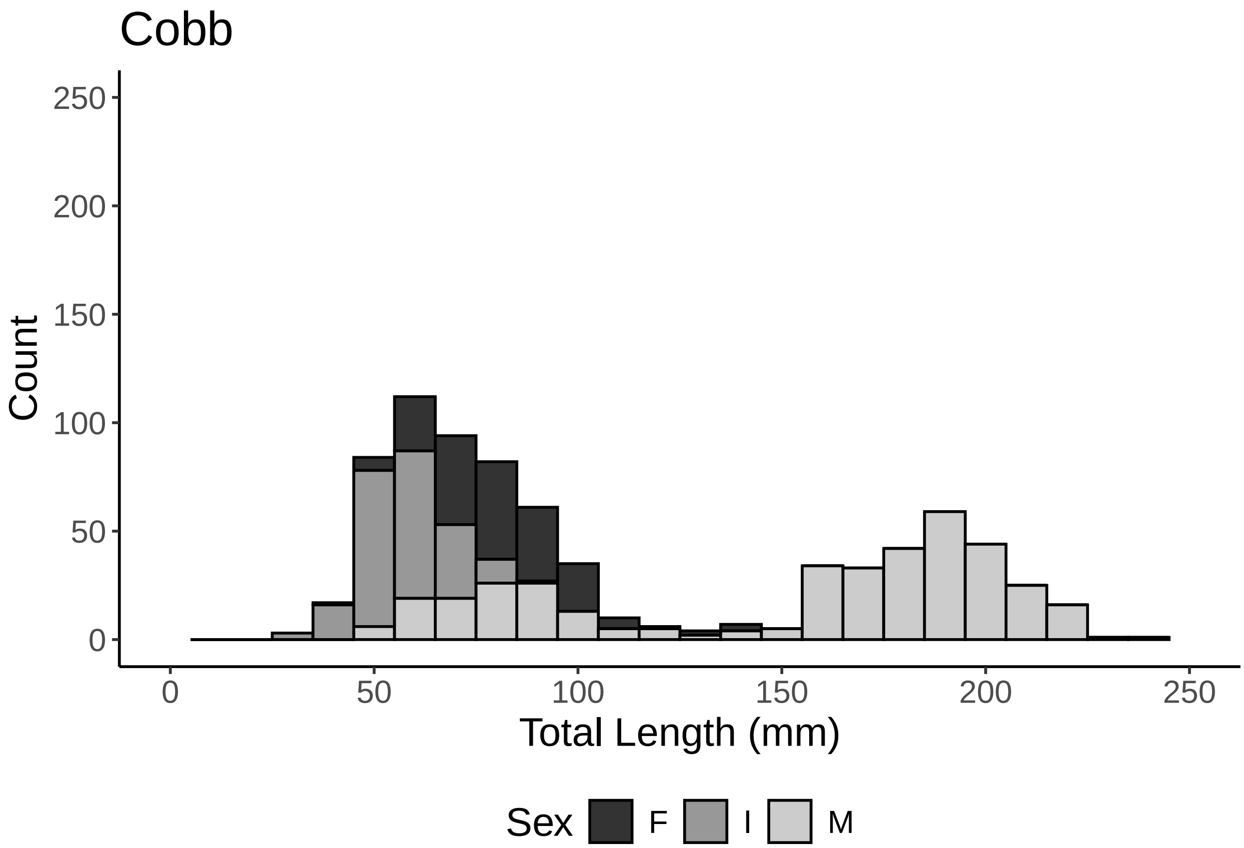
Characteristic	May	June	July	August	September	October
Total.Length						
N	83	12	54	148	3	19
Range	46, 163	62, 159	47, 118	57, 121	59, 82	54, 91
Mean(SD)	90(27)	103(34)	80(16)	80(11)	74(13)	66(10)

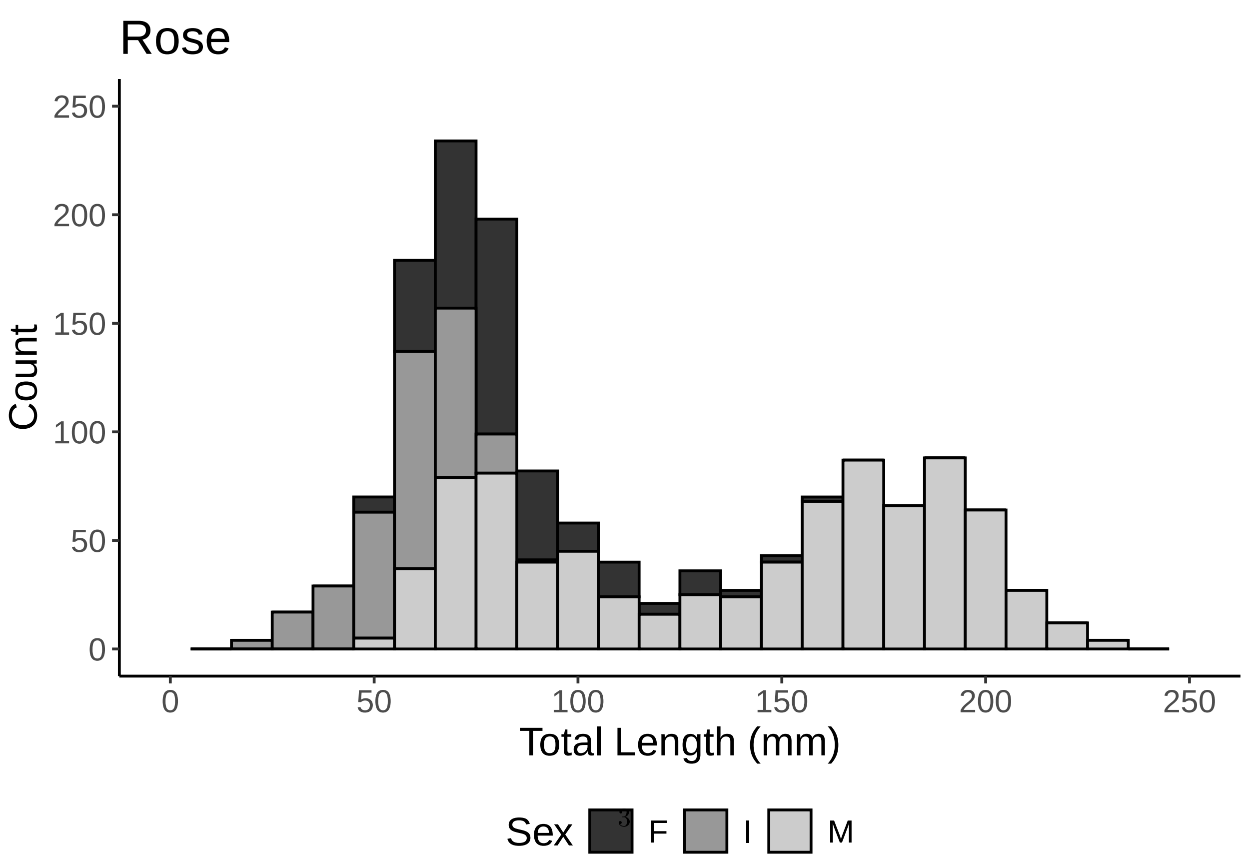
Characteristic	May	June	July	August	September	October
Total.Length						
N	78	13	48	149	13	4
Range	20, 75	35, 73	36, 79	40, 91	26, 56	55, 63
Mean(SD)	48(13)	50(11)	58(9)	67(8)	45(10)	59(4)

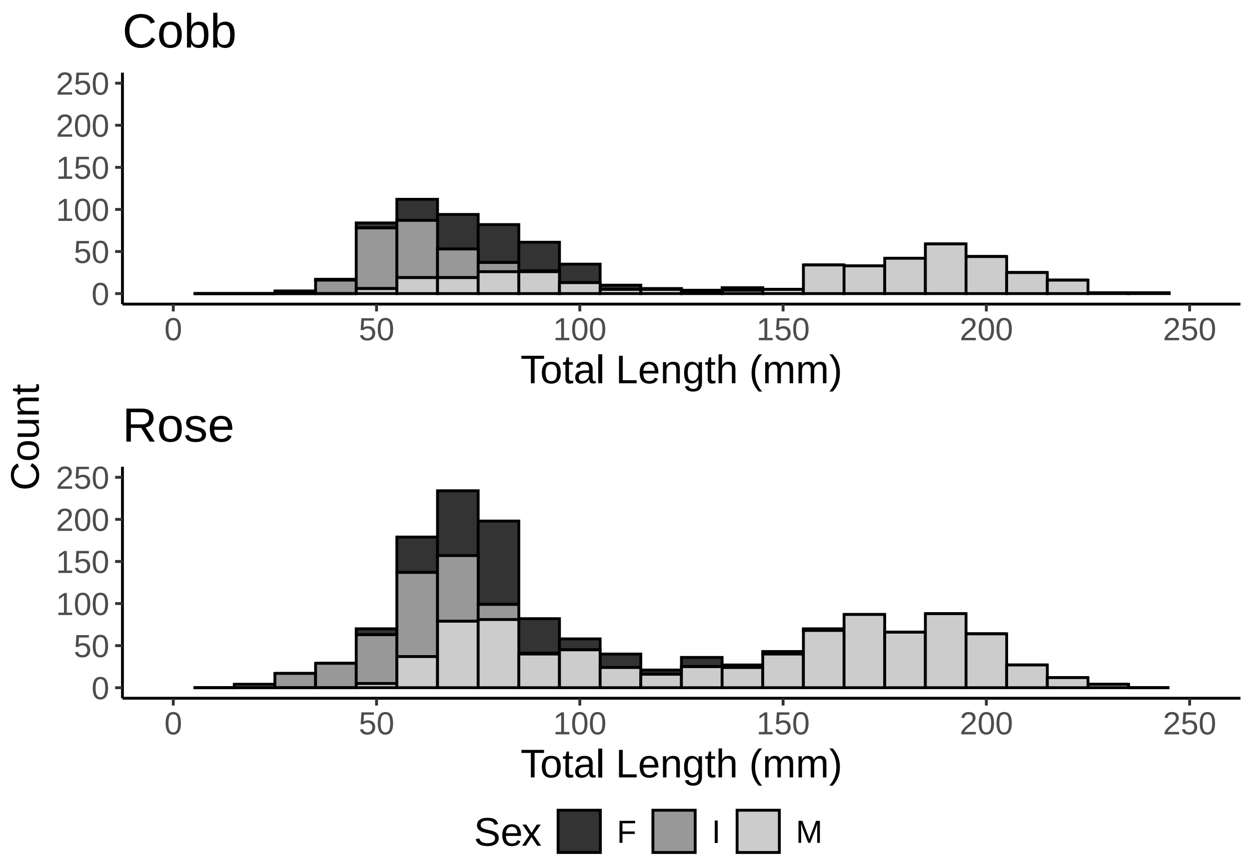
Characteristic	May	June	July	August	September	October
Male						
Total.Length						
N	508	57	80	163	0	24
Range	49, 230	65, 221	48, 146	57, 112	Inf, -Inf	47, 152
Mean(SD)	168(36)	152(38)	95(21)	79(11)	NA(NA)	86(27)
Female						
Total.Length						
N	83	12	54	148	3	19
Range	46, 163	62, 159	47, 118	57, 121	59, 82	54, 91
Mean(SD)	90(27)	103(34)	80(16)	80(11)	74(13)	66(10)
Immature						
Total.Length						
N	78	13	48	149	13	4
Range	20, 75	35, 73	36, 79	40, 91	26, 56	55, 63
Mean(SD)	48(13)	50(11)	58(9)	67(8)	45(10)	59(4)

2. Length Frequency visualization and statistical analysis

Histogram of round goby length frequencies





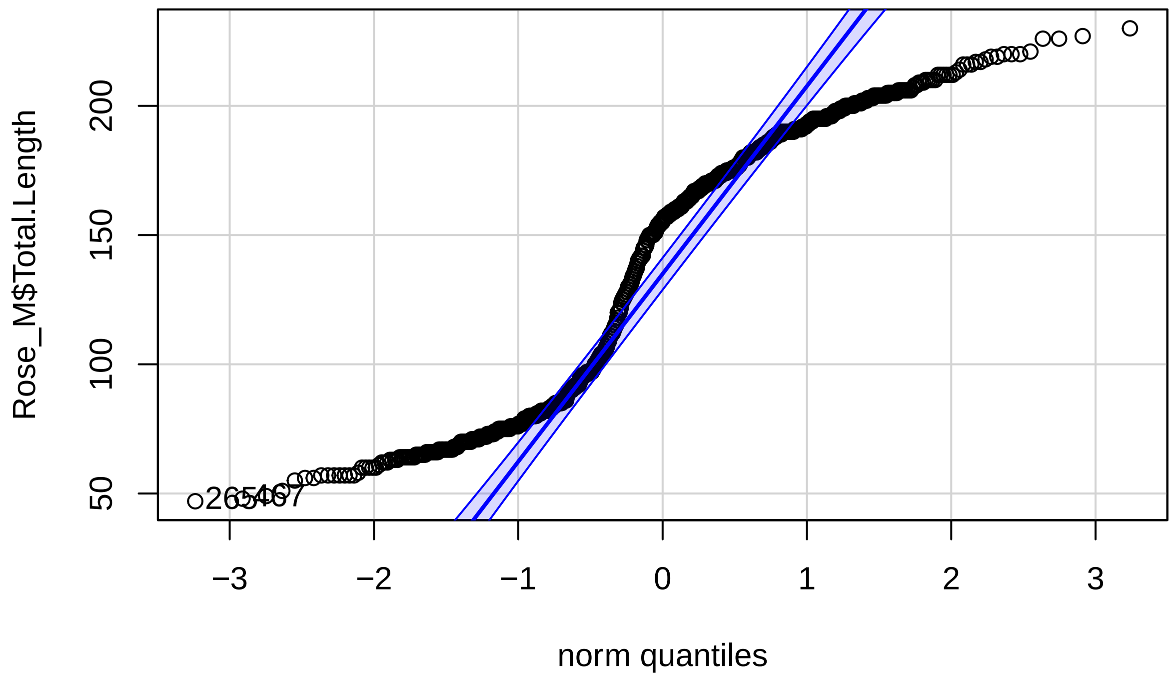


Shapiro-Wilk normality test and qqplots

Males

Rose

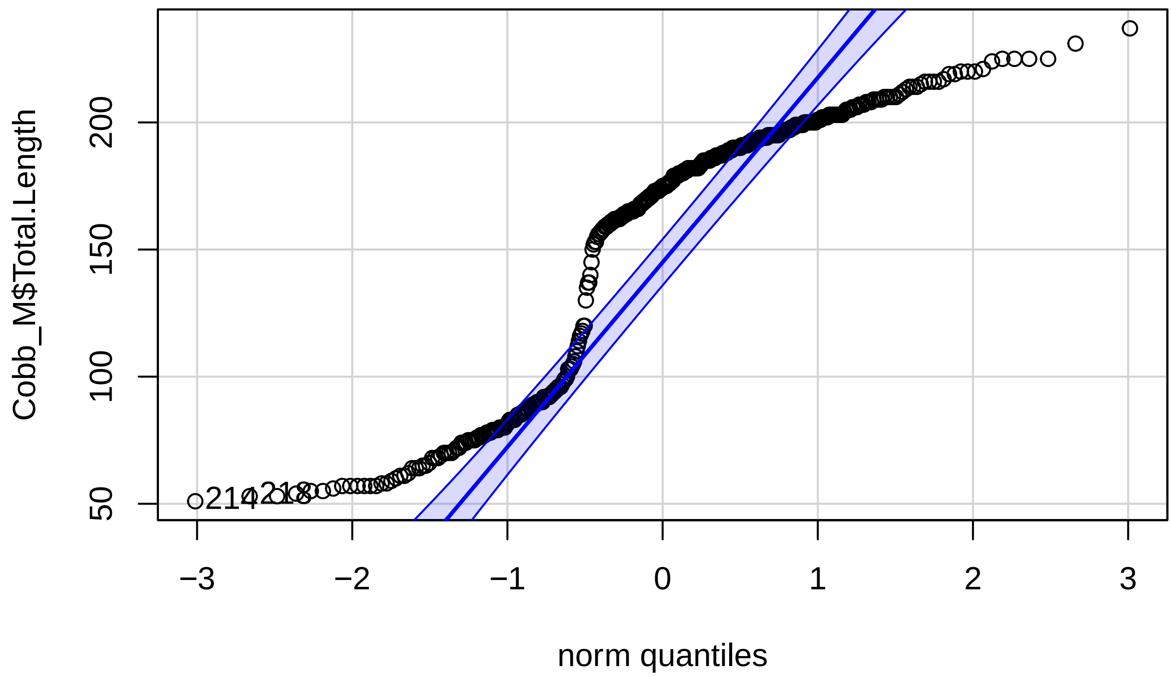
```
##
##  Shapiro-Wilk normality test
##
## data:  Rose_M$Total.Length
## W = 0.91278, p-value < 2.2e-16
```




```
## [1] 265 467
```

Cobb

```
##
##  Shapiro-Wilk normality test
##
## data:  Cobb_M$Total.Length
## W = 0.8684, p-value < 2.2e-16
```

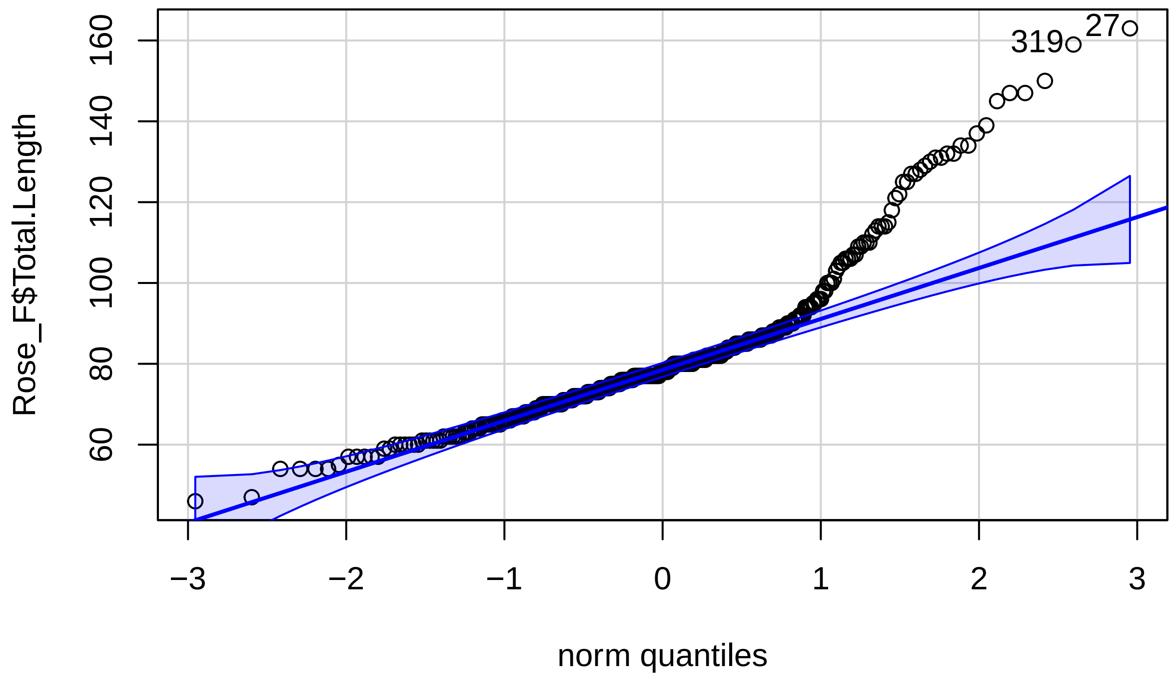



```
## [1] 214 218
```

Females

Rose

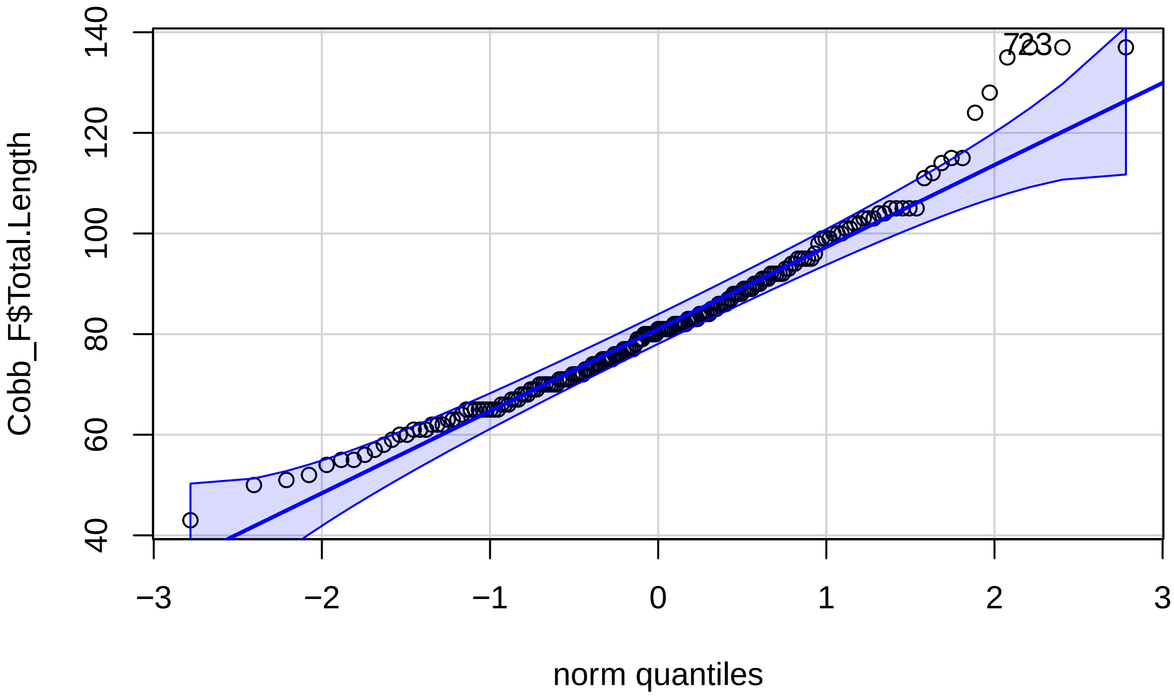
```
##
##  Shapiro-Wilk normality test
##
## data:  Rose_F$Total.Length
## W = 0.87356, p-value = 1.61e-15
```




```
## [1]  27 319
```

Cobb

```
##
##  Shapiro-Wilk normality test
##
## data:  Cobb_F$Total.Length
## W = 0.96199, p-value = 6.622e-05
```




```
## [1]  7 23
```

ECDF plot, Kolmogrov-Smirnov test and bootstrapped K-S test

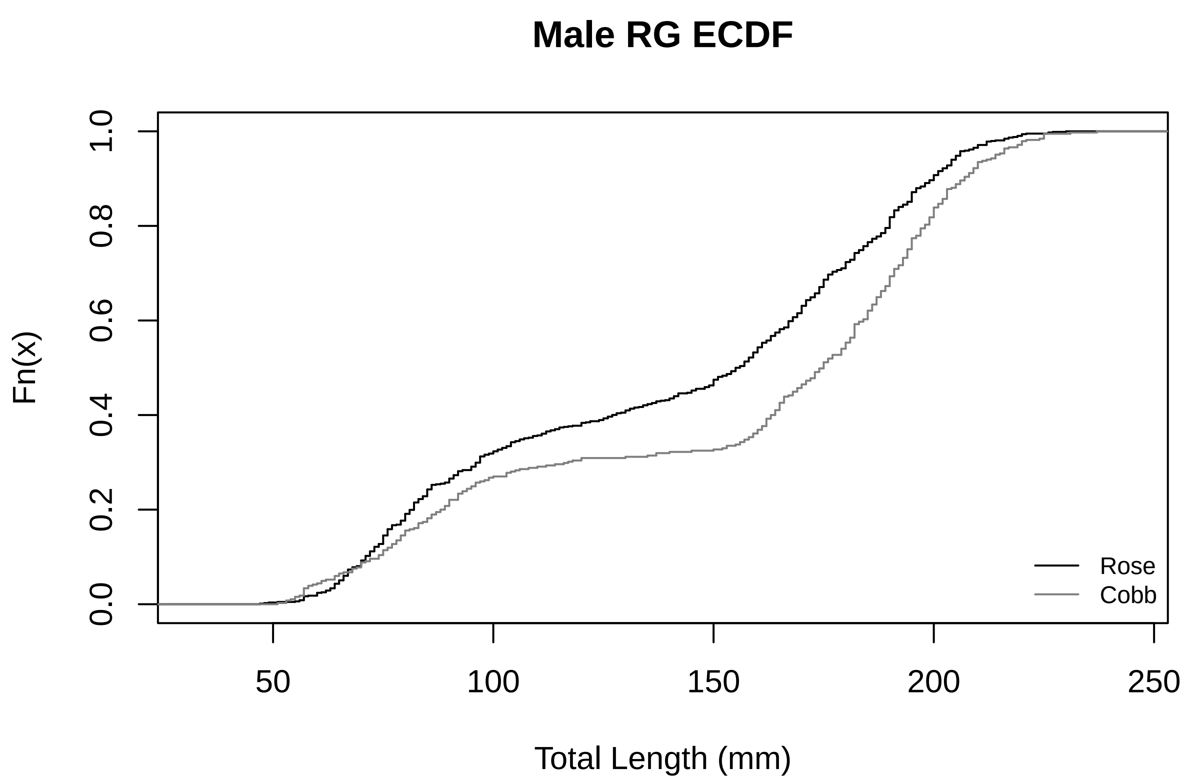
to determine whether the ECDF (empirical cumulative distribution function) are the same between two groups and can detect differences in the location (e.g., median), dispersion (e.g., variance), and shape of the distributions

Males

```
##
##  Asymptotic two-sample Kolmogorov-Smirnov test
##
## data:  Rose_M$Total.Length and Cobb_M$Total.Length
## D = 0.17946, p-value = 8.677e-08
## alternative hypothesis: two-sided
```

```
## $ks.boot.pvalue
## [1] 0
##
## $ks
##
##  Asymptotic two-sample Kolmogorov-Smirnov test
##
```

```
## data:  Tr and Co
## D = 0.17946, p-value = 8.677e-08
## alternative hypothesis: two-sided
##
##
## $nboots
## [1] 1000
##
## attr(,"class")
## [1] "ks.boot"
```

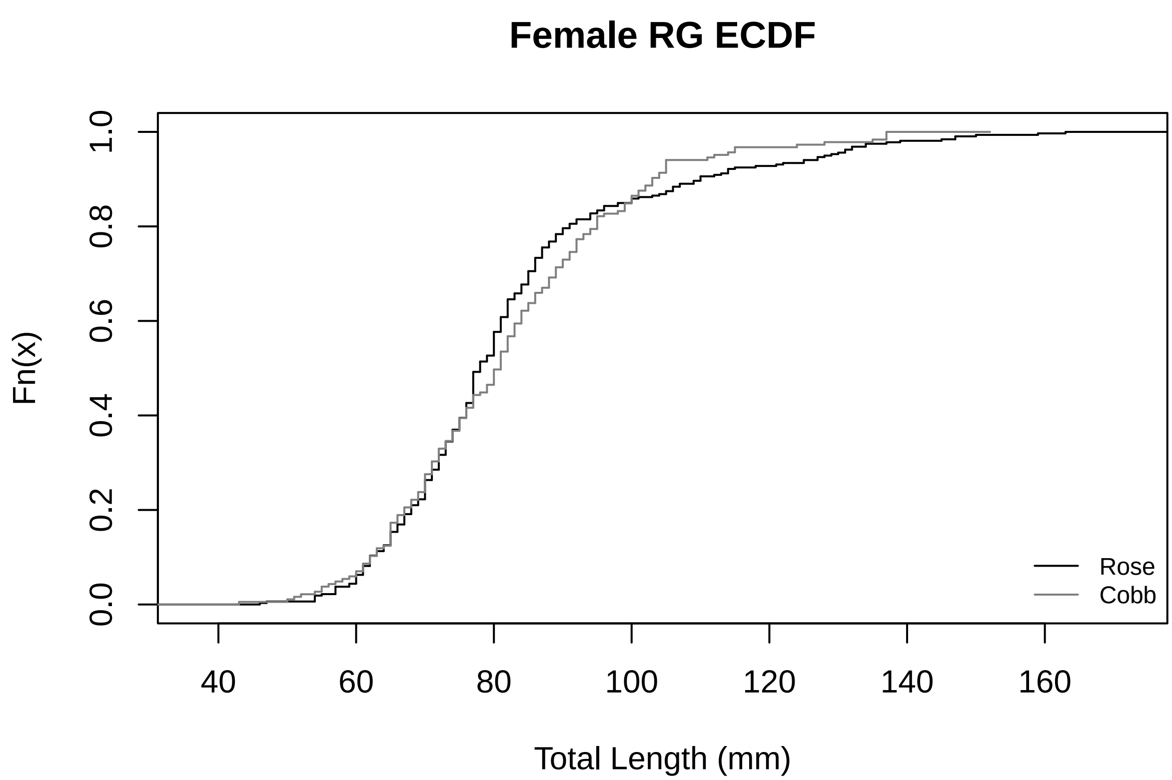


Females

```
##
##  Asymptotic two-sample Kolmogorov-Smirnov test
##
## data:  Rose_F$Total.Length and Cobb_F$Total.Length
## D = 0.085216, p-value = 0.3629
## alternative hypothesis: two-sided

## $ks.boot.pvalue
## [1] 0.297
##
## $ks
##
```

```
##  Asymptotic two-sample Kolmogorov-Smirnov test
##
## data:  Tr and Co
## D = 0.085216, p-value = 0.3629
## alternative hypothesis: two-sided
##
##
## $nboots
## [1] 1000
##
## attr(,"class")
## [1] "ks.boot"
```



Chi Square test

to detect differences in length frequencies (5mm classes) between sites and months

Males

```
##
##  Pearson's Chi-squared test
##
## data:  RG_M_Site_xtab
## X-squared = 80.158, df = 38, p-value = 7.678e-05
```

```
##
##  Pearson's Chi-squared test
##
## data:  RG_M_Month_xtab
## X-squared = 1246.8, df = 190, p-value < 2.2e-16
```

Females

```
##
##  Pearson's Chi-squared test
##
## data:  RG_F_Site_xtab
## X-squared = 33.525, df = 23, p-value = 0.07235
```

```
##
##  Pearson's Chi-squared test
##
## data:  RG_F_Month_xtab
## X-squared = 363.56, df = 115, p-value < 2.2e-16
```

3. Sex ratio calculation, visualization and statistical analysis

Between months

```
## # A tibble: 6 x 4
##   Month     Female  Male Ratio
##   <chr>      <int> <int> <dbl>
## 1 May          103   749 7.27
## 2 June          14    86 6.14
## 3 July         140   136 0.971
## 4 August       214   210 0.981
## 5 September     14    13 0.929
## 6 October       19    24 1.26
```

Rose

```
## # A tibble: 6 x 4
##   Month     Female.Rose Male.Rose Ratio.Rose
##   <chr>           <int>     <int>      <dbl>
## 1 May                83       508       6.12
## 2 June               12        57       4.75
## 3 July               54        80       1.48
## 4 August            148       164       1.11
## 5 September           3         0       0
## 6 October            19        24       1.26
```

Cobb

```
## # A tibble: 6 x 4
##   Month     Female.Cobb Male.Cobb Ratio.Cobb
##   <chr>           <int>     <int>      <dbl>
```

```
## 1 May                20       241      12.0
## 2 June                2        29      14.5
## 3 July               86        56       0.651
## 4 August             66        46       0.697
## 5 September          11        13       1.18
## 6 October             0         0     NaN
```

```
(All_Sex_ratio<- cbind(Sex_ratio, Rose_MF_Sex_ratio, Cobb_MF_Sex_ratio))
```

```
##       Month Female Male Ratio     Month Female.Rose Male.Rose Ratio.Rose
## 1       May    103  749 7.272       May          83       508       6.12
## 2      June     14   86 6.143      June          12        57       4.75
## 3      July    140  136 0.971      July          54        80       1.48
## 4    August    214  210 0.981    August         148       164       1.11
## 5 September     14   13 0.929 September           3         0       0.00
## 6   October     19   24 1.263   October          19        24       1.26
##       Month Female.Cobb Male.Cobb Ratio.Cobb
## 1       May          20       241     12.050
## 2      June           2        29     14.500
## 3      July          86        56      0.651
## 4    August          66        46      0.697
## 5 September          11        13      1.182
## 6   October           0         0        NaN
```

```
All_Sex_ratio <- All_Sex_ratio[, !duplicated(colnames(All_Sex_ratio))]
```

```
gt(All_Sex_ratio)
```

Month	Female	Male	Ratio	Female.Rose	Male.Rose	Ratio.Rose	Female.Cobb	Male.Cobb	Ratio.Cobb
May	103	749	7.272	83	508	6.12	20	241	12.050
June	14	86	6.143	12	57	4.75	2	29	14.500
July	140	136	0.971	54	80	1.48	86	56	0.651
August	214	210	0.981	148	164	1.11	66	46	0.697
September	14	13	0.929	3	0	0.00	11	13	1.182
October	19	24	1.263	19	24	1.26	0	0	NaN

Chi Square test

to detect differences in sex ratio between months

```
##
##  Chi-squared test for given probabilities
##
## data:  Sex_ratio$Ratio
## X-squared = 15, df = 5, p-value = 0.01
```

```
##
##          Pairwise comparisons using chi-squared tests
##
## data:  $(Sex_ratio,Ratio) and bonferroni
```

```
##
##  observed expected   Chi Pr(>Chi)
##    7.2718    2.927 7.742  0.03236 *
##    6.1429    2.927 4.242  0.23664
##    0.9714    2.927 1.567  1.00000
##    0.9813    2.927 1.552  1.00000
##    0.9286    2.927 1.637  1.00000
##    1.2632    2.927 1.135  1.00000
##
## P value adjustment method: bonferroni
```

```
## $method
## [1] "chi-squared tests"
##
## $data.name
## [1] "$(Sex_ratio,Ratio) and bonferroni"
##
## $observed
## [1] 7.272 6.143 0.971 0.981 0.929 1.263
##
## $expected
## [1] 2.93 2.93 2.93 2.93 2.93 2.93
##
## $p.adjust.method
## [1] "bonferroni"
##
## $statistic
## [1] 7.74 4.24 1.57 1.55 1.64 1.13
##
## $p.value2
## [1] 0.0324 0.2366 1.0000 1.0000 1.0000 1.0000
##
## $p.value
##   observed expected  Chi Pr(>Chi)
## 1    7.272     2.93 7.74   0.0324 *
## 2    6.143     2.93 4.24   0.2366
## 3    0.971     2.93 1.57   1.0000
## 4    0.981     2.93 1.55   1.0000
## 5    0.929     2.93 1.64   1.0000
## 6    1.263     2.93 1.13   1.0000
```

```
##       Month     Month Female Male Ratio            method
## 1       May       May    103  749 7.272 chi-squared tests
## 2      June      June     14   86 6.143 chi-squared tests
## 3      July      July    140  136 0.971 chi-squared tests
## 4    August    August    214  210 0.981 chi-squared tests
## 5 September September     14   13 0.929 chi-squared tests
## 6   October   October     19   24 1.263 chi-squared tests
##                            data.name observed expected p.adjust.method statistic
## 1 $(Sex_ratio,Ratio) and bonferroni    7.272     2.93      bonferroni      7.74
## 2 $(Sex_ratio,Ratio) and bonferroni    6.143     2.93      bonferroni      4.24
## 3 $(Sex_ratio,Ratio) and bonferroni    0.971     2.93      bonferroni      1.57
## 4 $(Sex_ratio,Ratio) and bonferroni    0.981     2.93      bonferroni      1.55
## 5 $(Sex_ratio,Ratio) and bonferroni    0.929     2.93      bonferroni      1.64
```

```
## 6 $(Sex_ratio,Ratio) and bonferroni    1.263     2.93      bonferroni      1.13
##   p.value2 p.value.observed p.value.expected p.value.Chi p.value.Pr(>Chi)
## 1   0.0324           7.272             2.93        7.74           0.0324
## 2   0.2366           6.143             2.93        4.24           0.2366
## 3   1.0000           0.971             2.93        1.57           1.0000
## 4   1.0000           0.981             2.93        1.55           1.0000
## 5   1.0000           0.929             2.93        1.64           1.0000
## 6   1.0000           1.263             2.93        1.13           1.0000
##   p.value.
## 1        *
## 2
## 3
## 4
## 5
## 6
```

Summary table of sex ratio across sampling months

Month	Female	Male	M:F Ratio	**X2**	**P-value**
May	103	749	7.272	7.74	0.0324
June	14	86	6.143	4.24	0.2366
July	140	136	0.971	1.57	1.0000
August	214	210	0.981	1.55	1.0000
September	14	13	0.929	1.64	1.0000
October	19	24	1.263	1.13	1.0000