TITLE

Various Relationships between Baculum Length And Other Baculum Measurements for South African Male Fur Seals

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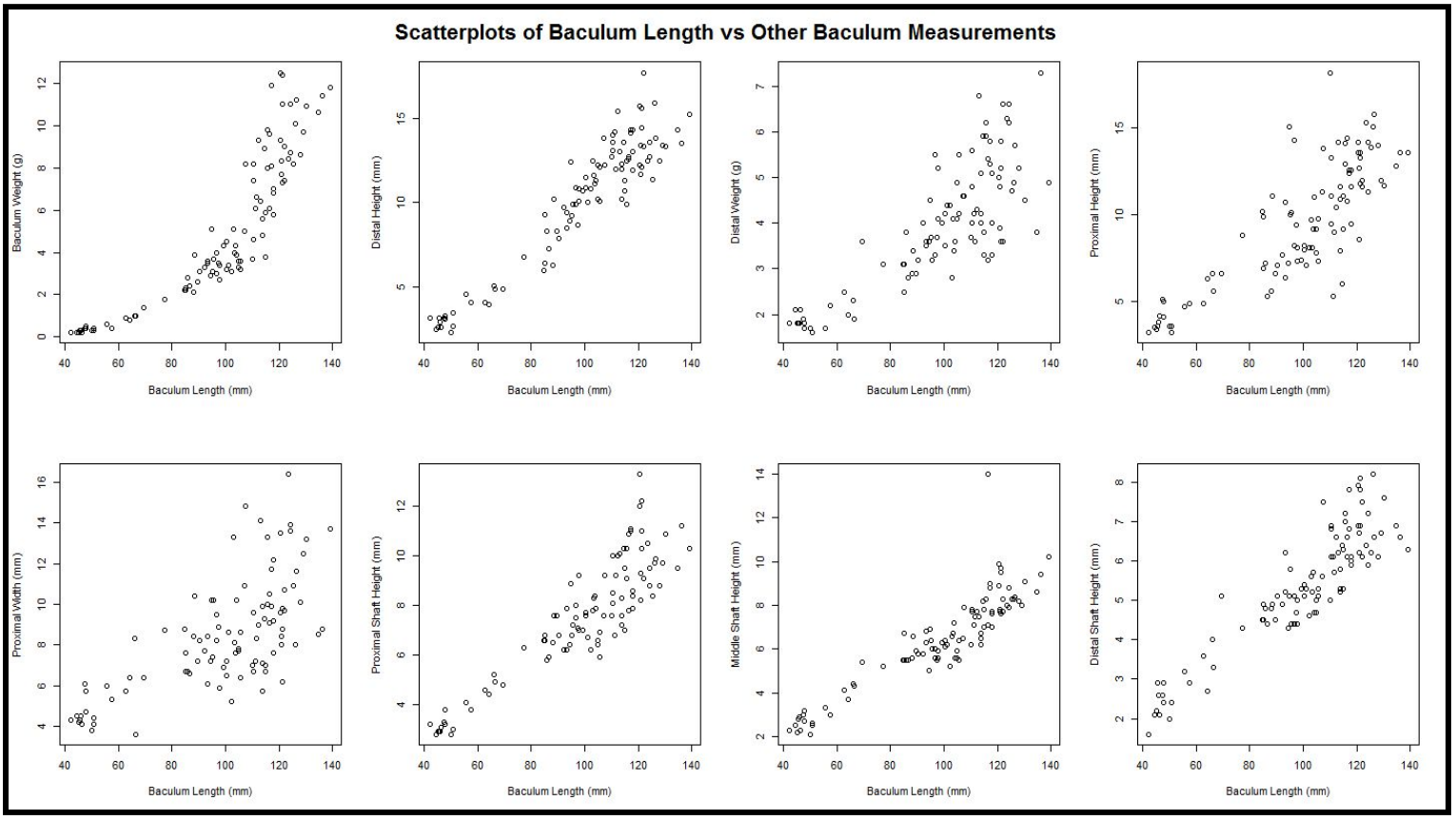
Software Used: RStudio

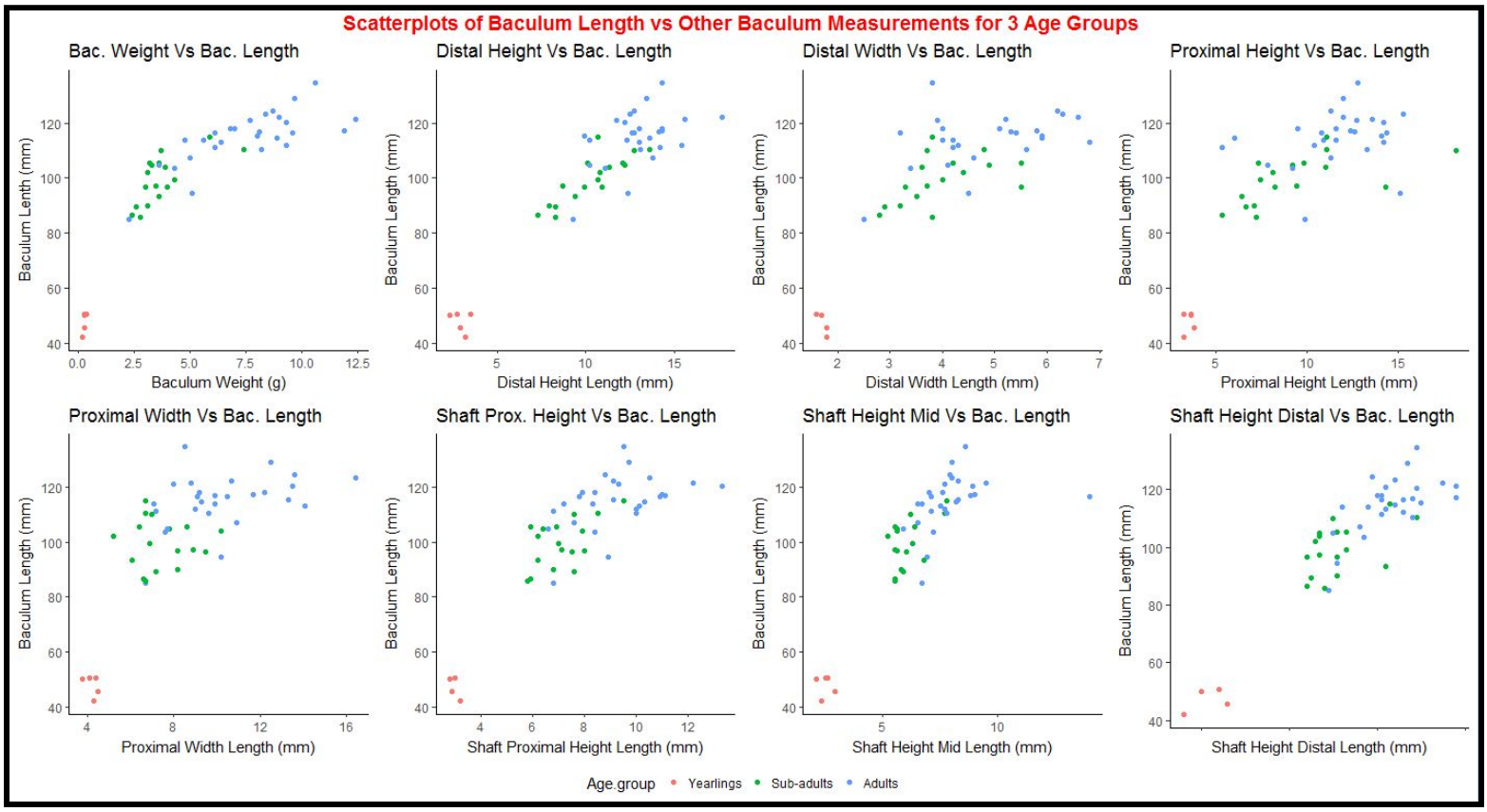
1) Baculum Length vs Other Baculum Measurements



BODY:

According to the above statistical graph which shows a collection of scatterplots, we have interpreted the relation of Baculum Length with other Baculum Measurements. In this graphic, we can observe that the plot for Baculum Length vs Baculum Weight is a bit positively curved rather than appearing completely linear. The plots for Baculum Length vs Distal Weight, Proximal Height and Proximal Width have a lot points scattered randomly and this doesn't show a perfect linear relationship due to the numerous unevenly scattered points in all directions. The plot for Baculum Length vs Middle Shaft Height seems to show a roughly positive linear relationship and is inclined a bit towards the x-axis showing a little curvature. Finally, in the plots of Baculum Length vs Distal Height, Proximal Shaft Height and Distal Shaft Height, we can infer a nearly perfect positive linear relationship with a minimal amount of randomly scattered points on either sides of the linear line. Overall, all the scatterplots do show a positive relationship which indicates that Baculum Length is directly proportional to other Baculum Measurements. Also, here we haven't shown any relationship of Baculum Length with respect to Rounded Ages or Age Groups as this is covered in the next section.

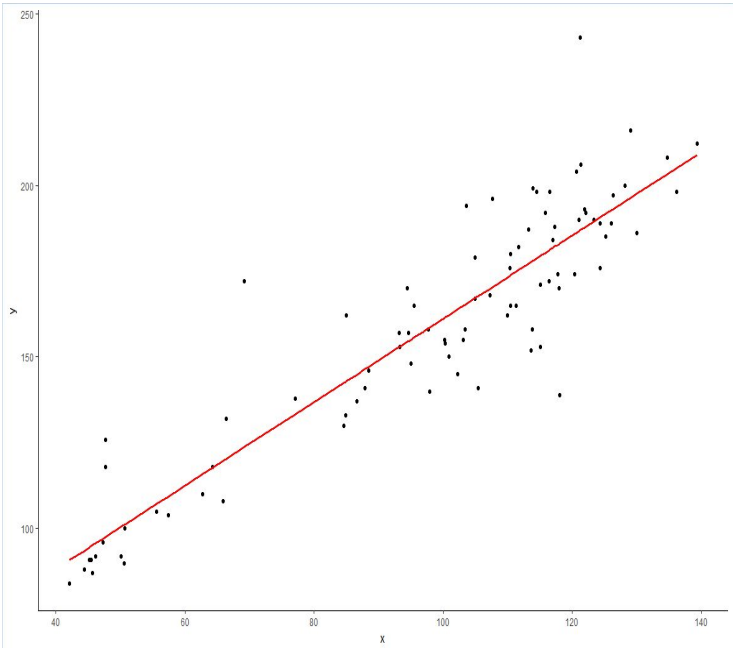
2) Baculum Length vs Other Baculum Measurements with respect to Age Groups



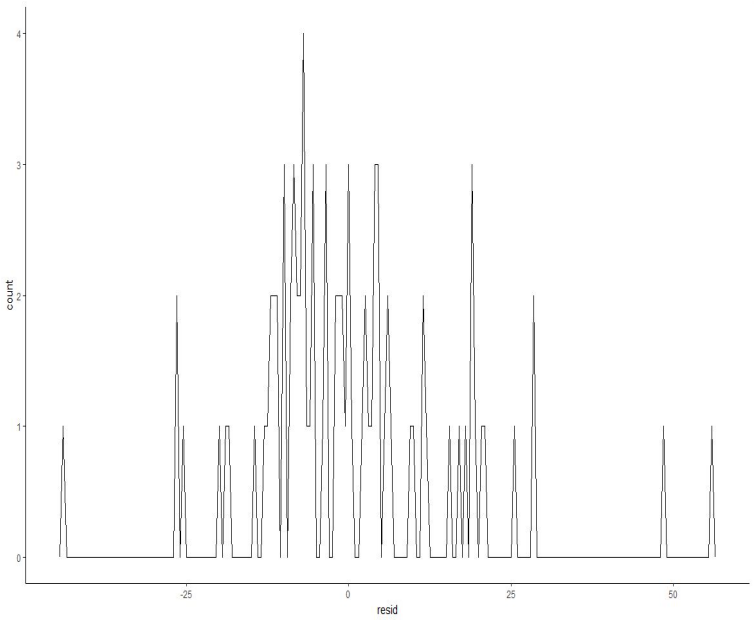
BODY:

Upon observation of the above statistical graphic, it can be summarized that it is a collection of scatterplots in order to show a relation between Baculum Length vs Other Baculum Measurements with respect to the three Age Groups (1) Yearling, 2) Subadults, 3) Adults). For the first Age Group, Yearling, only Baculum Weight scatterplot shows a thorough positive linear relationship even though there is a lack of data. Whereas, in other graphs, the Yearling relationship seems to be either negative or a mixture of positive and negative values and thus, it indicates no improvement overall. In the second Age Group, which is Subadults, the overall observation seems to be positive with a few exceptions that is, in the plot of Proximal Width Length where the points are scattered unevenly everywhere. This tells us that all the measurements increase positively and almost linearly with respect to Baculum Length in the Subadult stage except Proximal Width Length. For the last Age Group, namely Adults, Baculum Weight shows the most positive linear relationship followed by Shaft Height Distal Length. The other measurements do show a positive relation but the points seem pretty spread out from the supposed linear line. Only Proximal Height Length and Distal Height Length show a slight negative relationship at a certain point for a few sample of South African male fur seals.

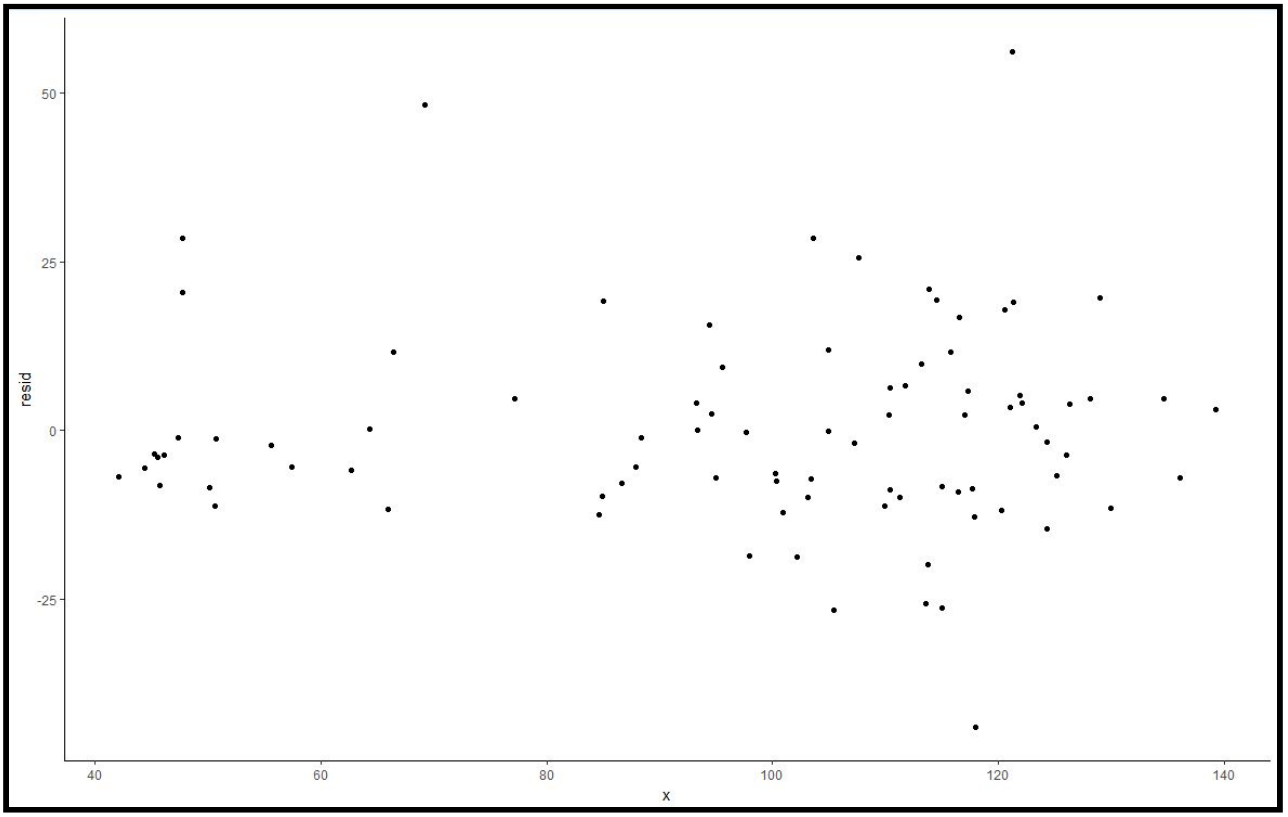
3) Baculum Length vs Standard Body Length using Linear Model Fitting Process



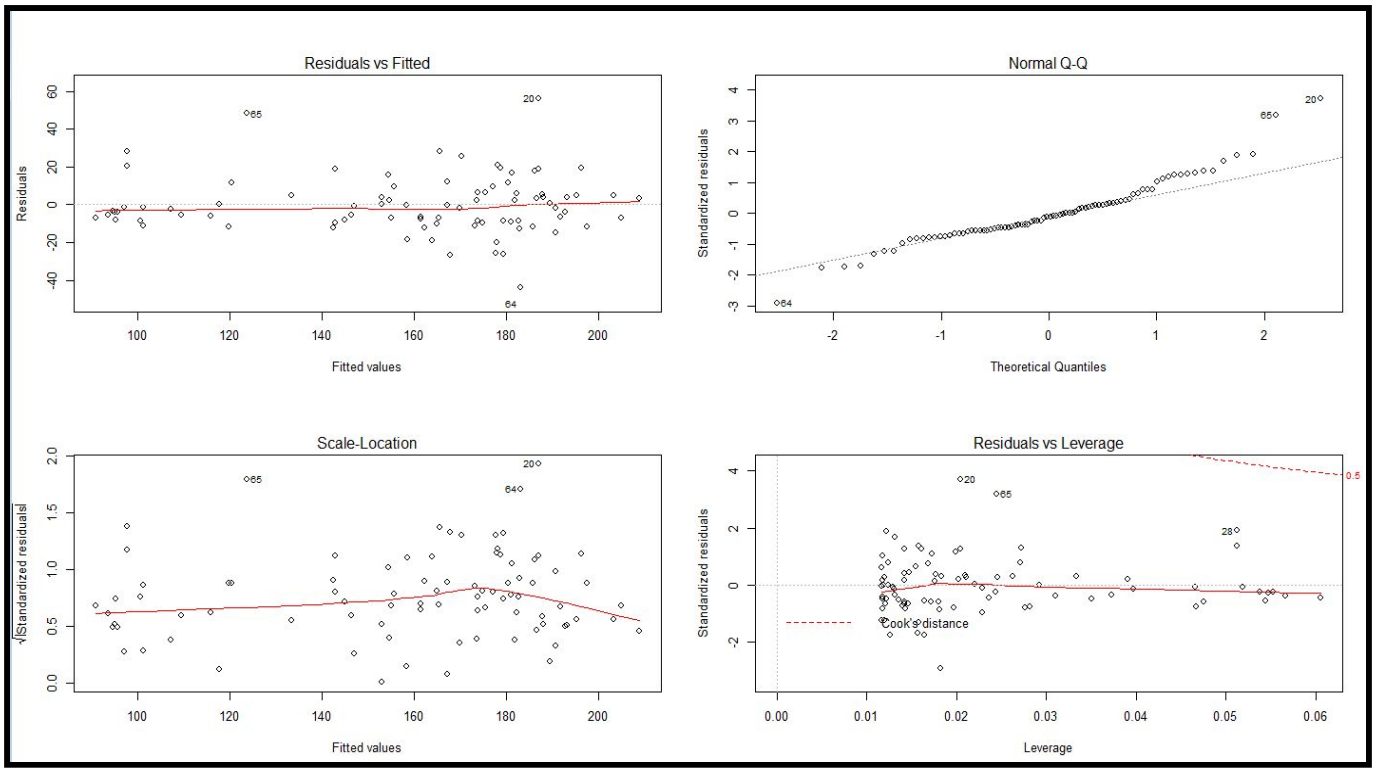
Relation of Baculum Length vs Standard Body Length with a Fitted Line



Residual Predictions



Scatterplot of Residuals vs Seal Length



Graphs Required for Fitting a Linear Model

BODY:

In the Residual vs Fitted Plot, the values look randomly and evenly scattered about the horizontal line (zero value). Thus, we can say that the model is adequate for consideration. Next, with the help of Normal Q-Q Plot, we can observe that the relation between Baculum Length and Standard Body Length is a positive linear relationship even though the points start deviating from the fitted line after a while in the graph. This can be said as the points of the scatterplot lie mostly on the fitted line on a overall observation. Since it appears linear, therefore we can proceed to observe the p-values from the numerical summary.

<u>Numerical Summary</u>

```
Call:
lm(formula = y ~ x, data = Baculumx)

Residuals:
    Min      1Q  Median      3Q     Max
-44.008  -8.613  -1.774   5.696  56.105

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 39.66367    6.16411   6.435 7.25e-09 ***
x            1.21478    0.06082  19.973  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 15.28 on 84 degrees of freedom
  (14 observations deleted due to missingness)
Multiple R-squared:  0.8261,    Adjusted R-squared:  0.824
F-statistic: 398.9 on 1 and 84 DF,  p-value: < 2.2e-16
```

H_0 : Baculum Length is not a useful indicator of Standard Body Length (Null Hypothesis)

H_1 : Baculum Length a useful indicator of Standard Body Length (Alternative Hypothesis)

According to the summary, the model fitted to the data has intercept of 39.66367 and slope 1.21478. Both are significantly different from zero (p-value for testing if the intercept equals zero is 7.25e-09 so we reject this hypothesis and the p-value for testing if the slope equals zero is less that 2e-16 so we reject this hypothesis). Since, p-value is less than 2.2e-16 thus, being less than 0.05, we agree to reject the null hypothesis.

CONCLUSION:

1) To summarize, we can say that the overall relationship of Baculum Length with other Baculum measurements is completely positively linear. Apart from that, only in the case of Distal Weight, Proximal Height and Proximal Width, the points are unevenly spread out in the plot. Also, there is a slight curvature in scatterplot of Baculum Weight. Thus, we can make a final statement as an answer to the research question saying that as the Baculum Length of the South African male fur seal increases, other Baculum Measurements increase as well. This summarises the overall relationship of Baculum Length with the other Baculum measurements.

2) Upon an overall observation, we can say that the relationship of Baculum Length with other Baculum Measurements is mostly linear in the subadult and adult stage whereas it is not positively linear in almost all the scatterplots in Yearling stage. Thus, for the Yearling stage, we can state that the Baculum Length does not increase in a positive linear way with other Baculum measurements. For sub-adult stage, the Baculum Length seems to have the best positive linear relationship with other Baculum Measurements, out of all the three age groups. Finally, in the adult stage, it does have a positive linear relationship but the points are unevenly scattered in many scatterplots. To make a final remark, we can say that this graphic suggests that the other Baculum Measurements have a lot of variability in the Yearling stage due to the steady growth of the Baculum in that age group but the measurements start progressing linearly once the South African male fur seal reaches the subadult and the adult stage indicating better development of the Baculum.

3) Upon all observations made in all the linear model fitting graphs and with respect to the Numerical Summary, we can infer to reject the null hypothesis due to p-value being less than 0.05. Therefore, we can say that evidence suggests that Baculum Length might be considered to be a useful indicator of the Standard Body Length. Thus, we have successfully answered this by making use of the linear model fitting process.