# Predicting Manduca Sexta Caterpillar Mass

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# Data

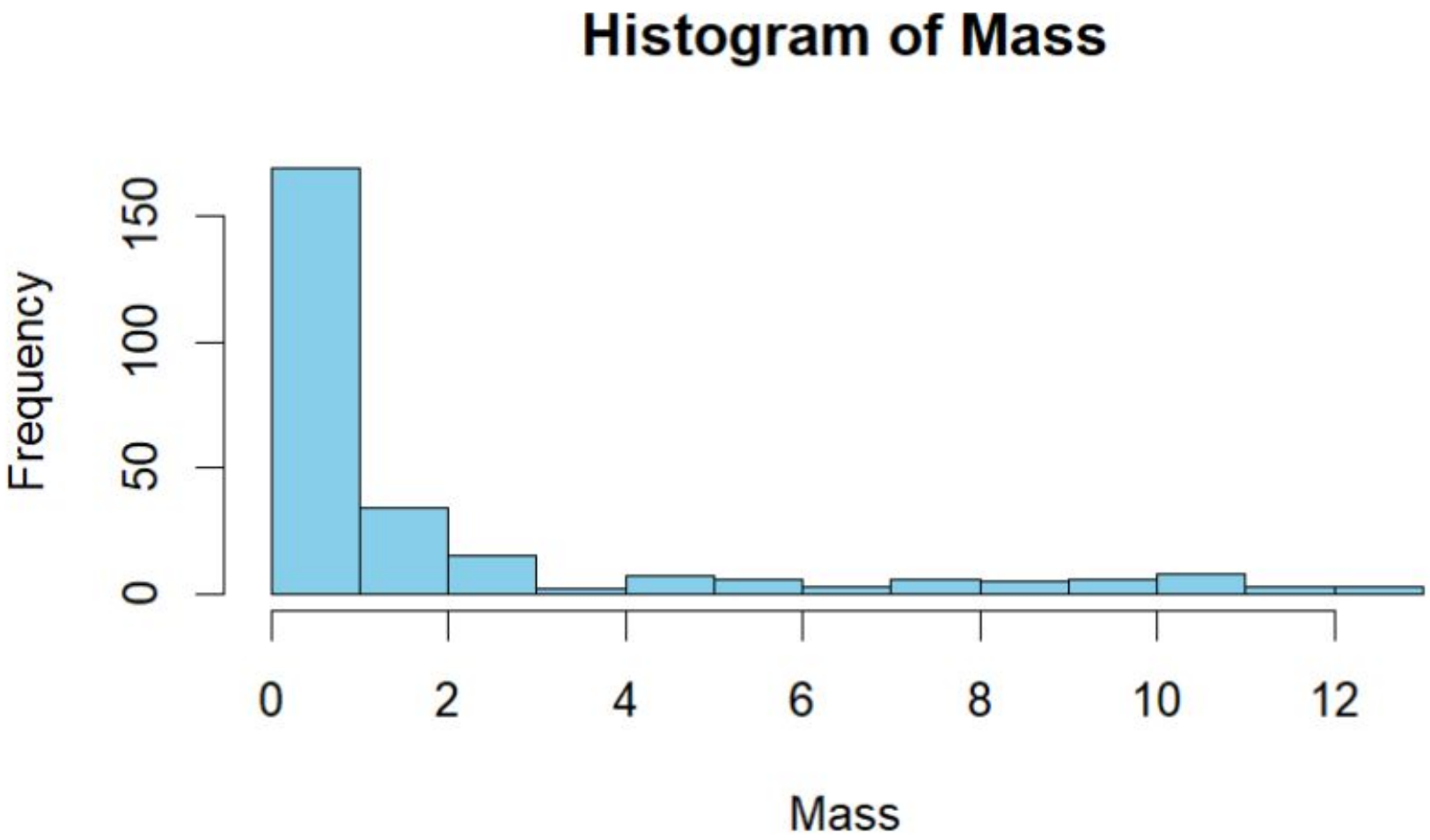
Measurements on a sample of 267 Manduca Sexta caterpillars

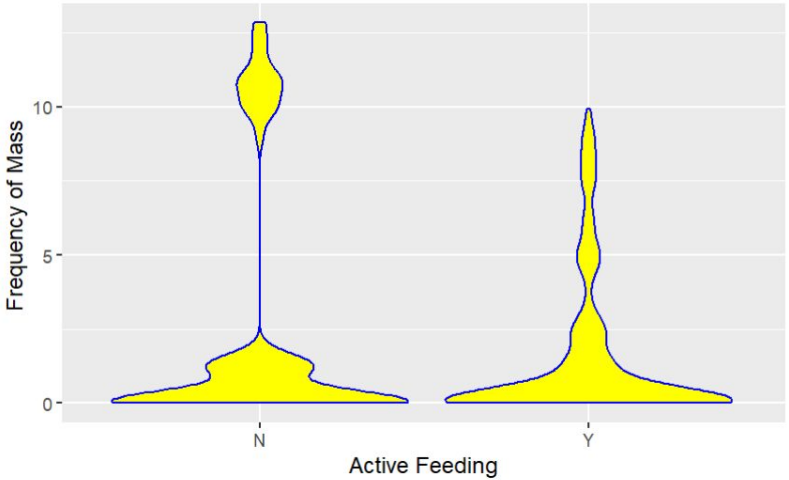
- Binary Data: Cleaned to be coded with 1 for “yes” and 0 for “no”
  - Active Feeding
  - Free in Growth Period (Fgp)
  - Maximum in Growth Period (Mgp)

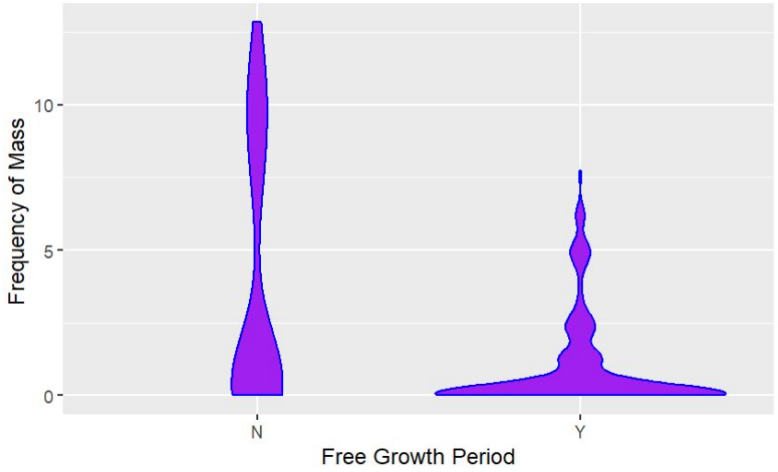
# Data Continued

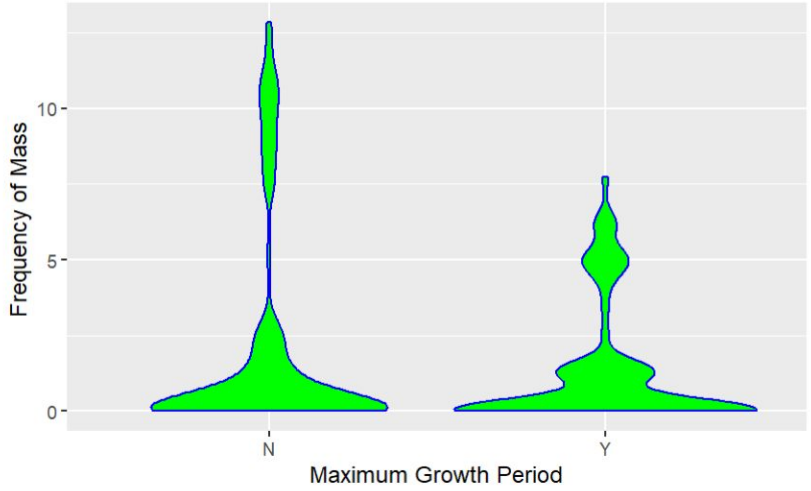
Continuous data (In Logarithmic and Non-Logarithmic)

- Mass (g)
- Food Intake (grams/day)
- Wet and Dry Frass (grams/day)
- CO2 and Nitrogen Assimilation (Ingestion – Excretion)
- Nitrogen in Frass


Histogram of Mass
Frequency
0
50
100
150
0
2
4
6
8
10
12
Mass


Frequency of Mass
10
5
0
N
Y
Active Feeding


Frequency of Mass
10
5
0
N
Y
Free Growth Period


Frequency of Mass
10
5
0
N
Y
Maximum Growth Period

# Process in Model Selection

Full linear model to predict mass

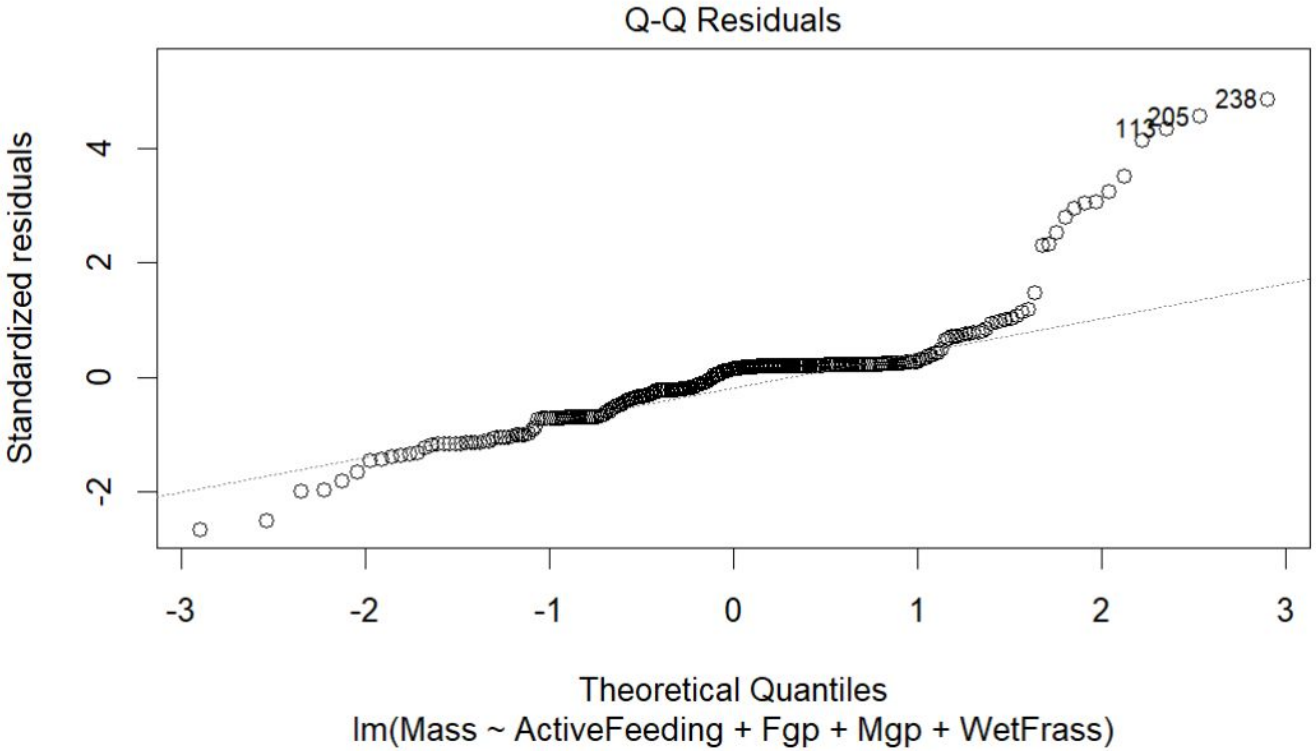
- Predictors: ActiveFeeding, Mgp, Fgp, Intake, WetFrass, DryFrass, Cassim, Nfrass, and Nassim.

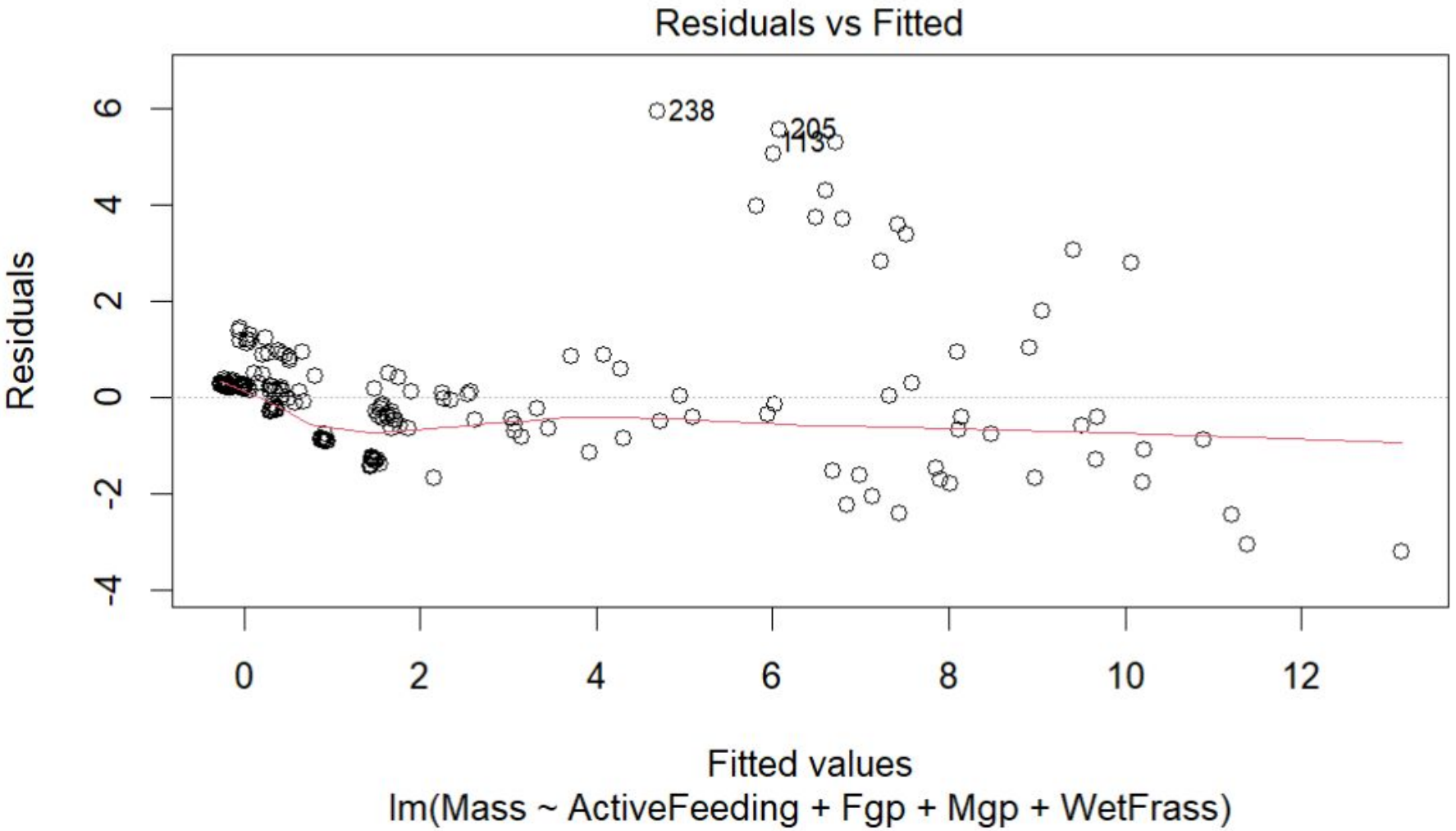
Calculated Variance Inflation Factor to remove highly correlated predictors

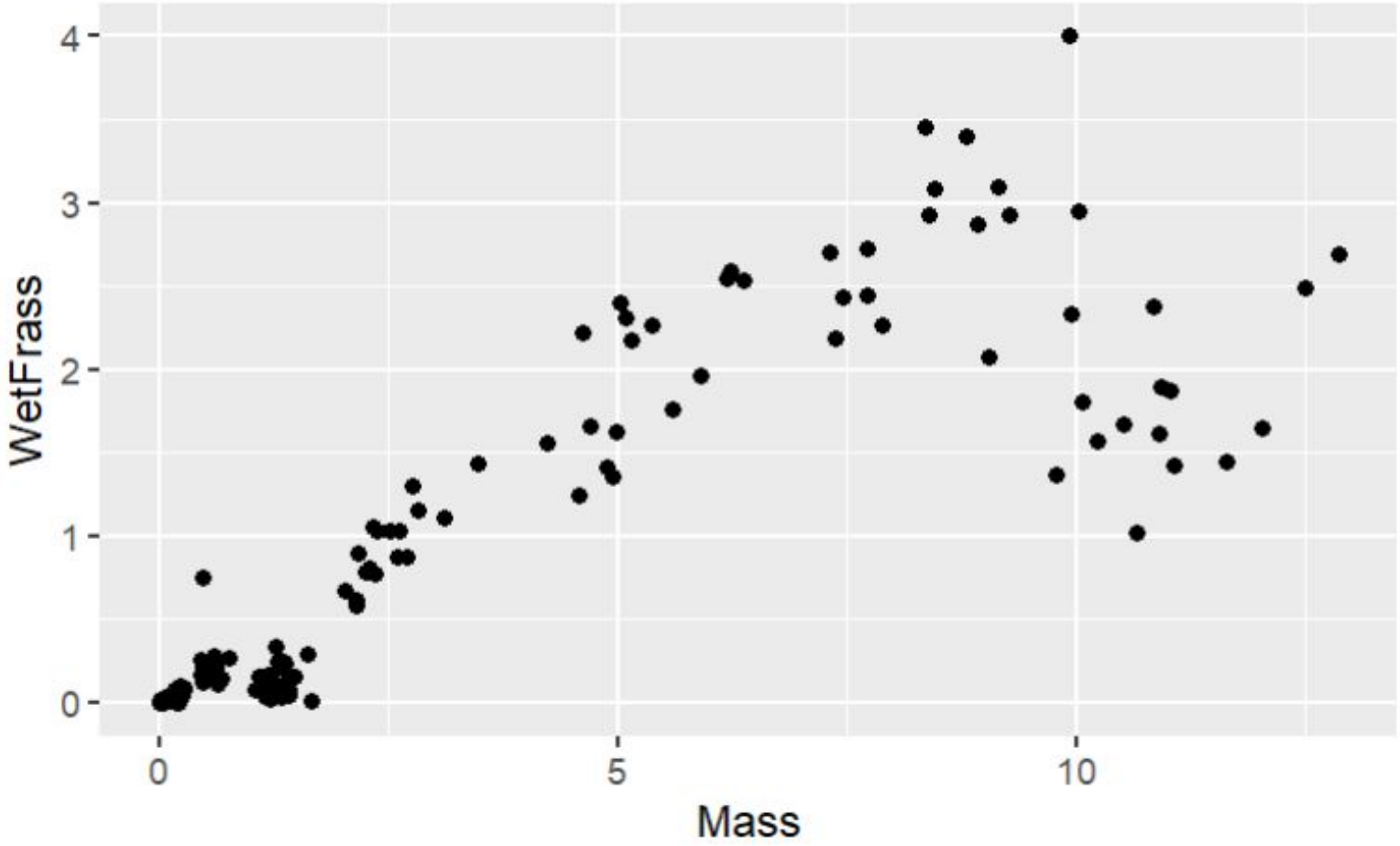
- Resulting Predictors: ActiveFeeding, Mgp, Fgp, WetFrass
  - Adjusted-$R^2$: 0.8504

| Variable | VIF |
|---|---|
| Intake | 1380.214928 |
| Dry Frass | 505.056122 |
| Cassim | 1982.637485 |
| Nfrass | 235.256090 |
| Nassim | 526.767524 |

# Motivation for Logarithmic Transformation




Residuals vs Fitted
Residuals
Fitted values
lm(Mass ~ ActiveFeeding + Fgp + Mgp + WetFrass)
238
205
113
6
4
2
0
-2
-4
0
2
4
6
8
10
12


WetFrass
4
3
2
1
0
0
5
10
Mass

# Chosen Model

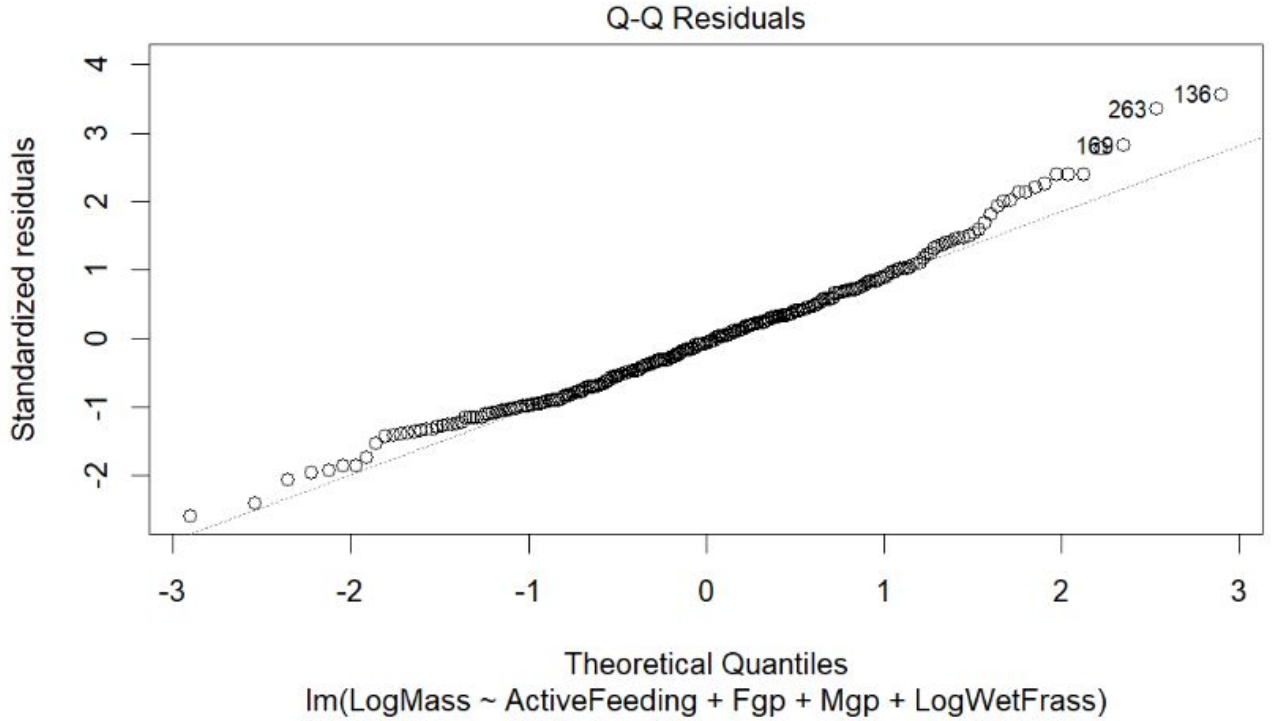
$$\widehat{Log(Mass)} = 0.95434 - 0.13572(ActiveFeeding) - 0.547(Fgp) + 0.14374(Mgp) + 0.84643(LogWetFrass)$$

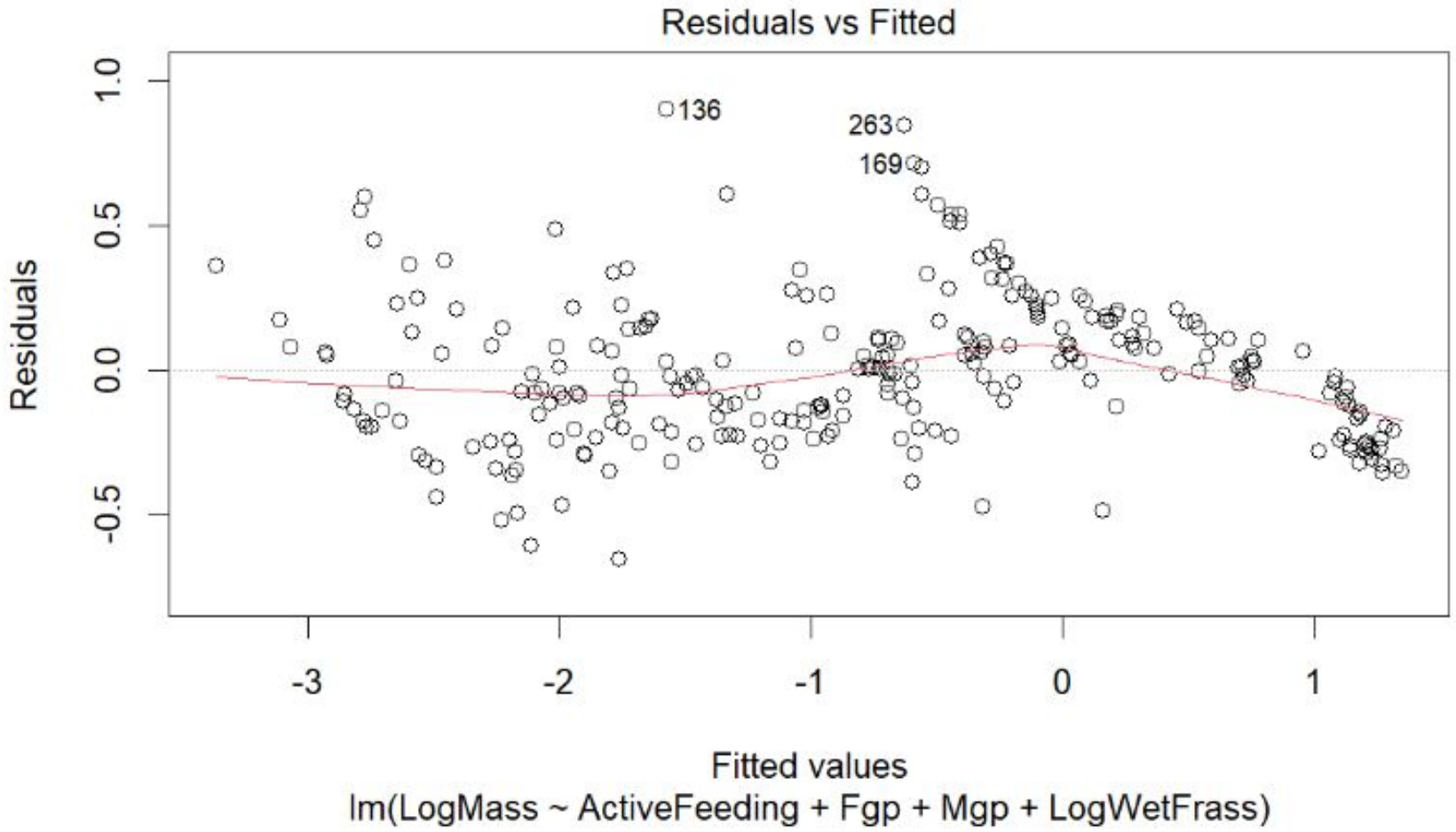
$$\widehat{Mass} = 2.596956 + 0.8730871(ActiveFeeding) + 0.5785907(Fgp) + 1.154584(Mgp) + 0.84643(WetFrass)$$

Interpreting Coefficients:

- Actively Feeding: When all other variables are held constant, the expected increase in mass for a caterpillar that is actively feeding compared to a caterpillar that is not is 0.8730871 grams
- Wet Frass: When all other variables are held constant, a one unit increase in wet frass causes the expected mass for a caterpillar to increase by 0.84643 grams

# Assessing the Model




Residuals vs Fitted
Residuals
1.0
0.5
0.0
-0.5
136
263
169
-3
-2
-1
0
1
Fitted values
lm(LogMass ~ ActiveFeeding + Fgp + Mgp + LogWetFrass)

# Assessing the Model

- Adjusted R^2: 0.9563
- P-values of predictor variables in t-test all below 0.05 level of significance
- Anova: p-values of predictor variables in F-test all below 0.05 level of significance.

t-test

| Variable | p-value |
|---|---|
| Intercept | ≈0 |
| ActiveFeeding | 0.000733 |
| Fgp | ≈0 |
| Mgp | 0.000238 |
| WetFrass | ≈0 |

F-test

| Variable | p-value |
|---|---|
| Intercept | ≈0 |
| ActiveFeeding | ≈0 |
| Fgp | ≈0 |
| Mgp | ≈0 |
| WetFrass | ≈0 |

# Assessing the Model

| Variable | Lower Confidence | Upper Confidence |
|---|---|---|
| ActiveFeeding | 0.8074069 | 0.9441047 |
| Fgp | 0.5310502 | 0.6303908 |
| Mgp | 1.0701404 | 1.2456911 |
| WetFrass | 0.82313640 | 0.86973280 |

- If the caterpillar is actively feeding, we are 95% confident that the average increase in the mass of the caterpillar will be between 0.8074069 and 0.9441047
- If the amount of wet frass increases by 1 gram, we are 95% confident that the average increase in the mass of the caterpillar will be between 0.83213640 and 0.86973280

# Predictions

95% Prediction interval with:

- Active Feeding, Free-Growth Period, Maximal Growth Period, LogWetFrass = -1.7

(0.2166868, 0.5956065)

- We expect 95% of caterpillars that are being actively fed during both a free and maximal growth period with the logarithmic Wet Frass being -1.7 to have a mass between 0.2166868 and 0.5956065 grams.

$$\widehat{log(Mass)} = 0.95434 - 0.13572 - 0.54716 + 0.14374 + 0.84643 * (-1.7) = -1.03731$$

$$\widehat{Mass} = e^{-1.023731} = 0.3592521$$

# Conclusions

Overall Model is good

- Residual plot and QQ plot was good, but could be better

Improvements:

- Data set had only 267 Manduca Sexta caterpillars

Limitations:

- Sample only contains Manduca Sexta caterpillars