Intermediate Statistics Final Report

Section 1:

Table 1 summarizes the describing statistics of each variable in the data set. It displays that each variable's mean is larger than the median, which means each variable is skewed to the right. Table 2 displays the correlations between each variable. Each pair of variables has a positive correlation, which means that, in a single organism, if there is more than one PCB present, there will be a larger overall number of PCB's in that organism. Table 3 is the regression analysis of 4 different PCBs. This table, along with a graphical representation, shows that there are outliers present in the data, which are removed for a better, less varied display of the data.

Table 4 displays the data when testing the significance of PCBs. The data, after the removal of PCB180, holds that 97% of the variance from the response variable is from explanatory variables. That data has displayed where the majority of our variance is coming from, however, has not helped us reduce the overall standard error. Table 5 displays the results of successfully reducing the standard error. Using a logarithmic function applied to each observation of each variable, and running the regression on that data greatly reduces the overall standard error (from ~6.4 to ~0.13) making it a much more reliable test.

Table 1: Statistics summary

	Count	Min	Q1	Median	Mean	Q3	Max	Std.dev.
PCB	69	6.0996	30.1830	47.9596	68.4674	91.6305	318.7461	3.019
PCB52	69	0.020	0.228	0.477	0.958	0.892	9.060	1.598
PCB118	69	0.236	1.490	2.420	3.256	3.890	18.900	3.019
PCB138	69	0.64	3.18	4.92	6.83	8.65	32.30	5.8627
PCB180	69	0.395	1.240	2.690	4.158	4.490	31.500	4.986

Table 2: Variable Correlations

Variable 1	Variable 2	Correlation
PCB	PCB52	0.5963572
	PCB118	0.843298
	PCB138	0.9288353
	PCB180	0.8008549
PCB52	PCB118	0.6849073
	PCB138	0.3008983
	PCB180	0.08692971
PCB118	PCB138	0.7293792
	PCB180	0.4374443
PCB138	PCB180	0.8823022

Table 3: Regression Analysis before removal of PCB180

	Estimate	Standard Error	t-value	P(T>|t|)
Intercept	0.9369	1.2293	0.762	0.449
PCB52	11.8727	0.7290	16.287	<2e-16
PCB118	3.7611	0.6424	5.855	1.79e-07
PCB138	3.8842	0.4978	7.803	7.19e-11
PCB180	4.1823	0.4318	9.687	3.64e-14

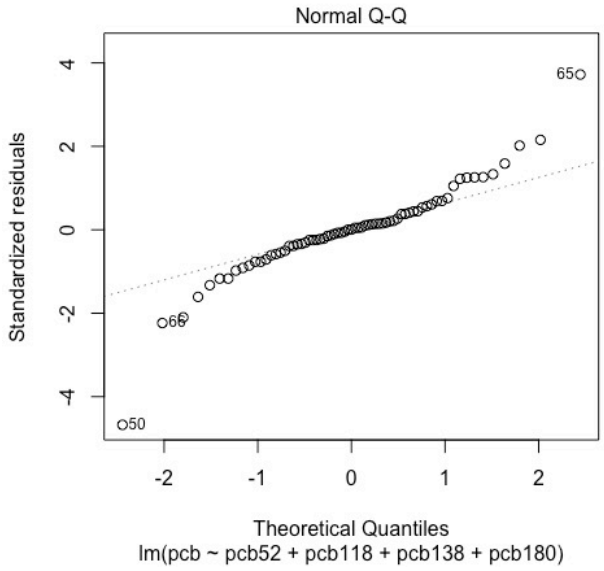


Table 4: Regression Analysis after removal of PCB180

	Estimate	Standard Error	t-value	P(T>|t|)
Intercept	-1.02	1.8895	-0.539	0.592
PCB52	12.6442	1.1291	11.198	<2e-16
PCB118	0.3131	0.8333	0.376	0.708
PCB138	8.2546	0.3279	25.177	<2e-16

Table 5: Effect of Logs

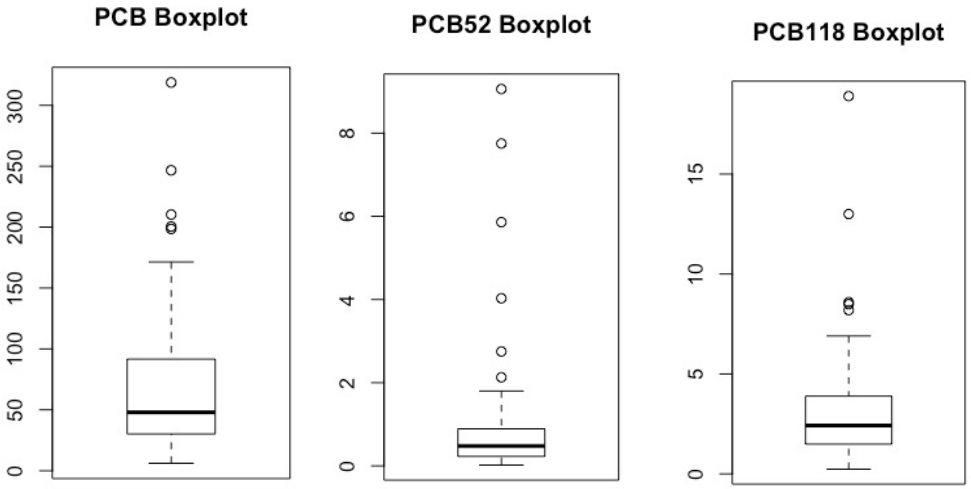
S	R-sq	R-sq (adj)	R-sq (pred)
0.134974	97.46%	97.17%	96.27%

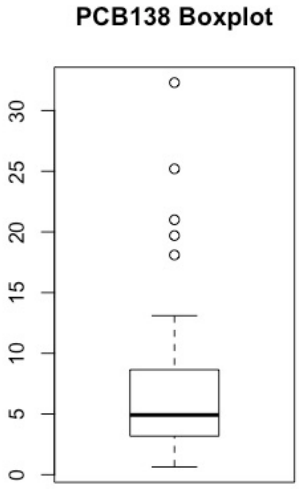
Section 2:

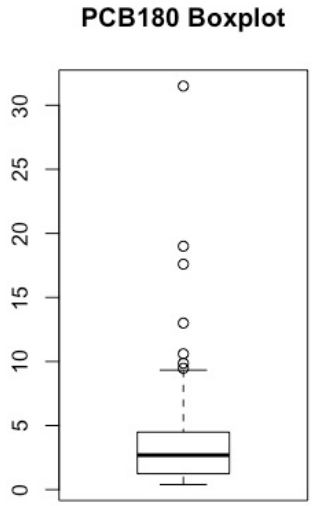
11.42: Relationships among PCB congeners.

a)

	Count	Mean	Std.dev.	Min	Q1	Median	Q3	Max
PCB	69	68.4674	3.019	6.0996	30.1830	47.9596	91.6305	318.7461
PCB52	69	0.958	1.598	0.020	0.228	0.477	0.892	9.060
PCB118	69	3.256	3.019	0.236	1.490	2.420	3.890	18.900
PCB138	69	6.83	5.8627	0.64	3.18	4.92	8.65	32.30
PCB180	69	4.158	4.986	0.395	1.240	2.690	4.490	31.500

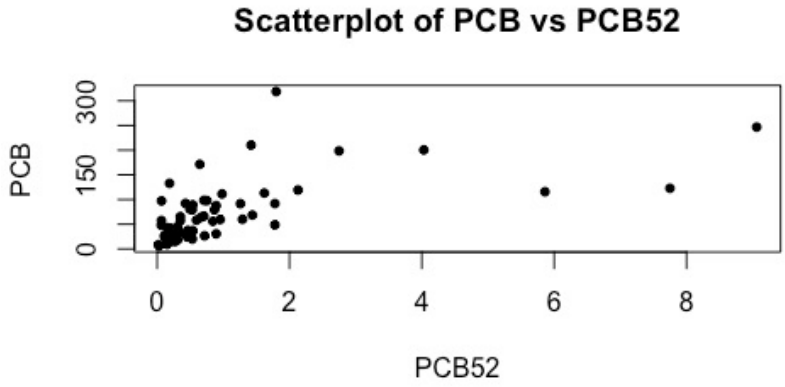


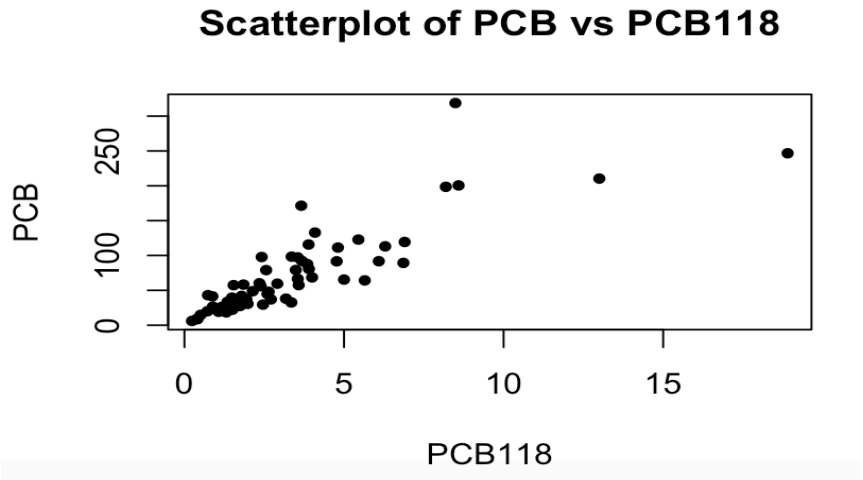


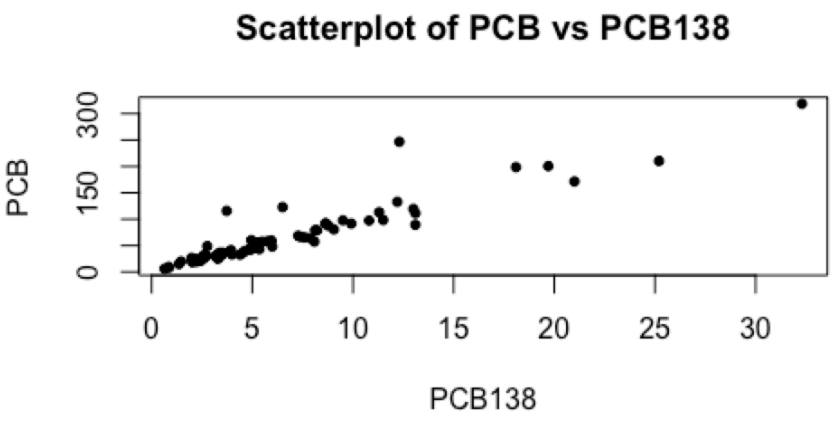


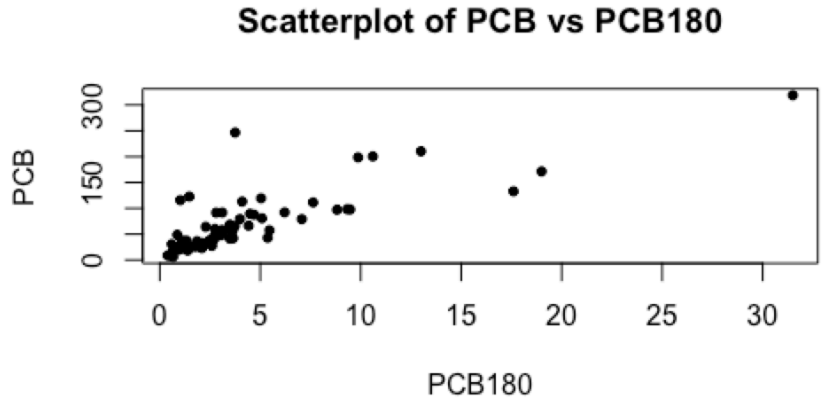
b)

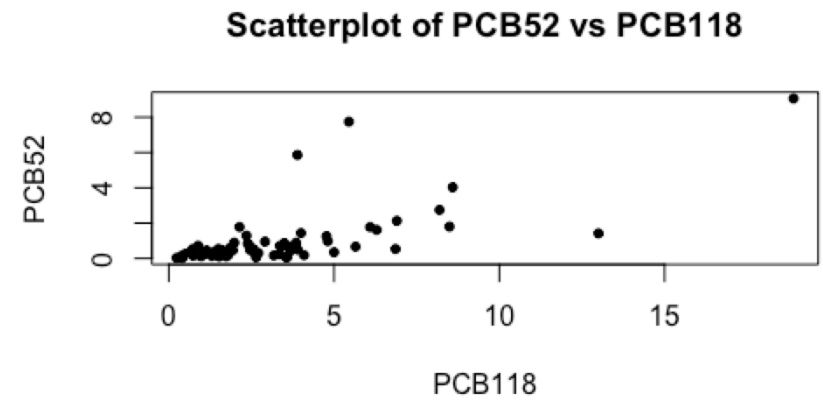
Variable 1	Variable 2	Correlation
PCB	PCB52	0.5963572
	PCB118	0.843298
	PCB138	0.9288353
	PCB180	0.8008549
PCB52	PCB118	0.6849073
	PCB138	0.3008983
	PCB180	0.08692971
PCB118	PCB138	0.7293792
	PCB180	0.4374443
PCB138	PCB180	0.8823022

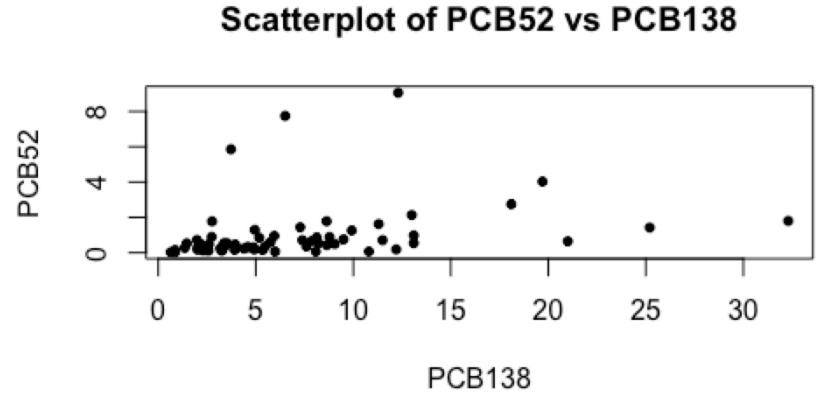


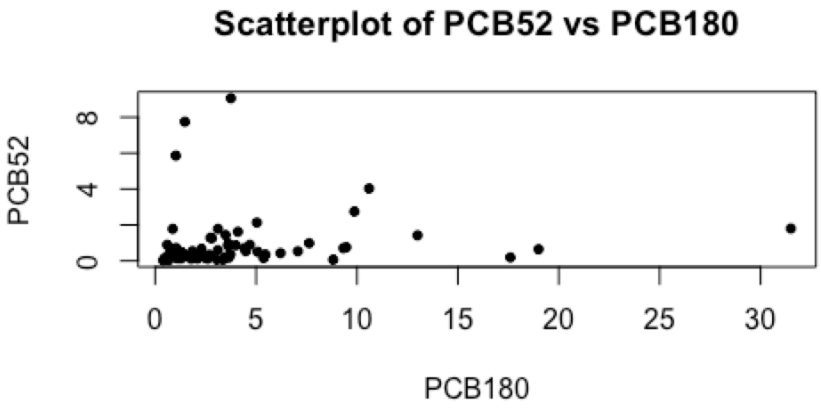


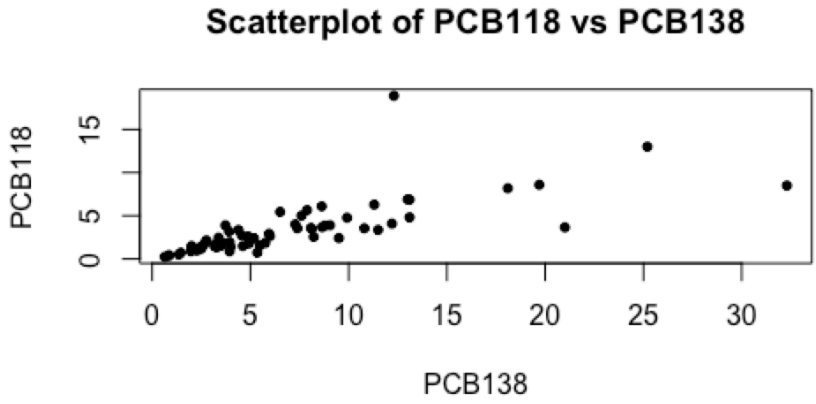

Scatterplot of PCB vs PCB138
PCB
0
150
300
0
5
10
15
20
25
30
PCB138

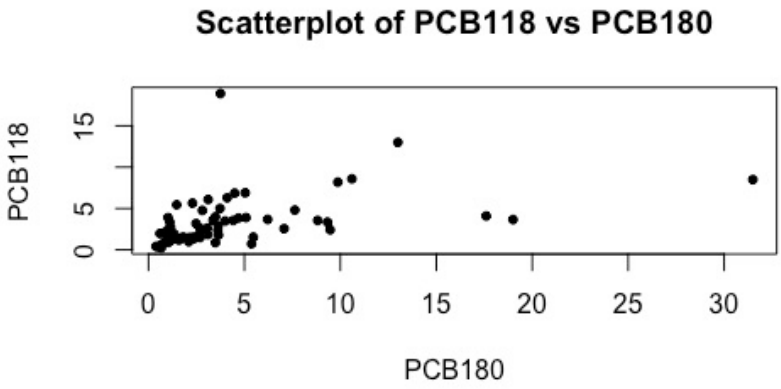

Scatterplot of PCB vs PCB180
PCB
0
150
300
0
5
10
15
20
25
30
PCB180

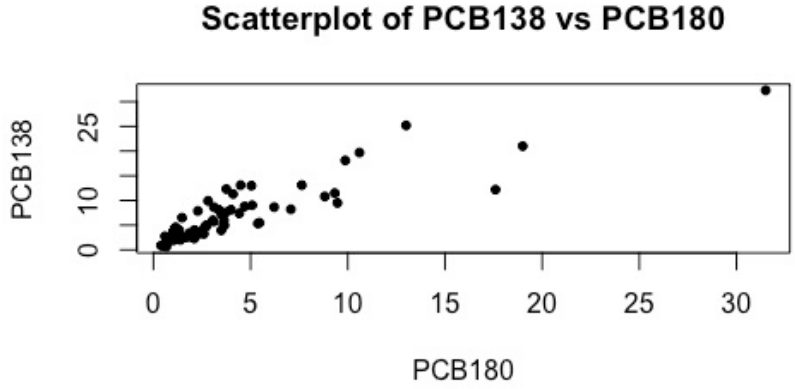

Scatterplot of PCB52 vs PCB118
PCB52
0
4
8
0
5
10
15
PCB118


Scatterplot of PCB52 vs PCB138
PCB52
0
4
8
0
5
10
15
20
25
30
PCB138


Scatterplot of PCB52 vs PCB180
PCB52
0
4
8
0
5
10
15
20
25
30
PCB180


Scatterplot of PCB118 vs PCB138
PCB118
0
5
15
0
5
10
15
20
25
30
PCB138


Scatterplot of PCB118 vs PCB180
PCB118
0
5
15
0
5
10
15
20
25
30
PCB180


Scatterplot of PCB138 vs PCB180
PCB138
0
10
25
0
5
10
15
20
25
30
PCB180

11.43: Predicting the total amount of PCB.

a) Statistical Model:

p = 4, n = 69

Explanatory variables: x_1, x_2, x_3, x_4

$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \beta_3 x_{i3} + \beta_4 x_{i4} + \varepsilon_i \qquad i = 1, 2, \ldots, 69$

Assumptions:

The deviations ε_i about the mean are independent and normally distributed $N(0, \sigma)$.

The standard deviation does not depend on the values of the explanatory variables.

Parameters: $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4$

b) Regression:

Response variable: PCB

Explanatory variables: PCB52, PCB118, PCB138, PCB180

$$\widehat{pcb} = \beta_0 + \beta_1 PCB52 + \beta_2 PCB118 + \beta_3 PCB138 + \beta_4 PCB180$$

Residuals:

Min	Q1	Median	Q3	Max
-22.0864	-2.4554	0.0278	2.7726	22.5487

Coefficients:

	Estimate	Standard Error	t-value	P(T>|t|)
Intercept	0.9369	1.2293	0.762	0.449
PCB52	11.8727	0.7290	16.287	<2e-16
PCB118	3.7611	0.6424	5.855	1.79e-07
PCB138	3.8842	0.4978	7.803	7.19e-11
PCB180	4.1823	0.4318	9.687	3.64e-14

Residual standard error: 6.382 on 64 degrees of freedom

Multiple R-squared: 0.9891, Adjusted R-squared: 0.9885

F-statistic: 1456 on 4 and 64 DF, p-value: < 2.2e-16

Multiple Regression equation:

$$\widehat{pcb} = 0.94 + 11.87 * PCB52 + 3.76 * PCB118 + 3.88 * PCB138 + 4.18 * PCB180$$

Interpretation:

Intercept term: 0.94 (fixed amount of PCB when all four congeners are 0)

PCB52: total amount of PCB is expected to increase by 11.87 percent when PCB52 is increased by 1.

PCB118: total amount of PCB is expected to increase by 3.76 percent when PCB118 is increased by 1.

PCB138: total amount of PCB is expected to increase by 3.88 percent when PCB138 is increased by 1.

PCB180: total amount of PCB is expected to increase by 4.18 percent when PCB180 is increased by 1.

Test: $\alpha = 0.05$

Null Hypothesis: H_0: $\beta_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$

Alternate Hypothesis: H_a: at least one β_i does not equal 0.

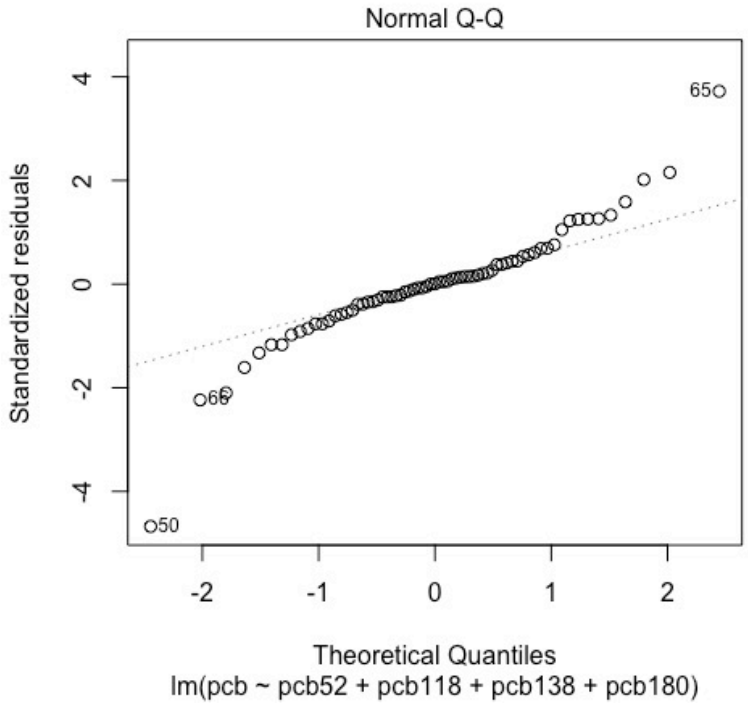
ANOVA:

Response: pcb

	df	Sum of Squares	Mean of Squares	F-value	P(F>f)
PCB52	1	85302	85302	2094.273	< 2.2e-16
PCB118	1	85429	85429	2097.405	< 2.2e-16
PCB138	1	62693	62693	1539.202	< 2.2e-16
PCB180	1	3822	3822	93.834	3.64e-14
Residual	64	2607	41		

Since the P-value is less than the level of significance, null hypothesis is rejected. All of the regression coefficients are significantly different from 0, except for the constant. $R^2 = 0.989$ which means 98.9% of the total PCB can be explained by the explanatory variables it the regression equation. The rest is unknown. The residual standard error is 6.382

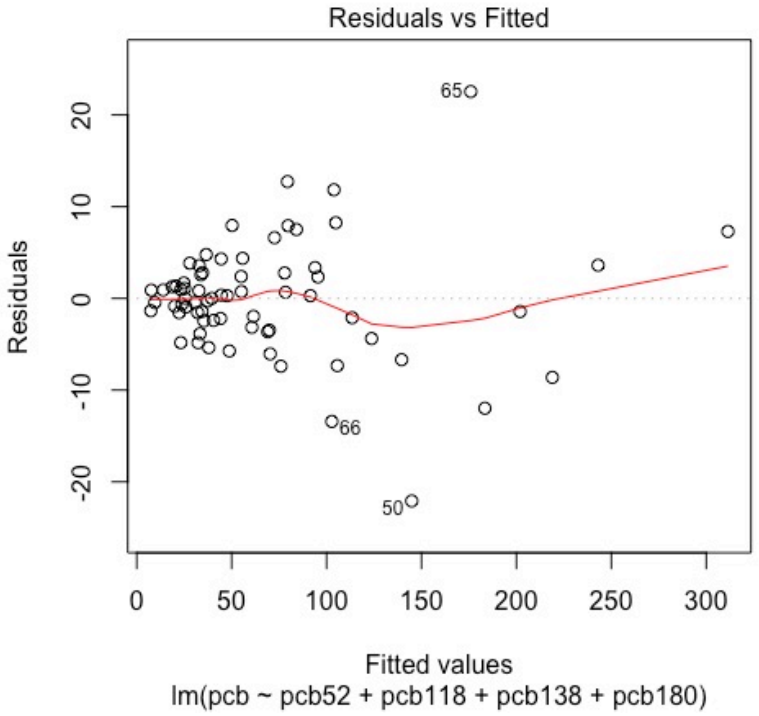
c) Results:



The residuals look normal, with 2 outliers. There are no specific patterns when the residuals are plotted against each explanatory variable; PCB52,PCB118, PCB138, PCB180.

11.44: Adjusting the analysis for potential outliers.

a)



There are no patterns here, but there are 2 outliers. The low residual at line 50, and the high residual at line 65. The overestimate would be the one at line 65.

b) The new multiple linear regression equation is:

$$\widehat{pcb} = 1.63 + 14.4 * PCB52 + 2.60 * PCB118 + 4.05 * PCB138 + 4.11 * PCB180$$

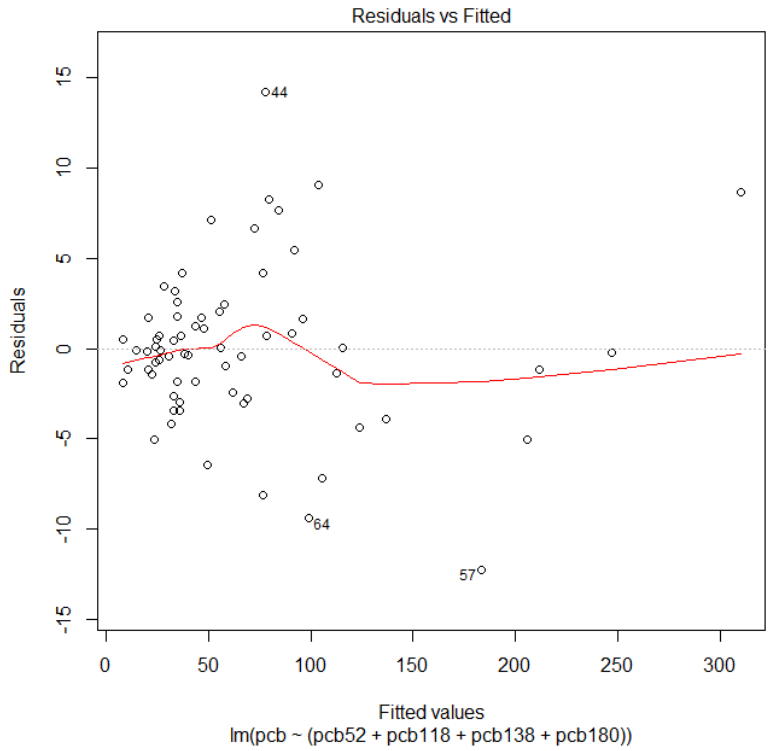
Residuals:

Min	Q1	Median	Q3	Max
-12.2421	-2.1762	-0.1378	1.7036	14.2051

Coefficients:

	Estimate	Standard error	t-value	P(T>|t|)
Intercept	1.6277	0.8858	1.838	0.0709
PCB52	14.4420	0.6960	20.751	< 2e-16
PCB118	2.5996	0.5164	5.034	4.40e-06
PCB138	4.0541	0.3752	10.805	6.89e-16
PCB180	4.1086	0.3175	12.942	< 2e-16

Residual standard error: 4.555 on 62 degrees of freedom
Multiple R-squared: 0.9941, Adjusted R-squared: 0.9938
F-statistic: 2629 on 4 and 62 DF, p-value: < 2.2e-16



When the outliers are removed, the residual standard error is reduced from 6.382 to 4.555. Within the table, the errors for the explanatory variables have also decreased.

11.45: More on predicting the total amount of PCB.

a) The multiple linear regression equation for:

Response Variable: PCB

Explanatory Variables: PCB52, PCB118, PCB138

$\widehat{pcb} = -1.02 + 12.6 * PCB52 + 0.313 * PCB118 + 8.25 * PCB138$

Residuals:

Min	Q1	Median	Q3	Max
-29.6219	-3.3502	0.8791	3.3785	29.5217

Coefficients:

	Estimate	Standard Error	t-value	P(T>|t|)
Intercept	-1.02	1.8895	-0.539	0.592
PCB52	12.6442	1.1291	11.198	<2e-16
PCB118	0.3131	0.8333	0.376	0.708
PCB138	8.2546	0.3279	25.177	<2e-16

Residual standard error: 9.945 on 65 degrees of freedom

Multiple R-squared: 0.9732, Adjusted R-squared: 0.972

F-statistic: 786.7 on 3 and 65 DF, p-value: < 2.2e-16

Interpretation:

Intercept term: -1.02 (fixed amount of PCB when all four congeners are 0)

PCB52: total amount of PCB is expected to increase by 12.64 percent when PCB52 is increased by 1.

PCB118: total amount of PCB is expected to increase by 0.31 percent when PCB118 is increased by 1.

PCB138: total amount of PCB is expected to increase by 8.25 percent when PCB138 is increased by 1.

b) Significance level: $\alpha = 0.05$

Coefficient for PCB118 = 0.313

p-val for PCB118 = 0.708

Significance Test: reject if $p>\alpha$

P = 0.708 > α. Therefore, reject.

c) In 11.43:

Coefficient for PCB118 = 3.761

p-val for PCB118 = 1.79e-07

Significance test: reject if $p>\alpha$

P = 1.79e-07 < α.

d) Excluding a variable in a multiple regression analysis can drastically change the results. The p-value of PCB118 in part A is much larger than the original analysis, and therefore is not significant, while the original analysis has a much smaller p-value, making it more significant.

11.46: Multiple regression model for total TEQ:

a) $\widehat{teq} = \beta_0 + \beta_1 * TEQPCB + \beta_2 * TEQDIOXIN + \beta_3 * TEQFURAN$

$\beta_0 = 0$, $\beta_1 = \beta_2 = \beta_3 = 1$

b) σ = 7.95e-06

c) Residuals:

Min	Q1	Median	Q3	Max
-5.638e-06	-2.844e-06	-1.680e-06	-1.130e-06	3.714e-05

Coefficients:

	Estimate	Standard Error	t-value	P(T>|t|)
Intercept	3.426e-07	1.917e-06	1.790e-01	0.859
TEQPCB	1	8.239e-07	1.214e+06	<2e-16
TEQDIOXIN	1	1.761e-06	5.677e+05	<2e-16
TEQFURAN	1	5.664e-06	1.766e+05	<2e-16

Residual standard error: 7.95e-06 on 65 degrees of freedom

Multiple R-squared: 1, Adjusted R-squared: 1

F-statistic: 9.581e+11 on 3 and 65 DF, p-value: < 2.2e-16

Interpretation:

Intercept term: 0 (fixed amount of TEQ when all four congeners are 0)

TEQPCB: total amount of TEQ is expected to increase by 1 percent when TEQPCB is increased by 1.

TEQDIOXIN: total amount of TEQ is expected to increase by 1 percent when TEQDIIOXIN is increased by 1.

TEQFURAN: total amount of TEQ is expected to increase by 1 percent when TEQFURAN is increased by 1.

Test: $\alpha = 0.05$

Null Hypothesis: H_0: $\beta_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$

Alternate Hypothesis: H_a: at least one β_j does not equal 0.

ANOVA:

Response: teq

	df	Sum of Squares	Mean of Squares	F-value	P(F>f)
TEQPCB	1	152.801	152.801	2.4174e+12	< 2.2e-16
TEQDIOXIN	1	26.903	26.903	4.2562e+11	< 2.2e-16
TEQFURAN	1	1.970	1.970	3.1174e+10	< 2.2e-16
Residual	65	0	0		

Since the P-value is less than the level of significance, null hypothesis is rejected.
All of the regression coefficients are significantly different from 0, except for the constant.
$R^2 = 1$ which means 100% of the total TEQ can be explained by the explanatory variables in the regression equation. The residual standard error is 7.95e-06.

11.47: Multiple regression model for total TEQ continued.

a) Residuals:

Min	Q1	Median	Q3	Max
-1.6655	-0.6000	-0.1814	0.5162	2.7025

Coefficients:

	Estimate	Standard error	t-value	P(T>|t|)
Intercept	1.059965	0.184450	5.747	2.73e-07
PCB52	-0.097277	0. 109383	-0.889	0.37716
PCB118	0.306184	0.096388	3.177	0.00229
PCB138	0.105786	0.074697	1.416	0.16156
PCB180	-0.003905	0.064784	-0.060	0.95212

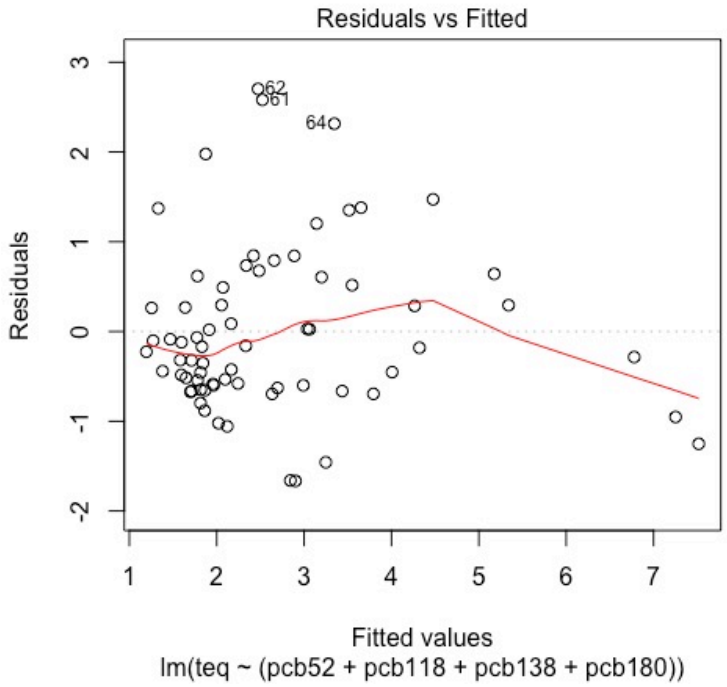
Residual standard error: 0.9576 on 64 degrees of freedom
Multiple R-squared: 0.6769, Adjusted R-squared: 0.6568
F-statistic: 33.53 on 4 and 64 DF, p-value: 4.489e-15
Interpretation:
Intercept term: 1.06 (fixed amount of PCB when all four congeners are 0)
PCB52: total amount of PCB is expected to decrease by 0.01 percent when PCB52 is increased by 1.
PCB118: total amount of PCB is expected to increase by 0.31 percent when PCB118 is increased by 1.
PCB138: total amount of PCB is expected to increase by 0.106 percent when PCB138 is increased by 1.
PCB180: total amount of PCB is expected to decrease by 0.004 percent when PCB180 is increased by 1.

ANOVA:

Response: teq

	df	Sum of Squares	Mean of Squares	F-value	P(F>f)
PCB52	1	29.85	29.85	32.553	3.21e-07
PCB118	1	83.61	83.61	91.174	6.30e-14
PCB138	1	9.52	9.52	10.378	0.00201
PCB180	1	0	0	0.004	0.95212
Residual	64	58.69	0.92		

R^2 = .6769, which means that 67.69% of TEQ is explained by the explanatory variables. The rest is unknown. The residual standard error is 0.9576.



The residuals are skewed to the right. When plotted against the explanatory variables, there are no clear patterns visible.

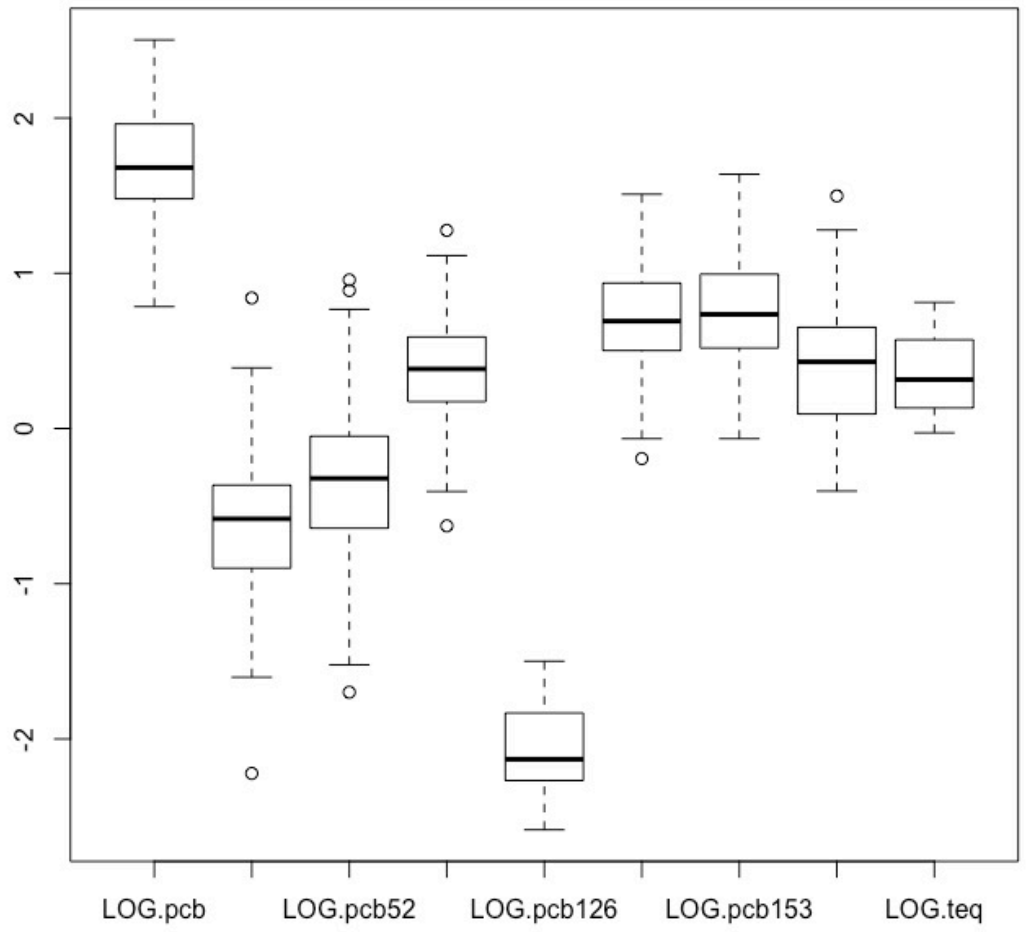
11.48: Predicting total amount of PCB using transformed variables.

a) If you do not do anything about the 16 zero values of PCB126, the software will change it to "#NUM!"

b) If you attempt to run a regression to predict the log of PCB using the log of PCB126 and PCB52 without accounting for the zero values, the software will not run the regression on "#NUM!" because it is not a numerical value. The software will throw an error rather than ignore them. It is not a good way of handling the situation, it is inconvenient to refuse those values when there is a large amount of 0 values.

c) Numerical and graphical representation of the data.

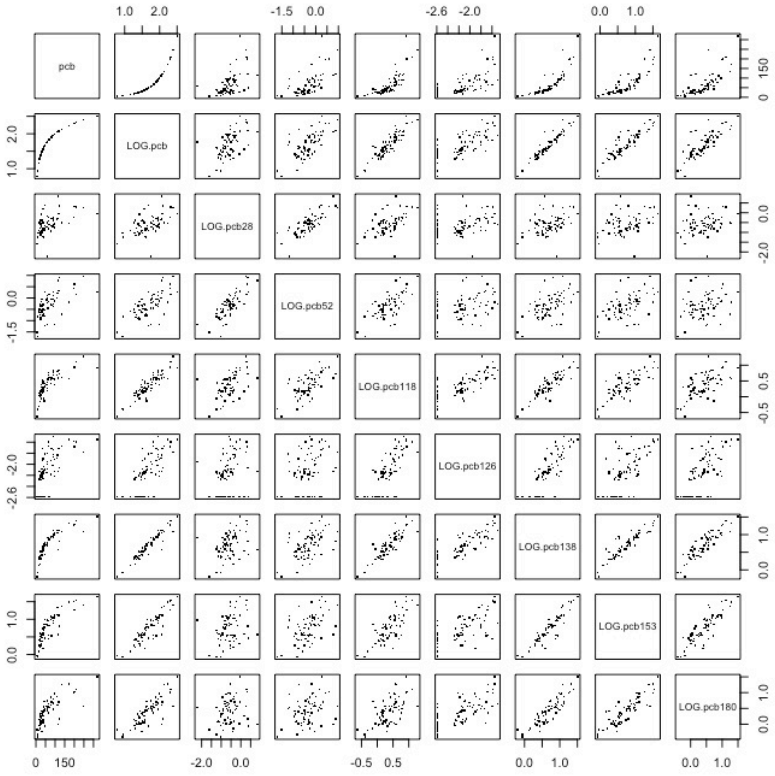
	Min	Q1	Median	Mean	Q3	Max
LOG.pcb	0.7853	1.4798	1.6809	1.7011	1.9620	2.5034
LOG.pcb28	-2.2218	-0.8996	-0.5817	-0.5793	-0.3645	0.8407
LOG.pcb52	-1.69897	-0.64207	-0.32148	-0.33537	-0.04964	0.95713
LOG.pcb118	-0.6271	0.1732	0.3838	0.3717	0.5899	1.2765
LOG.pcb126	-2.585	-2.268	-2.131	-2.104	-1.833	-1.499
LOG.pcb138	-0.1938	0.5024	0.6920	0.7009	0.9370	1.5092
LOG.pcb153	-0.0655	0.5185	0.7356	0.7397	0.9943	1.6385
LOG.pcb180	-0.40340	0.09342	0.42975	0.42354	0.65225	1.49831
LOG.teq	-0.02761	0.13274	0.31534	0.34950	0.57174	0.81245



11.49: Predicting total amount of PCB using transformed variables, continued.
a) Each pair of values has a positive correlation. The only variable that has any outliers is LOG.pcb28, however, each scatterplot related to the transformed variables is linearly correlated.

	pcb	LOG.pcb	LOG.pcb28	LOG.pcb52	LOG.pcb118
pcb	1.0000000	0.8861681	0.5406772	0.6314956	0.7857074
LOG.pcb	0.8861681	1.0000000	0.5699256	0.7005905	0.9064775
LOG.pcb28	0.5406772	0.5699256	1.0000000	0.7950316	0.5336685
LOG.pcb52	0.6314956	0.7005905	0.7950316	1.0000000	0.6709082
LOG.pcb118	0.7857074	0.9064775	0.5336685	0.6709082	1.0000000
LOG.pcb126	0.6518593	0.7292267	0.2721924	0.3308594	0.7394002
LOG.pcb138	0.8278464	0.9560549	0.3876895	0.5404601	0.8897442
LOG.pcb153	0.8286488	0.9049176	0.3260234	0.5192283	0.7798756
LOG.pcb180	0.7447056	0.8288974	0.2272701	0.3015365	0.6538711

	LOG.pcb126	LOG.pcb138	LOG.pcb153	LOG.pcb180
pcb	0.6518593	0.8278464	0.8286488	0.7447056
LOG.pcb	0.7292267	0.9560549	0.9049176	0.8288974
LOG.pcb28	0.2721924	0.3876895	0.3260234	0.2272701
LOG.pcb52	0.3308594	0.5404601	0.5192283	0.3015365
LOG.pcb118	0.7394002	0.8897442	0.7798756	0.6538711
LOG.pcb126	1.0000000	0.7923915	0.6465768	0.6954466
LOG.pcb138	0.7923915	1.0000000	0.9219441	0.8963662
LOG.pcb153	0.6465768	0.9219441	1.0000000	0.8668080
LOG.pcb180	0.6954466	0.8963662	0.8668080	1.0000000



Compared to the correlations from 11.42, each pair in each question has a positive correlation. However, the correlations are, in some cases, much higher than the original corrlations.

11.50: Even more on predicting the total amount of PCB using transformed variables.

a) Regression Equation:

$$\widehat{teq} = 1.52 - 0.043 * LN.PCB + 0.030 * LN.PCB52 + 1.21 * LN.PCB118 + 0.700 * LN.PCB138 - 0.716 * LN.PCB153 + 0.410 * LN.PCB180$$

Residuals:

Min	Q1	Median	Q3	Max
-2.3366	-0.7636	-0.1818	0.5010	2.2728

Coefficients:

	Estimate	Standard Error	t-value	P(T>|t|)
Intercept	1.51847	2.87722	0.528	0.5996
LN.pcb	-0.04296	0.92888	-0.046	0.9633
LN.pcb52	0.03077	0.22590	0.136	0.8921

LN.pcb118	1.20625	0.54254	2.223	0.0298
LN.pcb138	0.70015	0.98289	0.712	0.4789
LN.pcb153	-0.71591	0.40666	-1.760	0.0833
LN.pcb180	0.41045	0.50083	0.820	0.4156

Residual standard error: 1.069 on 62 degrees of freedom
Multiple R-squared: 0.6103, Adjusted R-squared: 0.5726
F-statistic: 16.18 on 6 and 62 DF, p-value: 4.207e-11
Interpretation:
Intercept term: 1.52 (fixed amount of PCB when all other congeners are 0)

LN.PCB: total amount of PCB is expected to decrease by 0.043 percent when PCB52 is increased by 1.

LN.PCB52: total amount of PCB is expected to increase by 0.030 percent when PCB52 is increased by 1.

LN.PCB118: total amount of PCB is expected to increase by 1.21 percent when PCB118 is increased by 1.

LN.PCB138: total amount of PCB is expected to increase by 0.700 percent when PCB138 is increased by 1.

LN.PCB153: total amount of PCB is expected to decrease by 0.716 percent when PCB153 is increased by 1.

LN.PCB180: total amount of PCB is expected to increase by 0.410 percent when PCB180 is increased by 1.

ANOVA:
Response: teq

	df	Sum of Squares	Mean of Squares	F-value	P(F>f)
LN.pcb	1	92.444	92.444	80.9532	7.508e-13
LN.pcb52	1	0.344	0.344	0.3008	0.585345
LN.pcb118	1	13.205	13.205	11.5640	0.001181
LN.pcb138	1	0.757	0.757	0.6625	0.418782
LN.pcb153	1	3.358	3.358	2.9403	0.091391
LN.pcb180	1	0.767	0.767	0.6717	0.415613
Residuals	62	70.800	1.142		

R^2 = .6103, which means that 61.03% of TEQ is explained by the explanatory variables. The rest is unknown. The residual standard error is 1.069.

11.51: Predicting total TEQ using transformed variables.

a) Regression Equation:

$$\widehat{lnteq} = 1.72 + 0.62 * LOG.pcb126 + 0.108 * LOG.pcb28$$

Residuals:

Min	Q1	Median	Q3	Max
-0.23924	-0.07739	0.01298	0.06054	0.41781

Coefficients:

	Estimate	Standard Error	t-value	P(T>|t|)
Intercept	1.72132	0.09879	17.424	< 2e-16
LOG.pcb126	0.62222	0.04801	12.960	< 2e-16

LOG.pcb28	0.10770	0.03246	3.318	0.00148

Residual standard error: 0.1267 on 66 degrees of freedom
Multiple R-squared: 0.7681, Adjusted R-squared: 0.7611
F-statistic: 109.3 on 2 and 66 DF, p-value: < 2.2e-16
Interpretation:
Intercept term: 1.72 (fixed amount of PCB when all other congeners are 0)
LN.PCB28: total amount of PCB is expected to increase by 0.622 percent when PCB52 is increased by 1.
LN.PCB126: total amount of PCB is expected to increase by 0.108 percent when PCB180 is increased by 1.

ANOVA:
Response: LOG.teq

	df	Sum of Squares	Mean of Squares	F-value	P(F>f)
LOG.pcb126	1	3.330	3.330	207.58	< 2e-16
LOG.pcb28	1	0.177	0.177	11.01	0.00148
Residuals	66	1.059	0.016		

R^2 = .7681, which means that 76.81% of TEQ is explained by the variables PCB126 and PCB28. The rest is unknown. The residual standard error is 0.1267.

11.52: Interpretation of coefficients in log PCB regressions.

a) Regression Equation:

$$\widehat{logpcb} = 1.61 + 0.045 * LOG.pcb28 + 0.0.042 * LOG.pcb52 + 0.192 * LOG.pcb118 + 0.563 * LOG.pcb126 - 0.089 * LOG.pcb138 - 0.090 * LOG.pcb153 + 0.063 * LOG.pcb180$$

Residuals:

Min	Q1	Median	Q3	Max
-0.23310	-0.07925	0.00317	0.06473	0.43508

Coefficients:

	Estimate	Standard error	t-value	P(T>|t|)
Intercept	1.60616	0.23982	6.697	7.65e-09
LOG.pcb28	0.04508	0.05626	0.801	0.426
LOG.pcb52	0.04209	0.06483	0.649	0.519
LOG.pcb118	0.19173	0.14548	1.318	0.192
LOG.pcb126	0.56299	0.08430	6.678	8.25e-09
LOG.pcb138	-0.08939	0.27753	-0.322	0.748
LOG.pcb153	-0.09030	0.11660	-0.774	0.442
LOG.pcb180	0.06266	0.13489	0.465	0.644

Residual standard error: 0.1277 on 61 degrees of freedom
Multiple R-squared: 0.7822, Adjusted R-squared: 0.7572
F-statistic: 31.29 on 7 and 61 DF, p-value: < 2.2e-16
Interpretation:
Intercept term: 1.61 (fixed amount of PCB when all other congeners are 0)
LN.PCB28: total amount of PCB is expected to decrease by 0.045 percent when PCB52 is increased by 1.

LN.PCB52: total amount of PCB is expected to increase by 0.042 percent when PCB52 is increased by 1.

LN.PCB118: total amount of PCB is expected to increase by 0.192 percent when PCB118 is increased by 1.

LN.PCB126: total amount of PCB is expected to increase by 0.563 percent when PCB138 is increased by 1.

LN.PCB138: total amount of PCB is expected to decrease by 0.089 percent when PCB153 is increased by 1.

LN.PCB180: total amount of PCB is expected to decrease by 0.090 percent when PCB180 is increased by 1.

LN.PCB180: total amount of PCB is expected to increase by 0.063 percent when PCB180 is increased by 1.

Test:

Null Hypothesis: $H_0 : \beta_j = 0$ where j = 1, 2, 3, 4, 5, 6

Alternate Hypothesis: $H_a : \beta_j \neq 0$

All of the regression coefficients are significantly different from 0, except for the constant, so we reject H_0.

ANOVA:

Response: LOG.teq

	df	Sum of Squares	Mean of Squares	F-value	P(F>f)
LOG.pcb28	1	0.81201	0.81201	49.8069	1.846e-09
LOG.pcb52	1	0.20151	0.20151	12.3601	0.0008338
LOG.pcb118	1	1.61853	1.61853	99.2774	2.048e-14
LOG.pcb126	1	0.91372	0.91372	56.0458	3.372e-10
LOG.pcb138	1	0.01388	0.01388	0.8514	0.3597981
LOG.pcb153	1	0.00776	0.00776	0.4757	0.4929960
LOG.pcb180	1	0.00352	0.00352	0.2158	0.6439272
Residuals	61	0.99449	0.01630		

R^2 = .7822, which means that 78.22% of TEQ is explained by the explanatory variables. The rest is unknown. The residual standard error is 0.1277.

Our original calculations stated that the standard error was 6.382. This means that taking the logarithm of PCB when all log congener PCB variables are considered because it led to an extreme reduction in error.