Chapter 4

Statistical Models

In this chapter we focused on a statistical model of blue swimming catch with month, year and gear. The model was performed to investigate seasonal pattern and trend of the blue swimming crab catch weight. Multiple linear regressions model was fitted to the natural logarithmic transformation of the catch weight. The models stratified by gear were also performed.

4.1 Model of catch weight with environmental factors

To avoid multicolinearity in the regression model of catch weigh we used morning air temperature, water level and rainfall as determinants. Table 4.1 shows linear regression model fitted to logarithm of the catch weight. The r-squared for the model was 34.6%. The model shows that morning air temperature and water level are statistically significant with p-values less than 0.001. The rainfall was statistically significant with p-value 0.014.

Determinants	Coeffient	Std. Error	t-value	p-value
Constant	-11.696	5.844	-2.001	0.047
Morning air temperature	0.870	0.229	3.808	<0.001
Water level	-4.538	0.604	-7.513	<0.001
Rainfall	0.002	0.001	2.500	0.014

Table 4.1: Linear regression model for logarithms of monthly catches and morning air temperature, water level and rain fall

Figure 4.1 shows a scatter plot of the observed catch of blue swimming crab with the natural logarithmic transformed values plotted against fitted values (left panel) and residuals plot (right panel). The normality assumption for the errors was plausible because the point in this plot follow the line corresponding to normality with no extreme outliers.

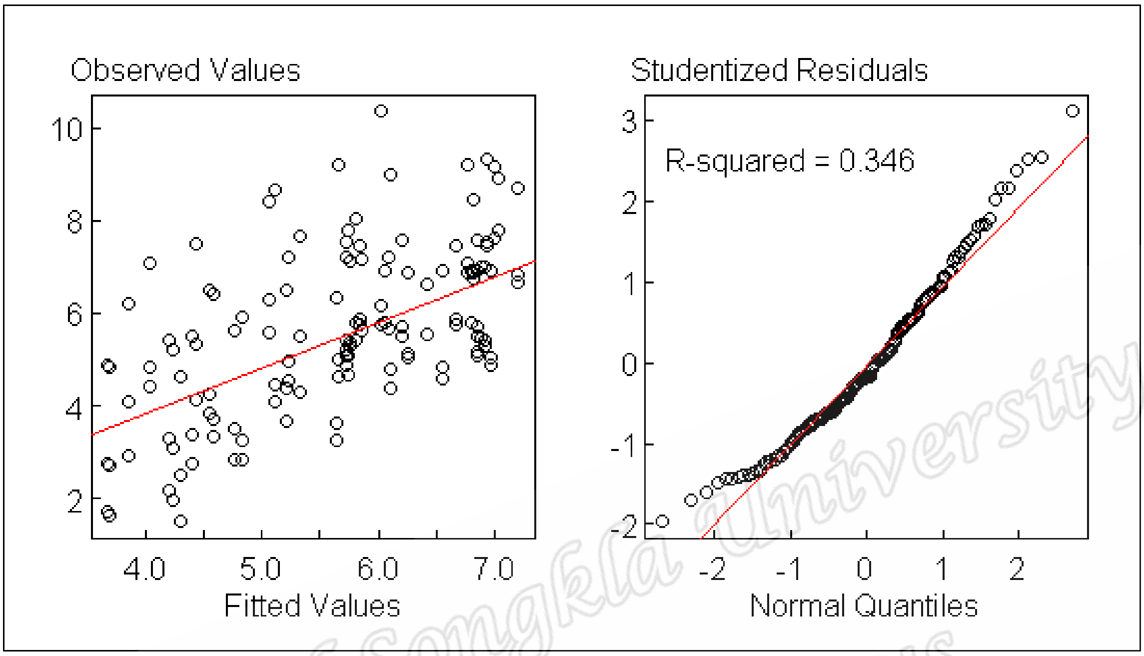

Figure 4.1: Plot of observed values and fitted values and residuals plot from model of catch weight with morning air temperature, water level and rainfall

Next we estimated the fitted values for the catch weights and catch weight separated by gears using the model. The time series plot of these values and actual catch are shown in Figures 4.2 to 4.5. The dotted line superimposed in the graph was the mean of the catch weight is 292.83 kilogram. The graphs show that the estimated catch weights do not fit well with the actual catch weights.

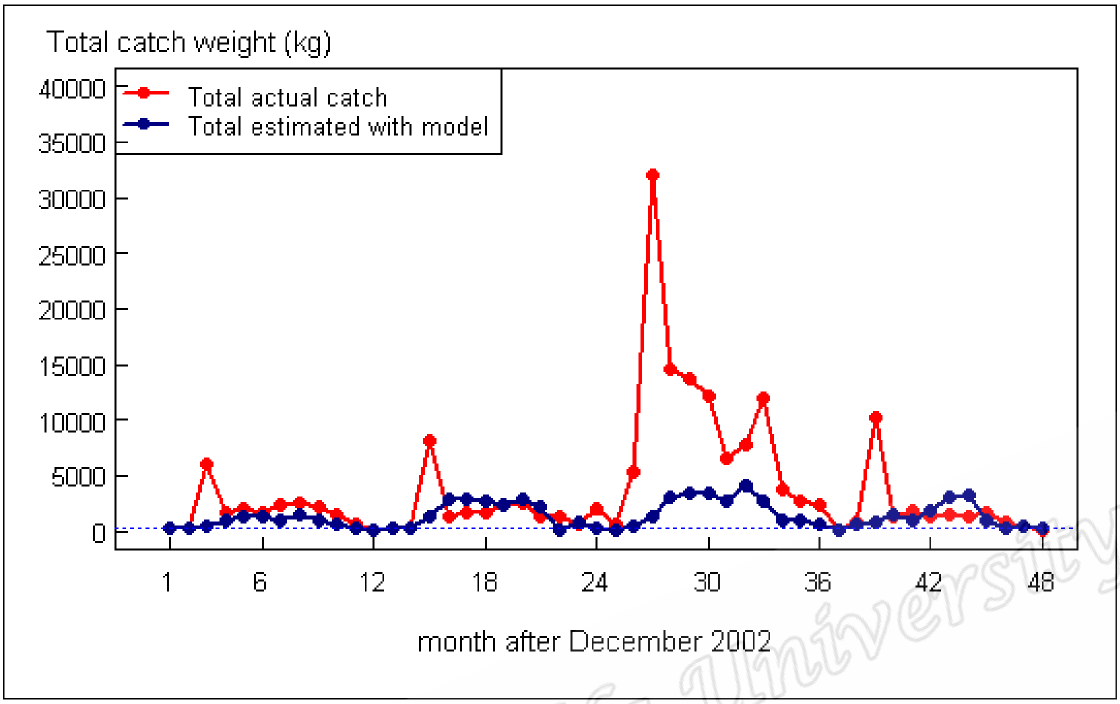

Figure 4.2: Total actual and estimated catch weight based on model of logarithm of catch weight with morning air temperature, water level and rainfall as determinants

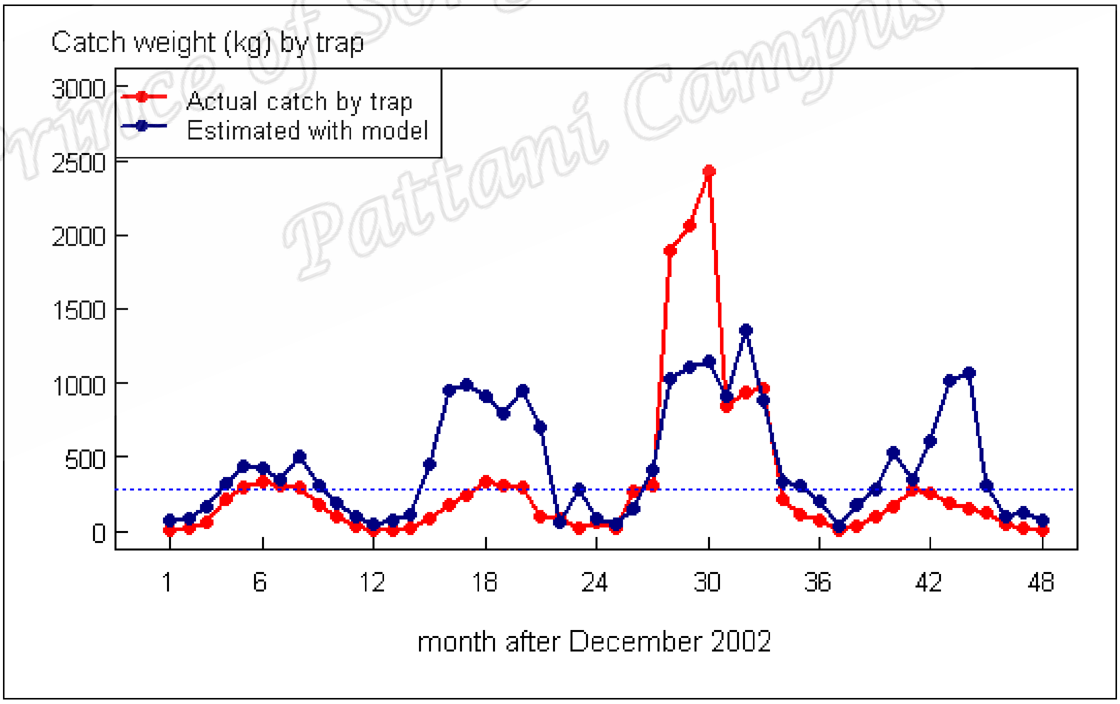

Figure 4.3: Actual and estimated catch weight using trap based on model of logarithm of catch weight with morning air temperature, water level and rainfall as determinants

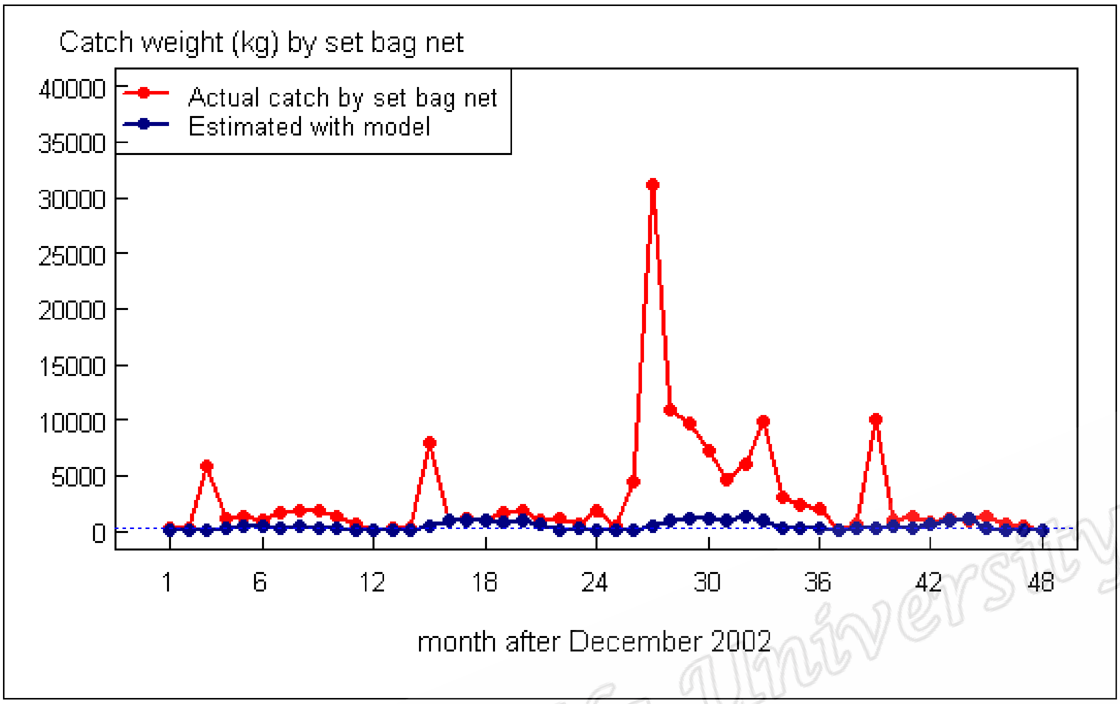

Figure 4.4: Actual and estimated catch weight using set bag based on model of logarithm of catch weight with morning air temperature, water level and rainfall as determinants

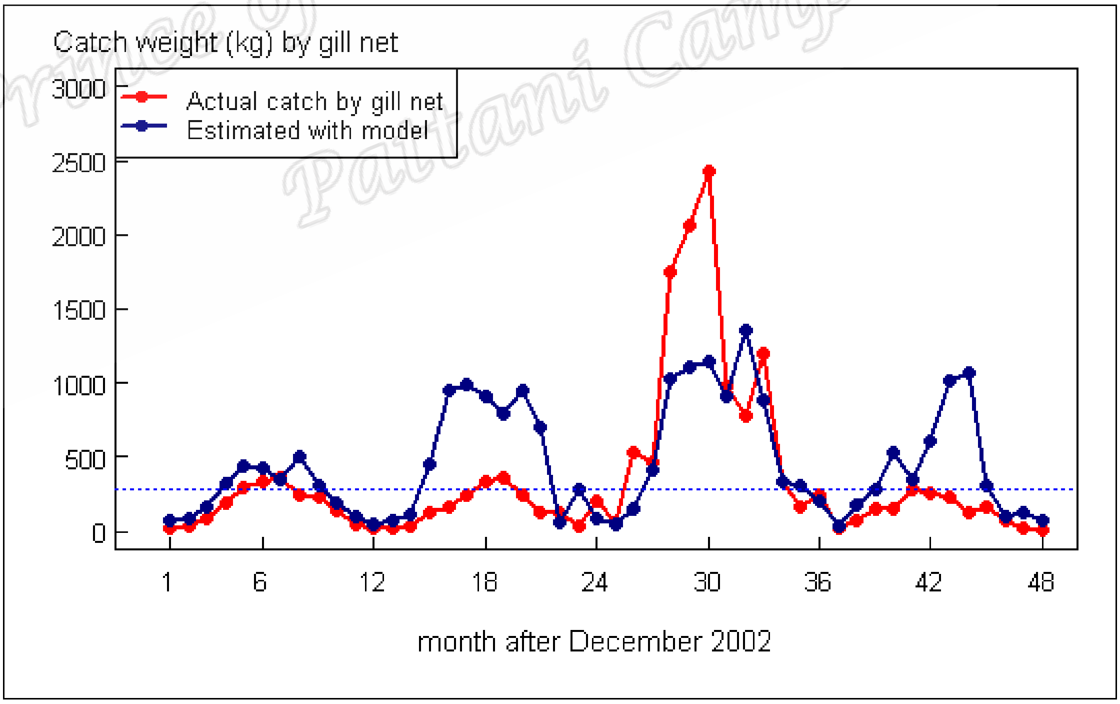

Figure 4.5: Actual and estimated catch weight using gill net based on model of logarithm of catch weight with morning air temperature, water level and rainfall as determinants

4.2 Model of catch weight with month, year and gear

There were 144 records of monthly catch weight data (48 month-year period from 2003 to 2006 with three gear types). The model fitted contained additive effects for gear type, year and month. The r-squared for this model was 0.888, residual standard error was 0.61 on 127 degrees of freedom. Figure 4.6 shows a scatter plot of the natural logarithmic transformed observed of blue swimming crab and the fitted values (left panel) and residuals plot (right panel). The normality assumption for the errors was plausible because the points in this plot follow the line corresponding to normality with no extreme outliers.

The adjusted blue swimming crab catch for each factor of interest was obtained by replacing the parameters corresponding to the other factors by a constant chosen to ensure that the fitted values of catch weight equals the observed catch. Sum contrasts were used to obtain confidence intervals (Tongkumchum and McNeil, 2009).

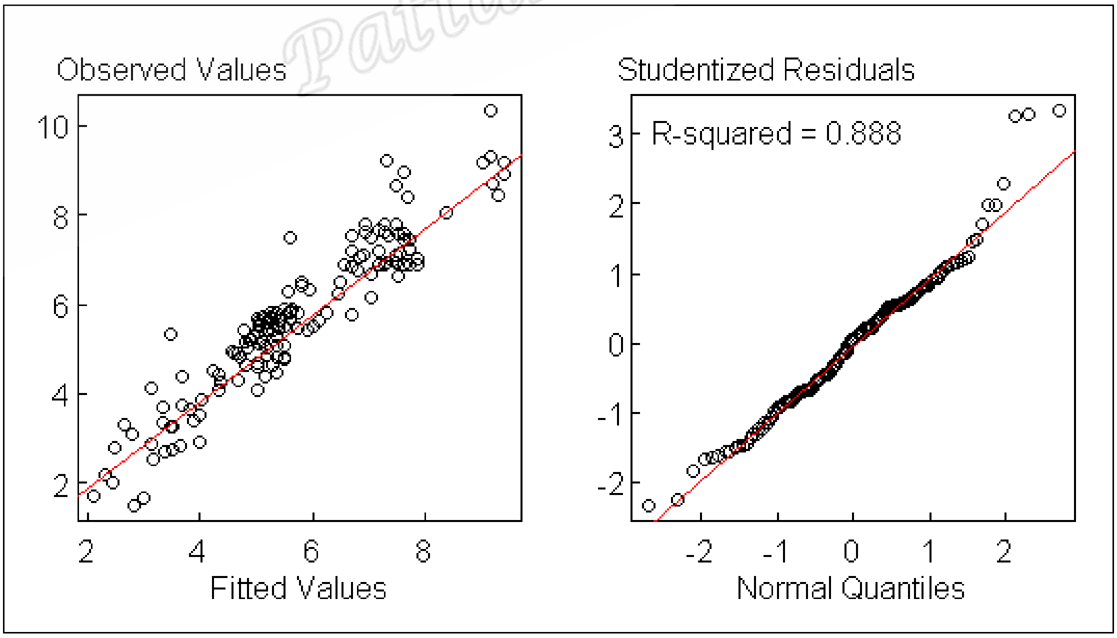

Figure 4.6: Scatter plot of observed values and fitted value and residuals plot from model of logarithm of catch weight with month, year and gear

Figure 4.7 shows 95% confidence intervals for blue swimming crab catch by gear (left panel), year (middle panel) and month (right panel) each adjusted for the effects of the other factors in the model. The dotted horizontal lines on each graph represent the average catch weight and it is 292.83 kilogram. The catch of blue swimming crab by set bag net was higher than the average and the catch in 2005 was also higher than the average. From March to September the catches were higher than the average.

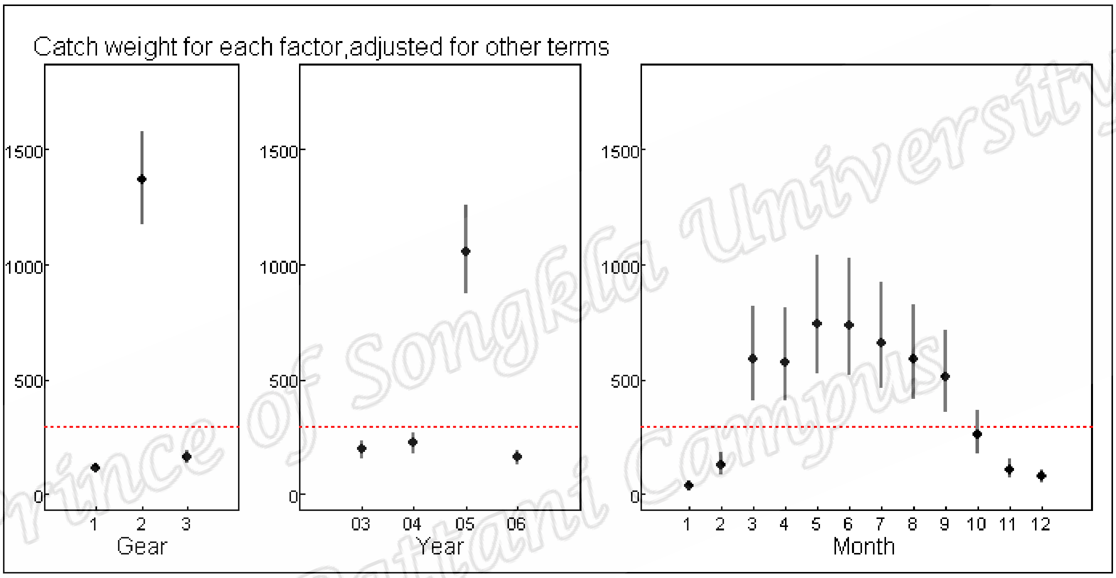

Figure 4.7: Blue swimming crab catch by factor, adjusted for all other factors

Next we compare the actual catch and the estimated catch from the model using time series plots. The graphs were separated by gear types. Figure 4.8 shows graphs for trap in the top panel, set bag net in the middle panel and gill net in the lower panel. The estimated values for trap were underestimated for the catch in the middle of the year especially in 2005. The estimated values for set bag net were not very well fit especially in March every year. The estimated values for gill net were fit quite well with the data with the exception only in March and June in 2005.

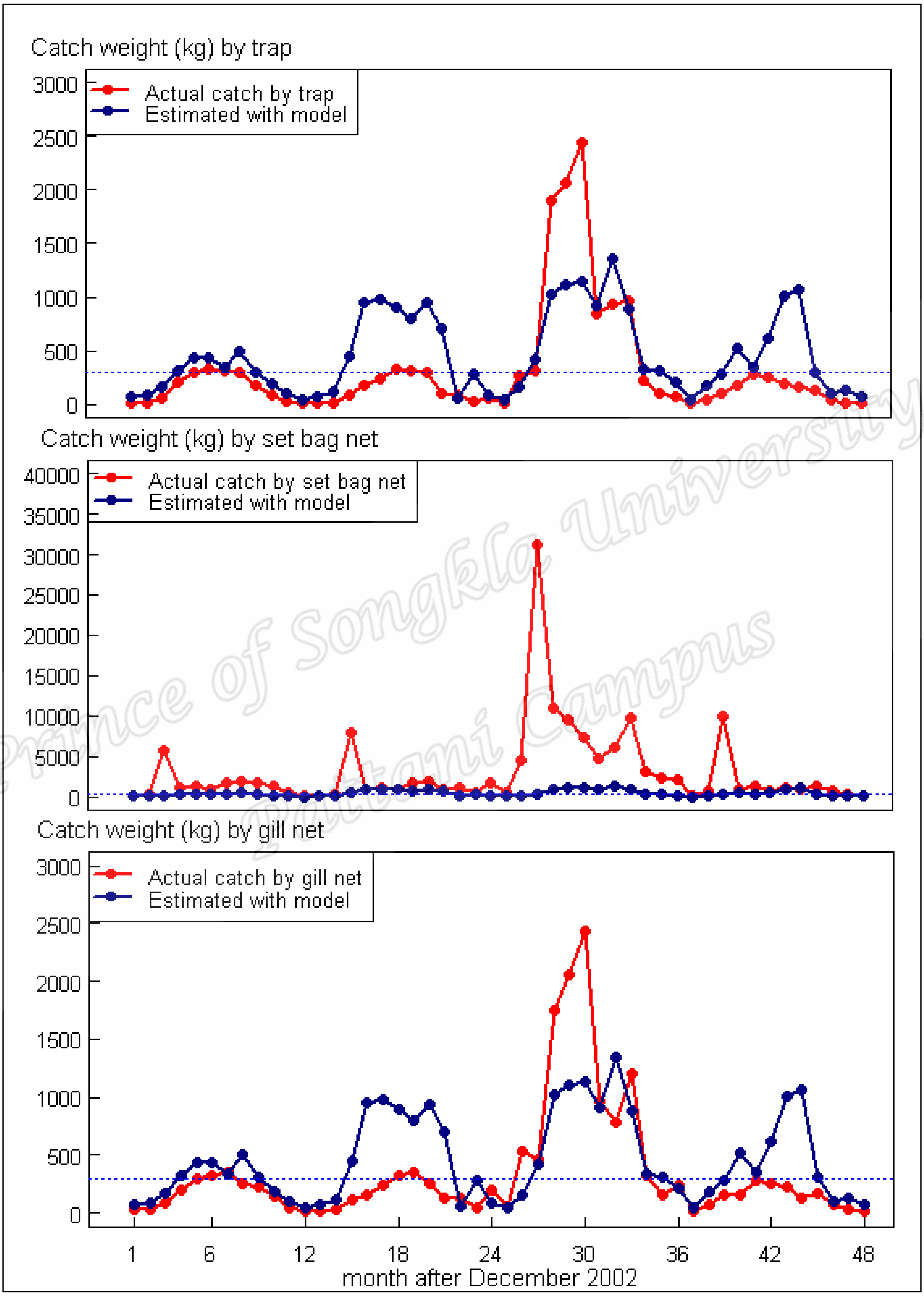

Figure 4.8: Actual and estimated catch weights based on model of logarithm of catch weight with month, year and gear as determinants

4.3 Models of catch weight by gear with month and year

Since the blue swimming crab was caught by set bag net had different patterns compared to those by trap and gill net, therefore we classified the data into three groups by gear types and fitted models separately to the data in each group. The data comprised 48 observations in each group. The determinants in each model were month and year. The catch on December 2004 was found to be an extreme outlier with 60.83 kilogram for trap, 1764 .04 for set bag net and 202.76 kilogram for gill net. The outlier was removed and we refitted the models. The r-squared were 96.1, 96.1 and 93.9 percent for trap, set bag net and gill net, respectively.

Figure 4.9 shows the residuals plots from the three models with the model for trap (left panel), the model for set bag net (middle panel), and the model for gill net (right panel). The graphs show that the models fit quite well with the data.

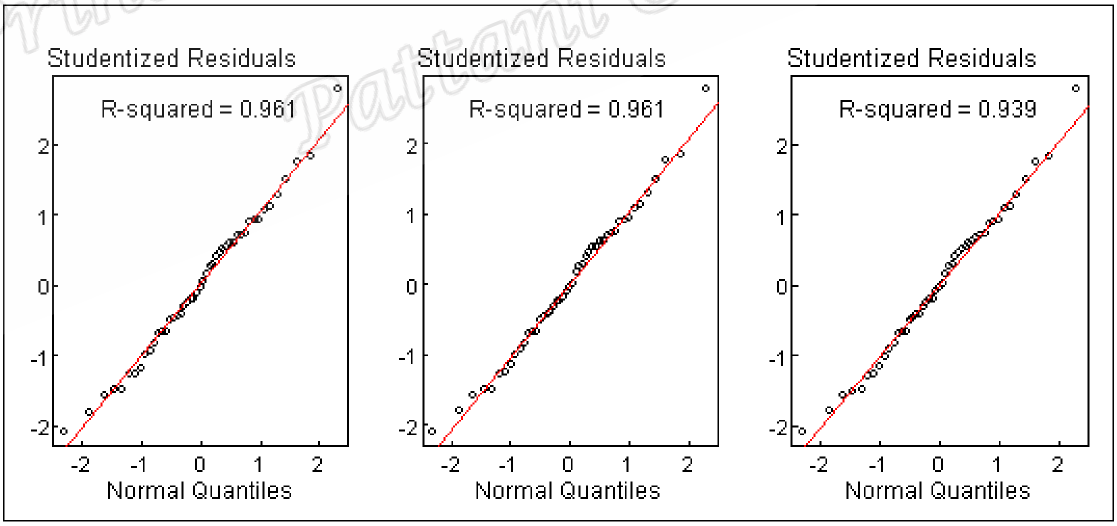

Figure 4.9: Diagnostic plots of linear models for trap, set bag net and gill net

Figure 4.10 show 95% confidence intervals for logarithms of blue swimming crab catch each adjusted for the effects of the other factors from three models. The dotted horizontal lines on each graph represented the mean catch by each gear. The catch weights was higher than average in 2005 for the three gears. The catch weights by trap and gill net were higher than average from April to September and lower than average in January, February, November and December. The catch weights by set bag net were higher than average in March and lower than average in January, November and December.

Figure 4.11 shows these graphs for trap in the top panel, set bag net in the middle panel and gill net in the lower panel. The estimated values were fit quite well with the data.

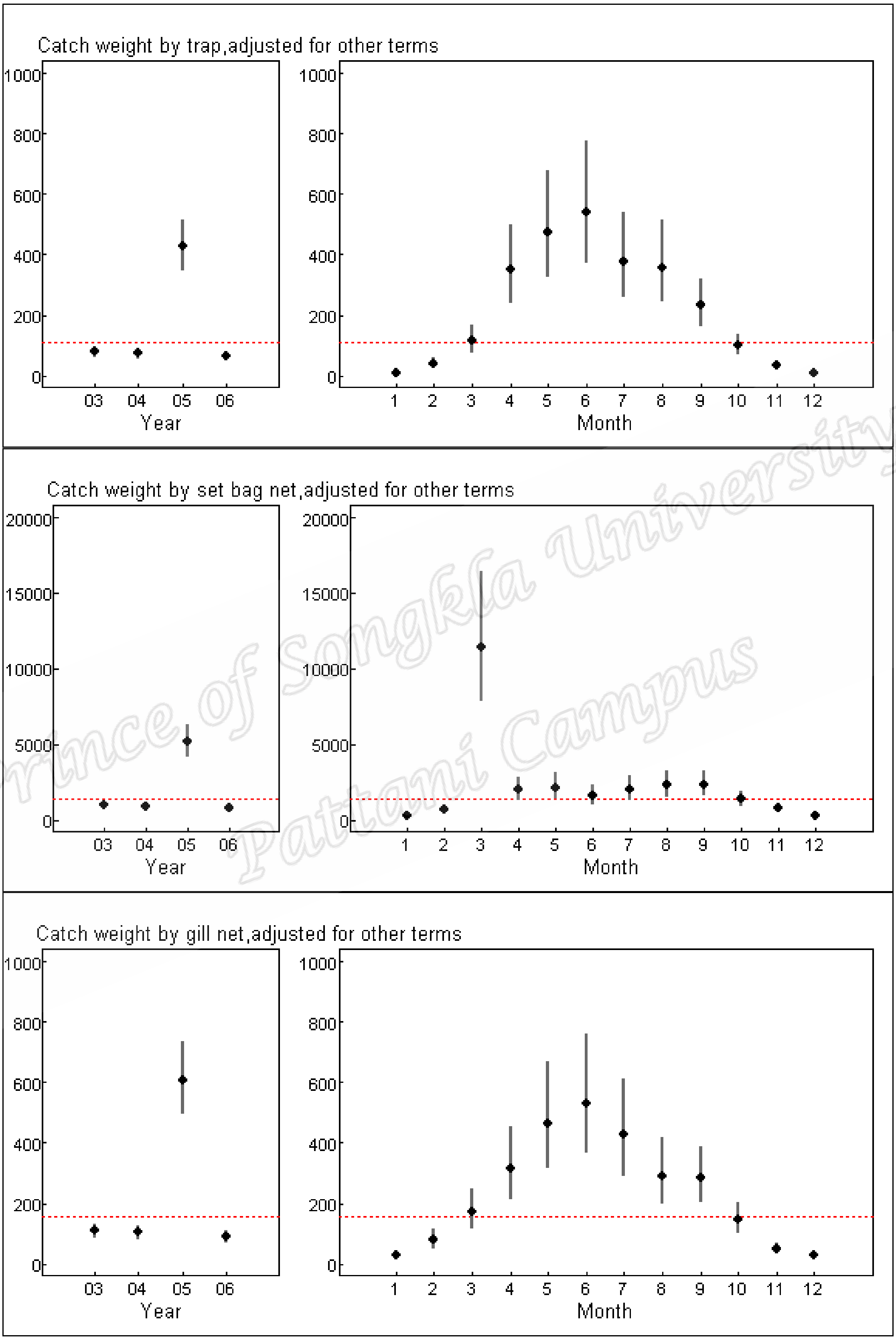

Figure 4.10: Blue swimming crab catch by three gear types, adjusted for other factors

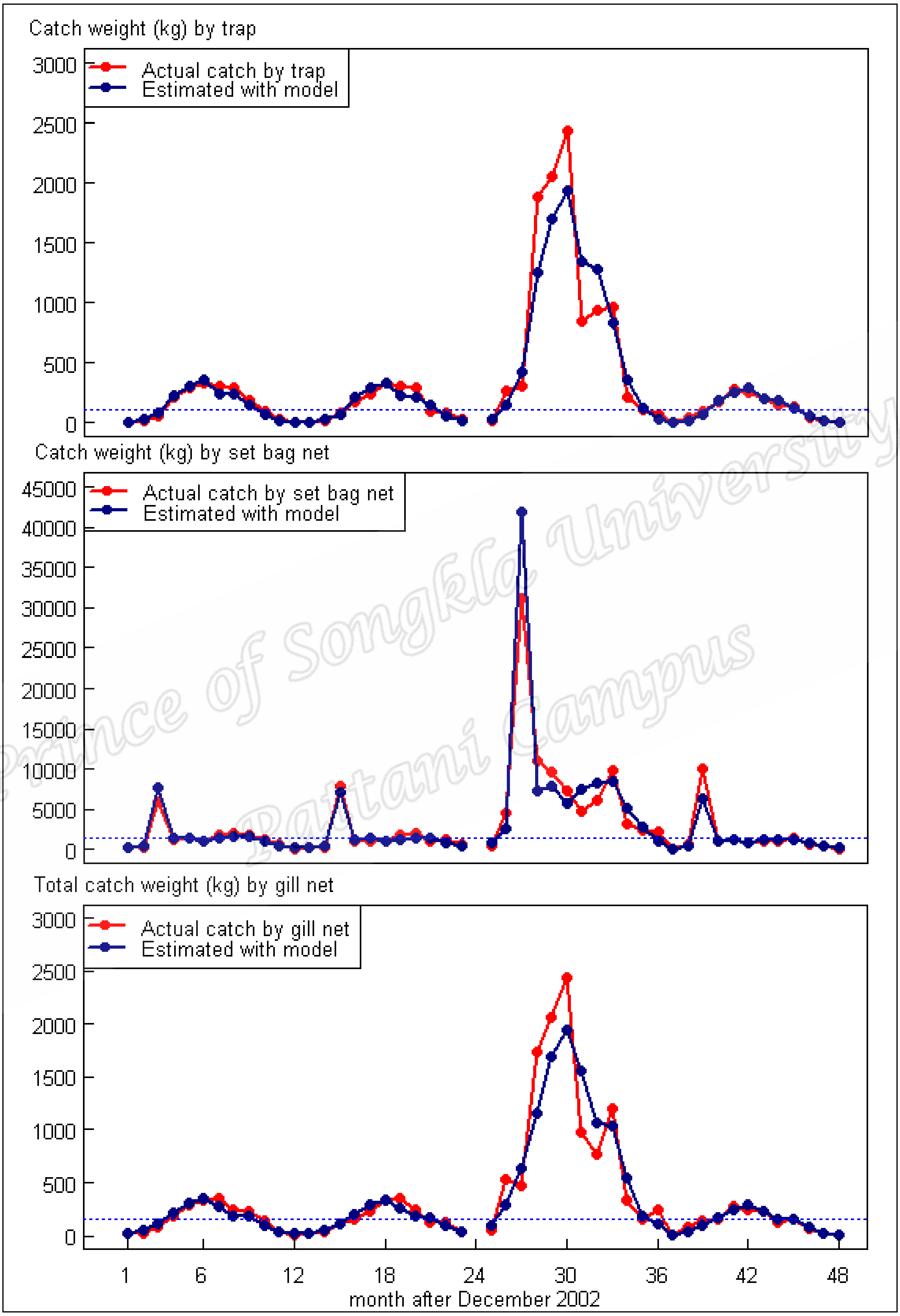

Figure 4.11: Actual and estimated catch weight based on model of logarithm of catch weight separated by gear