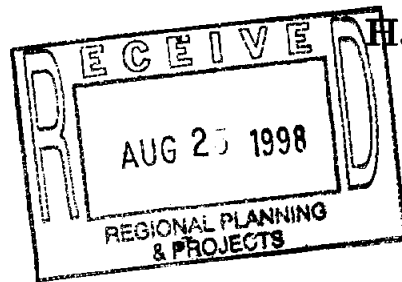


**Brown Shrimp Harvests in  
Upper Laguna Madre/Baffin Bay:  
A Regression Analysis**



**Harvest vs Freshwater Inflows**

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## 1. SUMMARY REPORT

### 1.1 Description of the Problem<sup>1</sup>

Bimonthly freshwater inflows into Upper Laguna Madre/Baffin Bay were recorded for the years 1959 to 1993. These variables, and various transformations of them, were used to construct a model for the annual harvest of brown shrimp.

### 1.2 Constructing Models - General Discussion

Stability of coefficient estimates and accuracy of predicted values are primary goals in constructing models for prediction. To this end, the data must be examined from three points of view: individual observations (to detect outliers or influential points); variables, individually and in groups (to select an optimal set of predictors); and the interaction of these two, which produces the overall structure of the data set (to determine whether multicollinearity is present or not). The first two of these were examined by both graphic and quantitative means; the third by quantitative means only.

#### 1.2.1 Detecting Influential Points and Outliers

The structures of individual variables were examined via box plots and histograms, as well as by all the usual numerical measures. For each pair of variables, 99 % prediction ellipses and 95% confidence regions were plotted in a further effort to look for unusual points. For example, suppose large values of Variable A are generally associated with large values for Variable B. If an observation consisted of a large value for Variable A but a small value for Variable B, that point would be considered unusual, even though it was well within the range of data for both variables and could not be considered an outlier.

In addition, a number of residual analysis techniques were employed. A large residual indicates a point not well-fit by the model. The deleted residual, however, is somewhat more useful in the search for influential points. The model is fitted without a given observation, and the predicted response and corresponding residual are calculated for that observation. The Studentized deleted residual is scaled to have a Student's *t* distribution. Histograms and normal P-P plots of the residuals were also examined.

Other quantities, such as the Mahalanobis distance, Cook's distance, the leverage value, standardized values for the *Dffits* (to measure the influence of a given observation on the predicted response) and the *Dfbetas* (to measure the influence of a given observation on the calculated coefficients) were also used to build a general picture of the influence of individual points. Plots were made of the standardized *Dffits* value for each model against the standardized *Dfbeta* values for each predictor in the model. Points which were extreme indicated observations which had strong effects on both predicted values and coefficient estimates.

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<sup>1</sup> The following discussion, prepared by Jacqueline Kiffe, was taken from *Seatrout Harvest in Galveston Bay: A Regression Analysis*, by F. Michael Speed, Sr. and Jacqueline Kiffe.

### 1.2.2 Variable Selection

For each regression, residuals were plotted against each of the independent variables to look for nonlinear relationships between the response variable and individual predictors. Partial residual plots were employed to examine the overall relationship between the response and individual predictors. A partial residual is a corollary to the deleted residual. That is, the model is fitted without a given variable and the predicted response and corresponding residual are calculated for each observation. This seeks to answer the question, "What is the relationship of this predictor to the response variable, taking all other variables into account?" Thus, it examines the marginal relationship of a given predictor to the response.

Numerous measures have been developed over the years to assess the adequacy of a given model. We examined a number of these, including  $R^2$  and mean squared error ( $MSE$ ), and several others which directly incorporate penalties for having too many predictors in the model, such as adjusted  $R^2$ ,  $C_p$ ,  $AIC$ , and  $SBC$ . It is well-established that too many predictors in a model can lead to bad prediction, just as too few can, and these measures are used as part of the attempt to find an optimal model.

### 1.2.3 Multicollinearity

Multicollinearity arises when one or more variables are nearly closely approximated by linear combinations of the remaining variables, resulting in unstable coefficient estimates. The variance inflation factor ( $VIF$ ) was calculated for each coefficient estimate to measure this instability, which is not usually considered profound for  $VIF$ 's less than 10. No problems were found with this data. Additionally, the condition index (a ratio of eigenvalues of the covariance matrix, with the largest eigenvalue always on top) was calculated. A ratio greater than 30 is considered cause for concern. Again, no evidence of multicollinearity was found.

### 1.2.4 Other Procedures

Several other miscellaneous diagnostics, including the Durbin-Watson test for serial autocorrelation were performed, and no general problems were detected. The Box-Cox procedure, used to find a transformation to normality, was also performed.

## 1.3 How the Final Model Was Chosen

### 1.3.1 Selecting the Data Set Used

First, the variables were explored thoroughly, individually and in pairs, in a first effort to detect outliers. The SAS<sup>®</sup> programming language allows a number of diagnostics to be calculated for a group of models on a given data set without actually performing a formal regression, thus allowing one to examine a large number of models quite efficiently. The Box-Cox procedure was performed to find if a transformation to normality was suggested. The log transform was suggested for some variables, and the squared root for others. At this point, there were several data sets for which the diagnostic series was calculated:

1. Untransformed brown shrimp data and untransformed inflow data
2. Log of brown shrimp data and log of inflow data
3. Square root of brown shrimp data and log of inflow data
4. Square root of brown shrimp data and square root of inflow data
5. Various transformation suggested by Box-Cox

### 1.3.2 Selecting the Points to be Omitted

The full regression with all diagnostics was performed for these models, each one contained all variables in its corresponding data set. All diagnostics were generated, and influential points were determined for each model.

*Table 1.1*  $R^2$  and Adjusted  $R^2$  for full data sets.

Data Set	$R^2$	Adj. $R^2$
1	0.1549	-0.0262
2	0.5543	0.4588
3	0.3632	0.2267
4	0.2553	0.0957
5	0.4818	0.3707

Data sets 2, and 5 presented the highest  $R^2$  values. These three models were considered as final candidates. The observations flagged as potentially influential are given in the summary table below, for each model.

**Table 1.2** Summary of points in data sets 2 and 5 flagged by Boxplots.

<b>Year</b>	<b>Variable</b>
1959	Ln(Sept.-Oct. Infl.), (Sept.-Oct. Infl.) <sup>0.1</sup>
1960	Ln(July-August Inflows), (July-August Infl.) <sup>0.2</sup>
1961	Ln(Sept.-Oct. Infl.), (Sept.-Oct. Infl.) <sup>0.1</sup>
1962	Ln(July-August Inflows), (July-August Infl.) <sup>0.2</sup>
1963	Ln(May-June Infl.), Ln(July-August Inflows), Ln(Sept.-Oct. Infl.) (May-June Infl.) <sup>0.2</sup> , (July-August Infl.) <sup>0.2</sup> , (Sept.-Oct. Infl.) <sup>0.1</sup>
1964	Ln(May-June Infl.), Ln(Sept.-Oct. Infl.), (May-June Infl.) <sup>0.2</sup> (Sept.-Oct. Infl.) <sup>0.1</sup>
1965	Ln(July-August Inflows), Ln(Sept.-Oct. Infl.), (July-August Infl.) <sup>0.2</sup> (Sept.-Oct. Infl.) <sup>0.1</sup>
1966	Ln(July-August Inflows), (July-August Infl.) <sup>0.2</sup>
1967	Ln(May-June Infl.), Ln(Sept.-Oct. Infl.), (May-June Infl.) <sup>0.2</sup> (Sept.-Oct. Infl.) <sup>0.1</sup>
1968	Ln(Sept.-Oct. Infl.), (Sept.-Oct. Infl.) <sup>0.1</sup>
1969	Ln(May-June Infl.), (May-June Infl.) <sup>0.2</sup>
1971	Ln(May-June Infl.), (May-June Infl.) <sup>0.2</sup>
1972	Ln(Sept.-Oct. Infl.), (Sept.-Oct. Infl.) <sup>0.1</sup>
1974	Ln(Sept.-Oct. Infl.), (Sept.-Oct. Infl.) <sup>0.1</sup>
1976	(July-August Infl.) <sup>0.2</sup> ,
1980	Ln(July-August Inflows), (July-August Infl.) <sup>0.2</sup>
1981	(July-August Infl.) <sup>0.2</sup>

**Table 1.3** Summary of points flagged by 99% prediction ellipses.

Year	Variable
1961	(Harvest- Nov.-Dec. Infl.), (Jan.-Feb. Infl.-Nov.-Dec. Infl.) (March-April Infl.-Nov.-Dec. Infl.), (May-June Infl.- Nov.-Dec. Infl.), (July-August Infl.- Nov-Dec. Infl.), (Sept.-Oct. Infl.-Nov-Dec. Infl.),
1976	(Harvest-March-April Infl.), (Harvest-July-August Infl.), (Jan.-Feb. Infl.-March-April Infl.), (Jan.-Feb. Infl.-July-August Infl.) (March-April Infl.-May-June Infl.), (March-April Infl.-July-August Infl.), (March-April Infl.-Sept.-Oct. Infl.), (March-April Infl.-Nov.-Dec. Infl.), (May-June Infl.- July-August Infl.), (July-August Infl.- Sept.-Oct. Infl.), (July-August Infl.- Nov-Dec. Infl.)
1992	(Harvest-Jan.-Feb. Infl.), (Jan.-Feb. Infl.-March-April Infl.), (Jan.-Feb. Infl.-May-June Infl.), (Jan.-Feb. Infl.-July-August Infl.), (Jan.-Feb. Infl.-Sept.-Oct. Infl.), (Jan.-Feb. Infl.-Nov.-Dec. Infl.)

**Table 1.4** Outliers of data set 2.

Year	BOX	SRE	SDR	LEV	MAH	COO	SDF	SDB	TOTAL
1959	1								1
1960	1								1
1961	1		1				1	1	4
1962	1								1
1963	3								3
1964	2								2
1965	2								2
1966	1								1
1967	2								2
1968	1								1
1969	1			1					2
1970			1	1			1	3	6
1971	1								1
1972	1								1
1974	1						1		2
1975							1		1
1980	1								1
1991			1						1



**Table 1.5** Outliers of data set 5.

Year	BOX	SRE	SDR	LEV	MAH	COO	SDF	SDB	TOTAL
1959	1								1
1960	1								1
1961	1						1	1	3
1962	1								1
1963	3								3
1964	2								2
1965	2								2
1966	1								1
1967	2								2
1968	1								1
1969	1								1
1970			1				1	2	4
1971	1								1
1972	1								1
1973							1		1
1974	1								1
1975				1					1
1976	1			1					2
1980	1								1
1981	1								1
1991			1						1

1

**A Key to Abbreviations:**

BOX	Box plot
SRE	Studentized residual
SDR	Studentized deleted residual
LEV	Leverage value
MAH	Mahalanobis distance
COO	Cook's distance
SDF	Standardized Dffits value
SDB	Standardized Dfbeta value

### 1.3.3 Selecting the Final Candidate Models

After the subset analysis led us to two models, Data Set 2 with 1970 omitted and Data Set 5 with 1970 omitted.

**Table 1.6**  $R^2$  and Adjusted  $R^2$  for data sets number 2 and 5.

Data set	Observations omitted	$R^2$	Adj. $R^2$
2	1970	0.6239	0.5567
5	1970	0.5498	0.4694

### 1.3.4 Selecting the Final Models

It appears that Data set 2 with 1970 omitted is the best model. Regression was performed using this model, and the deleted residuals were calculated.

$$\begin{aligned} \text{Ln}(\text{Brown Shrimp Harvest}) = & 0.93833 + 0.36428 * \text{Ln}(\text{Jan.-Feb. Inflows}) \\ & -0.22101 * \text{Ln}(\text{ March-Apr. Inflows}) \\ & +0.48068 * \text{Ln}(\text{ May-June. Inflows}) \\ & +0.99041 * \text{Ln}(\text{ July-Aug. Inflows}) \\ & -0.43677 * \text{Ln}(\text{Sept.-Oct. Inflows}) \end{aligned}$$

## 1.4 Best Model: Logged Harvest and Log of Inflows

### 1.4.1 Summary Information

**Table 1.7** Descriptive statistics for dependent and independent variables.

**Descriptive Statistics**

	Mean	Std. Deviation	N
Ln(Brown Shrimp Harvest)	1.2423	4.9519	34
Ln(January-February Inflows)	-.9126	4.3559	34
Ln(March-april Inflows)	-.8138	4.0979	34
Ln(May-June Inflows)	1.0470	3.8927	34
Ln(July-August Inflows)	.6730	3.3581	34
Ln(September-October Inflows)	1.6330	3.5407	34

**Table 1.8** Model summary for the final model.

**Model Summary<sup>b</sup>**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.790 <sup>a</sup>	.624	.557	3.2968	1.832

a. Predictors: (Constant), Ln(September-October Inflows), Ln(March-april Inflows), Ln(July-August Inflows), Ln(May-June Inflows), Ln(January-February Inflows)

b. Dependent Variable: Ln(Brown Shrimp Harvest)

**Table 1.9** Anova for the final model.

**ANOVA<sup>b</sup>**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	504.860	5	100.972	9.290	.000 <sup>a</sup>
	Residual	304.337	28	10.869		
	Total	809.197	33			

a. Predictors: (Constant), Ln(September-October Inflows), Ln(March-april Inflows), Ln(July-August Inflows), Ln(May-June Inflows), Ln(January-February Inflows)

b. Dependent Variable: Ln(Brown Shrimp Harvest)

**Table 1.10** Parameter estimates for the final model.

**Coefficients<sup>a</sup>**

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	.938	.718		1.306	.202	-.533	2.410
Ln(January-February Inflows)	.364	.177	.320	2.059	.049	.002	.727
Ln(March-april Inflows)	-.221	.169	-.183	-1.308	.202	-.567	.125
Ln(May-June Inflows)	.481	.181	.378	2.661	.013	.111	.851
Ln(July-August Inflows)	.990	.214	.672	4.636	.000	.553	1.428
Ln(September-October Inflows)	-.437	.214	-.312	-2.042	.051	-.875	.001

a. Dependent Variable: Ln(Brown Shrimp Harvest)

**Table 1.11** Residuals statistics for the final model.

**Residuals Statistics<sup>a</sup>**

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	-7.5718	6.8880	1.2423	3.9114	34
Std. Predicted Value	-2.253	1.443	.000	1.000	34
Standard Error of Predicted Value	.6682	2.1173	1.2864	.5209	34
Adjusted Predicted Value	-7.8865	7.8466	1.3827	3.9236	34
Residual	-10.2513	4.5736	4.180E-16	3.0368	34
Std. Residual	-3.109	1.387	.000	.921	34
Stud. Residual	-3.186	1.555	-.018	1.016	34
Deleted Residual	-10.7639	5.7450	-.1405	3.7509	34
Std. Deleted Residual	-3.919	1.597	-.047	1.106	34
Mahal. Distance	.385	12.640	4.853	4.218	34
Cook's Distance	.000	.502	.043	.097	34
Centered Leverage Value	.012	.383	.147	.128	34

a. Dependent Variable: Ln(Brown Shrimp Harvest)

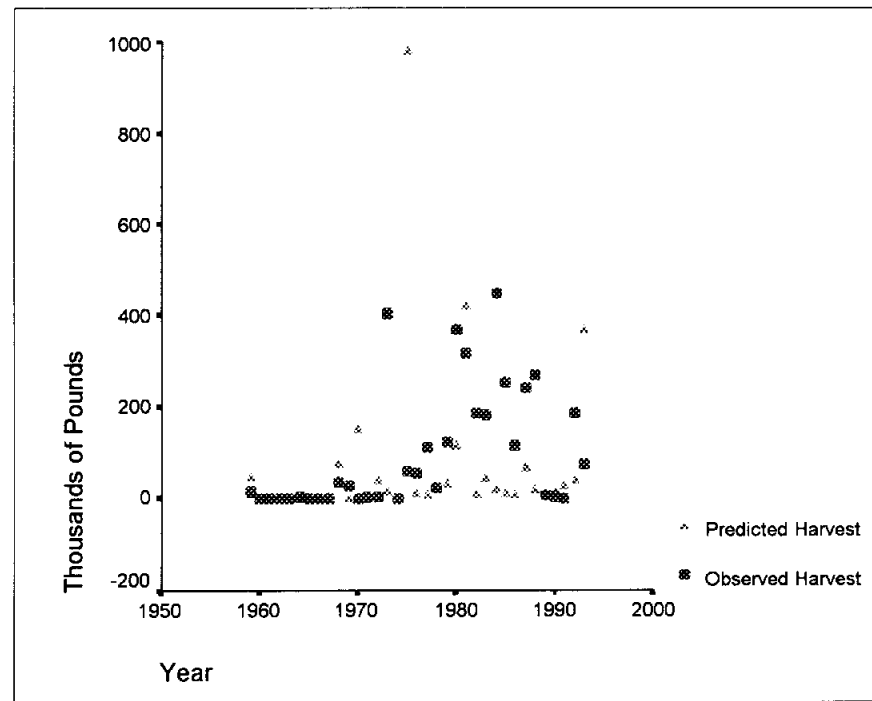


Figure 1.1 Predicted and observed values for the harvest.

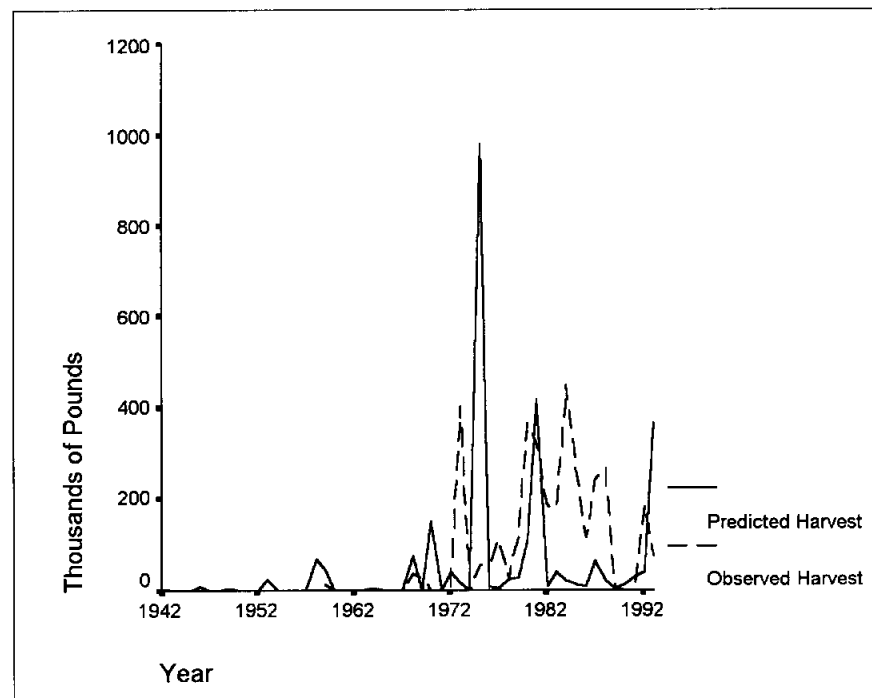


Figure 1.2 Predicted and observed values for the harvest.

**Table 1.12** Prediction Intervals for Brown Shrimp Harvest based on the final model.

<b>YEAR</b>	<b>BRSH</b>	<b>PRE_1</b>	<b>LICI_1</b>	<b>UICI_1</b>
1959	12.65	44.88	.00	1028691
1960	.00	.00	.00	26
1961	.00	.35	.00	15228
1962	.00	.00	.00	20
1963	.00	.00	.00	26
1964	2.80	2.08	.00	66583
1965	.00	.02	.00	1078
1966	.00	.00	.00	18
1967	.22	1.39	.00	42524
1968	34.87	75.16	.00	2061622
1969	26.57	.27	.00	6014
1970	.00	149.89	.00	5425403
1971	1.61	.38	.00	12966
1972	1.61	38.32	.00	522167
1973	402.82	16.35	.00	450003
1974	.00	.10	.00	3704
1975	56.78	980.40	.04	26180590
1976	55.96	9.40	.00	473142
1977	110.50	5.20	.00	61144
1978	23.63	22.57	.00	248012
1979	120.83	29.48	.00	334407
1980	366.31	112.88	.01	1428943
1981	316.18	418.77	.03	5571802
1982	185.94	6.18	.00	73606
1983	180.49	40.69	.00	458480
1984	448.41	19.09	.00	210004
1985	251.67	10.70	.00	124267
1986	115.08	7.69	.00	85274
1987	240.69	64.70	.00	908836
1988	268.06	20.32	.00	221700
1989	5.65	4.92	.00	53543
1990	1.15	13.41	.00	154032
1991	.00	28.32	.00	317422
1992	183.67	39.09	.00	639477
1993	74.22	366.84	.03	5149659

*BRSH* Observed brown shrimp harvest

*PRE\_1* Predicted brown shrimp harvest

*LICI\_1* Lower limit for 99% prediction interval for the brown shrimp harvest.

*UICI\_1* Upper limit for 99% prediction interval for the brown shrimp harvest.

## 2. EXPLORING THE DATA

### 2.1 Listing of data

*Table 2.1 The brown shrimp data and the inflow data.*

Year	Brown Sh.	JF_inflow	MA_inflow	MJ_inflow	JA_inflow	SO_inflow	ND_inflow
1959	12.65	7.00	.00	12.00	5.00	140.00	7.00
1960	.00	.00	.00	5.00	.00	8.00	.00
1961	.00	47.00	2.00	.00	10.00	152.00	220.00
1962	.00	.00	.00	4.00	.00	14.00	.00
1963	.00	.00	.00	.00	.00	.00	1.00
1964	2.80	.00	.00	.00	3.00	.00	.00
1965	.00	.00	2.00	37.00	.00	.00	.00
1966	.00	.00	14.00	100.00	.00	6.00	.00
1967	.22	.00	.00	.00	2.00	.00	.00
1968	34.87	1.00	.00	79.00	15.00	815.00	1.00
1969	26.57	1.00	1.00	.00	3.00	1.00	.00
1970	.00	.00	.00	39.00	28.00	1.00	1.00
1971	1.61	.00	.00	.00	27.00	7.00	.00
1972	1.61	61.00	15.00	62.00	12.00	418.00	2.00
1973	402.82	.00	.00	105.00	3.00	3.00	.00
1974	.00	.00	32.00	10.00	5.00	450.00	.00
1975	56.78	2.00	.00	51.00	10.00	1.00	.00
1976	55.96	.00	73.00	11.00	182.00	34.00	.00
1977	110.50	8.34	3.53	9.69	2.69	70.00	30.00
1978	23.63	3.81	3.19	10.62	5.37	7.07	4.39
1979	120.83	5.74	6.02	27.31	5.77	12.97	5.30
1980	366.31	3.41	1.93	5.22	100.30	72.66	2.82
1981	316.18	10.52	6.87	79.01	45.83	16.38	23.86
1982	185.94	8.48	16.68	6.63	2.67	14.10	6.49
1983	180.49	5.65	3.97	7.23	10.31	6.53	3.86
1984	448.41	7.37	1.46	4.98	5.28	11.14	5.09
1985	251.67	7.05	12.03	15.68	2.74	11.09	37.14
1986	115.08	4.62	1.80	10.56	3.24	40.99	7.63
1987	240.69	53.53	19.17	64.87	3.54	6.58	16.32
1988	268.06	2.46	1.81	4.95	5.39	3.61	3.57
1989	5.65	2.41	2.54	1.69	3.45	8.55	2.59
1990	1.15	3.82	8.35	4.01	4.76	3.73	2.23
1991	.00	4.69	4.86	9.09	7.09	6.38	2.52
1992	183.67	376.09	16.57	11.06	2.81	9.63	45.15
1993	74.22	5.18	4.41	112.16	23.57	5.00	5.64

---

Brown Shrimp	Brown Shrimp harvest (thousands of pounds)
JF_inflow	Lagged January-February inflows (thousands of acre-feet)
MA_inflow	Lagged March-April inflows (thousands of acre-feet)
MJ_inflow	Lagged May-June inflows (thousands of acre-feet)
JA_inflow	Lagged July-August inflows (thousands of acre-feet)
SO_inflow	Lagged September-October inflows (thousands of acre-feet)
ND_inflow	Lagged November-December inflows (thousands of acre-feet)



Table .2.3 Percentiles of the brown shrimp data and the inflow data.

		Percentiles						
		5	10	25	50	75	90	95
Weighted Average(Definition 1)	Brown Shrimp Harvest	1.000E-03	1.000E-03	1.000E-03	26.5650	183.6700	336.2316	411.9388
	Ln(Brown Shrimp Harvest)	-6.9078	-6.9078	-6.9078	3.2796	5.2131	5.8152	6.0199
	Square Root of Brown Shrimp Harvest	3.162E-02	3.162E-02	3.162E-02	5.1541	13.5525	18.3245	20.2915
	January-February Inflows	1.000E-03	1.000E-03	1.000E-03	3.4080	7.0530	49.6124	124.0170
	Ln(January-February Inflows)	-6.9078	-6.9078	-6.9078	1.2261	1.9535	3.9022	4.4747
	Square Root of January-February Inflows	3.162E-02	3.162E-02	3.162E-02	1.8461	2.6557	7.0400	10.1268
	March-April Inflows	1.000E-03	1.000E-03	1.000E-03	2.0000	8.3480	17.6776	40.2000
	Ln(March-april Inflows)	-6.9078	-6.9078	-6.9078	6931	2.1220	2.8700	3.6307
	Square Root of March-April Inflows	3.162E-02	3.162E-02	3.162E-02	1.4142	2.8893	4.2020	6.2343
	May-June Inflows	1.000E-03	1.000E-03	4.0140	10.0000	39.0000	87.4030	106.4318
	Ln(May-June Inflows)	-6.9078	-6.9078	1.3898	2.3026	3.6636	4.4638	4.6672
	Square Root of May-June Inflows	3.162E-02	3.162E-02	2.0035	3.1623	6.2450	9.3331	10.3157
	July-August Inflows	1.000E-03	1.000E-03	2.7380	5.0000	10.3140	35.1328	116.6432
	Ln(July-August Inflows)	-6.9078	-6.9078	1.0072	1.6094	2.3335	3.5293	4.7274
	Square Root of July-August Inflows	3.162E-02	3.162E-02	1.6547	2.2361	3.2115	5.8829	10.7103
	September-October Inflows	1.000E-03	1.000E-03	3.6140	8.0000	34.0000	258.4000	523.0000
	Ln(September-October Inflows)	-6.9078	-6.9078	1.2848	2.0794	3.5264	5.4285	6.2280
	Square Root of September-October Inflows	3.162E-02	3.162E-02	1.9011	2.8284	5.8310	15.5753	22.6802
	November-December Inflows	1.000E-03	1.000E-03	1.000E-03	2.5160	6.4900	32.8548	80.1160
	Ln(November-December Inflows)	-6.9078	-6.9078	-6.9078	9227	1.8703	3.4866	4.1266
Square Root of November-December Inflows	3.162E-02	3.162E-02	3.162E-02	1.5862	2.5475	5.7239	8.3417	
Tukey's Hinges	Brown Shrimp Harvest			.1115	26.5650	182.0820		
	Ln(Brown Shrimp Harvest)			-4.2064	3.2796	5.2044		
	Square Root of Brown Shrimp Harvest			.2514	5.1541	13.4936		
	January-February Inflows			1.000E-03	3.4080	7.0265		
	Ln(January-February Inflows)			-6.9078	1.2261	1.9497		
	Square Root of January-February Inflows			3.162E-02	1.8461	2.6507		
	March-April Inflows			1.000E-03	2.0000	7.6070		
	Ln(March-april Inflows)			-6.9078	6931	2.0243		
	Square Root of March-April Inflows			3.162E-02	1.4142	2.7548		
	May-June Inflows			4.4835	10.0000	38.0000		
	Ln(May-June Inflows)			1.4949	2.3026	3.6372		
	Square Root of May-June Inflows			2.1145	3.1623	6.1639		
	July-August Inflows			2.7720	5.0000	10.1570		
	Ln(July-August Inflows)			1.0195	1.6094	2.3180		
	Square Root of July-August Inflows			1.6649	2.2361	3.1869		
	September-October Inflows			3.6725	8.0000	25.1895		
	Ln(September-October Inflows)			1.3007	2.0794	3.1612		
	Square Root of September-October Inflows			1.9163	2.8284	4.9390		
	November-December Inflows			1.000E-03	2.5160	6.0645		
	Ln(November-December Inflows)			-6.9078	9227	1.8000		
Square Root of November-December Inflows			3.162E-02	1.5862	2.4611			

## 2.2.1 The brown shrimp data

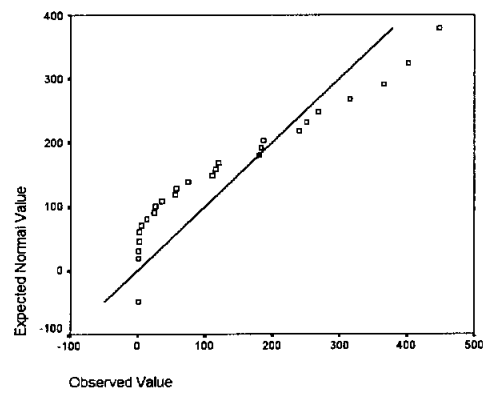
Table .2.4 Descriptives for the brown shrimp data.

Descriptives			Statistic	Std. Error
Brown Shrimp Harvest	Mean		99.6679	22.4249
	95% Confidence Interval for Mean	Lower Bound	54.0950	
		Upper Bound	145.2408	
	5% Trimmed Mean		86.9159	
	Median		26.5650	
	Variance		17600.707	
	Std. Deviation		132.6677	
	Minimum		.00	
	Maximum		448.41	
	Range		448.41	
	Interquartile Range		183.6690	
	Skewness		1.280	.398
	Kurtosis		.562	.778

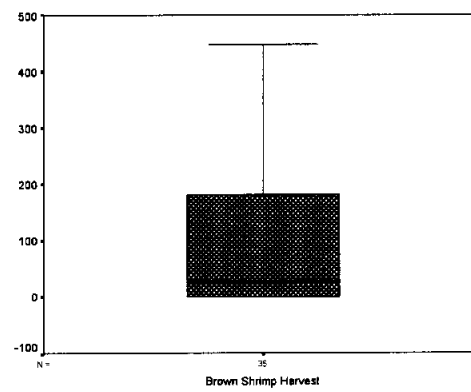
Table .2.5 Extreme Values for the brown shrimp data.

Extreme Values					
		Case Number	Year	Value	
Brown Shrimp Harvest	Highest	1	26	1984	448.41
		2	15	1973	402.82
		3	22	1980	366.31
		4	23	1981	316.18
		5	30	1988	268.06
	Lowest	1	4	1962	.00
		2	12	1970	.00
		3	7	1965	.00
		4	5	1963	.00
		5	16	1974	. <sup>a</sup>

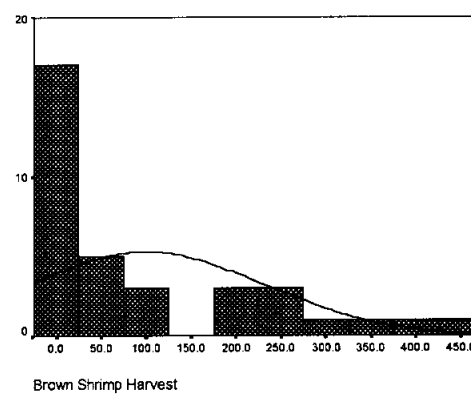
a. Only a partial list of cases with the value 0 are shown in the table of lower extremes.



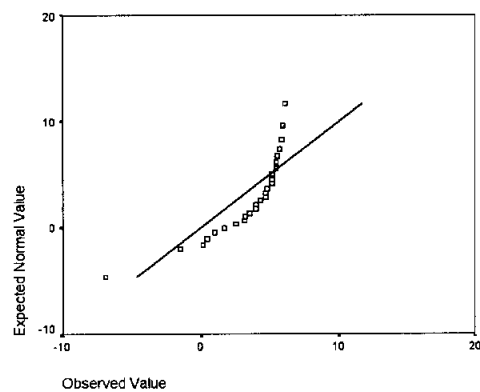
**Figure 2.1** Normal Q-Q Plot of Brown Shrimp Harvest.



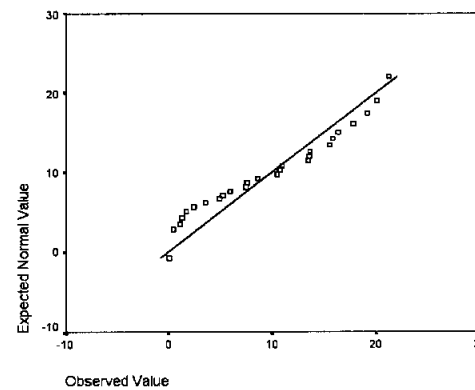
**Figure 2.2** BoxPlot of Brown Shrimp Harvest.



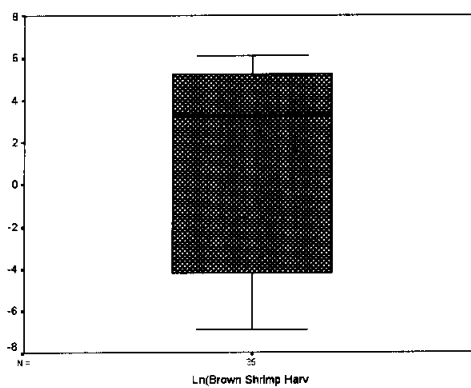
**Figure 2.3** Histogram of Brown Shrimp Harvest.



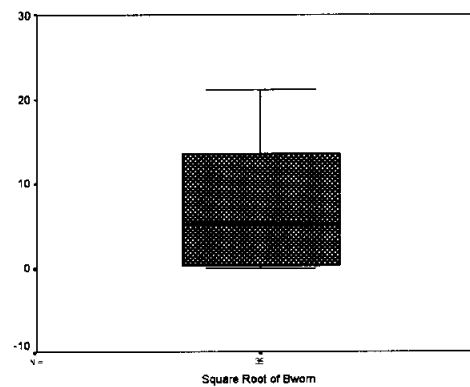
**Figure 2.4** Normal Q-Q Plot of Ln(Brown Shrimp Harvest).



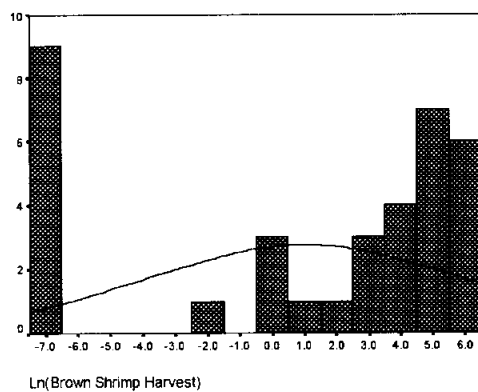
**Figure 2.5** Normal Q-Q Plot of Sqrt(Brown Shrimp Harvest).



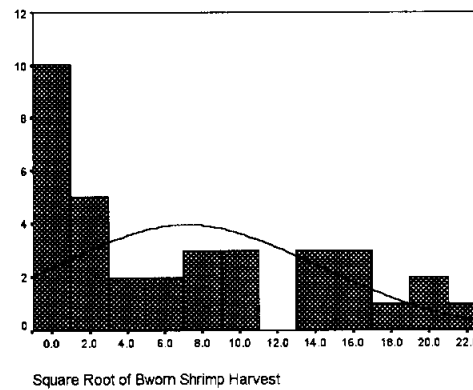
**Figure 2.6** BoxPlot of Ln(Brown Shrimp Harvest).



**Figure 2.7** BoxPlot of Sqrt(Brown Shrimp Harvest).



**Figure 2.8** Histogram of Ln(Brown Shrimp Harvest).



**Figure 2.9** Histogram of Sqrt(Brown Shrimp Harvest).

## 2.2.2 The January-February Inflows data

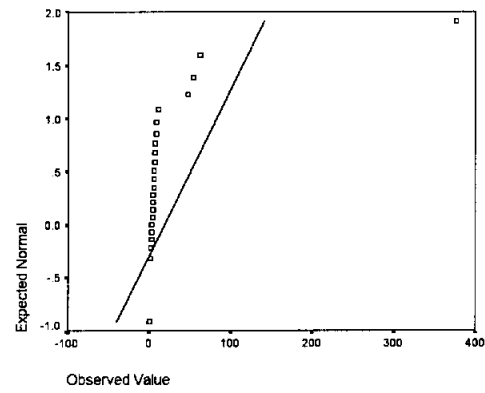
Table .2.6 Descriptives for the January-February Inflow data.

Descriptives			Statistic	Std. Error
January-February Inflows	Mean		18.0624	10.8239
	95% Confidence Interval for Mean	Lower Bound	-3.9344	
		Upper Bound	40.0591	
	5% Trimmed Mean		6.6777	
	Median		3.4080	
	Variance		4100.461	
	Std. Deviation		64.0348	
	Minimum		.00	
	Maximum		376.09	
	Range		376.08	
	Interquartile Range		7.0520	
	Skewness		5.456	.398
	Kurtosis		31.025	.778

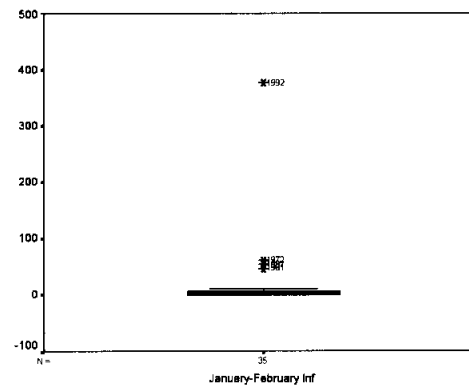
Table .2.7 Extreme Values for the January-February Inflow data.

Extreme Values					
		Case Number	Year	Value	
January-February Inflows	Highest	1	34	1992	376.09
		2	14	1972	61.00
		3	29	1987	53.53
		4	3	1961	47.00
		5	23	1981	10.52
	Lowest	1	5	1963	.00
		2	16	1974	.00
		3	6	1964	.00
		4	4	1962	.00
		5	7	1965	. <sup>a</sup>

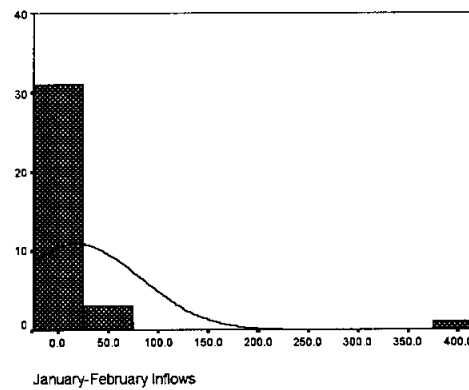
<sup>a</sup>. Only a partial list of cases with the value 0 are shown in the table of lower extremes.



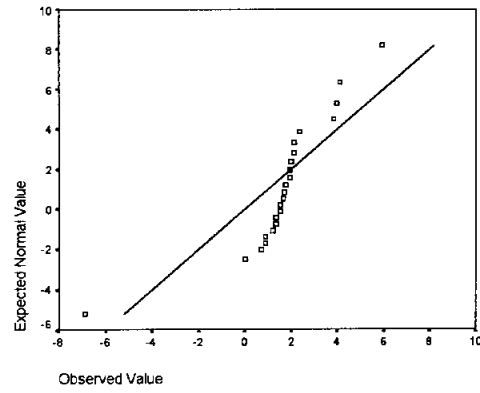
**Figure 2.10** Normal Q-Q Plot of January-February Inflows.



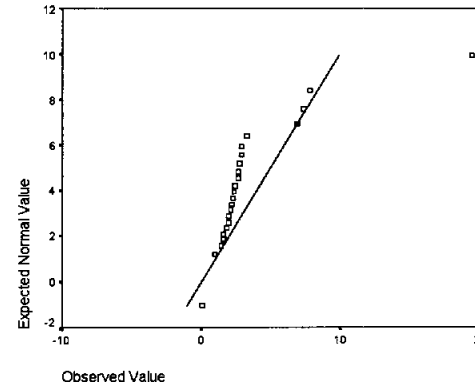
**Figure 2.11** BoxPlot of January-February Inflows.



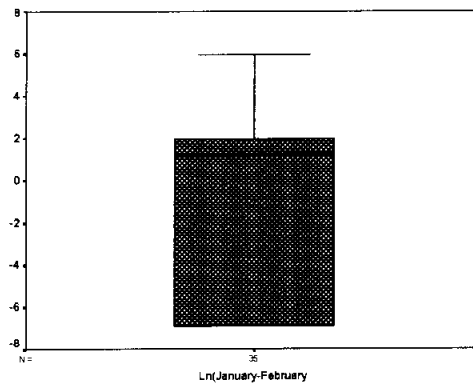
**Figure 2.12** Histogram of January-February Inflows.



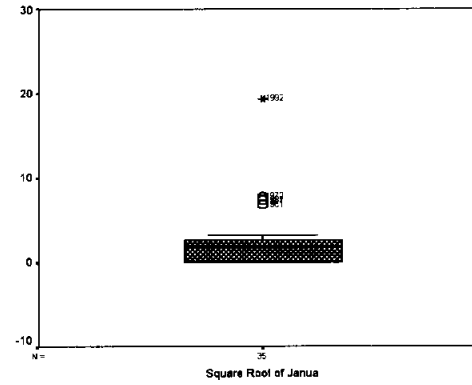
**Figure 2.13** Normal Q-Q Plot of Ln January-February Inflows).



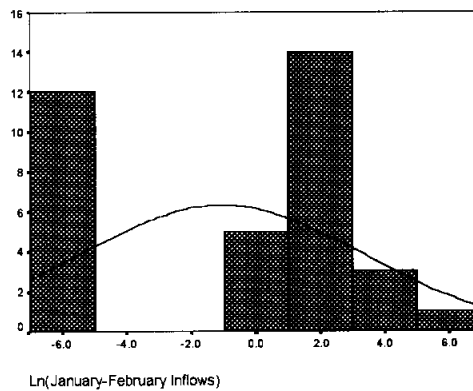
**Figure 2.14** Normal Q-Q Plot of Sqrt(January-February Inflows).



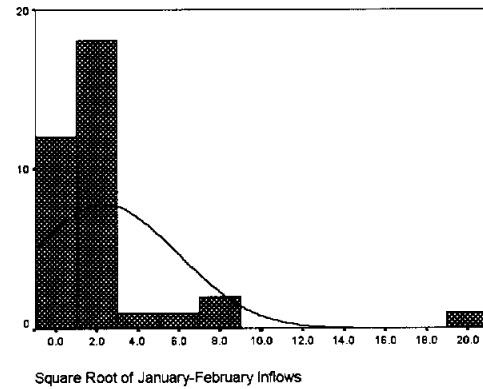
**Figure 2.15** BoxPlot of Ln(January-February Inflows).



**Figure 2.16** BoxPlot of Square Root of January-February Inflows.



**Figure 2.17** Histogram of Ln(January-February Inflows).



**Figure 2.18** Histogram of Sqrt(January-February Inflows).

### 2.2.3 The March-April Inflows data

**Table .2.8** Descriptives for the March-April Inflow data.

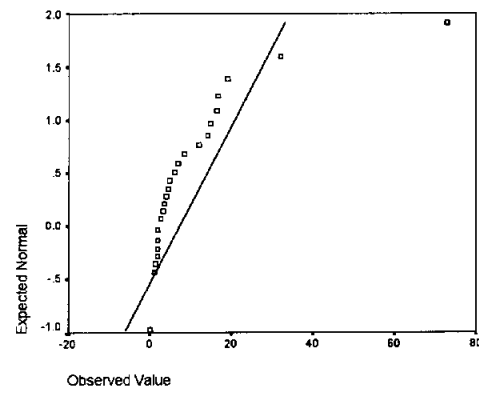
Descriptives			Statistic	Std. Error
March-April Inflows	Mean		7.2627	2.2927
	95% Confidence Interval for Mean	Lower Bound	2.6034	
		Upper Bound	11.9221	
	5% Trimmed Mean		4.9903	
	Median		2.0000	
	Variance		183.979	
	Std. Deviation		13.5639	
	Minimum		.00	
	Maximum		73.00	
	Range		73.00	
	Interquartile Range		8.3470	
	Skewness		3.721	.398
	Kurtosis		16.549	.778

**Table .2.9** Extreme Values for the March-April Inflow data.

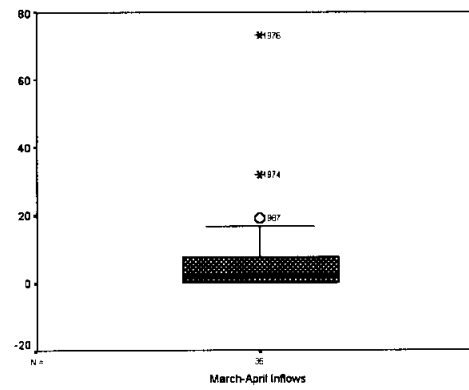
Extreme Values					
		Case Number	Year	Value	
March-April Inflows	Highest	1	18	1976	73.00
		2	16	1974	32.00
		3	29	1987	19.17
		4	24	1982	16.68
		5	34	1992	16.57
	Lowest	1	9	1967	.00
		2	1	1959	.00
		3	15	1973	.00
		4	6	1964	.00
		5	17	1975	. <sup>a</sup>

<sup>a</sup>. Only a partial list of cases with the value 0 are shown in the table of lower extremes.

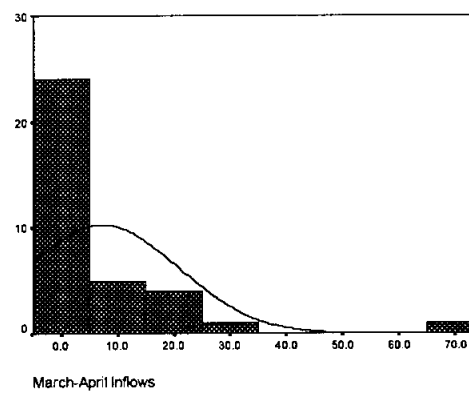




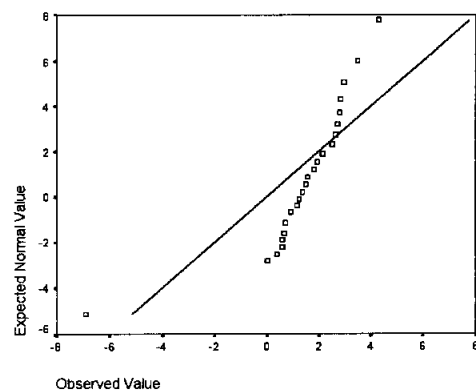
**Figure 2.19** Normal Q-Q Plot of March-April Inflows.



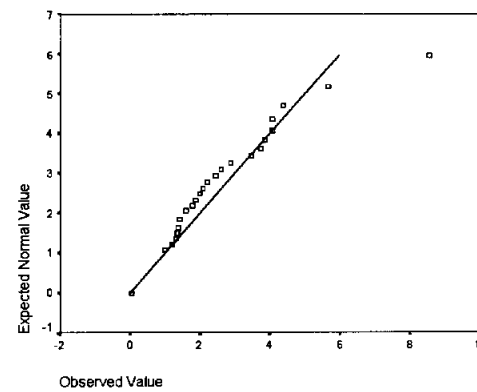
**Figure 2.20** BoxPlot of March-April Inflows.



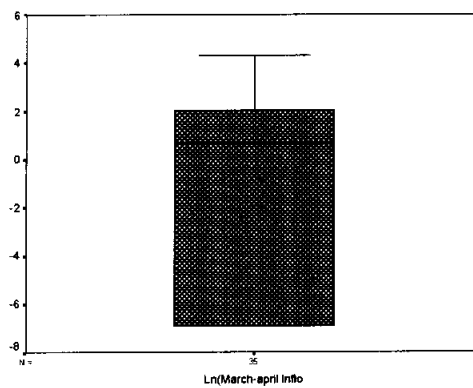
**Figure 2.21** Histogram of March-April Inflows.



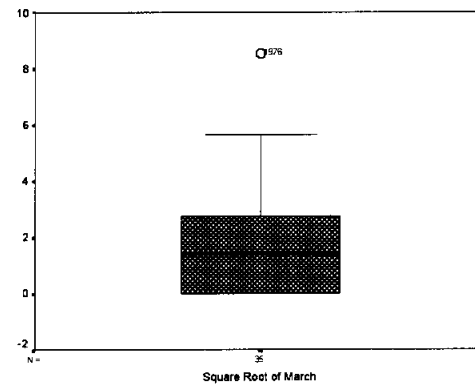
**Figure 2.22** Normal Q-Q Plot of Ln(March-April Inflows).



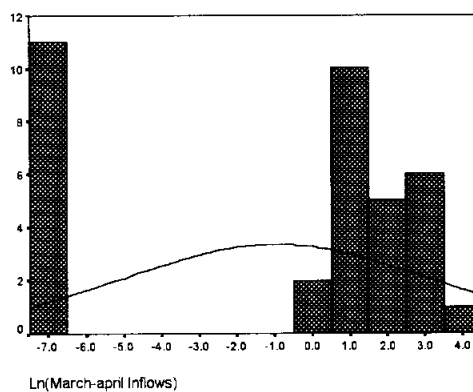
**Figure 2.23** Normal Q-Q Plot of Sqrt(March-April Inflows).



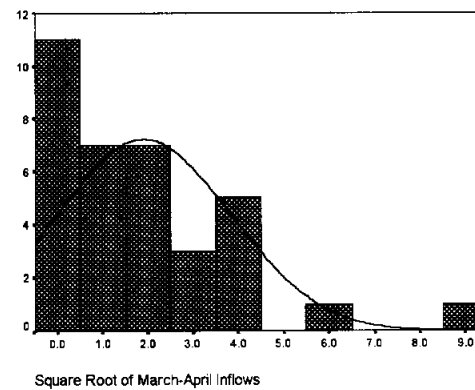
**Figure 2.24** BoxPlot of Ln(March-April Inflows).



**Figure 2.25** BoxPlot of Square Root of March-April Inflows.



**Figure 2.26** Histogram of Ln(March-April Inflows).



**Figure 2.27** Histogram of Sqrt(March-April Inflows).

### 2.2.4 The May-June Inflows data

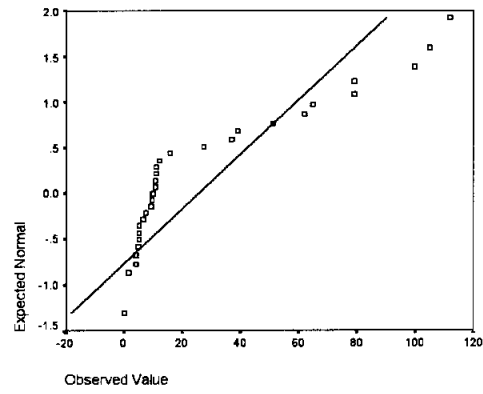
**Table .2.10** Descriptives for the May-June Inflow data.

Descriptives			Statistic	Std. Error
May-June Inflows	Mean		25.7075	5.6963
	95% Confidence Interval for Mean	Lower Bound	14.1313	
		Upper Bound	37.2837	
	5% Trimmed Mean		22.5032	
	Median		10.0000	
	Variance		1135.659	
	Std. Deviation		33.6995	
	Minimum		.00	
	Maximum		112.16	
	Range		112.16	
	Interquartile Range		34.9860	
	Skewness		1.444	.398
	Kurtosis		.834	.778

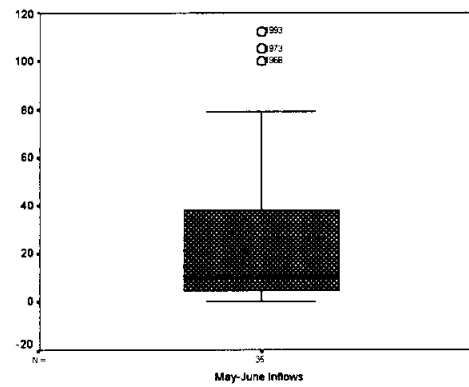
**Table .2.11** Extreme Values for the May-June Inflow data.

Extreme Values						
		Case Number	Year	Value		
May-June Inflows	Highest	1	35	1993	112.16	
		2	15	1973	105.00	
		3	8	1966	100.00	
		4	23	1981	79.01	
		5	10	1968	79.00	
	Lowest	1	6	1964	.00	
		2	9	1967	.00	
		3	11	1969	.00	
		4	5	1963	.00	
		5	13	1971	.00	<sup>a</sup>

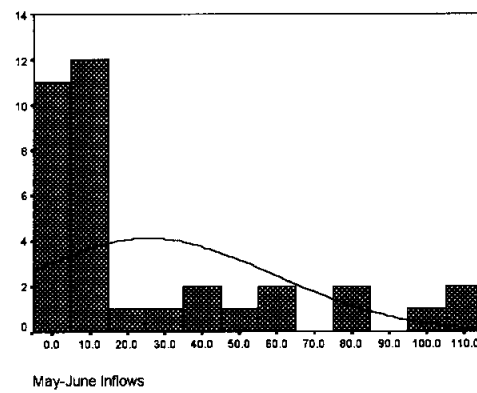
a. Only a partial list of cases with the value 0 are shown in the table of lower extremes.



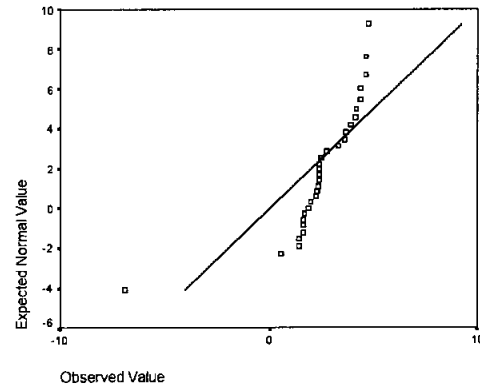
**Figure 2.28** Normal Q-Q Plot of May-June Inflows.



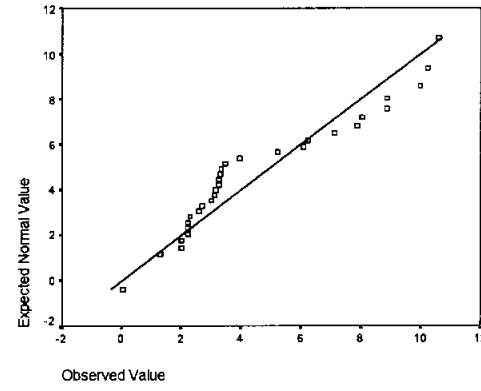
**Figure 2.29** BoxPlot of May-June Inflows.



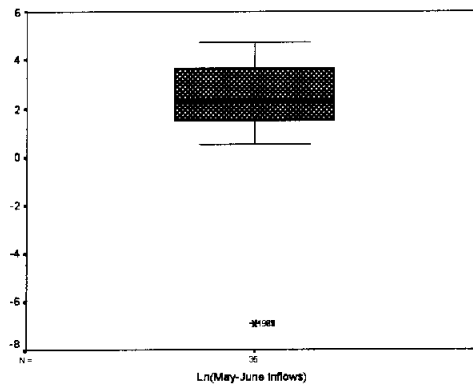
**Figure 2.30** Histogram of May-June Inflows.



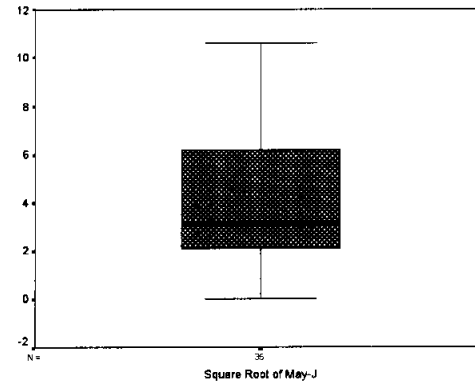
**Figure 2.31** Normal Q-Q Plot of Ln(May-June Inflows).



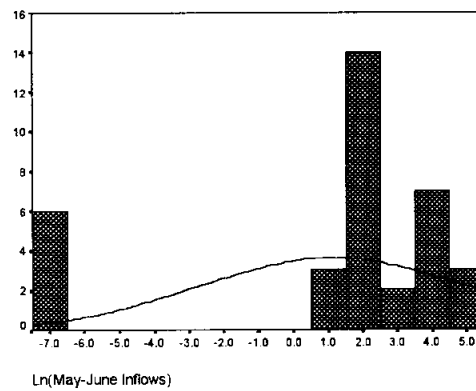
**Figure 2.32** Normal Q-Q Plot of Sqrt(May-June Inflows).



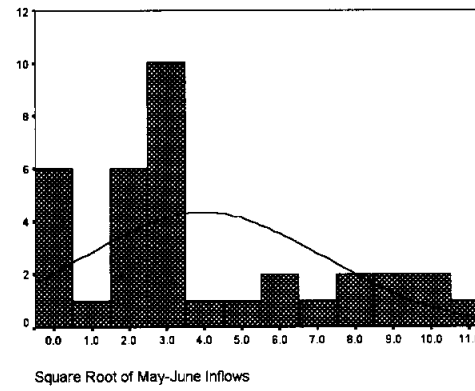
**Figure 2.33** BoxPlot of Ln(May-June) Inflows



**Figure 2.34** BoxPlot of Square Root of May-June Inflows.



**Figure 2.35** Histogram of Ln(May-June Inflows).



**Figure 2.36** Histogram of Sqrt(May-June Inflows).

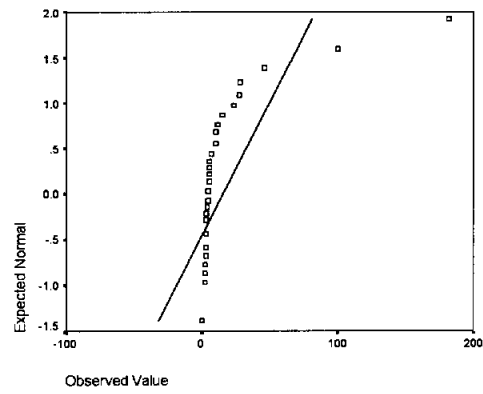
## 2.2.5 The July-August Inflows data

Table .2.12 Descriptives for the July-August Inflow data.

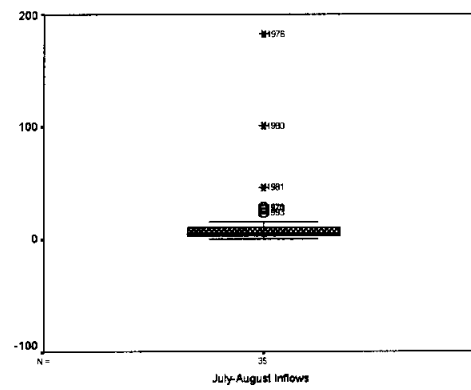
Descriptives			Statistic	Std. Error
July-August Inflows	Mean		15.4233	5.8007
	95% Confidence Interval for Mean	Lower Bound	3.6348	
		Upper Bound	27.2117	
	5% Trimmed Mean		8.9710	
	Median		5.0000	
	Variance		1177.688	
	Std. Deviation		34.3175	
	Minimum		.00	
	Maximum		182.00	
	Range		182.00	
	Interquartile Range		7.5760	
	Skewness		4.027	.398
	Kurtosis		17.550	.778

Table .2.13 Extreme Values for the July-August Inflow data.

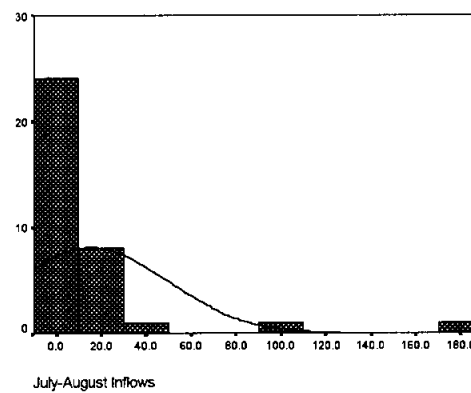
Extreme Values					
		Case Number	Year	Value	
July-August Inflows	Highest	1	18	1976	182.00
		2	22	1980	100.30
		3	23	1981	45.83
		4	12	1970	28.00
		5	13	1971	27.00
	Lowest	1	4	1962	.00
		2	2	1960	.00
		3	7	1965	.00
		4	8	1966	.00
		5	5	1963	.00



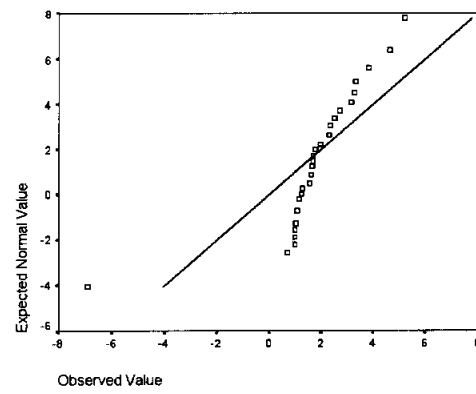
**Figure 2.37** Normal Q-Q Plot of July-August Inflows.



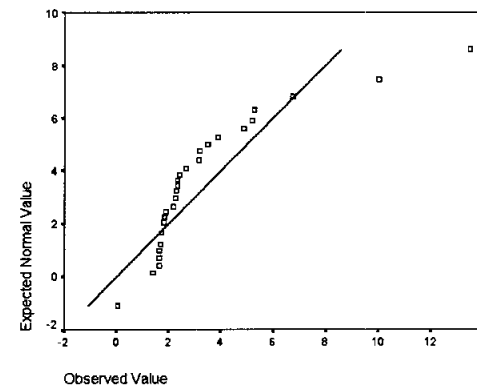
**Figure 2.38** BoxPlot of July-August Inflows.



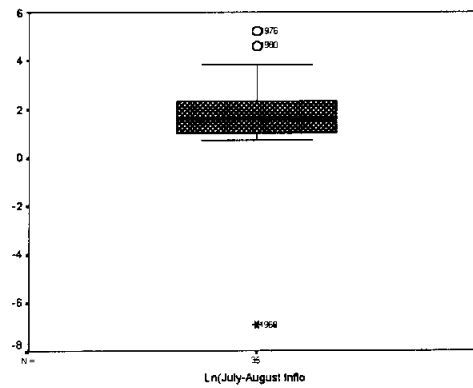
**Figure 2.39** Histogram of July-August Inflows.



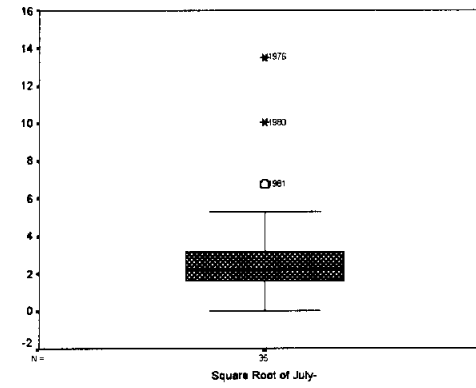
**Figure 2.40** Normal Q-Q Plot of Ln(July-August Inflows).



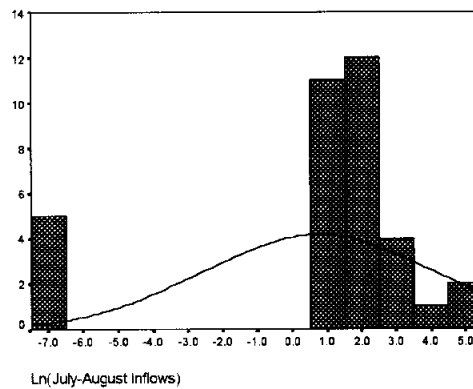
**Figure 2.41** Normal Q-Q Plot of Sqrt(July-August Inflows).



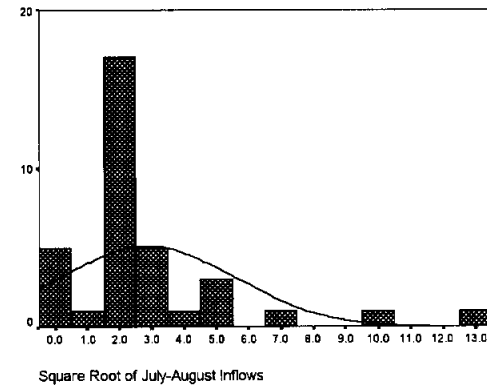
**Figure 2.42** BoxPlot of Ln(July-August Inflows).



**Figure 2.43** BoxPlot of Square Root of July-August Inflows.



**Figure 2.44** Histogram of Ln(July-August Inflows).



**Figure 2.45** Histogram of Sqrt(July-August Inflows).



## 2.2.6 The September-October Inflows data

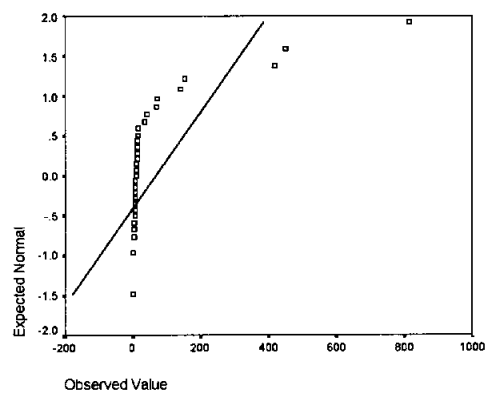
Table .2.14 Descriptives for the September-October Inflow data.

Descriptives			Statistic	Std. Error
September-October Inflows	Mean		67.3261	28.1078
	95% Confidence Interval for Mean	Lower Bound	10.2042	
		Upper Bound	124.4479	
	5% Trimmed Mean		38.2194	
	Median		8.0000	
	Variance		27651.613	
	Std. Deviation		166.2877	
	Minimum		.00	
	Maximum		815.00	
	Range		815.00	
	Interquartile Range		30.3860	
	Skewness		3.474	.398
	Kurtosis		12.758	.778

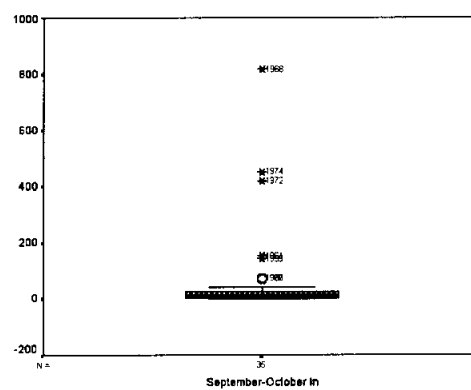
Table .2.15 Extreme Values for the September-October Inflow data.

Extreme Values					
		Case Number	Year	Value	
September-October Inflows	Highest	1	10	1968	815.00
		2	16	1974	450.00
		3	14	1972	418.00
		4	3	1961	152.00
		5	1	1959	140.00
	Lowest	1	9	1967	.00
		2	7	1965	.00
		3	5	1963	.00
		4	6	1964	.00
		5	11	1969	.a

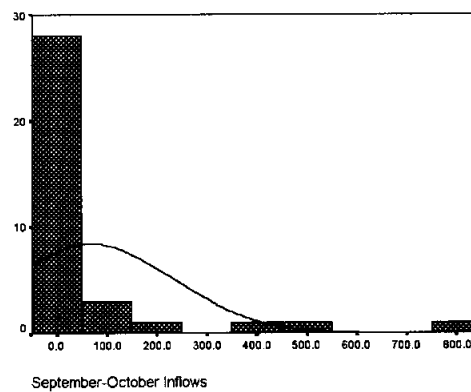
a. Only a partial list of cases with the value 1 are shown in the table of lower extremes.



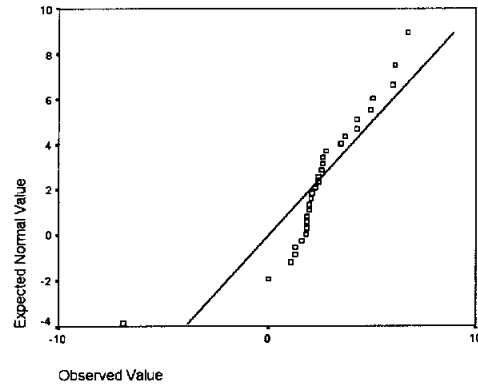
**Figure 2.46** Normal Q-Q Plot of September-October Inflows.



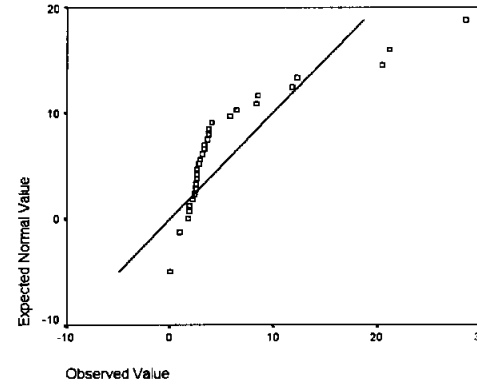
**Figure 2.47** BoxPlot of September-October Inflows.



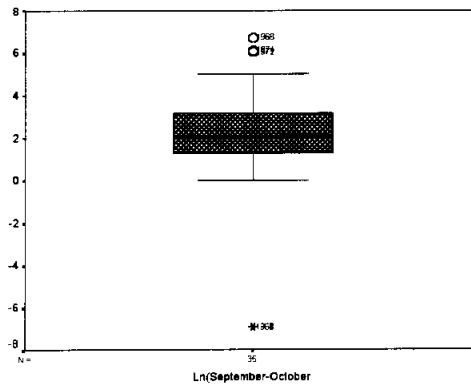
**Figure 2.48** Histogram of September-October Inflows.



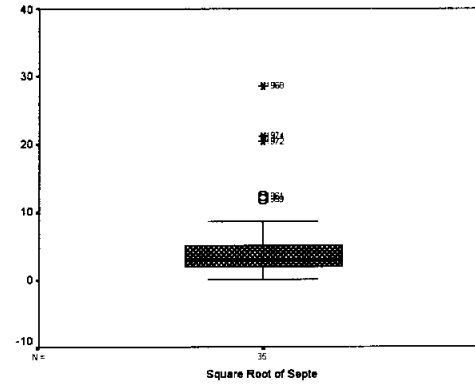
**Figure 2.49** Normal Q-Q Plot of  $\text{Ln}(\text{September-October Inflows})$ .



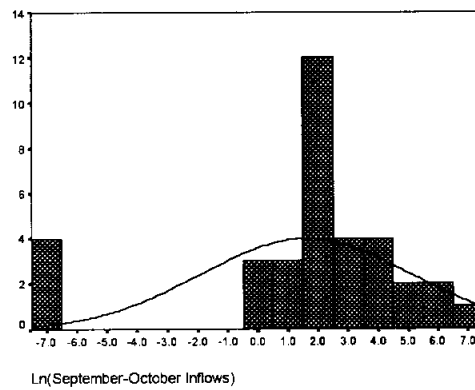
**Figure 2.50** Normal Q-Q Plot of  $\text{Sqrt}(\text{September-October Inflows})$ .



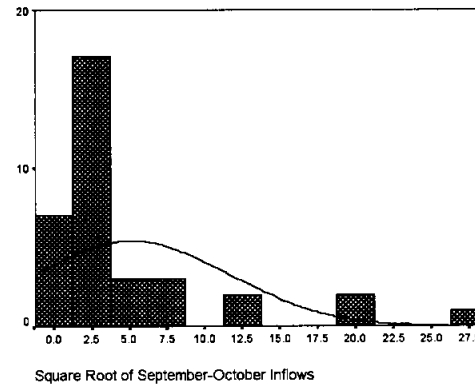
**Figure 2.51** BoxPlot of  $\text{Ln}(\text{September-October})$  Inflows.



**Figure 2.52** BoxPlot of Square Root of September-October Inflows.



**Figure 2.53** Histogram of  $\text{Ln}(\text{September-October Inflows})$ .



**Figure 2.54** Histogram of  $\text{Sqrt}(\text{September-October Inflows})$ .

## 2.2.7 The November-December Inflows data

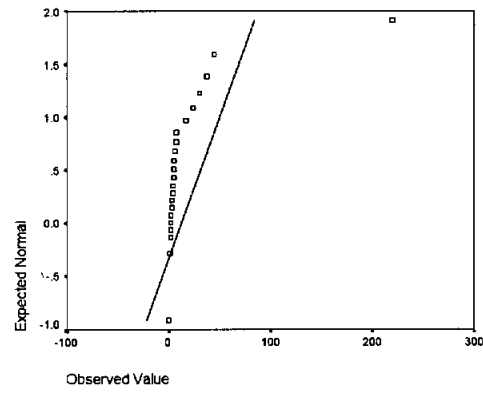
Table .2.16 Descriptives for the November-December Inflow data.

Descriptives			Statistic	Std. Error
November-December Inflows	Mean		12.4743	6.3789
	95% Confidence Interval for Mean	Lower Bound	-.4892	
		Upper Bound	25.4378	
	5% Trimmed Mean		5.8013	
	Median		2.5160	
	Variance		1424.166	
	Std. Deviation		37.7381	
	Minimum		.00	
	Maximum		220.00	
	Range		220.00	
	Interquartile Range		6.4890	
	Skewness		5.199	.398
	Kurtosis		28.843	.778

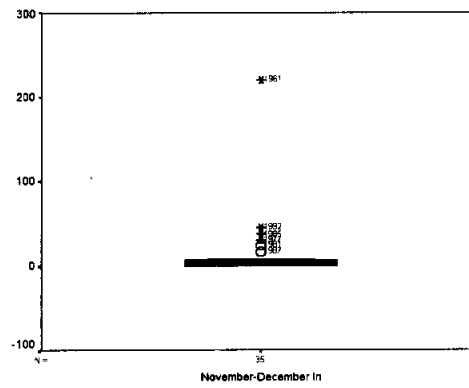
Table .2.17 Extreme Values for the November-December Inflow data.

Extreme Values					
		Case Number	Year	Value	
November-December Inflows	Highest	1	3	1961	220.00
		2	34	1992	45.15
		3	27	1985	37.14
		4	19	1977	30.00
		5	23	1981	23.86
	Lowest	1	9	1967	.00
		2	11	1969	.00
		3	8	1966	.00
		4	13	1971	.00
		5	15	1973	.00 <sup>a</sup>

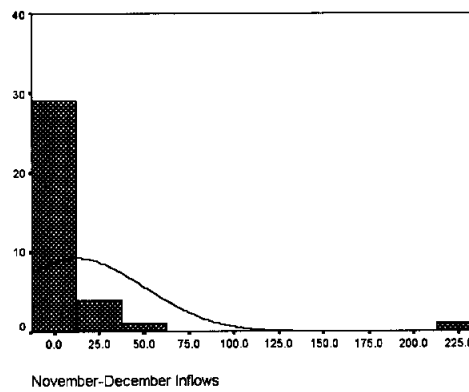
a. Only a partial list of cases with the value 0 are shown in the table of lower extremes.



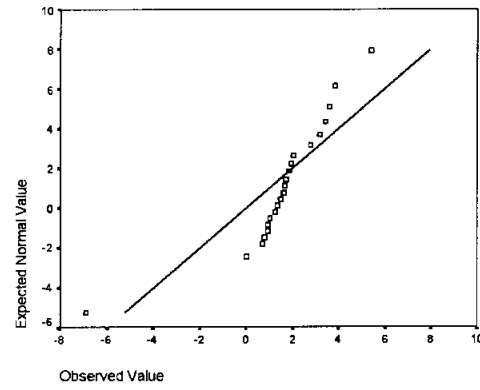
**Figure 2.55** Normal Q-Q Plot of November-December Inflows.



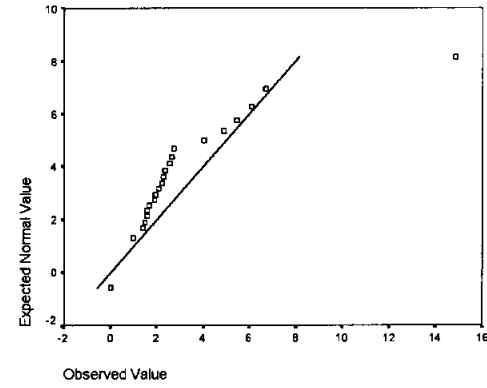
**Figure 2.56** BoxPlot of November-December Inflows.



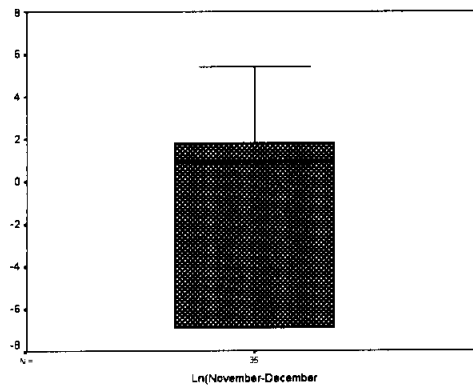
**Figure 2.57** Histogram of November-December Inflows.



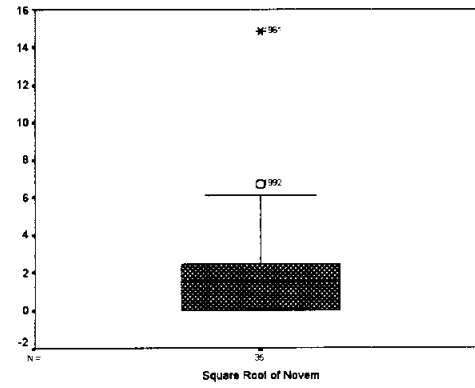
**Figure 2.58** Normal Q-Q Plot of  $\text{Ln}(\text{November\_December Inflows})$ .



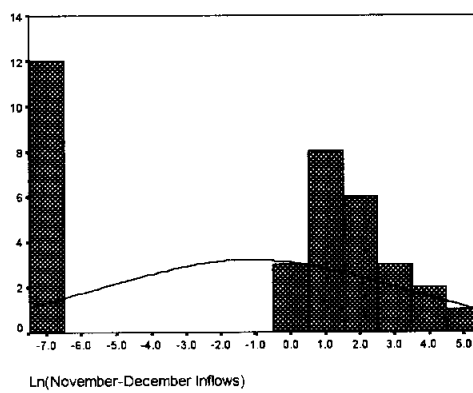
**Figure 2.59** Normal Q-Q Plot of  $\text{Sqrt}(\text{November\_December Inflows})$ .



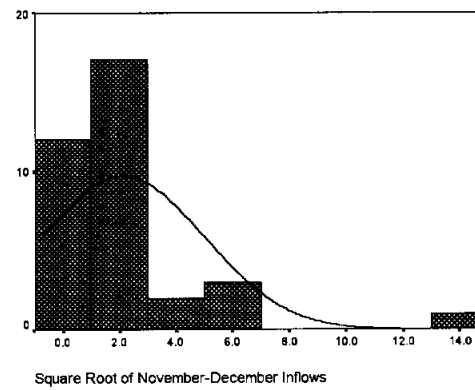
**Figure 2.60** BoxPlot of  $\text{Ln}(\text{November\_December Inflows})$ .



**Figure 2.61** BoxPlot of Square Root of  $\text{November\_December Inflows}$ .

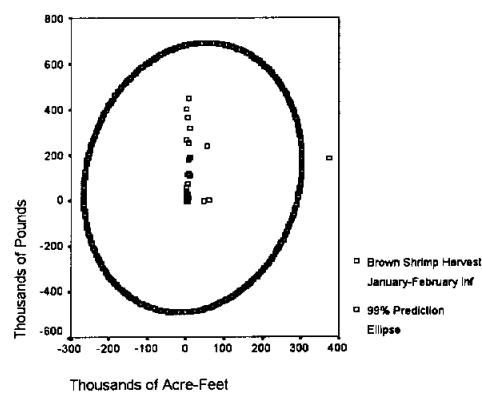


**Figure 2.62** Histogram of  $\text{Ln}(\text{November\_December Inflows})$ .

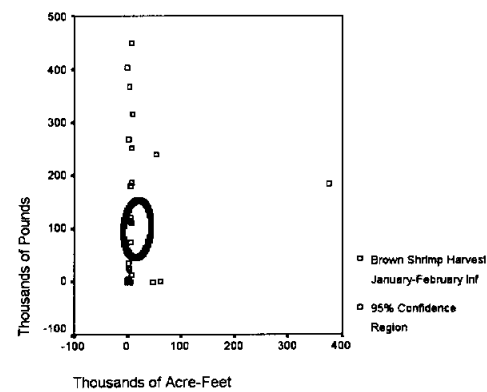


**Figure 2.63** Histogram of  $\text{Sqrt}(\text{November\_December Inflows})$ .

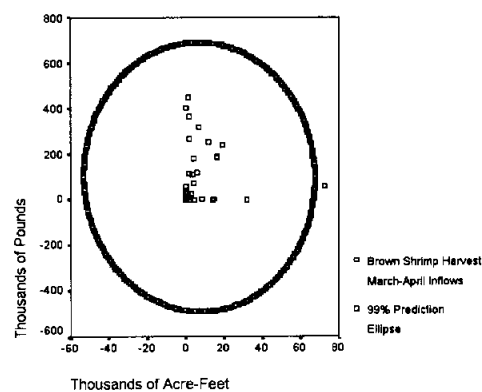
## 3. PREDICTION ELLIPSES AND CONFIDENCE REGIONS



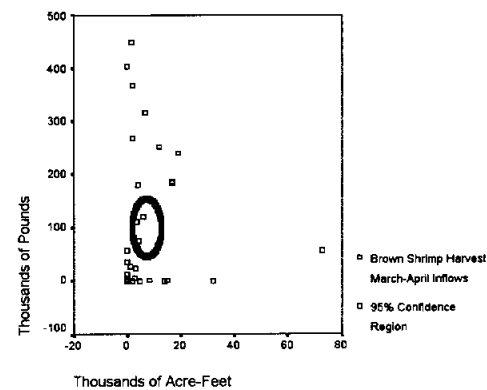
*Figure 3.1* Brown Shrimp Harvest vs. January-February Inflows, PE.



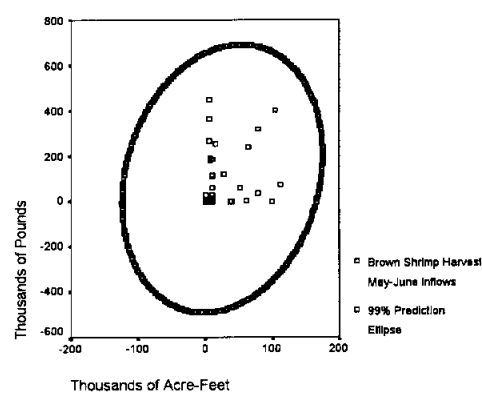
*Figure 3.2* Brown Shrimp Harvest vs. January-February Inflows, CR.



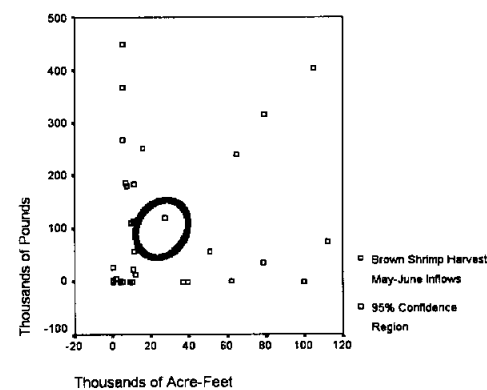
*Figure 3.3* Brown Shrimp Harvest vs. March-April Inflows, PE.



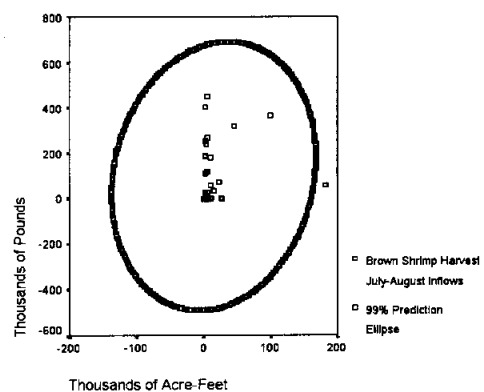
*Figure 3.4* Brown Shrimp Harvest vs. March-April Inflows, CR.



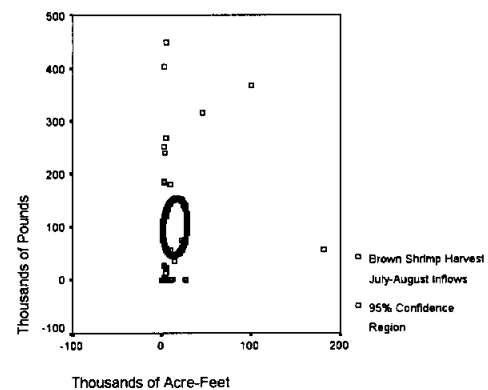
*Figure 3.5* Brown Shrimp Harvest vs. May-June Inflows, PE.



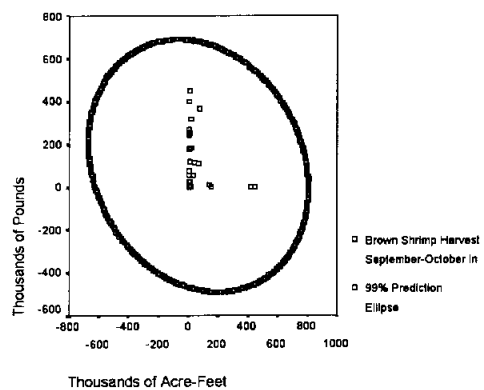
*Figure 3.6* Brown Shrimp Harvest vs. May-June Inflows, CR.



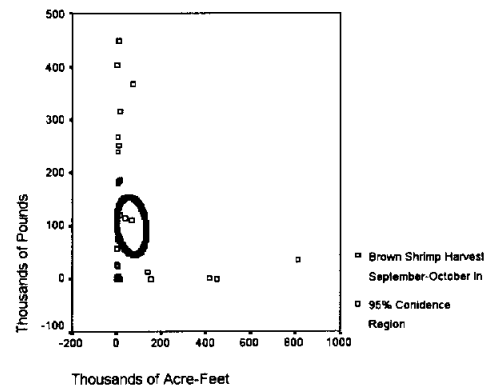
**Figure 3.7** Brown Shrimp Harvest vs. July-August Inflows, PE.



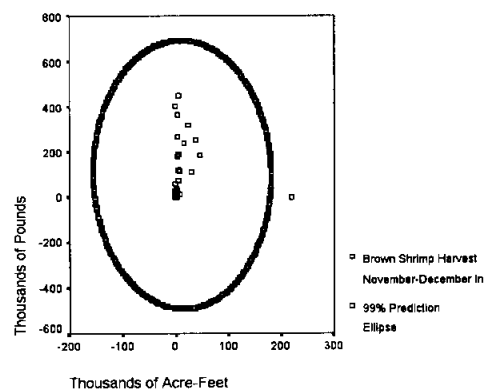
**Figure 3.8** Brown Shrimp Harvest vs. July-August Inflows, CR.



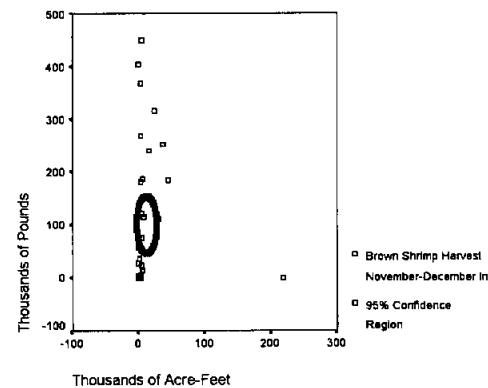
**Figure 3.9** Brown Shrimp Harvest vs. September-October Inflows, PE.



**Figure 3.10** Brown Shrimp Harvest vs. September-October Inflows, CR.

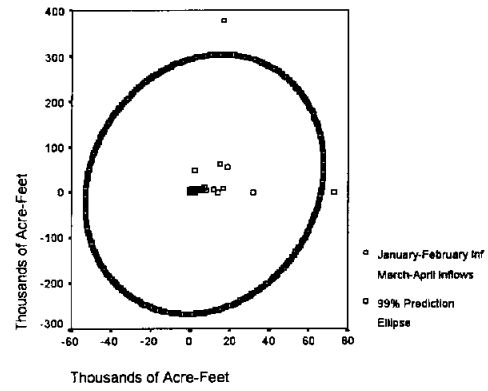


**Figure 3.11** Brown Shrimp Harvest vs. November-December Inflows, PE.

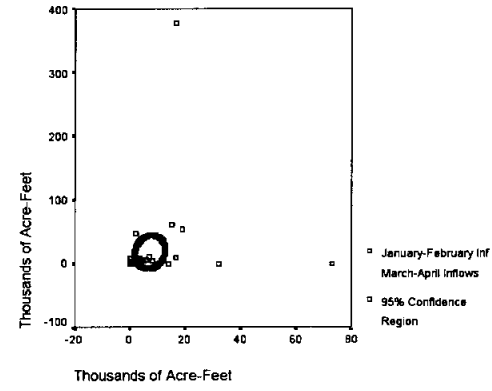


**Figure 3.12** Brown Shrimp Harvest vs. November-December Inflows, CR.

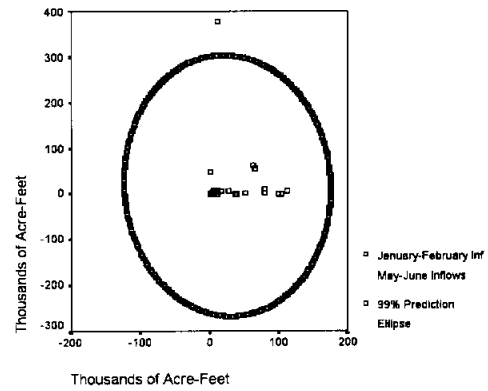




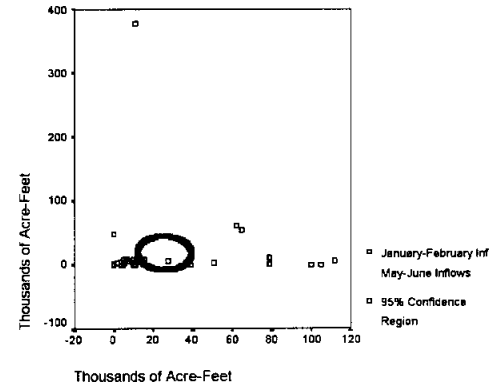
**Figure 3.13** January-February Inflows vs. March-April Inflows, PE.



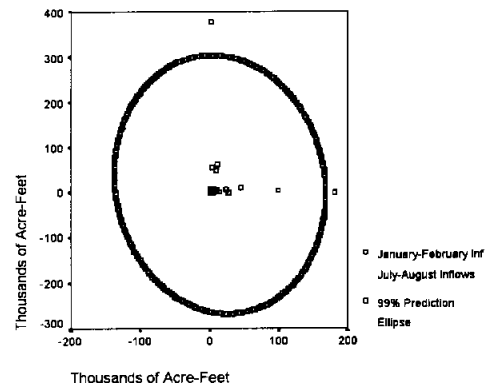
**Figure 3.14** January-February Inflows vs. March-April Inflows, CR.



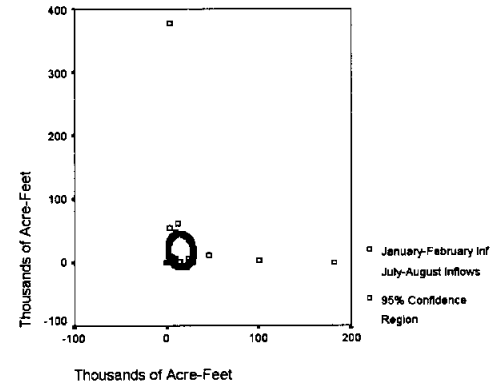
**Figure 3.15** January-February Inflows vs. May-June Inflows, PE.



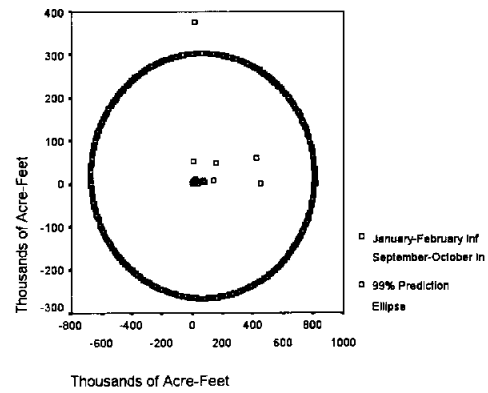
**Figure 3.16** January-February Inflows vs. May-June Inflows, CR.



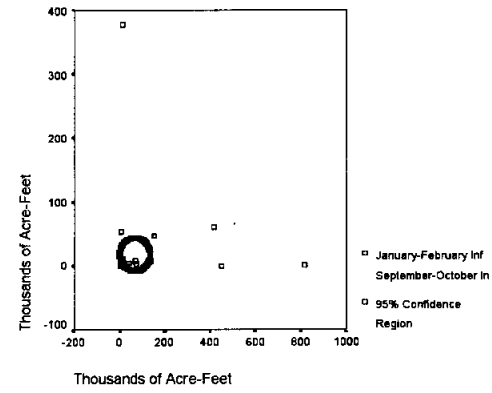
**Figure 3.17** January-February Inflows vs. July-August Inflows, PE.



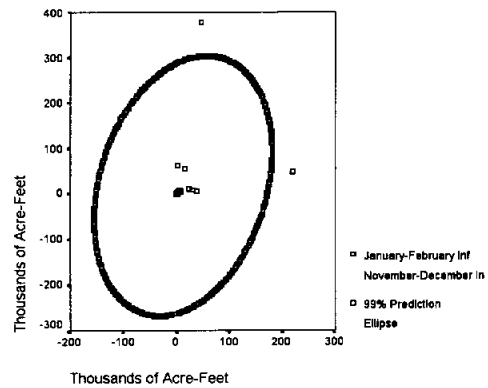
**Figure 3.18** January-February Inflows vs. July-August Inflows, CR.



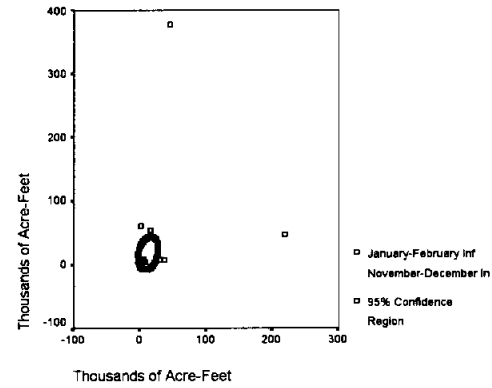
**Figure 3.19** January-February Inflows vs. September-October Inflows, PE.



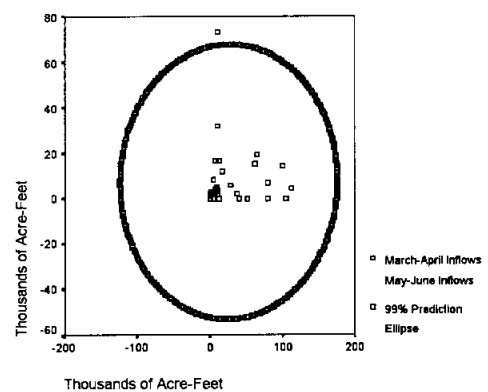
**Figure 3.20** January-February Inflows vs. September-October Inflows, CR.



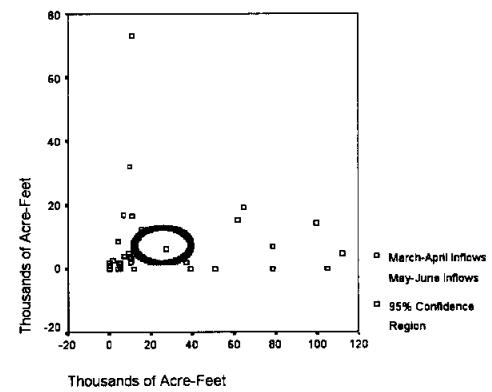
**Figure 3.21** January-February Inflows vs. November-December Inflows, PE.



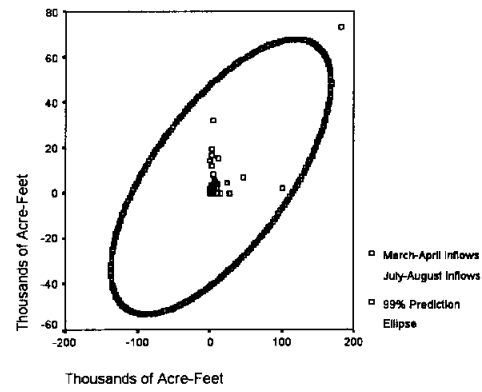
**Figure 3.22** January-February Inflows vs. November-December Inflows, CR.



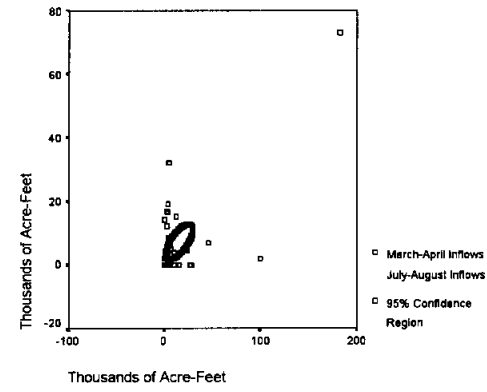
**Figure 3.23** March-April Inflows vs. May-June Inflows, PE.



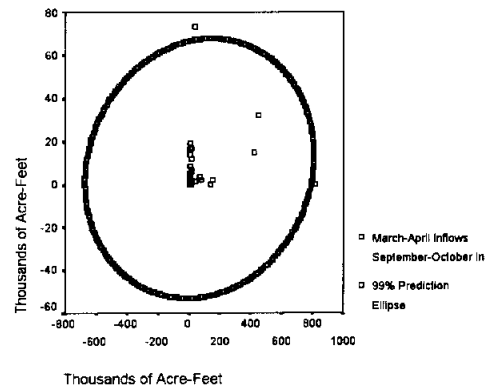
**Figure 3.24** March-April Inflows vs. May-June Inflows, CR.



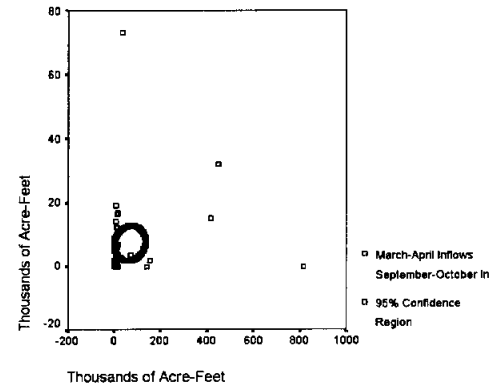
**Figure 3.25** March-April Inflows vs. July-August Inflows, PE.



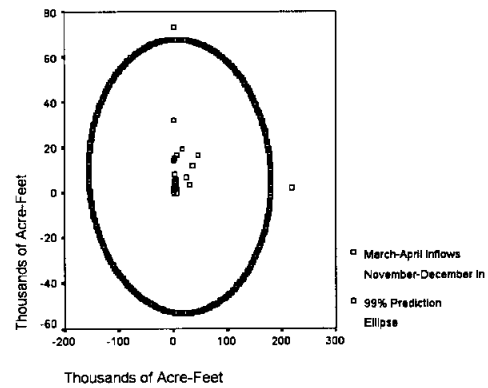
**Figure 3.26** March-April Inflows vs. July-August Inflows, CR.



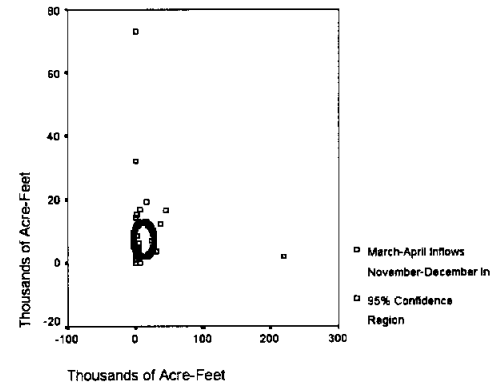
**Figure 3.27** March-April Inflows vs. September-October Inflows, PE.



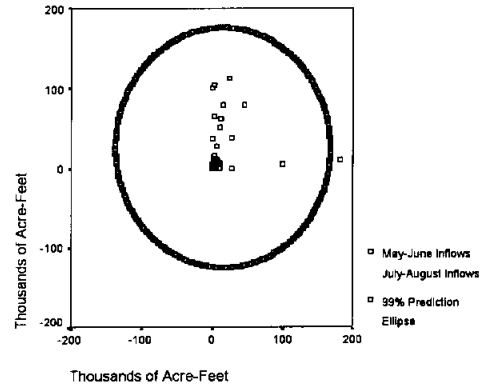
**Figure 3.28** March-April Inflows vs. September-October Inflows, CR.



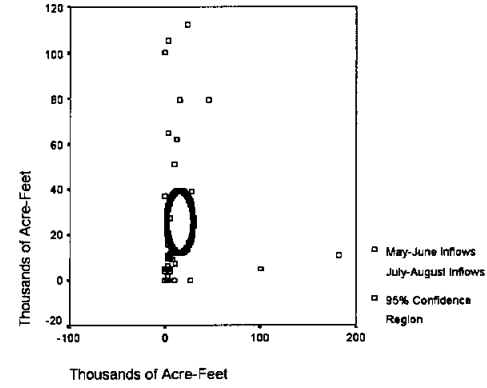
**Figure 3.29** March-April Inflows vs. November-December Inflows, PE.



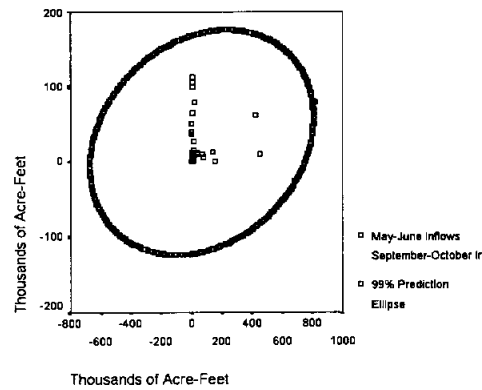
**Figure 3.30** March-April Inflows vs. November-December Inflows, CR.



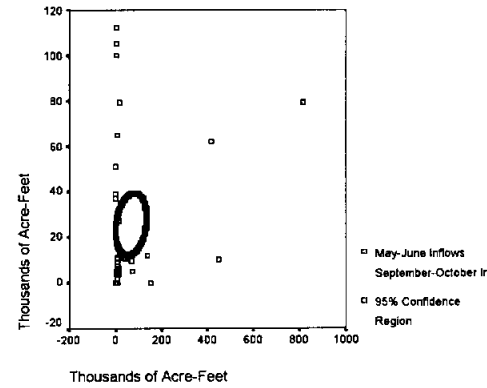
**Figure 3.31** *May-June Inflows vs. July-August Inflows, PE.*



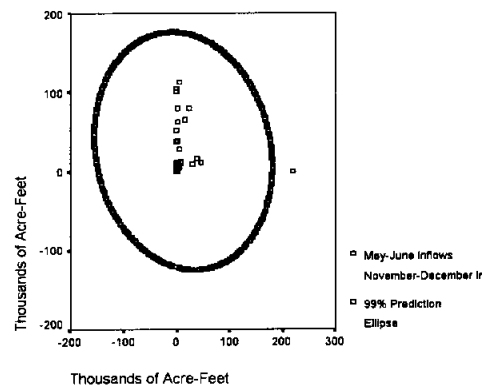
**Figure 3.32** *May-June Inflows vs. July-August Inflows, CR.*



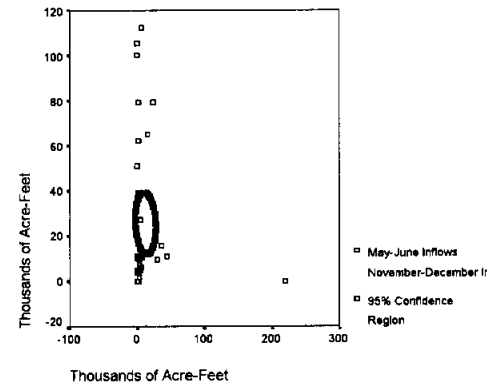
**Figure 3.33** *May-June Inflows vs. September-October Inflows, PE.*



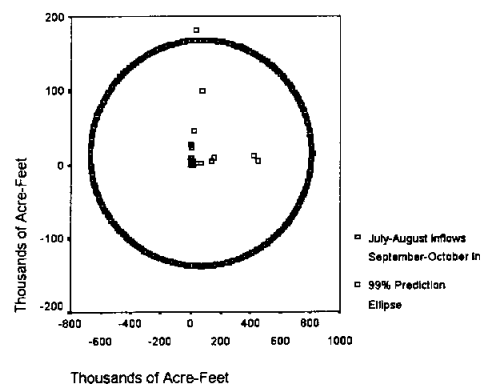
**Figure 3.34** *May-June Inflows vs. September-October Inflows, CR.*



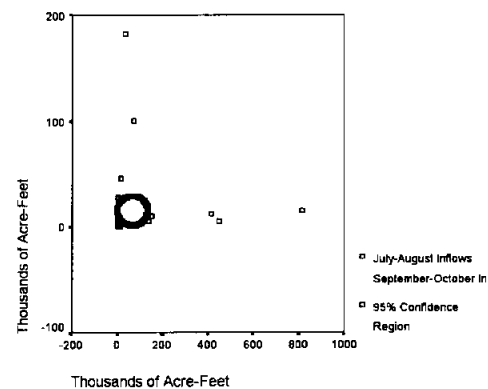
**Figure 3.35** *May-June Inflows vs. November-December Inflows, PE.*



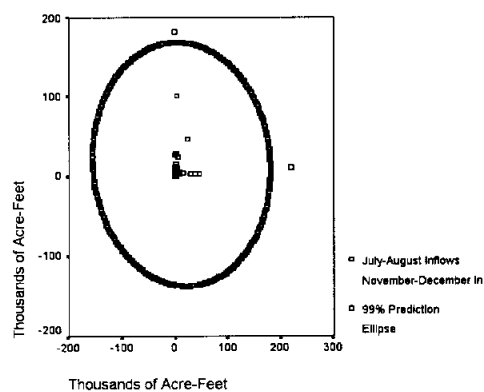
**Figure 3.36** *May-June Inflows vs. November-December Inflows, CR.*



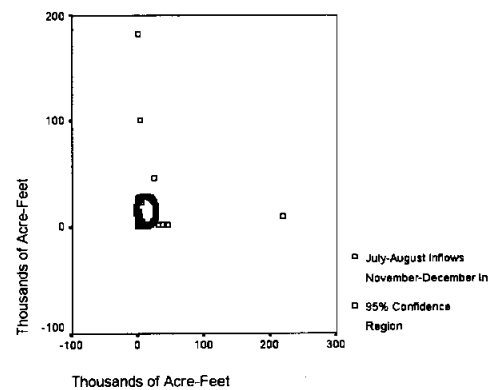
**Figure 3.37** July-August Inflows. vs. September-October Inflows, PE.



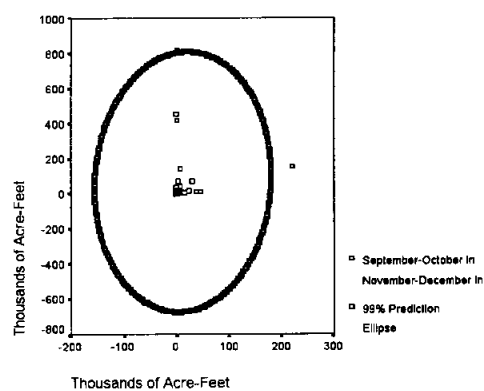
**Figure 3.38** July-August Inflows. vs. September-October Inflows, CR.



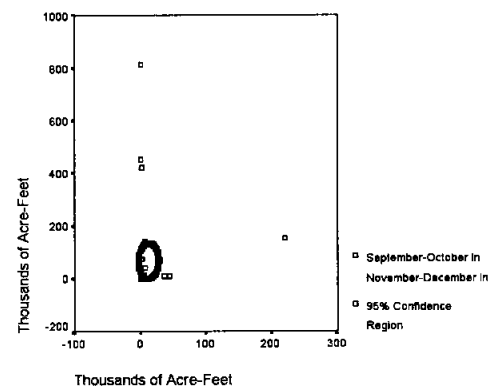
**Figure 3.39** July-August Inflows. vs. November-December Inflows, PE.



**Figure 3.40** July-August Inflows. vs. November-December Inflows, CR.



**Figure 3.41** September-October Inflows vs. November-December Inflows, PE.

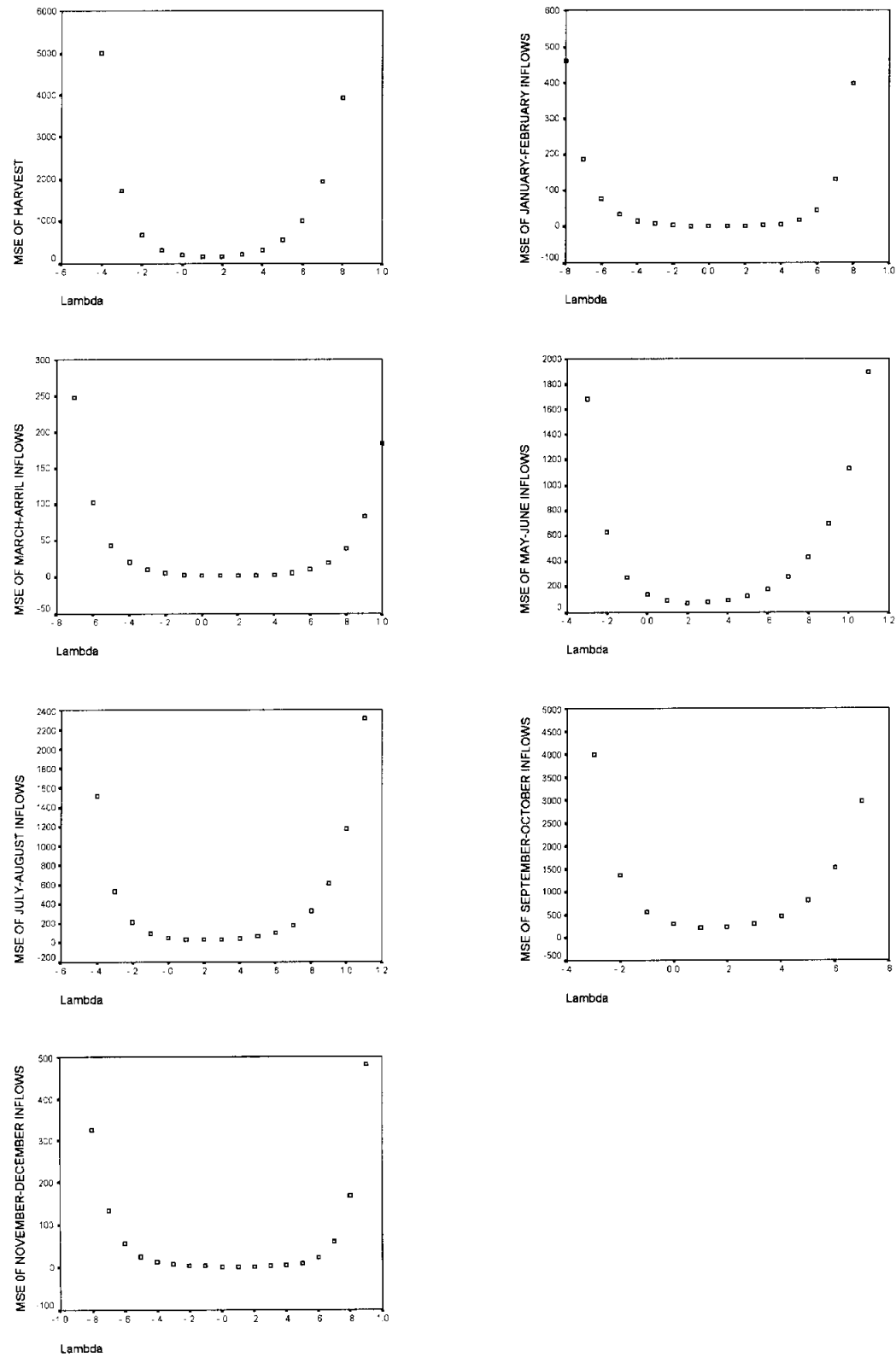


**Figure 3.42** September-October Inflows vs. November-December Inflows, CR.

#### 4. BOX-COX ANALYSIS

**Table .4.1** Mean Square Error from Box-Cox transformation of the Brown Shrimp data and the inflow data for different lambda.

Lam	Brown	JF_inflow	MA_inflow	MJ_inflow	JA_inflow	SO_inflow	ND_inflow
-2.0	Shrimp	86892507	1.48E+08	3.06E+13	2.82E+12	3.54E+14	48575282
-1.9	4.77E+12	30038551	50136405	6.81E+12	6.75E+11	7.18E+13	17121067
-1.8	1.09E+12	10442029	17097077	1.52E+12	1.63E+11	1.46E+13	6068140
-1.7	2.51E+11	3652376	5866447	3.43E+11	3.95E+10	3.00E+12	2164038
-1.6	5.82E+10	1286400	2026929	7.76E+10	9.63E+09	6.20E+11	777112.9
-1.5	1.36E+10	456641.2	705829.6	1.77E+10	2.37E+09	1.29E+11	281255.6
-1.4	3.20E+09	163546.1	247985.9	4.08E+09	5.88E+08	2.71E+10	102703.1
-1.3	7.63E+08	59175.5	88021.8	9.51E+08	1.48E+08	5.74E+09	37888.0
-1.2	1.84E+08	21666.3	31615.0	2.24E+08	37440560	1.23E+09	14143.5
-1.1	44868111	8043.6	11513.7	53485857	9634363	2.68E+08	5353.4
-1.0	11141220	3035.7	4262.6	12987856	2520331	59365460	2059.9
-0.9	2821956	1168.6	1609.5	3217276	672506.8	13398616	808.4
-0.8	732386.4	460.8	622.5	816661.0	183838.6	3098350	324.9
-0.7	195952.9	187.2	248.0	213705.3	51782.7	738443.6	134.5
-0.6	54509.3	78.9	102.6	58125.2	15145.2	182856.3	57.8
-0.5	15956.9	34.9	44.4	16616.8	4646.7	47567.0	26.0
-0.4	5002.9	16.4	20.4	5069.7	1515.9	13200.9	12.4
-0.3	1724.1	8.3	10.1	1684.9	535.2	3996.2	6.4
-0.2	678.2	4.7	5.53	626.7	209.3	1364.8	3.7
-0.1	320.8	3.0	3.40	270.0	93.6	555.4	2.4
0.0	193.5	2.2	2.41	140.5	49.9	292.3	1.8
<u>0.1</u>	<u>154.7</u>	<u>2.1</u>	<u>2.02</u>	91.6	33.3	<u>215.7</u>	<u>1.6</u>
<u>0.2</u>	162.3	2.4	2.03	<u>76.0</u>	<u>28.7</u>	223.7	1.9
0.3	211.8	3.8	2.44	78.0	31.6	299.5	2.7
0.4	322.9	7.4	3.44	93.9	41.9	471.2	4.8
0.5	548.3	17.4	5.55	126.1	63.1	819.5	10.1
0.6	1004.3	46.0	9.90	181.8	103.5	1525.8	23.9
0.7	1944.5	131.8	19.0	275.1	180.0	2987.2	61.6
0.8	3927.7	399.2	38.9	430.9	326.4	6083.6	168.3
0.9	8202.8	1259.7	83.0	692.4	611.8	12796.2	481.3
1.0	17600.7	4100.5	184.0	1135.7	1177.7	27651.6	1424.2
1.1	38620.3	13675.8	419.9	1894.3	2317.6	61139.6	4327.1
1.2	86354.7	46505.3	982.3	3205.2	4646.8	137873.7	13426.7
1.3	196223.8	160665.8	2344.9	5491.2	9466.6	316268.9	42376.8
1.4	452133.6	562397.4	5694.1	9511.5	19553.4	736389.9	135627.8
1.5	1054551	1990490	14027.8	16637.9	40876.1	1737211	439157.7
1.6	2486151	7111648	34985.3	29362.1	86357.0	4146033	1436031
1.7	5917327	25616335	88175.3	52234.9	184150.6	9997473	4735512
1.8	14204424	92929434	224256.3	93607.6	395953.8	24330319	15730548
1.9	34359686	3.39E+08	574858.6	168875.0	857684.6	59702735	52590048
2.0	83691768	1.25E+09	1483772	306538.3	1870221	1.48E+08	1.77E+08



**Figure 4.1** Box-Cox Transformation - MSE of Brown Shrimp vs.  $\lambda$  and MSE of Inflow data vs.  $\lambda$ .

## 5. MODEL CHOICE DIAGNOSTICS

### 5.1 Untransformed brown shrimp data and untransformed inflow data

**Table 5.1** Regression Models for Dependent Variable: BROWN SHRIMP on INFLOWS

In	Rsq	Adj Rsq	C(p)	AIC	MSE	SBC	Variables in Model
1	0.0341	0.0048	1.001	343.9	17516	347.0	QSO_LAG
1	0.0337	0.0044	1.015	343.9	17523	347.0	QMJ_LAG
1	0.0195	-.0102	1.484	344.4	17780	347.6	QJA_LAG
1	0.0146	-.0153	1.648	344.6	17870	347.7	QJF_LAG
-----							
2	0.0870	0.0300	1.248	343.9	17073	348.6	QMJ_LAG QSO_LAG
2	0.0538	-.0053	2.348	345.2	17695	349.9	QJA_LAG QSO_LAG
2	0.0536	-.0055	2.354	345.2	17698	349.9	QMJ_LAG QJA_LAG
2	0.0498	-.0096	2.480	345.3	17769	350.0	QJF_LAG QMJ_LAG
-----							
3	0.1073	0.0209	2.575	345.2	17232	351.4	QMJ_LAG QJA_LAG QSO_LAG
3	0.1032	0.0164	2.711	345.3	17312	351.5	QJF_LAG QMJ_LAG QSO_LAG
3	0.0877	-.0006	3.224	345.9	17611	352.1	QMJ_LAG QSO_LAG QND_LAG
3	0.0871	-.0013	3.246	345.9	17623	352.2	QMA_LAG QMJ_LAG QSO_LAG
-----							
4	0.1267	0.0102	3.934	346.4	17421	354.2	QJF_LAG QMJ_LAG QJA_LAG QSO_LAG
4	0.1225	0.0055	4.073	346.6	17504	354.3	QMA_LAG QMJ_LAG QJA_LAG QSO_LAG
4	0.1121	-.0063	4.416	347.0	17711	354.7	QJF_LAG QMA_LAG QMJ_LAG QJA_LAG
4	0.1085	-.0103	4.535	347.1	17783	354.9	QMJ_LAG QJA_LAG QSO_LAG QND_LAG
-----							
5	0.1546	0.0088	5.008	347.3	17445	356.6	QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG
5	0.1267	-.0239	5.933	348.4	18021	357.7	QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG
5	0.1236	-.0275	6.036	348.5	18085	357.9	QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG
5	0.1134	-.0395	6.373	348.9	18295	358.3	QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG
-----							
6	0.1549	-.0262	7.000	349.2	18063	360.1	QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG

N = 35



## 5.2 Log of brown shrimp data and log of inflow data

**Table 5.2** Regression Models for Dependent Variable:  $\ln(\text{BROWN SHRIMP})$  on  $\ln(\text{INFLOWS})$

In	<i>Rsq</i>	<i>Adj Rsq</i>	<i>C(p)</i>	<i>AIC</i>	<i>MSE</i>	<i>SBC</i>	Variables in Model
1	0.3687	0.3495	8.664	100.5	16.72	103.6	LN_QJA
1	0.3289	0.3086	11.16	102.7	17.77	105.8	LN_QJF
1	0.1434	0.1175	22.81	111.2	22.68	114.3	LN_QND
1	0.0688	0.0406	27.50	114.1	24.66	117.2	LN_QSO
-----							
2	0.4739	0.4410	4.054	96.13	14.37	100.8	LN_QJF LN_QJA
2	0.4106	0.3737	8.030	100.1	16.09	104.8	LN_QMJ LN_QJA
2	0.3952	0.3574	8.995	101.0	16.51	105.7	LN_QJA LN_QND
2	0.3814	0.3427	9.863	101.8	16.89	106.5	LN_QMA LN_QJA
-----							
3	0.4979	0.4493	4.542	96.49	14.15	102.7	LN_QJF LN_QJA LN_QND
3	0.4892	0.4397	5.094	97.10	14.40	103.3	LN_QJF LN_QMJ LN_QJA
3	0.4871	0.4374	5.224	97.24	14.46	103.5	LN_QJF LN_QJA LN_QSO
3	0.4762	0.4255	5.908	97.98	14.76	104.2	LN_QJF LN_QMA LN_QJA
-----							
4	0.5242	0.4607	4.894	96.62	13.86	104.4	LN_QJF LN_QMJ LN_QJA LN_QSO
4	0.5135	0.4486	5.565	97.39	14.17	105.2	LN_QJF LN_QMJ LN_QJA LN_QND
4	0.5115	0.4464	5.688	97.53	14.23	105.3	LN_QJF LN_QJA LN_QSO LN_QND
4	0.5001	0.4335	6.403	98.34	14.56	106.1	LN_QJF LN_QMA LN_QJA LN_QND
-----							
5	0.5494	0.4717	5.309	96.71	13.58	106.0	LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND
5	0.5292	0.4481	6.576	98.24	14.18	107.6	LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO
5	0.5199	0.4372	7.159	98.92	14.46	108.3	LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND
5	0.5124	0.4283	7.634	99.47	14.69	108.8	LN_QJF LN_QMA LN_QJA LN_QSO LN_QND
-----							
6	0.5543	0.4588	7.000	98.32	13.91	109.2	LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND

N = 35

### 5.3 Square root of brown shrimp data and log of inflow data

**Table 5.3** Regression Models for Dependent Variable:  $\text{Sqrt}(\text{BROWN SHRIMP})$  on  $\text{Ln}(\text{INFLOWS})$

In	<i>Rsq</i>	<i>Adj Rsq</i>	<i>C(p)</i>	<i>AIC</i>	<i>MSE</i>	<i>SBC</i>	Variables in Model
1	0.2257	0.2022	3.044	130.9	39.85	134.0	LN_QJF
1	0.1699	0.1447	5.497	133.4	42.72	136.5	LN_QND
1	0.1616	0.1362	5.860	133.7	43.15	136.8	LN_QJA
1	0.1378	0.1117	6.909	134.7	44.38	137.8	LN_QMJ
-----							
2	0.2896	0.2452	2.233	129.9	37.70	134.6	LN_QJF LN_QMJ
2	0.2777	0.2325	2.758	130.5	38.34	135.2	LN_QMJ LN_QJA
2	0.2660	0.2201	3.272	131.1	38.96	135.7	LN_QJF LN_QJA
2	0.2512	0.2044	3.921	131.7	39.74	136.4	LN_QMJ LN_QND
-----							
3	0.3361	0.2719	2.188	129.5	36.37	135.8	LN_QJF LN_QMJ LN_QJA
3	0.3236	0.2582	2.739	130.2	37.06	136.4	LN_QMJ LN_QJA LN_QND
3	0.2977	0.2297	3.878	131.5	38.48	137.7	LN_QJF LN_QMJ LN_QSO
3	0.2907	0.2221	4.185	131.9	38.86	138.1	LN_QJF LN_QMJ LN_QND
-----							
4	0.3615	0.2764	3.071	130.2	36.15	137.9	LN_QJF LN_QMJ LN_QJA LN_QSO
4	0.3414	0.2536	3.955	131.3	37.28	139.0	LN_QMJ LN_QJA LN_QSO LN_QND
4	0.3378	0.2495	4.116	131.4	37.49	139.2	LN_QJF LN_QMJ LN_QJA LN_QND
4	0.3362	0.2477	4.187	131.5	37.58	139.3	LN_QJF LN_QMA LN_QMJ LN_QJA
-----							
5	0.3630	0.2531	5.008	132.1	37.31	141.4	LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND
5	0.3617	0.2517	5.063	132.2	37.38	141.5	LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO
5	0.3441	0.2310	5.837	133.1	38.41	142.4	LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND
5	0.3378	0.2236	6.115	133.4	38.78	142.8	LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND
-----							
6	0.3632	0.2267	7.000	134.1	38.63	145.0	LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND

N = 35

#### 5.4 Square root of of brown shrimp data and square root of inflow data

**Table 5.4** Regression Models for Dependent Variable:  $\text{Sqrt}(\text{BROWN SHRIMP})$  on  $\text{Sqrt}(\text{INFLOWS})$

In	<i>Rsq</i>	<i>Adj Rsq</i>	<i>C(p)</i>	<i>AIC</i>	<i>MSE</i>	<i>SBC</i>	Variables in Model
1	0.0733	0.0452	3.842	137.2	47.70	140.3	SQR_QJF
1	0.0638	0.0354	4.200	137.6	48.18	140.7	SQR_QMJ
1	0.0622	0.0338	4.258	137.6	48.26	140.7	SQR_QJA
1	0.0457	0.0168	4.880	138.2	49.12	141.3	SQR_QND
-----							
2	0.1414	0.0877	3.283	136.5	45.57	141.2	SQR_QJF SQR_QJA
2	0.1285	0.0741	3.765	137.1	46.25	141.7	SQR_QJF SQR_QMJ
2	0.1206	0.0656	4.065	137.4	46.68	142.0	SQR_QMJ SQR_QND
2	0.1146	0.0593	4.288	137.6	46.99	142.3	SQR_QMJ SQR_QJA
-----							
3	0.1852	0.1064	3.633	136.7	44.64	142.9	SQR_QJF SQR_QMJ SQR_QJA
3	0.1779	0.0984	3.908	137.0	45.04	143.2	SQR_QJF SQR_QJA SQR_QSO
3	0.1699	0.0895	4.211	137.4	45.48	143.6	SQR_QMJ SQR_QJA SQR_QND
3	0.1638	0.0829	4.439	137.6	45.81	143.8	SQR_QJF SQR_QMJ SQR_QSO
-----							
4	0.2386	0.1371	3.626	136.3	43.10	144.1	SQR_QJF SQR_QMJ SQR_QJA SQR_QSO
4	0.2283	0.1254	4.014	136.8	43.69	144.6	SQR_QMJ SQR_QJA SQR_QSO SQR_QND
4	0.1939	0.0864	5.308	138.3	45.64	146.1	SQR_QJF SQR_QMJ SQR_QJA SQR_QND
4	0.1888	0.0807	5.498	138.5	45.92	146.3	SQR_QJF SQR_QMA SQR_QMJ SQR_QJA
-----							
5	0.2540	0.1253	5.050	137.6	43.69	147.0	SQR_QJF SQR_QMJ SQR_QJA SQR_QSO SQR_QND
5	0.2407	0.1098	5.547	138.2	44.47	147.6	SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO
5	0.2286	0.0956	6.004	138.8	45.18	148.1	SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND
5	0.1968	0.0583	7.199	140.2	47.04	149.5	SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QND
-----							
6	0.2553	0.0957	7.000	139.6	45.17	150.4	SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND

N = 35

### 5.5 Various transformation suggested by Box-Cox

**Table 5.6** Regression Models for Dependent Variable:  $(BROWN\ SHRIMP)^{0.1}$  on variously transformed INFLOWS.

In	Rsq	Adj Rsq	C(p)	AIC	MSE	SBC	Variables in Model
1	0.2944	0.2730	7.125	-57.54	0.1828	-54.43	QR_QJF
1	0.2323	0.2091	10.48	-54.59	0.1989	-51.47	QR_QJA
1	0.1566	0.1310	14.57	-51.29	0.2185	-48.18	QR_QND
1	0.0768	0.0488	18.88	-48.13	0.2392	-45.02	QR_QMJ
-----							
2	0.4091	0.3721	2.929	-61.74	0.1579	-57.08	QR_QJF QR_QJA
2	0.3237	0.2815	7.539	-57.02	0.1807	-52.36	QR_QJF QR_QMJ
2	0.3125	0.2696	8.146	-56.45	0.1837	-51.78	QR_QJA QR_QND
2	0.3053	0.2619	8.535	-56.08	0.1856	-51.42	QR_QJF QR_QND
-----							
3	0.4314	0.3764	3.721	-61.09	0.1568	-54.87	QR_QJF QR_QMJ QR_QJA
3	0.4304	0.3753	3.776	-61.03	0.1571	-54.81	QR_QJF QR_QJA QR_QSO
3	0.4213	0.3653	4.270	-60.47	0.1596	-54.25	QR_QJF QR_QJA QR_QND
3	0.4105	0.3535	4.851	-59.83	0.1626	-53.61	QR_QJF QR_QMA QR_QJA
-----							
4	0.4706	0.4000	3.605	-61.59	0.1509	-53.81	QR_QJF QR_QMJ QR_QJA QR_QSO
4	0.4419	0.3675	5.155	-59.74	0.1590	-51.97	QR_QJF QR_QJA QR_QSO QR_QND
4	0.4412	0.3666	5.195	-59.70	0.1593	-51.92	QR_QJF QR_QMJ QR_QJA QR_QND
4	0.4364	0.3612	5.455	-59.40	0.1606	-51.62	QR_QJF QR_QMA QR_QMJ QR_QJA
-----							
5	0.4786	0.3887	5.174	-60.12	0.1537	-50.79	QR_QJF QR_QMJ QR_QJA QR_QSO QR_QND
5	0.4738	0.3831	5.429	-59.81	0.1551	-50.47	QR_QJF QR_QMA QR_QMJ QR_QJA QR_QSO
5	0.4460	0.3505	6.934	-58.00	0.1633	-48.67	QR_QJF QR_QMA QR_QMJ QR_QJA QR_QND
5	0.4424	0.3462	7.130	-57.77	0.1644	-48.44	QR_QJF QR_QMA QR_QJA QR_QSO QR_QND
-----							
6	0.4818	0.3707	7.000	-58.34	0.1582	-47.45	QR_QJF QR_QMA QR_QMJ QR_QJA QR_QSO QR_QND

N = 35

Dependent Variable:  $(BROWN\ SHRIMP)^{0.1}$   
 Independent Variables:  $QR\_QJF=(January-February\ Inflows)^{0.1}$   
 $QR\_QMA=(March-April\ Inflows)^{0.1}$   
 $QR\_QMJ=(May-June\ Inflows)^{0.2}$   
 $QR\_QMJ=(July-Agust\ Inflows)^{0.2}$   
 $QR\_QND=(September-October\ Inflows)^{0.1}$   
 $QR\_QND=(November-December\ Inflows)^{0.1}$

## 6. REGRESSION FOR THE BEST MODELS

### 6.1 Regression - Log of brown shrimp data on log of inflow data

#### 6.1.1 ANOVA and Parameter Estimates

**Table 6.1** Model Summary for log of brown shrimp data on log of inflow data.

**Model Summary<sup>b</sup>**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.745 <sup>a</sup>	.554	.459	3.7292	1.974

a. Predictors: (Constant), Ln(November-December Inflows), Ln(May-June Inflows), Ln(July-August Inflows), Ln(March-april Inflows), Ln(September-October Inflows), Ln(January-February Inflows)

b. Dependent Variable: Ln(Brown Shrimp Harvest)

**Table 6.2** ANOVA table of log of brown shrimp data on log of inflow data

**ANOVA<sup>b</sup>**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	484.318	6	80.720	5.804	.001 <sup>a</sup>
	Residual	389.403	28	13.907		
	Total	873.722	34			

a. Predictors: (Constant), Ln(November-December Inflows), Ln(May-June Inflows), Ln(July-August Inflows), Ln(March-april Inflows), Ln(September-October Inflows), Ln(January-February Inflows)

b. Dependent Variable: Ln(Brown Shrimp Harvest)

**Table 6.3** Table of coefficients for log of brown shrimp data on log of inflow data.

**Coefficients<sup>a</sup>**

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	.985	.814		1.211	.236	-.682	2.652
Ln(January-February Inflows)	.766	.290	.667	2.646	.013	.173	1.360
Ln(March-april Inflows)	-.104	.187	-.085	-.555	.583	-.486	.278
Ln(May-June Inflows)	.317	.195	.241	1.623	.116	-.083	.717
Ln(July-August Inflows)	.759	.228	.500	3.330	.002	.292	1.226
Ln(September-October Inflows)	-.352	.240	-.243	-1.469	.153	-.843	.139
Ln(November-December Inflows)	-.328	.261	-.281	-1.255	.220	-.864	.207

<sup>a</sup>. Dependent Variable: Ln(Brown Shrimp Harvest)

### 6.1.2 Collinearity Diagnostic

**Table 6.4** Variance Inflation for log of brown shrimp data on log of inflow data.

**Coefficients<sup>a</sup>**

	Collinearity Statistics	
	Tolerance	VIF
Ln(January-February Inflows)	.251	3.988
Ln(March-april Inflows)	.677	1.477
Ln(May-June Inflows)	.720	1.390
Ln(July-August Inflows)	.707	1.415
Ln(September-October Inflows)	.581	1.721
Ln(November-December Inflows)	.318	3.143

<sup>a</sup>. Dependent Variable: Ln(Brown Shrimp Harvest)

**Table 6.5** Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(BROWN SHRIMP) on Ln(INFLOWS):

Number	Eigenvalue	Condition Index	Var Prop LN_QJF	Var Prop LN_QMA	Var Prop LN_QMJ	Var Prop LN_QJA	Var Prop LN_QSO	Var Prop LN_QND
1	3.04975	1.00000	0.0209	0.0344	0.0202	0.0275	0.0330	0.0223
2	1.03031	1.72047	0.0158	0.0161	0.4035	0.1131	0.0465	0.0264
3	0.78842	1.96677	0.0151	0.1633	0.0032	0.3824	0.1613	0.0458
4	0.56864	2.31587	0.0226	0.7272	0.0480	0.1242	0.0116	0.1056
5	0.40512	2.74372	0.0001	0.0169	0.5244	0.3180	0.7303	0.0025
6	0.15776	4.39673	0.9255	0.0421	0.0007	0.0347	0.0172	0.7973

## 6.1.3 Residuals Diagnostics

**Table 6.6** Residuals Diagnostics for log of brown shrimp data on log of inflow data.

**Residuals Statistics<sup>a</sup>**

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	-8.5907	7.4931	1.0094	3.7742	35
Std. Predicted Value	-2.544	1.718	.000	1.000	35
Standard Error of Predicted Value	.7658	2.5894	1.5427	.6430	35
Adjusted Predicted Value	-10.1575	10.6275	1.2696	4.1165	35
Residual	-10.1441	5.4029	-5.0753E-17	3.3842	35
Std. Residual	-2.720	1.449	.000	.907	35
Stud. Residual	-2.787	1.625	-.030	1.043	35
Deleted Residual	-12.1671	6.7949	-.2601	4.5754	35
Std. Deleted Residual	-3.220	1.676	-.058	1.113	35
Mahal. Distance	.462	15.421	5.829	5.080	35
Cook's Distance	.000	.645	.059	.135	35
Centered Leverage Value	.014	.454	.171	.149	35

a. Dependent Variable: Ln(Brown Shrimp Harvest)

Table 6.7 Case Values for Residuals Diagnostics for log of brown shrimp data on log of inflow data.

YEAR	PRE_1	RES_1	DRE_1	ADJ_1	ZPR_1	ZRE_1	SRE_1 <sup>1</sup>	SDR_1 <sup>2</sup>
1959	2.8215	-.2837	-.3600	2.8978	.4801	-.0761	-.0857	-.0842
1960	-6.7902	-.1176	-.1641	-6.7437	-2.0665	-.0315	-.0372	-.0366
1961	-.1183	-6.7894	-10.9199	4.0121	-.2988	-1.8206	-2.3089	*-2.5198
1962	-7.0581	.1503	.2156	-7.1233	-2.1375	.0403	.0483	.0474
1963	-8.5907	1.6829	3.2498	-10.1575	-2.5436	.4513	.6271	.6202
1964	-.2480	1.2780	1.7880	-.7580	-.3332	.3427	.4053	.3992
1965	-3.7769	-3.1308	-5.3313	-1.5765	-1.2682	-.8395	-1.0955	-1.0996
1966	-6.7285	-.1793	-.2661	-6.6417	-2.0502	-.0481	-.0586	-.0575
1967	-.5557	-.9494	-1.3109	-.1942	-.4147	-.2546	-.2991	-.2942
1968	2.7791	.7724	1.0173	2.5341	.4689	.2071	.2377	.2337
1969	1.8969	1.3827	2.3281	.9515	.2351	.3708	.4811	.4744
1970	.0962	-7.0040	-12.1671	5.2593	-.2419	-1.8781	-2.4754	*-2.7503
1971	-1.7002	2.1764	3.1262	-2.6500	-.7179	.5836	.6994	.6929
1972	4.6951	-4.2189	-4.7828	5.2591	.9766	-1.1313	-1.2045	-1.2147
1973	.5956	5.4029	6.7949	-.7964	-.1096	1.4488	1.6247	1.6764
1974	-2.6022	-4.3055	-6.4884	-.4193	-.9569	-1.1545	-1.4173	-1.4445
1975	7.4931	-3.4539	-6.5883	10.6275	1.7179	-.9262	-1.2791	-1.2945
1976	.9801	3.0446	5.0229	-.9982	-.0078	.8164	1.0486	1.0506
1977	1.3374	3.3676	3.6469	1.0581	.0869	.9030	.9397	.9377
1978	2.7414	.4209	.4408	2.7215	.4589	.1129	.1155	.1134
1979	3.0655	1.7288	1.8227	2.9716	.5448	.4636	.4760	.4693
1980	4.0276	1.8759	2.0240	3.8794	.7997	.5030	.5225	.5156
1981	4.8506	.9057	1.0003	4.7560	1.0178	.2429	.2552	.2509
1982	2.1313	3.0942	3.2924	1.9331	.2972	.8297	.8559	.8517
1983	3.4623	1.7334	1.8224	3.3733	.6499	.4648	.4766	.4699
1984	2.8643	3.2414	3.3902	2.7155	.4915	.8692	.8889	.8855
1985	1.8272	3.7009	4.0272	1.5009	.2167	.9924	1.0352	1.0366
1986	1.7605	2.9851	3.1450	1.6006	.1990	.8004	.8216	.8167
1987	4.4307	1.0528	1.1683	4.3152	.9065	.2823	.2974	.2925
1988	2.5285	3.0628	3.2055	2.3858	.4025	.8213	.8402	.8357
1989	1.6003	.1307	.1364	1.5945	.1565	.0350	.0358	.0352
1990	2.6899	-2.5475	-2.6904	2.8327	.4453	-.6831	-.7020	-.6955
1991	3.2363	-10.1441	-10.6499	3.7421	.5900	-2.7201	-2.7871	*-3.2197
1992	4.7355	.4777	.5498	4.6634	.9872	.1281	.1374	.1350
1993	4.8510	-.5439	-.6008	4.9079	1.0179	-.1458	-.1533	-.1506

PRE\_1 Predicted value of harvest

RES\_1 Ordinary residuals: observed harvest minus predicted harvest

DRE\_1 Deleted residuals: resid. obtained when the model is fitted without that obser.

ADJ\_1 Adjusted predicted value: predicted value of harvest when the model is fitted without that observation

ZPR\_1 Z-score of the predicted value of harvest

ZRE\_1 Z-score of the residual

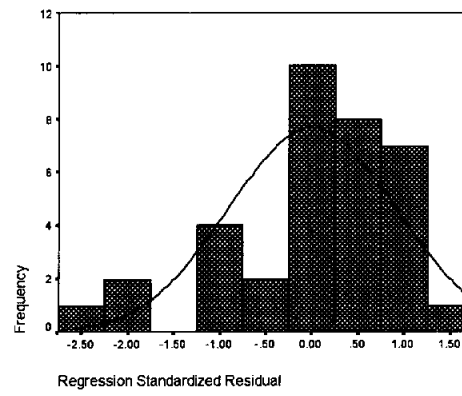
SRE\_1 Studentized residual

SDR\_1 Studentized deleted residuals

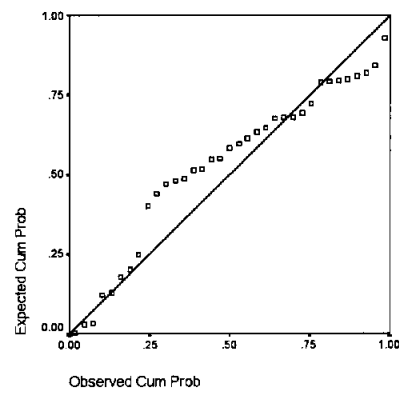
<sup>1</sup>Values greater than 3 are flagged.

<sup>2</sup>This is flagged if it exceeds  $t_{n-p-2, \alpha} = t_{27, 0.01} = 2.473$ .

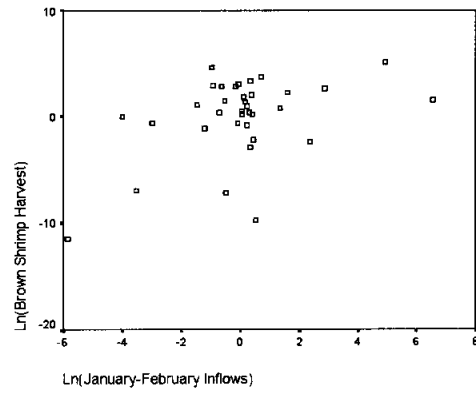




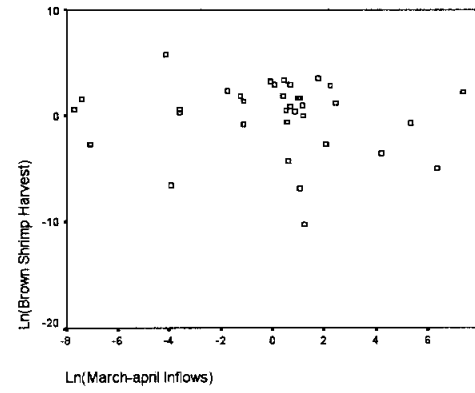
**Figure 6.1** Histogram of Standardized Residuals.



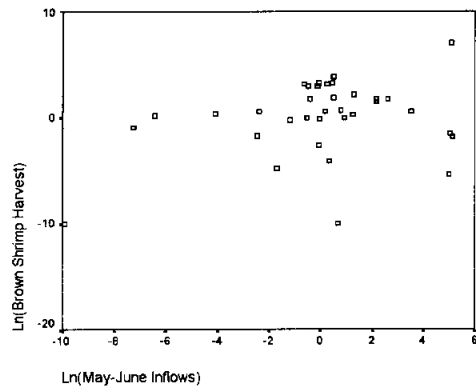
**Figure 6.2** Normal P-P Plot of Residuals.



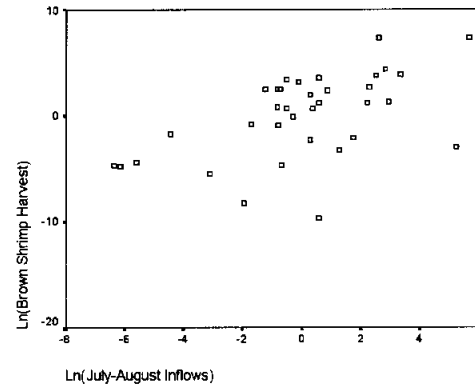
**Figure 6.3** Partial Residual Plot for  
*Ln(January-February Inflows)*.



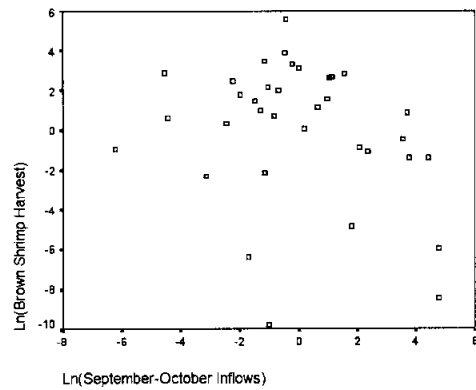
**Figure 6.4** Partial Residual Plot for  
*Ln(March-April Inflows)*.



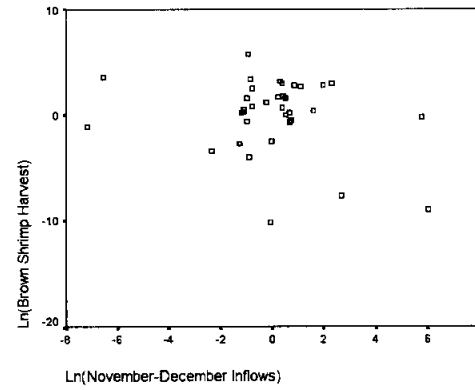
**Figure 6.5** Partial Residual Plot for *Ln(May-June Inflows)*.



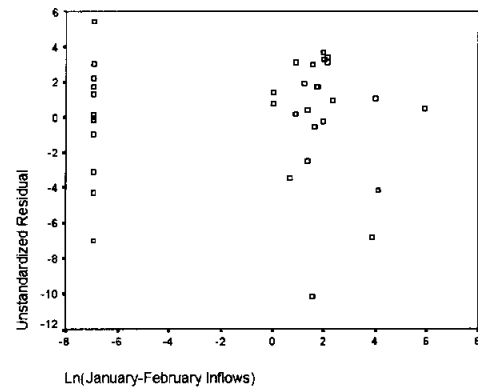
**Figure 6.6** Partial Residual Plot for *Ln(July-August Inflows)*.



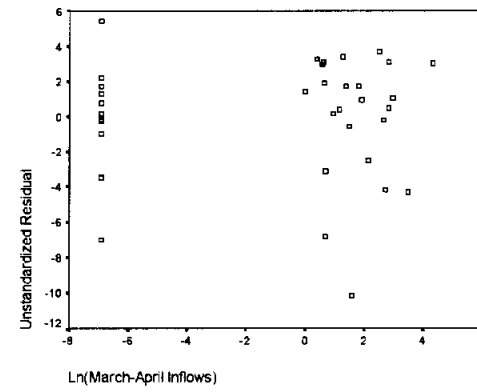
**Figure 6.7** Partial Residual Plot for  
*Ln(September-October Inflows)*.



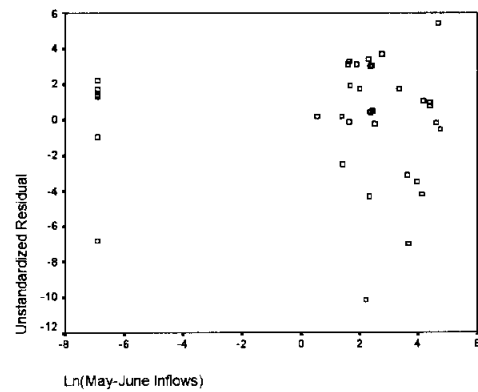
**Figure 6.8** Partial Residual Plot for  
*Ln(November-December Inflows)*.



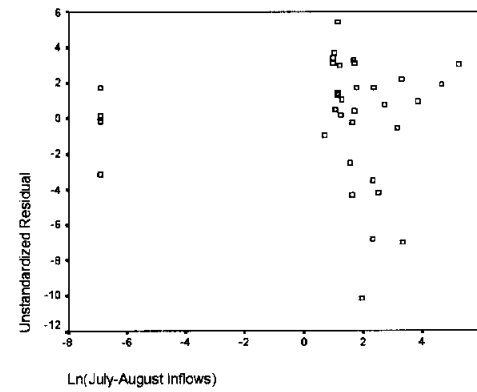
**Figure 6.9** Residuals Plot for Ln(January-February Inflows).



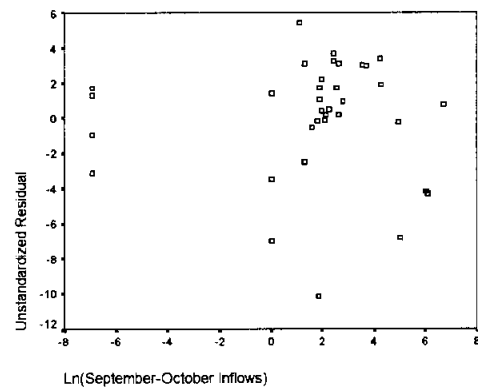
**Figure 6.10** Residuals Plot for Ln(March-April Inflows).



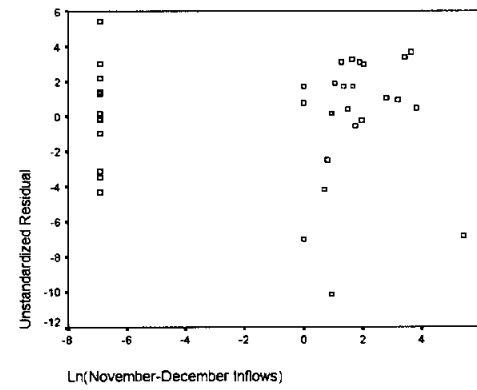
**Figure 6.11** Residuals Plot for Ln(May-June Inflows).



**Figure 6.12** Residuals Plot for Ln(July-August Inflows).



**Figure 6.13** Residuals Plot for Ln(September-October Inflows).



**Figure 6.14** Residuals Plot for Ln(November-December Inflows).

## 6.1.4 Prediction Intervals for Brown Shrimp Harvest

Table 6.8 Prediction Intervals for Brown Shrimp Harvest.

YEAR	LICI_1	LN_BRSH	UICI_1
1959	-8.523	2.538	14.166
1960	-18.464	-6.908	4.884
1961	-12.216	-6.908	11.979
1962	-18.819	-6.908	4.703
1963	-21.136	-6.908	3.955
1964	-11.931	1.030	11.434
1965	-16.025	-6.908	8.471
1966	-18.596	-6.908	5.139
1967	-12.195	-1.505	11.084
1968	-8.699	3.551	14.258
1969	-10.322	3.280	14.116
1970	-12.202	-6.908	12.395
1971	-13.467	.476	10.066
1972	-6.200	.476	15.591
1973	-10.716	5.998	11.907
1974	-14.515	-6.908	9.311
1975	-5.025	4.039	20.012
1976	-11.186	4.025	13.146
1977	-9.355	4.705	12.030
1978	-7.794	3.162	13.277
1979	-7.501	4.794	13.633
1980	-6.648	5.903	14.703
1981	-5.930	5.756	15.632
1982	-8.479	5.225	12.742
1983	-7.091	5.196	14.016
1984	-7.664	6.106	13.393
1985	-8.887	5.528	12.541
1986	-8.803	4.746	12.324
1987	-6.372	5.484	15.233
1988	-8.003	5.591	13.060
1989	-8.920	1.731	12.120
1990	-7.885	0.142	13.265
1991	-7.310	-6.908	13.783
1992	-6.224	5.213	15.695
1993	-5.931	4.307	15.633

*LICI\_1* Lower limit for 99% prediction interval for the natural log of brown shrimp harvest.

*LN\_BRSH* Natural log of brown shrimp harvest.

*UICI\_1* Upper limit for 99% prediction interval for the natural log of brown shrimp harvest.

## 6.1.5 Outliers and Influential Point Detection

Table 6.9 Mahalanobis distance, Cook's distance, Leverage value and associated p-values

YEAR	MAH_1	COOK_1	LEV_1 <sup>1</sup>	MAH_PV <sup>2</sup>	COOK_PV <sup>3</sup>
1959	6.2347	.0003	.1834	.5126	.0000
1960	8.6634	.0001	.2548	.2777	.0000
1961	11.8890	.4633	.3497	.1043	.1475
1962	9.3177	.0001	.2741	.2306	.0000
1963	15.4212	.0523	.4536	.0310	.0003
1964	8.7268	.0094	.2567	.2729	.0000
1965	13.0619	.1205	.3842	.0706	.0038
1966	10.1227	.0002	.2977	.1817	.0000
1967	8.4052	.0049	.2472	.2982	.0000
1968	7.2141	.0026	.2122	.4069	.0000
1969	12.8347	.0226	*.3775	.0762	.0000
1970	13.4564	.6453	*.3958	.0617	.2850
1971	9.3585	.0305	.2752	.2279	.0000
1972	3.0377	.0277	.0893	.8815	.0000
1973	5.9941	.0972	.1763	.5404	.0019
1974	10.4672	.1455	.3079	.1636	.0067
1975	15.2042	.2121	.4472	.0335	.0203
1976	12.4198	.1021	.3653	.0876	.0022
1977	1.6325	.0105	.0480	.9774	.0000
1978	.5657	.0001	.0166	.9992	.0000
1979	.7802	.0018	.0229	.9976	.0000
1980	1.5174	.0031	.0446	.9817	.0000
1981	2.2436	.0010	.0660	.9451	.0000
1982	1.0751	.0067	.0316	.9935	.0000
1983	.6890	.0017	.0203	.9984	.0000
1984	.5204	.0052	.0153	.9994	.0000
1985	1.7835	.0135	.0525	.9708	.0000
1986	.7573	.0052	.0223	.9979	.0000
1987	2.3896	.0014	.0703	.9352	.0000
1988	.5423	.0047	.0159	.9993	.0000
1989	.4622	.0000	.0136	.9996	.0000
1990	.8339	.0039	.0245	.9971	.0000
1991	.6432	.0553	.0189	.9987	.0003
1992	3.4872	.0004	.1026	.8366	.0000
1993	2.2476	.0004	.0661	.9449	.0000

MAH\_1 Mahalanobis distance  
 COOK\_1 Cook's distance  
 LEV\_1 Leverage value

*MAHA\_PV* P-value associated with the Mahalanobis distance

*COOK\_P* P-value associated with Cook's distance

<sup>1</sup>This is flagged if it exceeds  $(2p+1)/n$  or 0.5, whichever is smaller.

<sup>2</sup> $MAHA\_PV = 1 - F(MAH\_1)$ , where F is the CDF of a Chi-squared random variable with  $p+1$  degrees of freedom. Small values indicate a problem.

<sup>3</sup> $COOK\_PV = F(COOK\_1)$ , where F is the CDF of an F-ratio random variable with  $p+1$  numerator degrees of freedom and  $n-p-1$  denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

Table 6.10 Standardized *dfits* value and Standardized *dfbeta* values

YEAR	<i>SDFFITs</i>	<i>SDFBET_0</i>	<i>SDFBET_1</i>	<i>SDFBET_2</i>
1959	-.0437	-.0027	-.0098	.0366
1960	-.0230	-.0017	-.0013	.0078
1961	*-1.9654	-.7028	.1268	-.1671
1962	.0312	.0016	.0014	-.0103
1963	.5984	.3126	-.2000	-.0541
1964	.2522	.1061	.0051	-.0272
1965	-.9219	-.4446	-.0359	-.3002
1966	-.0400	-.0081	.0066	-.0186
1967	-.1816	-.0794	-.0058	.0200
1968	.1316	-.0213	.0048	-.0995
1969	.3923	.1378	.2348	.0743
1970	*-2.3613	.0569	*1.6518	.7146
1971	.4578	-.0089	-.0963	-.0735
1972	-.4441	-.1250	-.2376	-.0380
1973	.8510	-.1169	-.1428	-.3923
1974	*-1.0286	.1105	.4875	-.5631
1975	*-1.2332	-.1015	-.9095	.6327
1976	.8469	-.0515	-.4189	.4962
1977	.2700	.1437	-.0501	.0219
1978	.0247	.0197	.0004	.0049
1979	.1094	.0767	.0046	.0255
1980	.1449	.0405	-.0229	.0103
1981	.0811	.0362	-.0148	.0091
1982	.2155	.1716	.0230	.0969
1983	.1065	.0835	.0141	.0237
1984	.1897	.1514	.0480	-.0043
1985	.3078	.2137	-.0782	.0958
1986	.1890	.1126	-.0118	.0023
1987	.0969	.0683	.0380	.0176
1988	.1804	.1530	-.0043	.0284
1989	.0074	.0063	.0001	.0021
1990	-.1647	-.1430	-.0249	-.0735
1991	-.7189	-.5727	-.1326	-.2009
1992	.0524	.0378	.0323	.0038
1993	-.0487	-.0234	.0012	-.0044

<i>SDFFITs</i>	Standardized <i>dfits</i> value
<i>SDFBET_0</i>	Standardized <i>dfbeta</i> for the intercept term
<i>SDFBET_1</i>	Standardized <i>dfbeta</i> for log of January-February inflows
<i>SDFBET_2</i>	Standardized <i>dfbeta</i> for log of March-April inflows

\*Items are flagged if  $|sdfits|$  or  $|sdfbeta|$  exceed 1.0 for a small data set or  $2\sqrt{(p + 1) / n}$  for a large data set. The cutoff used here is 1.

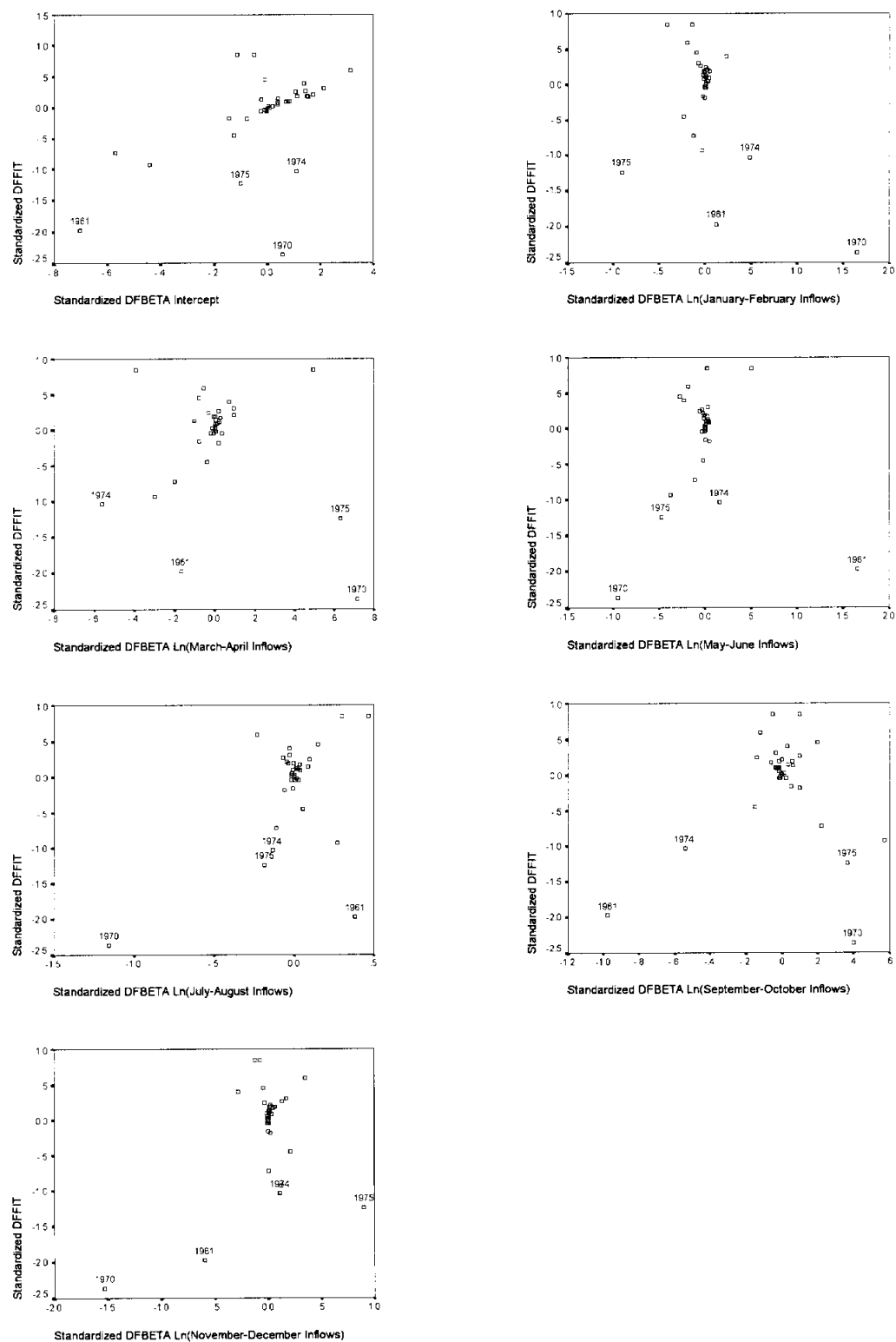
Table 6.11 Standardized *dfbeta* values

YEAR	SDFBET_3	SDFBET_4	SDFBET_5	SDFBET_6
1959	-.0046	.0046	-.0144	-.0048
1960	.0001	.0163	-.0105	.0033
1961	*1.6567	.3813	-.9781	-.5975
1962	-.0016	-.0221	.0161	-.0043
1963	-.1852	-.2351	-.1241	.3480
1964	-.0595	.0960	-.1385	-.0318
1965	-.3792	.2731	.5742	.1283
1966	-.0046	.0240	-.0093	.0057
1967	.0450	-.0617	.0989	.0235
1968	.0304	.0093	.0610	.0078
1969	-.2341	-.0318	.0262	-.2835
1970	-.9498	*-1.1559	.3979	*-1.5276
1971	-.2809	.1434	.1970	-.0455
1972	-.0229	.0538	-.1487	.2114
1973	.5016	.2965	-.0538	-.1242
1974	.1583	-.1356	-.5441	.1107
1975	-.4824	-.1875	.3634	.8984
1976	.0183	.4657	.0983	-.0802
1977	-.0340	-.0729	.0970	.1350
1978	.0047	.0025	-.0063	.0055
1979	.0329	.0078	-.0209	.0179
1980	-.0119	.0815	.0331	.0164
1981	.0360	.0369	-.0250	.0292
1982	-.0235	-.0454	-.0013	.0246
1983	.0132	.0252	-.0328	.0081
1984	-.0031	-.0059	-.0128	.0191
1985	.0291	-.0338	-.0333	.1734
1986	-.0052	-.0373	.0569	.0640
1987	.0350	-.0099	-.0394	-.0046
1988	.0211	.0303	-.0629	.0498
1989	-.0022	-.0006	.0004	.0013
1990	.0026	-.0118	.0538	.0005
1991	-.1134	-.1139	.2195	.0106
1992	.0013	-.0150	-.0123	-.0080
1993	-.0293	-.0213	.0250	-.0076

<i>SDFBET_3</i>	Standardized <i>dfbeta</i> for log of May-June inflows
<i>SDFBET_4</i>	Standardized <i>dfbeta</i> for log of July-August inflows
<i>SDFBET_5</i>	Standardized <i>dfbeta</i> for log of September-October inflows
<i>SDFBET_6</i>	Standardized <i>dfbeta</i> for log of November-December inflows

\*Items are flagged if  $|sdfbeta|$  exceed 1.0 for a small data set or  $2\sqrt{(p+1)/n}$  for a large data set. The cutoff used here is 1.





**Figure 6.15** Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of log of inflow variables.

## 6.2 Regression - Various transformation

### 6.2.1 ANOVA and Parameter Estimates

**Table 6.12** Model Summary for various transformation.

**Model Summary<sup>b</sup>**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.694 <sup>a</sup>	.482	.371	.3978	1.773

a. Predictors: (Constant), (November-December Inflows)<sup>0.1</sup>, (May-June Inflows)<sup>0.2</sup>, (July-August Inflows)<sup>0.2</sup>, (March-April Inflows)<sup>0.1</sup>, (September-October Inflows)<sup>0.1</sup>, (January-February Inflows)<sup>0.1</sup>

b. Dependent Variable: (Brown Harvest)<sup>0.1</sup>

**Table 6.13** ANOVA table of various transformations.

**ANOVA<sup>b</sup>**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.119	6	.687	4.339	.003 <sup>a</sup>
	Residual	4.431	28	.158		
	Total	8.550	34			

a. Predictors: (Constant), (November-December Inflows)<sup>0.1</sup>, (May-June Inflows)<sup>0.2</sup>, (July-August Inflows)<sup>0.2</sup>, (March-April Inflows)<sup>0.1</sup>, (September-October Inflows)<sup>0.1</sup>, (January-February Inflows)<sup>0.1</sup>

b. Dependent Variable: (Brown Harvest)<sup>0.1</sup>

**Table 6.14** Table of coefficients for various transformations.

**Coefficients<sup>a</sup>**

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	.397	.292		1.358	.185	-.202	.995
(January-February Inflows) <sup>0.1</sup>	.855	.350	.648	2.441	.021	.138	1.573
(March-April Inflows) <sup>0.1</sup>	-9.812E-02	.235	-.068	-.417	.680	-.580	.384
(May-June Inflows) <sup>0.2</sup>	.153	.105	.217	1.459	.156	-.062	.367
(July-August Inflows) <sup>0.2</sup>	.355	.128	.417	2.772	.010	.093	.617
(September-October Inflows) <sup>0.1</sup>	-.330	.237	-.232	-1.391	.175	-.816	.156
(November-December Inflows) <sup>0.1</sup>	-.222	.338	-.163	-.655	.518	-.914	.471

a. Dependent Variable: (Brown Harvest)<sup>0.1</sup>**6.2.2 Collinearity Diagnostic****Table 6.15** Collinearity Diagnostic for various transformations.

**Coefficients<sup>a</sup>**

	Collinearity Statistics	
	Tolerance	VIF
(January-February Inflows) <sup>0.1</sup>	.263	3.807
(March-April Inflows) <sup>0.1</sup>	.704	1.421
(May-June Inflows) <sup>0.2</sup>	.840	1.190
(July-August Inflows) <sup>0.2</sup>	.819	1.221
(September-October Inflows) <sup>0.1</sup>	.666	1.501
(November-December Inflows) <sup>0.1</sup>	.300	3.337

a. Dependent Variable: (Brown Harvest)<sup>0.1</sup>**Table 6.16** Collinearity Diagnostics(intercept adjusted) for various transformations.

Number	Eigenvalue	Condition Index	Var Prop QR_QJF	Var Prop QR_QMA	Var Prop QR_QMJ	Var Prop QR_QJA	Var Prop QR_QSO	Var Prop QR_QND
1	1.69444	1.00000	0.0005	0.1427	0.0015	0.1418	0.0077	0.0035
2	1.32162	1.13230	0.2432	0.0048	0.1293	0.0000	0.0202	0.2713
3	1.19703	1.18977	0.0678	0.0001	0.2486	0.0107	0.3764	0.0540
4	0.82907	1.42961	0.3499	0.0028	0.2541	0.0049	0.2926	0.1717
5	0.68250	1.57566	0.1606	0.0050	0.3650	0.0317	0.2628	0.4755
6	0.27533	2.48076	0.1780	0.8446	0.0015	0.8109	0.0403	0.0239

### 6.2.3 Residuals Diagnostics

**Table 6.17** Residuals Diagnostics for various transformations.

Residuals Statistics <sup>a</sup>					
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	.5170	1.7599	1.2322	.3481	35
Std. Predicted Value	-2.055	1.516	.000	1.000	35
Standard Error of Predicted Value	8.089E-02	.2805	.1678	6.008E-02	35
Adjusted Predicted Value	.5259	1.8758	1.2559	.3643	35
Residual	-.9019	.6948	-9.5162E-17	.3610	35
Std. Residual	-2.267	1.747	.000	.907	35
Stud. Residual	-2.324	1.967	-.026	1.017	35
Deleted Residual	-1.1658	.8811	-2.3741E-02	.4599	35
Stud. Deleted Residual	-2.540	2.081	-.042	1.068	35
Mahal. Distance	.435	15.932	5.829	4.340	35
Cook's Distance	.000	.455	.042	.097	35
Centered Leverage Value	.013	.469	.171	.128	35

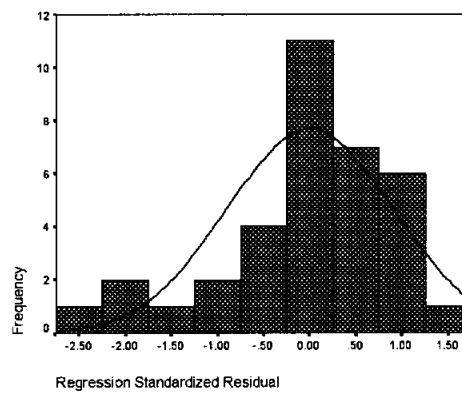
a. Dependent Variable: (Brown Harvest)<sup>0.1</sup>

Table 6.18 Case Values for Residuals Diagnostics for various transformations.

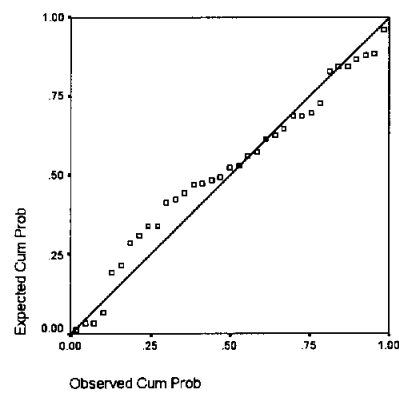
YEAR	PRE_1	RES_1	DRE_1	ADJ_1	ZPR_1	ZRE_1	SRE_1 <sup>1</sup>	SDR_1 <sup>2</sup>
1959	1.3178	-.0289	-.0364	1.3253	.2460	-.0727	-.0816	-.0801
1960	.5592	-.0580	-.0736	.5748	-1.9336	-.1457	-.1642	-.1613
1961	1.2245	-.7233	-1.0840	1.5852	-.0220	-1.8184	-2.2260	-2.4095
1962	.5266	-.0254	-.0331	.5343	-2.0272	-.0638	-.0729	-.0715
1963	.5170	-.0158	-.0248	.5259	-2.0547	-.0398	-.0498	-.0489
1964	.9806	.1278	.1651	.9434	-.7227	.3214	.3652	.3595
1965	.8478	-.3466	-.5006	1.0018	-1.1042	-.8714	-1.0472	-1.0491
1966	.6651	-.1639	-.2456	.7468	-1.6291	-.4121	-.5045	-.4977
1967	.9462	-.0859	-.1099	.9702	-.8216	-.2160	-.2443	-.2402
1968	1.3129	.1135	.1674	1.2590	.2318	.2854	.3466	.3411
1969	1.1937	.1944	.2882	1.0999	-.1105	.4887	.5951	.5881
1970	1.2342	-.7331	-1.1658	1.6669	.0059	-1.8428	-2.3239	*-2.5401
1971	.9892	.0595	.0798	.9690	-.6979	.1496	.1732	.1702
1972	1.6501	-.6013	-.7630	1.8118	1.2006	-1.5116	-1.7028	-1.7661
1973	1.1270	.6948	.8811	.9408	-.3021	1.7468	1.9669	2.0806
1974	.7000	-.1988	-.3279	.8291	-1.5289	-.4998	-.6419	-.6350
1975	1.7216	-.2239	-.3781	1.8758	1.4062	-.5629	-.7315	-.7253
1976	1.3465	.1490	.2963	1.1992	.3286	.3745	.5282	.5213
1977	1.2004	.4004	.4474	1.1534	-.0913	1.0065	1.0640	1.0667
1978	1.3485	.0234	.0245	1.3475	.3342	.0589	.0602	.0591
1979	1.4101	.2051	.2162	1.3990	.5111	.5156	.5294	.5225
1980	1.6118	.1928	.2271	1.5775	1.0906	.4848	.5261	.5192
1981	1.7487	.0295	.0353	1.7430	1.4840	.0743	.0812	.0797
1982	1.2843	.4021	.4340	1.2523	.1496	1.0107	1.0501	1.0521
1983	1.4427	.2386	.2507	1.4306	.6049	.5998	.6148	.6079
1984	1.3646	.4769	.4993	1.3422	.3804	1.1989	1.2267	1.2383
1985	1.2724	.4657	.5285	1.2096	.1156	1.1708	1.2472	1.2603
1986	1.2337	.3736	.3960	1.2113	.0044	.9392	.9670	.9658
1987	1.6564	.0740	.0862	1.6442	1.2187	.1861	.2008	.1973
1988	1.3095	.4396	.4597	1.2895	.2222	1.1051	1.1301	1.1359
1989	1.1950	-.0061	-.0064	1.1954	-.1067	-.0152	-.0157	-.0154
1990	1.3239	-.3096	-.3295	1.3439	.2636	-.7783	-.8030	-.7978
1991	1.4031	-.9019	-.9446	1.4457	.4909	-2.2672	-2.3203	*-2.5352
1992	1.7599	-.0757	-.0983	1.7826	1.5162	-.1903	-.2169	-.2131
1993	1.7010	-.1627	-.1919	1.7302	1.3471	-.4090	-.4442	-.4377
PRE_1	Predicted value of harvest							
RES_1	Ordinary residuals: observed harvest minus predicted harvest							
DRE_1	Deleted residuals: residuals obtained when the model is fitted without that observation							
ADJ_1	Adjusted predicted value: predicted value of harvest when the model is fitted without that observation							
ZPR_1	Z-score of the predicted value of harvest							
ZRE_1	Z-score of the residual							
SRE_1	Studentized residual							
SDR_1	Studentized deleted residuals							

<sup>1</sup>Values greater than 3 are flagged.

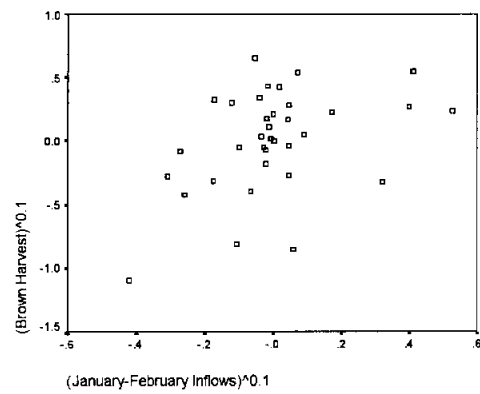
<sup>2</sup>This is flagged if it exceeds  $t_{n-p-2, \alpha} = t_{27, 0.01} = 2.473$ .



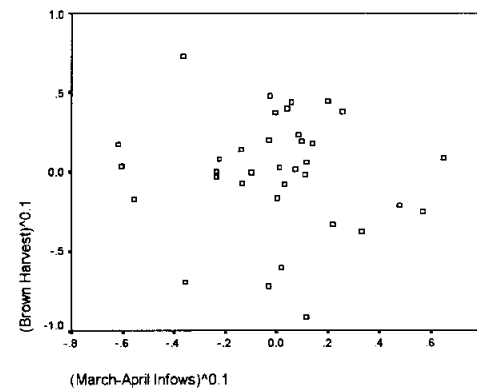
**Figure 6.16** Histogram of Standardized Residuals.



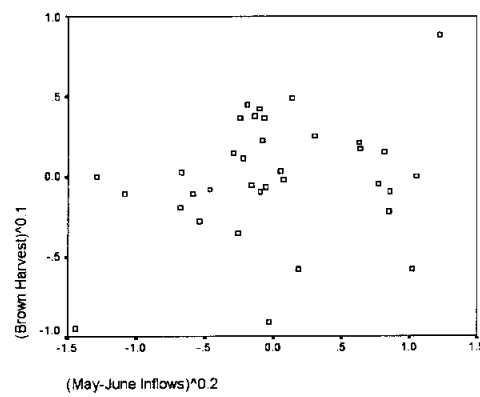
**Figure 6.17** Normal P-P Plot of Residuals.



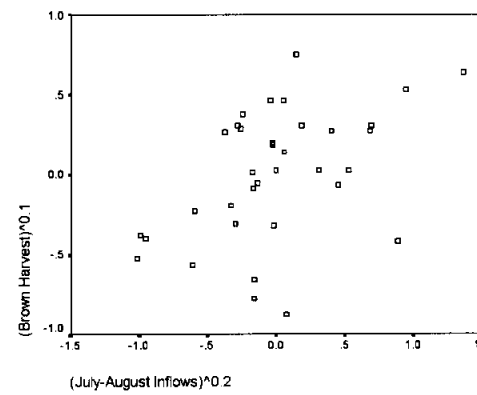
**Figure 6.18** Partial Residual Plot for  $(\text{January-February Inflows})^{0.1}$ .



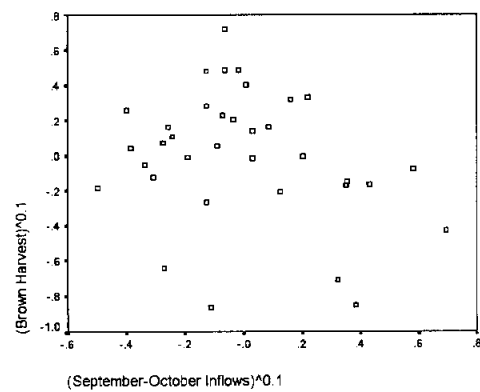
**Figure 6.19** Partial Residual Plot for  $(\text{March-April Inflows})^{0.1}$ .



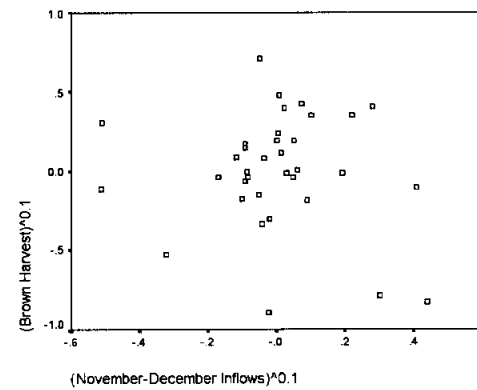
**Figure 6.20** Partial Residual Plot for  $(\text{May-June Inflows})^{0.2}$ .



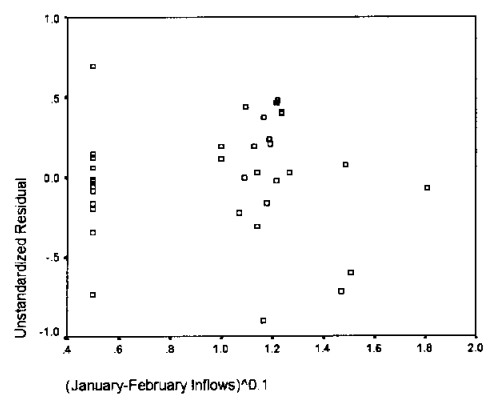
**Figure 6.21** Partial Residual Plot for  $(\text{July-August Inflows})^{0.2}$ .



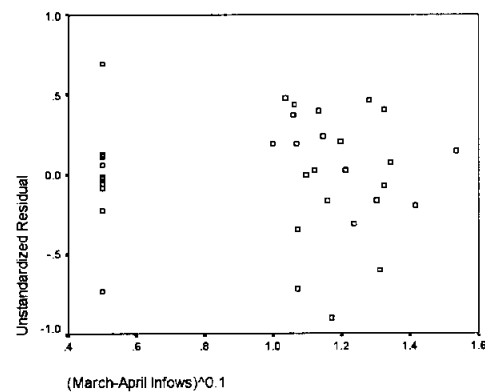
**Figure 6.22** Partial Residual Plot for  $(\text{September-October Inflows})^{0.1}$ .



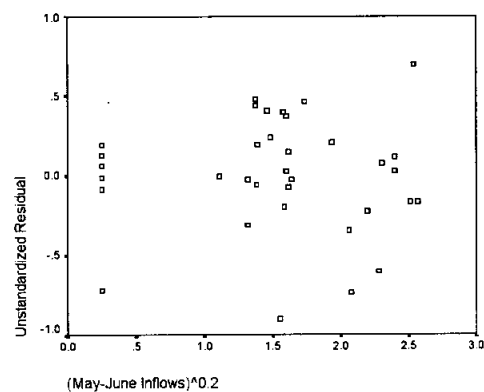
**Figure 6.23** Partial Residual Plot for  $(\text{November-December Inflows})^{0.1}$ .



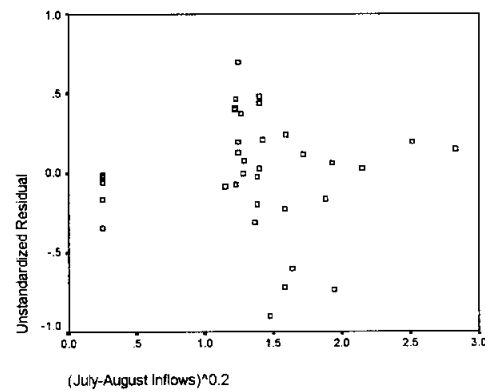
**Figure 6.24** Residuals Plot for  $(\text{January-February Inflows})^{0.1}$ .



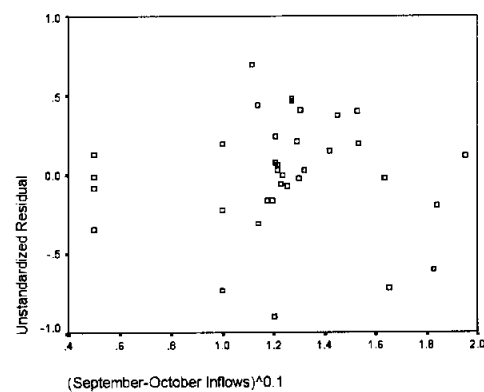
**Figure 6.25** Residuals Plot for  $(\text{March-April Inflows})^{0.1}$ .



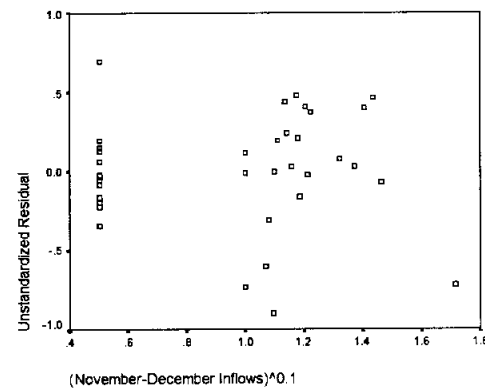
**Figure 6.26** Residuals Plot for  $\text{sqrt}(\text{May-June Inflows})^{0.2}$ .



**Figure 6.27** Residuals Plot for  $(\text{July-August Inflows})^{0.2}$ .



**Figure 6.28** Residuals Plot for  $(\text{September-October Inflows})^{0.1}$ .



**Figure 6.29** Residuals Plot for  $(\text{November-December Inflows})^{0.1}$ .



#### 6.2.4 Prediction Intervals for Brown Shrimp Harvest

**Table 6.19** Prediction Intervals for Brown Shrimp Harvest.

<b>YEAR</b>	<b>LICI_1</b>	<b>TR_BRSH</b>	<b>UICI_1</b>
1959	.111	1.289	2.525
1960	-.651	.501	1.769
1961	-.044	.501	2.493
1962	-.694	.501	1.747
1963	-.765	.501	1.799
1964	-.236	1.108	2.198
1965	-.409	.501	2.105
1966	-.604	.501	1.934
1967	-.267	.860	2.159
1968	.049	1.426	2.577
1969	-.072	1.388	2.459
1970	-.053	.501	2.521
1971	-.242	1.049	2.220
1972	.440	1.049	2.860
1973	-.083	1.822	2.337
1974	-.598	.501	1.998
1975	.417	1.498	3.026
1976	.002	1.496	2.691
1977	.045	1.601	2.356
1978	.227	1.372	2.470
1979	.283	1.615	2.537
1980	.433	1.805	2.791
1981	.563	1.778	2.934
1982	.145	1.686	2.423
1983	.317	1.681	2.568
1984	.241	1.841	2.488
1985	.110	1.738	2.435
1986	.104	1.607	2.364
1987	.482	1.730	2.830
1988	.187	1.749	2.432
1989	.068	1.189	2.322
1990	.192	1.014	2.456
1991	.279	.501	2.527
1992	.541	1.684	2.979
1993	.521	1.538	2.881

*LICI\_1* Lower limit for 99% prediction interval for (Brown Shrimp Harvest)<sup>(0.1)</sup>.  
*TR\_BRSH* (Brown Shrimp Harvest)<sup>(0.1)</sup>  
*UICI\_1* Upper limit for 99% prediction interval for (Brown Shrimp Harvest)<sup>(0.1)</sup>

## 6.2.5 Outliers and Influential Point Detection

Table 6.20 Mahalanobis distance, Cook's distance, Leverage value and associated p-values

YEAR	MAH_1	COOK_1	LEV_1 <sup>1</sup>	MAH_PV <sup>2</sup>	COOK_PV <sup>3</sup>
1959	6.0406	.0002	.1777	.5350	.0000
1960	6.2415	.0010	.1836	.5119	.0000
1961	10.3419	.3530	.3042	.1700	.0785
1962	6.9431	.0002	.2042	.4348	.0000
1963	11.2770	.0002	.3317	.1270	.0000
1964	6.6989	.0056	.1970	.4609	.0000
1965	9.4850	.0696	.2790	.2197	.0006
1966	10.3365	.0181	.3040	.1703	.0000
1967	6.4538	.0024	.1898	.4879	.0000
1968	9.9756	.0081	.2934	.1900	.0000
1969	10.0940	.0244	.2969	.1833	.0000
1970	11.6488	.4554	.3426	.1127	.1420
1971	7.6582	.0015	.2252	.3637	.0000
1972	6.2357	.1114	.1834	.5125	.0029
1973	6.2148	.1481	.1828	.5149	.0071
1974	12.4152	.0382	.3652	.0877	.0001
1975	12.8931	.0526	*.3792	.0748	.0003
1976	15.9324	.0394	*.4686	.0257	.0001
1977	2.6040	.0190	.0766	.9191	.0000
1978	.4346	.0000	.0128	.9997	.0000
1979	.7774	.0022	.0229	.9977	.0000
1980	4.1605	.0070	.1224	.7611	.0000
1981	4.5670	.0002	.1343	.7126	.0000
1982	1.5321	.0125	.0451	.9812	.0000
1983	.6703	.0027	.0197	.9986	.0000
1984	.5506	.0101	.0162	.9992	.0000
1985	3.0674	.0300	.0902	.8787	.0000
1986	.9509	.0080	.0280	.9956	.0000
1987	3.8176	.0009	.1123	.8005	.0000
1988	.5122	.0083	.0151	.9994	.0000
1989	.7590	.0000	.0223	.9978	.0000
1990	1.0861	.0059	.0319	.9933	.0000
1991	.5649	.0364	.0166	.9992	.0001
1992	6.8611	.0020	.2018	.4435	.0000
1993	4.1983	.0051	.1235	.7567	.0000

MAH\_1 Mahalanobis distance

COOK\_1 Cook's distance

LEV\_1 Leverage value

*MAHA\_PV* P-value associated with the Mahalanobis distance

*COOK\_PV* P-value associated with Cook's distance

<sup>1</sup>This is flagged if it exceeds  $(2p+1)/n$  or 0.5, whichever is smaller.

<sup>2</sup> $MAHA\_PV = 1 - F(MAH\_1)$ , where F is the CDF of a Chi-squared random variable with  $p+1$  degrees of freedom. Small values indicate a problem.

<sup>3</sup> $COOK\_PV = F(COOK\_1)$ , where F is the CDF of an F-ratio random variable with  $p+1$  numerator degrees of freedom and  $n-p-1$  denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

**Table 6.21** Standardized *dfits* value and Standardized *dfbeta* values

YEAR	<i>SDFFITs</i>	<i>SDFBET_0</i>	<i>SDFBET_1</i>	<i>SDFBET_2</i>
1959	-.0409	.0012	-.0072	.0321
1960	-.0837	-.0412	.0036	.0250
1961	*-1.7015	.3425	.2757	.0522
1962	-.0394	-.0174	.0020	.0112
1963	-.0367	-.0229	.0166	.0035
1964	.1940	.1649	.0159	-.0337
1965	-.6992	-.3516	.0712	-.2488
1966	-.3513	-.0303	.0937	-.1734
1967	-.1269	-.1112	-.0110	.0217
1968	.2350	-.0528	-.0046	-.1517
1969	.4085	.1742	.2607	.0592
1970	*-1.9516	-.2113	*1.1947	.6702
1971	.0993	.0375	-.0061	-.0256
1972	-.9160	.3730	-.5617	-.0261
1973	*1.0771	.3303	-.1105	-.5027
1974	-.5118	.1179	.1862	-.2757
1975	-.6018	-.2024	-.4373	.3102
1976	.5183	-.1076	-.1763	.2835
1977	.3657	-.1206	-.1220	.0275
1978	.0123	-.0004	-.0003	.0027
1979	.1217	-.0289	-.0001	.0317
1980	.2189	-.0679	-.0098	-.0098
1981	.0352	-.0135	-.0076	.0007
1982	.2966	-.0463	.0188	.1662
1983	.1369	-.0041	.0254	.0315
1984	.2681	.0112	.0812	-.0173
1985	.4627	-.1117	-.2017	.1600
1986	.2364	-.0543	-.0356	-.0023
1987	.0799	-.0142	.0322	.0148
1988	.2426	.0398	-.0154	.0388
1989	-.0036	-.0005	.0000	-.0011
1990	-.2025	-.0189	-.0329	-.1069
1991	-.5515	.0003	-.1323	-.1799
1992	-.1166	.0085	-.0853	-.0046
1993	-.1854	.0376	.0092	-.0010

*SDFFITs* Standardized *dfits* value

*SDFBET\_0* Standardized *dfbeta* for the intercept term

*SDFBET\_1* Standardized *dfbeta* for (January-February Inflows)<sup>(0.1)</sup>

*SDFBET\_2* Standardized *dfbeta* for (March-April Inflows)<sup>(0.1)</sup>

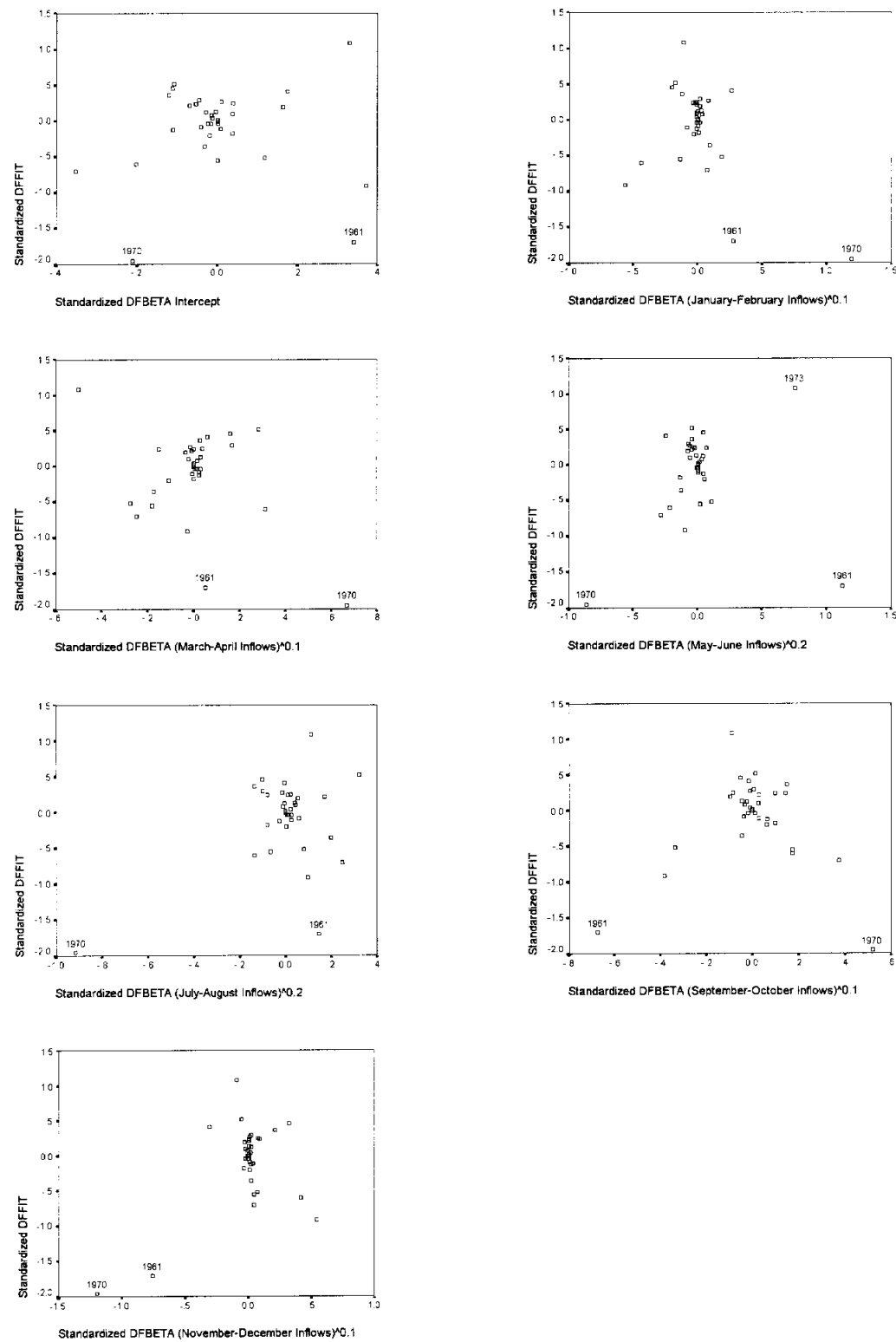
\*Items are flagged if  $|sdfits|$  or  $|sdfbeta|$  exceed 1.0 for a small data set or  $2\sqrt{(p + 1) / n}$  for a large data set. The cutoff used here is 1.

Table 6.22 Standardized *dfbeta* values

YEAR	<i>SDFBET_3</i>	<i>SDFBET_4</i>	<i>SDFBET_5</i>	<i>SDFBET_6</i>
1959	-.0019	.0048	-.0191	-.0038
1960	.0026	.0557	-.0382	.0125
1961	*1.1237	.1463	-.6749	-.7592
1962	.0034	.0261	-.0210	.0059
1963	.0094	.0117	.0100	-.0213
1964	-.0726	.0535	-.0977	-.0316
1965	-.2823	.2485	.3744	.0422
1966	-.1247	.1995	-.0461	.0260
1967	.0486	-.0271	.0624	.0210
1968	.0690	.0085	.1440	.0060
1969	-.2428	-.0059	-.0147	-.3107
1970	-.8656	-.9161	.5182	*-1.2004
1971	-.0562	.0443	.0237	-.0195
1972	-.0975	.0977	-.3829	.5435
1973	.7567	.1112	-.0890	-.0943
1974	.1154	.0781	-.3384	.0698
1975	-.2134	-.1364	.1724	.4112
1976	-.0420	.3239	.0132	-.0562
1977	-.0398	-.1352	.1491	.2135
1978	.0008	.0001	-.0032	.0032
1979	.0432	-.0045	-.0231	.0242
1980	-.0430	.1713	.0289	.0017
1981	.0188	.0192	-.0127	.0144
1982	-.0700	-.0983	.0063	.0235
1983	-.0122	.0379	-.0465	.0039
1984	-.0619	-.0163	-.0113	.0102
1985	.0493	-.1038	-.0509	.3220
1986	-.0165	-.0818	.0962	.0875
1987	.0358	-.0116	-.0328	-.0060
1988	-.0299	.0218	-.0864	.0740
1989	.0019	.0007	-.0003	-.0004
1990	.0551	.0038	.0621	.0134
1991	.0190	-.0656	.1730	.0456
1992	.0061	.0257	.0277	.0352
1993	-.1322	-.0813	.0955	-.0366

<i>SDFBET_3</i>	Standardized <i>dfbeta</i> for (May-June Inflows) <sup>(0.2)</sup>
<i>SDFBET_4</i>	Standardized <i>dfbeta</i> for (July-August Inflows) <sup>(0.2)</sup>
<i>SDFBET_5</i>	Standardized <i>dfbeta</i> for (September-October Inflows) <sup>(0.1)</sup>
<i>SDFBET_6</i>	Standardized <i>dfbeta</i> for (November-December Inflows) <sup>(0.1)</sup>

\*Items are flagged if  $|sdfbeta|$  or  $|sdfbeta|$  exceed 1.0 for a small data set or  $2\sqrt{(p+1)/n}$  for a large data set. The cutoff used here is 1.



**Figure 6.30** Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of various transforms of inflow variables.

## 7. EXAMINING SUBSETS OF THE DATA

## 7.1 Log of brown shrimp data and log of inflow data: 1970 Omitted

**Table 7.1** Regression Models for Dependent Variable: Ln(BROWN SHRIMP) on Ln(INFLOWS): 1970 Omitted

In	Rsq	Adj Rsq	C(p)	AIC	MSE	SBC	Variables in Model
1	0.4557	0.4387	9.093	91.09	13.76	94.14	LN_QJA
1	0.2977	0.2758	20.44	99.75	17.76	102.8	LN_QJF
1	0.1659	0.1399	29.91	105.6	21.09	108.7	LN_QND
1	0.0876	0.0591	35.53	108.7	23.07	111.7	LN_QMJ
-----							
2	0.5198	0.4889	6.488	88.83	12.53	93.40	LN_QMJ LN_QJA
2	0.5065	0.4747	7.443	89.75	12.88	94.33	LN_QJF LN_QJA
2	0.4840	0.4507	9.063	91.27	13.47	95.85	LN_QJA LN_QND
2	0.4578	0.4228	10.94	92.96	14.15	97.54	LN_QJA LN_QSO
-----							
3	0.5610	0.5171	5.529	87.78	11.84	93.88	LN_QMJ LN_QJA LN_QSO
3	0.5431	0.4974	6.816	89.14	12.32	95.24	LN_QJF LN_QMJ LN_QJA
3	0.5334	0.4867	7.514	89.85	12.59	95.96	LN_QMJ LN_QJA LN_QND
3	0.5290	0.4819	7.830	90.17	12.70	96.28	LN_QMA LN_QMJ LN_QJA
-----							
4	0.6009	0.5459	4.664	86.54	11.14	94.17	LN_QJF LN_QMJ LN_QJA LN_QSO
4	0.5873	0.5304	5.643	87.68	11.52	95.31	LN_QMJ LN_QJA LN_QSO LN_QND
4	0.5679	0.5083	7.038	89.24	12.06	96.87	LN_QJF LN_QMA LN_QMJ LN_QJA
4	0.5670	0.5072	7.104	89.31	12.08	96.95	LN_QMA LN_QMJ LN_QJA LN_QSO
-----							
5	0.6239	0.5567	5.013	86.52	10.87	95.68	LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO
5	0.6071	0.5370	6.220	88.01	11.35	97.16	LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND
5	0.6010	0.5297	6.661	88.53	11.53	97.69	LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND
5	0.5679	0.4907	9.038	91.24	12.49	100.4	LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND
-----							
6	0.6241	0.5406	7.000	88.50	11.27	99.19	LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND

N=34

**Table 7.2** Analysis of Variance for Dependent Variable: Ln(BROWN SHRIMP) on Ln(INFLOWS): 1970 Omitted

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	6	505.01146	84.16858	7.471	0.0001
Error	27	304.18519	11.26612		
C Total	33	809.19665			
Root MSE	3.35650	R-square	0.6241		
Dep Mean	1.24226	Adj R-sq	0.5406		
C.V.	270.19336				

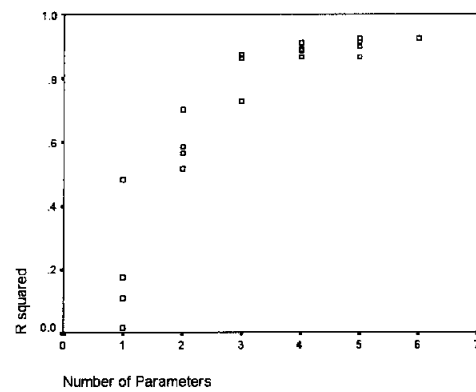
**Table 7.3** Parameter Estimates for Dependent Variable: Ln(BROWN SHRIMP) on Ln(INFLOWS): 1970 Omitted

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T	Variance Inflation
INTERCEP	1	0.943561	0.73263885	1.288	0.2087	0.00000000
LN_QJF	1	0.335834	0.30409377	1.104	0.2792	5.13942325
LN_QMA	1	-0.223589	0.17346819	-1.289	0.2084	1.48014232
LN_QMJ	1	0.483899	0.18595442	2.602	0.0149	1.53484821
LN_QJA	1	0.995828	0.22243709	4.477	0.0001	1.63430190
LN_QSO	1	-0.438191	0.21805686	-2.010	0.0546	1.74600959
LN_QND	1	0.031259	0.26920405	0.116	0.9084	4.10333434

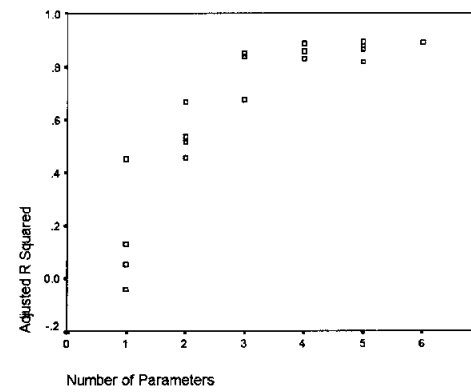
**Table 7.4** Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(BROWN SHRIMP) on Ln(INFLOWS): 1970 Omitted

Prop Number	Eigenvalue	Condition Index	Var Prop LN_QJF	Var Prop LN_QMA	Var Prop LN_QMJ	Var Prop LN_QJA	Var Prop LN_QSO	Var Prop LN_QND
1	3.11612	1.00000	0.0158	0.0334	0.0185	0.0244	0.0308	0.0166
2	1.04751	1.72476	0.0122	0.0211	0.3533	0.1022	0.0418	0.0191
3	0.77165	2.00955	0.0106	0.1203	0.0002	0.3043	0.2010	0.0523
4	0.57969	2.31851	0.0219	0.7230	0.0235	0.1208	0.0479	0.0549
5	0.36920	2.90520	0.0112	0.1015	0.5520	0.2842	0.6773	0.0016
6	0.11584	5.18665	0.9283	0.0007	0.0524	0.1641	0.0012	0.8554

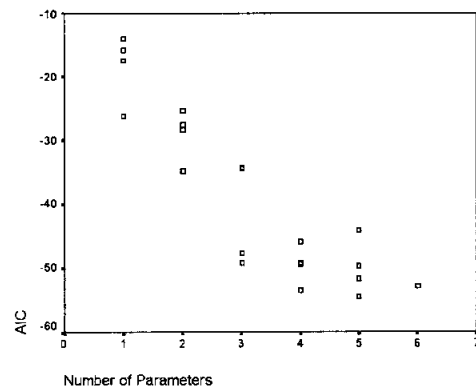




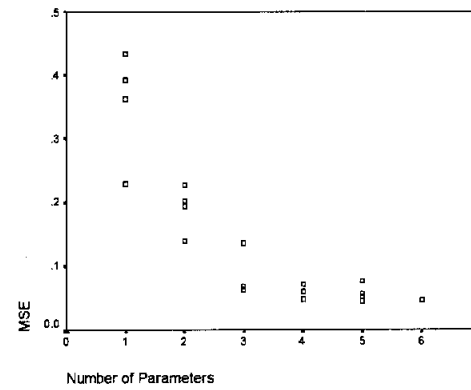
**Figure 7.1** The  $R^2$  criteria vs. Number of parameters.



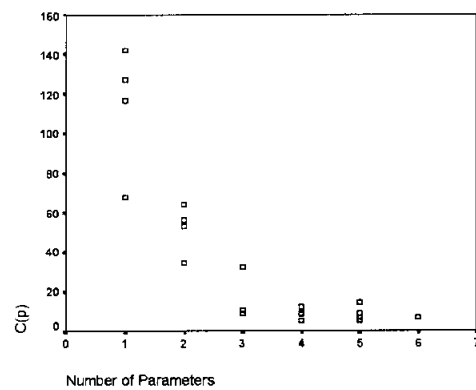
**Figure 7.2** The Adjusted  $R^2$  criteria vs. Number of parameters.



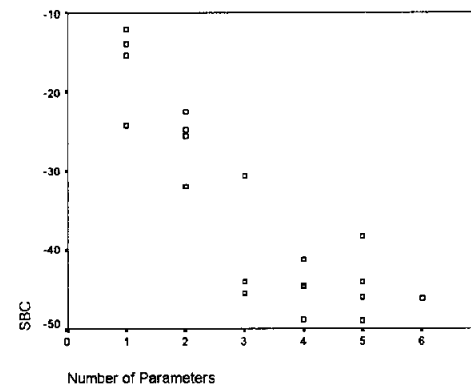
**Figure 7.3** The AIC criteria vs. Number of parameters..



**Figure 7.4** MSE vs. Number of parameters.



**Figure 7.5** The  $C(p)$  criteria vs. Number of parameters.



**Figure 7.6** The SBC criteria vs. Number of parameters.

## 7.2 Various Transformation of data: 1970 Omitted

Table 7.7 Regression Models for Dependent Variable: Various Transformations 1970 Omitted

In	Rsq	Adj Rsq	C(p)	AIC	MSE	SBC	Variables in Model
1	0.3054	0.2837	11.95	-57.59	0.1736	-54.54	QR_QJA
1	0.2663	0.2434	14.31	-55.73	0.1834	-52.67	QR_QJF
1	0.1708	0.1449	20.08	-51.57	0.2073	-48.51	QR_QND
1	0.1055	0.0775	24.03	-48.99	0.2236	-45.94	QR_QMJ
-----							
2	0.4263	0.3892	6.654	-62.09	0.1481	-57.51	QR_QJF QR_QJA
2	0.3851	0.3455	9.138	-59.73	0.1587	-55.15	QR_QJA QR_QND
2	0.3792	0.3391	9.497	-59.41	0.1602	-54.83	QR_QMJ QR_QJA
2	0.3095	0.2650	13.70	-55.79	0.1782	-51.21	QR_QMA QR_QJA
-----							
3	0.4664	0.4130	6.232	-62.55	0.1423	-56.44	QR_QJF QR_QMJ QR_QJA
3	0.4583	0.4041	6.718	-62.04	0.1444	-55.94	QR_QJF QR_QJA QR_QSO
3	0.4446	0.3890	7.548	-61.19	0.1481	-55.08	QR_QMJ QR_QJA QR_QND
3	0.4339	0.3773	8.194	-60.54	0.1510	-54.44	QR_QJF QR_QMA QR_QJA
-----							
4	0.5317	0.4671	4.286	-64.99	0.1292	-57.36	QR_QJF QR_QMJ QR_QJA QR_QSO
4	0.5087	0.4409	5.674	-63.36	0.1355	-55.73	QR_QMJ QR_QJA QR_QSO QR_QND
4	0.4864	0.4155	7.024	-61.85	0.1417	-54.22	QR_QJF QR_QMA QR_QMJ QR_QJA
4	0.4664	0.3928	8.229	-60.55	0.1472	-52.92	QR_QJF QR_QMJ QR_QJA QR_QND
-----							
5	0.5498	0.4694	5.192	-64.33	0.1286	-55.17	QR_QJF QR_QMA QR_QMJ QR_QJA QR_QSO
5	0.5334	0.4500	6.185	-63.11	0.1333	-53.95	QR_QJF QR_QMJ QR_QJA QR_QSO QR_QND
5	0.5235	0.4385	6.778	-62.40	0.1361	-53.25	QR_QMA QR_QMJ QR_QJA QR_QSO QR_QND
5	0.4869	0.3953	8.989	-59.89	0.1466	-50.73	QR_QJF QR_QMA QR_QMJ QR_QJA QR_QND
-----							
6	0.5530	0.4536	7.000	-62.57	0.1324	-51.89	QR_QJF QR_QMA QR_QMJ QR_QJA QR_QSO QR_QND

N = 34

**Table 7.8** Analysis of Variance for Dependent Variable: Various Transformations: 1970 Omitted

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	6	4.42358	0.73726	5.567	0.0007
Error	27	3.57596	0.13244		
C Total	33	7.99953			
Root MSE	0.36393	R-square	0.5530		
Dep Mean	1.25368	Adj R-sq	0.4536		
C.V.	29.02877				

**Table 7.9** Parameter Estimates for Dependent Variable: Various Transformations: 1970 Omitted

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob >  T	Variance Inflation
INTERCEP	1	0.453390	0.26825944	1.690	0.1025	0.00000000
QR_QJF	1	0.472323	0.35421966	1.333	0.1935	4.42691346
QR_QMA	1	-0.242493	0.22278055	-1.088	0.2860	1.43285606
QR_QMJ	1	0.235773	0.10122383	2.329	0.0276	1.30447152
QR_QJA	1	0.462368	0.12454497	3.712	0.0009	1.33745521
QR_QSO	1	-0.442445	0.22152087	-1.997	0.0560	1.54235971
QR_QND	1	0.149874	0.34222040	0.438	0.6649	4.08101177

**Table 7.10** Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Various Transformations: 1970 Omitted

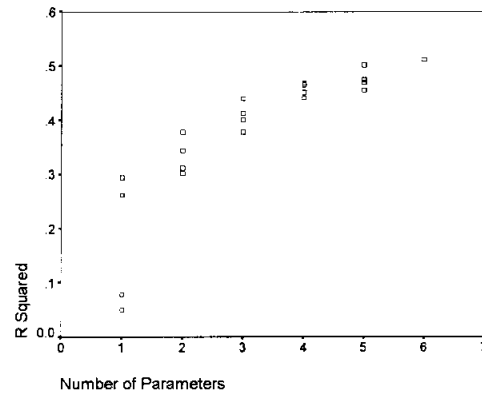
Prop Number	Eigenvalue	Condition Index	Var Prop QR_QJF	Var Prop QR_QMA	Var Prop QR_QMJ	Var Prop QR_QJA	Var Prop QR_QSO	Var Prop QR_QND
1	2.86831	1.00000	0.0204	0.0407	0.0189	0.0286	0.0379	0.0192
2	1.03362	1.66583	0.0270	0.0061	0.3822	0.0078	0.0728	0.0534
3	0.88279	1.80253	0.0070	0.0322	0.1621	0.5328	0.0563	0.0109
4	0.64668	2.10605	0.0083	0.6824	0.0147	0.0619	0.2404	0.0145
5	0.44145	2.54902	0.0276	0.2384	0.3528	0.3192	0.5848	0.0031
6	0.12715	4.74952	0.9097	0.0002	0.0692	0.0497	0.0078	0.8989

**Table 7.11** Parameter Estimates of Models for Dependent Variable Various Transformations  
1970 Omitted

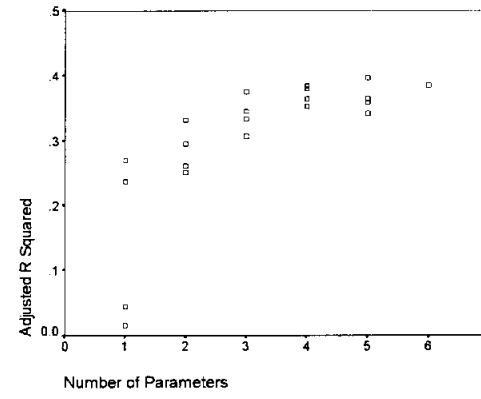
OBS	_RMSE_	INTERCEP	QR_QJF	QR_QMA	QR_QMJ	QR_QJA	QR_QSO	QR_QND
1	0.41670	0.63444	.	.	.	0.46254	.	.
2	0.42826	0.58345	0.67525	.	.	.	.	.
3	0.45529	0.72840	.	.	.	.	.	0.54412
4	0.47288	0.91513	.	.	0.22372	.	.	.
5	0.38478	0.29607	0.48420	.	.	0.35630	.	.
6	0.39833	0.34641	.	.	.	0.40057	.	0.38430
7	0.40025	0.38010	.	.	0.18801	0.44000	.	.
8	0.42211	0.56075	.	0.09728	.	0.44555	.	.
9	0.37722	0.14769	0.42150	.	0.14207	0.35303	.	.
10	0.38006	0.49615	0.56979	.	.	0.41193	-0.28992	.
11	0.38485	0.14269	.	.	0.16965	0.38579	.	0.34989
12	0.38854	0.36766	0.53934	-0.14539	.	0.36958	.	.
13	0.35942	0.38560	0.52360	.	0.20260	0.43536	-0.43633	.
14	0.36813	0.36391	.	.	0.23560	0.47246	-0.43570	0.45682
15	0.37641	0.24061	0.50241	-0.24327	0.16780	0.37466	.	.
16	0.38365	0.14401	0.40408	.	0.14294	0.35359	.	0.01958
17	0.35864	0.47064	0.59915	-0.23154	0.22623	0.45477	-0.43011	.
18	0.36513	0.37026	0.42959	.	0.20867	0.44017	-0.44544	0.10805
19	0.36895	0.43521	.	-0.20957	0.26133	0.49442	-0.43227	0.52295
20	0.38286	0.23059	0.44796	-0.24802	0.17111	0.37689	.	0.06296
21	0.36393	0.45339	0.47232	-0.24249	0.23577	0.46237	-0.44245	0.14987

**Table 7.12** Criteria Statistics of Models for Dependent Variable: Various Transformations. 1970 Omitted

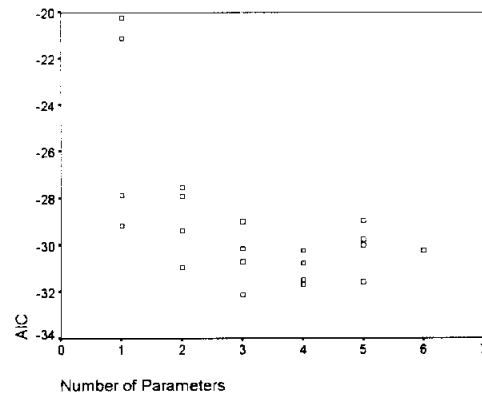
OBS	_MSE_	_RSQ_	_ADJRSQ_	_CP_	_AIC_	_SBC_
1	0.17364	0.30541	0.28370	11.9532	-57.5879	-54.5352
2	0.18340	0.26635	0.24342	14.3126	-55.7277	-52.6749
3	0.20729	0.17081	0.14490	20.0831	-51.5655	-48.5128
4	0.22361	0.10550	0.07755	24.0278	-48.9879	-45.9351
5	0.14806	0.42625	0.38923	6.6544	-62.0863	-57.5072
6	0.15867	0.38513	0.34546	9.1381	-59.7330	-55.1539
7	0.16020	0.37919	0.33914	9.4970	-59.4059	-54.8268
8	0.17818	0.30952	0.26497	13.7049	-55.7898	-51.2107
9	0.14230	0.46635	0.41299	6.2322	-62.5500	-56.4445
10	0.14444	0.45831	0.40414	6.7180	-62.0414	-55.9359
11	0.14811	0.44457	0.38902	7.5480	-61.1895	-55.0841
12	0.15096	0.43387	0.37725	8.1944	-60.5407	-54.4353
13	0.12918	0.53169	0.46710	4.2858	-64.9906	-57.3588
14	0.13552	0.50871	0.44094	5.6739	-63.3617	-55.7299
15	0.14168	0.48636	0.41552	7.0236	-61.8493	-54.2175
16	0.14719	0.46641	0.39281	8.2288	-60.5535	-52.9217
17	0.12862	0.54980	0.46941	5.1918	-64.3317	-55.1735
18	0.13332	0.53336	0.45004	6.1848	-63.1122	-53.9540
19	0.13612	0.52354	0.43846	6.7780	-62.4040	-53.2459
20	0.14658	0.48693	0.39531	8.9892	-59.8871	-50.7289
21	0.13244	0.55298	0.45364	7.0000	-62.5724	-51.8878



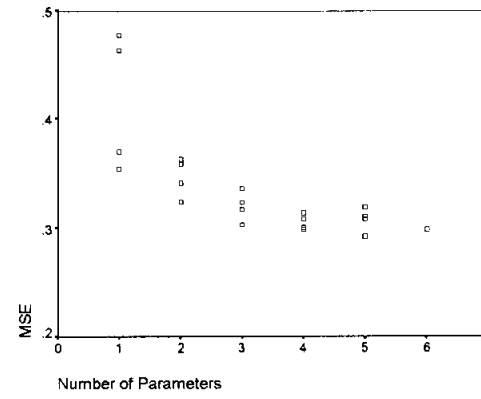
**Figure 7.7** The  $R^2$  criteria vs. Number of parameters.



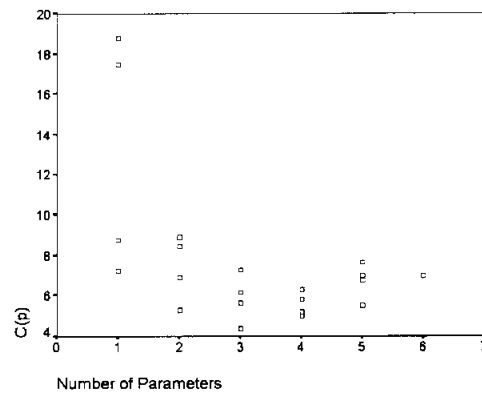
**Figure 7.8** The Adjusted  $R^2$  criteria vs. Number of parameters.



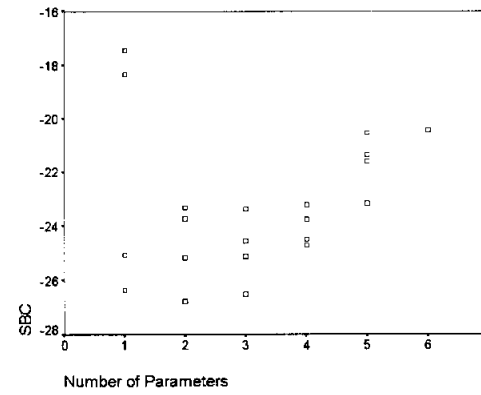
**Figure 7.9** The AIC criteria vs. Number of parameters..



**Figure 7.10** MSE vs. Number of parameters.



**Figure 7.11** The  $C(p)$  criteria vs. Number of parameters.



**Figure 7.12** The SBC criteria vs. Number of parameters.