Chapter 3

Preliminary Data Analysis

In this chapter we describe the preliminary data analysis based on the quantities of the various species of fish collected each day from the Pattani Fishery Port over the 5-year period from 1999 to 2003. In the first section of this chapter we show time series plot of the marine fish daily catches. The frequency distributions of the marine fish catches are investigated in Section 3.2, with the aim of using a data transformation to reduce skewness. After further study of the most appropriate transformation, in Section 3.3 we compare the marine fish catches by day, month and year.

3.1 Time series plots

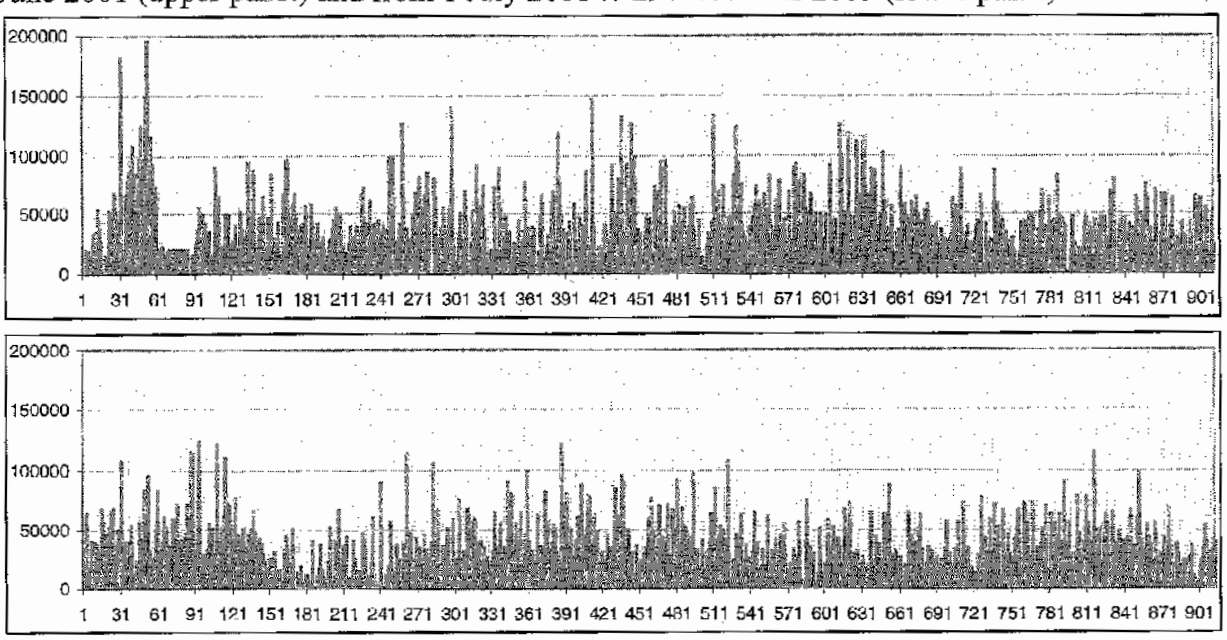
A time series is sequence of observations observed over time, usually at regular intervals. The daily catches of marine fish of various species, measured in kilograms weight, landed from fishing boats at Pattani Fishery Port, provide an example of time series. However, on some days no boats came in, or no boats caught any fish of a particular species. This situation could be regarded as a zero catch if an attempt was made to fish but nothing was caught or as a missing value if no boats landed.

Figures 3.1 to 3.4 display graphs of these data as bar charts.

For mackerel, shown in the top panels of Figure 3.1, the maximum quantity landed on any day over the 5-year period was 196,000 kilograms, observed on 22 February 1999, with a secondary peak of 181,800 kilograms on 31 January 1999. For other food fish, shown in the bottom panels of Figure 3.1, the maximum quantity recorded was 773,030

kilograms, observed on 20 January 1999, with several secondary peaks close to 700,000 kilograms over the next 27 months.

Mackerel daily catches (kilograms) at Pattani Fishery Port from 2 January 1999 to 30 June 2001 (upper panel) and from 1 July 2001 to 29 December 2003 (lower panel)



Other food fish daily catches (kilograms) at Pattani Fishery Port from 2 January 1999 to 30 June 2001 (upper panel) and from 1 July 2001 to 29 December 2003 (lower panel)

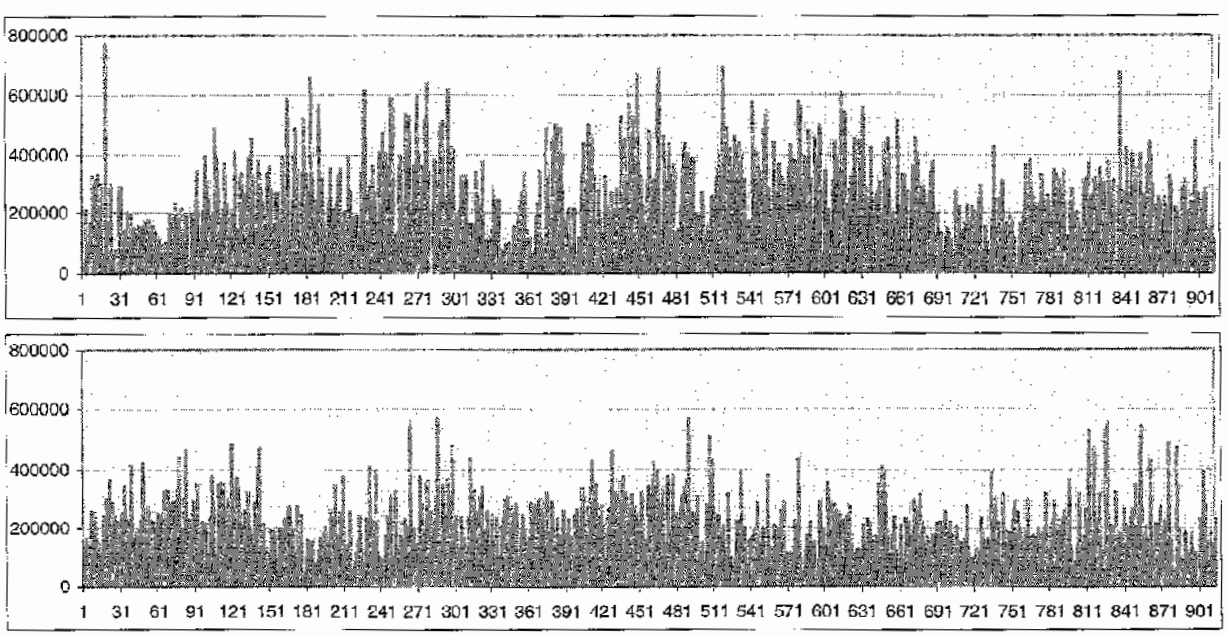
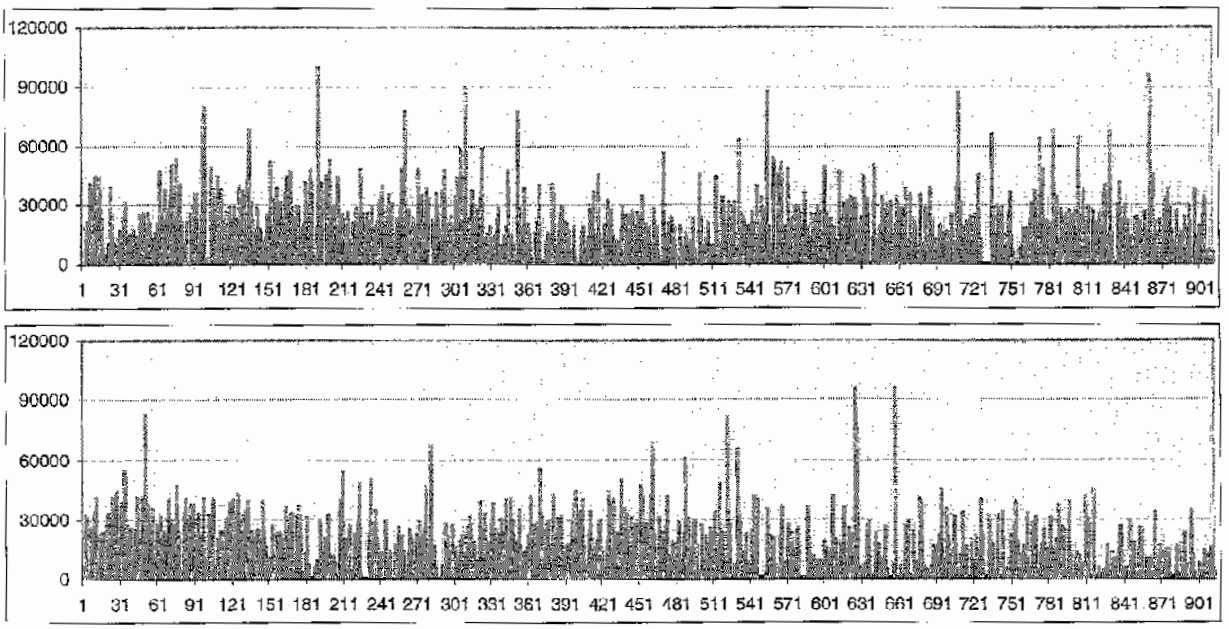


Figure 3.1: Daily catches of mackerel and other food fish from Pattani Fishery Port: 1999-2003

For squid, shown in the top panels of Figure 3.2, the maximum quantity landed on any day over the 5-year period was 99,400 kilograms, observed on 10 July 1999. There were three other occasions when the squid catch exceeded 90,000 kilograms: 9 May 2001, 16 March 2003 and 16 April 2003. For scads, shown in the bottom panels of Figure 3.4, the maximum quantity landed on any day was 667,800 kilograms, observed on 2 October 2003, with one other catch above 600,000 kilograms on 19 September 2001.

Trash fish, shown in the top panels of Figure 3.3, had a maximum catch of 650,000 kilograms, observed on both 15 October 1999 and 15 November 1999 with two secondary peaks on 28 October 1999 and 28 November 1999. For shrimp, shown in the bottom panels, the maximum quantity landed on any day over the 5-year period was 15,500 kilograms, observed on 12 January 2002, with a secondary peak of 13,300 kilograms on 18 April 1999.

Squid daily catches (kilograms) at Pattani Fishery Port from 2 January 1999 to 30 June 2001 (upper panel) and from 1 July 2001 to 29 December 2003 (lower panel)



Scads daily catches (kilograms) at Pattani Fishery Port from 2 January 1999 to 30 June 2001 (upper panel) and from 1 July 2001 to 29 December 2003 (lower panel)

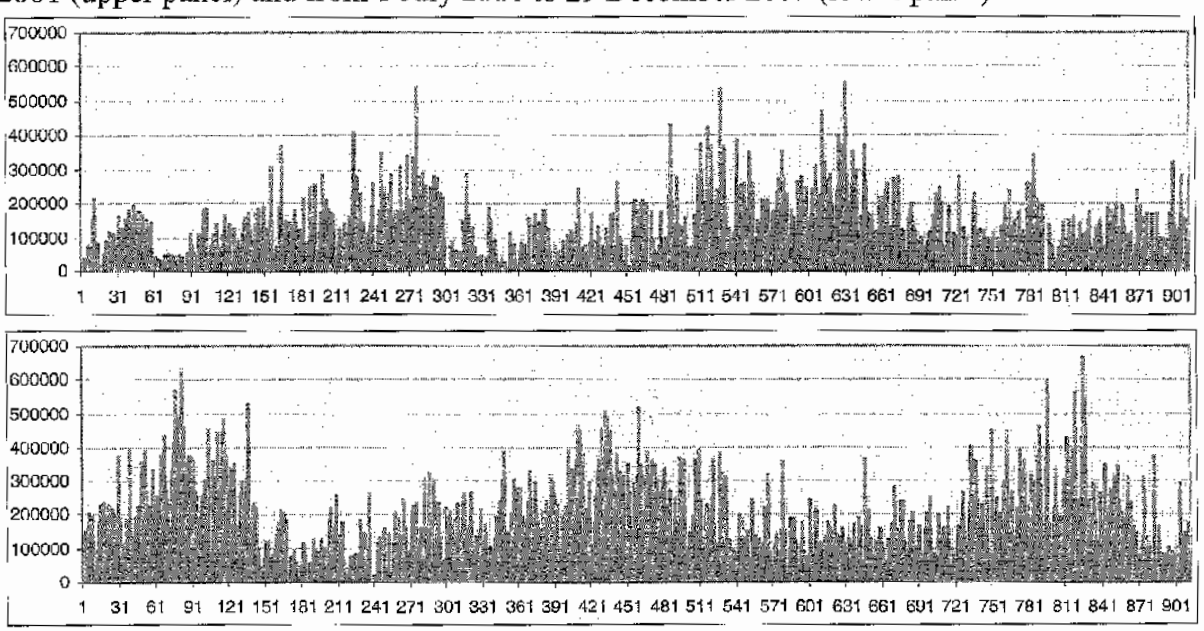
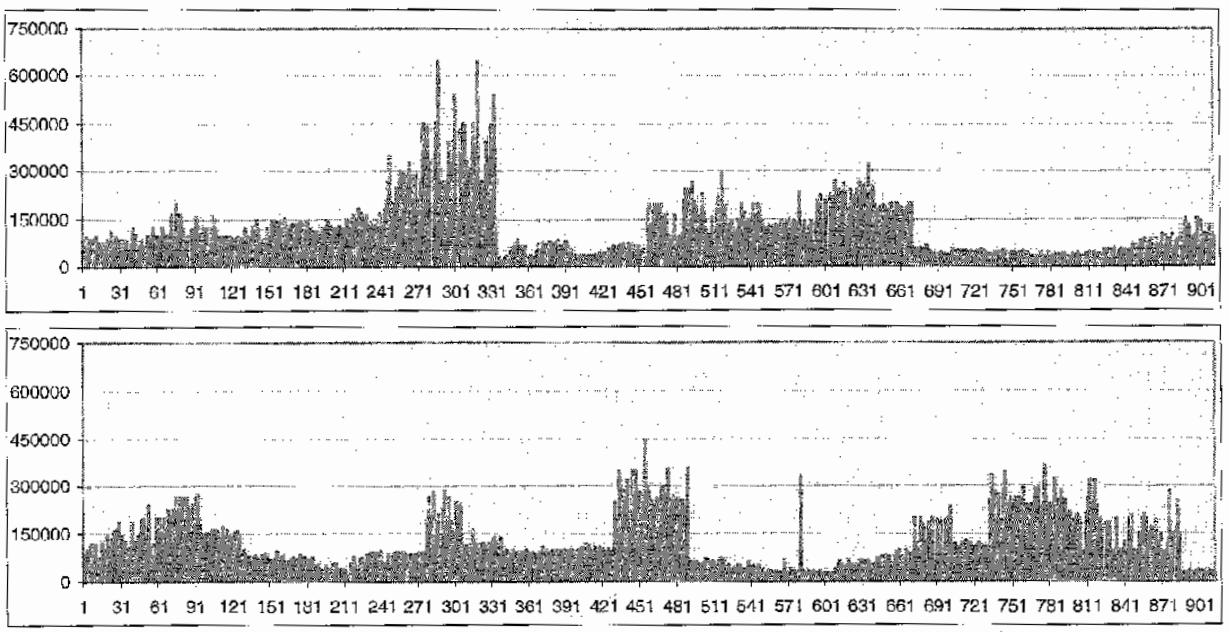


Figure 3.2: Daily catches of squid and scads from Pattani Fishery Port: 1999-2003

Trash fish daily catches (kilograms) at Pattani Fishery Port from 2 January 1999 to 30 June 2001 (upper panel) and from 1 July 2001 to 29 December 2003 (lower panel)



Shrimp daily catches (kilograms) at Pattani Fishery Port from 2 January 1999 to 30 June 2001 (upper panel) and from 1 July 2001 to 29 December 2003 (lower panel)

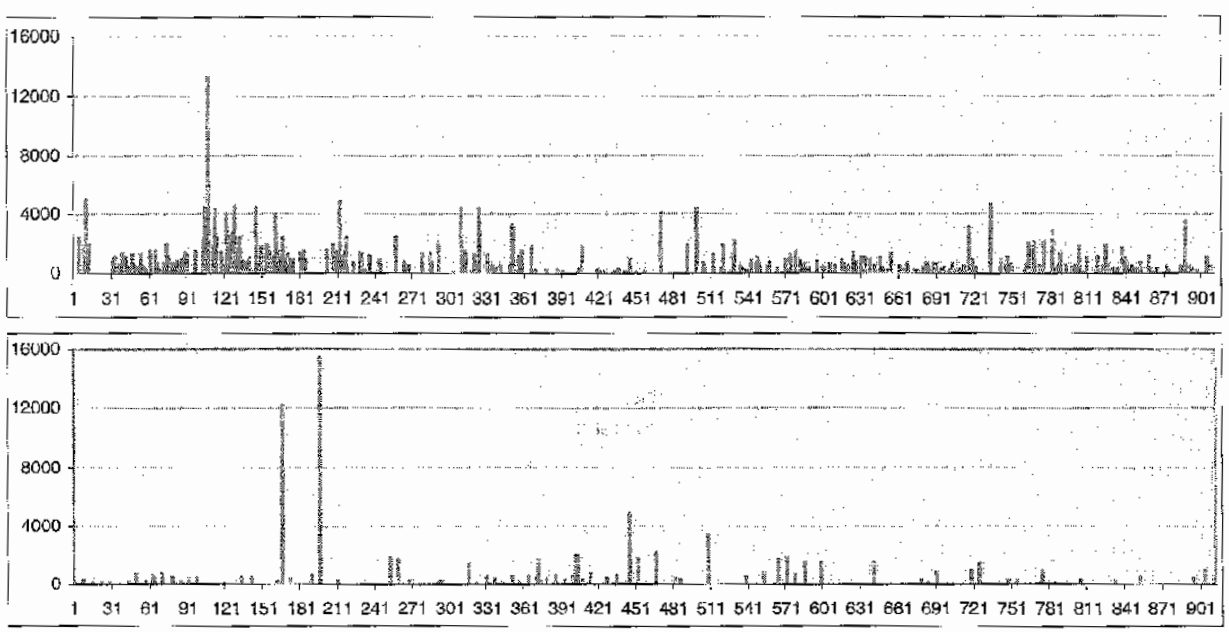
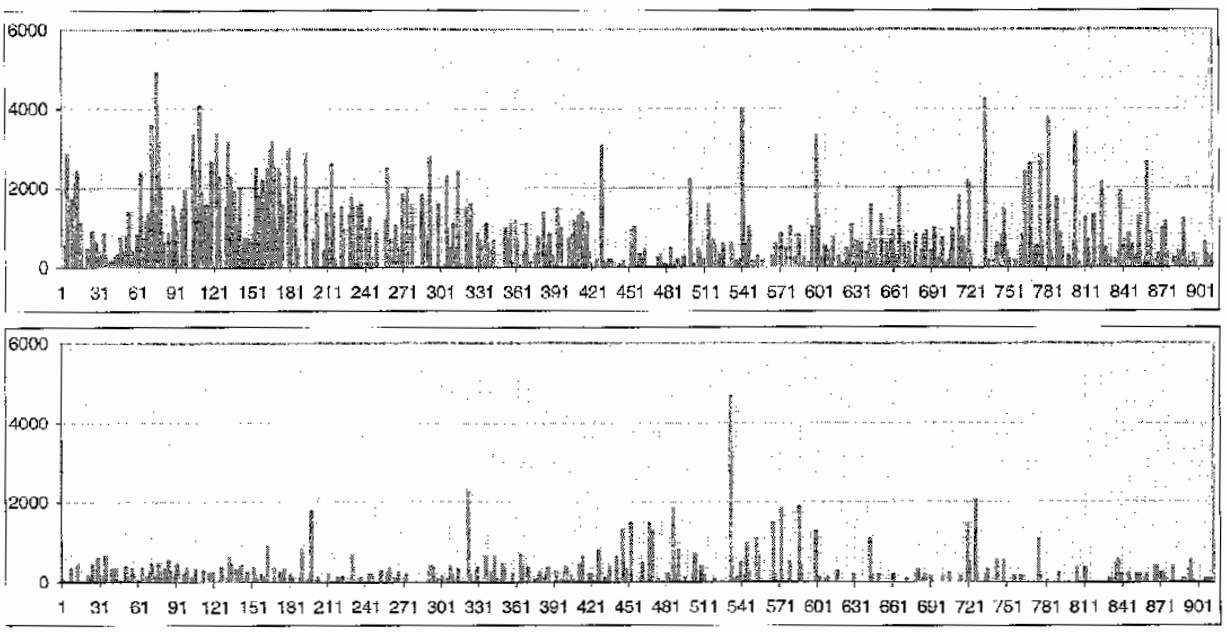


Figure 3.3: Daily catches of trash fish and shrimp from Pattani Fishery Port: 1999-2003

For lobster, shown in the top panels of Figure 3.4, the maximum quantity was 4,900 kilograms, observed on 17 March 1999, with secondary peaks on 13 December 2002.

Crab, shown in the bottom panels, had a maximum quantity was 26,000 kilograms, observed on 28 June 1999, with no other peaks anywhere near as prominent.

Lobster daily catches (kilograms) at Pattani Fishery Port from 2 January 1999 to 30 June 2001 (upper panel) and from 1 July 2001 to 29 December 2003 (lower panel)



Crab daily catches (kilograms) at Pattani Fishery Port from 2 January 1999 to 30 June 2001 (upper panel) and from 1 July 2001 to 29 December 2003 (lower panel)

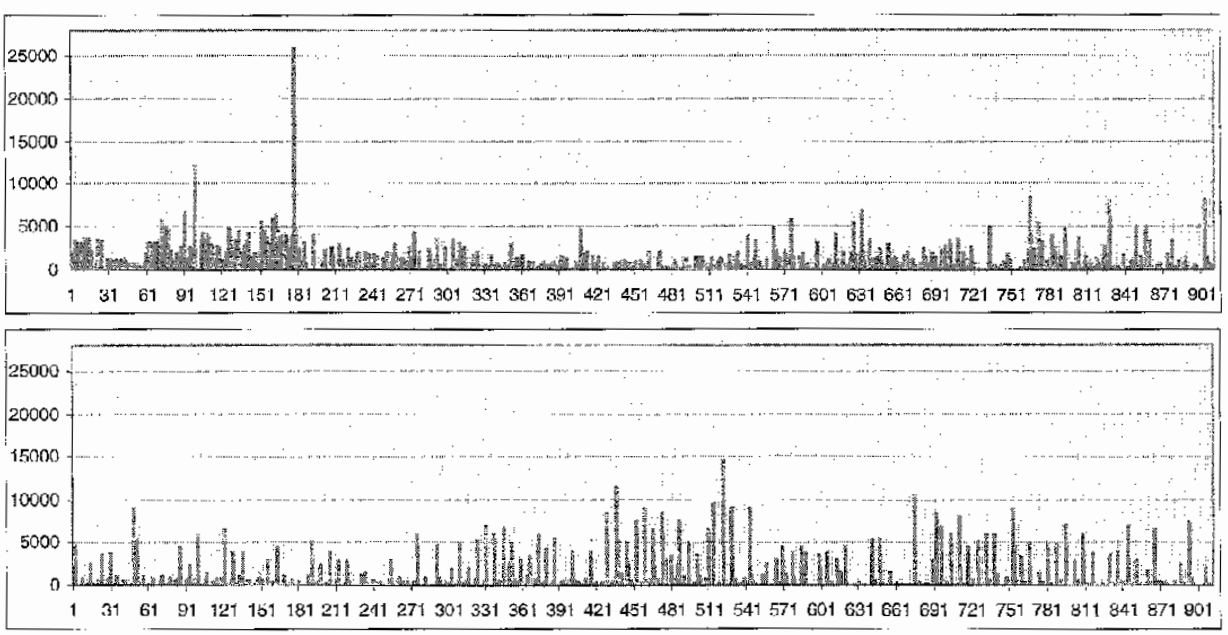


Figure 3.4: Daily catches of lobster and crab from Pattani Fishery Port: 1999-2003

3.2 The frequency distributions of the marine fish catch

Figure 3.5 shows histograms and brief numerical summaries of the daily catch weights of the five species apart from the shellfish before and after a data transformation aimed at reducing the skewness. For these distributions the data corresponding to a zero catch on any day were omitted from the calculations. The skewness coefficients for the weights were all found to be large: 1.53 for mackerel, 0.94 for other food fish, 1.45 for squid, 1.23 for scads, and 1.57 for trash fish. However, after taking cube roots of the weights, these skewness coefficients were reduced to –0.01, –0.34, –0.16, –0.16, and 0.43, respectively, an average of –0.04.

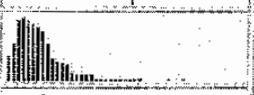
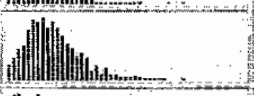
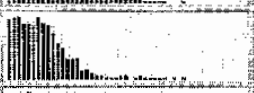
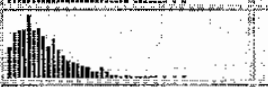
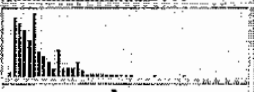
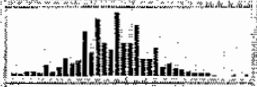
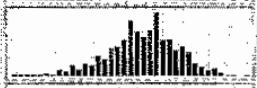
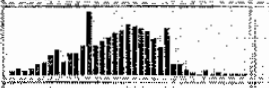
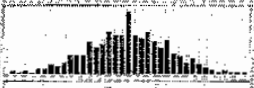
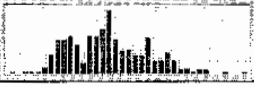
Variable name	Size	Graph	Minimum	Maximum	Mean	StDev	Skewness	Kurtosis
mackerelKg	1765		1000	196,800	35,340.517	23,595.788	1.532	3.927
otherFoodFishKg	1785		1500	773,030	206,145.354	119,174.975	0.944	1.177
squidKg	1567		500	99,400	19,660.570	14,268.036	1.450	3.907
scadsKg	1763		800	667,800	142,218.862	103,217.767	1.233	1.810
trashFishKg	1788		5000	650,800	116,553.128	83,252.250	1.572	3.607
mackerelCubrt	1765		9	58.000	30.727	7.245	-0.012	0.250
otherFoodFishCubrt	1785		11	91.000	56.165	12.070	-0.338	0.319
squidCubrt	1567		7	46.000	24.791	6.819	-0.162	-0.199
scadsCubrt	1763		9	87.000	48.423	13.180	-0.159	-0.031
trashFishCubrt	1788		17	86.000	45.884	10.810	0.432	-0.287

Figure 3.5: Frequency distributions before and after cube root transformation of daily catch weights of five marine fish types from Pattani Fishery Port: 1999-2003.

Previous investigators have suggested taking logarithms of fish catch weights prior to statistical analysis, but these data indicate that taking cube roots provides distributions

that are more symmetrically distributed, and thus more amenable to statistical analysis requiring the normality assumption. Taking logarithms over transforms, and results in negative skewness coefficients. The skewness coefficients resulting from taking logarithms were found to be –0.94, –1.35, –0.94, –1.36 and –0.08 respectively.

Figure 3.6 shows histograms and brief numerical summaries of the daily shellfish catch weights of the three species before and after a data transformation aimed at reducing the skewness. For these distributions the data corresponding to a zero catch on any day were again omitted from the calculations. The skewness coefficients for the weights were all found to be large: 5.44 for shrimp, 3.52 for crab, and 2.20 for lobster. However, taking cube roots did not effectively remove the skewness in the shellfish catch weights. The skewness coefficients resulting from taking cube roots were found to be 1.13, 0.76 and 0.72 respectively.

However, after taking logarithms of the weights, these skewness coefficients were reduced to 0.07, 0.07 and –0.14, respectively, averaging out to zero.

Variable name	Size	Graph	Minimum	Maximum	Mean	StDev	Skewness	Kurtosis
shrimpKg	378		80	15,500	1,079.757	1,493.752	5.443	41.977
lobsterKg	719		10	4,900	658.608	760.766	2.202	5.565
crabKg	897		10	26,000	1,665.377	2,077.013	3.517	24.914
shrimpLog	378		4.382	9.649	6.476	1.000	0.072	-0.192
lobsterLog	719		2.303	8.497	5.932	1.077	0.067	-0.553
crabLog	897		2.303	10.166	6.787	1.181	-0.135	-0.410

Figure 3.6: Frequency distributions before and after natural logarithm transformations of daily catch weights of three marine shellfish types from Pattani Fishery Port: 1999-2003.

Figure 3.7 shows histograms and brief numerical summaries of the monthly catch weights of the five species apart from the shellfish before and after a data transformation aimed at reducing the skewness. The skewness coefficients for the weights were all found to be fairly large: 0.86 for mackerel, 0.24 for other food fish, -0.11 for squid, 0.72 for scads, and 1.07 for trash fish. However, after taking square roots of the weights, these skewness coefficients were reduced to 0.06, –0.004, –0.37, 0.24, and 0.52, respectively.

riable name	Size	Graph	Minimum	Maximum	Mean	StDev	Skewness	Kurtosis
mackerelKg	60		421600	2,221,900.000	1,039,600.200	295,051.922	0.056	3.473
FoodFishKg	60		3507750	9,879,650.000	6,132,824.283	1,561,243.654	0.242	0.591
squidKg	60		210200	821,200.000	513,468.550	142,336.366	-0.109	0.900
scadsKg	60		1004900	9,304,800.000	4,178,861.217	1,868,433.556	0.715	-0.067
trashFishKg	60		325229	9,541,772.000	3,473,283.200	2,233,509.657	1.068	0.501
mackSqrt	60		649.307	1,490.604	1,009.525	144.212	0.064	1.730
otherSqrt	60		1872.899	3,143.191	2,456.413	317.073	-0.004	-0.722
squidSqrt	60		458.476	906.201	709.299	102.657	-0.368	-0.641
scadsSqrt	60		1002.447	3,050.377	1,994.394	452.400	0.241	-0.421
trashSqrt	60		508.421	3,088.976	1,774.476	574.473	0.520	-0.483

Figure 3.7: Frequency distributions before and after square root transformation of monthly catch weights of five marine fish types from Pattani Fishery Port: 1999-2003.

Figure 3.8 shows histograms and brief numerical summaries of the monthly shellfish catch weights of the three species before and after a data transformation aimed at reducing the skewness. The skewness coefficients for the weights were all found to be large: 2.17 for shrimp and lobster, 2.61 for crab. However, taking square roots did not effectively remove the skewness in the shellfish catch weights. The skewness

coefficients resulting from taking square roots were found to be 0.85, 1.06 and 1.56 respectively.

However, after taking logarithms of the weights, these skewness coefficients were reduced to -0.43, -0.06 and 0.65, respectively.

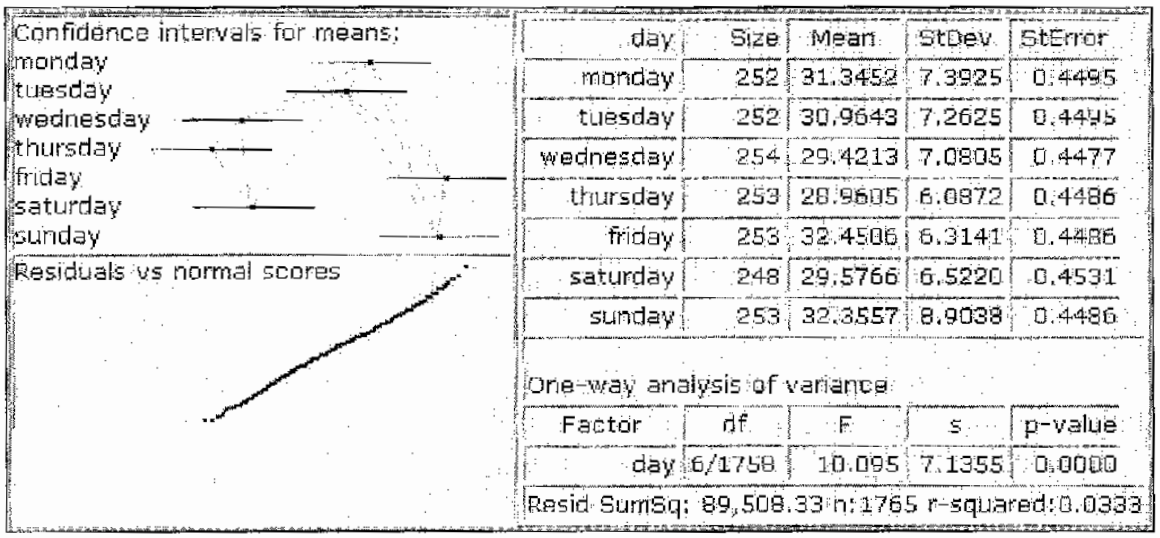
Variable name	Size	Graph	Minimum	Maximum	Mean	StDev	Skewness	Kurtosis
shrimpKg	57		280	37,410.000	7,160.491	7,483.880	2.173	5.804
lobsterKg	60		480	39,952.000	7,892.317	7,750.269	2.172	5.477
crabKg	60		7430	106,500.000	24,897.383	16,696.914	2.612	9.210
shrimpLog	57		5.635	10.530	8.348	1.134	-0.429	-0.293
lobsterLog	60		6.174	10.595	8.575	0.921	-0.064	-0.270
crabLog	60		8.913	11.576	9.970	0.527	0.654	0.653

Figure 3.8: Frequency distributions before and after natural logarithm transformations of monthly catch weights of three marine shellfish types from Pattani Fishery Port: 1999-2003.

3.3 Comparison of the marine fish catches by day, month and year

In this section we compare the marine fish catches with respect to the day of the week, the month of the year, and the year. Confidence intervals, with means joined when pairs are not statistically different, show the differences in the means of the transformed daily catches.

Figure 3.9 shows statistically significant differences in the catches on different days of the week for mackerel and other food fish catch.

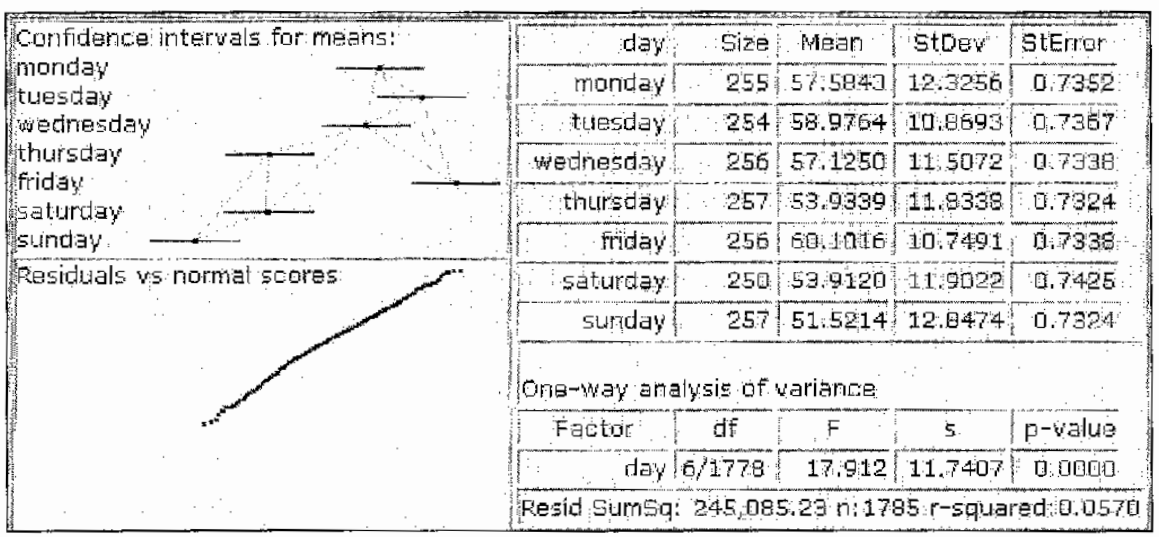


day	Size	Mean	StDev	StError
monday	252	31.3452	7.3925	0.4495
tuesday	252	30.9643	7.2625	0.4495
wednesday	254	29.4213	7.0805	0.4477
thursday	253	28.9605	6.6872	0.4486
friday	253	32.4506	6.3141	0.4486
saturday	248	29.5766	6.5220	0.4531
sunday	253	32.3557	8.9038	0.4486

One-way analysis of variance

Factor	df	F	s	p-value
day	6/1758	10.095	7.1355	0.0000

Resid SumSq: 89,508.33 n:1765 r-squared:0.0333



day	Size	Mean	StDev	StError
monday	255	57.5843	12.3256	0.7352
tuesday	254	58.9764	10.8693	0.7367
wednesday	256	57.1250	11.5072	0.7338
thursday	257	53.9339	11.8338	0.7324
friday	256	60.1016	10.7491	0.7338
saturday	250	59.9120	11.9022	0.7425
sunday	257	51.5214	12.8474	0.7324

One-way analysis of variance

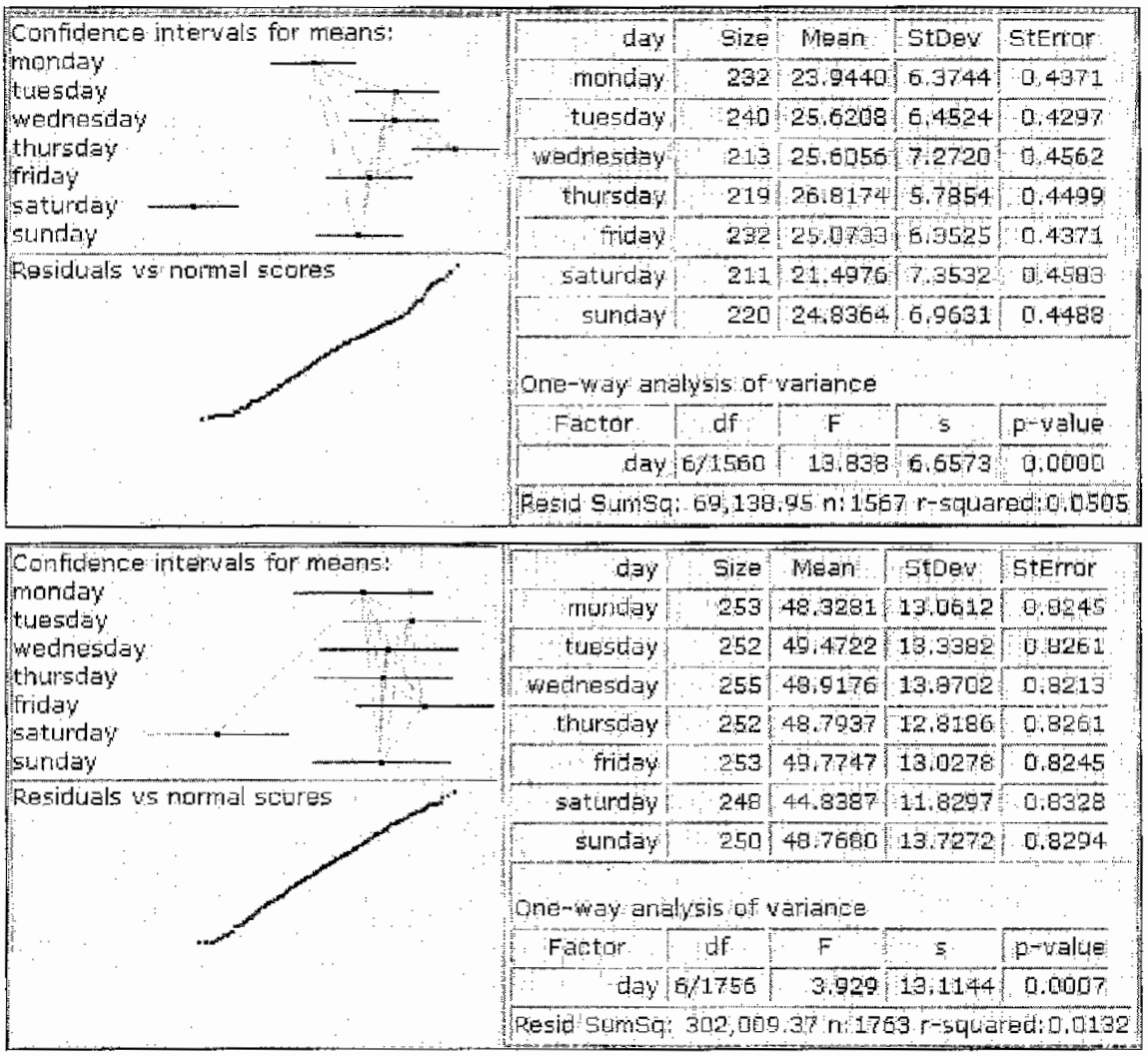
Factor	df	F	s	p-value
day	6/1778	17.912	11.7407	0.0000

Resid SumSq: 245,085.29 n:1785 r-squared:0.0570

Figure 3.9: Comparison of mackerel (top panel) and other food fish catches by day of week

For mackerel, the catches on Friday and Sunday are higher than those on Wednesdays, Thursdays and Saturdays, with Mondays and Tuesdays having average catches. For other food fish, the pattern is different. The catches on Friday are still relatively high and the catches on Saturday are still lower than on Mondays and Tuesdays, but Sunday has the lowest catches.

The patterns for squid and scads are similar, as shown in Figure 3.10. In each case the catches are lower on Saturday than on others days of the week, but there is no evidence of any difference between the amounts caught on these other days.



day	Size	Mean	StDev	StError
monday	232	23.9440	6.3744	0.4371
tuesday	240	25.6208	6.4524	0.4297
wednesday	213	25.6056	7.2720	0.4562
thursday	219	26.8174	5.7854	0.4499
friday	232	25.0733	6.3525	0.4371
saturday	211	21.4976	7.3532	0.4583
sunday	220	24.8364	6.9631	0.4488

One-way analysis of variance

Factor	df	F	s	p-value
day	6/1560	13.838	6.6573	0.0000

Resid SumSq: 69,138.95 n: 1567 r-squared: 0.0505

day	Size	Mean	StDev	StError
monday	253	48.3281	13.0612	0.8245
tuesday	252	49.4722	13.3382	0.8261
wednesday	255	48.9176	13.8702	0.8213
thursday	252	48.7937	12.8186	0.8261
friday	253	49.7747	13.0278	0.8245
saturday	248	44.8387	11.8297	0.8328
sunday	250	48.7680	13.7272	0.8294

One-way analysis of variance

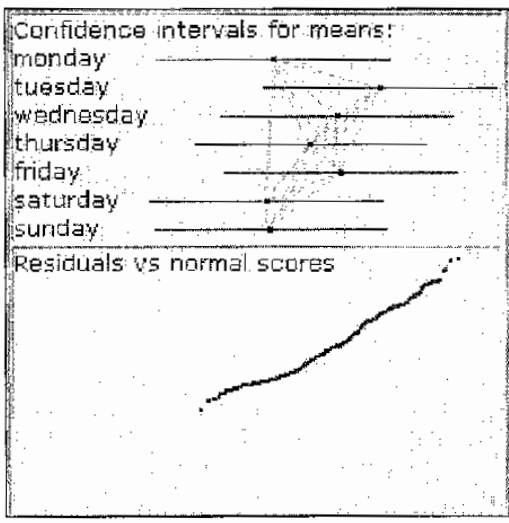
Factor	df	F	s	p-value
day	6/1756	3.929	13.1144	0.0007

Resid SumSq: 302,009.37 n: 1763 r-squared: 0.0132

Figure 3.10: Comparison of daily catches of squid (top panel) and scads by day of week

For scads, the catch on Friday has the highest and the catch on Saturday is still lowest and the catch on Tuesday, Wednesday, Thursday and Sunday having average catches.

Figure 3.11, which shows the comparison for trash fish, indicates that there is no statistically significant day of week effect on the catch (p-value = 0.76).



day	Size	Mean	StDev	StError
monday	254	45.4488	10.9228	0.6788
tuesday	254	46.6850	10.7149	0.6788
wednesday	256	46.1797	10.9031	0.6761
thursday	257	45.8677	10.9043	0.6748
friday	256	46.2344	10.8537	0.6761
saturday	253	45.3597	10.3261	0.6801
sunday	258	45.4109	11.0782	0.6735

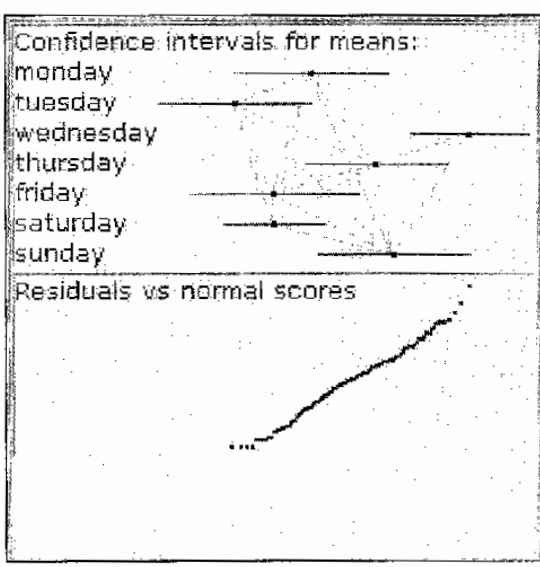
One-way analysis of variance

Factor	df	F	s	p-value
day	6/1781	0.559	10.8182	0.7635

Resid SumSq: 208,435.53 n:1788 r-squared:0.0019

Figure 3.11: Comparison of trash fish catch by day of week

For shellfish, the confidence intervals for the means of the log-transformed catches are shown in Figures 3.12, 3.13, and 3.14. For shrimp, Figure 3.12 shows that the catches are greater on Wednesdays, with no differences observed between the catches on other days.



day	Size	Mean	StDev	StError
monday	43	6.3766	1.0071	0.1464
tuesday	43	6.0851	0.7431	0.1464
wednesday	70	6.9793	0.9417	0.1147
thursday	50	6.6273	0.9442	0.1358
friday	35	6.2373	0.8378	0.1623
saturday	95	6.2376	0.9354	0.0985
sunday	42	6.6943	1.2607	0.1481

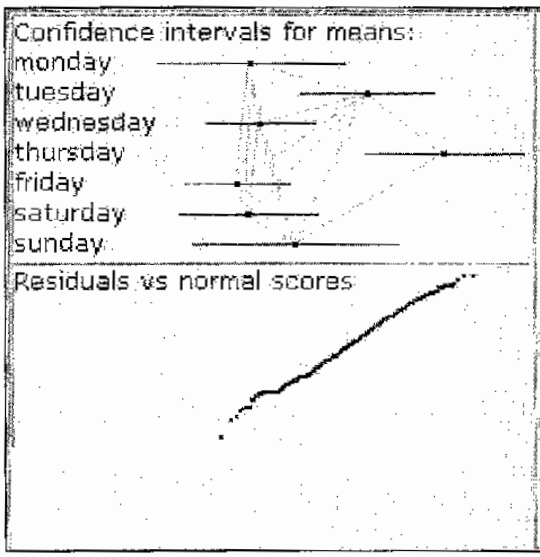
One-way analysis of variance

Factor	df	F	s	p-value
day	6/371	6.378	0.9600	0.0000

Resid SumSq: 341.94 n:378 r-squared:0.0935

Figure 3.12: Comparison of shrimp catch by day of week

For lobster (Figure 3.13), Thursday have higher catches than Mondays, Wednesdays, Fridays and Saturdays, but no other differences are statistically significant.



day	Size	Mean	StDev	StError
monday	56	5.8126	1.0519	0.1418
tuesday	105	6.1672	1.0345	0.1036
wednesday	160	5.8449	1.2648	0.0839
thursday	76	6.4032	1.1129	0.1217
friday	177	5.7705	0.8969	0.0798
saturday	99	5.8097	0.9145	0.1067
sunday	46	5.9490	1.1460	0.1565

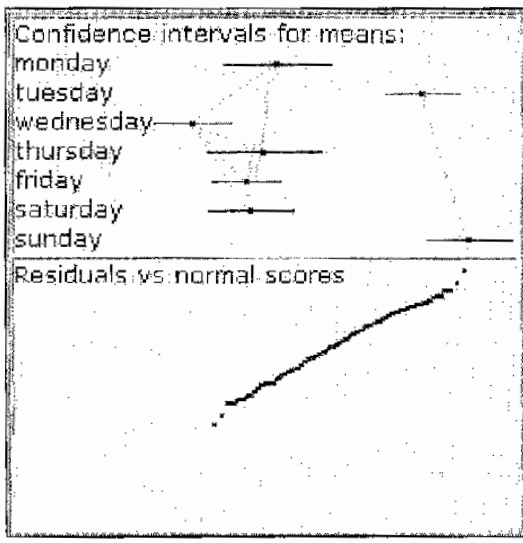
One-way analysis of variance

Factor	df	F	s	p-value
day	6/712	4.559	1.0614	0.0002

Resid SumSq: 802.06 n: 719 r-squared: 0.0370

Figure 3.13: Comparison of lobster catch by day of week

Finally, Figure 3.14 shows that crab catches tended to be higher on Tuesdays and Sundays, with no differences between other days of the week.



day	Size	Mean	StDev	StError
monday	78	6.6562	1.0908	0.1240
tuesday	163	7.3241	1.1635	0.0858
wednesday	146	6.2735	1.1934	0.0906
thursday	68	6.5942	1.2229	0.1328
friday	194	6.5213	0.9999	0.0786
saturday	123	6.5933	0.9627	0.0987
sunday	125	7.5375	1.0765	0.0979

One-way analysis of variance

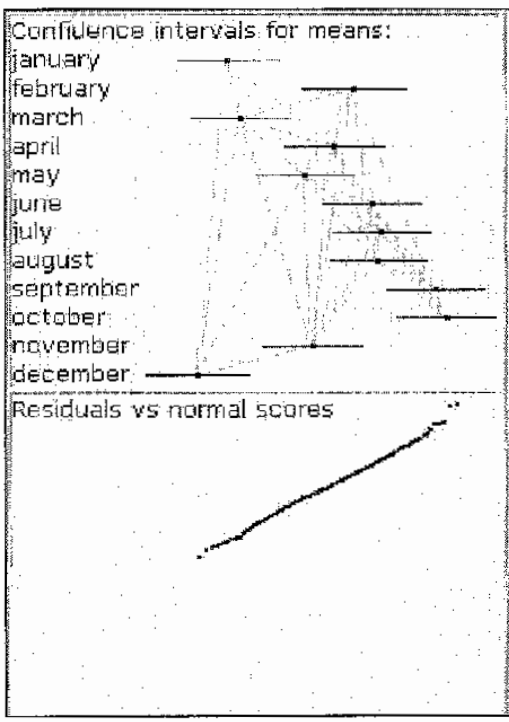
Factor	df	F	s	p-value
day	6/890	25.210	1.0951	0.0000

Resid SumSq: 1,067.30 n: 897 r-squared: 0.1453

Figure 3.14: Comparison of crab catch by day of week

Figure 3.15 shows that there is an increasing trend on mackerel catches with the months. The lowest catch was on December. They slightly increased on January and moderate increased on February. From March to October, the mackerel catches increased gradually and dropped down again on November. For other food fish, the

lowest other food fish catch were on December. There is an increasing trend from January to September, slightly decreased on October and dropped down on November.

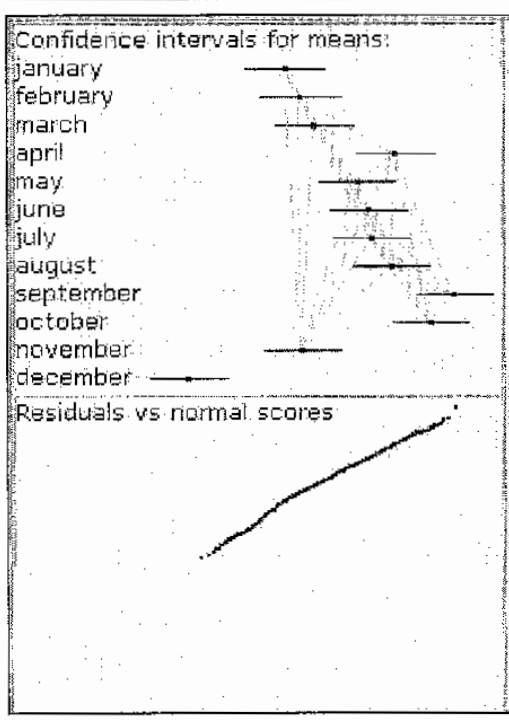


month	Size	Mean	StDev	StError
january	142	28.3099	7.5071	0.5920
february	134	31.2164	9.1556	0.6095
march	147	28.5850	6.8054	0.5819
april	144	30.7500	6.8219	0.5879
may	155	30.0452	6.6022	0.5667
june	149	31.6174	6.7179	0.5780
july	151	31.8344	6.5273	0.5741
august	155	31.7484	6.1861	0.5667
september	149	33.0872	7.8257	0.5780
october	152	33.3355	6.4430	0.5722
november	147	30.2177	6.6183	0.5819
december	140	27.6071	7.2655	0.5963

One-way analysis of variance

Factor	df	F	s	p-value
month	11/1753	9.750	7.0551	0.0000

Resid SumSq: 87,253.88 n:1765 r-squared:0.0577



month	Size	Mean	StDev	StError
january	144	53.1597	12.9554	0.9694
february	136	53.8309	11.0993	0.9975
march	151	54.5232	11.5873	0.9467
april	146	58.4521	12.6066	0.9628
may	155	56.6645	11.0661	0.9344
june	150	57.1400	11.7176	0.9498
july	154	57.2987	10.3192	0.9374
august	155	58.2516	11.5885	0.9344
september	149	61.3557	11.0717	0.9530
october	152	60.1513	11.4063	0.9436
november	140	53.9797	12.2449	0.9562
december	145	48.4828	11.7864	0.9661

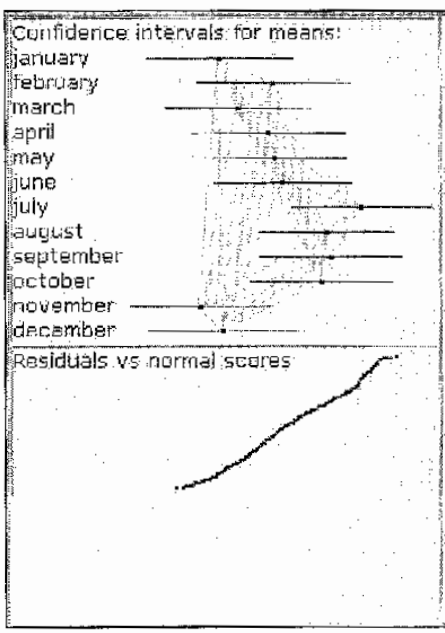
One-way analysis of variance

Factor	df	F	s	p-value
month	11/1773	13.409	11.6331	0.0000

Resid SumSq: 239,939.15 n:1785 r-squared:0.0768

Figure 3.15: Comparison of mackerel (top panel) and other food fish by month

Figure 3.16 shows that there is an increasing trend on squid catches with the months. The lowest catch was on November. They slightly increased on December to January and moderate increased on February. From March to July, the mackerel catches increased gradually and slightly decreased on August to October. For scads, the lowest scads catch were on March. There is an increasing trend from April to September, slightly decreased on October and dropped down on November and December.

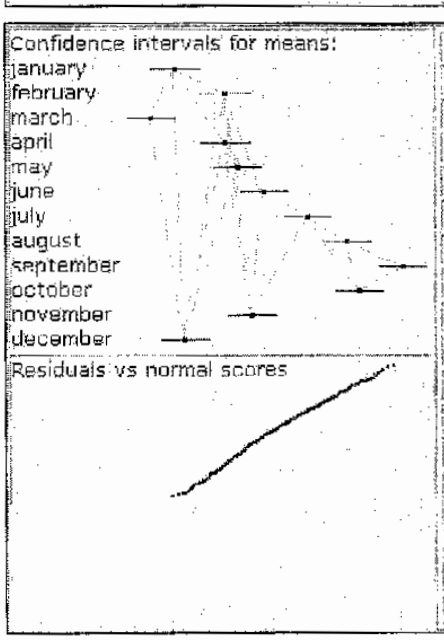


month	Size	Mean	StDev	StError
january	125	23.8320	6.4891	0.6078
february	116	24.7069	6.2457	0.6309
march	128	24.1484	7.3282	0.6006
april	114	24.6228	7.4328	0.6364
may	137	24.7372	6.2382	0.5806
june	141	24.8723	6.7674	0.5723
july	135	26.1630	6.9842	0.5848
august	145	25.5862	6.3744	0.5643
september	133	25.6617	6.8234	0.5892
october	133	25.5263	6.7224	0.5892
november	130	23.5145	6.9052	0.5784
december	122	23.8852	7.2136	0.6152

One-way analysis of variance

Factor	df	F	s	p-value
month	11/1555	2.002	6.7952	0.0249

Resid SumSq: 71,802.09 n: 1567 r-squared: 0.0140



month	Size	Mean	StDev	StError
january	141	41.4610	11.9454	0.9922
february	134	45.3955	9.8987	1.0177
march	145	39.5890	11.8104	0.9750
april	144	45.4722	10.4446	0.9818
may	154	46.4026	11.6071	0.9494
june	149	48.5101	12.4089	0.9652
july	154	52.0130	11.1020	0.9494
august	154	55.1364	11.1976	0.9494
september	149	59.5235	12.2885	0.9652
october	150	56.1267	13.5341	0.9610
november	146	47.5959	12.8033	0.9750
december	142	42.2535	11.7125	0.9887

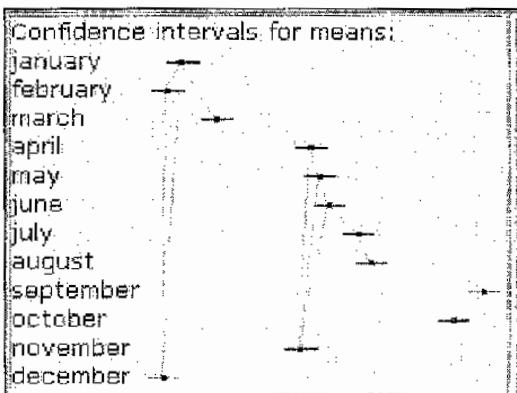
One-way analysis of variance

Factor	df	F	s	p-value
month	11/1751	41.265	11.7812	0.0000

Resid SumSq: 243,032.48 n: 1763 r-squared: 0.2859

Figure 3.16: Comparison of squid (top panel) and scads catch by month

Figure 3.17 shows that there is an increasing trend on trash fish catches with the months. The lowest catch was on December. They slightly increased on January and slightly decrease on February. From March to October, the trash fish catches increased gradually and dropped down again on November.



month	Size	Mean	StDev	StError
january	144	36.3125	5.9267	0.6245
february	140	35.1286	5.1297	0.6334
march	151	38.9934	5.8052	0.6099
april	146	46.1575	8.4459	0.6202
may	155	46.8710	7.3394	0.6020
june	150	47.6533	4.1353	0.6119
july	153	49.9216	7.5337	0.6059
august	155	50.8645	8.1113	0.6020
september	149	59.5705	6.6294	0.6140
october	152	57.2697	8.6353	0.6079
november	146	45.3904	13.2953	0.6202
december	147	34.8503	4.2818	0.6181

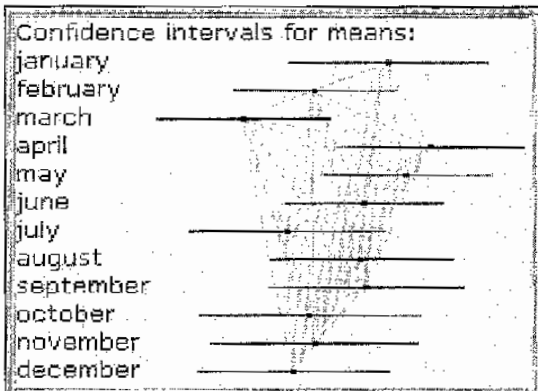
One-way analysis of variance

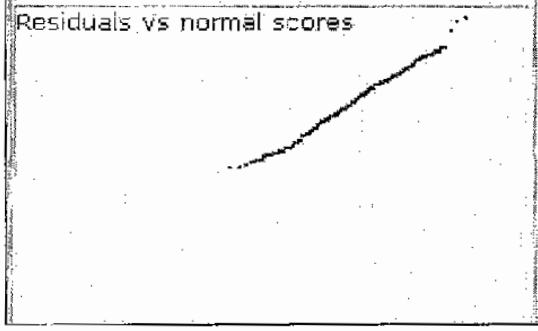
Factor	df	F	s	p-value
month	11/1776	176.541	7.4945	0.0000

Resid SumSq: 99,753.50 n:1788 r-squared:0.5223

Figure 3.17: Comparison of trash fish catch by month

For shellfish, the confidence intervals for the means of the log-transformed catches are shown in Figures 3.18 and 3.19. For shrimp, Figure 3.18 which shows that there is an increasing trend on shrimp catches with the months. The lowest catch was on March. They moderate increased on April. From May to July, the shrimp catches decreased gradually and increased gradually on August to September. It decreased again from October to December.





month	Size	Mean	StDev	StError
january	27	6.6583	1.2542	0.1913
february	40	6.3763	0.8794	0.1572
march	36	6.1080	1.0555	0.1657
april	30	6.8193	1.1965	0.1815
may	38	6.7238	0.9793	0.1612
june	43	6.5647	0.9307	0.1516
july	28	6.2704	0.9212	0.1879
august	32	6.5506	0.9101	0.1757
september	28	6.5712	0.6974	0.1879
october	22	6.3512	0.7829	0.2119
november	25	6.3737	1.0750	0.1988
december	29	6.2921	1.1296	0.1846

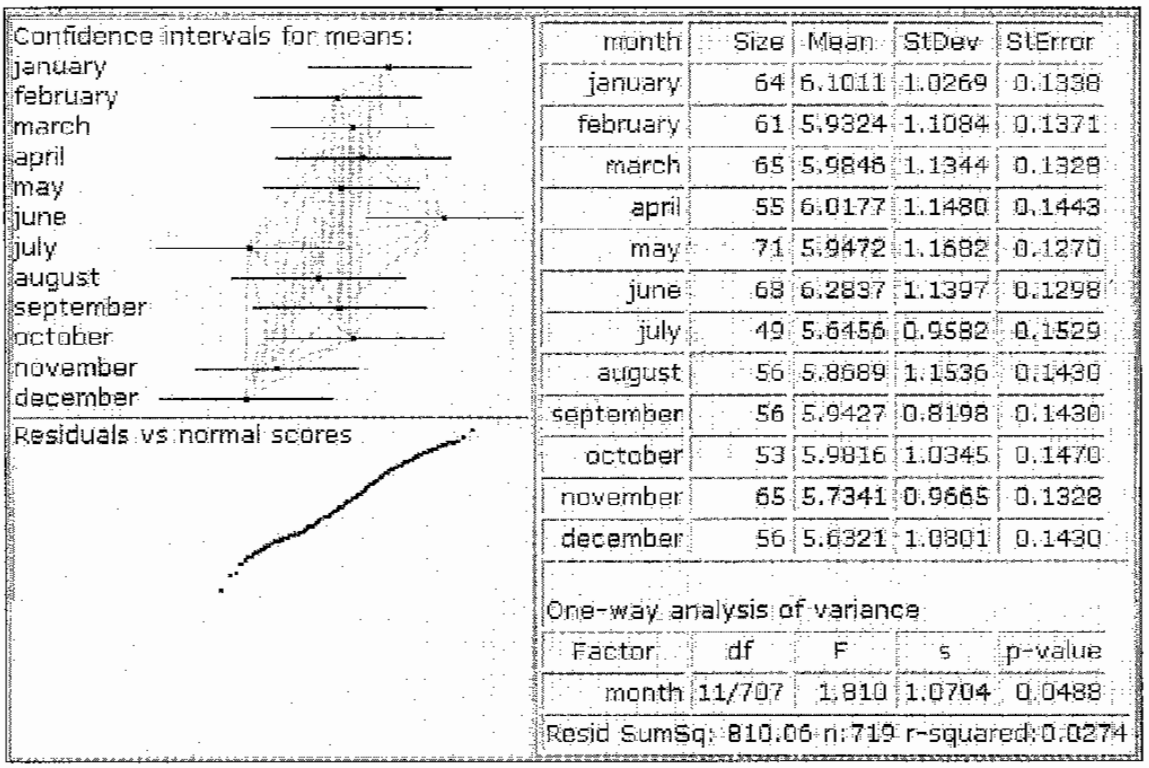
One-way analysis of variance

Factor	df	F	s	p-value
month	11/366	1.433	0.9940	0.1556

Resid SumSq: 361.63 n:378 r-squared:0.0412

Figure 3.18: Comparison of shrimp catch by month

Figure 3.19 shows that the lobster catches on June were slightly higher than the other months. The comparison for crab indicates that there is no statistically significant between different months. However on June has the highest catch.

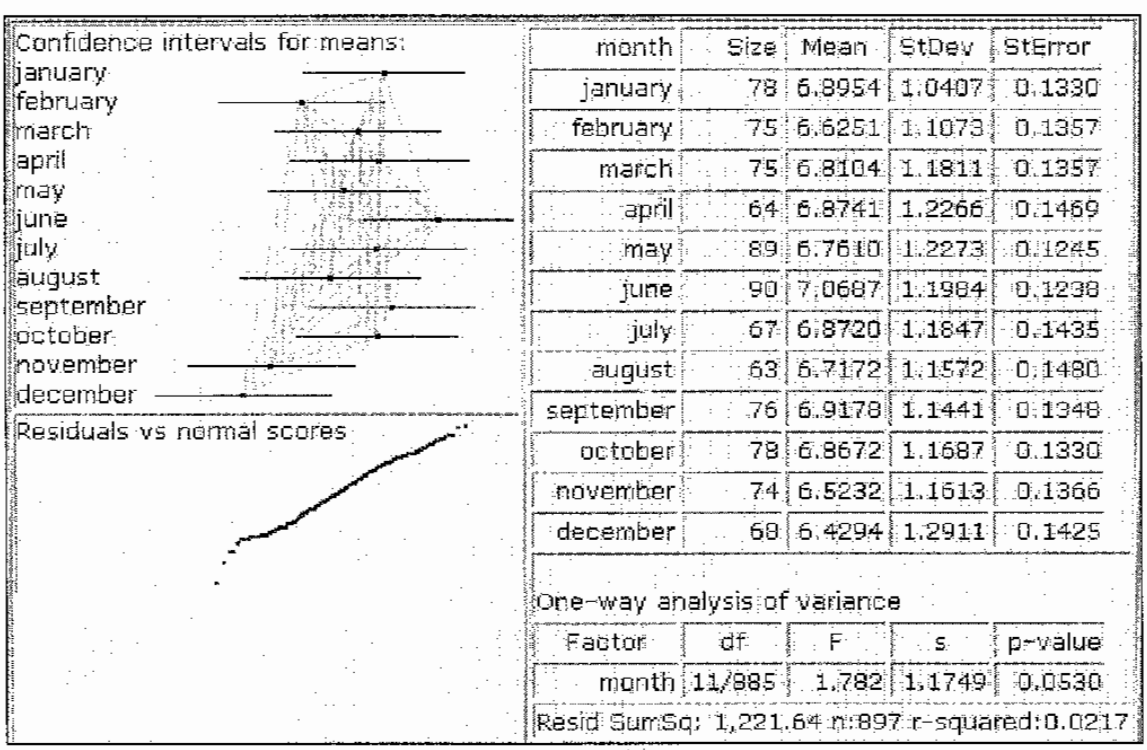


month	Size	Mean	StDev	StError
january	64	6.1011	1.0269	0.1338
february	61	5.9324	1.1084	0.1371
march	65	5.9846	1.1344	0.1328
april	55	6.0177	1.1480	0.1443
may	71	5.9472	1.1682	0.1270
june	68	6.2837	1.1397	0.1298
july	49	5.6456	0.9582	0.1529
august	56	5.8689	1.1536	0.1430
september	56	5.9427	0.8198	0.1430
october	53	5.9816	1.0345	0.1470
november	65	5.7341	0.9665	0.1328
december	56	5.6321	1.0801	0.1430

One-way analysis of variance

Factor	df	F	s	p-value
month	11/707	1.810	1.0704	0.0488

Resid SumSq: 810.06 n:719 r-squared:0.0274



month	Size	Mean	StDev	StError
january	78	6.8954	1.0407	0.1330
february	75	6.6251	1.1073	0.1357
march	75	6.8104	1.1811	0.1357
april	64	6.8741	1.2266	0.1469
may	89	6.7610	1.2273	0.1245
june	90	7.0687	1.1984	0.1238
july	67	6.8720	1.1847	0.1435
august	63	6.7172	1.1572	0.1480
september	76	6.9178	1.1441	0.1348
october	78	6.8672	1.1687	0.1330
november	74	6.5232	1.1613	0.1366
december	68	6.4294	1.2911	0.1425

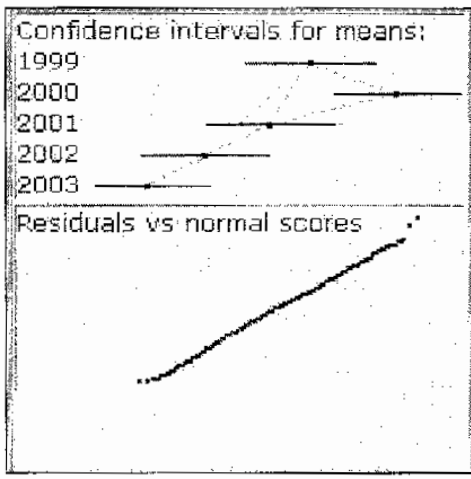
One-way analysis of variance

Factor	df	F	s	p-value
month	11/885	1.782	1.1749	0.0530

Resid SumSq: 1,221.64 n:897 r-squared:0.0217

Figure 3.19: Comparison of lobster (top panel) and crab catch by month

Figure 3.20 shows that the highest mackerel catches were on the year 2000. After the year 2000, the catch slightly decreased.



year	Size	Mean	StDev	StError
1999	347	31.2536	7.6305	0.3855
2000	358	32.2626	7.3170	0.3796
2001	351	30.7778	6.9267	0.3833
2002	353	30.0113	7.4746	0.3822
2003	356	29.3207	6.5125	0.3806

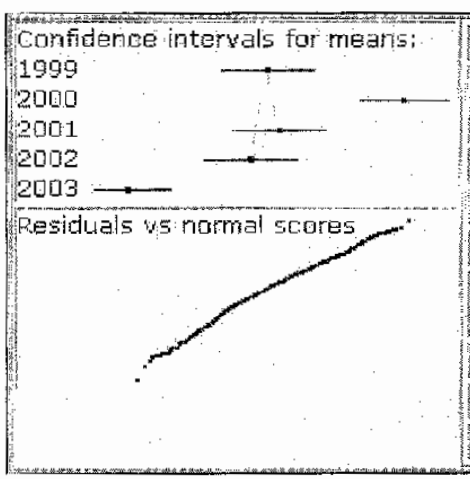
One-way analysis of variance

Factor	df	F	s	p-value
year	4/1760	8.813	7.1817	0.0000

Resid SumSq: 90,774.17 n: 1765 r-squared: 0.0196

Figure 3.20: Comparison of mackerel catch by year

Figure 3.21 shows that the highest other food fish catches were on year 2000. After the year 2000, the catch slightly decreased.



year	Size	Mean	StDev	StError
1999	355	56.2225	13.1570	0.6209
2000	360	59.8806	13.0110	0.6245
2001	357	56.5042	10.7840	0.6271
2002	357	55.7227	10.9754	0.6271
2003	356	52.4522	11.0787	0.6280

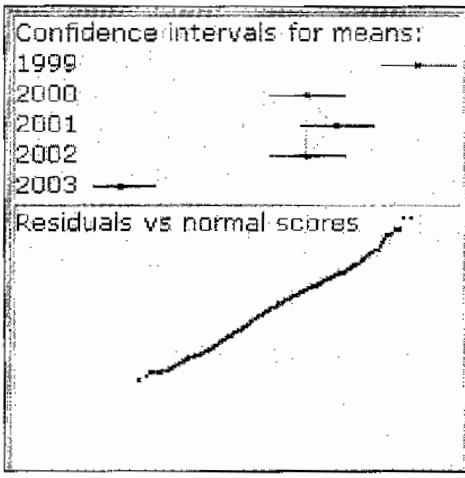
One-way analysis of variance

Factor	df	F	s	p-value
year	4/1780	17.787	11.8490	0.0000

Resid SumSq: 249,910.26 n: 1785 r-squared: 0.0364

Figure 3.21: Comparison of other food fish catches by year

Figure 3.22 shows that maximum catches were on the year 1999 and the minimum catches were on 2003. For squid, the catches were decrease dramatically from 1999 to 2003 with no different between the year 2000, 2001 and 2002.



year	Size	Mean	StDev	StError
1999	310	27.0613	6.2731	0.3734
2000	313	24.9073	6.1154	0.3716
2001	329	25.4833	6.8432	0.3625
2002	325	24.9262	6.4565	0.3647
2003	290	21.3034	7.1638	0.3861

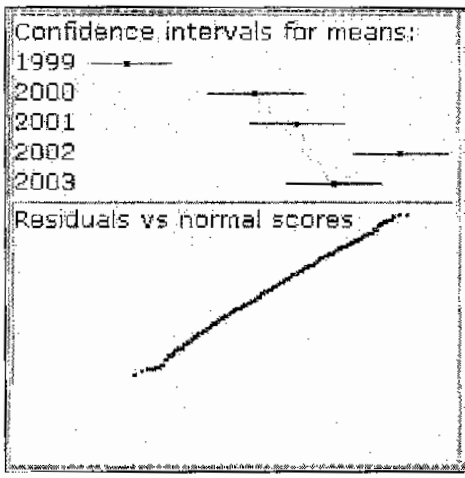
One-way analysis of variance

Factor	df	F	s	p-value
year	4/1562	30.609	6.5750	0.0000

Resid SumSq: 67,525.83 n: 1567 r-squared: 0.0727

Figure 3.22: Comparison of squid catch by year

Figure 3.23 shows that maximum catches were on the year 2002 and the minimum catches were on 1999. For scads, the catches were increase dramatically from 2000 to 2002 and dropped down again on the year 2003 with no different between 2000, 2001, 2002 and 2003.



year	Size	Mean	StDev	StError
1999	345	43.9942	12.3253	0.6966
2000	356	47.6011	12.9920	0.6858
2001	354	48.7938	13.8660	0.6877
2002	353	51.7847	13.0087	0.6887
2003	355	49.8366	12.4297	0.6867

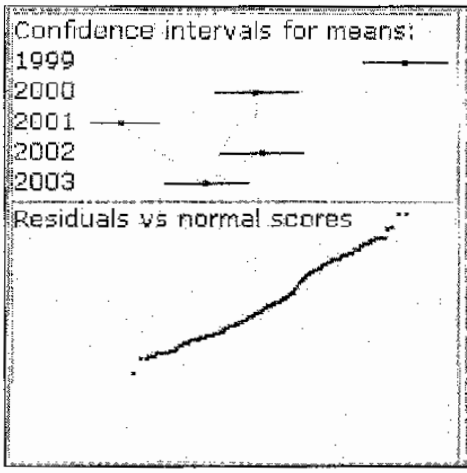
One-way analysis of variance

Factor	df	F	s	p-value
year	4/1758	17.554	12.9388	0.0000

Resid SumSq: 294,309.46 n: 1763 r-squared: 0.0384

Figure 3.23: Comparison of scads catch by year

Figure 3.24 shows that maximum catches were on the year 1999 and the minimum catches were on 2001. For trash fish, the catches were decrease dramatically from 2000 to 2001 with no different between 2000, 2001, 2002 and 2003.



year	Size	Mean	StDev	StError
1999	353	49.9802	11.0432	0.5613
2000	359	46.0474	10.0017	0.5566
2001	360	42.5139	8.8591	0.5558
2002	360	46.2000	10.3053	0.5558
2003	356	44.7444	12.2495	0.5589

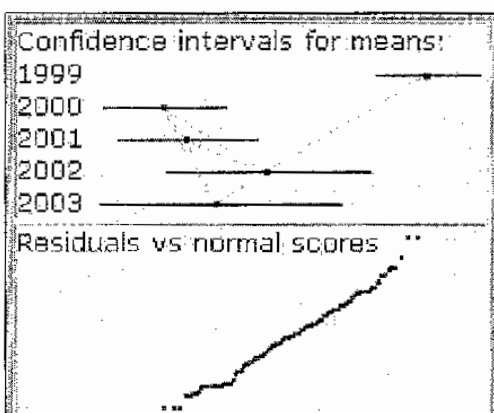
One-way analysis of variance

Factor	df	F	s	p-value
year	4/1783	23.645	10.5462	0.0000

Resid SumSq: 198,308.33 n:1788 r-squared:0.0504

Figure 3.24: Comparison of trash fish catch by year

Figure 3.25 shows that maximum catches were on the year 1999 and the minimum catches were on 2000. For shrimp, the catches were increase dramatically from 2000 to 2002 and slightly decreased on the year 2003.



year	Size	Mean	StDev	StError
1999	137	6.9288	0.8977	0.0804
2000	102	6.1317	0.9208	0.0932
2001	79	6.2017	0.9616	0.1059
2002	37	6.4459	1.0969	0.1547
2003	23	6.2912	0.9436	0.1962

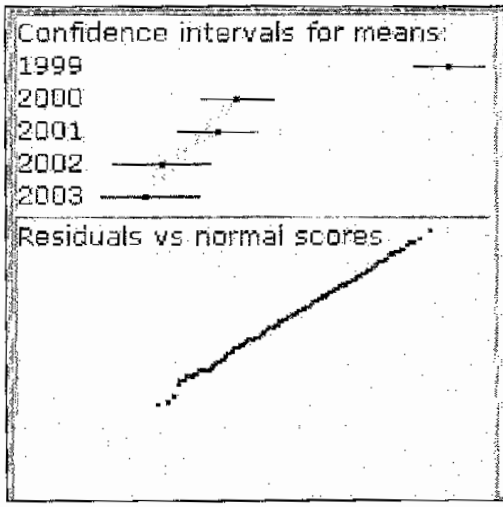
One-way analysis of variance

Factor	df	F	s	p-value
year	4/373	13.257	0.9410	0.0000

Resid SumSq: 330.26 n:378 r-squared:0.1245

Figure 3.25: Comparison of shrimp catch by year

Figure 3.26 shows that maximum catches were on the year 1999 and the minimum catches were on 2003. For lobster, the catches were decrease dramatically from 2000 to 2003 with no different between 2000, 2001, 2002 and 2003.



year	Size	Mean	StDev	StError
1999	198	6.6322	1.0462	0.0698
2000	183	5.7953	0.9538	0.0726
2001	155	5.7293	0.9671	0.0789
2002	107	5.5110	0.9346	0.0950
2003	76	5.4426	0.9730	0.1127

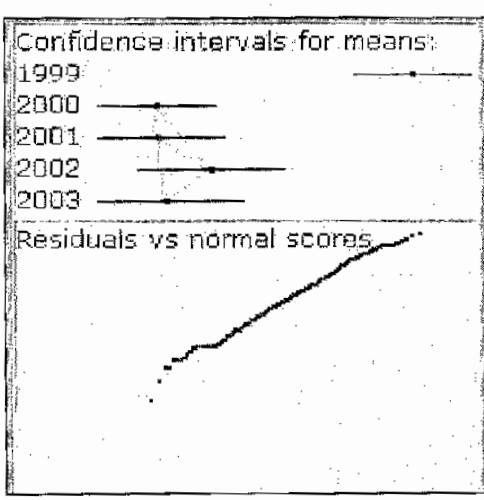
One-way analysis of variance

Factor	df	F	s	p-value
year	4/714	37.326	0.9822	0.0000

Resid SumSq: 688.83 n:719 r-squared:0.1729

Figure 3.26: Comparison of lobster catch by year

Figure 3.27 shows that maximum catches were on the year 1999 and the minimum catches were on 2003. For crab, the catches were decrease dramatically after the year 1999 with no different between 2000, 2001, 2002 and 2003.



year	Size	Mean	StDev	StError
1999	232	7.2362	0.9851	0.0756
2000	211	6.5929	0.9492	0.0793
2001	175	6.5989	1.0881	0.0871
2002	154	6.7312	1.3592	0.0928
2003	125	6.6157	1.5067	0.1080

One-way analysis of variance

Factor	df	F	s	p-value
year	4/892	12.264	1.1519	0.0000

Resid SumSq: 1,183.60 n:897 r-squared:0.0521

Figure 3.27: Comparison of crab catch by year

Figure 3.28 shows marine fish catches and shellfish catches by day of week. For the marine fish catch, the maximum catches were other food fish, followed by scads, trash fish, mackerel and squid respectively. Compared between different days, the catches were quite high on Friday. For the shellfish catches, the maximum catches were crab, followed by shrimp and lobster respectively.

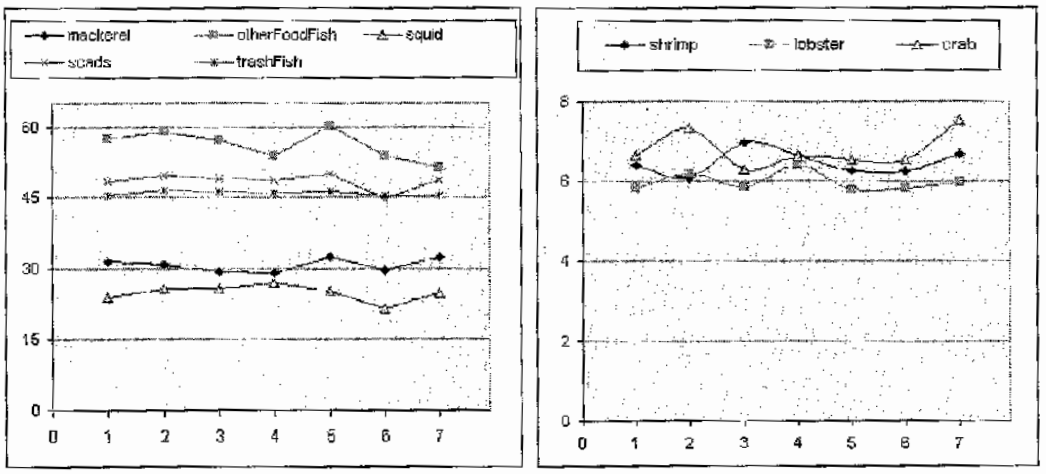


Figure 3.28: Marine fish and shellfish catches by day of week

Figure 3.29 shows marine fish catches and shellfish catches by months. For the marine fish catch, the maximum catches were other food fish, followed by scads, trash fish, mackerel and squid respectively. Compared between different months, the catches were quite high on September. For the shellfish catches, the maximum catches were crab, followed by shrimp and lobster respectively.

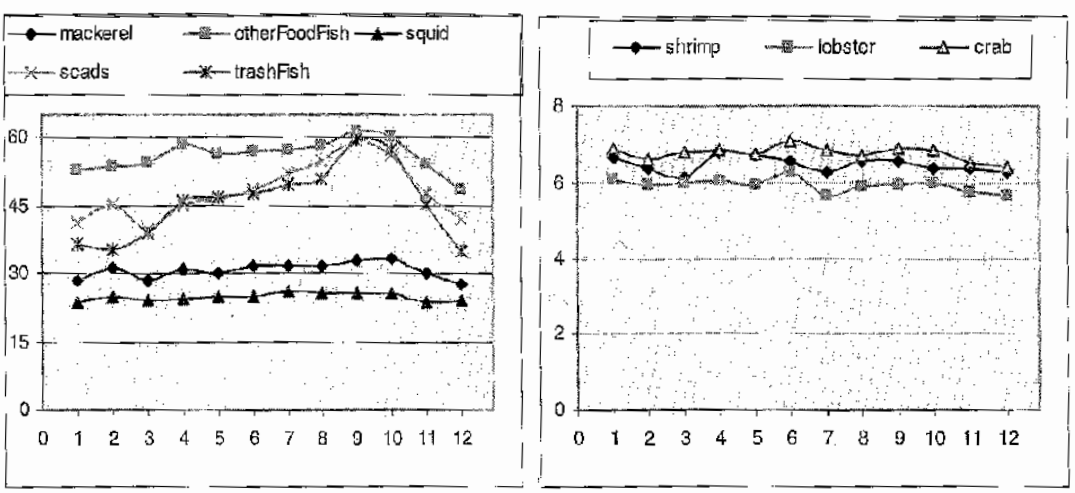


Figure 3.29: Marine fish and shellfish catches by month

Figure 3.30 shows marine fish catches and shellfish catches by years. For the marine fish catch, the maximum catches were other food fish, followed by scads, trash fish, mackerel and squid respectively. Compared between different years, the catches were

quite high on the year 2000. For the shellfish catches, the maximum catches were crab, followed by shrimp and lobster respectively. Compared between different years, the catches were quite high on the year 1999.

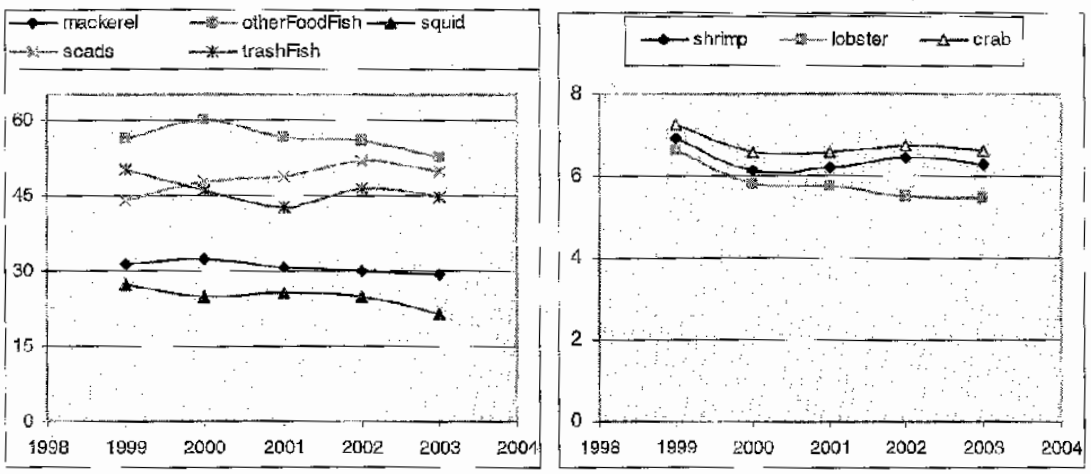


Figure 3.30: Marine fish and shellfish catches by year

In Chapter 4 we use time series analysis to investigate and model the trends in the monthly series of marine fish catch in Pattani Fisheries Port.