Chapter 5

Conclusions and Discussion

5.1 Conclusions

As stated in Chapter 1, this study had the following objectives.

1. To study trends in the quantity of marine fish caught at Pattani Fishery Port.
2. To develop statistical models for forecasting the quantity of the various types of marine fish landed at a Pattani Fishery Port, allowing for trend and seasonality.

The data for our study cover the period of 60 months from January 1999 to December 2003. To satisfy the statistical assumption of constant variance, we found that the marine fish catch needed to be transformed using square roots and the shellfish catch needed to be transformed using logarithms.

To study trends in the quantity of marine fish, we first used linear regression analysis to fit a model of the form $y_t = a_t + bt$, where y_t is the transformed marine fish catch t months after December 1998 and a_t is a monthly seasonal effect. This type of model is called a *trend+seasonal* model and is useful for forecasting purposes.

The forecasting formula when the data are transformed using square roots is given by Equation (2.6), that is, $f_t = y_t^2+s^2$ where s is the standard deviation of the residuals and y_t is the fitted value, as defined above. This formula is thus applicable to the monthly marine fish catches.

The forecasting formula when the data are transformed using natural logarithms is given by Equation (2.7), that is, $f_t = \exp(y_t+s^2/2)$, where s is the standard deviation of the residuals and y_t is the fitted value, as defined above. This formula is applicable to the monthly shellfish catches.

After fitting the statistical model, we found that mackerel, other food fish and squid have decreasing catches, whereas the catches of scads are increasing, and trash fish catches have no detectable trend up or down. Shrimp and lobster catches are decreasing exponentially, and the crab catch is constant.

The forecasting values for each marine fish catch in any month t are thus obtained. To illustrate, we show how these forecasts are calculated for various values of t.

(a) The forecast mackerel catch for October in year 2004, that is, $t = 70$.

Mackerel catch: $y_t = a_t + bt$, where $t = 70$;

$a_t = a_{70} = a_{10}$ (periodicity) $= 940.0182 + 253.2849 = 1193.3031$, $b = -1.5715$;

$y_t = a_t + bt = 1193.3031 - 1.5715 \times 70 = 1083.2981$

$f_t = y_t^2 + s^2 = (1083.2981)^2 + (96.9082)^2 = 1{,}182{,}926.$

(b) The forecast other food fish catch for November in year 2004, that is, $t = 71$.

Other food fish catch: $y_t = a_t + bt$, where $t = 71$;

$a_t = a_{71} = a_{11} = 2449.03 + 133.3908 = 2582.4208,\ b = -6.8489;$

$y_t = a_t + bt = 2582.4208 - 6.8489 \times 71 = 2096.148$

$f_t = y_t^2 + s^2 = (2096.148)^2 + (218.4888)^2 = 4{,}441{,}574.$

(c) The forecast squid catch for December in year 2004, that is, $t = 72$.

Squid catch: $y_t = a_t + bt$, where $t = 72$;

$a_t = a_{72} = a_{12} = 803.0827,\ b = -3.0749;$

$y_t = a_t + bt = 803.0827 - 3.0749 \times 72 = 581.6899$

$f_t = y_t^2 + s^2 = (581.6899)^2 + (88.2425)^2 = 346{,}150.$

(d) The forecast scads catch for January in year 2005, that is, $t = 73$.

Scads catch: $y_t = a_t + bt$, where $t = 73$;

$a_t = a_{73} = a_1 = 1391.4648 + 0 = 1391.4648$, $b = 7.8559$;

$y_t = a_t + bt = 1391.4648 + 7.8559 \times 73 = 1964.9455$

$f_t = y_t^2 + s^2 = (1964.9455)^2 + (243.7649)^2 = 3{,}920{,}432$.

(e) The forecast trash fish catch for February in year 2005, that is, $t = 74$.

Trash fish catch: $y_t = a_t + bt$, where $t = 74$;

$a_t = a_{74} = a_2 = 1234.6520 - 94.554 = 1140.098$;

$y_t = a_t + bt = 1140.098$

$f_t = y_t^2 + s^2 = (1140.098)^2 + (376.6084)^2 = 1{,}441{,}657$.

(f) The forecast shrimp catch for March in year 2005, that is, $t = 75$.

Shrimp catch: $y_t = a_t + bt$, where $t = 75$;

$a_t = a_{75} = a_3 = 9.6991$, $b = -0.0458$;

$y_t = a_t + bt = 9.6991 - 0.0458 \times 75 = 6.2641$

$f_t = \exp(y_t + s^2/2) = \exp(6.2641) + (0.8221^2/2) = 737$.

(g) The forecast lobster catch for April in year 2005, that is, $t = 76$.

Lobster catch: $y_t = a_t + bt$, where $t = 76$;

$a_t = a_{76} = a_4 = 9.8595$, $b = -0.0421$;

$y_t = a_t + bt = 9.8595 - 0.0421 \times 76 = 6.6599$

$f_t = \exp(y_t + s^2/2) = \exp(6.6599) + (0.5587^2/2) = 912$.

(h) Crab catch:

For the crab catch, trend and the seasonal effect are not statistically significant. This means that the forecast is the same for all future values of t, and is equal to the mean of the lognormal distribution with constant mean, that is, from the lower panel of Table 4.16, $\exp(9.9695+0.5273^2/2) = 24551.363$.

5.2 Discussion and Limitations

Discussion

In this study, using monthly data from the Pattani Fishery Port published for the five years from 1999 to 2003, we investigated the trends and seasonal patterns of marine fish catches, classified into the eight types of marine fish catch. We used statistical methods to investigate the patterns over the time period, and we used statistical time series analysis methods to fit models used for short-term forecasting.

Our study found that monthly catch data has to be transformed using different transformation functions depending on fish type.

The marine fish catch varies between different types of fish. The maximum catches were for food fish (other than mackerel), followed by scads, trash fish, mackerel, squids, crab, shrimp and lobster. This result can be explained by the fact that the other food fish and the trash fish comprise more than ten types of fish (Department of Fisheries, 2000a). However, the high quantity of the scads may be due to the biology of the scads, which spawn all year (Department of Fisheries, 2000c).

The results from one way analysis of variance and multiple regression analysis using daily data showed differences in catches between days, months and years. However, these models gave a quite small value of r-squared compared to models of the monthly data, namely the *trend+seasonal* models. Therefore, it is not necessary to use the daily data for forecasting.

The *trend+seasonal* model can be used to forecast the monthly catch for the eight types of marine fish. Since we now know the observations corresponding to monthly catches for the year 2004 (not used in fitting the model), we can compare the forecasts with these observed values. The results are shown in Figure 5.1. It can be seen from the graph that the forecasts and the observed values are quite similar in quantity and direction for mackerel, other food fish, trash fish, shrimp, lobster and crab. However, our models give overestimated forecast values for the squid and scads catches.

A decreasing trend occurred in five marine fish types (mackerel, other food fish, squid, shrimp and lobster), no detectable trend up or down in two types (trash fish and crab) and an increasing trend only in the scads. This decreasing trend could be related to fewer amounts of marine fish in the sea, or a declining number of fishermen and fishery employees (Department of Fisheries, 2003b, 2003c). In our analysis we did not take these variables into account. This is a major limitation of our study. The increasing trend in scads is similar to those found at Songkhla Fishery Port. This result may be related to the biology of the scads.

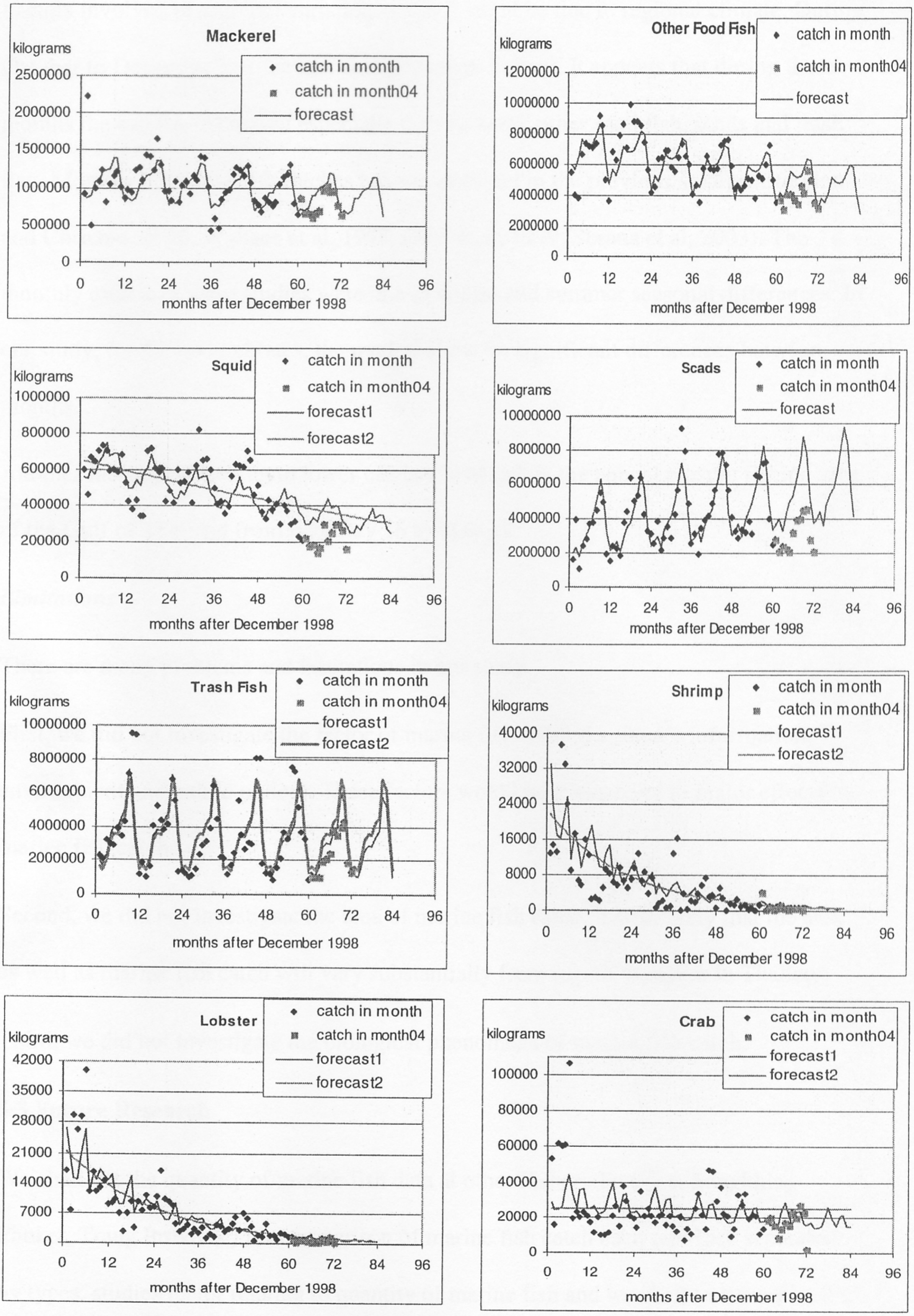

Figure 5.1: Model checking for forecasting the marine fish at Pattani Fishery Port

Factors involved in seasonal variation in catch might be due to regional climate. During October to December it is the monsoon season in Pattani. It appears that during these months the catches decreased especially for mackerel, other food fish, scads and trash fish. Monthly effects in fish catches have been found in the previous studies (Stergiou and Christou, 1996, Wallace et al, 1998, Goni et al, 1999, Sbrana et al, 2003). The monthly effects in these studies were due to winter and summer seasonal differences. In our study, for the invertebrates, the models show no significant differences between months.

Another factor contributing to lower catches in March is the annual closure fishing area of the Gulf of Thailand from February 16 to May 15.

Limitations

There are many problems and limitations in our study.

First, we did not investigate the factor of marine fish catch (i.e. boat's information, environment and public policy). These factors would have expected to major effects on marine fish catch.

Second, we did not investigate the area of marine fish catch. It was likely that the area as well as marine fish catch will vary substantially from region to region in Thailand.

Third, we did not investigate the biological phenomena of marine fish catch.

5.3 Future Research

We shall get the quantity of marine fish data at other Fishery Port (i.e. Songkhla, Phuket, Trang Province) for comparison of marine fish catch each province separated by types, studies factor relating to quantity of marine fish and we shall to survey boat's information. However, important as these issues are, addressing them was beyond the scope of this thesis. Hopefully they will have investigated in further studies.