Chapter 7

MANAGEMENT OPTIONS, SIMULATION AND POLICY IMPLICATIONS

7.1 Introduction

In this chapter, policy options for managing the fishery are selected and the model is used to simulate and analyse different scenarios. Following this section, a rationale for the selection of policy options for the fishery is presented in Section 7.2. This is followed by an outline of assumptions used in simulating the 'base-case' model under various alternative management schemes. Results of the simulation are reported in Section 7.4 and the adjustment path for the selected policies is examined in Section 7.5. Section 7.6 discusses the implications of simulation results for selected policies. The final section provides a summary and concluding remarks.

7.2 Rationale

It is commonly believed that assessment of appropriate management strategies for a fishery requires an analytical tool in the form of a model. The model summarises how a fishery works and forms the basis of advice to the management authority. In this study, a surplus production model was used to model biological aspects of the system. Copes models were used to represent economic and social aspects of the fishery. The results of these models can be viewed as an initial condition for the system. Simulations were conducted to show how various policy options would affect key aspects of the fishery.

The surplus production model for fish stock in the study site described in Chapter 5 is a static model. Hence, the model has limitations in explaining the system because it does not incorporate changes in biological and economic parameters through time[1]. Dynamic models may be preferable when decision makers are concerned with changes in the system either with or without consideration of optimal exploitation of the resource through time. However Waugh (1984, p. 53) argued that static models have one major advantage over dynamic models. The static models are easily applied to current problems of fishery management given the relatively limited availability of data. In addition, static models provide a relatively simple and direct method of analysing equilibrium conditions in the absence of property rights and provide optimal conditions associated with various management objectives. Hence, researchers still use static models for empirical analysis of fishery management problems.

Simulation allowed a comparison of the relative effects of alternative policy options on the fishery. The term 'simulation' in this study is limited to selecting changes in parameters based on results for the bionomic equilibrium for the fishery specified in Chapter 5. The term 'policy' refers to instruments used by government pursuing various strategies. Interpretations of policy simulations are based on comparison of results of initial conditions (without policy) with results with policy options. With simulation, initiation of the 'base-case' model as described in Chapter 5 is required, where the 'base-case' represents the existing situation for the inland fishery in the study area.

7.3 Assumptions

The initial conditions for the system were specified in terms of predicted biological and economic values which yield a bionomic equilibrium. That is, the equilibrium stock size and equilibrium fishing effort. With these initial conditions, the level of standard fishing effort and catch for the riverine fishery were 9,324 thousand trips and 22.8 thousand tonnes, respectively. For the swamp fishery, the initial conditions for the level of standard fishing effort and catch were 6,184 thousand trips and 14.5 thousand tonnes, respectively. In terms of the relationship between supply and demand for freshwater fish, the initial condition was represented by the intersection

[1] For dynamic models, see for example Clark (1985).

of average cost and average revenue curves. The supply and demand relationships and their corresponding sustained yield/catch curve for the fishery are illustrated in Figure 7.1. The demand curve and average and marginal cost curves are plotted in the top half of the figure[2]. The lower half of the figure shows the sustained yield curve[3]. Since the equilibrium stock size and amount of fishing effort represent biological and socioeconomic aspects of the fishery, the initial conditions for the fishery can be interpreted as biological and socioeconomic equilibrium conditions for the fishery without policy intervention.

Considering Figure 7.1, the backward-bending curve (AC) is the long-run average cost curve in terms of catch for the fishery as a whole. This curve is directly related to the sustained yield curve presented in the lower half of the chart. The marginal cost curve (MC) shows the increase in cost that results from per unit of fish production increases. The marginal revenue curve (MR) shows the change in revenue produced by a change in the number of fish sold. Generally, this curve is below the demand curve (AR). Since the fish price is assumed to be constant, marginal revenue equals average revenue. In other words, demand for freshwater fish is assumed to be perfectly elastic implying that there would be no consumer surplus for the commodity (Lal *et al.* 1992, p. 54). Since any point in the sustained yield curve is a biological equilibrium, the corresponding intersection between AC and AR represents an equilibrium in both an economic and a biological sense. The rent in the fishery is zero, reflecting that stock have no scarcity value (Hannesson 1993, p. 25). There would be more than enough surplus growth[4] to satisfy demand, and stock would have no value as a factor of production because the catch per unit of effort is constant and dependent on the stock. The level of effort will not change unless costs change; and,

[2] For riverine fishery, the top half of the chart represents MC, AC and AR curves as expressed in equations (5.20), (5.21) and (5.27), respectively. The same applies in the case of swamp fishery, with different equations (5.23), (5.24) and (5.28), respectively.

[3] Expression of the sustained yield curve in the lower half of the chart follows the expression in equation (5.1) for the riverine fishery and equation (5.3) for the swamp fishery.

[4] Surplus growth is defined as the catch plus the net change in biomass over some finite time period (Hilborn and Walter 1992, p.79; Hannesson 1993, p. 11).

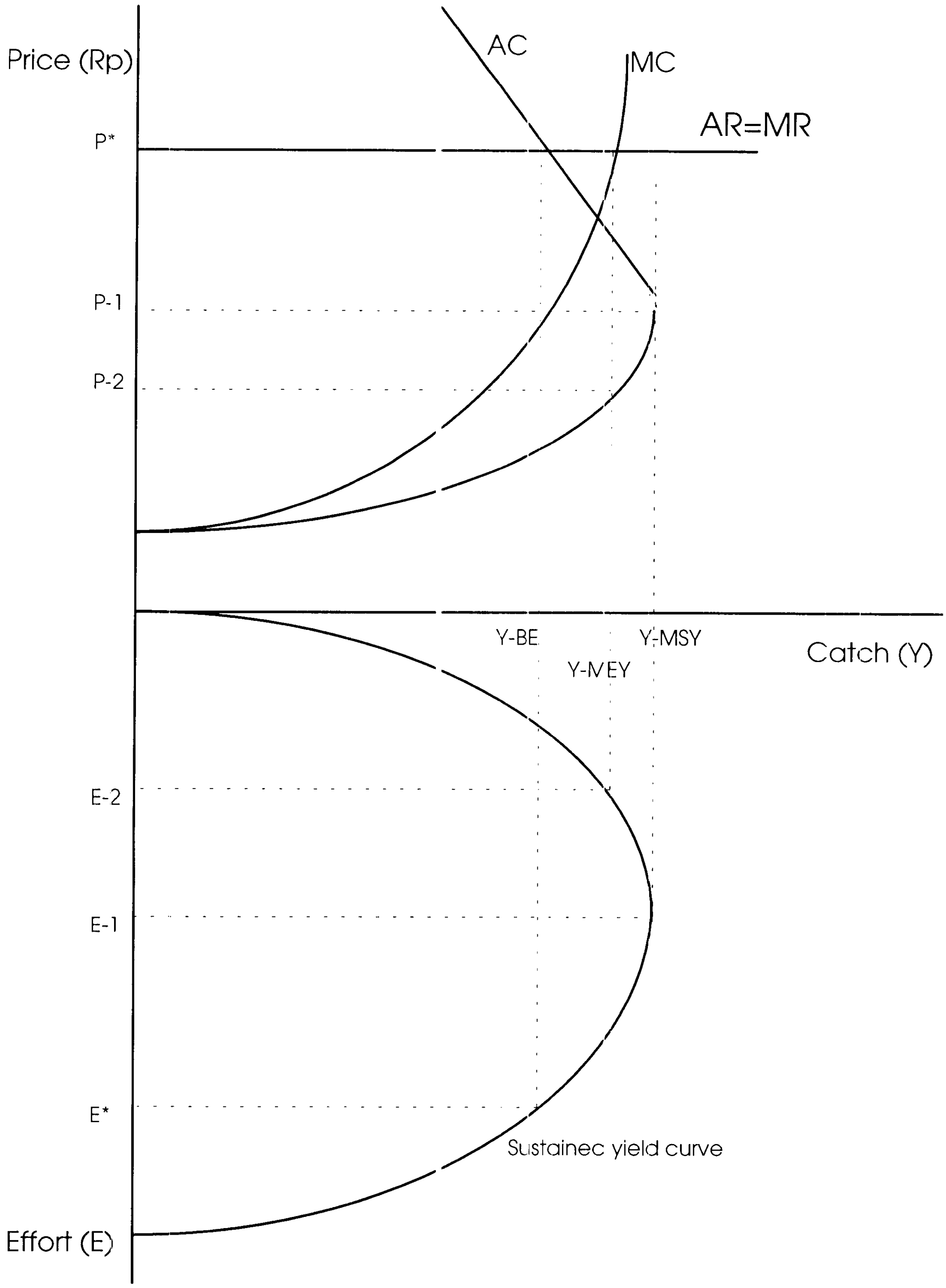


Figure 7.1 Typical supply and demand curve relationship for freshwater fish and their corresponding sustained yield curve

in a deterministic world, as long as effort remains constant, the fish biomass will not change.

As discussed in the previous chapter, the fishing licence is currently the main management device for fishery resources and is specified in the Basic Fisheries Act of the Republic of Indonesia (*Undang Undang* No. 9/1985). As a general rule, fishing requires a licence and is subject to a fishery tax. Fishing without a licence may incur a fine of up to 50 million rupiah or five years in prison. However, small-scale fishers whose daily living depends on their catch are exempt.

The inland fishery of South Sumatra is unique in the sense that licences to fish for a period of 12 months are granted by the authority through an auction system. Fishers who directly participate in fishing have to buy the licence directly from the winning bidders. The annual amount of money spent on licences by each fisher is viewed as a 'licence fee'. It is likely that prices paid by bidders increase from year to year and hence fees paid by fishers are also likely to increase. Taking this condition into account, it was assumed that the licence fee is increased by 10 and 25 per cent (scenario 1).

Labour cost, which is used as a proxy for the opportunity cost of fishing, may increase in line with development of other sectors. In this simulation, the cost of labour increases by 25 and 50 per cent (scenario 2). Assumptions that the total cost of the fishing effort increased by 10 and 25 per cent (scenario 3) were made to accommodate the possibility of inflation in South Sumatra province. This possibility was simulated by assuming that the average price of freshwater fish increases by 10 and 25 per cent (scenario 4).

The number of licence holders may decline in future so the rate of exploitation in the inland fishery resource will also be reduced. To maintain the fish stock, the authority may restrict fishing gear since this policy is easily implemented and effective in preventing depletion of the fish stock. Similarly, the policy of closed areas and seasons for fishing may be implemented by the authority. In general, the effect of these management policies is to reduce total fishing effort. In view of this argument, total fishing effort in the study site may decline. To analyse the effect of this policy, it was assumed that fishing effort was reduced by 10, 25 and 50 per cent (scenario 5).

Mixed regulations that combine increases in licence fees and restrictions on fishing effort may provide better management options for the inland fishery. This is included in the simulation by assuming that licence fees increase and total fishing effort is reduced (scenario 6).

The variables which change as a result of these scenarios are shown in Table 7.1. The management alternatives directly affect variables c_i, p_i and/or E_i, which, in turn, affect the level of catch and profits.

The changes in variable values following simulation are presented in Table 7.1 and can be grouped into four categories:

(1) those directly affecting total cost per unit of fishing effort (scenarios 1, 2 and 3);
(2) those directly affecting price of freshwater fish (scenario 4);
(3) those directly affecting total fishing effort (scenario 5)), and
(4) combinations of (1) and (5) specified in scenario (6).

Given constant 'base-case' biological parameters in the system, the effects of policy changes are explained by using Figure 7.1.

Table 7.1 Description of selected policy options in the inland fishery management in South Sumatra, Indonesia

Case	Description	Variable change
1-A	Licence fee is increased by 10 per cent	c_i
1-B	Licence fee is increased by 25 per cent	c_i
2-A	Labour cost is increased by 10 per cent	c_i
2-B	Labour cost is increased by 25 per cent	c_i
3-A	Cost per unit of fishing effort is increased by 10 per cent	c_i
3-B	Cost per unit of fishing effort is increased by 25 per cent	c_i
4-A	Price of fish is increased by 10 per cent	p_i
4-B	Price of fish is increased by 25 per cent	p_i
5-A	Fishing effort is reduced by 10 per cent	E_i
5-B	Fishing effort is reduced by 25 per cent	E_i
5-C	Fishing effort is reduced by 50 per cent	E_i
6-A1	Licence fee is increased by 10 per cent and fishing effort is reduced by 10 per cent	c_i and E_i
6-A2	Licence fee is increased by 10 per cent and fishing effort is reduced by 25 per cent	c_i and E_i
6-A3	Licence fee is increased by 10 per cent and fishing effort is reduced by 50 per cent	c_i and E_i
6-B1	Licence fee is increased by 25 per cent and fishing effort is reduced by 10 per cent	c_i and E_i
6-B2	Licence fee is increased by 25 per cent and fishing effort is reduced by 25 per cent	c_i and E_i
6-B3	Licence fee is increased by 25 per cent and fishing effort is reduced by 50 per cent	c_i and E_i

Policy options directly affecting total cost of fishing

Using Figure 7.1, a typical pattern of changes caused by increasing the cost of fishing effort can be explained as follows. Since cost per unit of fishing effort (c_i) is directly related to the AC curve[5], an increase in the cost per unit of fishing effort will shift the AC curve upward. As the AC curve shifts upward, the new equilibrium (AC=AR) moves to the right in the upper half part of Figure 7.1 indicating that the level of catch from the sustained yield curve has increased and that the level of fishing effort has decreased.

Policy options directly affecting price of the fish

From Figure 7.1, the effects of an increase in the price of freshwater fish can also be explained as follows. Given a constant cost per unit of fishing effort and the constant values of biological parameters, an increase in fish price shifts the AR curve upward and hence causes a new equilibrium. Given that the fishery is being overexploited, as indicated by the intersection of the AR and AC curves, the new equilibrium will result in reduced catch. The corresponding level of fishing effort can be obtained from the lower half of the chart, which shows that the level of fishing effort increases.

Policy options directly affecting total fishing effort

The graphical approach to analysing the effects of limited-entry regulation can also be illustrated using Figure 7.1. Starting from the lower half of the chart, a small reduction in fishing effort would increase the catch. After reaching MSY, further reduction in fishing effort reduces the catch. If restrictions on fishing effort are applied as a small reduction from the initial base-case then, as effort decreases, the level of catch increases. With constant costs per unit of fishing effort and constant fish price, total revenue will be greater than total costs, indicating there is a resource rent or profit in the fishery. However, if control by the authority is lax, fishers may ignore this regulation (Matthiasson 1996, p. 176). In the long run, the condition expressed by equalising average revenue and average cost curves tends to

---

[5] See equation (5.23) for the riverine fishery and equation (5.26) for the swamp fishery.

equilibrium. That is, fishers are encouraged to increase effort as potential profits are realised. This process continues until the bionomic equilibrium is reached. Limiting fishing effort means the number of fishing units must be reduced. Anderson (1977, p. 159) indicates that entire restrictions on the number of fishing units would indirectly result in increased costs as a consequence of reactions by fishers. This is because in the short run, with reduced fishing effort, it is not possible to produce as much per period with the existing fishing unit. However, if this policy is only partially controlled by the government, fishers will react differently resulting in normal profit maximising behaviour in the long run. In other words, as the stock size increases because of restrictions on effort, average returns per unit of effort will increase. Consequently, this stimulates each fisher to increase effort until marginal costs equal the higher return. This, in turn, results in increases in total costs associated with fishing effort. In this study, it is assumed that in the long run the biological equilibrium of the fishery would be reached by this type of policy. However, it is assumed that the level of fishing effort is kept at the point specified by such a policy through enforcement authorities or local community policing.

Policy options directly affecting total cost of fishing effort and total fishing effort

The expected effect of this policy option is to increase the level of catch as a consequence of both increasing the stock and forcing the AC curve to shift upward. If these regulations are only a partial control, fishers will tend to increase fishing effort until the average cost of producing one unit of output is the same as the price of fish. In this case, the same assumption as above is made, in the sense that government is successful at maintaining the level of effort specified by the policy. Hence, at that reduced level of fishing effort, catch and biomass of the fishery would be stabilised to reach biological equilibrium and rent would be obtained by those exploiting the resource.

7.4 Simulation Results

The results from the simulation model described in the previous section are reported in this section. The simulation is based on a static surplus production model and hence the results are similar to those that would be obtained from comparative static analysis. The model contains no dynamic assumptions and hence exploration of the dynamic characteristics of the equilibrium of the fishery system is not possible. Essentially, this means that the speed at which equilibrium is approached cannot be determined. Even though this may be a limitation, the results from the simulation provide useful information about the long-run equilibrium of the system.

7.4.1 Policy options affecting total cost of fishing effort

As discussed in the previous section, policy options which affect total costs of fishing effort are increases in licence fees (cases 1-A and 1-B), labour costs (cases 2-A and 2-B), and costs per unit of fishing effort (cases 3-B and 3-B). As indicated in Table 7.1, the first two policy options affect part of the total cost of fishing effort while the last policy option affects the total cost of fishing effort itself so that the effect of the former is likely to be relatively lower than the latter.

Quantitative results from the simulation model are presented in Appendix 7.1. The results are categorised as so-called 'short-run' and 'long-run' effects of given policy options in terms of total fishing effort (E_i), total catch (Y_i), average cost (AC_i), and cost per unit of fishing effort (c_i). With given policy, the short-run effect may be determined by an immediate change of indicators specified in Appendix 7.1. whereas the long-run effect may be determined by that of indicators at a new bionomic equilibrium.

<u>Effect of increase in licence fee</u>

The increases in licence fees of 10 and 25 per cent in the riverine fishery reduced total standardised fishing effort by 0.18 per cent and 0.46 per cent, respectively. However, catch increased by 0.26 per cent and 0.77 per cent, respectively. Similarly, in the swamp fishery, total standard fishing effort decreased by 0.4 per cent and 0.99 per cent while catch increased by 0.61 per cent and 1.51 per cent, respectively. These results are not surprising since the licence fee is only a relatively small part (4.42 per cent) of the total cost per unit of standard fishing effort. Those patterns of changes are consistent with the theoretical model That is, changes in fishing effort are not always followed by changes in catch in the same direction.

At first, an increase in the licence fee would cause an increase in the average cost per unit of output but would not affect the initial level of fishing effort and catch. This means that policy option cases 1-A and 1-B resulted in a slight upward shift in the AC curve. In the riverine fishery, 10 and 25 per cent increases in the licence fee caused increases in average costs of 0.41 per cent and 1.06 per cent, respectively. In the swamp fishery, these policy options resulted in an increase in average costs of 0.97 per cent (case 1-A) and 2.43 per cent (case 1-B). With constant biological parameters and fish prices, a new bionomic equilibrium would be reached as the level of effort and catch adjusted to the new cost structure.

Effect of increase in labour cost of fishing

In the riverine fishery, the relative changes in effort and catch were respectively -3.51 and 4.61 per cent in case 2-A, and -7.01 and 8.62 per cent in case 2-B. In the swamp fishery, the relative change in effort caused by policy options 2-A and 2-B were -3.72 and -7.44 per cent, respectively. Levels of catch changed 5.43 per cent (case 2-A) and 10.15 per cent (case 2-B).

Given initial levels of effort and catch, the effect of an increase in labour costs is to directly increase the average cost per unit of output and hence the average cost curve shifts upward. With constant biological parameters and prices for fish, a new bionomic equilibrium is reached whenever effort and catch adjust. Hence, effort was reduced to 8, 997 thousand trips and catch increased to 23.9 thousand tonnes with policy 2-A in the riverine fishery. With case 2-B, effort in the riverine fishery was reduced to 8,670 thousand trips and the catch increased to 24.8 thousand tonnes. Similarly, the level of effort in the swamp fishery was reduced to 5,954 thousand trips and catch increased to 15.2 thousand tonnes for case 2-A. In case 2-B, the effort in the swamp fishery was reduced to 5,724 thousand trips and catch increased to 15.9 thousand tonnes.

Effect of increase in total cost per unit of fishing effort

The effects of increasing total cost of fishing effort were similar to both increasing the licence fee and increasing the labour costs of fishing. However, the relative changes in effort and catch caused by increasing total fishing cost (cases 3-B and 3-B) were higher than previously. This is because the licence fee and labour costs of fishing are part of the total cost of fishing effort. By increasing total costs by 10 per cent and 25 per cent, fishing effort in the riverine fishery was reduced by 4.17 per cent and 10.43 per cent, respectively and catch increased by 5.41 per cent and 11.97 per cent, respectively. In the swamp fishery, these policy options resulted in a reduction in fishing effort of 3.91 per cent (case 3-B) and 9.78 per cent (case 3-B) but an increase in catch of 5.69 per cent (case 3-B) and 12.77 per cent (case 3-B).

In summary, the results from analysis of policy options affecting total cost of fishing effort in terms of change in fishing effort and catch in both environments are presented in Table 7.2. In terms of their effects on biomass, the results are presented in Table 7.3.

Table 7.2 Comparative static analysis of policy options affecting total cost of fishing effort in terms of relative change in level of fishing effort and catch in both types of resource

Policy option	Relative change (per cent)			
	Riverine		Swamp	
	Effort	Catch	Effort	Catch
Base case	9,324,472	22,820,553	6,183,575	14,463,960
Case:				
1-A	-0.2	0.3	-0.4	0.6
1-B	-0.5	0.8	-1.0	1.5
2-A	-3.5	4.6	-3.7	5.4
2-B	-7.0	8.6	-7.4	10.2
3-B	-4.2	5.4	-3.9	5.7
3-B	-10.4	12.0	-9.8	12.8

Note: Values of fishing effort and catch of the base case are in trips and kg, respectively.

Table 7.3 Comparative static analysis of policy options affecting total cost of fishing effort in terms of relative change in biomass of the fish stock and catch in both types of resource

Policy option	Riverine		Swamp	
	Stock size (X) (kg)	Catch (Y) (kg)	Stock size (X) (kg)	Catch (Y) (kg)
Base case	23,141,131	22,320,553	7,034,846	6,183,575
Case:				
1-A	23,243,537	22,379,231	7,105,868	14,552,248
1-B	23,397,136	22,996,544	7,212,802	14,683,004
2-A	25,086,697	23,871,618	7,702,914	15,248,822
2-B	27,032,274	24,788,124	8,371,250	15,931,821
3-B	25,455,242	24,055,559	7,738,036	15,287,259
3-B	28,926,412	25,551,123	8,793,222	16,310,418

7.4.2 Policy options directly affecting price of freshwater fish

Results from the simulation of policy options directly affecting the price of fish are presented in Appendix 7.2. In the riverine fishery, increases in price of 10 and 25 per cent increase effort by 3.8 and 8.3 per cent, respectively. However, catch is reduced by 5.6 per cent and 13.3 per cent In the swamp fishery, the pattern is similar. Increases in price of 10 and 25 per cent increase effort by 3.6 per cent and 7.8 per cent and reduce catch by 5.7 and 13.7 per cent, respectively. In summary, the relative effects of increasing the price of freshwater fish in South Sumatra are presented in Table 7.4.

Table 7.4 Comparative static analysis of an increase in fish price in terms of relative change in level of fishing effort and catch in both types of resource

Policy option	Relative change (per cent)			
	Riverine		Swamp	
	Effort	Catch	Effort	Catch
Case:				
4-A	3.8	-5.6	3.6	-5.7
4-B	8.3	-13.3	7.8	-13.7

7.4.3 Policy options directly affecting total fishing effort

As mentioned above, scenarios are selected under the limited-entry management scheme by assuming that the amount of standard fishing effort is reduced by 10, 25 and 50 per cent. Results from the simulation are presented in Appendix 7.3.

Table 7.5 shows the relative impact of limited-entry regulations. With these fishing effort reductions, total catch increased as a consequence of increases in biomass. In the riverine fishery, policy option 5-A causes an increase in total catch and biomass of

11.6 per cent and 24.0 per cent, respectively. Policy option 5-B indirectly increased total catch and stock biomass by 20.0 per cent and 59.9 per cent, respectively. Policy option 5-C indirectly increased total catch and stock size by 9.9 per cent and 119.9 per cent, respectively. In the swamp fishery, limited-entry regulations that reduce fishing effort by 10 per cent, 25 per cent and 50 per cent increased the total catch by 13.0 per cent, 22.9 per cent and 13.9 per cent, respectively. The biomass increased by 25.6 per cent (case 5-A), 63.9 per cent (case 5-B) and 127.7 per cent (case 5-C). These results show that policy regulations that restrict the level of effort will significantly increase biomass and total catch in the fishery. However, although stock size increased considerably with further reduction in effort, the total catch reached its highest level in the case 5-B (25 per cent reduction in fishing effort). The theoretical basis of this phenomenon has been explained previously.

Table 7.5 Comparative static analysis of policy options affecting total fishing effort in terms of relative change in level catch and stock size in both types of resource

Policy option	Relative change (per cent)			
	Riverine		Swamp	
	Stock size	Catch	Stock size	Catch
Case:				
5-A	24.0	11.6	25.5	13.0
5-B	59.9	20.0	63.9	22.9
5-C	119.9	9.9	127.7	13.9

The essential advantage of policy regulations that restrict fishing effort was to generate resource rent or profit in that particular fishery. As shown in Table 7.7, the profits generated by these policies were 3,742 million rupiah (case 5-A), 7,795 million rupiah (case 5-B) and 10,393 million rupiah in the swamp fishery. In the riverine fishery, the profits were 5 982 million rupiah (case 5-A), 12,464 million rupiah (case 5-B) and 16,619 million rupiah (case 5-C).

Table 7.6 Resource rent or profit generated by limited-entry regulations in both types of resource

Case	Riverine fishery (million rupiah)	Swamp fishery (million rupiah)
5-A	5 982	3,746
5-B	12,464	7,795
5-C	16,619	10,393

7.4.4 Policy options directly affecting total cost of fishing effort and total fishing effort

Mixed regulations in terms of increased licence fees and reduced fishing effort directly affect the total cost per unit of effort and level of total effort. Results of the simulations included in this group are presented in Appendix 7.4. The results are similar to those policies presented in Sections 7.4.1 and 7.4.3.

The impacts of mixed policy regulations are presented in Table 7.7, indicating changes in biomass and total catch. In terms of the amount of resource rent or profit generated by the policies, the results are presented in Table 7.8.

Table 7.7 Percentage change in stock size (X) and catch (Y) by various policy options affecting total cost of fishing effort and restricting fishing effort in the long run in both types of resource

Policy	Riverine		Swamp	
	Stock (X)	Catch (Y)	Stock (X)	Catch (Y)
6-A1	24.0	11.6	25.6	13.0
6-A2	59.9	20..0	63.9	22.9
6-A3	119.9	9.9	127.7	13.0
6-B1	24.0	11.6	25.6	13.0
6-B2	59.9	20.0	63.9	22.9
6-B3	119.9	9.9	127.7	13.9

Table 7.8 Resource rent or profit generated by various policy options affecting total cost of fishing effort and restricting fishing effort in the long run in both types of resource

Case	Riverine fishery (million rupiah)	Swamp fishery (million rupiah)
6-A1	5.872	3,593
6-A2	12,372	7,671
6-A3	16,557	10,311
6-B1	5.706	3,371
6-B2	12,233	7,486
6-B3	16,465	10,187

In the riverine fishery, policy scenarios 6-A1, 6-A2 and 6-A3 increased stock size by 24.0 per cent, 59.9 per cent and 119.9 per cent, respectively. This, in turn, increased sustainable total catch by 11.6 per cent, 20.0 per cent and 9.9 per cent, respectively. Thus, the strongest effect of these policies on total catch is in 6-A2, followed by 6-A1 then 6-A3. The same pattern of changes in biomass and total catch applies for the scenarios 6-B1, 6-B2 and 6-B2.

In the swamp fishery, the biomass increased 25.6 per cent, 63.9 per cent and 127.7 per cent with the policy options 6-A1, 6-A2 and 6-A3, respectively. These policies caused increases in sustainable total catch of 13.0 per cent (case 6-A1), 22.9 per cent (case 6-A2) and 13.9 per cent (case 6-A3). These results indicate that the strongest impact of those policies on total catch is in the case of 6-A2, followed by the cases 6-A1 and then 6-A3. A similar pattern of changes in biomass and total catch occurs with 6-B1, 6-B2 and 6-B3.

As shown in Table 7.8, the highest resource rent generated from the riverine fishery was associated with scenario 6-A3, followed by scenarios 6-B3, 6-A2, 6-B2, 6-A1 and 6-B1. Similar patterns for generating resource rents by those scenarios apply for the swamp fishery.

In the riverine fishery, the policy scenarios 6-A1, 6-A2 and 6-A3 generate rents of 5,872 million rupiah, 12,372 million rupiah and 16,557 million rupiah of resource rent, respectively. The policy scenarios 6-B1, 6-B2 and 6-B3 provide 5,706 million rupiah, 12,233 million rupiah and 16 465 million rupiah profit. In the swamp fishery, the amount of resource rent generated by the policies are 3,593 million rupiah (case 6-A1), 7,671 million rupiah (case 6-A2), 10,311 million rupiah (case 6-A3), 3,371 million rupiah (case 6-B1), 7,486 million rupiah (case 6-B2) and 10.187 million rupiah (case 6-B3).

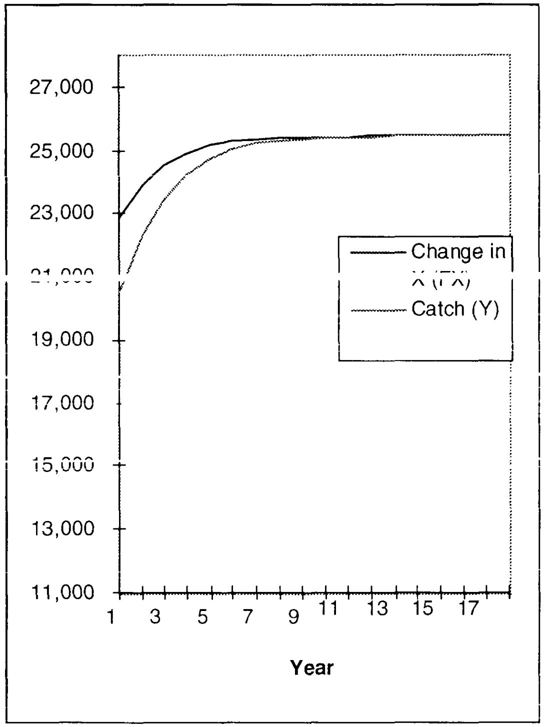
7.5 Adjustment Path

7.5.1 Adjustment path caused by policies restricting the fishing effort

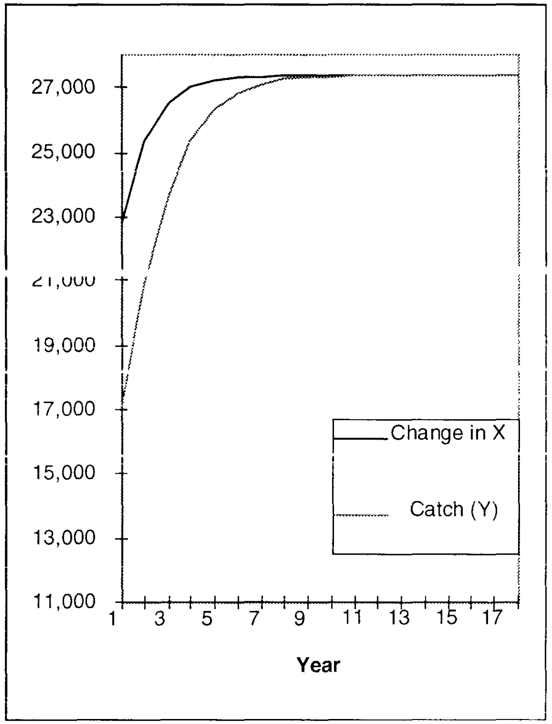
The evolution of change in stock size and level of catch by different limited-entry policies is illustrated in Figure 7.2 (riverine) and Figure 7.3 (swamp). These results were obtained by numerically integrating the model starting with the initial equilibrium and allowing catch and biomass to stabilise under alternative levels of effort.

The evolution of total catch (Y) and change in stock size (X) are shown in Figure 7.2. This figure shows that effort restriction policies result in an improvement in the fishery resource. Even though the greatest improvement in terms of increase in stock size comes from scenario 5-C, the highest positive impact on total catch is from scenario 5-B. The adjustment path to reach biological equilibrium in terms of change in stock size (FX) and catch (Y) caused by those policies shows that the longest time required to reach biological equilibrium in the riverine fishery was shown by the policy scenarios 5-A and 5-B (18 years), followed by policy scenarios 5-C (14 years). In the swamp fishery, the same policy scenarios as in the riverine required a relatively shorter time to recover biological equilibrium. The longest time required to reach equilibrium was in the case 5-A (10 years), then followed by cases 5-B (8 years) and 5-C (7 years) (see Figures 7.3a, b and c).

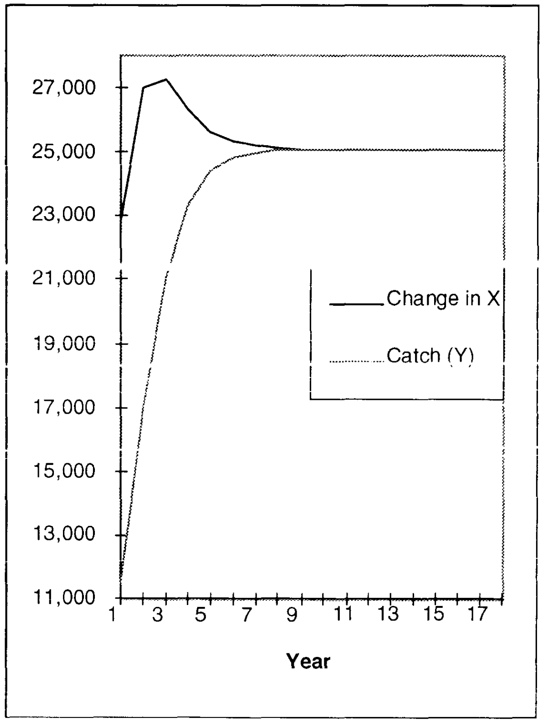
Figure 7.2 Evolution of total catch (Y) and change in stock (FX) caused by 10 per cent (a), 25 per cent (b) and 50 per cent (c) reduction in the initial fishing effort in riverine fishery



(a)

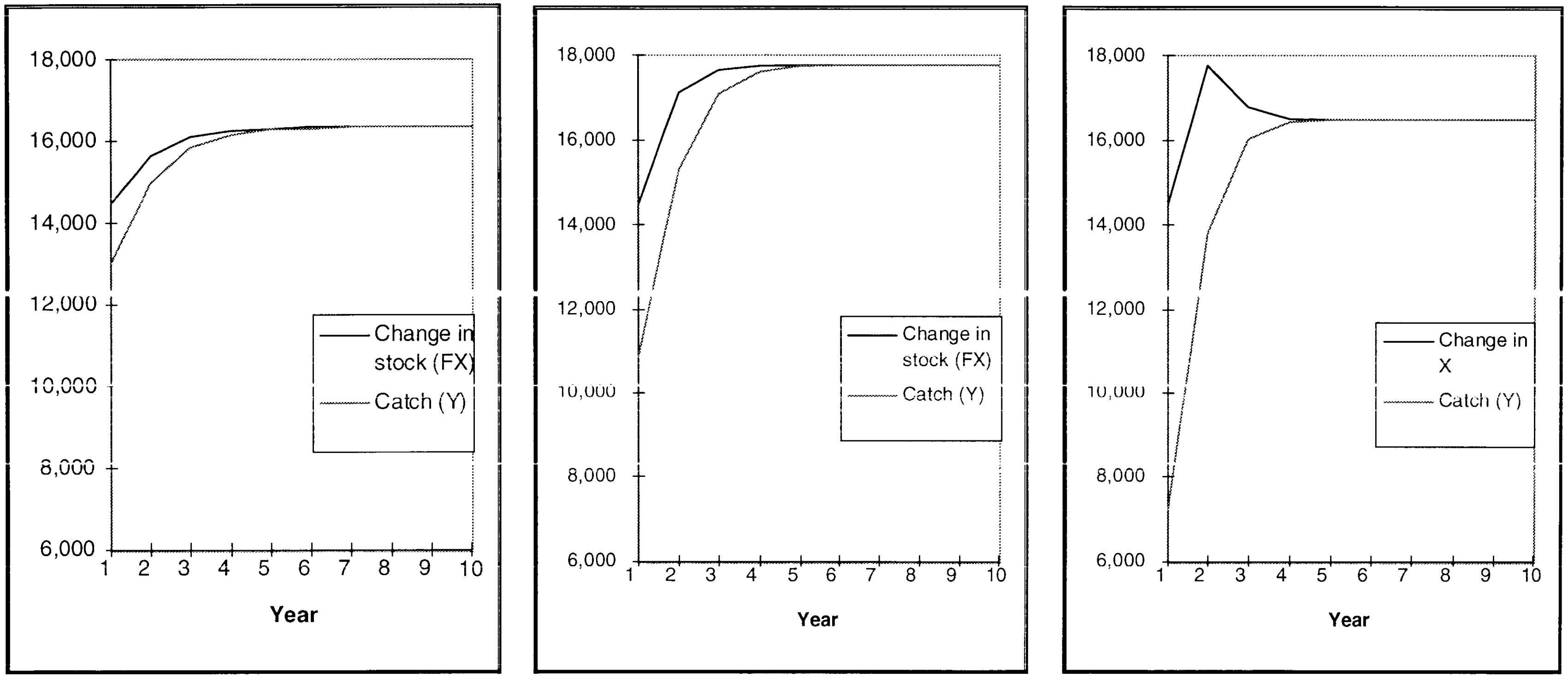


(b)



(c)

Figure 7.3 Evolution of total catch (Y) and change in fish stock (FX) caused by 10 per cent (a), 25 per cent (b) and 50 per cent (c) reduction in the initial fishing effort in swamp fishery

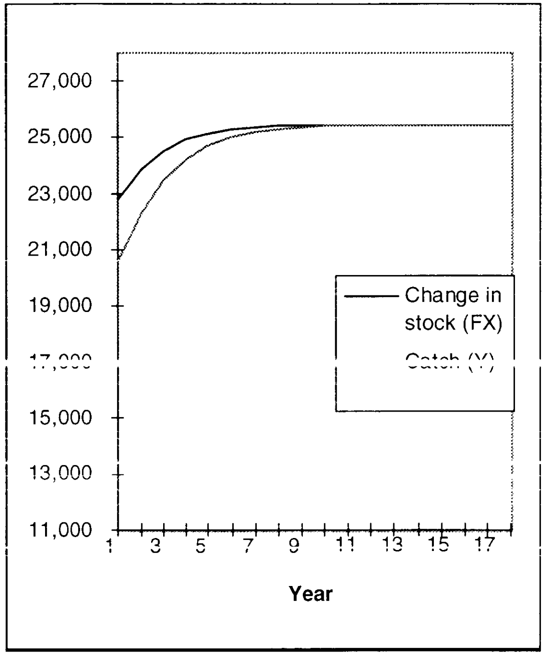


(a) (b) (c)

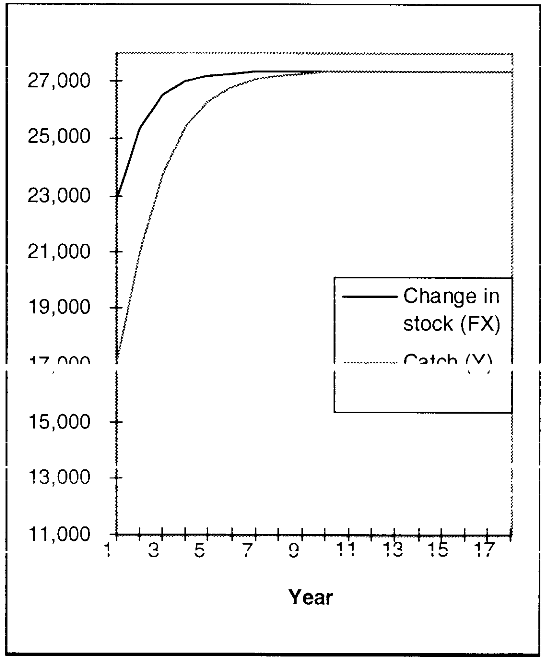
7.5.2 Adjustment path caused by policies which increase the total cost of fishing effort and restrict fishing effort

Using similar procedures to the previous section, the trajectory for each policy which combines the increase in licence fee and restriction in effort is shown in Figures 7.4 (riverine) and 7.5 (swamp). Trajectories for both resources show the same general pattern. With these policies, fishery resources in both types of environment would be improved. The pattern of improvement, in terms of the increase in biomass, in scenario 6 is the same as in scenario 5. The time required to stabilise with policy scenarios 5 and 6 was 18 years (10 and 25 per cent restriction in effort) and 14 years (50 per cent restriction in effort), regardless of the existence of increasing licence fee policies. The same pattern applies in the case of swamp fishery.

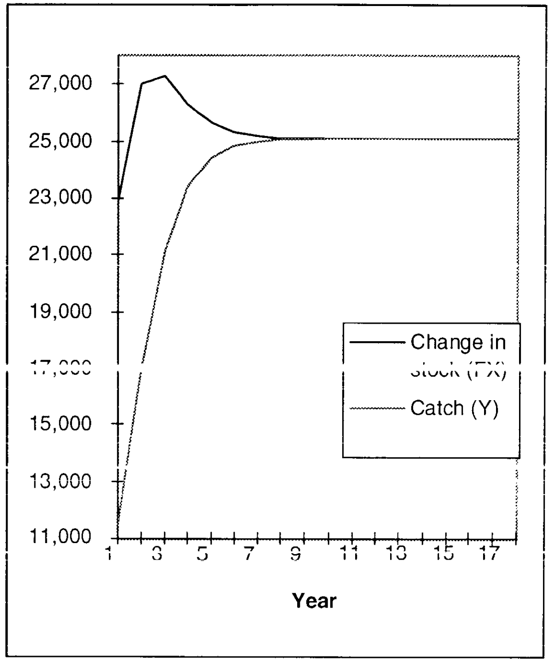
Figure 7.4 Evolution of total catch (Y) and change in stock (FX) caused by mixed regulation in the riverine fishery



Case 6-A1

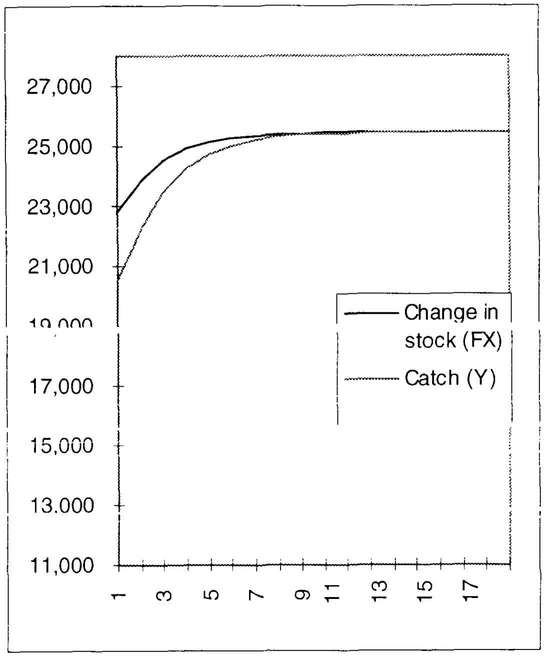


Case 6-A2

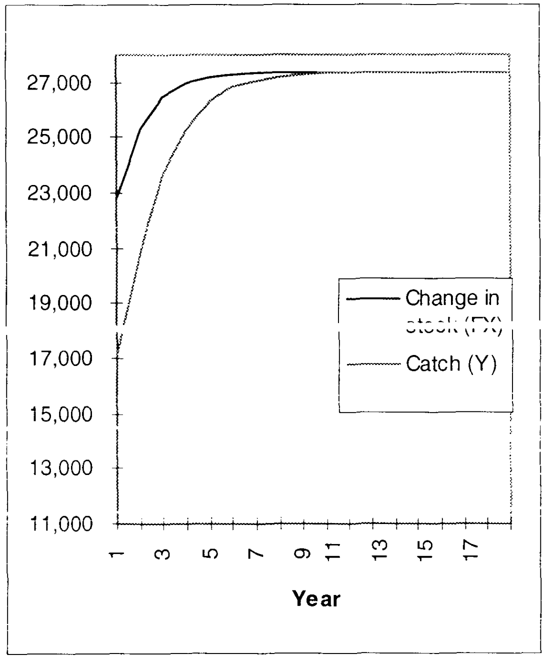


Case 6-A3

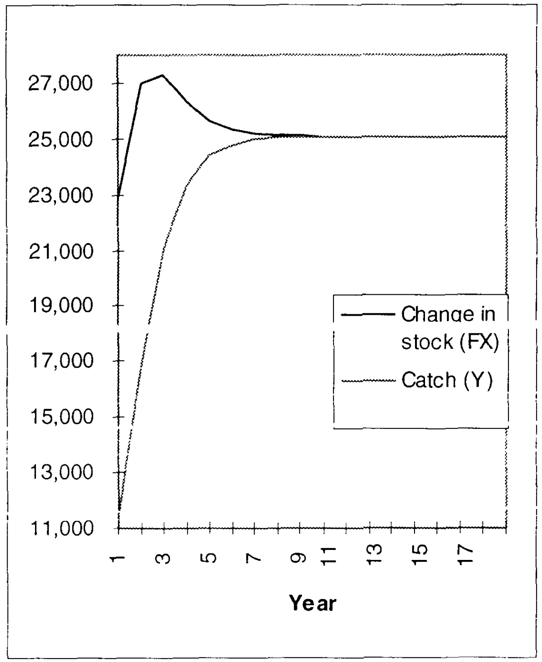
Figure 7.4 continued



Case 6-B1

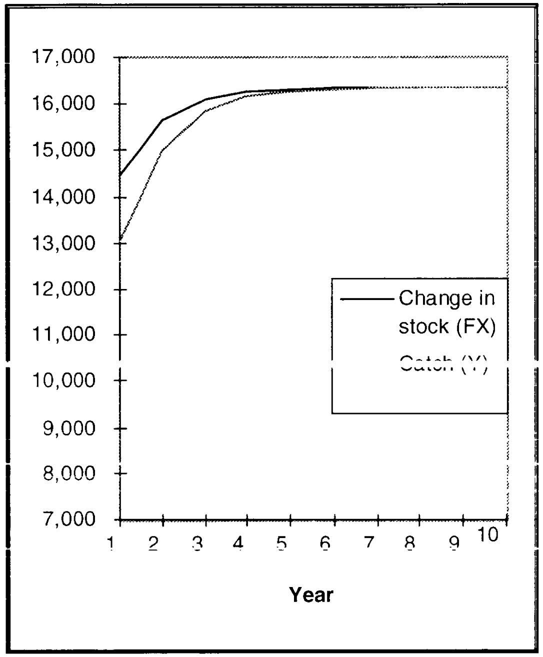


Case 6-B2

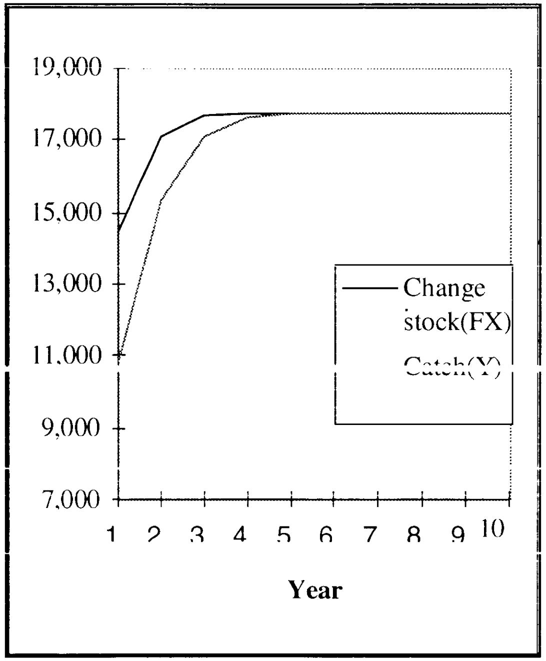


Case 6-B3

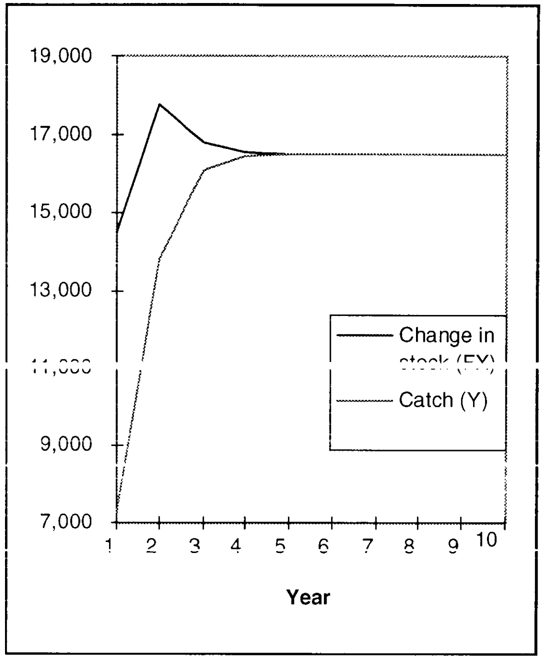
Figure 7.5 Evolution of total catch (Y) and change in stock (FX) caused by mixed regulation in the swamp fishery



Case 6-A1

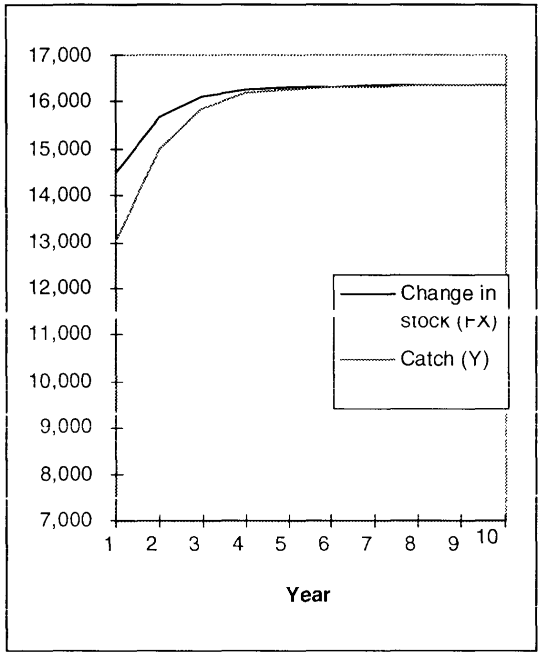


Case 6-A2

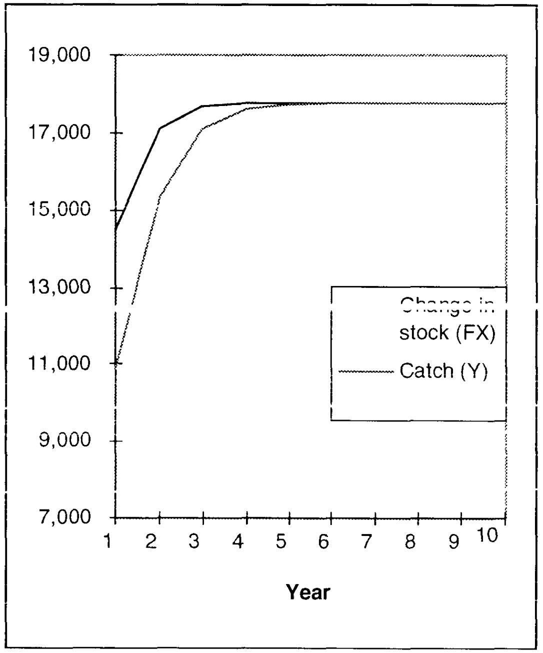


Case 6-A3

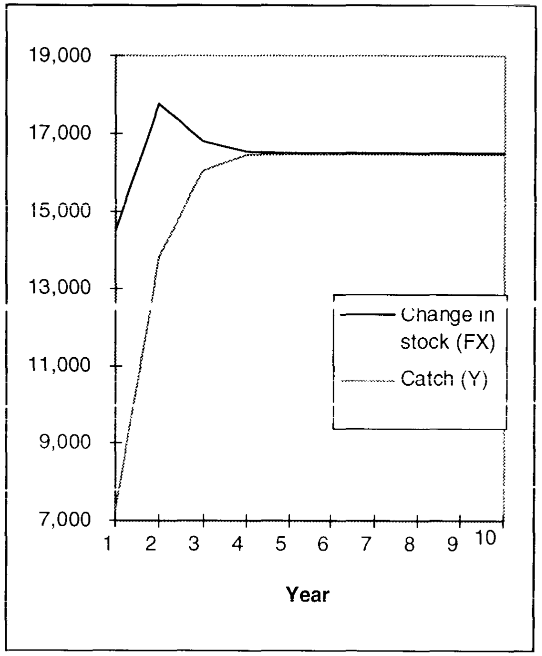
Table 7.5 continued



Case 6-B1



Case 6-B2



Case 6-B3

7.6 Implications of the simulation results

7.6.1 Policy options directly affecting total cost of fishing effort

The effect of increasing the licence fee was to reduce the level of effort. The advantage of this policy is that the increased licence fee is relatively easy from an enforcement standpoint. Hence, the actual fishery authority tends to concentrate on the policy of issuing licences. Even though good data and information concerning the status of the fishery were not available, casual observation indicates that government regulations to manage the fishery have focussed on increasing licence fees. It can be concluded from the simulation results that the licence fees will decrease the level of fishing effort and increase total catch. However, Tai (1992, p. 190) indicates that with these policies total social benefits remain the same since licence fees are merely transfer payments. In addition, studies by Bell (1970) in Anderson (1977, p. 199) indicate that increases in licence fees were of little importance compared to the establishment of a 'grandfather system' whereby fishing units were classified according to the success of previous fishers.

A distinction between short run and long run has been made since the enforcement of fishery regulations in Indonesia may not be strict. Enforcement of imposed fisheries regulations remains an issue for the government (Koeshendrajana 1991; Warren and Elston 1994; and Viswanathan *et al.* 1997)

The effects of an increase in labour costs would be similar to those of an increase in the licence fee. The difference between policy options is in terms of the magnitude of the induced change in fishing effort and catch. This is because the labour cost contributes relatively more than the licence fee to the total cost of fishing effort[6]. The increase in wages in other sectors where wages exceed wages in the fishery sector implies that labour opportunity costs are increasing. With this policy, the potential social profit in the fishery can be reduced by voluntary action with fishers exiting from fishing. Furthermore, this condition encourages higher labour productivity in the fishery sector.

In the case of increasing the total cost of fishing effort (policy scenario 3), the effects were similar to both increasing the licence fee (scenario 1) and increasing labour costs of fishing (scenario 2).

7.6.2 Policy options directly affecting price of freshwater fish

The increase in the price of fish will reduce the supply of fish in the long run by increasing fishing effort beyond MSY. This is consistent with fishery economic theory (Gordon 1954; Copes 1970) which states that in increase in the price of fish will reduce the supply of fish in the long run by expanding fishing effort beyond MSY. Ahmed (1997, p.17) states that an increase in price reduces fish consumption by the low income consumers. This conclusion was supported by Delgado and Courbois (1997, p. 22). Their studies on the changing fish trade and demand patterns in developing countries revealed that, although an increase in fish prices would disadvantage consumers it may also disadvantage fish producers. This is because as fish prices increase, more fish are being sold and a relatively small quantity of harvested fish would be consumed by producers. They would consume only smaller and lower-market-value fish in the household thus lowering the quality of the fish they eat (Williams 1996). Thus, government may wish to maintain the price at a reasonable level if nutrition is a priority.

7.6.3 Policy options directly affecting total fishing effort

Theoretically, limited-entry regulations may not be able to fully produce the desired impact on a fishery (Tai 1992, p. 181). This is because the fishery will be highly profitable after rationalisation and hence encourage fishers to increase effort. The additional fishing effort in this case can be indirectly reduced by altering the potential profit through increasing the licence fees or establishing a tax on catch. These charges will also generate public revenue which can be used to manage the fishery.

---

[6] See Table 4.3.

As discussed in the previous chapter, local government has tended to increase regional indigenous income (*Pendapatan Asli Daerah, PAD*) from its regional resources. Even though there was no explicit figure, it is believed that inland fishery resources contributed more than 50 per cent of the total *PAD* of Ogan Komering Ilir (OKI) and Musi Banyuasin (MUBA) of South Sumatra province[7]. This amount of money was supposed to be redistributed to the fishing community by providing inland fishery infrastructure, educational training related to the fishery and developing activities related to fishery, for example, introducing aquaculture. By culturing local high-priced fish, supply of freshwater fish in that area can be increased. Graphically, this is explained by relaxing and shifting the backward bending supply of freshwater fish to bend forward to the right as is illustrated by Ye and Beddington (1996, p. 107).

Limited-entry regulation represents one of a number of alternative policy actions that may provide benefits to those in the fishery and society. In the simulation, limited-entry regulation to the fishery was viewed in terms of reducing the number of licence holders. Alternatively, limited entry could also be viewed in terms of restricting the type of fishing units in the study site. Restriction of fishing effort by closing areas and seasons for fishing is often used by the authority in order to protect the fishery from over-fishing and to allow fish stock in that particular fishing ground to recover. This regulation is popular with biologists because of its flexibility in the sense that areas can be opened or closed according to current knowledge of the authority (Waugh 1984, p.126). Limited entry in terms of restrictions on the types of fishing units is also commonly imposed by government. Such regulations are easy to implement and effective in preventing depletion of fish stock. However, this type of regulation is controversial in the sense that fishers are not free to use the technology that they prefer.

The results of simulation of restriction on the amount of fishing effort differed from those of increasing the cost of fishing effort. In the former, the selected policies affect stock size and total catch, but do not allow bionomic equilibrium to be restored, and,

---

[7] Personal communication from the chief of local fishery services and *Bappeda*.

produce resource rent for those exploiting the resource. In the latter, the policies affect stock size, total catch and allow a new equilibrium to be reached.

As has been discussed, restriction on the fishing effort may not be desirable for the case of small-scale fishers, as these policies imply that the number of fishers must be reduced. As indicated by Hanley *et al.* (1996, p. 287), a typical problem associated with fishing communities is that the opportunity cost of labour and capital devoted to fishing effort are low. This is because few alternative employment opportunities exist for the labour and capital employed in fishing. An FAO report cited by Ahmed (1997, p. 8) indicates that, in developing countries, population pressures and a lack of alternative employment opportunities, compounded by the inability of governments to take necessary conservation and management decisions, have resulted in seriously over-exploited inland fishery resources with catch rate, fish size and income all declining. In essence, fishers may not support such policies because they expect to get some of these rents. In this context, the government may consider sharing profits with fishers. In other words, in order to maintain fishing effort at the desired level, the incentives to expand fishing effort in the fishery have to be removed.

The distribution of rent has to be governed by an administration rule, which opens the possibility of profitable rent seeking. In the inland fishery of South Sumatra, rights to fish have been regulated by licensing through an annual auction. However, this regulation is viewed by Matthiasson (1996) as a 'worthless regulatory regime' if it is not followed up with control which consequently requires considerable costs.

7.6.4 Policy options directly affecting total cost of fishing effort and total fishing effort

As shown in Table 7.9, the pattern of change in stock size and catch caused by mixed regulation in terms of increasing the licence fee and restricting the amount of fishing effort are the same. However, the effects of those policies in terms of resource rents are different. In general, with the same combination of restriction on fishing effort, the resource rent is higher when the increase in licence fee is lower. With the same combination of increase in the licence fee, a higher reduction in effort will generate a relatively higher resource rent.

7.7 Summary and Concluding Remarks

The results of the simulation show that any policy imposed on the fishery will affect equilibrium of the stock size, total catch and effort in the long run. This, in turn, causes changes in any possible resource rent or profits generated by the fishery. The effects of selected regulations which increase costs per unit of fishing effort is to reduce the initial level of effort, but increase total catch. The greatest impact on reduction in total effort is given by the increase in variables which contribute mostly to the total cost per unit of fishing effort.

Increases in fish prices disadvantaged the fishery resource, consumers and producers. With the price increases, access to the fishery resource become more desirable hence the resource is depleted. Consumers are disadvantaged because they have to pay higher prices for fish. Producers become worse-off because they may suffer nutritionally and lose employment.

For the small-scale inland fishery of South Sumatra, the availability of alternative employment opportunities for labour and capital employed in fishing is low. Hence, a limited-entry management scheme may significantly reduce total effort in the short run. However, the results will be undesirable in the long run. This is because fishers will respond to any positive profits generated in the fishery by increasing their fishing effort. In this context, removing the incentives to expand fishing effort can be fully or partially brought about through other regulatory regimes, for example, a licensing scheme. Alternatively, introducing aquaculture through future research may be the best solution for solving such a complex problem in the fishing community. Thus, a pure limited-entry regulation is not recommended in the case of the small-scale fishery. This type of regulatory regime must be accompanied by another regulatory scheme.

Mixed regulations which consider biological and socioeconomic improvement in the fishery are desirable; however, as with all the policy options, the chance of success will depend on the acceptability of the regulation in a particular fishery.

Chapter 8

SUMMARY AND CONCLUSIONS

8.1 Introduction

The main objective of this chapter is to summarise the major findings of this study and draw policy conclusions from the study. Following this introduction, a summary of the study is given. The findings are discussed in the light of the objectives and hypothesis outlined in Chapter 1. Then, some policy implications are discussed. Limitations of the study are discussed in Section 8.4. The last two sections assess the contribution of the study and provide suggestions for areas of further study.

8.2 Summary of the Study

Even though inland capture fisheries have accounted for less than a quarter of the total fisheries' employment in Indonesia, fishing in the inland water body resources, such as floodplains, rivers and lakes, is important for the rural people. The fishery generates significant income and provides employment opportunities. The resource also has an important role as a source of protein in the diets of many households, both in rural areas and urban centres. For the government, inland fishery resources are considered the main source of regional indigenous income (*Pendapatan Asli Daerah, PAD*). For many rural people living in the floodplains of the river and its major tributaries in the study site, fishing has been traditionally considered as an important occupation. The fishery is very complicated, comprising many different types of gear (fishing unit) and harvested fish species.

The main problem for the inland fishery resource in South Sumatra, Indonesia, is the tendency for the resource to be over-fished. This has been well recognised as shown by some overall indicators, such as virtual disappearance of certain important species and continuous reduction in the size of fish caught. This problem is compounded by the fact that property rights are not properly assigned to the resource. The interests of small-scale fishers have received too little attention from decision makers. In contrast, the resource authority has tended to collect resource rent generated by the fishery through increasing licence fees and other charges. Consequently, the tendency is for the fishing community to deplete the resource. In addition, there are relatively few studies on the resource so that it is likely that past policy decisions were not supported by good information. The fishery tends to be 'open access' which leads to biological and economic over-fishing.

One possible solution to the problem is to introduce a form of collective management of the fishery resource which changes the 'open-access' resource to a 'common property' resource. The concept of 'common property' resource means a redistribution of property rights so that a number of owners have rights. Practically, a major problem confronting management is the determination of the type and level of control which should be applied to the fisheries in order to achieve the objectives of maintaining the flow of benefits derived from the fishery and improving the productivity of the resources on a sustainable basis.

Management measures are needed in order to overcome these problems. Given the performance of the inland fishery, management of the fishery should consider two factors: first, the importance of the fishery to the fishing community; and, second, the objectives for management of the fishery itself. In the light of both considerations, the theoretical framework developed to analyse the fishery would include biological, economic and social aspects of inland fishery.

The theoretical framework used draws on biological and economic reference points and combines them into a 'bioeconomic' model. With this model, resource allocation for the fishery was analysed. As discussed, regulations in terms of quotas, gear restrictions, closed seasons and areas of fishing do not directly deal with the open-access problem. It appears that none of these management schemes would significantly improve the economic performance of the fishery. However, they would significantly benefit the biological status of the fishery resource. On the other hand, licensing, taxation and individual quotas may significantly improve the economic efficiency of the fishery.

The review of the literature shows previous research has mainly dealt with biomass dynamic models with temperate marine fisheries in developed countries. The literature on tropical inland fisheries in developing countries is very limited. In fact, problems occurring in such fisheries may be more complex than in marine fisheries, comprising not only biological and economic aspects, but also social, institutional and political dimensions. Thus, the theoretical framework of bioeconomic analysis for fisheries should be applied to such resources, taking into consideration all these important considerations.

The tropical inland fishery of South Sumatra is very complex, being small-scale, multi-species and involving many types of fishing units. The fishing community households often depend exclusively on fishing. Many species of fish are harvested by employing many types of fishing units which may not be well reflected in the statistical data. Because of this problem, the inland fishery system was represented as a simple model by deriving supply and demand functions as single equations.

Primary data were collected to describe recent costs of fishing and socioeconomic conditions in the fishing community. Secondary data, combined with results of analysis of primary data, were used to derive supply and demand functions. Given the available data, and in order to satisfy the requirements for applying the selected model, different types of fishing gear were standardised into a single fishing unit and mixed species of harvested fish were treated as an aggregate fish stock.

Supply models of the inland fishery were estimated by applying the bioeconomic models of Gordon-Schaefer and Gordon-Fox and Copes. Demand for fish was defined in terms of an ordinary demand function, with fish price, price of beef and income per capita as independent variables. However, the analysis was not conclusive and it was assumed that the demand was perfectly elastic. In other words, the price of freshwater fish was assumed to be constant. In the case of the small-scale inland fishery, it seems that the constant price model is appropriate, indicating that Sumatran freshwater fish supply has no effect on the market price of fish.

Given the constant cost of fishing effort and price of freshwater fish, bioeconomic models based on the Gordon-Fox and Gordon-Schaefer approaches were developed. Both models indicate that the South Sumatra inland fishery has been over-fished both biologically and economically during the period of the study.

Based on the Gordon-Schaefer approach (Panayotou 1982), opportunity cost of fishing was included in the bioeconomic model, and hence the objective of fishery management was to maximise social yield. Given these objectives, the reduction in average fishing effort required to achieve optimum resource allocation was less than in the standard bioeconomic model.

Empirical results revealed that both riverine and swamp fisheries in South Sumatra were biologically and economically over-fished during the period of the study.

Simulation was carried out to compare the relative effects of alternative policy options on the fishery. Results from the Copes model provided a 'base case' representing the bionomic equilibrium under current conditions in the fishery. The optimisation carried out in this study is static, hence results of the simulation are limited to long-run equilibria and considerations of optimal exploitation through time are not provided. However, the ajustment path through time, as the system reaches a new equilibrium in response to management policies, was analysed by numerically integrating the model and estimating the time required for catch to reach its new long-run sustainable level.

In summary, it was concluded that the Gordon-Schaefer and Gordon-Fox static surplus production models are robust as a first step in assessing the status of inland fishery in South Sumatra, and the extended Copes model in terms of supply of and demand for freshwater fish is useful for understanding and explaining the fishery.

8.3 Policy Implications

In general, the main policy implication derived from the study was that proper regulation of the inland fishery in South Sumatra would require control of the total standardised fishing effort. Results indicated that the fishery has been over-fished, which, for the purpose of an economically efficient management policy, means that the level of fishing effort should be reduced, resulting in a reduction in average cost per unit of effort. However, reducing fishing effort indiscriminately is not desirable; the reduction in fishing effort should be accompanied by creation of alternative productive activities such as aquaculture.

Because of the small-scale nature of the inland fishery, it is argued that the appropriate model to be applied must consider unemployment. This implies that maximising social yield (MScY) is preferable to maximising economic yield (MEY).

Simulation results indicated that an increase in factors related to the cost of fishing effort reduced the total fishing effort in the long run and increased fish stock biomass, hence total catch increased. For the decision maker, the model can aid in selecting the most responsive factor to affect the cost of fishing effort.

Limited-entry regulations in terms of directly restricting fishing effort were shown to be desirable in the long run. However, such regulations should be accompanied by other regulatory regimes. This is because fishing effort restrictions require considerable cost in terms of maintenance and control. The problem of enforcement may be overcome if the government decentralised management of the fishery to the local level. In other words, the current state property rights should be transferred to the community for common property management, with joint rights between the government and the fishing community.

The current trend of increasing fish prices may negatively affect fishers, consumers, and the resource itself. In addition to the fact that in the long run, fish production would not be increased as a result of an increase in effort, fishers would consume smaller and lower value fish in their households with the higher prices, thus lowering their household's nutritional status. The fishery resource would be disadvantaged because access to the resource and depletion would be encouraged. The policy implication is that the government may wish to control the fish price at an appropriate level.

8.4 Limitations of the Study

One major constraint in the study was the availability of data. This constraint limited the scope of the study and many interesting aspects of the fishery were left unexplored. Surplus production models were the best option available to obtain estimates of biological parameters. The lack of time series data on many social, economic and cultural variables resulted in simplification of the dynamics of the fishery system.

Data problems are compounded by the fact that official fishery statistics may not precisely reflect the inland fishery of South Sumatra. This is because the fishery is characterised by many different types of gear and harvested fish species. The lack of appropriate data did not allow the application of the surplus production model by specific species or group of species. Instead, standardised fishing effort was applied and aggregate catch was used.

Many uncertainties exist in fishery resource exploitation, such as resource availability, price, production, supply of fishing effort and fishers's response to policy regulations. Those were not directly included in the study. More realistic representations of the fishery should incorporate these uncertainties.

8.5 Contributions of the study

The primary contribution of the study is the application of an appropriate theoretical framework to assess the inland fishery in South Sumatra, given the relatively limited available data. The method used in the study appears robust and provides a formal estimate of the status of the fishery.

The second contribution of this study is that, to the best our knowledge, it represents the first attempt at estimating supply and demand relationships, based on the static surplus production model, for a tropical small-scale fishery in a developing country.

Another contribution made in this study is the use of an extended static surplus production model which incorporates the problem of small-scale fisheries in terms of unemployment. This extension has not been applied in any study of this subject. This enables a better understanding of the nature of small-scale fisheries in the study.

Finally, the empirical results presented here may help decision makers better understand and select appropriate policy regulations to solve problems in the small-scale inland fishery in South Sumatra.

8.6 Areas for Further Study

Although the primary objectives of the study have been achieved, a number of suggestions and areas of further research should be considered in order to determine even better policy regulations in the fishery.

In terms of data, the government could record it more consistently to reflect the actual inland fishery condition. This may be achieved by allocating resources (manpower, money and time) to the fishery service office at the village level. Data should also be recorded at shorter time intervals.

The model and analysis can be modified and extended in a number of ways. The assumption of equilibrium yield in the surplus production models is particularly restrictive. The assumption of constant efficiency of fishing effort may not reflect the dynamic nature of the inland fishery. These assumptions can be relaxed. For example, in order to avoid the assumption of zero rate of change in biomass all year and of an exact index of relative abundance which may not be biologically correct, effort-averaging methods, process-error estimators and observation-error estimators can be applied. Alternatively, combined methods of the maximum likelihood and the Kalman filter could also be used. Other possible extensions of the model to reflect changes in the efficiency of fishing effort can be based on the procedure suggested by Wallace *et al.* (1996, p. 592), which modifies the catch function in terms of:

$$Y_t = q_t(1+gT)\,E_t\,X_t$$

where T represents a time trend and g is coefficient of time trend, to the standard catch function.

Other biological models or ecological models could be used to represent the biology of the fishery as indicated by Hilborn and Walters (1992). Finally, the behaviour of fishers in supplying fishing effort needs to be modelled in greater detail.

REFERENCES

Ahmed, M. 1997, 'Policy issues deriving from the scope, determinants of growth, and changing structure of supply of fish and fishery products in developing countries', *Paper Presented* at the International Consultation on Fisheries Policy Research in Developing Countries: Issues, Priorities and Needs, North Sea Centre, Hirtshals, Denmark, June 2-5, 1997.

Anderson, L.G. 1977, *The Economics of Fishery Management,* The Johns Hopkins Univ. Press, Baltimore and London, pp. 296.

Anon. 1994, *'Floodplain fisheries project: Poverty, equity and sustainability in the management of inland capture fisheries in South and South-East Asia'*, Internal report to Bath University Center for Development Sudies, Marine Resource Assessment Group (MRAG).

Arifin, Z. and Ondara, R. 1982, 'Pengelolaan Perikanan di Perairan Umum Lubuk Lampam', *Prosiding Puslitbang Perikanan No. 1/SPPU/1986,* Badan Penelitian dan Pengembangan Pertanian, Jakarta, (in Indonesian).

Bailey, C. 1986, 'Government protect on of traditional resource use rights: the case of Indonesian fisheries', in *Community Management; Asian Experience and Perspectives,* ed. D.C. Korten. West Harford, Kumarian Press, 292-308.

Bailey, C. Pollnac, R.B. and S.P. Malvestuto. 1990, 'Local resource management of Kapuas River fishery', *Paper presented* at the 1st Meeting of the International Association for the Study of Common Property, Duke University, Raleigh, North Carolina, 27-30 September 1990.

Bailey C. and C. Zerner. 1992, 'Loc.ıl managementr of fisheries resource in Indonesia: opportunities and constrainıs', in *Contributions to Fisheries Development Policy in Indonesia,* eds Po lnac, R.B. et al., Center Research Institutes for Fisheries, Agency for Agricultural Reseach and Development, Jakarta, Ch. 3, 38-56.

Berck. P. and G. Johns. 1991, 'Estimating structural resource models when stock is uncertain: theory and its app ication to Pacific Halibut', *in Stochastic Models and Option Values,* eds Lunc, D. and B. Oksendal, Elsevier Science Publisher B.V., North-Holland, 243-66

Beverton, R.J.H. and S.J. Holt. 1956, 'The theory of fishing', in *Key papers on fish populations*, ed. Cushing, D.H., IRL Press, Oxford, Washington DC, 39-109.

Beverton, R.J.H. and S.J. Holt. 195?, *On the dynamics of exploited fish populations*, Min. Agr. Fish. and Food (U. K), Fish. Investig. Ser. II, 19, London, 533 p.

BPS (Biro Pusat Statistik, Center Bureau of Statistics). 1994, *Statistik Indonesia (Statistical year book of Indonesia) 1993,* BPS, Jakarta.

BPS (Biro Pusat Statistik, Center Bureau of Statistics). 1995, *Sumatra Selatan dalam Angka (South Sumatra in figures) 1994,* BPS, Jakarta.

Bromley, D.W. and M.M. Cernea. 1989, 'The management of common property natural resource: some conceptual and operational fallacies', *World Bank Discuss. Pap.* 57, World Bank, Washington, DC.

Caddy, J.F. 1996, 'An objective approach to the negotiation of allocations from shared living resources', *Marine Policy* 20(2), 145-55.

Caddy, J.F. and J.A. Gulland. 1983, Historical patterns of fish stocks', *Marine Policy* 7, 267-78.

Campell, D. and J. Haynes. 1990, 'Resource rent in fishery', *Discussion Paper* 90-10, ABARE

Campell, H.F. and R.K. Lindner. 1990, 'The production of fishing effort and the economic performance of licence limitation programs', *Land Economics* 66 (1), 56-66.

Charles, A.T. 1988, 'Fishery Socioeconomics : A survey', *Land Economics* 64(3), 276-95

Christy Jr, F.C. 1982, 'Territorial use rights in marine fisheries: definitions and conditions', *FAO Fish. Tech. Pap. No. 227,* Food and Agriculture Organisation of the United Nations, Rome.

Christy, F.T. 1973, 'Fisherman quotas : a tentative suggestion for domestic management', *Ocasional Paper No. 19, Law of the Sea Institute*, University of Rhode Islan, Kingston.

Clark, C.W. 1985, *'Bioeconomic modelling and fisheries management',* John Wiley & Sons, New York, pp. 91.

Clark, C.W. 1985, *Bioeconomic modelling and fisheries management,* John Wiley and Sons, New York

Comitini, S. and D.S. Huang, 1967, 'A study of production and factor shares in halibut fishing industry', *Journal of Political Economy* 75, 366-72.

Copes, P. 1970, 'The backward-bending supply curve of the fishing industry', *Scottish Journal of Political Economy* 17, 69-77.

Copes, P. 1986, 'A critical review of the individual quota as a device in fisheries management', *Land Economics* 62, 278-291.

Copes, P. 1970, 'The backward-bending supply curve of the fishing industry', *Scotish Journal of Political Econom* 17, 69-77.

Copes, P. 1988, 'Transferable, non-transferable and limited term fishing rights: Fisheries rationalization in a socioeconomic context. *Working Paper, Institute of Fisheries Analysis, Simon Fraser University, Burnaby, Canada.*

Crutchfield, J.A. 1979, 'Economic and social implications of the main policy alternatives for controlling fishing effort', *J. Fish. Res. Board Can.* 36, 742-52

Cunningham, S., M.R. Dunn and D. Whitmarsh. 1985, *'Fisheries economics: An introduction',* St. Martin's Press, New York, pp. 372.

Cushing, D.H. 1983, *Key papers on fish populations,* IRL Press, Oxford-Washington DC.

Danielsen, F. and W.J.M. Verheught. 1989, *Integrating conservation and land-use planning in the Coastal region of South Sumatra,* PHPA, AWB-Indonesia, Bogor.

Delgado, C.L. and C. Courbois. 1997, 'Changing fish trade and demand patterns in developing countries and their significance for policy research', *Paper prepared* for the International Consultation on Fisheries Policy Research in Developing Countries: Issues, Priorities and Needs, North Sea Centre, Hirtshals, Denmark, June 2-5, 1997.

Directorate General of Fisheries (DGF). 1992, *Annual fishery statistics of Indonesia*, Directorate General of Fisheries (DGF), Jakarta.

Fisheries Services of South Sumatra (*Dinas Perikanan Propinsi Sumatra Selatan*). 1982, *'Fishery Statistics of South Sumatra Provinces, Years 1968 to 1980 (Buku Statistik Perikanan Propinsi Sumatra Selatan, Tahun 1968-1980)'*, Fisheries Services of South Sumatra.

Fisheries Services of South Sumatra (*Dinas Perikanan Propinsi Sumatra Selatan*). various years[a], *'Annual Book of Fisheries Statistics of South Sumatra Province, Years 1979 to 1994 (Buku Tahunan Statistik Perikanan Tingkat Propinsi Tahun 1979-1994) '*, Fisheries Services of South Sumatra.

Fisheries Services of South Sumatra (*Dinas Perikanan Propinsi Sumatra Selatan*). various years[b], *'Annual report of South Sumatra Fishery Services (Laporan Tahunan Perikanan Propinsi Sumatra Selatan, Tahun 1978-1993)'*, Fisheries Services of South Sumatra.

Fox, W.W. 1970, 'An exponential surplus-yield model for optimising exploited fish populations', *Trans. Amer. Fish. Soc.*, 1, 80-88.

Fox, W.W. 1975. Fitting the generalized stock production model by least-squares and equilibrium approximation', *Fishery Bulletin* 73 (1), 23-37.

Fraser, G.A. 1977, Limited entry : experience of the British Columbia salmon fishery', *Journal of Fisheries Research Board of Canada* 36 (7), 754-63.

Furubotn, E.G. and J.W. Pejovich. 1972, 'Property rights and economic theory: survey of recent literature', *Journal of Economic Literature* 10.

Gordon, H.S. 1953, 'An economic approach to the optimum utilisation of fishery resources', *J. Fish. Res. Bd. Can.* 10 (7), 442-57.

Gordon, H.S. 1954, 'The economic theory of a common property resource : the fishery', *Journal of Political Economy* 62, 124-42.

Graham, M. 1935, 'Modern theory of exploiting a fishery, and application to North Sea Trawling', in *Key papers on fish populations*, ed. Cushing, D.H., IRL Press, Oxford-Washington DC, 25-35.

Griffiths, W.E., Hill, R.C. and G.C. Judge. 1993, *'Learning and Practicing Econometrics'*, John Wiley & Sons.

Gujarati, D. 1988, *'Basic Econometrics'*, Second Edition, McGraw Hill, New York.

Gulland, J.A. 1978, *Fish population dynamics*, John Wiley & Sons, New York.

Gulland, J.A. 1983, *Fish stock assessment : a manual of basic methods,* John Wiley & Sons, New York.

Gulland, J.A. and S. Garcia. 1984, 'Observed patterns in multispecies fisheries', in *Exploitation of marine communities.* ed. May, R.M., Springer-Verlag, 155-190.

Hanley, N., Shogren, J.F. and B. White. 1996, *'Environmental economics in theory and practice',* MacMillan texts in Economics, Customer Service Department, Macmillan Distribution Ltd, England.

Hannesson, R. 1993, *Bioeconomic analysis of fisheries,* Fishing News Books, Oxford, 137 p.

Helmberger, P.G. and J-P Cavas. 1996, *'The Economic of Agricultural Prices'*, Prentice Hall, Upper Saddle River, New Jersey.

Hilborn, R. and C.J. Walters. 1992, *Quantitative fisheries stock assessment : choice, dynamics and uncertainty,* Chapman and Hall, London, 570 p.

Hill, H. 1989, *Unity and diversity: regional economic development in Indonesia since 1970,* Oxford University Press, New York.

Hongskul, V. 1975, Fishery dynamics of the Northeastern Pacific Groundfish Resource, *Unpublished PhD thesis,* University of Washington, Seattle.

Jackson, D.C. 1989, 'Research orientations for developing management strategies for the Musi River Fishery,' *Fisheries Research and Development Project (FRDP) Report.* Pusat Penelitian dan Pengembangan Perikanan, Jakarta.

Kaida, Y. 1980, 'Physiographic regions in the Komering-Ogan river basin, South Sumatra', in *South Sumatra : Man and Agriculture,* eds. Tsubouchi, Y. *et al.*, The Center for Southeast Asian Studies, Kyoto University, Kyoto, Part II (2).

Koeshendrajana, S. 1991, '*Bioeconomic Analysis of the Fisheries Management : A Case of the Jatiluhur Reservoir Fisheries',* Unpublished M.Sc. Thesis, Kasetsart University, Bangkok-Thailand.

Kusuma-Atmadja, K. and T.H. Purwaka. 1996, 'Legal and institutional aspects of coastal zone management in Indonesia', *Marine Policy* 20(1), 63-86.

Lal, P., Holland, P. and P. Power. 1992, 'Recreational fisheries management - who pays?' *ABARE.*

Laloe, F. 1995, 'Should surplus production models be fishery description tools rather than biological models ?', *Aquatic Living Resource* 8(1), 1-16.

Lawson, R. M. 1984, *Economics of fisheries development,* Frances Pinter Publisher, London, 283 p

Malvestuto, S.P. 1989, 'Project proposal considerations for the Musi River fishery in South Sumatra, Indonesia', *Fisheries Research and Development Project (FRDP) Report.* Pusat Penelitian dan Pengembangan Perikanan, Jakarta.

Matthiasson, T. 1996, 'Why fishing fleets tend to be "too big"', *Marine Resource Economics* 11, 173-79.

Meany, T.F. 1977, 'License limitation in a multipurpose fishery', *Australian Fisheries* 36(11), 8-11,19.

Nikijuluw, V. 1997, 'Review on community-based fisheries management studies in eastern Indonesia', *Fisheries Co-management Research Project Working Paper No. 21,* ICLARM, Makati City, Philippines.

Panayotou, T. 1982, 'Management Concepts for Small-Scale Fisheries : Economic and Social Aspects', *FAO Fisheries Technical Paper* No. 228.

Panayotou, T. 1983, 'Territorial use rights in fisheries', Paper presented at the expert consultation on the regulation of fishing effort (fishing mortality). *FAO Fishery Report* 289, 153-60.

Panayotou, T. 1985, *'Small-scale Fisheries in Asia: Socioeconomic Analysis and Policy,* IDRC 229e, Ottawa, Canada.

Pauly, D. 1979, 'Theory and management of tropical multispecies stock: a review, with emphasis on the Southeast Asian demersal fisheries, *ICLARM Studies Reviews No.1*, ICLARM, Manila, Philippines.

Pauly, D. 1984, 'Fish population dynamics in tropical waters : a manual for use programmable calculator', *ICLARM Studies Review* 8, 325 p.

Pearse, P.H. and J.E.Wilen. 1979, 'Impact of Canada's Pacific salmon fleet control program', *Journal of Fisheries Research Board of Canada* 36, 764-89.

Pella, J.J. and P.K. Thomlinson. 1969 'A generalized stock production model', *Bulletin of the Inter American Tropical Tuna Commission* 14, 421-96.

Polacheck, T., R. Hilborn and A.E. Punt. 1983, 'Fitting surplus production models: comparing methods and measuring uncertainty,' *Canadian Journal of Fisheries and Aquatic Science* 50, 2597-607.

Pollnac, R.B. and Malvestuto, S.P. 1992, 'Biological and socioeconomic conditions for development and management of riverine fisheries resource on Kapuas and Musi rivers', in *Contribution to fisheries development policy in Indonesia,* eds Pollnac, R.B. et al., Center Research Institutes for Fisheries, Agency for Agricultural Research and Development, Ch. 2, 24-37.

Pomeroy, R.S. 1994, 'Community management and common property of coastal fisheries in Asia and the Pacific: concepts, methods and experiences', *ICLARM Conference Proceedings* 45, 149 p.

Pomeroy, R.S., S. Sverdrup-Jensen and J.R. Nielsen. 1994, 'Fisheries co-management: A worldwide, collaborative research project', *In* Liao, D.S. (ed.), Proceedings of the 7th biennial conference of the International Institute of Fisheries Economics and Trade, volume 1, National Taiwan Ocean University-International Institute of Fisheries Economics and Trade.

Pope, J.G. 1979, 'Stock assessment in multispecies fisheries, with special reference to the trawl fishery in the Gulf of Thailand', *SCS/DEV/79/19*, South China Sea Fisheries Development and Coordinating Programme, Manila, Philippines.

Punt, A.E. 1988, 'Model selection for the dynamics of southern African Hake resources', *Unpublished Master of Science Thesis,* Cape Town, University of Cape Town.

Ralston, S. and J.S. Polovina. 1982, 'A multispecies analysis of the commercial deep-sea handline fishery in Hawai' *Fish. Bull.*, 80(3), 435-48.

Regier, H.A. and A.P. Grima. 1985, 'Fishery resource allocation : an exploratory essay', *Can. J. Fish. Aquat. Sci.*42, 845-59.

Regional Bodies of South Sumatra *(Badan Perencanaan dan Pembangunan Daerah, Bappeda).* 1992, *Economic Indicators of South Sumatra (Indicator ekonomi Sumatra Selatan),* Regional Bodies of South Sumatra (Bappeda).

Research station of RIFF Mariana, South Sumatra *(Sub Balai Penelitian Perikanan Air Tawar, Mariana, Sumatra Selatan).* various year, *Technical Reports (Laporan teknis),* South Sumatra Research Station of RIFF Mariana.

Rettig, R.B. 1989, 'Is fishery management at a turning point ? Reflections on the evolution of rights based fishing', in *Rights Based Fishing*, eds. P.A. Neher et al., Kluwer Academic Press, The Netherland, 47-64.

Ricker, W.E. 1975, 'Computation and Interpretation of biological statistics of fish population', *Bulletin of the Fisheries Research Board of Canada* 191.

Ricker, W.E. 1954, 'Stock and Recruitment', *Journal of the Fisheries Research Board of Canada* 11, 559-623.

Rothschild, B.J. 1978, 'Fishing effort , Chapter 5, 96-115 in *Fish population dynamics,* ed. Gulland, J.A., John Wiley & Sons, New York.

Runge, C.F. 1981, 'Common property externalities: Isolation, assurance, and resource depletion in a traditional grazing context', *Am. J. of Agric. Econ.* 63(4), 595-606.

Russell, E.S. 1931, 'Some theoretical considerations on the 'overfishing' problem', in *Key papers on fish populations*, ed. Cushing, D.H., IRL Press, Oxford-Washington DC, 5-22.

Schaefer, M.B. 1957a, 'A study of the dynamics of populations important to the management of commercial marine fisheries', *Bulletin of the Inter American Tropical Tuna Commission* 2, 247-85

Schaefer, M.B. 1957b, 'Some consideration of population dynamics and economic in relation to the management of marine fisheries', *Journal of the Fisheries Research Board of Canada* 14, 669-81.

Schaefer, M.B. 1954, 'Some aspect of the dynamics of population important to the management of the commercial marine fisheries', *Bulletin of the Inter American Tropical Tuna Commission* 1 (2), 27-56.

Scott, A. 1979, 'Development of economic theory on fishery regulation', *Journal of the Fisheries Research Board of Canada* 36, 725-41.

Sinclair, P.R. 1983, 'Fishermen Divided : the Impact of Limited Entry Licensing in Northwest Newfounland', Human Organisation 42, 307-13.

Smith, R. 1979, 'A research framework for traditional fisheries', *ICLARM Studies and Reviews No. 2,* Manila, Philippines.

Sparre, P. and S.C. Venema. 1992, 'Introduction to tropical fish stock assessment', Part 1, Manual, *FAO Fisheries Technical Paper* No. 306.1, Rev. 1. Rome, FAO, 376 p.

Statistical Office of South Sumatra Privince. 1980a, *'South Sumatra in Figures'*, Statistical Office of South Sumatra Privince

Statistical Office of South Sumatra Privince. 1980b, *'Gross domestic Product of South Sumatra Figures'*, Statistical Office of South Sumatra Privince

Statistical Office of South Sumatra Privince. 1985a, *'South Sumatra in Figures'*, Statistical Office of South Sumatra Privince

Statistical Office of South Sumatra Privince. 1985b, *'Gross domestic Product of South Sumatra Figures'*, Statistical Office of South Sumatra Privince

Statistical Office of South Sumatra Privince. 1995a, *'South Sumatra in Figures'*, Statistical Office of South Sumatra Privince

Statistical Office of South Sumatra Privince. 1995b, *'Gross domestic Product of South Sumatra Figures'*, Statistical Office of South Sumatra Privince

Stevensen, G.G. 1991, *'Common property economics: A general theory and land use applications'*, Cambridge University Press, Cambridge.

Susilowati, I. 1996. 'A review of natural resource laws and policies in Indonesia and its prospect for fisheries co-management', *Fisheries Co-management Research Project Working Paper No. 20,* ICLARM, Makati City, Philippines.

Tai, Shzee-Yew. 1992, 'Management of Small Pelagic Fisheries on the Northwest Coast of Peninsular Malaysia : A Bio-Socioeconomic Simulation Analysis', *Unpublished PhD Dissertation,* Canada, Simon Fraser University.

Thomas, R.M. and Soedijarto. 1980 'Political style and education law in Indonesia', *Asian Studies Monograph Series*, Asian Research Service, Hongkong.

Tisdel, C. 1987, 'Transaction costs/property rights and market failure in relation to science and technology policy', *Research report of occasional paper No. 134,* University of Newcastle, Shortland, NSW 2308.

various years, *'Annual report of South Sumatra Fishery Services'*, Fishery

Tomek, W.G. and K.L. Robinson. 1990, *Agricultural Product Price (third edition),* Cornell University Press, Ittaca.

Viswanathan, K.K., N.M.R. Abdulah, I. Susilowati, I.M. Siason and C. Ticao. 1997, 'Enforcement and compliance with fisheries regulations in Malaysia, Indonesia and the Philippines', Research Reports No. 5, *Fisheries Co-management Project*, ICLARM, Makati City, Philippines.

Wallace, I.F., Lindner, R.K. and D.D. Dole. 1996, 'Why does harvest efficiency appear to fall over time in the production functions of fisheries', *in* McAleer *et al.* (ed.) Proceedings of the Econometric Society Australasian Meeting 1996. V.3, Perth, University of Western Australia, 571-97.

Walters, C.J. 1969, 'A generalized computer simulation model for fish population studies', *Trans. Am. Fish. Soc.* 98, 505-12.

Walters, C.J. 1973, ' Delay-defferential equation models for fisheries', *Journal of Fish. Res. Board Canada* 30, 939-45.

Walters, C.J. 1986, *Adaptive Management of Renewable Resources*, MacMillan, New York, 374pp.

Warren, C. and K. Elston. 1994, 'Environmental regulation in Indonesia', *Asia paper 3,* University of Western Australia Press in association with Asia Research Centre on Social, Political and Economic Change, Murdoch University, Western Australia.

Waugh, G. 1984, *Fisheries Management: Theoretical development and contemporary applications,* Westview Press. Boulder.

Welcomme, R.L. 1985, 'River fisheries', *FAO Fisheries Technical Paper*, 262, 330 p.

White, K.J. 1993, *'Shazam User's Reference Manual Version 7.0',* McGraw Hill, New York.

Williams, M. 1996, 'The transition in the contribution of living aquatic resources to food security', Food, Agriculture and Environment, *Discussion Paper 13,* International Food Policy Research Institute, Washington D.C., USA.

Ye, Y. and J.R. Beddington. 1996, 'Bioeconomic interactions between the capture fisheries and aquaculture', *Marine Resource Economics* 11, 105-23.

Yoshimoto, S.S., and R.P. Clarke. 1993, 'Comparing dynamic versions of the Schaefer and Fox production models and their application to lobster fisheries', *Can. J. Fish. Aquat Sci.* 50, 181-189

Zerner, C. 1990, 'Community management of marine resources in the Maluku islands', Unpublished report prepared for *Fisheries Research and Development Project* (FRDP), Puslitbang Perikanan, Indonesia.

Zerner, C. 1991, 'Key issues in Indonesian fisheries law and institutional development: implementation, environmental management, and the rights of small-scale fishers', Unpublished report prepared for *Fisheries Research and Development Project* (FRDP), Puslitbang Perikanan, Indonesia.

Appendixes

Appendix 2.1 Inland fishery statistical data according to type of fishing gear, unit, trip and production from different types of resource in South Sumatra, Indonesia, in 1979

Type of fishing gear	Swamp			River			Lake			T o t a l		
	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production
Gillnets :												
Drift gillnet				2,080	334.758	2,938.20				2,080	334,758	2,938.20
Fixed gillnet	2,426	307,714	1,716.90	700	164.393	1.151.00	186	48,210	317.20	3,312	520,317	3,185.10
Cast nets *(Anco)*	290	50,538	273.00	669	88.323	315.70	117	11.362	45.50	1,076	150,223	634.20
Lift nets *(Serok)*	200	16,260	42.50	733	157,737	432.00				933	173.997	474.50
Hooks and lines:												
Rawai	638	31,690	82.10	650	118.549	244.70				1,575	150.239	326.80
Pancing	1,900	236,129	938.10	3,850	333,934	1,673.00	287	37.192	129.00	5,750	607,255	2,740.10
Portable traps :												
Sero	1,120	108,102	1,445.00	1,172	207,875	4,747.00	42	2,118	72.20	2,334	318,095	6,264.20
Filtering barriers *(Jermal)*				403	75,383	1,509.60				403	75,383	1,509.60
Bubu	2,828	378,791	1,356.80	2,615	437,900	2,004.60	197	22,928	112.60	5,640	839,619	3,474.00
Other gear	3,884	401,129	1,916.50	4,357	628,618	4,211.10	435	83,075	439.40	8,676	1.112.822	6,567.00
T o t a l	13,286	1,530.353	7,770.90	17.229	2,547,470	19,226.90	1,264	204,885	1,115.90	31,779	4,282.708	28.113.70

Source: Fishery Service of South Sumatra (various years).

Appendix 2.1 continued: year 1980

Type of fishing gear	Swamp			River			Lake			Total		
	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production
Gillnets :												
Drift gillnet				2,260	381,198	3,840.20				2,260	381,198	3,840.20
Fixed gillnet	2,182	340,919	2,187.30	769	111,160	929.00	304	62,142	303.20	3,255	514,221	3,419.50
Cast nets *(Anco)*	338	62,347	319.60	667	90,249	276.80	115	12,239	53.20	1,120	164,835	649.60
Lift nets *(Serok)*	243	18,239	37.80	686	59,320	436.00				929	77,559	473.80
Hooks and lines:												
Rawai	339	39,183	151.60	720	122,570	265.60				1,059	161,753	417.20
Pancing	2,964	436,394	2,137.00	2,606	419,851	1,931.80	282	36,269	125.10	5,852	892,514	4,193.90
Portable traps :												
Sero	1,233	121,808	1,672.10	1,145	156,409	4,175.90	43	1,707	64.30	2,421	279,924	5,912.30
Filtering barriers *(Jermal)*				403	74,111	1,998.30				403	74,111	1,998.30
Bubu	3,098	454,841	2,063.70	3,187	469,394	2,240.60	205	24,744	135.10	6,490	948,979	4,439.40
Other gear	3,255	388,100	2,133.60	5,254	786,821	4,151.00	499	99,000	409.90	9,008	1,273,921	6,694.50
Total	13,652	1,861,831	10,702.70	17,697	2,671,083	20,245.20	1,448	236,101	1,090.80	32,797	4,769,015	32,038.70

Appendix 2.1 continued: year 1981

Type of fishing gear	Swamp			River			Lake			T o t a l		
	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production
Gillnets :												
Drift gillnet				2,303	303,307	3,972.20				2,303	303,307	3,972.20
Fixed gillnet	2,021	400,755	2,016.10	1,308	154,411	1,286.40	278	58,649	275.80	3,607	613,815	3,578.30
Cast nets *(Anco)*	309	47,997	225.70	705	81,442	372.40	127	18,596	41.50	1,141	148,035	639.60
Lift nets *(Serok)*	519	31,660	123.20	554	74,827	427.70				1,073	106,487	550.90
Hooks and lines:												
Rawai	326	36,729	157.8	791	87,794	202.4				1,117	124,523	360.20
Pancing	2,718	384,492	1,883.20	2,888	454,254	2,422.00	139	22,907	95.10	5,745	861.653	4,400.30
Portable traps :												
Sero	928	84.285	1.465.80	1.334	200.281	5.581.00	68	5,204	193.10	2,330	289.770	7,239.90
Filtering barriers *(Jermal)*				275	97,913	2,655.40				275	97,913	2,655.40
Bubu	3,718	628,849	2,650.30	3,584	626,529	3,243.30	214	34,692	266.20	7,516	1,290,070	6,159.80
Other gear	4,313	509,874	2,637.20	5,301	718,429	4,771.70	421	65,591	349.80	10,035	1,293,894	7,758.70
T o t a l	14,852	2,124,641	11,159.30	19,043	2,799,187	24,934.50	1,247	205,639	1,221.50	35,142	5,129,467	37,315.30

Appendix 2.1 continued: year 1982

Type of fishing gear	Swamp			River			Lake			Total		
	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production
Gillnets :												
Drift gillnet				2,069	346,037	3,570.50				2,069	346,037	3,570.50
Fixed gillnet	2,721	406,001	2,988.50	835	133,608	1,024.10	282	54,914	265.20	3,838	594,523	4,277.80
Cast nets *(Anco)*	297	52,260	246.30	747	89,809	370.10	128	10,915	39.10	1,172	152,984	655.50
Lift nets *(Serok)*	639	37,833	177.00	388	59,292	341.00				1,027	97,125	518.00
Hooks and lines:												
Rawai	286	27,395	110.4	668	82,524	238				954	109,919	348.40
Pancing	2,529	384,672	1,545.00	2,248	400,289	2,042.40	283	28,241	109.2	5,060	813,202	3,696.60
Portable traps :												
Sero	941	100,971	1,739.80	1,380	182,217	4,908.40	65	4,467	224.70	2,386	287,655	6,872.90
Filtering barriers *(Jermal)*				378	102,649	2,746.00				378	102,649	2,746.00
Bubu	4,393	607,363	2,998.30	3,273	564,516	3,029.70	259	26,664	288.40	7,925	1,198,543	6,316.40
Other gear	4,187	366,574	2,094.10	4,631	704,008	4,530.70	407	54,197	359.70	9,225	1,124,779	6,984.50
Total	15,993	1,983,069	11,899.40	16,617	2,664,949	22,800.90	1,424	179,398	1,286.30	34,034	4,827,416	35,986.60

Appendix 2.1 continued: year 1983

Type of fishing gear	Swamp			River			Lake			Total		
	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production
Gillnets :												
Drift gillnet				2,172	377,723	3,636.50				2,172	377,723	3,636.50
Fixed gillnet	2,801	457,991	2,813.90	887	118,647	1,017.10	277	48,207	280.00	3,965	624,845	4,111.00
Cast nets *(Anco)*	295	47,803	241.00	830	61,251	343.80	129	13,211	48.70	1,254	122,265	633.50
Lift nets *(Serok)*	708	36,285	148.70	473	52,760	396.40				1,181	89,045	545.10
Hooks and lines:												
Rawai	285	26,103	110.9	1,113	65,834	211.5				1,398	91,937	322.40
Pancing	2,444	410,213	2,076.40	2,453	359,261	2,016.20	292	26,591	110.4	5,189	796,065	4,203.00
Portable traps :												
Sero	895	41,684	1,726.90	1,323	231,632	4,760.30	65	5,953	227.30	2,283	279,269	6,714.50
Filtering barriers *(Jermal)*				392	95,365	2,642.90				392	95,365	2,642.90
Bubu	4,300	504,672	2,944.30	3,556	527,064	3,069.10	260	28,709	321.20	8,116	1,060,445	6,334.60
Other gear	4,140	299,512	2,190.30	4,969	647,779	4,659.30	415	53,364	341.90	9,524	1,000,655	7,191.50
Total	15,868	1,824,263	12,252.40	18,168	2,537,316	22,753.10	1,438	176,035	1,329.50	35,474	4,537,614	36,335.00

Appendix 2.1 continued: year 1984

Type of fishing gear	Swamp			River			Lake			Total		
	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production
Gillnets :												
Drift gillnet				2,246	377,138	3,787.10				2,246	377,138	3,787.10
Fixed gillnet	2,414	455,605	3,290.00	1,045	124,182	1,091.00	285	40,291	283.70	3,744	620,078	4,664.70
Cast nets *(Anco)*	287	55,296	301.00	648	66,727	325.40	123	13,509	52.80	1,058	135,532	679.20
Lift nets *(Serok)*	377	21,487	65.50	528	57,974	406.10				905	79,461	471.60
Hooks and lines:												
Rawai	171	17,922	94	1,033	65,760	203				1,204	83,682	297.00
Pancing	2,583	458,844	2,331.20	2,369	366,922	2,010.40	291	28,852	128.3	5,243	854,618	4,469.90
Portable traps :												
Sero	920	77,252	1,327.70	1,281	216,061	4,460.30	54	2,664	174.7	2,255	295,977	5,962.70
Filtering barriers *(Jermal)*				392	98,803	2,441.70				392	98,803	2,441.70
Bubu	3,188	585,060	2,861.30	3,399	531,912	3,326.10	253	35,379	324.00	6,840	1,152,351	6,511.40
Other gear	3,327	332,313	1,953.90	5,231	622,706	4,640.40	409	42,685	327.20	8,967	997,704	6,921.50
Total	13,267	2,003,779	12,224.60	18,172	2,528,185	22,691.50	1,415	163,380	1,290.70	32,854	4,695,344	36,206.80

Appendix 2.1 continued: year 1985

Type of fishing gear	Swamp			River			Lake			Total		
	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production
Gillnets :												
Drift gillnet				2,185	343,545	3,429.90				2,185	343,545	3,429.90
Fixed gillnet	2,654	616,845	3,733.60	1,439	232,178	1,687.60	283	46,069	272.20	4,376	895,092	5,693.40
Cast nets *(Anco)*	285	45,686	236.40	696	74,622	384.40	123	10,987	42.40	1,104	131,295	663.20
Lift nets *(Serok)*	376	29,740	87.20	670	72,743	490.80				1,046	102,483	578.00
Hooks and lines:												
Rawai	242	30,300	125.2	1,059	69,623	229.5				1,301	99,923	354.7
Pancing	2,471	415,863	2,264.60	2,508	388,034	2,103.80	290	28,437	119.8	5,269	832.334	4,488.20
Portable traps :												
Sero	944	112.210	2,119.30	1,475	227,166	4,673.80	46	9,217	107.5	2,465	348,593	6,900.60
Filtering barriers *(Jermal)*				449	91,193	2,193.20				449	91,193	2,193.20
Bubu	3,143	484,273	2,920.00	3,179	463,178	2,933.00	246	35,398	280.90	6,568	982,849	6,133.90
Other gear	3,802	402,669	2,406.50	5,497	681,627	5,218.60	416	48,583	358.90	9,715	1,132,879	7,984.00
Total	13,917	2,137,586	13,892.80	19,157	2,643,909	23,344.60	1,404	178,691	1,181.70	34,478	4,960,186	38,419.10

Appendix 2.1 continued: year 1986

Type of fishing gear	Swamp			River			Lake			Total		
	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production
Gillnets :												
Drift gillnet				2,238	293,843	3,150.60				2,238	293,843	3,150.60
Fixed gillnet	3,507	615,494	3,996.20	1,318	229,297	1,689.60	382	47,846	329.00	5,207	892,637	6,014.80
Cast nets *(Anco)*	205	24,309	125.90	695	86,194	382.50	119	13,171	38.30	1,019	123,674	546.70
Lift nets *(Serok)*	516	41,526	95.90	638	78,694	448.60				1,154	120,220	544.50
Hooks and lines:												
Rawai	461	22,511	107.1	673	80,753	230.6				1,134	103,264	337.70
Pancing	2,137	353,579	2,134.50	2,563	416,942	1,977.10	324	30,492	126.9	5,024	801,013	4,238.50
Portable traps :												
Sero	886	107,364	2,633.00	1,580	235,503	5,853.90	137	8,000	214.2	2,603	350,867	8,701.10
Filtering barriers *(Jermal)*				475	111,813	2,798.50				475	111,813	2,798.50
Bubu	3,496	474,885	2,921.00	2,965	379,814	2,401.00	249	31,270	354.4	6,710	885,969	5,676.40
Other gear	3,113	403,835	2,525.90	5,187	742,890	4,989.80	414	51,167	381.30	8,714	1,197,892	7,897.00
Total	14,321	2,043,503	14,539.50	18,332	2,655,743	23,922.20	1,625	181,946	1,444.10	34,278	4,881,192	39,905.80

Appendix 2.1 continued: year 1987

Type of fishing gear	Swamp			River			Lake			Total		
	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production
Gillnets :												
Drift gillnet				1,500	302,236	3,408.60				1,500	302,236	3,408.60
Fixed gillnet	3,499	609,997	4,043.90	2,048	204,317	1,514.10	264	39,065	302.40	5,811	853,379	5,860.40
Cast nets *(Anco)*	206	22,704	127.40	703	80,072	388.60	126	11,348	39.00	1,035	114,124	555.00
Lift nets *(Serok)*	518	40,728	304.10	703	90,236	411.60				1,221	130,964	715.70
Hooks and lines:												
Rawai	462	21,795	108	673	62,020	235.2				1,135	83,815	343.2
Pancing	2,083	341,259	2,115.50	2,627	367,194	2,058.70	296	25,763	123.8	5,006	734,216	4,298.00
Portable traps :												
Sero	780	101,851	2,630.10	1,461	236,235	5,352.60	96	5,890	216.4	2,337	343,976	8,199.10
Filtering barriers *(Jermal)*				1,493	373,841	4,251.00				1,493	373,841	4,251.00
Bubu	3,436	486,133	2,932.70	2,959	370,874	2,379.20	180	41,031	364	6,575	898,038	5,675.90
Other gear	3,105	418,897	2,755.30	5,163	649,804	4,180.80	395	46,117	367	8,663	1,114,818	7,303.10
Total	14,089	2,043,364	15,017.00	19,330	2,736,829	24,180.40	1,357	169,214	1,412.60	34,776	4,949,407	40,610.00

Appendix 2.1 continued: year 1988

Type of fishing gear	Swamp			River			Lake			Total		
	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production
Gillnets :												
Drift gillnet				1,919	295,661	3,363.60				1,919	295,661	3,363.60
Fixed gillnet	2,386	463,754	2,651.50	1,214	217,926	1,472.40	246	46,419	305.20	3,846	728,099	4,429.10
Cast nets *(Anco)*	191	20,810	122.20	593	83,721	715.40	106	11,674	43.40	890	116,205	881.00
Lift nets *(Serok)*	667	68,768	410.80	791	74,550	355.40				1,458	143,318	766.20
Hooks and lines:												
Rawai	174	16,236	95.6	618	46,557	202				792	62,793	297.6
Pancing	1,929	369,248	2,052.10	2,926	376,467	2,149.00	245	23.813	114.1	5,100	769,528	4,315.20
Portable traps :												
Sero	1.459	139,047	3,287.00	1,107	241,794	4,546.40	54	10,518	235.7	2.620	391,359	8,069.10
Filtering barriers *(Jermal)*				1,490	390,831	4,164.50				1,490	390,831	4,164.50
Bubu	3,313	522,634	2,682.30	2,492	405,534	2,789.10	150	39,845	265.7	5,955	968,013	5,737.10
Other gear	3,147	454,106	3,023.00	6,361	699,104	4,732.10	367	53,462	317.6	9,875	1,206,672	8,072.70
Total	13,266	2,054,603	14,324.50	19,511	2,832,145	24,489.90	1,168	185,731	1,281.70	33,945	5,072,479	40,096.10

Appendix 2.1 continued: year 1989

Type of	Swamp			River			Lake			T o t a l		
fishing gear	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production
Gillnets :												
Drift gillnet				1,763	321,347	2,826.40				1.763	321,347	2,826.40
Fixed gillnet	2,230	479,758	3,011.20	2,193	178,393	1,274.10	366	61,319	402.80	4.789	719,470	4,688.10
Cast nets *(Anco)*	173	20,559	105.50	804	49.880	233.80	133	17,315	51.70	1,110	87,754	391.00
Lift nets *(Serok)*	749	52,295	247.00	182	89,463	394.60				931	141,758	641.60
Hooks and lines:												
Rawai	145	16,718	80.4	394	60,214	227.2				539	76,932	307.6
Pancing	1,952	393,471	2,328.70	2,906	443,123	2,714.40	309	35.696	145.8	5,167	872,290	5,188.90
Portable traps :												
Sero	951	129,668	2,129.90	1,070	209,380	5.011.70	70	3,584	93.4	2,091	342,632	7,235.00
Filtering barriers *(Jermal)*				1,490	266,380	3,152.60				1,490	266,380	3,152.60
Bubu	3,512	464,883	2,581.30	3,356	409,710	2,703.80	273	34,631	264.5	7,141	909,224	5,549.60
Other gear	3,188	460,249	2,900.20	5,362	765,870	5,357.60	528	55,872	422.5	9,078	1,281,991	8,680.30
T o t a l	12,900	2,017,601	13,384.20	19,520	2,793,760	23,896.20	1,679	208,417	1,380.70	34,099	5,019,778	38,661.10

Appendix 2.1 continued: year 1990

Type of fishing gear	Swamp			River			Lake			Total		
	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production
Gillnets :												
Drift gillnet				1,710	273,752	2,663.30				1,710	273,752	2,663.30
Fixed gillnet	2,217	581,598	3,154.20	2,417	223,663	1,392.90	366	54,681	344.60	5,000	859,942	4,891.70
Cast nets *(Anco)*	173	18,541	87.70	818	54,360	235.50	129	12,536	58.40	1,120	85,437	381.60
Lift nets *(Serok)*	749	92,263	745.40	216	88,893	381.90				965	181,156	1,127.30
Hooks and lines:												
Rawai	199	21,791	116.6	514	51,157	220.4				713	72,948	337.00
Pancing	1,527	439,664	2,224.20	3,112	589,930	3,514.40	307	38,886	187.4	4,946	1,068,480	5,926.00
Portable traps :												
Sero	1,478	146,769	2,286.10	1,155	193,840	4,384.90	70	9,221	249.5	2,703	349,830	6,920.50
Filtering barriers *(Jermal)*				1,400	82,225	1,748.00				1,400	82,225	1,748.00
Bubu	2,160	486,946	2,509.80	2,289	502,717	2,636.80	295	43,905	283	4,744	1,033,568	5,429.60
Other gear	3,991	377,177	2,458.90	6,578	768,624	5,654.70	529	55,376	421.6	11,098	1,201,177	8,535.20
Total	12,494	2,164,749	13,582.90	20,209	2,829,161	22,832.80	1,696	214,605	1,544.50	34,399	5,208,515	37,960.20

Appendix 2.1 continued: year 1991

Type of fishing gear	Swamp			River			Lake			Total		
	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production
Gillnets :												
Drift gillnet				1,709	314,463	2,218.70				1,709	314,463	2,218.70
Fixed gillnet	2,278	204,892	1,653.90	1,356	152,605	1,063.90	311	31,958	225.20	3,945	389,455	2,943.00
Cast nets *(Anco)*	183	19,237	73.00	716	57,794	190.40	126	9,237	28.80	1,025	86,268	292.20
Lift nets *(Serok)*	657	34,698	92.70	219	70,809	205.70				876	105,507	298.40
Hooks and lines:												
Rawai	205	20,337	110.1	529	35,252	118.8				734	55,589	228.90
Pancing	1,776	432,412	1,987.60	3,561	513,463	2,832.20	300	36,186	214.3	5,637	982,061	5,034.10
Portable traps :												
Sero	1,530	173,953	3,574.80	1,234	364,258	6,596.20	74	26,051	282.4	2,838	564,262	10,453.40
Filtering barriers *(Jermal)*				1,053	80,106	838.80				1,053	80,106	838.80
Bubu	2,166	413,807	2,107.80	2,416	432,751	2,251.00	209	34,248	236	4,791	880,806	4,594.80
Other gear	4,048	617,095	5,476.10	7,321	1,000,021	6,871.00	658	61,356	425.9	12,027	1,678,472	12,773.00
Total	12,843	1,916,431	15,076.00	20,114	3,021,522	23,186.70	1,678	199,036	1,412.60	34,635	5,136,989	39,675.30

Appendix 2.1 continued: year 1992

Type of fishing gear	Swamp			River			Lake			Total		
	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production
Gillnets :												
Drift gillnet				1,718	272,906	1,909.00				1,718	272,906	1,909.00
Fixed gillnet	2,294	442,426	3,077.90	1,306	146,504	1,041.60	283	28,648	208.00	3,883	617,578	4,327.50
Cast nets *(Anco)*	172	17,904	65.90	705	62,301	229.50	125	11,829	36.30	1,002	92,034	331.70
Lift nets *(Serok)*	657	29,033	92.60	220	59,947	248.10				877	88,980	340.70
Hooks and lines:												
Rawai	150	91,984	535.8	560	91,684	361.9				710	183,668	897.70
Pancing	1,841	489,976	2,630.30	3,587	517,956	2,667.80	372	29,978	216.6	5,800	1,037,910	5,514.70
Portable traps :												
Sero	1,597	144,336	3,247.90	1,645	280,350	5,580.90	74	9,510	238.3	3,316	434,196	9,067.10
Filtering barriers *(Jermal)*												
Bubu	2,240	286,490	1,887.10	2,721	388,608	2,387.10	209	29,338	212.3	5,170	704,436	4,486.50
Other gear	4,217	588,353	5,175.60	7,620	957,709	7,143.10	635	53,612	469.5	12,472	1,599,674	12,788.20
Total	13,168	2,090,502	16,713.10	20,082	2,777,965	21,569.00	1,698	162,915	1,381.00	34,948	5,031,382	39,663.10

Appendix 2.1 continued: year 1993

Type of fishing gear	Swamp			River			Lake			Total		
	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production
Gillnets :												
Drift gillnet				1,434	228,103	1,652.90				1,434	228,103	1,652.90
Fixed gillnet	2,315	224,763	1,793.70	1,331	166,062	1,384.00	330	38,691	368.30	3,976	429,516	3,546.00
Cast nets *(Anco)*	264	34,304	129.70	415	49,260	214.60	114	11,563	30.40	793	95,127	374.70
Lift nets *(Serok)*	165	17,288	61.00	502	83,124	318.60				667	100,412	379.60
Hooks and lines:												
Rawai	550	77,423	485.9	235	49,509	130.1				785	126,932	616.00
Pancing	2,377	381,263	2,393.50	3,472	624.477	2,862.80	474	75,072	403.7	6,323	1,080,812	5,660.00
Portable traps :												
Sero	1,375	351,926	4,681.30	2,298	337,327	5,713.90	134	40,521	795.8	3,807	729.774	11,191.00
Filtering barriers *(Jermal)*												
Bubu	2,468	210,611	1,328.00	2,350	294,008	2,074.70	272	40,528	322.1	5,090	545,147	3,724.80
Other gear	4,202	707,843	5,907.80	7,280	979,598	7,720.40	682	101,560	708.5	12,164	1,789,001	14,336.70
Total	13,716	2,005,421	16,780.90	19,317	2,811,468	22,072.00	2,006	307,935	2,628.80	35.039	5.124.824	41,482.00

Appendix 2.1 continued: year 1994

Type of fishing gear	Swamp			River			Lake			T o t a l		
	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production	Unit	Trip	Production
Gillnets :												
Drift gillnet				1,672	169,530	1,705.80				1,672	169,530	1,705.80
Fixed gillnet	2,301	260,466	1,854.90	1,310	185,542	1,328.80	389	53,688	377.70	4,000	499,696	3,561.40
Cast nets *(Anco)*	360	30,437	138.60	474	38,777	206.10	115	10,665	26.60	949	79,879	371.30
Lift nets *(Serok)*	162	34,506	72.00	316	169,422	372.60				478	203.928	444.60
Hooks and lines:												
Rawai	555	41,705	201.5	254	21,088	152				809	62,793	353.5
Pancing	2,129	394,452	2,376.80	3,701	451,765	2,851.20	544	76,558	269.5	6,374	922,375	5,497.50
Portable traps :												
Sero	1,382	235,261	5,628.00	2,305	284,732	6,255.40	132	31,326	443	3.819	551.319	12.326.40
Filtering barriers *(Jermal)*												
Bubu	2,340	279,343	1,580.50	2.559	338.915	2.099.40	323	44.679	292.4	5.222	662.937	3,972.30
Other gear	4.246	756,853	5.740.30	7.012	1.037.063	7.277.50	726	104.537	728.8	11,984	1.898,453	13,746.60
T o t a l	13,475	2,033,023	17,592.60	19,603	2,696,834	22,248.80	2,229	321,253	2,137.80	35,307	5,163,703	41,979.20

Source: Fishery Service of South Sumatra (various year).

Appendix 4.1 Questionnaire on cost and earning of fishing in the inland fishery of South Sumatra, Indonesia

QUESTIONNAIRE
COST AND EARNINGS SURVEY

Code No. :
District :
Subdistrict :
Village :

Name of interviewer :
Date of interviewer :

Name of respondent :
Age :
Number of families :
Status :
Fishing experience :

Why do you go fishing ?

....
....

Do you go fishing each season ?

	Yes	No
Dry season		
Receding (March - June)	☐	☐
Low water (July - September)	☐	☐
Wet season		
Raising (October - November)	☐	☐
High water (December - February)	☐	☐

Type of gear being use in the following seasons :

	DR	DL	WR	WH
1. Gillnets	☐	☐	☐	☐
2. Cash-nets	☐	☐	☐	☐
3. Lift nets	☐	☐	☐	☐
4. Hook and lines	☐	☐	☐	☐
5. Portable traps	☐	☐	☐	☐
6. Filtering barriers	☐	☐	☐	☐
7. Others specify	☐	☐	☐	☐

Name of fishing ground :

What is the most species of the harvested fish?

How much fish harvested and its price? (Daily/Weekly/Monthly/ Seasonally)

	Quantity	**Price**
Dry season		
Receding (**March - June**)	☐	☐
Low water (**July - September**)	☐	☐
Wet season		
Raising (**October - November**)	☐	☐
High water (**December - February**)	☐	☐

Type and Number of fishing boat :

Motor ☐

Non-motor ☐

The nature of ownership of the boat : Self-owned ☐

Share-rented ☐

Cash-rented ☐

Specification of the boat :

Length and Width :
Tonnage :
Date of purchase :
Price :
Expected life :

How much money do you spend for maintaining the fishing unit (include: repainting, hull repair, deck facilities, etc.)?

Boat [ ]
Fishing gear [ ]

How much non-durable items expenses do you pay? (Daily/Weekly/Monthly/Seasonally)

Kerosene lamp [ ]
Flashlight [ ]
Utensil [ ]
Others, specify .... [ ]

How many crew on-boat in the following seasons?

Dry season
Receding (**March - June**) [ ]
Low water (**July - September**) [ ]

Wet season
Raising (**October - November**) [ ]
High water (**December - February**) [ ]

How much money do you spend for food? (Daily/Weekly/Monthly/Seasonally)

....

How many days do you spend for fishing in each season?

Season	of days	of hours/day
1	....	....
2	....	....
3	....	....
4	....	....

Do you have any alternative source of income instead of fishing?

....
....

What do you feel to be the most crucial problems during your last year's experiences?

....
....

Appendix 4.2a Total unit, trip, production by fishing gear and year in the rivers fishery resource and their standardised CPUE and catch in South Sumatra, Indonesia

T o t a l	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Drift Gillnet																
Unit	2,080	2,260	2,303	2,069	2,172	2,246	2,185	2,238	1,500	1,919	1,763	1,710	1,709	1,718	1,434	1,672
Trip	334,758	381,198	303,307	346,037	377,723	377,138	343,545	293,843	302,236	295,661	321,347	273,752	314,463	272,906	228,103	169,530
Production	2,938.20	3,840.20	3,972.20	3,570.50	3,636.50	3,787.10	3,429.90	3,150.60	3,408.60	3,363.60	2,826.40	2,663.30	2,218.70	1,909.00	1,652.90	1,705.80
CPUE	0.008777	0.010074	0.013096	0.010318	0.009627	0.010042	0.009984	0.010722	0.011278	0.011377	0.008795	0.009729	0.007056	0.006995	0.007246	0.010062
Fixed Gillnet																
Unit	700	769	1,308	835	887	1,045	1,439	1,318	2,048	1,214	2,193	2,417	1,356	1,306	1,331	1,310
Trip	[illegible]	111,160	154,411	133,608	118,047	124,182	232,178	229,297	204,317	217,926	178,393	223,663	152,605	146,504	166,062	185,542
Production	1,151.00	929	1,286.40	1,024.10	1.017.10	1,091.00	1,687.60	1,689.60	1,514.10	1,472.40	1,274.10	1,392.90	1,063.90	1,041.60	1,384.00	1,328.80
CPUE	0.007002	0.008357	0.008331	0.007665	0.008572	0.008785	0.007269	0.007369	0.007411	0.006756	0.007142	0.006228	0.006972	0.00711	0.008334	0.007162
Anco																
Unit	669	667	705	747	830	648	696	695	703	593	804	818	716	705	415	474
Trip	88,323	90,249	81,442	89,809	61,251	66,727	74,622	86,194	80,072	83,721	49,880	54,360	57,794	62,301	49,260	38,777
Production	315.7	276.8	372.4	370.1	343.8	325.4	384.4	382.5	388.6	715.4	233.8	235.5	190.4	229.5	214.6	206.1
CPUE	0.003574	0.003067	0.004573	0.004121	0.005613	0.004877	0.005151	0.004438	0.004853	0.008545	0.004687	0.004332	0.003294	0.003684	0.004356	0.005315
Serok																
Unit	733	686	554	388	473	528	670	638	703	791	182	216	219	220	502	316
Trip	157,737	59,320	74,827	59,292	52,760	57,974	72,743	78,694	90,236	74,550	89,463	88,893	70,809	59,947	83,124	169,422
Production	432	436	427.7	341	396.4	406.1	490.8	448.6	411.6	355.4	394.6	381.9	205.7	248.1	318.6	372.6
CPUE	0.002739	0.00735	0.005716	0.005751	0.007513	0.007005	0.006747	0.005701	0.004561	0.004767	0.004411	0.004296	0.002905	0.004139	0.003833	0.002199

Appendix 4.2a continued.

T o t a l	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Rawai																
Unit	650	720	791	668	1,113	1,033	1,059	673	673	618	394	514	529	560	235	254
Trip	118,549	122,570	87,794	82,524	65,834	65,760	69,623	80,753	62,020	46,557	60,214	51,157	35,252	91,684	49,509	21,088
Production	244.7	265.6	202.4	238	211.5	203	229.5	230.6	235.2	202	227.2	220.4	118.8	361.9	130.1	152
CPUE	0.002064	0.002167	0.002305	0.002884	0.003213	0.003087	0.003296	0.002856	0.003792	0.004339	0.003773	0.004308	0.00337	0.003947	0.002628	0.007208
Pancing																
Unit	3,850	2,606	2,888	2,248	2,453	2,369	2,508	2,563	2,627	2,926	2,906	3,112	3,561	3,587	3,472	3,701
Trip	333,934	419,851	454,254	400,289	359,261	366,922	388,034	416,942	367,194	376,467	443,123	589,930	513,463	517,956	624,477	451,765
Production	1,673.00	1,931.80	2,422.00	2,042.40	2,016.20	2,010.40	2,103.80	1,977.10	2,058.70	2,149.00	2,714.40	3,514.40	2,832.20	2,667.80	2,862.80	2,851.20
CPUE	0.00501	0.004601	0.005332	0.005102	0.005612	0.005479	0.005422	0.004742	0.005607	0.005708	0.006126	0.005957	0.005516	0.005151	0.004584	0.006311
Sero Trap																
Unit	1,172	1,145	1,334	1,380	1,323	1,281	1,475	1,580	1,461	1,107	1,070	1,155	1,234	1,645	2,298	2,305
Trip	207,875	156,409	200,281	182,217	231,632	216,061	227,166	235,503	236,235	241,794	209,380	193,840	364,258	280,350	337,327	284,732
Production	4,747.00	4,175.90	5,581.00	4,908.40	4,760.30	4,460.30	4,673.80	5,853.90	5,352.60	4,546.40	5,011.70	4,384.90	6,596.20	5,580.90	5,713.90	6,255.40
CPUE	0.022836	0.026699	0.027866	0.026937	0.020551	0.020644	0.020574	0.024857	0.022658	0.018803	0.023936	0.022621	0.018109	0.019907	0.016939	0.021969
Jermal Trap																
Unit	403	403	275	378	392	392	449	475	1,493	1,490	1,490	1,400	1,053			
Trip	75,383	74,111	97,913	102,649	95,365	98,803	91,193	111,813	373,841	390,831	266,380	82,225	80,106			
Production	1,509.60	1,998.30	2,655.40	2,746.00	2,642.90	2,441.70	2,193.20	2,798.50	4,251.00	4,164.50	3,152.60	1,748.00	838.8			
CPUE	0.020026	0.026964	0.02712	0.026751	0.027714	0.024713	0.02405	0.025028	0.011371	0.010656	0.011835	0.021259	0.010471			
Bubu Trap																
Unit	2,615	3,187	3,584	3,273	3,556	3,399	3,179	2,965	2,959	2,492	3,356	2,289	2,416	2,721	2,350	2,559
Trip	437,900	469,394	626,529	564,516	527,064	531,912	463,178	379,814	370,874	405,534	409,710	502,717	432,751	388,608	294,008	338,915
Production	2,004.60	2,240.60	3,243.30	3,029.70	3,069.10	3,326.10	2,933.00	2,401.00	2,379.20	2,789.10	2,703.80	2,636.80	2,251.00	2,387.10	2,074.70	2,099.40
CPUE	0.004578	0.004773	0.005177	0.005367	0.005823	0.006253	0.006332	0.006322	0.006415	0.006878	0.006599	0.005245	0.005202	0.006143	0.007057	0.006194

Appendix 4.2a continued.

T o t a l	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Lainnya (Others)																
Unit	4,357	5,254	5,301	4,631	4,969	5,231	5,497	5,187	5,163	6,361	5,362	6,578	7,321	7,620	7,280	7,012
Trip	628,618	786,821	718,429	704,008	647,779	622,706	681,627	742,890	649,804	699,104	765,870	768,624	1,000,021	957,709	979,598	1,037,063
Production	4,211.10	4,151.00	4,771.70	4,530.70	4,659.30	4,640.40	5,218.60	4,989.80	4,180.80	4,732.10	5,357.60	5,654.70	6,871.00	7,143.10	7,720.40	7,277.50
CPUE	0.006699	0.005276	0.006642	0.006436	0.007193	0.007452	0.007656	0.006717	0.006434	0.006769	0.006995	0.007357	0.006871	0.007459	0.007881	0.007017
Total Catch	19226.9	20245.2	24934.5	22800.9	22753.1	22691.5	23344.6	23922.2	24180.4	24489.9	23896.2	22832.8	23186.7	21569	22072	22248.8
Total Standard Effort	7968722	9767450	12848280	10658653	9180946	8364851	7057137	5933176	4878222	4988222	5233669	8753780	5804116	4082591	2618949	4017995
Standard CPUE	0.002413	0.002073	0.001941	0.002139	0.002478	0.002713	0.003308	0.004032	0.004957	0.00491	0.004566	0.002608	0.003995	0.005283	0.008428	0.005537

Appendix 4.2b Total unit, trip, production by fishing gear and year in the Swamps fishery and their standardised CPUE and effort in South Sumatra, Indonesia

Fishing Gear	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Fixed Gillnet																
Unit	2,612	2,486	2,299	3,003	3,078	2,699	2,937	3,889	3,763	2,632	2,596	2,583	2,589	2,577	2,645	2,690
Trip	355,924	403,061	459,404	460,915	506,198	495,896	662,914	663,340	649,062	510,173	541,077	636,279	236,850	471,074	263,454	314,154
Production	2,034.10	2,490.50	2,291.90	3,253.70	3,093.90	3,573.70	4,005.80	4,325.20	4,346.30	2,956.70	3,414.00	3,498.80	1,879.60	3,285.90	2,162.00	2,232.60
CPUE	0.005715	0.006179	0.004989	0.007059	0.006112	0.007207	0.006043	0.00652	0.006696	0.005795	0.00631	0.005499	0.007936	0.006975	0.008206	0.007107
Anco																
Unit	107	152	126	125	124	110	408	324	332	297	306	302	309	297	378	475
Trip	61,900	74,586	66,593	63,175	61,014	68,805	56,673	37,480	34,052	32,484	37,874	31,077	28,474	29,733	45,867	41,102
Production	318.50	372.80	267.20	285.40	289.70	353.80	278.80	164.20	166.40	165.60	157.20	146.10	101.80	102.20	160.10	165.20
CPUE	0.005145	0.004998	0.004012	0.004518	0.004748	0.005142	0.004919	0.004381	0.004887	0.005098	0.004151	0.004701	0.003575	0.003437	0.003491	0.004019
Serok																
Unit	200	213	519	639	708	377	376	516	518	667	749	749	657	657	165	162
Trip	16,260	18,239	31,660	37,833	36,285	21,487	29,740	41,526	40,728	68,768	52,295	92,263	34,698	29,033	17,288	34,506
Production	42.50	37.80	123.20	177.00	148.70	65.50	87.20	95.90	304.10	410.80	247.00	745.40	92.70	92.60	61.00	72.00
CPUE	0.002614	0.002072	0.003891	0.004678	0.004098	0.003048	0.002932	0.002309	0.007467	0.005974	0.004723	0.008079	0.002672	0.003189	0.003528	0.002087
Rawai																
Unit	638	339	326	286	285	171	242	461	462	174	145	199	205	150	550	555
Trip	31,690	39,183	36,729	27,395	26,103	17,922	30,300	22,511	21,795	16,236	16,718	21,791	20,337	91,984	77,423	41,705
Production	82.10	151.60	157.80	110.40	110.90	94.00	125.20	107.10	108.00	95.60	80.40	116.60	110.10	535.80	485.90	201.50
CPUE	0.002591	0.003869	0.004296	0.00403	0.004249	0.005245	0.004132	0.004758	0.004955	0.005888	0.004809	0.005351	0.005414	0.005825	0.006276	0.004832

Appendix 4.2b continued.

Fishing Gear	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Pancing																
Unit	1,900	3,246	2,857	2,812	2,736	2,874	2,761	2,461	2,379	2,174	2,261	1,834	2,076	2,213	2,851	2,673
Trip	273,321	472,663	407,399	412,913	436,804	487,696	444,300	384,071	367,022	393,061	429,167	478,550	468,598	519,954	456,335	470,810
Production	1,067.10	2,262.10	1,978.30	1,654.20	2,186.80	2,459.50	2,384.40	2,261.40	2,239.30	2,166.20	2,474.50	2,411.60	2,201.90	2,846.90	2,797.20	2,646.10
CPUE	0.003904	0.004786	0.004856	0.004006	0.005006	0.005043	0.005367	0.005888	0.006101	0.005511	0.005766	0.005039	0.004699	0.005475	0.00613	0.00562
Sero Trap																
Unit	1,162	1,276	996	1,006	960	974	990	1,023	876	1,513	1,021	1,548	1,604	1,671	1,509	1,514
Trip	110,220	123,515	89,489	105,438	47,637	79,916	121,427	115,364	107,741	149,565	133,252	155,990	200,004	153,846	392,447	266,587
Production	1,517.20	1,736.40	1,658.90	1,964.50	1,954.20	1,502.40	2,226.80	2,847.20	2,846.50	3,522.70	2,223.30	2,535.60	3,857.20	3,486.20	5,477.10	6,071.00
CPUE	0.013765	0.014058	0.018537	0.018632	0.041023	0.0188	0.018339	0.02468	0.02642	0.023553	0.016685	0.016255	0.019286	0.02266	0.013956	0.022773
Bubu Trap																
Unit	3,025	3,303	3,932	4,652	4,560	3,441	3,389	3,745	3,616	3,463	3,785	2,455	2,375	2,449	2,740	2,663
Trip	401,719	479,585	663,541	634,027	533,381	620,439	519,671	506,155	527,164	562,479	499,514	530,851	448,055	315,828	251,139	324,022
Production	1,469.40	2,198.80	2,916.50	3,286.70	3,265.50	3,185.30	3,200.90	3,275.40	3,296.70	2,948.00	2,845.80	2,792.80	2,343.80	2,099.40	1,650.10	1,872.90
CPUE	0.003658	0.004585	0.004395	0.005184	0.006122	0.005134	0.006159	0.006471	0.006254	0.005241	0.005697	0.005261	0.005231	0.006647	0.00657	0.00578
Lainnya (Others)																
Unit	4,319	3,754	4,734	4,594	4,555	3,736	4,218	3,527	3,500	3,514	3,716	4,520	4,706	4,852	4,884	4,972
Trip	484,204	487,100	575,465	420,771	352,876	374,998	451,252	455,002	465,014	507,568	516,121	432,553	678,451	641,965	809,403	861,390
Production	2,355.90	2,543.50	2,987.00	2,453.80	2,532.20	2,281.10	2,765.40	2,907.20	3,122.30	3,340.60	3,322.70	2,880.50	5,902.00	5,645.10	6,616.30	6,469.10
CPUE	0.004866	0.005222	0.005191	0.005832	0.007176	0.006083	0.006128	0.006389	0.006714	0.006582	0.006438	0.006659	0.008699	0.008793	0.008174	0.00751
Total Catch	8886.8	11793.5	12380.8	13185.7	13581.9	13515.3	15074.5	15983.6	16429.6	15606.2	14764.9	15127.4	16489.1	18094.1	19409.7	19730.4
Total Standard Effort	4640975	4787623	7573612	6597145	6842005	6731566	4557570	4802313	5858133	6830128	4785324	5735803	4926004	2993435	2153145	3348192
Standard CPUE	0.001915	0.002463	0.001635	0.001999	0.001985	0.002008	0.003308	0.003328	0.002805	0.002285	0.003085	0.002637	0.003347	0.006045	0.009015	0.005893

Appendix 5.1 Regression results of the Schaefer and Fox models for freshwater fish in South Sumatra, Indonesia

```
Hello/Bonjour/Aloha/Howdy/G Day/Kia Ora/Konnichiwa/Buenos Dias/Nee Hau
Welcome to SHAZAM - Version 7.0 - FEB 1993 SYSTEM=MS-DOS PAR= 116
|_sample 1 32
|_read (13) site year catch effort cpue tm
  6 VARIABLES AND     32 OBSERVATIONS STARTING AT OBS     1

|_genr cpues=1000*cpue
|_genr dgab=0
|_if (site.eq.2)dgab=1
|_****
|_*** GENERATE DUMMY VARIABLES FOR SLOPE
|_****
|_genr degab=effort*dgab
|_****
|_*** SCHAEFER MODEL WITH DUMMY SLOPE
|_****
|_ols cpues effort degab / exactdw anova rstat

REQUIRED MEMORY IS PAR=   14 CURRENT PAR=  116
 OLS ESTIMATION
     32 OBSERVATIONS     DEPENDENT VARIABLE = CPUES
...NOTE..SAMPLE RANGE SET TO:    1,   32

DURBIN-WATSON STATISTIC  =   1.38621

DURBIN-WATSON PROBABILITY =    0.016242

 R-SQUARE =   0.7680     R-SQUARE ADJUSTED =   0.7520
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.85217
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.92313
SUM OF SQUARED ERRORS-SSE=   24.713
MEAN OF DEPENDENT VARIABLE =   3.5979
LOG OF THE LIKELIHOOD FUNCTION = -41.2714

MODEL SELECTION TESTS - SEE JUDGE ET.AL.(1985, P.242)
 AKAIKE (1969) FINAL PREDICTION ERROR- FPE =   0.93206
  (FPE ALSO KNOWN AS AMEMIYA PREDICTION CRITERION -PC)
 AKAIKE (1973) INFORMATION CRITERION- LOG AIC = -0.70913E-01
 SCHWARZ(1978) CRITERION-LOG SC =  0.66500E-01
MODEL SELECTION TESTS - SEE RAMANATHAN(1992,P.167)
 CRAVEN-WAHBA(1979) GENERALIZED CROSS VALIDATION(1979) -GCV=  0.94032
 HANNAN AND QUINN(1979) CRITERION -HQ=  0.97495
 RICE (1984) CRITERION-RICE=  0.95049
 SHIBATA (1981) CRITERION-SHIBATA =  0.91708
 SCHWARTZ (1978) CRITERION-SC=   1.0688
 AKAIKE (1974)INFORMATION CRITERION-AIC=  0.93154
```

ANALYSIS OF VARIANCE - FROM MEAN

	SS	DF	MS	F
REGRESSION	81.791	2.	40.896	47.990
ERROR	24.713	29.	0.85217	
TOTAL	106.50	31.	3.4356	

ANALYSIS OF VARIANCE - FROM ZERO

	SS	DF	MS	F
REGRESSION	496.04	3.	165.35	194.029
ERROR	24.713	29.	0.85217	
TOTAL	520.75	32.	16.273	

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 29 DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
EFFORT	-0.62926E-06	0.7052E-07	-8.923	0.000	-0.856	-0.8132	-1.0675
DEGAB	-0.33711E-06	0.5936E-07	-5.679	0.000	-0.726	-0.5175	-0.2435
CONSTANT	8.3149	0.5110	16.27	1.000	0.949	0.0000	2.3110

DURBIN-WATSON = 1.3862 VON NEUMANN RATIO = 1.4309 RHO = 0.28520
RESIDUAL SUM = -0.66613E-15 RESIDUAL VARIANCE = 0.85217
SUM OF ABSOLUTE ERRORS= 20.243
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.7680
RUNS TEST: 10 RUNS, 12 POSITIVE, 20 NEGATIVE, NORMAL STATISTIC = -2.3053

SCHAEFER MODEL WITH DUMMY SLOPE AND PROXY TECH-CHANGES

|_ols cpues effort degab tm / exactdw anova rstat

REQUIRED MEMORY IS PAR= 15 CURRENT PAR= 116
OLS ESTIMATION
32 OBSERVATIONS DEPENDENT VARIABLE = CPUES
...NOTE..SAMPLE RANGE SET TO: 1, 32

DURBIN-WATSON STATISTIC = 1.49945

DURBIN-WATSON PROBABILITY = 0.028350

R-SQUARE = 0.8185 R-SQUARE ADJUSTED = 0.7991
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.69038
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.83089
SUM OF SQUARED ERRORS-SSE= 19.331
MEAN OF DEPENDENT VARIABLE = 3.5979
LOG OF THE LIKELIHOOD FUNCTION = -37.34[illegible]3

MODEL SELECTION TESTS - SEE JUDGE ET.AL.(1985, P.242)
AKAIKE (1969) FINAL PREDICTION ERROR- FPE = 0.77668
(FPE ALSO KNOWN AS AMEMIYA PREDICTION CRITERION -PC)
AKAIKE (1973) INFORMATION CRITERION- LOG AIC = -0.25404
SCHWARZ(1978) CRITERION-LOG SC = -0.70828E-01
MODEL SELECTION TESTS - SEE RAMANATHAN(1992,P.167)
CRAVEN-WAHBA(1979) GENERALIZED CROSS VALIDATION(1979) -GCV= 0.78901
HANNAN AND QUINN(1979) CRITERION -HQ= 0.82422
RICE (1984) CRITERION-RICE= 0.80541
SHIBATA (1981) CRITERION-SHIBATA= 0.75510
SCHWARTZ (1978) CRITERION-SC= 0.93162
AKAIKE (1974)INFORMATION CRITERION-AIC= 0.77566

ANALYSIS OF VARIANCE - FROM MEAN

	SS	DF	MS	F
REGRESSION	87.173	3.	29.058	42.090
ERROR	19.331	28.	0.69038	
TOTAL	106.50	31.	3.4356	

ANALYSIS OF VARIANCE - FROM ZERO

	SS	DF	MS	F
REGRESSION	501.42	4.	125.35	181.573
ERROR	19.331	28.	0.69038	
TOTAL	520.75	32.	16.273	

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 28 DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
EFFORT	-0.45870E-06	0.8809E-07	-5.207	0.000	-0.701	-0.5928	-0.7782
DEGAB	-0.27758E-06	0.5753E-07	-4.825	0.000	-0.674	-0.4261	-0.2005
TM	0.12500	0.4477E-01	2.792	0.995	0.467	0.3158	0.2953
CONSTANT	6.0567	0.9304	6.510	1.000	0.776	0.0000	1.6834

DURBIN-WATSON = 1.4994 VON NEUMANN RATIO = 1.5478 RHO = 0.24876
RESIDUAL SUM = 0.38858E-15 RESIDUAL VARIANCE = 0.69038
SUM OF ABSOLUTE ERRORS= 17.675
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.8185
RUNS TEST: 12 RUNS, 14 POSITIVE, 18 NEGATIVE, NORMAL STATISTIC = -1.7352
|_stop

FOX MODEL WITH DUMMY SLOPE

```
|_ols lcpues effort degab / exactdw anova rstat

REQUIRED MEMORY IS PAR=   15 CURRENT PAR=  116
 OLS ESTIMATION
     32 OBSERVATIONS     DEPENDENT VARIABLE = LCPUES
...NOTE..SAMPLE RANGE SET TO:    1,    32

DURBIN-WATSON STATISTIC  =   1.08997

DURBIN-WATSON PROBABILITY =    0.000959

 R-SQUARE =   0.8612     R-SQUARE ADJUSTED =   0.8516
VARIANCE OF THE ESTIMATE-SIGMA**2 =   0.30546E-01
STANDARD ERROR OF THE ESTIMATE-SIGMA =   0.17477
SUM OF SQUARED ERRORS-SSE=   0.88583
MEAN OF DEPENDENT VARIABLE =    .1732
LOG OF THE LIKELIHOOD FUNCTION =  11.9854

MODEL SELECTION TESTS - SEE JUDGE ET.AL.(1985, P.242)
 AKAIKE (1969) FINAL PREDICTION ERROR- FPE =   0.33409E-01
  (FPE ALSO KNOWN AS AMEMIYA PREDICTION CRITERION -PC)
 AKAIKE (1973) INFORMATION CRITERION- LOG AIC =  -3.3995
 SCHWARZ(1978) CRITERION-LOG SC =   -3.2621
MODEL SELECTION TESTS - SEE RAMANATHAN(1992,P.167)
 CRAVEN-WAHBA(1979) GENERALIZED CROSS VALIDATION(1979) -GCV=  0.33706E-01
 HANNAN AND QUINN(1979) CRITERION -HQ=   0.34947E-01
 RICE (1984) CRITERION-RICE=   0.34070E-01
 SHIBATA (1981) CRITERION-SHIBATA =   0.32873E-01
 SCHWARTZ (1978) CRITERION-SC=   0.38310E-01
 AKAIKE (1974)INFORMATION CRITERION-AIC=   0.33391E-01
```

ANALYSIS OF VARIANCE - FROM MEAN

	SS	DF	MS	F
REGRESSION	5.4946	2.	2.7473	89.941
ERROR	0.88583	29.	0.30546E-01	
TOTAL	6.3804	31.	0.20582	

ANALYSIS OF VARIANCE - FROM ZERO

	SS	DF	MS	F
REGRESSION	49.539	3.	16.513	540.595
ERROR	0.88583	29.	0.30546E-01	
TOTAL	50.425	32.	1.5758	

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 29 DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
EFFORT	-0.15999E-06	0.1335E-07	-11.98	0.000	-0.912	-0.8447	-0.8324
DEGAB	-0.92251E-07	0.1124E-07	-8.208	0.000	-0.836	-0.5786	-0.2044
CONSTANT	2.3895	0.9675E-01	24.70	1.000	0.977	0.0000	2.0367

DURBIN-WATSON = 1.0900 VON NEUMANN RATIO = 1.1251 RHO = 0.41942
RESIDUAL SUM = 0.19429E-15 RESIDUAL VARIANCE = 0.30546E-01
SUM OF ABSOLUTE ERRORS= 3.4891
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.8612
RUNS TEST: 12 RUNS, 14 POSITIVE, 18 NEGATIVE, NORMAL STATISTIC = -1.7352

SCHAEFER MODEL WITH DUMMY SLOPE AND PROXY TECH-CHANGES

```
l_ols lcpues effort degab tm / exactdw anova  stat

REQUIRED MEMORY IS PAR=  15 CURRENT PAR= 116
 OLS ESTIMATION
     32 OBSERVATIONS     DEPENDENT VARIABLE = LCPUES
...NOTE..SAMPLE RANGE SET TO:    1,   32

DURBIN-WATSON STATISTIC  =   1.18525

DURBIN-WATSON PROBABILITY =   0.001921

 R-SQUARE =  0.9263     R-SQUARE ADJUSTED =  0.9184
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.16804E-01
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.12963
SUM OF SQUARED ERRORS-SSE=  0.47052
MEAN OF DEPENDENT VARIABLE =   1.1732
LOG OF THE LIKELIHOOD FUNCTION =  22.1086

MODEL SELECTION TESTS - SEE JUDGE ET.AL.(1985, P.242)
 AKAIKE (1969) FINAL PREDICTION ERROR- FPE =   0.18905E-01
   (FPE ALSO KNOWN AS AMEMIYA PREDICTION CRITERION -PC)
 AKAIKE (1973) INFORMATION CRITERION- LOG AIC =  -3.9697
 SCHWARZ(1978) CRITERION-LOG SC =  -3.7864
MODEL SELECTION TESTS - SEE RAMANATHAN(1992,P.167)
 CRAVEN-WAHBA(1979) GENERALIZED CROSS VALIDATION(1979) -GCV=  0.19205E-01
 HANNAN AND QUINN(1979) CRITERION -HQ=  0.20062E-01
 RICE (1984) CRITERION-RICE=  0.19605E-01
 SHIBATA (1981) CRITERION-SHIBATA=  0.18379E-01
 SCHWARTZ (1978) CRITERION-SC=  0.22676E-01
 AKAIKE (1974)INFORMATION CRITERION-AIC=  0.18880E-01

                 ANALYSIS OF VARIANCE - FROM MEAN
                        SS         DF          MS            F
REGRESSION          5.9099       3.        .9700          117.232
ERROR               0.47052     28.       0.16804E-01
TOTAL               6.3804      31.       0.20582

                 ANALYSIS OF VARIANCE - FROM ZERO
                        SS         DF          MS            F
REGRESSION         49.954        4.       12.489          743.182
ERROR               0.47052     28.       0.16804E-01
TOTAL              50.425       32.        1.5758


VARIABLE  ESTIMATED  STANDARD   T-RATIO   PARTIAL STANDARDIZED ELASTICITY
 NAME     COEFFICIENT  ERROR     28 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
EFFORT   -0.11261E-06  0.1374E-07   -8.193   0.000-0.840    -0.5946          -0.5859
DEGAB    -0.75715E-07  0.8975E-08   -8.436   0.000-0.847    -0.4749          -0.1677
TM        0.34722E-01  0.6984E-02    4.971   1.000 0.685     0.3585           0.2516
CONSTANT  1.7622       0.1452       12.14    1.000 0.917     0.0000           1.5020
```

DURBIN-WATSON = 1.1852 VON NEUMANN RATIO = 1.2235 RHO = 0.40550
RESIDUAL SUM = 0.27756E-16 RESIDUAL VARIANCE = 0.16804E-01
SUM OF ABSOLUTE ERRORS= 2.8399
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.9263
RUNS TEST: 12 RUNS, 17 POSITIVE, 15 NEGATIVE, NORMAL STATISTIC = -1.7817
I_stop

Appendix 5.2 Regression results of estimates of demand for freshwater fish in South Sumatra, Indonesia

|_ols cons pfgc pbgc ygc / exactdw anova rstat

REQUIRED MEMORY IS PAR= 19 CURRENT PAR= 105
OLS ESTIMATION
16 OBSERVATIONS DEPENDENT VARIABLE = CONS
...NOTE..SAMPLE RANGE SET TO: 1, 16

DURBIN-WATSON STATISTIC = 1.2268

DURBIN-WATSON PROBABILITY = 0.010065

R-SQUARE = 0.9444 R-SQUARE ADJUSTED = 0.9305
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.16385
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.40478
SUM OF SQUARED ERRORS-SSE= 1.9662
MEAN OF DEPENDENT VARIABLE = 18.425
LOG OF THE LIKELIHOOD FUNCTION = -5.93108

MODEL SELECTION TESTS - SEE JUDGE ET.AL.(1985, P.242)
AKAIKE (1969) FINAL PREDICTION ERROR- FPE = 0.20481
(FPE ALSO KNOWN AS AMEMIYA PREDICTION CRITERION -PC)
AKAIKE (1973) INFORMATION CRITERION- LOG AIC = -1.5965
SCHWARZ(1978) CRITERION-LOG SC = -1.4033
MODEL SELECTION TESTS - SEE RAMANATHAN(1992,P.167)
CRAVEN-WAHBA(1979) GENERALIZED CROSS VALIDATION(1979) -GCV= 0.21847
HANNAN AND QUINN(1979) CRITERION -HQ= 0.20462
RICE (1984) CRITERION-RICE= 0.2457[illegible]
SHIBATA (1981) CRITERION-SHIBATA = 0.18433
SCHWARTZ (1978) CRITERION-SC= 0.24577
AKAIKE (1974)INFORMATION CRITERION-AIC= 0.20261

ANALYSIS OF VARIANCE - FROM MEAN

	SS	DF	MS	F
REGRESSION	33.404	3.	11.135	67.956
ERROR	1.9662	12.	0.16385	
TOTAL	35.370	15.	2.3580	

ANALYSIS OF VARIANCE - FROM ZERO

	SS	DF	MS	F
REGRESSION	5465.1	4.	1366.3	8338.612
ERROR	1.9662	12.	0.16385	
TOTAL	5467.1	16.	341.69	

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 12 DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
PFGC	-0.30837	0.1147	-2.687	0.010	-0.613	-0.2564	-0.1851
PBGC	0.11007	0.4298E-01	2.561	0.988	0.594	0.6118	0.2873
YGC	0.46371E-03	0.2011E-03	2.306	0.980	0.554	0.4879	0.2434
CONSTANT	12.057	1.094	11.02	1.000	0.954	0.0000	0.6544

DURBIN-WATSON = 1.2217 VON NEUMANN RATIO = 1.3031 RHO = 0.37771
RESIDUAL SUM = -0.30531E-15 RESIDUAL VARIANCE = 0.16385
SUM OF ABSOLUTE ERRORS= 4.8079
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.9444
RUNS TEST: 6 RUNS, 9 POSITIVE, 7 NEGATIVE, NORMAL STATISTIC = -1.5133

|_ols pfgc cons pbgc ygc / exactdw anova rstat

REQUIRED MEMORY IS PAR= 19 CURRENT PAR= 105
OLS ESTIMATION
16 OBSERVATIONS DEPENDENT VARIABLE = PFGC
...NOTE..SAMPLE RANGE SET TO: 1, 16

DURBIN-WATSON STATISTIC = 0.92067

DURBIN-WATSON PROBABILITY = 0.001601

R-SQUARE = 0.6822 R-SQUARE ADJUSTED = 0.6028
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.64741
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.80462
SUM OF SQUARED ERRORS-SSE= 7.7689
MEAN OF DEPENDENT VARIABLE = 1 .062
LOG OF THE LIKELIHOOD FUNCTION = -16.923

MODEL SELECTION TESTS - SEE JUDGE ET.AL.(1985, P.242)
AKAIKE (1969) FINAL PREDICTION ERROR- FPE = 0.80926
(FPE ALSO KNOWN AS AMEMIYA PREDICTION CRITERION -PC)
AKAIKE (1973) INFORMATION CRITERION- LOG AIC = -0.22246
SCHWARZ(1978) CRITERION-LOG SC = -0.29317E-01
MODEL SELECTION TESTS - SEE RAMANATHAN(1992,P.167)
CRAVEN-WAHBA(1979) GENERALIZED CROSS VALIDATION(1979) -GCV= 0.86321
HANNAN AND QUINN(1979) CRITERION -HQ= 0.80850
RICE (1984) CRITERION-RICE= 0.97111
SHIBATA (1981) CRITERION-SHIBATA= 0.7283
SCHWARTZ (1978) CRITERION-SC= 0.97111
AKAIKE (1974)INFORMATION CRITERION-AIC= 0.80054

ANALYSIS OF VARIANCE - FROM MEAN

	SS	DF	MS	F
REGRESSION	16.681	3.	5.5602	8.588
ERROR	7.7689	12.	0.64741	
TOTAL	24.450	15.	.6300	

ANALYSIS OF VARIANCE - FROM ZERO

	SS	DF	MS	F
REGRESSION	1974.7	4.	493.66	762.526
ERROR	7.7689	12.	0.64741	
TOTAL	1982.4	16.	23.90	

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 12 DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
CONS	-1.2185	0.4534	-2.687	0.010	-0.613	-1.4655	-2.0294
PBGC	0.27912	0.6925E-01	4.031	0.999	0.758	1.8659	1.2136
YGC	0.56450E-04	0.4800E-03	0.1176	0.546	0.034	0.0714	0.0494
CONSTANT	19.542	4.558	4 287	0.999	0.778	0.0000	1.7665

DURBIN-WATSON = 0.9207 VON NEUMANN RATIO = 0.9820 RHO = 0.50549
RESIDUAL SUM = 0.19984E-14 RESIDUAL VARIANCE = 0.64741
SUM OF ABSOLUTE ERRORS= 8.6671
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.6822
RUNS TEST: 7 RUNS, 7 POSITIVE, 9 NEGATIVE, NORMAL STATISTIC = -0.9869

|_ols lcons pfgc pbgc ygc / exactdw anova rstat

REQUIRED MEMORY IS PAR= 19 CURRENT PAR= 105
OLS ESTIMATION
16 OBSERVATIONS DEPENDENT VARIABLE = LCONS
...NOTE..SAMPLE RANGE SET TO: 1, 16

DURBIN-WATSON STATISTIC = 1.18273

DURBIN-WATSON PROBABILITY = 0 007756

R-SQUARE = 0.9418 R-SQUARE ADJUSTED = 0.9272
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.50710E-03
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.22519E-01
SUM OF SQUARED ERRORS-SSE= 0.60852E-02
MEAN OF DEPENDENT VARIABLE = 2.9104
LOG OF THE LIKELIHOOD FUNCTION = 40.2929

MODEL SELECTION TESTS - SEE JUDGE ET.AL.(1985, P.242)
AKAIKE (1969) FINAL PREDICTION ERROR- FPE = 0.63387E-03
(FPE ALSO KNOWN AS AMEMIYA PREDICTION CRITERION -PC)
AKAIKE (1973) INFORMATION CRITERION- LOG AIC = -7.3745
SCHWARZ(1978) CRITERION-LOG SC = -7.1813
MODEL SELECTION TESTS - SEE RAMANATHAN(1992,P.167)
CRAVEN-WAHBA(1979) GENERALIZED CROSS VALIDATION(1979) -GCV= 0.67613E-03
HANNAN AND QUINN(1979) CRITERION -HQ= 0.63328E-03
RICE (1984) CRITERION-RICE= 0.76065E-03
SHIBATA (1981) CRITERION-SHIBATA = 0.57048E-03
SCHWARTZ (1978) CRITERION-SC= 0.76065E-03
AKAIKE (1974)INFORMATION CRITERION-AIC= 0.62705E-03

ANALYSIS OF VARIANCE - FROM MEAN

	SS	DF	MS	F
REGRESSION	0.98393E-01	3.	0.32798E-01	64.677
ERROR	0.60852E-02	12.	0.50710E-03	
TOTAL	0.10448	15.	0.69652E-02	

ANALYSIS OF VARIANCE - FROM ZERO

	SS	DF	MS	F
REGRESSION	135.63	4.	3 ı.907	66865.635
ERROR	0.60852E-02	12.	(.50710E-03	
TOTAL	135.64	16.	ı.4772	

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 12 DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
PFGC	-0.14988E-01	0.6383E-02	-2.348	0.018	-0.561	-0.2293	-0.0570
PBGC	0.60530E-02	0.2391E-02	2.532	0.987	0.590	0.6190	0.1000
YGC	0.24297E-04	0.1119E-04	2.171	0.975	0.531	0.4704	0.0807
CONSTANT	2.5501	0.6086E-01	41.90	1.000	0.997	0.0000	0.8762

DURBIN-WATSON = 1.1827 VON NEUMANN RATIO = 1.2616 RHO = 0.40120
RESIDUAL SUM = -0.52042E-16 RESIDUAL VARIANCE = 0.50710E-03
SUM OF ABSOLUTE ERRORS= 0.27036
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.9418
RUNS TEST: 6 RUNS, 9 POSITIVE, 7 NEGATIVE, NORMAL STATISTIC = -1.5133
|_*

|_ols lcons lpfgc lpbgc lygc / exactdw anova rstat

REQUIRED MEMORY IS PAR= 19 CURRENT PAR= 105
OLS ESTIMATION
16 OBSERVATIONS DEPENDENT VARIABLE = LCONS
...NOTE..SAMPLE RANGE SET TO: 1, 16

DURBIN-WATSON STATISTIC = 1.174 4

DURBIN-WATSON PROBABILITY = 0.008670

R-SQUARE = 0.9394 R-SQUARE ADJUSTED = 0.9242
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.52782E-03
STANDARD ERROR OF THE ESTIMATE SIGMA = 0.22974E-01
SUM OF SQUARED ERRORS-SSE= 0.63339E-02
MEAN OF DEPENDENT VARIABLE = 2.9104
LOG OF THE LIKELIHOOD FUNCTION = 39.9724

MODEL SELECTION TESTS - SEE JUDGE ET.AL.(1985, P.242)
AKAIKE (1969) FINAL PREDICTION ERROR- FPE = 0.65978E-03
(FPE ALSO KNOWN AS AMEMIYA PREDICTION CRITERION -PC)
AKAIKE (1973) INFORMATION CRITERION- LOG AIC = -7.3344
SCHWARZ(1978) CRITERION-LOG SC = -7.1413
MODEL SELECTION TESTS - SEE RAMANATHAN(1992,P.167)
CRAVEN-WAHBA(1979) GENERALIZED CROSS VALIDATION(1979) -GCV= 0.70376E-03
HANNAN AND QUINN(1979) CRITERION -HQ= 0.65916E-03
RICE (1984) CRITERION-RICE= 0.79173E-03
SHIBATA (1981) CRITERION-SHIBATA= 0.59380E-03
SCHWARTZ (1978) CRITERION-SC= 0.79173E-03
AKAIKE (1974)INFORMATION CRITERION-AIC= 0.65267E-03

ANALYSIS OF VARIANCE - FROM MEAN

	SS	DF	MS	F
REGRESSION	0.98144E-01	3.	0.32715E-01	61.980
ERROR	0.63339E-02	12.	0.52782E-03	
TOTAL	0.10448	15.	0.69652E-02	

ANALYSIS OF VARIANCE - FROM ZERO

	SS	DF	MS	F
REGRESSION	135.63	4.	33.907	64239.990
ERROR	0.63339E-02	12.	0.52782E-03	
TOTAL	135.64	16.	8.4772	

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 12 DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
LPFGC	-0.21786	0.6903E-01	-3.156	0.004	-0.674	-0.3060	-0.1794
LPBGC	0.32547	0.1057	3.079	0.995	0.664	0.7301	0.4314
LYGC	0.19281	0.1016	1.898	0.959	0.480	0.4023	0.6070
CONSTANT	0.41046	0.6268	0.6548	0.738	0.186	0.0000	0.1410

DURBIN-WATSON = 1.1741 VON NEUMANN RATIO = 1.2524 RHO = 0.38896
RESIDUAL SUM = -0.41633E-16 RESIDUAL VARIANCE = 0.52782E-03
SUM OF ABSOLUTE ERRORS= 0.25440
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.9394
RUNS TEST: 6 RUNS, 9 POSITIVE, 7 NEGATIVE, NORMAL STATISTIC = -1.5133

|_ols lpfgc lcons lpbgc lygc / exactdw anova rstat

REQUIRED MEMORY IS PAR= 19 CURRENT PAR= 105
OLS ESTIMATION
16 OBSERVATIONS DEPENDENT VARIABLE = LPFGC
...NOTE..SAMPLE RANGE SET TO: 1, 16

DURBIN-WATSON STATISTIC = 0.97315

DURBIN-WATSON PROBABILITY = 0.002706

R-SQUARE = 0.7063 R-SQUARE ADJUSTED = 0.6329
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.50443E-02
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.71023E-01
SUM OF SQUARED ERRORS-SSE= 0.60532E-01
MEAN OF DEPENDENT VARIABLE = 2.3972
LOG OF THE LIKELIHOOD FUNCTION = 21.9144

MODEL SELECTION TESTS - SEE JUDGE ET.AL (1985, P.242)
AKAIKE (1969) FINAL PREDICTION ERROR- FPE = 0.63054E-02
(FPE ALSO KNOWN AS AMEMIYA PREDICTION CRITERION -PC)
AKAIKE (1973) INFORMATION CRITERION- LOG AIC = -5.0772
SCHWARZ(1978) CRITERION-LOG SC = -4.8840
MODEL SELECTION TESTS - SEE RAMANATHAN(1992,P.167)
CRAVEN-WAHBA(1979) GENERALIZED CROSS VALIDATION(1979) -GCV= 0.67258E-02
HANNAN AND QUINN(1979) CRITERION -HQ= 0.62995E-02
RICE (1984) CRITERION-RICE= 0.75665E-02
SHIBATA (1981) CRITERION-SHIBATA= 0.56749E-02
SCHWARTZ (1978) CRITERION-SC= 0.75665E-02
AKAIKE (1974)INFORMATION CRITERION-AIC= 0.62375E-02

ANALYSIS OF VARIANCE - FROM MEAN

	SS	DF	MS	F
REGRESSION	0.14556	3.	0.48519E-01	9.619
ERROR	0.60532E-01	12.	0.50443E-02	
TOTAL	0.20609	15.	0.13739E-01	

ANALYSIS OF VARIANCE - FROM ZERO

	SS	DF	MS	F
REGRESSION	92.	4.	23.022	4563.980
ERROR	0.60532E-01	12.	0.50443E-02	
TOTAL	92.149	16.	5.7593	

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 2 DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
LCONS	-2.0821	0.6597	-3.156	0.004	-0.674	-1.4824	-2.5279
LPBGC	1.1341	0.2898	3.913	0.999	0.749	1.8113	1.8249
LYGC	0.12146	0.3564	0.3407	0.630	0.098	0.1804	0.4643
CONSTANT	2.9695	1.776	1.672	0.940	0.435	0.0000	1.2387

DURBIN-WATSON = 0.9732 VON NEUMANN RATIO = 1.0380 RHO = 0.49675
RESIDUAL SUM = 0.41633E-16 RESIDUAL VARIANCE = 0.50443E-02
SUM OF ABSOLUTE ERRORS= 0.74952
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.7063
RUNS TEST: 7 RUNS, 8 POSITIVE, 8 NEGATIVE, NORMAL STATISTIC = -1.0351
|_END

Appendix 5.3 Production structure of the fisheries in South Sumatra, Indonesia, during 1979-1994

Year	Capture		Aquaculture	Total
	Inland (tonne)	Marine (tonne)	(tonne)	(tonne)
1979	28,113.70	44,530.00	934.10	73,577.80
	(38.2)	(60.5)	(1.3)	(100)
1980	32,038.70	53,858.90	1,101.10	86,998.70
	(36.8)	(61.9)	(1.3)	(100)
1981	37,315.30	56,455.60	1,106.00	94,876.90
	(39.3)	(59.5)	(1.2)	(100)
1982	35,986.60	62,508.20	1,303.40	99,798.20
	(36.1)	(62.6)	(1.3)	(100)
1983	36,335.00	67,728.80	1,383.40	105,447.20
	(34.2)	(64.2)	(1.3)	(100)
1984	36,206.80	73,141.30	1,558.90	110,907.00
	(32.6)	(66.0)	(1.4)	(100)
1985	38,419.10	74,215.30	1,704.40	114,338.80
	(33.6)	(64.9)	(1.5)	(100)
1986	39,905.80	74,186.40	1,964.20	116,056.40
	(34.4)	(63.9)	(1.7)	(100)
1987	40,610.00	76,629.00	3,133.50	120,372.50
	(33.7)	(63.7)	(2.6)	(100)
1988	40,096.10	84,129.00	3,241.30	127,466.40
	(31.5)	(66.0)	(2.5)	(100)
1989	38,661.10	88,767.10	3,437.90	130,866.10
	(29.5)	(67.8)	(2.6)	(100)
1990	37,960.20	92,081.00	3,814.50	133,855.70
	(28.4)	(68.8)	(2.8)	(100)
1991	39,675.80	92,595.00	3,220.00	135,490.80
	(29.3)	(68.3)	(2.4)	(100)
1992	39,663.10	94,781.70	4,138.30	138,583.10
	(28.6)	(68.4)	(3.0)	(100)
1993	41,481.70	102,744.00	5,492.40	149,718.10
	(27.7)	(68.6)	(3.7)	(100)
1994	41,979.20	112,557.70	6,730.30	161,267.20
	(26.0)	(69.8)	(4.2)	(100)

Note: Values in parentheses are percentages.

Sources: Fishery Services of South Sumatra (various years).

Appendix 5.4 Integral method for estimating the catchability coefficient from the estimated coefficient result of the Schaefer model in the riverine and swamp fishery of South Sumatra, Indonesia

Based on the regression results of the Schaefer model, coefficients of a_i and b_i, as presented in Table 5.1, the value of q_t can be calculated as follows:

$$\hat{q}_t = \frac{\ln\left|\frac{\left(z_t U_t^{1-m} + \frac{1}{-b_i}\right)}{\left(z_t U_{t-1}^{1-m} + \frac{1}{-b_i}\right)}\right|}{(z_t m - z_t)}$$

where:

$$z_t = -\left(\frac{a_i}{-b_i}\right) - \hat{E}_t$$

and

$$\hat{E}_t = \frac{(E_t - E_{t-1})}{2}$$

The average catchability coefficient over n years:

$$\bar{q} = \exp\left[\sum_{t=1}^{n-1} \frac{\ln|\hat{q}_t|}{(n-1)}\right]$$

$\hat{q}_t$: estimates catchability coefficient of the standardised fishing gear

U_t : catch per unit of standardsed fishing effort in year t

E_t : standardised fishing effort in year t

n : number of observation in year, t = 1, 2, 3, ..., n

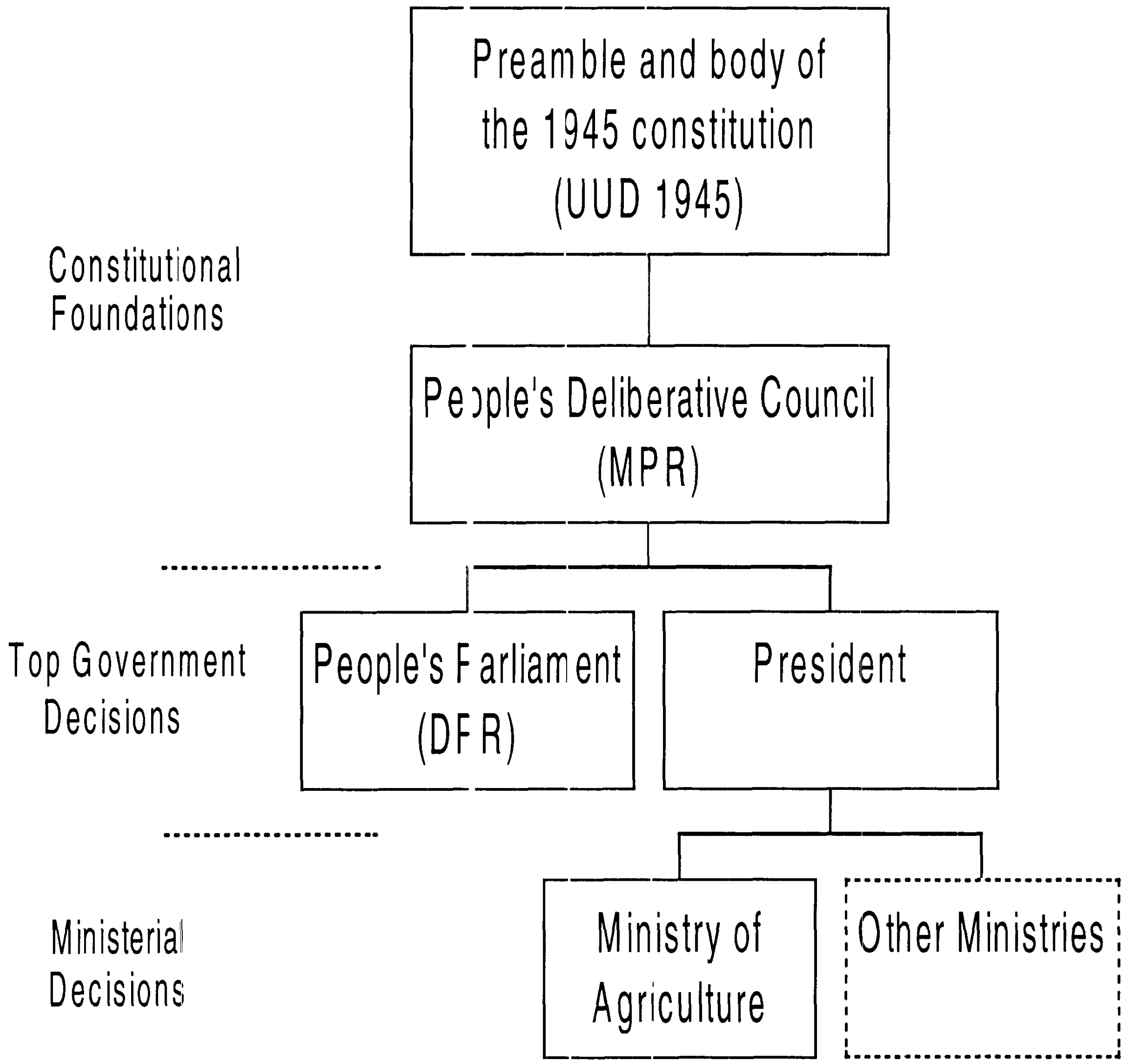
m : constant parameter with a value of 2 for the Schaefer model (and a value of 1.0001 for the Fox model)

$\bar{q}$: average catchability coefficient

a_i and b_i : estimates coefficients in the Schaefer model, i=1 (riverine) and i=2 (swamp).

Source : Fox (1970, 1975).

Appendix 6.1 Indonesian governmental structure



Source : Adapted from Thomas and Soedijarto (1980, p. 12)

Appendix 7.1a Effects of increasing licence fees in the fishery system

Indicator	Base case	Case 1-A			Case 1-B		
		Short run	Long run	Relative change	Short run	Long run	Relative change
Riverine fishery							
Effort	9,324,472	9,324,472	9,307,261	-0.18	9,324,472	9,281,445	-0.46
Catch	22,820,553	22,820,553	22,879,231	0.26	22,820,553	22,996,544	0.77
Stock size	23,141,131	23,141,131	23,243,537	0.44	23,141,131	23,397,136	1.11
Average Revenue	1,215	1,215	1,215	-	1,215	1,215	-
Average Cost	1,215	1,220	1,215	-0.41	1,228	1,215	-1.06
Cost of fishing effort	2,974	2,987	2,987	-	3,006	3,006	-
Profit	0	-123	0	-100.00	-307	0	-100.00
Swamp fishery							
Effort	6,183,575	6,183,575	6,159,139	-0.40	6,183,575	6,122,347	-0.99
Catch	14,463,960	14,463,960	14,552,248	0.61	14,463,960	14,683,004	1.51
Stock size	7,034,846	7,034,846	7,105,868	1.01	7,034,846	7,212,802	2.53
Average Revenue	1,125	1,125	1,125	-	1,125	1,125	-
Average Cost	1,125	1,136	1,125	-0.97	1,153	1,125	-2.43
Cost of fishing effort	2,631	2,658	2,658	-	2,698	2,698	-
Profit	0	-164	0	-100.00	-412	0	-100.00

Appendix 7.1b Effects of increasing labour cost of fishing effort in the fishery system

Indicator	Base case	Case 2-A			Case 2-B		
		Short run	Long run	Relative change	Short run	Long run	Relative change
Riverine fishery							
Effort	9,324,472	9,324,472	8,997,483	-3.51	9,324,472	8,670,492	-7.01
Catch	22,820,553	22,820,553	23,871,618	4.61	22,820,553	24,788,124	8.62
Stock size	23,141,131	23,141,131	25,086,697	8.41	23,141,131	27,032,274	16.81
Average Revenue	1,215	1,220	1,215	-0.41	1,228	1,215	-1.06
Average Cost	1,215	1,317	1,215	-7.74	1,419	1,215	-14.38
Cost of fishing effort	2,974	3,224	3,224	-	3,474	3,474	-
Profit	0	-2331	0	-100.00	-4662	0	-100.00
Swamp fishery							
Effort	6,183,575	6,183,575	5,953,718	-3.72	6,183,575	5,723,770	-7.44
Catch	14,463,960	14,463,960	15,248,822	5.43	14,463,960	15,931,821	10.15
Stock size	7,034,846	7,034,846	7,702,914	9.50	7,034,846	8,371,250	19.00
Average Revenue	1,215	1,215	1,215	-	1,215	1,215	-
Average Cost	1,215	1,317	1,215	-7.76	1,419	1,215	-14.39
Cost of fishing effort	2,974	3,224	3,224	-	3,474	3,474	-
Profit	-	-1,545	-	-100.00	-3,091	-	-100.00

Appendix 7.1c Effects of increasing total cost of fishing effort in the fishery system

Indicator	Base case	Case 3-A			Case 3-B		
		Short run	Long run	Relative change	Short run	Long run	Relative change
Riverine fishery							
Effort	9,324,472	9,324,472	8,935,542	-4.17	9,324,472	8,352,146	-10.43
Catch	22,820,553	22,820,553	24,055,559	5.41	22,820,553	25,551,123	11.97
Stock size	23,141,131	23,141,131	25,455,242	10.00	23,141,131	28,926,412	25.00
Average Revenue	1,215	1215	1215	-	1215	1215	-
Average Cost	1,215	1336.5	1215	-9.09	1518.75	1215	-20.00
Cost of fishing effort	2,974	3270.927	3270.93	0.00	3716.963	3716.96	-
Profit	-	(2,773)	-	-100.00	-6,932	-	-100.00
Swamp fishery							
Effort	6,183,575	6,183,575	5,941,634	-3.91	6,183,575	5,578,585	-9.78
Catch	14,463,960	14,463,960	15,287,259	5.69	14,463,960	16,310,418	12.77
Stock size	7,034,846	7,034,846	7,738,036	10.00	7,034,846	8,793,222	25.00
Average Revenue	1,125	1,125	1125	-	1,125	1125	-
Average Cost	1,125	1237.453	1125	-9.09	1406.196	1125	-20.00
Cost of fishing effort	2,631	2894.518	2894.518	-	3289.225	3289.225	-
Profit	-	(1,627)	-	-100.00	-4,067-	-	-100.00

Appendix 7.2 Effects of increasing price of freshwater fish in the fishery system

Indicator	Base case	Case 4-A			Case 4-B		
		Short run	Long run	Relative change	Short run	Long run	Relative change
Riverine fishery							
Effort	9,324,472	9,324,472	9,678,045	3.79	9,324,472	10,102,333	8.34
Catch	22,820,553	22,820,553	21,532,618	-5.64	22,820,553	19,779,419	-13.33
Stock size	23,141,131	23,141,131	21,037,390	-9.09	23,141,131	18,512,904	-20.00
Average Revenue	1,215	1336.5	1336.5	-	1518.75	1518.75	-
Average Cost	1,215	1215	1336.5	10.00	1215	1518.75	25.00
Cost of fishing effort	2,974	2973.57	2973.57	-	2973.57	2973.57	-
Profit		2,773		100.00	6,932	-	-100.00
Swamp fishery							
Effort	6,183,575	6,183,575	6,403,613	3.56	6,183,575	6,667,659	7.83
Catch	14,463,960	14,463,960	13,616,953	-5.86	14,463,960	12,477,021	-13.74
Stock size	7,034,846	7,034,846	6,395,315	-9.09	7,034,846	5,627,877	-20.00
Average Revenue	1,125	1,125	1,238	10.00	1,125	1,406	25.00
Average Cost	1,125	1,125	1,238	10.00	1,125	1,406	25.00
Cost of fishing effort	2,631	2631.48	2631.48	-	2631.48	2631.48	-
Profit	-	1,627	-	-100.00	4,068	-	-100.00

Appendix 7.3 Effects of reducing fishing effort in the fishery system

Indicator	Initial stage	Case 2-A		Case 2-B		Case 2-C	
		Final stage	Relative change	Final stage	Relative change	Final stage	Relative change
Riverine fishery							
Effort	9,324,472	8,392,025	-10.00	6,993,354	-25.00	4,662,236	-50.00
Catch	22,820,553	25,461,614	11.57	27,373,647	19.95	25,088,140	9.94
Stock size	23,141,131	28,688,103	23.97	37,010,913	59.94	50,881,144	119.87
Profit	-	5,982		12,464		16,619	
Swamp fishery							
Effort	6,183,575	5,565,218	-10.00	4,637,681	-25.00	3,091,788	-50.00
Catch	14,463,960	16,343,108	12.99	17,776,427	22.90	16,469,934	13.87
Stock size	7,034,846	8,832,010	25.55	11,527,911	63.87	16,020,987	127.74
Profit	-	3,742		7,795		10,393	

Appendix 7.4 Effects of increasing licence fee and reducing fishing effort in the fishery system

Indicator		Case 6-A1		Case 6-A2		Case 6-A3	
	Initial stage	Final stage	Relative change	Final stage	Relative change	Final stage	Relative change
Riverine fishery							
Effort	9,324,472	8,392,025	-10.00	6,993,354	-25.00	4,662,236	-50.00
Catch	22,820,553	25,461,958	11.57	27,373,726	19.95	25,088,140	9.94
Stock size	23,141,131	28,688,491	23.97	37,011,021	59.94	50,881,144	119.87
Profit	-	5,872		12,372		16,557	
Swamp fishery							
Effort	6,183,575	5,565,218	10.00	4,637,681	25.00	3,091,788	-50.00
Catch	14,463,960	16,343,108	12.99	17,776,287	22.90	16,469,934	13.87
Stock size	7,034,846	8,832,010	25.55	11,527,820	63.87	16,020,987	127.74
Profit	-	3,593		7,671		10,311	

Continued Appendix 7.4

Indicator	Initial stage	Case 6-B1		Case 6-B2		Case 6-B3	
		Final stage	Relative change	Final stage	Relative change	Final stage	Relative change
Riverine fishery							
Effort	9,324,472	8,392,025	-10.00	6,993,354.00	-25.00	4,662,236	-50.00
Catch	22,820,553	25,461,958	11.57	27,373,725.75	19.95	25,088,140	9.94
Stock size	23,141,131	28,688,491	23.97	37,011,020.80	59.94	50,881,144	119.87
Profit	-	5,706		12,233.80		16,465	
Swamp fishery							
Effort	6,183,575	5,565,218	10.00	4,637,681.25	25.00	3,091,788	50.00
Catch	14,463,960	16,343,108	12.99	17,776,286.72	22.90	16,469,934	13.87
Stock size	7,034,846	8,832,010	25.55	11,527,820.21	63.87	16,020,987	127.74
Profit	-	3,371		7,485.64		10,187	