LICENCE REDUCTION AND GEAR RESTRICTION POLICIES

IN LIMITED ENTRY FISHERIES:

A BIOECONOMIC ANALYSIS[1]

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1. INTRODUCTION

Input restrictions such as reductions in the number of licence holders and gear restrictions are frequently used to control fishing effort in limited entry fisheries. Despite the popularity of these schemes, there have been few quantitatives studies of the effects of introducing such schemes. The purpose of this paper is to develop a model of a fishery to evaluate the economic benefits from licence reduction and gear restriction schemes in limited entry fisheries.

A bioeconomic model of a fishery is developed in Section 2. Hypothetical data are used to define an open access and limited entry equilibrium in the fishery in sections 3 and 4. The effect of reducing the number of licence holders and introducing a gear restriction is examined in Section 5.

2. THE MODEL

Response to limited entry and gear restriction regulations is incorporated into the model by assuming that fishers seek to maximize individual profits. Total catch in the fishery per period (Q) is:

$$Q = f(E) = f(\Sigma Ei) \tag{1}$$

where E denotes total fishing effort and Ei denotes fishing effort applied by the ith individual. It is assumed that the marginal product of fishing effort in each period is positive and declining ($\partial Q/\partial E>0$, $\partial^2 Q/\partial E^2<0$). It is also assumed that fishers are equally skillful, can fish anywhere in the fishery, and that the fish are evenly distributed throughout the fishery. Thus catch of the ith fisher, q_i, is:

$$q_i = \frac{E_i}{E} f(E) \tag{2}$$

Assuming a perfectly competitive fishery, the profit equation for individual fishers is:

$$\pi_i = P q_i - V(E_i) - FC \tag{3}$$

where π_i denotes profit, P denotes the price of fish, V(Ei) is the short-run variable cost function dependent on Ei and FC denotes fixed costs. For a profit maximizing firm exploiting the fishery, the first order condition is:

$$\partial \pi_i / \partial E_i = P\left(Q/E + (E_i/E)(\partial f/\partial E - Q/E)\right) - \partial V/\partial E_i = 0 \tag{4}$$

This expression can be used to derive the well known result that unrestricted access to the fishery will result in the dissipation of potential rent to the fish stock.

Following the traditional approach (eg Gordon 1954), the supply of fishing effort is assumed to be perfectly elastic, implying that marginal cost $\partial V/\partial E_i$ is a constant c and fixed costs are assumed to be zero. Equations (3) and (4) can be rewritten as:

$$\pi_i = (\underline{PQ} - c)\ Ei, \quad , \text{ and,} \qquad (5)$$
$$E$$

$$\partial\pi_i/\partial E_i = P\left(Q/E + (E_i/E)(\partial f/\partial E - Q/E)\right) - c = 0 \qquad (6)$$

These assumptions ensure that intra marginal rents are zero.

Equation (5) is positive for Ei > 0 if

$$PQ/E - c > 0 \qquad (7)$$

As marginal product of fishing effort is declining, marginal product is less than average product. Thus from equation (6)

$$PQ/E - c = P(E_i/E)(-\partial f/\partial E + Q/E) > 0 \qquad (8)$$

and tive profits are made. Positive profits will attract more fishers to the fishery. Entry will continue until each fisher provides a very small share of fishing effort and profit π_i will tend to zero (Gravelle and Rees 1981). Total industry revenue will equal total costs.

$$PQ - cE = 0 \qquad (9)$$

Assuming the price of fish and the marginal cost of fishing effort represent their social values, the socially optimal level of fishing effort to apply will occur when marginal revenue is equated to marginal cost.

$$P\,\partial f/\partial E - c = 0 \qquad (10)$$

As all fishers are equally skilled, $E = nE_i$, where „ denotes the number of fishers, which can be substituted into equation (6).

$$P(Q/nE_i + (1/n)((\partial f/\partial E_i)(1/n) - Q/(nE_i))) - c = 0$$

Letting *n* equal one (the condition required for sole ownership), the profit maximising decision of the sole owner will be equivalent to the socially optimal outcome.

$$P\frac{\partial f}{\partial E_i} - c = 0 \qquad (11)$$

This result has been widely documented throughout the literature (eg Clark 1985).

An implication of this model is that rent to the fish stock will only be completely dissipated as the number of fishers tends to infinity. Conversely, if entry restrictions are applied, individual fishers will capture some of the rent, even though none has an exclusive right to the fishing ground. This result is consistent with the model developed by Cheung (1970).

To develop the empiriral model, it is necessary to specify functional forms for the production and cost functions. It is assumed that these can be represented as:

$$Q = fE^{\alpha}X \qquad 0 < \alpha < 1 \qquad ((12)$$

$$VC = \pi E_i^{\theta} \tag{13}$$

where f denotes the technical efficiency parameter, α denotes the elasticity of catch (Q) with respect to fishing effort (E), X denotes stock size, π denotes a shift parameter and θ determines the slope of the marginal cost functions. Substituting (12) and (13) into (4) provides

$$\partial \pi_i / \partial E_i = P f E^{\alpha-1} X \left(1 + (E_i/E)(\alpha - 1)\right) - \pi E_i^{\theta} = 0 \tag{14}$$

Substituting nEi for E and rearranging

$$E_i = \left[\pi / \left(P f n^{\alpha-1} X \left(1 + (1/n)(\alpha - 1)\right)\right)\right]^{1/(\alpha-1-\theta)} \tag{15}$$

Equation (15) denotes the profit maximising level of fishing effort applied by individual fishers for given prices of fish and cost of fishing effort (derived input demand function).

The supply of fish curve is obtained by substituting equation (15) into the production function.

$$Qs = n^{\alpha} f \left[\frac{\pi}{pfn^{\alpha-1} X \left(1 + \frac{1}{n}(\alpha - 1)\right)}\right]^{\frac{\alpha}{\alpha-1-\theta}} X \tag{16}$$

The behaviour of consumers is represented by an aggregate linear demand function.

$$Q_D = \gamma - \varepsilon P \tag{17}$$

Where Υ is the demand intercept and ε is the slope coefficient. A linear demand function was chosen in preference to a constant elasticity function because it allows the price elasticity of demand to increase as quantity consumed decreases. There are many different types of fish available, a reduction in the supply of a fish type is likely to increase the price of that species and encourage product substitution.

The market clearing condition for the model is

$$Qs = Q_D. \tag{18}$$

The equilibrium price is determined by solving equations (16) and (17) for P. Due to the functional form of the supply and demand function, an analytical solution for price cannot be derived using equation (18). However Newton's iterative method can be used to approximate the equilibrium price. Setting equation (18) to zero

$$F(p) = n^{\alpha} f \left[\frac{\pi}{Pfn^{\alpha-1}\, X\, (1 + (1/n)(\alpha - 1))} \right]^{\frac{\alpha}{\alpha-1-\theta}} X - \varepsilon P - \Upsilon = 0 \tag{19}$$

Differentiating equation (19) with respect to P.

$$F^1(p) = \frac{-\alpha n^{\alpha} fX}{\alpha - 1 - \theta} \left[\frac{\pi}{fn^{\alpha-1}\, X\, (1 + (1/n)(\alpha - 1))} \right]^{\frac{\alpha}{\alpha-1-\theta}} P^{\frac{-2\alpha+\theta+1}{\alpha-1-\theta}} - \varepsilon = 0 \tag{20}$$

Execution of Newtons method requires specification of a starting price P1. A new price is estimated using

$$P2 = P1 - \frac{F(P1)}{F^{1}(P1)}$$

Several iterations using this algorithm will usually cause the estimated price to converge to an equilibrium price. By substituting the estimated equilibrium price into equations (15) and (16), the amount of fishing effort applied by individual fishers and the total supply of fish to the market is estimated.

As indicated above, fishers will be encouraged to enter the fishery until economic rent is dissipated ie equilibrium price is equal to average cost of fish. Average cost of fish (AC) is found by integrating the marginal cost function and dividing by qi

$$AC = \frac{FC}{qi} + \frac{\pi}{(\theta + 1)} \frac{Ei^{\theta + 1}}{qi} \qquad (21)$$

where the constant of integration, FC, is equal to fixed costs.

The decision to enter (or leave) the fishery will depend on the potential entrants (leavers) expectation on the effect of entry on the average cost of fishing and the optimal amount of fishing effort to be applied. Assuming a naieve specification of these expectations so that $AC\ exp_t = AC_{t-1}$ and $Ei\ exp_t = Ei_{t-1}$, potential entrants (leavers) would estimate the quantity of fish that could be profitably marketed (Q_{DES}) using the demand function.

$$Q_{DES} = \Upsilon - \xi \, AC \exp$$

The desired number of fishers to generate this supply (N_{DES}) is calculated from the supply function.

$$N_{DES} = \left[\frac{Q_{DES}}{f \, Ei^{\alpha} \, X} \right]^{\frac{1}{\alpha}} \tag{22}$$

The number of fishers entering or leaving the fishery is modelled as a partial adjustment process

$$n_t - n_{t-1} = \gamma (N_{DES\,t} - n_{t-1}) \tag{23}$$

where γ is the coefficient of adjustment.

Implicit in the above model is the assumption that fishing will always occur provided the price of fish is positive. A minimum price (Pmin) at which firms cease production can be incorporated into the model by substituting (P-Pmin) for P in equations (15), (16), (19) and (20) and adding Pmin to equation (21).

The stock dynamics of the fishery are the modelled using the method developed by Deriso (1980) and later extended by Schnute (1985). The Deriso-Schnute model updates biomass and also incorporates the desirable biological characteristics of age structure, growth and variable recruitment that occurs with some time lag. Thus it is superior to a surplus production model. It has the form

$$B_{t+1} = (1+r)\, S_t B_t - r\, S_t - S_{t-1} B_{t-1} + W_r R_t - r\, W_{r-1} R_{t-1} \qquad (22)$$

where B_{t+1} is the biomass in period $t+1$, r is the Brody growth coefficient, S_t is the total survival rate (taking account of both fishing and natural nortality), B_t is the biomass in period t, S_{t-1} is the survival rate in period $t-1$, W_r is the weight of an individual fish at recruitment, R_t or R_{t-1} is recruitment in period t or $t-1$.

A linear plateau model (Dillon 1977, p 170) is used to represent the stock recruitment relationship. The model implies that recruitment is independent of stock size above a critical biomass. Below this critical level, recruitment is proportionately related to stock size.

Welfare is estimated using producer and consumer surplus. As the demand function is linear, consumer surplus (CS) is calculated as (area ABP* in Fig. 1).

$$CS = 0.5\,((-\gamma/\varepsilon - P)\, Q) \qquad (24)$$

Producer surplus is estimated as the sum of intramarginal rents plus rent to the fish stock. The industry marginal cost of fishing effort curve IMC (non-fish resource cost of fishing effort) is obtained by setting average return equal to marginal cost per unit of fishing effort, and substituting the derived demand for fishing effort into the production function.

$$Q^* = f X n^{\alpha}\left[\frac{\pi}{f n^{\alpha-1} X}\right]^{\frac{\alpha}{\alpha-1-\theta}} MC^{\frac{-\alpha}{\alpha-1-\theta}} \quad (25)$$

Intramarginal rents (IR) are obtained by integrating equation (25) with respect to marginal cost MC (area PminC MC in Fig 1)

$$IR = \frac{(\alpha-1-\theta)}{(-1-\theta)} f X n^{\alpha}\left[\frac{\pi}{f n^{\alpha-1} X}\right]^{\frac{\alpha}{\alpha-1-\theta}} MC^{\frac{-1-\theta}{\alpha-1-\theta}} \quad (26)$$

The equilibrium quantity of fish supplied is substituted into equation (25) to calculate MC. Rent to fish stock is estimated as area P*BC MC in Fig 1.

$$(P^* - MC)\, Q^* \quad (27)$$

Grass social benefits (GSB) generated from fishing in any period is measured by the area beneath the consumers demand curve (area ABQ*O in Fig 1)

$$GSB = (0.5\,(-\Upsilon/\varepsilon - P) + P)\, Q \quad (28)$$

A social cost curve (SCC) is defined by equating marginal revenue with marginal cost, and substituting the resulting fishing effort demand function into the fishery production function.

$$Qs = f n^{\alpha} X\, (\pi/(P\alpha f n^{\alpha-1} X))^{\alpha/(\alpha-1-\theta)} \quad (29)$$

Gross social cost (GSC - area 0Q*DPmin in Fig 1) is calculated by rearranging equation (29) so that price becomes the dependent variable, and then integrating with respect to Q

$$GSC = \frac{-\alpha}{(-1-\theta)} Q^{\frac{-1-\theta}{-\alpha}} (fn^{\alpha} X)^{\frac{-\alpha+1+\theta}{-\alpha}} \frac{\pi}{\alpha fn^{\alpha-1} X} \qquad (30)$$

Net social benefits (NSB) from fishing in a given period are determined as

$$NSB = GSB - GSC \qquad (31)$$

A computer program was prepared using the above equations to simulate price, catch, fishing effort, stock levels and welfare measures [illegible] a hypothetical fishery over 50 time periods. Parameter values used in the simulations are listed in Table 1.

3. RESULTS FOR AN UNREGULATED FISHERY

The model is initially run to simulate unregulated fishing of an unexploited fish stock.

It is assumed that 20 boats are operating in the fishery in year 0. Additional boats enter or leave the fishery depending on profitability.

From Figure 2, catch is initially high, but declines with time. The rate of decline in catch from year 0 to 16 is slow, rapidly accelerating between years 16 to 26 before stabilising at approximately 600,000 kg per year. The decline in catch causes price to increase from $18/kg to $23/kg (Fig 2). Total fishing effort increases, peaking in year 18. It then declines, before stabilising at 29,000 units (Fig 3). Catch rate declines throughout the entire period (Fig 3), as does biomass (Fig 4).

Table 1 Predetermined Parameter Values

Parameter	Value
τ	3,000,000
ε	- 100,000
π	0.05
θ	2
X	10,000,000
α	0.7
f	0.0003
Pmin	2
r	0.2
Wr	1
Wbr	0.7
FC	30,000
γ	0.2
m	0.2

The main cause of the change in total fishing effort is changes in the number of fishers (Fig 5). High profits initially encourage additional boats to enter the fishery. As catch (and profitability) declines between years 16 to 26, the number of boats operating in the fishery also declines, stabilising at 300 fishers.

Recruitment is initially constant (Fig 4). In year 16, biomass is reduced below the critical level (250,000), and recruitment declines from 1.3m to 0.8m recruits per period. The resultant decline in biomass (Fig 4) causes the reduction in catch and fishing effort noted above.

These results demonstrate how the combined effect of individual fishers seeking to maximise profits can cause the demise of the biomass, till the point where recruitment failure occurs. While the species does not become extinct, the potential benefits from exploiting the stock are reduced (catch declines). The social cost of the reduced benefits provides an economic rationale for government intervention to reduce fishing effort. A policy frequently implemented is limited entry. In the next section, the model is run to examine the effect of restricting entry to the fishery.

4. LIMITED ENTRY

A limited entry policy is simulated by restricting entry to 275 boats (the open-access equilibrium is 304 boats). The equilibrium levels for catch, fishing effort, price, biomass and recruitment are provided in Table 3.

Table 3 Equilibrium Values for Selected Parameters in a Limited Entry (275 boats) and Open Access Fishery

Variable	Unit	Open-access	Limited entry
Catch	kg	623,399	854,774
Fishing effort	effort units	29,112	29,132
Catch rate	kg/effort unit	21.41	29.34
Price	$/kg	23.74	21.42
Biomass	number	1,448,813	2,136,602
Recruitment	number	805,734	1,104,394
Boats	number	304	275

From Table 3, the limited entry policy has little effect on total fishing effort, which declines from 29,132 to 29,112 units. However, by restricting entry, biomass is maintained at a higher level (2,136,602 cf 1,448,813), as is recruitment per period (1,104,394 cf 805,734). This causes catch to increase from 623,399 to 854,774 kgs. Catch rate increases from 21.4 to 29.3 kg/effort unit.

While the limited entry policy has generated some benefits (through increasing catch), it has not prevented biomass from falling below the critical level to maintain recruitment (250,000). Further controls are required to prevent recruitment failure.

5. GEAR RESTRICTIONS AND LICENCE REDUCTION SCHEMES IN LIMITED ENTRY FISHERIES

Policies that may be implemented to reduce fishing effort in limited entry fisheries are gear restriction or licence reduction schemes. The economic benefits of these policies are examined in this section. The specific policies evaluated are:

(a) a reduction in the number of licence holders from 275 to 200. This could be achieved through implementing a licence buy-back scheme.

(b) a gear restriction, which reduces the catching efficiency of gear by 13.3%, and maintains the existing number of boats (275). An example of a gear restriction is a reduction in length of net permitted to be used by licence holders.

The reduction in licence holders is modelled by altering the variable, n, in the model outlined above. A gear restriction is modelled by reducing the variable f (implying that each unit of fishing effort becomes less effective) and raising Pmin so that the supply curve shifts upwards. Values for these parameters (see Table 4) were chosen so that both policies had a similar impact on catch (Fig 6) and biomass (Fig 7). This was necessary to validly compare the economic benefits accruing from each policy. In the simulations, recruitment is dependent on biomass in the previous period. Longer lags are easily simulated.

Table 4 Values for Key Parameters to Compare the Effects of a Reduction in the Number of Licences and a Gear Restriction.

Parameter	Policy		
	Existing	Reduction in Licences	Gear Restriction
n	275	200	275
f	0.0003	0.0003	0.002b
Pmin	2	2	3

From Figure 6, both policies reduce catch in the short-run (from 880,000 to 730,000 kgs). They also effectively reduce fishing effort (Fig 8). The reduction in the number of licence holders reduces fishing effort (from 29,000 to 23,000 units). While the gear restriction reduces fishing effort by a lesser amount (29,000 to 28,000 units), each unit of effort is less effective.

The reduction in fishing effort allows biomass to increase above the critical level (Fig 7). Recruitment also increases. The resultant increase in catch encourages licence holders to increase fishing effort (Fig 8). With a gear restriction, fishing effort increases to approximately the same level as it was prior to the policy change (29,000 units). The reduction in licence holders causes a permanent reduction in fishing effort to 24,000 units. As catch is approximately the same in both cases, catch rate is higher with the reduced number of licence holders relative to the gear restriction (40 kg per effort unit cf 33 kg per effort unit, Fig 9). In both cases, catch rate is higher than that obtained before the additional restrictions on fishing effort were introduced. This is made possible by the increase in catch resulting from the higher biomass and recruitment.

Estimates of the economic benefits arising from each policy are provided in Figures 10, 11 and 12. From Figure 10, both policies adversely affect licence holders in the short-run. The decline in producer surplus is greater for a gear restriction than a reduction in the number of licence holders (Fig 10). As biomass and catch increase, producers surplus increases. The greatest increase occurs when the number of licence holders are reduced; annual benefits are greater and become positive more rapidly. Using a 10 per cent discount rate, the net present value of the change in producer surplus is \$5.19 m when the number of licence holders are reduced and \$2.18 m when the gear restriction is implemented.

Consumers surplus reduces following implementation of both policies. However, the increase in catch (Fig 6) and associated decline in price (Fig 13) increases consumer surplus. The discounted net present value of the change in consumers surplus is approximately the same for each policy (Table 5).

In the fishery analysed, consumers benefits are greater than producer (licence holder) benefits. The distribution of benefits between

Table 5 Discounted Net Present Value of Change in Benefits ($m)

Policy	Producers Surplus	Consumers Surplus	Social Welfare
Reduction in licences issued from 275 to 200	5.19	6.90	4.52
Gear restriction	-2.18	6.70	-1.90
Reduction in licences issued from 275 to 225	6.39	8.37	5.57
Reduction in licences issued from 275 to 175	3.70	5.20	3.23
Reduction in licences issued from 275 to 100	-3.91	-2.28	-3.41

producers and consumers depends on the price elasticity of demand. Producers will benefit more than consumers as the price elasticity of demand increases. In this case, the price elasticity of demand (calculated at the equilibrium price and quantity values following introduction of the policies) is 2.1.

Benefits to society from implementing the policies show similar trends to those observed for producers surplus (Fig 12). The discounted net present value of benefits is $4.52 m for the reduction in licence holders and -$1.90 m for the gear restriction.

6. DISCUSSION

Licence reduction and gear restriction policies are often put forward as options to rationalize limited entry fisheries (Copes 1986). A deficiency of these policies is that they allow fishers to substitute non-restricted inputs for those that are restricted, thereby dissipating potential benefits in the long-run. This has caused some economists to suggest that these policies will be ineffective (eg McConnell and Norton 1978). Others (Anderson 1985; Campbell and Lindner 1988) have demonstrated that under some situations, benefits may be positive.

Results presented above indicate that implementation of either a gear restriction or a policy to reduce the number of licence holders will produce positive benefits in limited entry fisheries that are exploited to the point where recruitment is impaired (Fig 10, 11, 12). Moreover, benefits from a reduction in the number of licence holders will be greater than those for a gear restriction.

From these results, it is concluded that policies implemented to reduce the number of licences are preferred to gear restriction policies in fisheries where recruitment overfishing has occurred. A licence reduction policy does not affect the marginal costs of remaining licence holders. A gear restriction, however, reduces the catching efficiency of fishing effort and raises the minimum price at which effort is applied, shifting the marginal cost curve upwards.

From Figure 8, the reduction in the number of licence holders reduces total fishing effort. However fishing effort per licence holder increases from 105.9 to 120.5 units. The expansion in fishing effort reflects the potential that exists for remaining licence holders to substitute fishing time for the number of boats.

Simulations were also run to determine the effect of variation in the number of licensed fishers on benefits from reducing the number of licence holders (Table 5). Results indicate that benefits are sensitive to the number of licence holders remaining in the fishery. If the reduction in licences issued is too severe (eg 275 to 100), benefits to producers, consumers and society will be reduced. Benefits are maximised when the number of licences is reduced to the point where recruitment failure is averted (about 225). Further reductions reduce benefits.

These results imply that licence reduction schemes can produce positive benefits in fisheries where excessive fishing effort impairs recruitment. In fisheries where recruitment is not being impaired, schemes to reduce the number of licences issued reduce benefits. Thus licence reduction schemes may not be very efficient methods of achieving economic rationalisation in fisheries where stocks are not threatened.

REFERENCES

Anderson, L G (1985). Potential economic benefits from gear restrictions and licence limitation in fisheries regulation, Land Economics 61(4): 409:418.

Campbell, H F and Lindner, R K (1988). The Production of Fishing Effort and the Economic Performance of Licence Limitation Programmes, Agricultural Economics Discussion Paper 8/88, University of Western Australia, pp 14.

Cheung, S N S (1970). Contractual Arrangements and Resource Allocation in Marine Fisheries. In A D Scott (ed) Economics of Fisheries Management A Symposium, H R MacMillan Lectures in Fisheires, University of British Columbia, Vancouver.

Clark, L W (1985). Bioeconomic Modelling and Fisheries Management, John Wiley and Sons.

Copes, P (1986). Prawn Fisheries Management in South Australia, with specific reference to problems in Gulf St Vincent and Investigator Strait, report to the Minister of Fisheries of South Australia, pp 219.

Deriso, R (1980). Harvesting strategies and parameter estimation for an age structured model, Can J Fish Aquat. Sci. 37:268-282.

Dillon, J L (1977). The Analysis of Response in Crop and Livastock Production, Pergamon.

Gordon, H S (1954). The economic theory of a common property resource, J of Polit. Econ. 62:124-42.

Gravelle, H and Rees, R (1981). Microeconomics, Longman, London.

McConnell, K E and Norton V J (1978). "Fisheries Management Schemes." In Limited Entry as a Fisheries Management Tool, R B Rettig and J C Ginter (eds), Seattle, University of Washington Press.

Schnute, J (1985). A general theory for analysis of catch and effort data, Can. J. Aquat. Sc. 42:414-429.

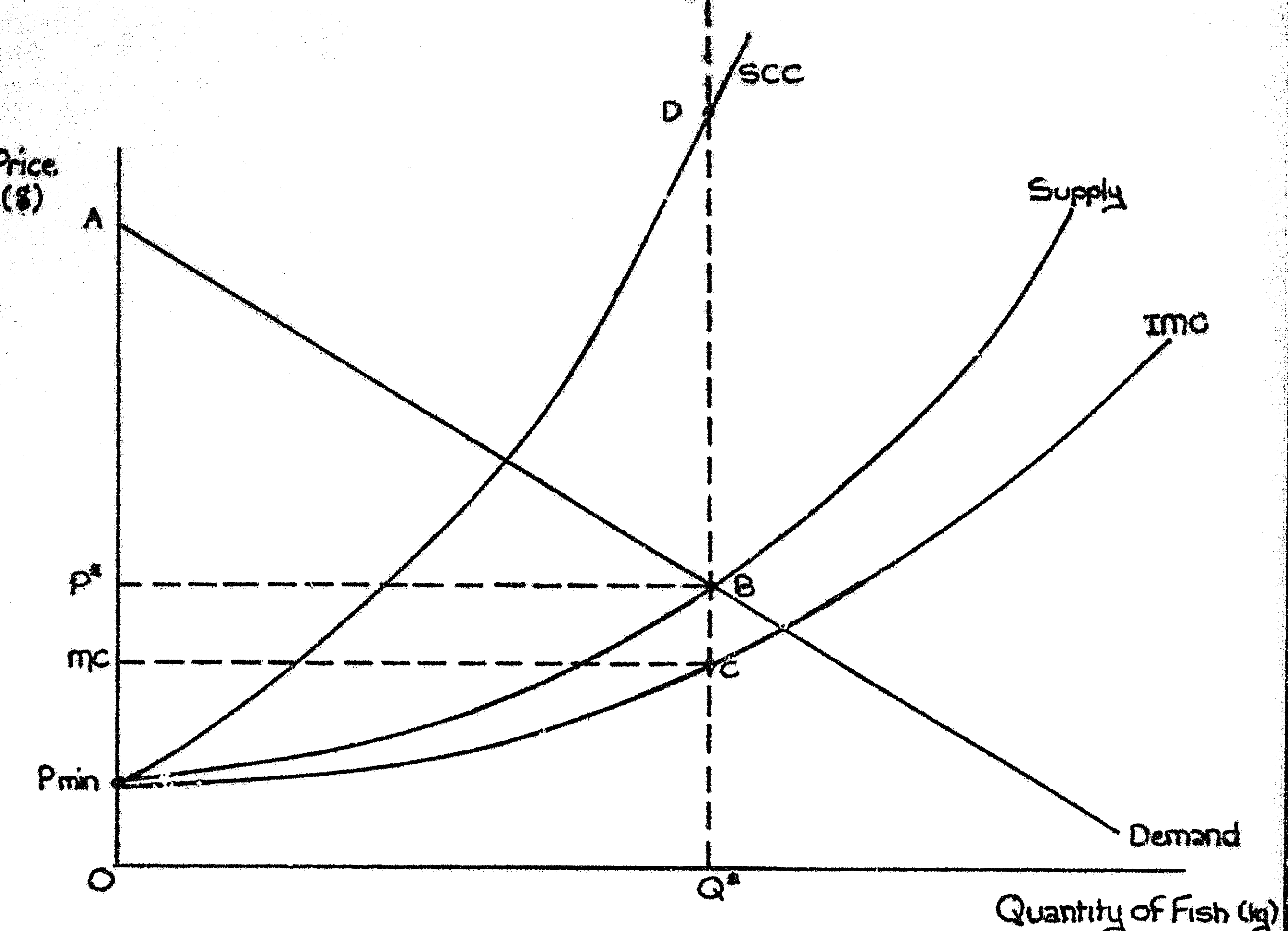


Fig 1 The Economic Model

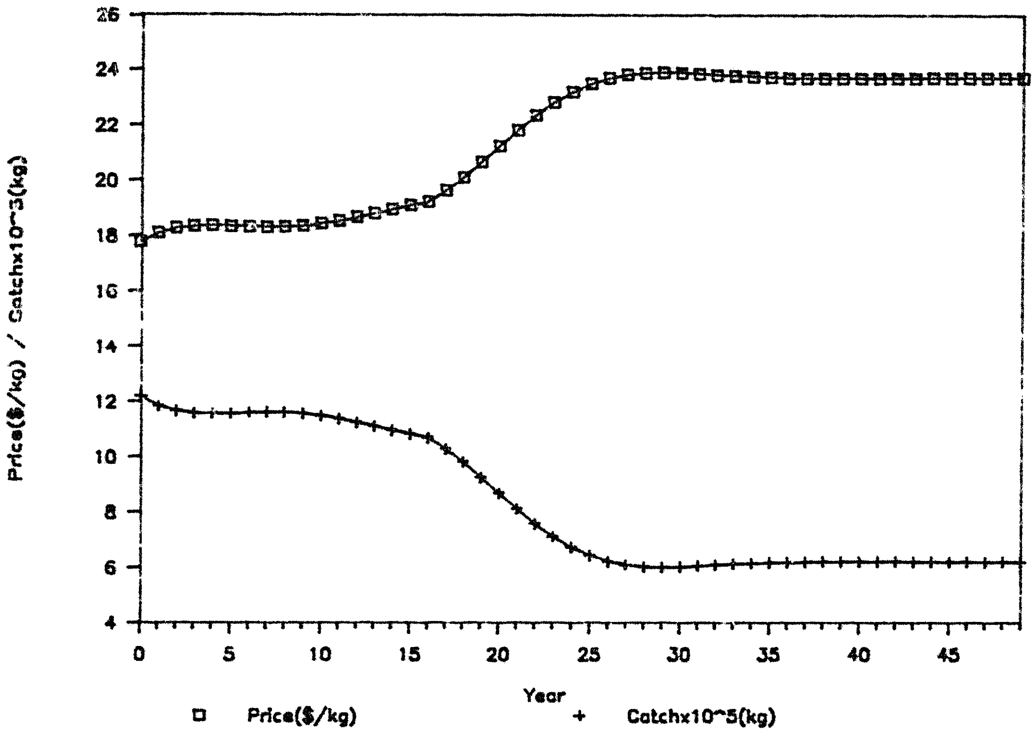
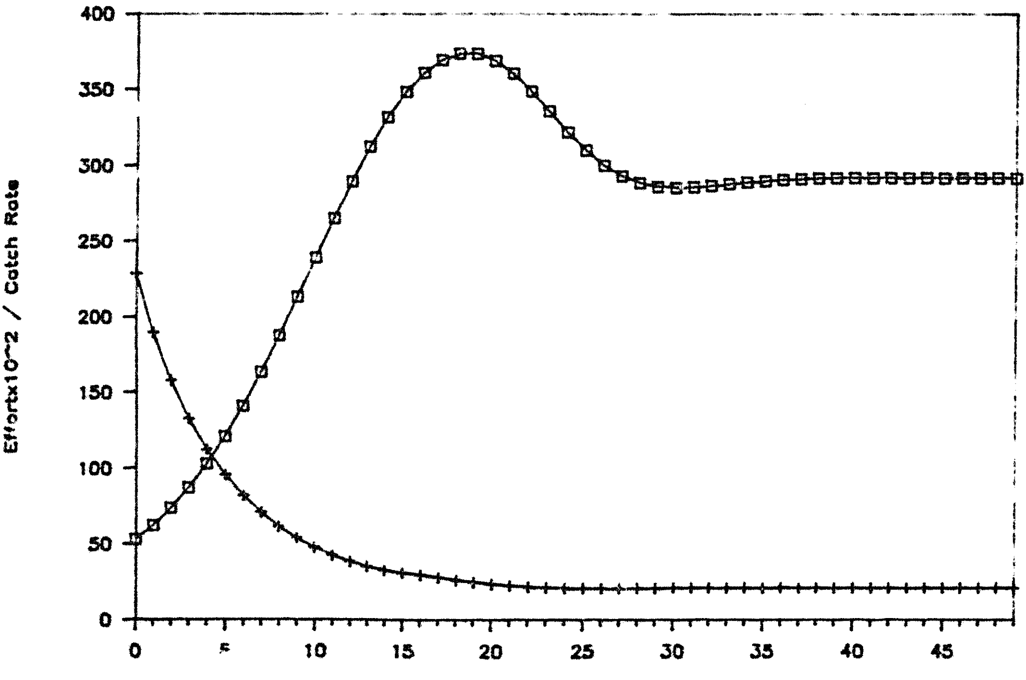
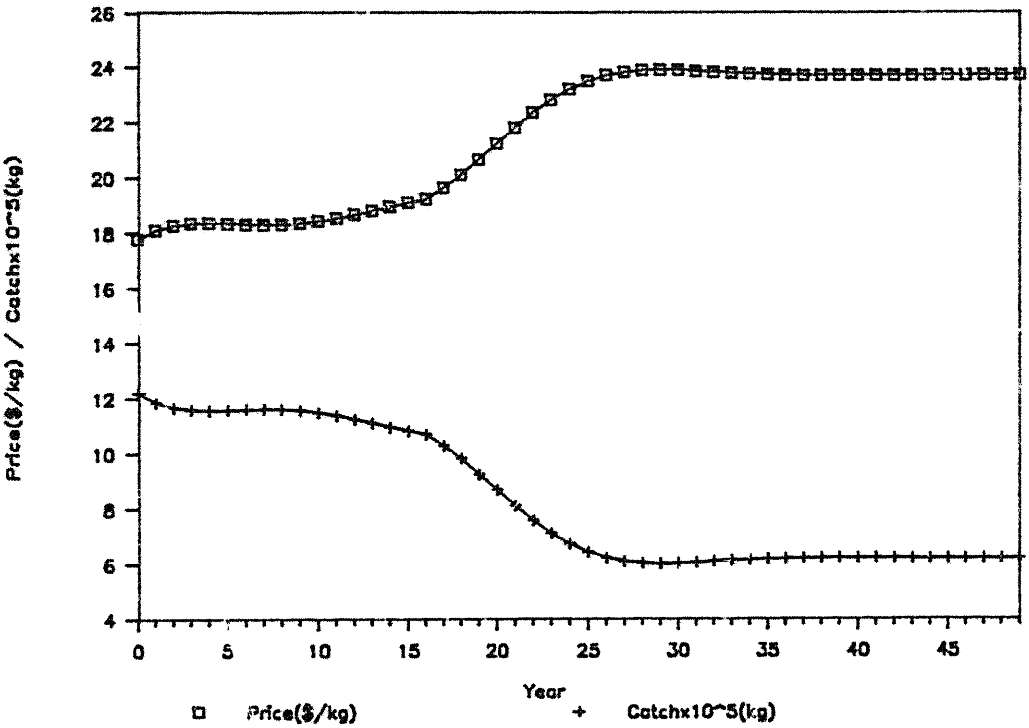


Fig 2 Price and Catch in an Unregulated Fishery





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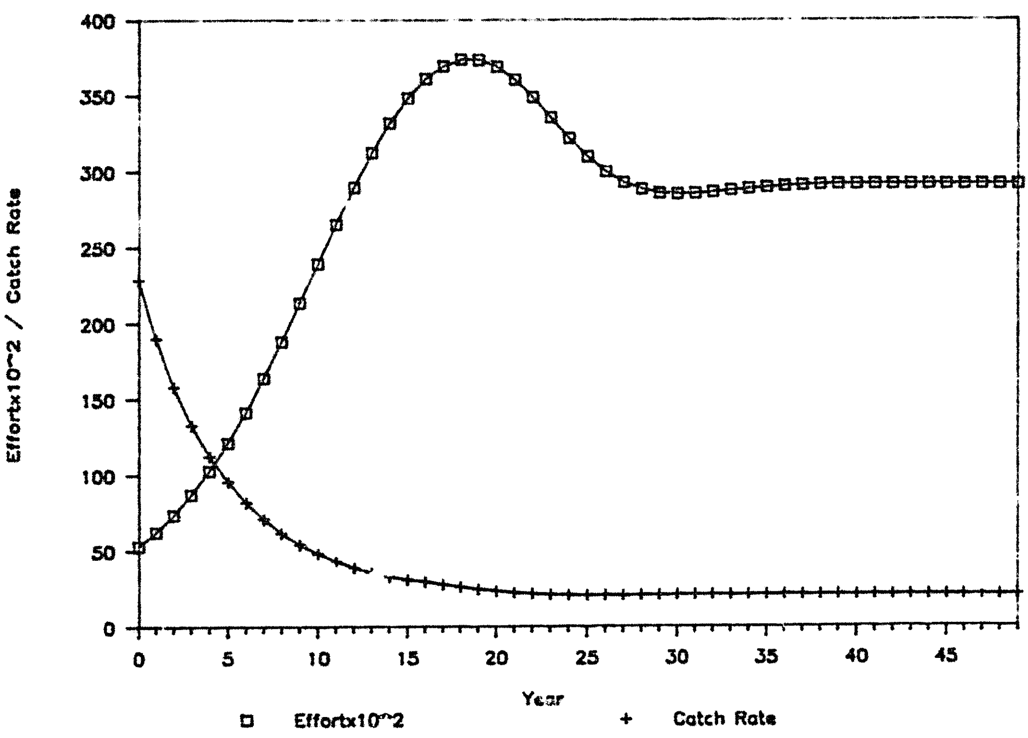


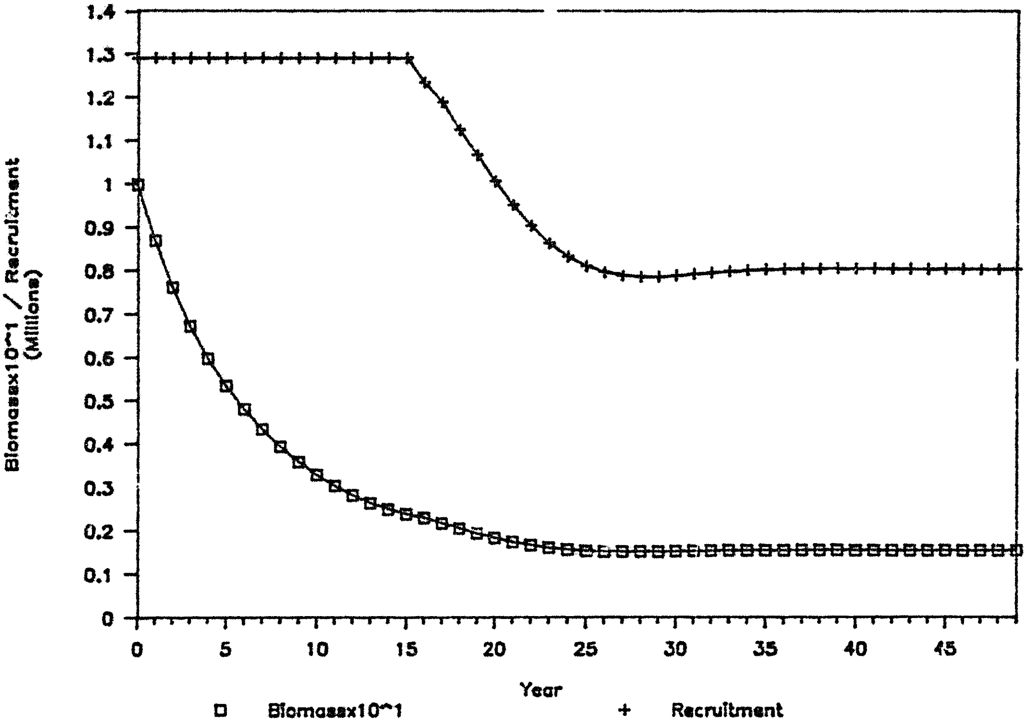
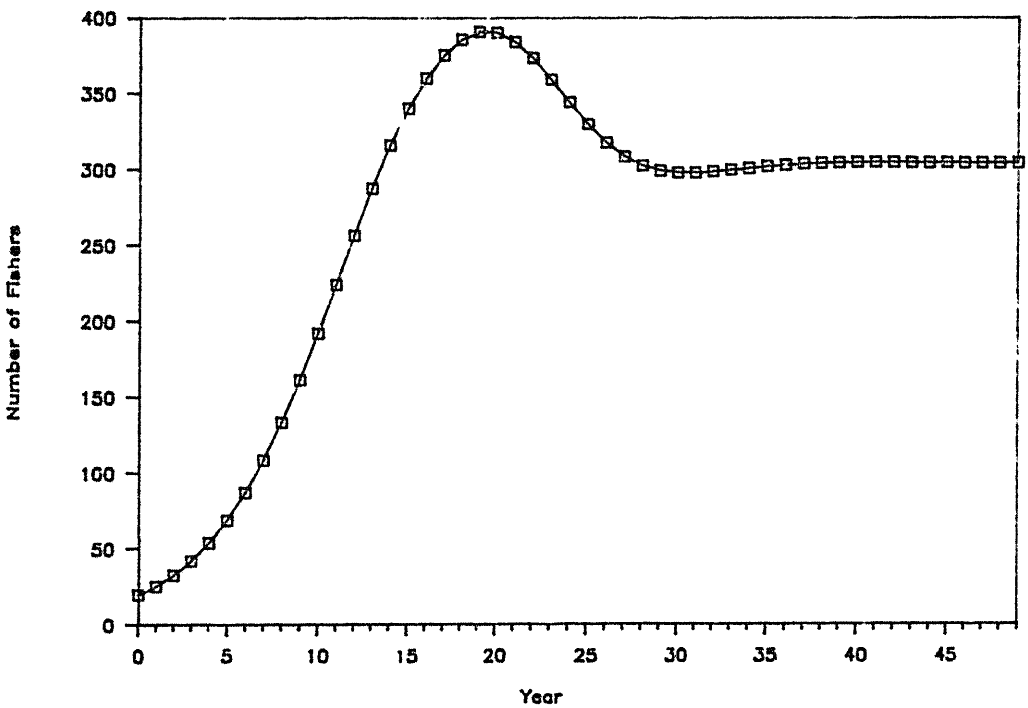


Fig 4 Biomass and Recruitment in an Unregulated Fishery



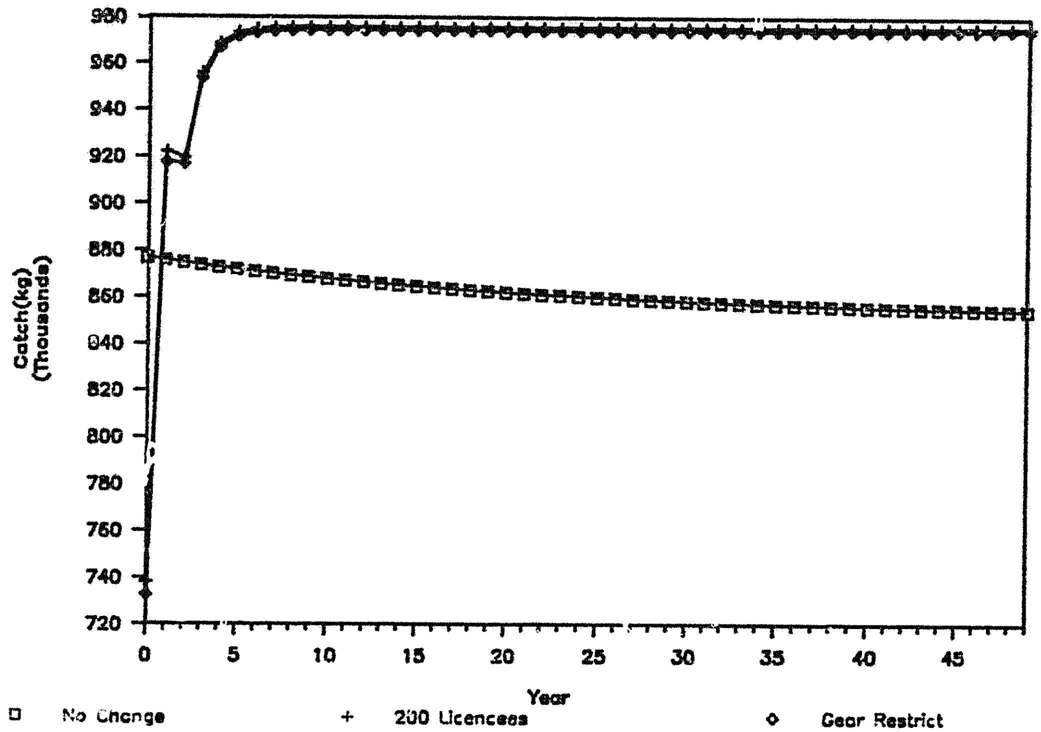
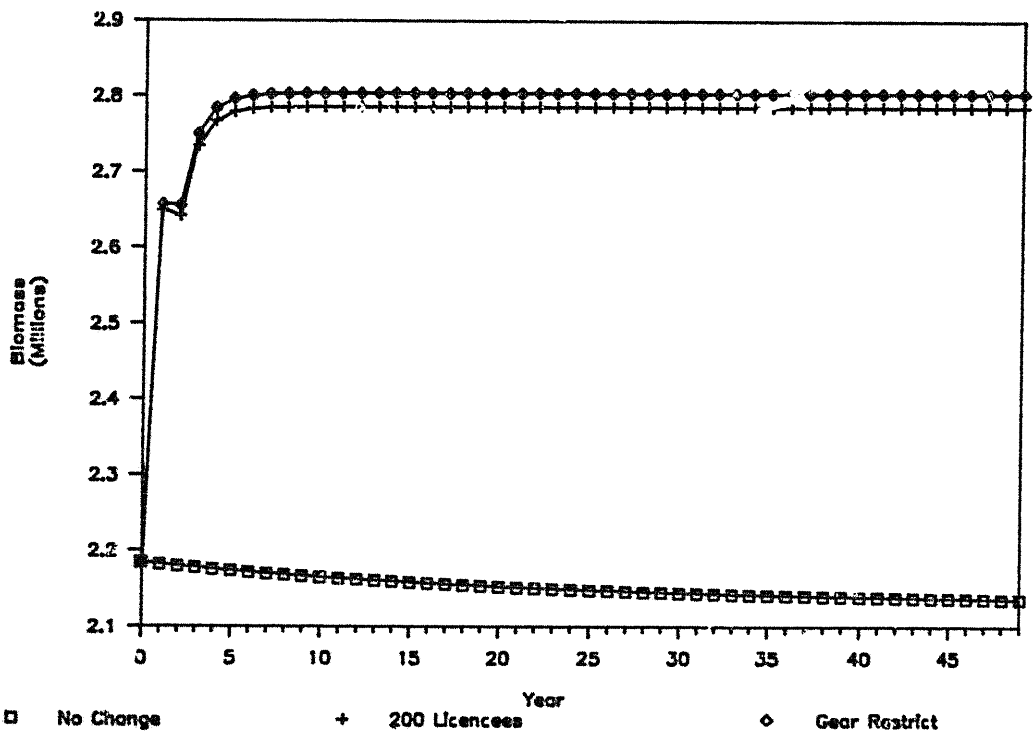


Fig 6 Effect of Reduction in Licencees and Gear Restriction on Catch



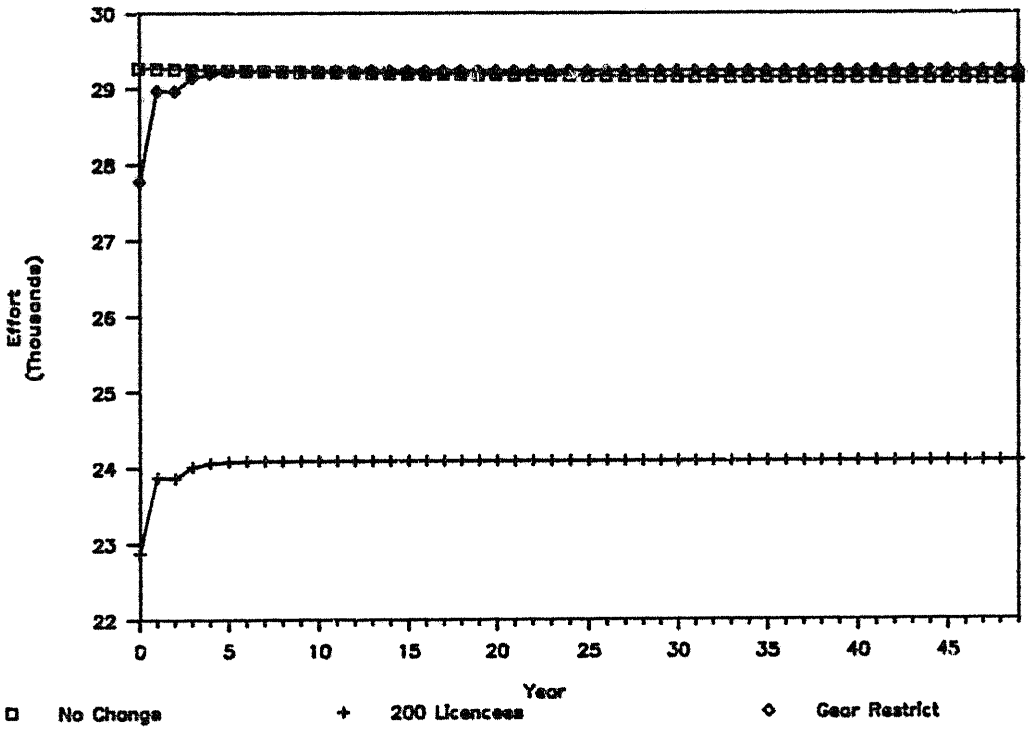
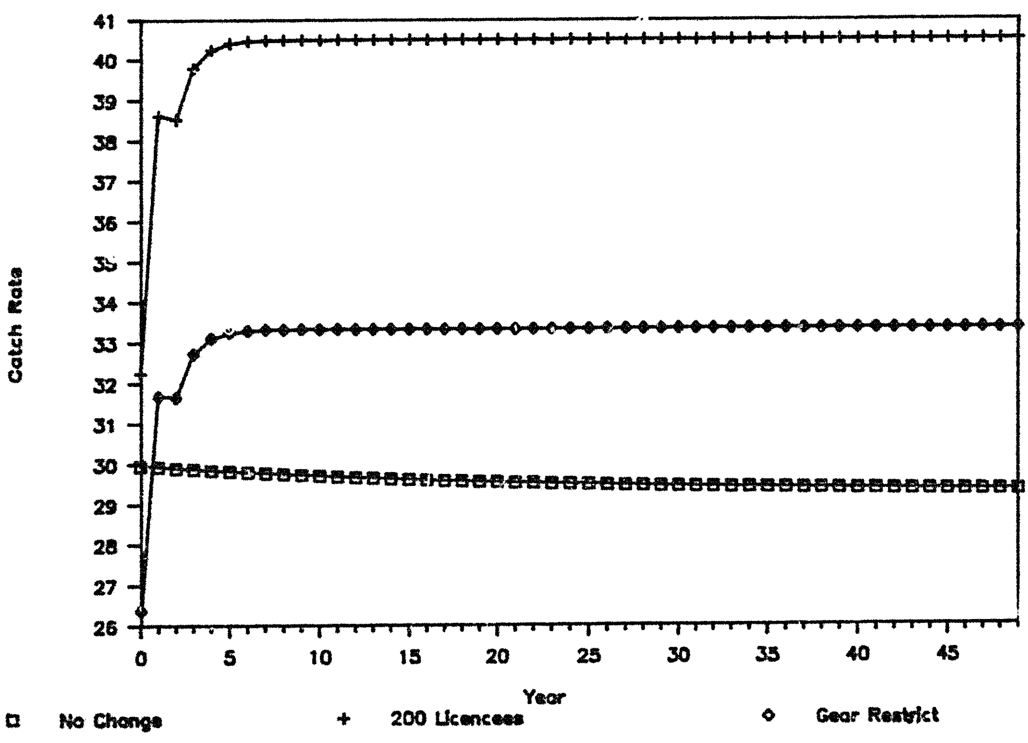


Fig 8 Effect of Reduction in Licencees and Gear Restriction on Fishing Effort



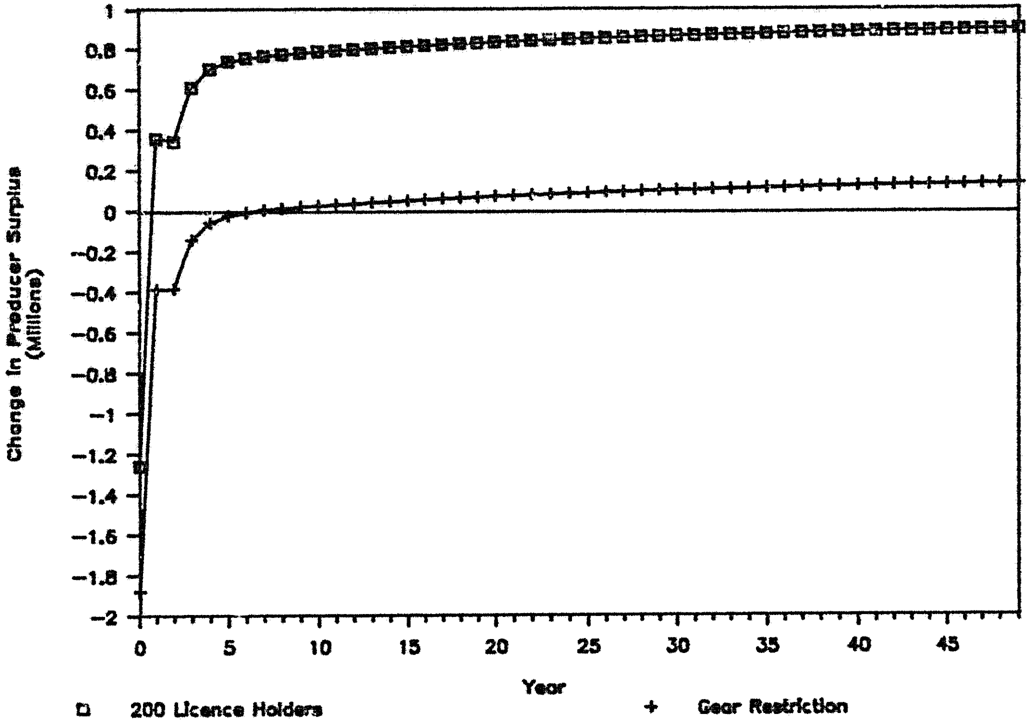


Fig 10 Change in Producers' Surplus from Reduction in Licencees and Gear Restriction

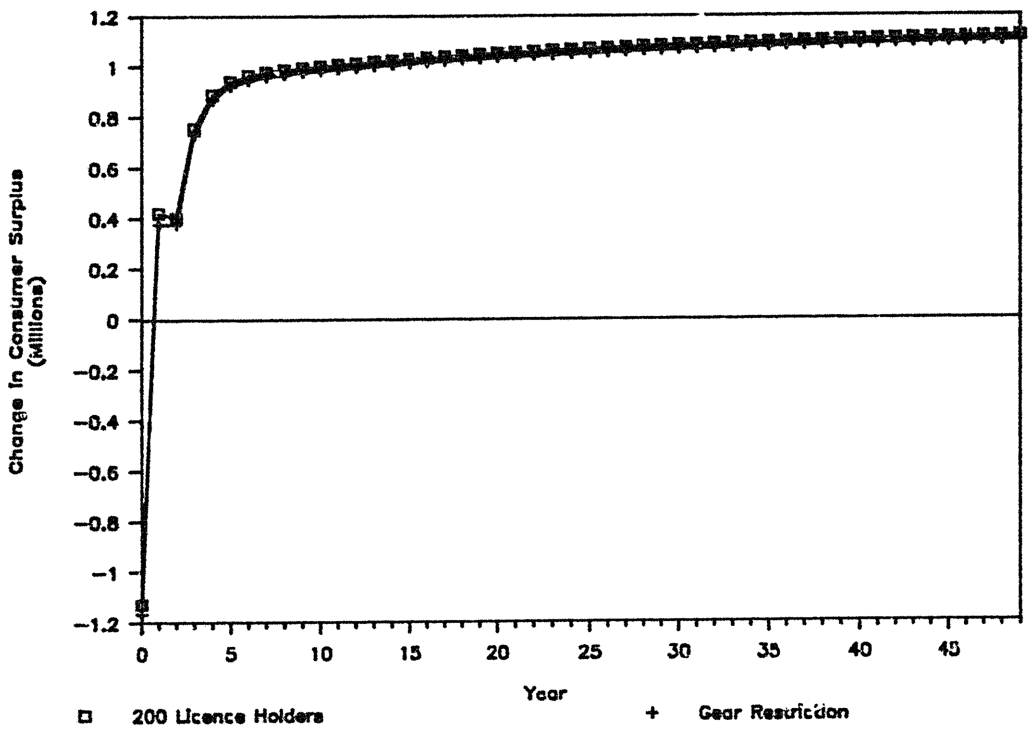


Fig 11 Change in Consumers Surplus from Reduction in Licencees and

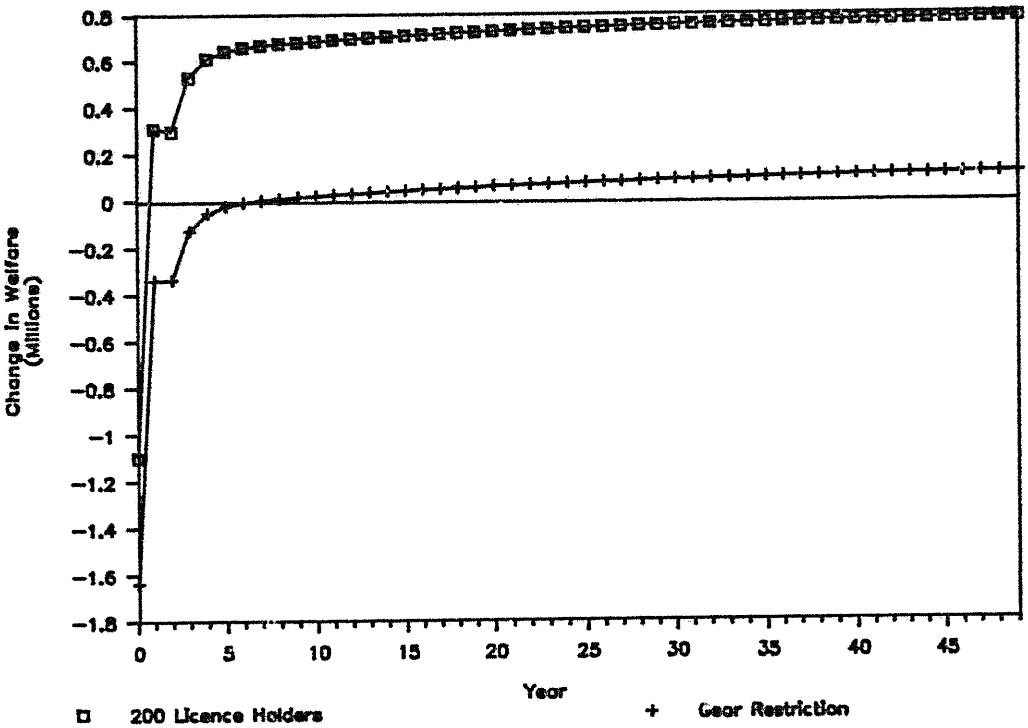


Fig 12 Change in Welfare from Reduction in Licencees and Gear Restriction

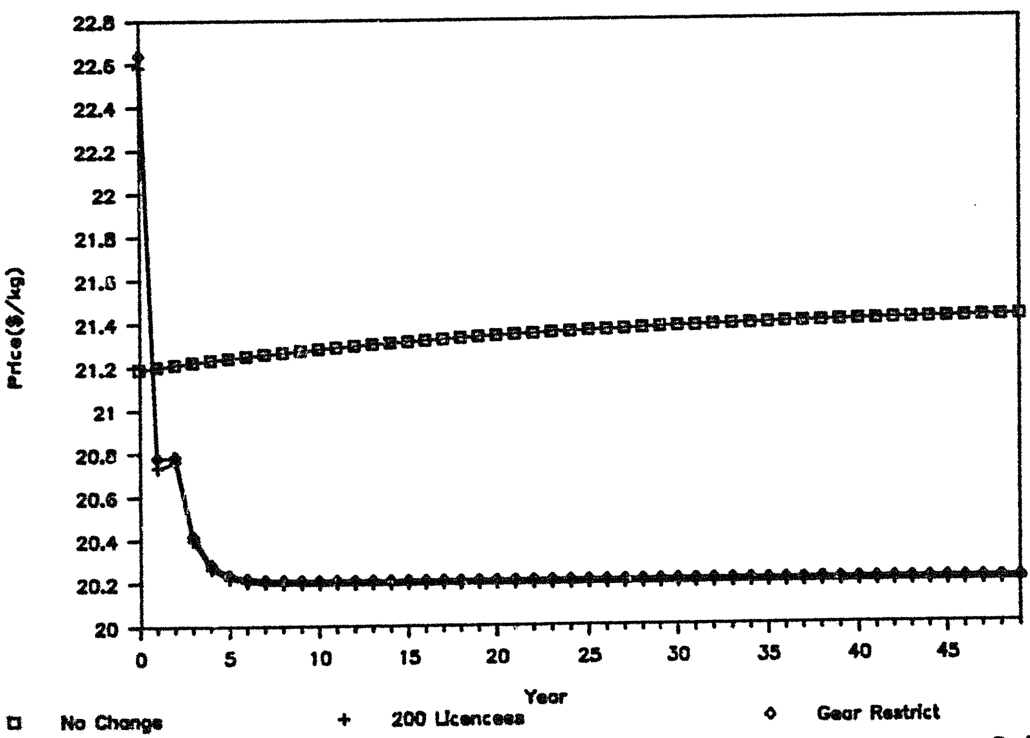


Fig 13 Effect of Reduction in Licencees and Gear Restriction on Price