NEW ZEALAND'S INSHORE FISHERY: A PERSPECTIVE ON THE CURRENT DEBATE

R.A. Sandrey

and

D.K. O'Donnell

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PREFACE

This Research Report presents a comprehensive review of the theoretical aspects which should be considered in the evaluation of options for management of the New Zealand inshore fishery. Publication of this material is intended to stimulate a rigorous examination of the basis for fisheries management policies. The point is made that all aspects of the situation should be included in the analysis of policy options and that the resulting policy should be determined efficiently upon the basis of economic and social objectives.

Dr R A Sandrey is a lecturer with the Department of Agricultural Economics and Marketing at Lincoln College and Ms D K O'Donnell is the Scientific Liaison Officer with the Department of Scientific & Industrial Research, Wellington.

R. G. Lattimore
Director

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SUMMARY

The New Zealand inshore fin fishing industry has a problem of overfishing in certain prime species. This report examines the historical, distributional and economic efficiency aspects of managing the inshore fishery.

Overfishing occurs when excessive harvesting reduces fish stocks below some desirable level and future benefits are foregone to provide for consumption now. Reducing harvest to correct for overfishing will lead to another problem - that of overcapitalisation. This occurs when a given level of harvest could be achieved by using less of societies financial resources.

Chapter three looks at the effect of open access on a renewable resource and shows why an individual fisher has no economic incentive to preserve fish stocks under these conditions. The dynamics of fisheries harvest will lead to reduced future stocks in many situations unless some form of supply control is imposed. However, differences between maximising fish harvests and maximising the discounted present value of a resource are discussed and it is shown that in most cases, maximising physical yields is not an economically optimal solution.

Alternative methods of reducing harvest are discussed. Gear restrictions and season closures neither address the common property issue nor lead to a minimum cost harvest. Taxes, either input or output, are theoretically appealing but difficulties include political opposition to their introduction, lack of flexibility in handling stochastic influences, and the problem of fishers locked into the industry with low incomes. The licensing of vessels or fishers is only a short term solution as technological changes can increase current capacity, thus continuing both overfishing and overcapitalisation.

Finally, given that supply control is needed, transferable quotas present an excellent long term solution. However, the working of these quotas depend upon the initial allocation, accurate estimation of the quota level, and intervention costs. The issues of initial allocation of quotas and the distribution of economic rents are the two major equity issues involved with an introduction of quotas. Both of these issues are discussed.

Chapter six looks at economies of scale in the fishing industry using duality theory. Constant returns to fuel and diseconomies of scale to labour are found to exist, although the restrictive assumptions used in the analysis may limit the importance of these findings.

If supply controls are introduced, effort transfer to less preferred and alternative fish species should be encouraged to lessen the need to instigate a buy-back policy and to reduce disruption to sectors of the fishing industry other than fishers. It is shown that the opportunity cost of not harvesting prime species and the initial infant industry costs may be accentuating the pressure on prime species. Transferable quotas will alleviate the first problem and some form of assistance may be needed to overcome the second problem.

Several alternative species are shown to have potential value to the inshore fishery. Additionally, quality improvement (added value) and the need for fisheries extension services are discussed. The conditions which would lessen the need for an intervention policy are listed. A discussion showing the effects of each of these is given with snapper as an example.

Finally, it is considered that before any policy is adopted it must be shown that clear economic benefits result from a change in the present system. The paper argues that the presence of biological overfishing is not clear proof of the need to restructure the industry. However, if supply control is introduced then transferable quotas are economically efficient provided that enforcement and administrative costs are not excessive. Equity is ensure if initial allocation is fair and the rents accrue to the residents of New Zealand. The industry in general need not suffer if consideration is given to effort transfer.

CHAPTER 1

INTRODUCTION

The New Zealand inshore fin fishing industry has a problem of overfishing in certain prime species. This situation occurs when excessive harvesting reduces fish stocks below some desirable level and the future regeneration of these stocks is threatened. This imposes a "cost", in the form of a sacrifice of future potential harvest and consumption of the stocks. In resource economics, the present value of this cost has become known as the "user cost". Additionally, the cost of overcapitalisation is borne by society if corrective measures are needed to reduce fishing effort. Overcapitalisation occurs when the desired level of harvest could be obtained by employing less financial resources than are currently being employed.

If a reduction in harvest is called for, then by definition this reduced harvest can be obtained by less effort than is currently being employed and excess capacity will initially exist in the industry. Thus, a solution to the first problem inevitably causes the second problem. Normally problems of overcapitalisation can be corrected over time by a transfer of financial resources to alternative sectors of the economy using the familiar market mechanism. However, resources become locked into the industry, thus accentuating the initial problem of overfishing.

Species facing severe overfishing are snapper, trevally, groper, school shark and rig. Additionally, some overfishing may be occurring with terakihi, red gurnard and warehou. Regionally, Northland (East Coast), West Auckland, Hauraki Gulf and the Bay of Plenty face the most serious problems. Concern over this problem has been intensifying over the last three years, during which time a ban has been imposed on any increase in the inshore fishing effort. This moratorium was only designed as an interim measure and currently a longer term solution to the problem of too much pressure on the prime species is being considered by fishers. The proposed new package of measures has a plan to allocate individual transferable quotas to fishers, and to incorporate financial assistance to fishers who voluntarily reduce their catches. It has been estimated that some $28 million of taxpayers' funds may be needed to effect this reduction, of which $26 million is needed in the four North Island regions mentioned above (National Fisheries Management Advisory Committee, 1983).

Only a small number of vessels land most of the inshore catch, with some 1.5 percent of the fleet landing half the catch. Twenty percent of all vessels account for ninety percent of the catch. During 1983 additional measures were taken to preserve the fish stocks and some 3,500 part-time and smaller operators were removed from the industry. No compensation is sought for these part-timers who represented half of the fishers and landed about five percent of the domestic catch (Berryman, 1983). Although a few of these fishers have been able to reinstate their licences, most have been forced to leave the industry. No research has been undertaken into the social and economic backgrounds of these part-timers or the impacts on their lives or livelihoods of removing their licences.

This report summarises the historical, distributional and economic efficiency aspects of managing the inshore fishery. The proposed new management measures are examined from these perspectives. A discussion on how economic and biological considerations affect the inshore fishery is given using New Zealand snapper as an example. The potential for effort transfer is considered as a solution to the overfishing problem in certain species.

CHAPTER 2

OVERVIEW OF THE HISTORY OF FISHERIES MANAGEMENT

Whaling was introduced to New Zealand in 1792, almost 50 years before British sovereignty was proclaimed and before the first immigrants arrived under an organised colonization scheme. By the turn of the 19th century falling prices for whale products and the drastic reduction of commercially important whale species lead to the demise of the industry. Populations have never fully recovered.

New Zealand's jurisdiction extended to three nautical miles off the coast - historically the distance of a cannonball shot. By 1914 a policy of judicious exploitation was introduced, coupling fisheries development with conservation. This policy was reversed in 1927 with conservation as the sole objective. Seasonal closures for all methods of fishing were introduced and Danish seining was prohibited because it was deemed to be excessively efficient. Northern fishers established a strong and successful lobby to get an exemption for their area. In 1929, trawling in the Hauraki Gulf was also prohibited.

Licensing was introduced in 1936 for the catching, wholesaling and retailing sectors under the first Labour government. Further action was taken in 1937 following concern at overfishing although the total catch at the time was only 30,000 tonnes. This catch level ought to be compared with the 470,000 tonnes that was extracted from New Zealand's waters in 1977, although the latter case included the deep water fishing. It seems likely that in the aftermath of the Depression fishers were concerned with depressed market prices for fish (Riley, 1980).

In 1945 a one-man licensing authority was established which introduced minimum fish sizes, gear restrictions, area closures and non-transferable vessel licences. These licences specified one port for landing fish. Although the sale of licences was technically illegal, the fishing industry appears to have had little difficulty in finding ways around the law. Old fishermen tell stories of rotten-hulled dingies with a licence number clearly painted on the side being sold for thousands of pounds. A wide disparity in fish prices was also evident at this time. The fact that high priced prime species in one port were being discarded in other ports and vice versa, simply highlights how familiarity with fish species can lead to entrenched consumer attitudes. With high profits obtainable from prime species there was no pressure to market the lesser known species.

By 1955 the restriction to land into only one port became impractical. Larger vessels with a greater fishing range blurred the boundaries between the different regions. This restriction was removed but limited licensing remained. Enthusiasm for developing the fishing industry and its export potential culminated in open access fishing being introduced in 1963 along with the formation of the Fishing

Industry Board. In 1965 New Zealand's fishing zone was extended to 12 miles. Foreign licensed vessels were phased out of this zone and only allowed to operate more than 12 miles offshore by 1970 (Bradstock, 1979). This changed in 1978 when the 200 mile Exclusive Economic Zone was put into effect. The effects of this additional effort beyond the 12 mile zone are being felt today. A second major cause of over-fishing was the encouragement given to the domestic industry by the Government from 1978 to 1984 in the form of low interest and suspensory loans and duty free importation of new and near-new vessels.

A raft of controls were introduced in 1963 for the Foveaux Strait Oyster Fishery to prevent the explosion of fishing effort which would have accompanied open access. This has generally been lauded as a management success. In contrast, the Nelson scallop fishery collapsed within 15 years of having an open access policy. Scallops, Ellesmere eels and rock lobster are now all managed through controlled fisheries.

In recent years foreign effort has largely been replaced by co-operative ventures and domestic deepwater vessels. The squid and bluefin fisheries are controlled by vessel numbers but the deepwater demersal fishery is managed through a policy of individual transferable quotas which was introduced in 1982.

CHAPTER 3

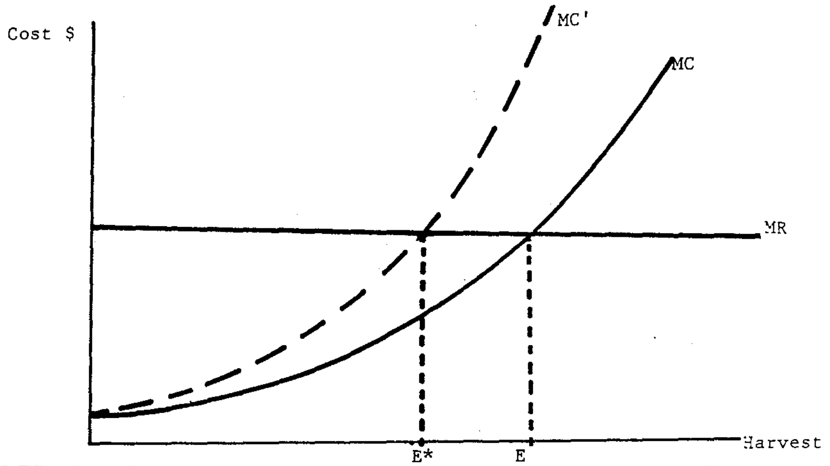
THEORETICAL ISSUES OF FISHERIES MANAGEMENT

The effect of open access on a renewable common property resource is well known to analysts. The following account summarises some of the major points to set the stage for the discussion later in the paper.

It is instructive to begin the analysis by looking at a representative individual fishers harvesting decision. Following the basic managerial response of operating where marginal costs are equated to marginal revenue (i.e. the cost of the last fish landed is equal to its contribution to revenue), each individual will harvest at point E as shown in Figure 1. Marginal costs facing the fisher (MC) are rising, and the contribution to revenue (MR) of each fish is constant as more and more fish are harvested.[1] Included in the marginal cost are the operating costs of running the vessel (fuel, crew, depreciation, etc) and all opportunity costs faced by the fisher. These opportunity costs are the value of resources (capital, labour, management) in the next best alternative use. However, not included in these costs are the user costs introduced earlier. These user costs are included in the societal cost curve, MC'. Although each individual will be affected in the future by collective harvesting decisions, a given fisher has no economic incentive to reduce harvest in the current period. If individuals had that incentive (or compulsion) to reduce harvest, the socially optimal harvest of E* would be the individual fishers response, where MC' is equated to marginal revenue. This is

FIGURE 1

Individual Fishers' Cost Curves



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[1] Although marginal revenue for the industry may be declining, most individual fishers will not influence the price of fish.

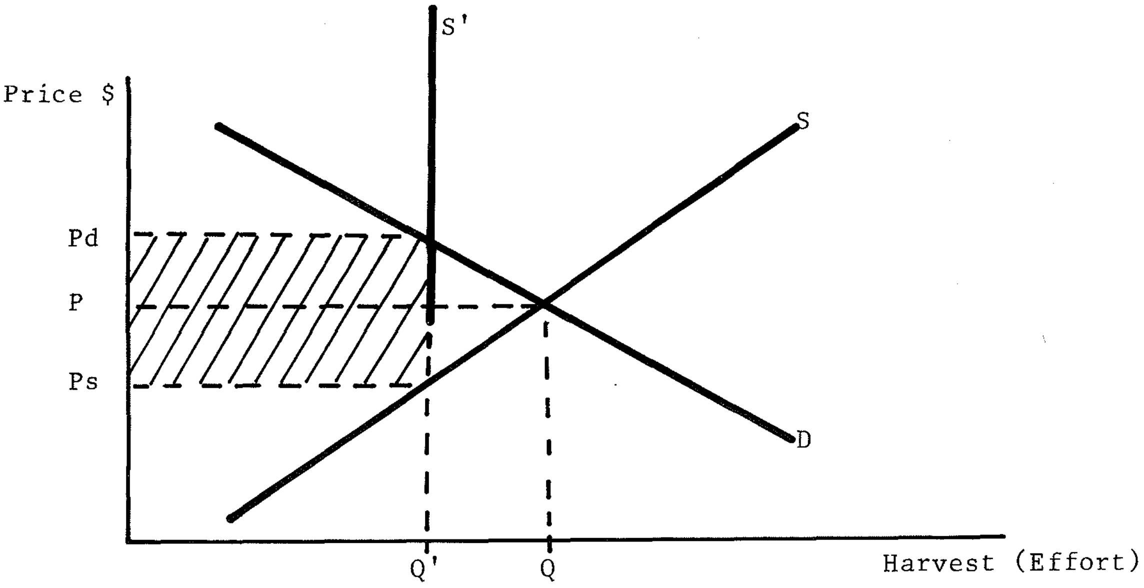
essentially the tragedy of the commons - all fishers contribute to the problem and would benefit from its solution, but no incentive is offered to individuals to work towards a reduction in harvest under an open access policy. If one fisher reduces harvest, that catch will be landed by another.

Resource management of a common property resource is firstly a problem of finding the optimal harvest (E*) for each specie which maximises collective benefits over time from the resource stocks. Secondly, fisheries resource management is concerned with designing a scheme to ensure that the catch is restrained to that level. Returning to Figure 1, this means we should reduce effort and move back towards E*. Finding the optimal level of effort is a complex calculation, and presumes an understanding of parameters that in practice are seldom knowable with precision. So far we have been concerned solely with private resource use. However, intervention by the State to direct private resource use introduces the need to economise on tax funds as well as fishery resources. As Wilson (1982) points out, it is not difficult to conceive of a fisheries management scheme in which the gross social benefits of improved fisheries management are outweighed by the costs of intervention by the State or a State sponsored agency.

A static analysis can be useful to demonstrate the immediate effects of reducing effort. This is shown in Figure 2, where industry effort is reduced from Q to Q'. Fish prices will increase to the extent that demand is less than perfectly elastic, as demonstrated by the move from P to Pd in Figure 2.

FIGURE 2

The Value of Fish Quotas

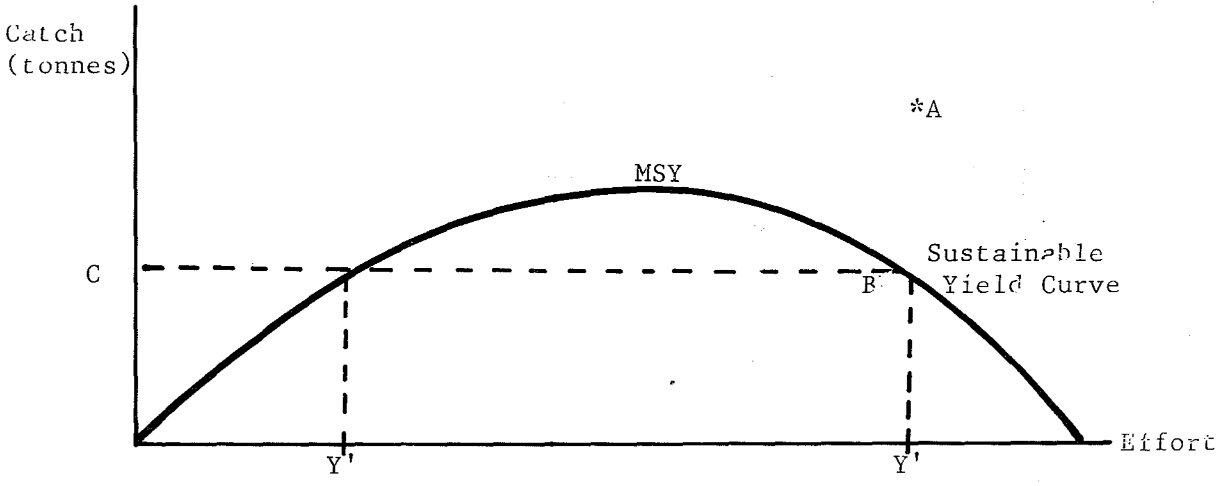


In the presence of the quota restriction, economic rents accrue to the quota holders equal to the differences between the demand (Pd) and supply price (Ps) per unit. To the extent that marginal operators harvest costs are above average industry cost this will understate economic rents and enable the efficient operator to pay more for a quota. This raises two distributional issues. The first concerns who should receive the rents - the State, all existing fishers or large fishers. The second issue concerns how to transfer quotas. These issues will be addressed later.

The collective effect of individual operators can be seen by examining the diagram (Figure 3) used to demonstrate the common property problem. As more and more effort is put into fishing,[2] the catch (in tonnes) will first increase. As the effort continues to increase, the catch will initially increase. However, this increase (shown as point A) is not sustainable. The greatest sustainable catch possible is at Ymax, the so-called maximum sustainable (MSY). Point B with a catch of C tonnes is the best that can be hoped for by continuing to harvest with effort at Y. Biological overfishing is, by definition, taking place as the stocks are being harvested faster than they can be regenerated. Note also that a catch of C can be accomplished with either effort Y or Y'.

FIGURE 3

Catch/Effort Relationships



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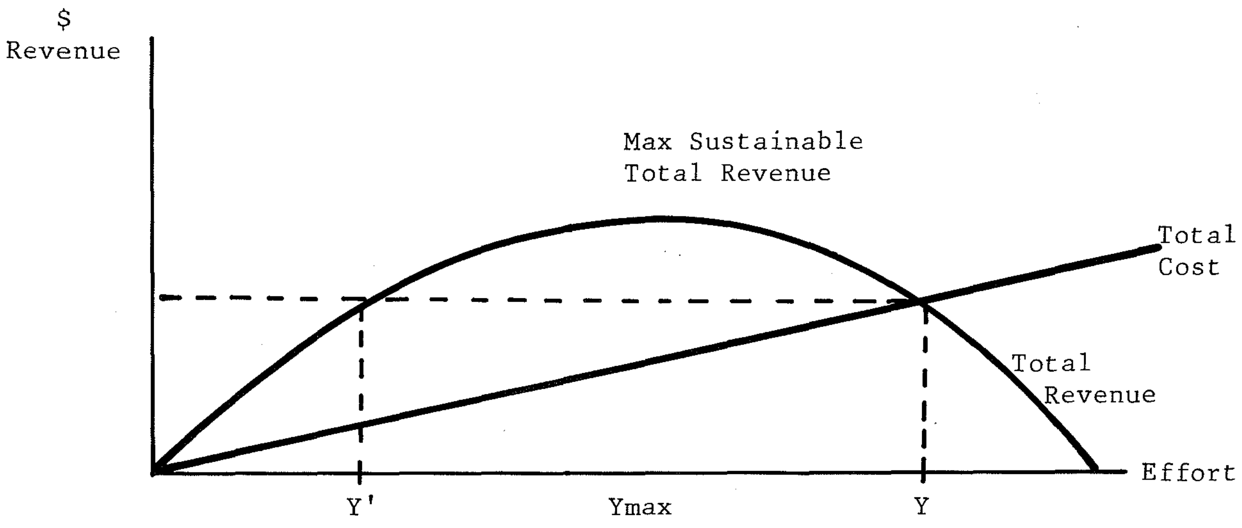
[2] This effort can either be measured by increased effort from existing operators or new entrants to the industry. Both are possibilities in an open access situation as long as economic incentives operate to expand effort.

Given the relationship above and common property conditions, at what level should the fish stocks be harvested? To conceptualise this, refer to Figure 4, where the sustainable yield curve is translated to total revenue expressed as a function of effort. This is a long term equilibrium situation, as is Figure 3. The sustainable yield curve (Figure 3) and sustainable total revenue curve (Figure 4) will have a similar shape, with any difference caused by the price responsiveness of the market. Total cost is the cost faced by individuals and does not include the user cost. Effort will expand to Y, where total costs are equated to total revenue.[3] The same total revenue can be obtained at Y' with less effort, thus a misallocation of resources is occurring. An economic rent to the resource is indicated at Y' by the difference between total revenue and total cost. Maximisation of this economic rent will occur at some undetermined point where marginal costs equal marginal revenue, and this point is referred to in the literature as the maximum economic yield. Many authors have suggested that maximum economic yield is desirable, but as Clark (1976, p.30) points out, this ignores the dynamics of the model. All we can say is that if stocks are threatened at Y, then it is probable that effort should be reduced from Y.

FIGURE 4

Fishing Effort and Revenue



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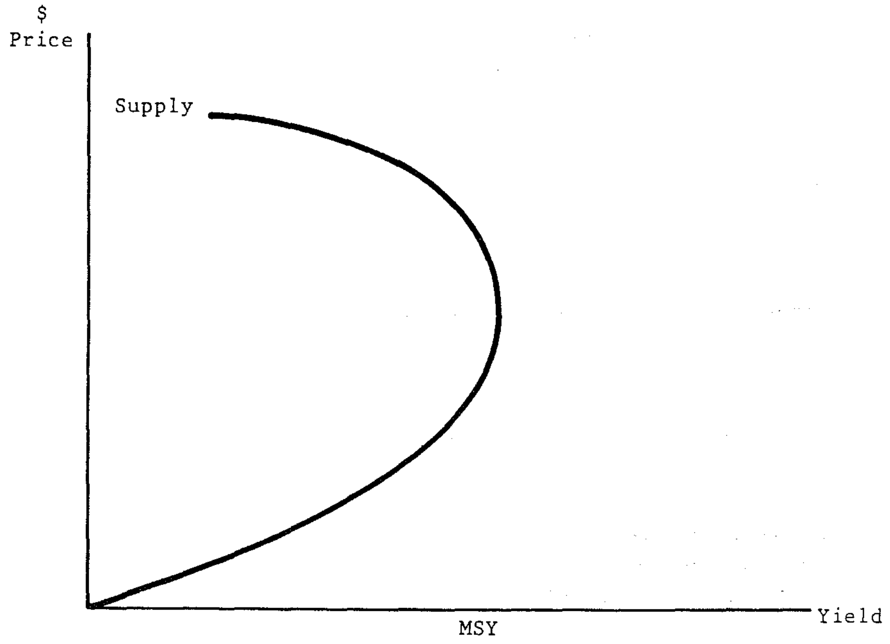
[3] This is because new entrants will be attracted to the industry as long as some profits can be made. This will continue until all rent is dissipated (Clark 1976, p25-26).

Although Figures 3 and 4 help to understand the nature of a common property resource, many questions are ignored. For example, is the total revenue curve changing because of changes in total yield or is there a price response? As shown in Figure 2, both the price effect (slope of the demand curve) and the marginal cost (slope of the supply curve) will influence the economic rent, so it is important to know these relationships. Additionally, the role of discounting is ignored. If a zero discount rate is used and there is no price effect, then the biologically optimal point (YMAX, MSY in Figure 3) and the point of maximum total sustainable revenue will be the optimal harvest level. When these conditions do not hold, then finding the economically optimal harvest rate becomes complex, and could be to either the left or right of the MSY point. Obviously, any harvest greater than MSY (point A, Figure 3) cannot be an equilibrium level of harvest, and this point is elaborated upon in the next two diagrams.

Decreasing current effort to Q' will increase the harvest in the future if overfishing is taking place. This is the backward bending supply curve in a dynamic sense, and is shown in Figure 5. Effort increases as the price rises, short term yields increase (point A, Figure 3) past a sustainable yield (MSY), and future yields decrease as this level of harvest cannot be sustained. (Clark, 1976, p.154; Hannesson, 1979, p.65).

FIGURE 5

<u>Backward Bending Fish Supply Curve</u>

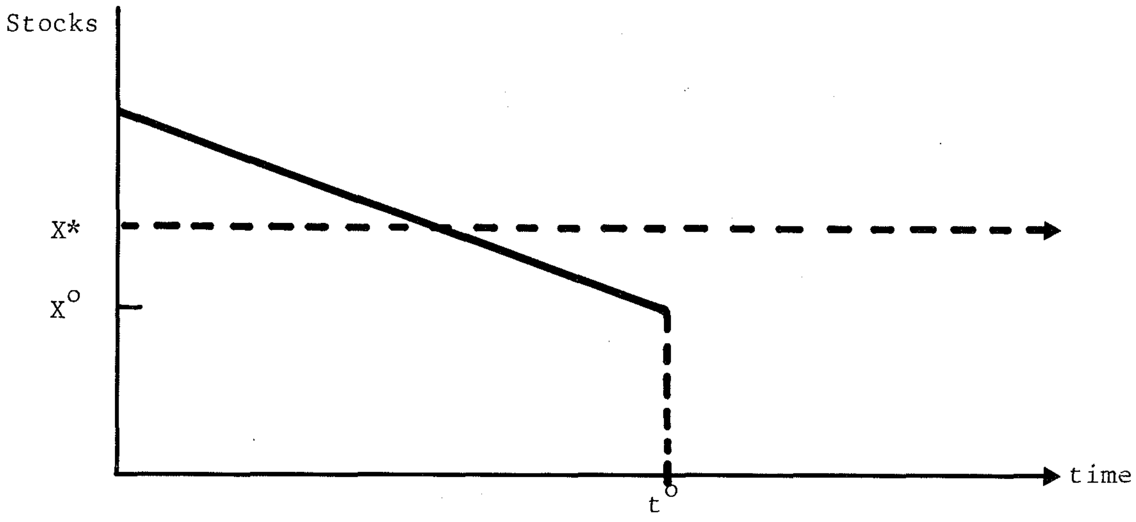


Unless some restriction is placed on harvest, an open access situation may lead to reduced future supplies where high prices entice increased effort from fishers. The same result can be expected from an artificial lowering of the cost structure, as has happened in New Zealand with input subsidies (New Zealand Treasury, 1984).

Dynamic effects upon the fish stocks are shown in Figure 6. Starting from the current time period (t^0), fish stocks are at a level given by X^0. Concern is expressed because the optimal stock level is considered to be higher at X^*. Resource managers now have to decide upon an optimal time path from time t^0. This is precisely the problem for some species of fish in the New Zealand inshore industry (NAFMAC, 1983, M.A.F., 1984). The dynamic nature of the problem is such that if X^* was the optimal time path at time zero, it may not be the optimal time path at t . This is the Samuelson Turnpike theorem; once we have left the "turnpike" X^*, it may not be optimal to return to that path. Clark (1976) has shown that the factors influencing the optimal rate are the time horizon, the price responsiveness to changes in supply, the discount rate used, and the stock recruitment rate.

FIGURE 6

Resource Stocks Over Time



The planning horizon receives little consideration in practice, although determination of the time period may alter the path. Increasing the terminal period (T) to infinity implies an application of the Turnpike theorem as shown in Figure 6.

The path advocated for threatened inshore species is to harvest an interim yield lower than the proposed long term yield (NAFMAC, 1983, MAF, 1984). Let us call the point in time at which harvest changes from interim to long term harvest t. This gives a different time path from present time to the change, t^0 to t, than from the change onwards, t to T. No economic or biological justification for these differing time paths is provided by the New Zealand fisheries managers, except in very general terms: "The chances of recovery are improved if in the short term catches are dropped below present sustainable yields" (Major, 1984), and "The need, therefore, is to reduce catches to a level that will enable fish stocks to recover to their previous levels..." (MAF, 1984).

This problem of differing time paths is not trivial and should be given serious consideration. The objectives of (a) maximising the sustained physical yield from the fisheries and (b) maximising the discounted economic benefits from the resource will produce different harvest policies in most cases.[4] Economists' contribution to resource management have been to demonstrate this basic principle and point out that the policy (a) above is generally not optimal (Lewis, 1982, p.62, Larkin, 1977).

Lewis is very specific on this issue:

> "The most important implication of our models is that the policy of maximising the sustained physical yield from the fishery is generally not optimal... The policy is deficient in that it fails to specify the rate at which the fishery should approach its optimal steady state population if it is initially displaced from it...
>
> Although the inefficiencies of the maximum yield policy have been discussed repeatedly in the literature, the policy is still retained by most fishery commissions because it is deemed to be "workable".

Even if the maximum yield policy is followed because it is easier, the economic advantages of this maximum yield policy need to be compared with alternative policy options.

Given that we are optimising economic returns from the resource over time, subject to constraints, the economic problem may be expressed as:

$$\text{Max PV} = \int e^{-rt} R\ (X,E)\ dt \qquad (1)$$

where: PV = present value
r = discount rate
R = net revenues (Revenue minus total costs, including user and social costs)
E = harvest or effort (assuming linearity)
X = fish stocks
t = time

---

[4] This ignores the trivial case where no harvest is taking place because either the cost is too high or the price is too low to attract any entrants to the industry. We assume that some level of harvest is occurring.

Changes in price are reflected in R, and as discussed earlier (Figure 2) we would expect the optimal harvest to be less with a price responsive resource. The price elasticity of demand is a measure of the degree of responsiveness.

Uncertainty as to future price trends complicates analysis of optimal harvests. If real prices are increasing over time, and changes in effort are costless, then delaying harvest may increase benefits. Anderson (1977, p.43-46) discusses this relationship in a present value framework between two time periods, but this can be extended to several time periods using a control model. If the converse holds, and fish prices are dropping, then an increased harvest is called for. The assumption of costless changes in effort may be an heroic one, as this assumes a high opportunity value can be placed upon the fishing capital and some alternative use exists in the short term for this displaced capital.

A similar increase in harvest can be expected with a high discount rate (equation 1). Using a zero discount rate implies that the optimal harvest is approximated by the maximum biological yield, while an infinite rate will lead to the same harvest as an open access situation. Some positive real rate will be intermediate between these two extremes (all other influences held constant).

The stock recruitment rate or growth function ($\dot{X}$) will also have some impact upon the optimal time path (Anderson, 1977; Clark, 1976). With a specie that has a long life span coupled with low reproductive rates the optimal path may be to harvest early and possibly eliminate the species. Faster growing and highly reproductive species such as squid are the opposite situation - increased economic justification can be made to reduce the short term harvest for long term benefits.

Equation (1) can be re-expressed using transition equations to model the change in resource stocks from one time period to the next. This approach is particularly applicable to a fish resource, and follows the necessary conditions derived by Burt and Cummings (1970) for the optional exploitation (harvest) rate of a given resource.

Changes in resource levels depend upon the natural growth rate, f(X), (or ($\dot{X}$)) and the actual harvest level, H, and can be represented as:

$$X_{t+1} = X_t + f\ (X_t) - H_t \qquad (2)$$

where X_{t+1} represents resource stocks in the next time period and other variables are as defined. For a renewable resource f (X_t) is greater than zero, i.e. a positive growth rate. This assumes that we are looking at some point below the maximum sustainable biomass, as f(X_t) will be zero in this trivial case. Harvest can be equal to or greater than zero indicating non-negativity in the harvest rate.

In equation (1) E was defined as harvest or effort. We can refine this by making E a composite variable representing inputs of capital and labour to the harvest process and making the actual harvest, H_t, dependent upon effort as:

$$H_t = g(X_t, E_t) \qquad (3)$$

where g (.) is the production function for harvesting. We can assume that the harvest rate will decline with smaller fish stocks (dg/dx>0) as fish become harder to locate. This is the refinement of equation (1) where harvest and effort were considered to be linear.

Incorporating equation (3) into equation (2) we can follow the approach used by Lewis (1982) to allow for uncertainty in both resource growth and natural depletion rates. This can be represented as:

$$X_{t+1} = X_t + N_{1t} f(X_t) - N_{2t} g(X_t, E_t) \qquad (4)$$

where N_1 and N_2 are random variables. The changes in natural growth rate are represented by N_1, while N_2 might represent random changes in the water temperature and weather conditions. We would assume that the expected values of these variables are both equal to one over time with a fixed distribution.

Selection of the optimal harvest rate, H*, reduces to maximising the present value of the resource stock as discussed in equation (1) and shown in Figure 6 as X*. Equation (4) enables the effect of uncertainty to be seen more clearly. Producers generally are risk averse in their price attitude, and fishers have not demonstrated an attitude which differs from the norm (Lewis, 1982). This effectively means that consideration must be given to a "safety margin" in allocating harvesting rights if society adopts the same view. This uncertainty can be extended to account for changes in costs and revenues between years and systematic changes in the distribution of variables over time. Interaction between stocks can be considered as well as the important issue in fisheries economics of nonobservable stocks. The reader is referred to Lewis (1982), Clark (1976), Hannesson (1978), Dasgupta (1982), or Anderson (1977) for a more rigorous mathematical treatment of this problem using a control theory framework.

Limiting access will not automatically remedy fishery management problems, as more factors are involved than just simply the problem of open access (Rothschild, 1983). Many actors are involved in the play besides fishers - boatbuilders, processors, policy managers, bankers, retailers, exporters, and the final consumer. These interactions, as well as complex biological interactions in the fish stocks, need to be recognised in long term management plans.

Problems of overfishing are accentuated by fluctuating incomes and government policies formulated to encourage fishing. During periods of high incomes, measured by increased prices, high yields, or lowered costs, investment is encouraged in the industry. When returns decrease, these same investments may be trapped because of low opportunity values, staying in the industry and continuing the problems of overfishing. This is essentially the problem known to agricultural economists as asset fixity (Johnson and Pasour, 1981). With the next swing in prices, more investment is encouraged and the cycle continues. The end result may be what Crutchfield (1979, p.746) describes as the ultimate absurdity as investment is encouraged because prices are rising due to biological scarcity, thus contributing to the overfishing of the species. The expansion of the domestic fleet following the introduction of the 200 mile zone in 1978 has been an example of this asset fixity situation. Many of the vessels built ostensibly for the deep water were found to be too small to work offshore and have become locked into the inshore fleet.

Open access will usually lead to overfishing. Some form of supply control may be needed to ensure the optimal harvest rate, but finding that optimal rate is likely to be a non-trivial problem. Once found, that harvest rate is likely to be modified by many factors. Positive discount rates, falling real prices, short term planning horizons, and slow biological growth and reproductive rates will tend to increase the optimal harvest. Similarly, increasing real returns, high growth and reproductive rates, and a long planning horizon will tend to decrease harvest. Input subsidies and asset fixity will accentuate the problems of overfishing, and indirectly, overcapitalisation.

CHAPTER 4

POLICY OPTIONS FOR SUPPLY CONTROL

The objective of this Chapter is to examine alternative policy options available to restrict harvest of a species. Although each policy has the common goal to reduce harvest, and in theory the final result should be the same, adjustment mechanisms differ for the policies. Additionally, costs, measured as direct and indirect costs, differ for each policy. Specific emphasis is given to the option of individual transferrable quotas.

Four alternative methods of supply control are commonly considered for fisheries management:

(a) gear restrictions and season closures;
(b) taxes on either inputs or outputs;
(c) licence schemes;
(d) quotas, both total resource and individual.

Limitations of the first three are well documented (Howe, 1979, Clark, 1976, Hannesson, 1979, Bell, 1978). Gear restrictions may well protect a resource, but usually lead to distortions from a minimum cost harvest. Seasonality closure may be necessary to protect spawning stock in some cases, but are a very artificial form of control and do not address the common property problem. Harvest can always be reduced by outlawing everything except the use of bent pins on Tuesdays! At best, both regulated inefficiency and season closures are short term solutions treating symptoms and not causes of problems. Difficulties include little flexibility in handling stochastic influences and the problem of fishers "locked" into the system in periods of low returns.

The use of taxes on either inputs or outputs to internalise the externalities are a theoretically appealing solution. Referring back to Figure 2 (Chapter 3) enables the effects to be seen. A tax on inputs will shift the marginal cost curve (MC) to the left and will increase the direct cost to a fisher for any given harvest. Similarly, a tax on output should reduce effort by lowering the marginal revenue curve (MR). Societies marginal cost curve (MC') will only move to the left if transaction and enforcement costs are involved. Taxes on either inputs or outputs paid by fishers are transfer payments, and in the case of, for example, a fuel tax, transaction and enforcement cost would be very low. Thus the MC and MC' curves would move closer together and E would approach E*.

It is important to look at the objective or motives for placing a tax on either inputs or output. It will be argued later that fees should be imposed upon transferable quotas, but this is because of distributional considerations once an economically efficient policy is adopted. The usual concept of tax (as discussed with reference to Figure 2) is to use these taxes to move towards an optimal policy. Thus the instrument is used to enhance efficiency.

Difficulties of taxes include political opposition to their introduction, lack of flexibility in handling stochastic influences, and the asset fixity problem of fishers locked into the system. New Zealand fishers are concerned about rising costs and particularly fuel costs, in the fishing industry (France, 1983, Kenton, 1983, Dickie, 1983). It should be pointed out that without those rising fuel costs of the late 1970's and early 1980's, the overfishing problem may well have become worse at the present time. However, even though fuel prices have acted to restrict supply there may well have been a compensatory increase in fish prices (and profits) with this reduced supply, thus the overall effect may be ambiguous. The task of a manager informing fishers that incomes must be reduced to ensure the long term viability of the industry is not an enviable one. Substitutability of resources out of fishing may be slow, thus the problem of low incomes may persist for some considerable time before the initial problem of overfishing is overcome. Thus an attempt to solve one problem (overfishing) may lead directly to an equally serious and more politically sensitive problem (fishers' incomes). Fishing effort may in fact increase because of the lower costs of new entrants as a result of buying "written down" vessels.

Licensing of vessels or fishers is also only a short term solution. Productive capacity of an existing vessel can be increased and contribute to both overfishing and overcapitalisation. Thus, although licensing, taxes, closures and gear restrictions can undoubtedly all have some beneficial effects, they also have problems.

This leaves the option of quotas. Total seasonal quotas have been applied. They will usually lead to a modern times Oklahoma land rush as fishers compete for their share of the quota. Individual quotas, expressed as a percentage of the allocated catch, present an attractive solution. Short run efficiency is achieved as fishers have control over the choice of inputs to minimise cost. Once initial allocations have been made, transferability of quotas would facilitate long run efficiency. An open market enables operators to freely enter or leave the industry. There are two kinds of costs that would face individual fishers: the usual costs of production (harvest) and the costs (including opportunity) of holding or acquiring a fishing quota. Thus, in terms of traditional microeconomic theory, an operator will adjust marginally to a profit maximisation position. Formal mathematical proof of this is contained in an appendix by Moloney and Pearse (1979, p.865-6) and discussed in Clark (1982, p.281), using the maximum principle. By the process of Walrasian tatonnement, rights will accrue to the efficient operators. Values of these rights will indicate values of the resource and also indicate the possible economies of size for each fishery by their eventual distribution.

Transferability can either be on a temporary basis enabling some flexibility during a particular season, or a long term basis. Stochastic effects in yields for a particular species between seasons can be accommodated by setting a total species harvest and expressing individual quotas as a percentage.

New Zealand has had experience with transferable quotas in the deep water fishery. The current inshore problem differs in many ways from the deep water industry. Major differences are that few operators are involved in the deep water recovery leading to lower enforcement costs, and the initial allocation of quota was facilitated by not having to withdraw capacity from the industry.

Enforcement costs involved with policing of an inshore quota system are likely to be high. Initial allocations of quotas to larger commercial operators may reduce these enforcement costs, as it is presumably easier to police a smaller number of vessels. However, this may well be at the expense of an equitable allocation of the quotas and may not encourage the most efficient harvesting techniques. Selection of the quota allocation on the basis of administrative ease is most unlikely to lead to an appropriate distribution of wealth or increase earning potential amongst fishers. Such a procedure also begs the question as to whether the quota rights ought to be granted at zero cost to fishers at all. There are some precedents in this area. Increasingly New Zealand import quotas are not granted to traders but are sold by tender on an annual basis resulting in the rent accruing to taxpayers.

Questions of the possible administrative options for the quotas are contained in Duncan (1984), albeit in a preliminary manner. A detailed description of current policy options is outlined in MAF (1984). As discussed in Meaney (1980), enforcement costs are likely to depend upon both the marketing channels available and the unit value of the fish. Few market outlets are easy to control, but many small distributors accentuate the problem of keeping track of landings. Similarly, a high unit value of fish increases the incentive to sell undeclared catches. These administrative enforcement costs may constitute a considerable percentage of gains made to the industry by the quota system.

Given that some form of supply control is needed, transferable quotas must be considered an excellent long term solution. We concur with Campbell that ITQ's (Individual Transferable Quotas) provide a means whereby the effects of inadequate property rights may be mitigated. The working of ITQ's depends on three processes - initial allocation, estimation of total quota and enforcement of individual quotas (Campbell, 1985). Efficiency is enhanced by enabling operators to move to a least-cost situation and, provided the initial allocation is equitable, no major distributional issues are involved. A multi-species harvest can be accommodated by both an inter and intra seasonal transfer of quotas for each species. Intervention costs (enforcement and transaction costs) need to be considered, and could conceivably negate any benefits derived from the introduction of ITQ's. The need to equitably distribute the initial allocation of rights is a potentially contentious issue with equity implications.

A similar conclusion is reached by Cunningham when discussing the role of economics in fisheries management:

> "ITQ's are very appealing on both theoretical and practical grounds, and certainly appear to be the best of the alternatives considered for economic regulation of fishing. They are compatible with reducing effort to any level desired, and with distributing whatever rent may accrue at this level in a socially optimal manner. Their

major drawbacks can be overcome simply by improving enforcement and by accepting that when managing a more or less randomly fluctuating resource, optimisation on the basis of some long-run average is about the best which can be expected." (Cunningham, 1983, p.77)

CHAPTER 5

DISTRIBUTIONAL ISSUES

Some major equity issues are involved if a quota policy is introduced. The first issue has already been decided - units not "wholly or substantially involved in the fishery" (NAFMAC, 1983) have been arbitrarily precluded from the industry. No compensatory arrangements have been discussed with this numerically large section of the industry who represent half the number of fishers. No attempt even appears to have been made to ascertain who these people are or the effects of precluding them from the industry. This decision is especially interesting in view of the call from commercial fishers for $28 million in compensation and the proposed vessel buyback tender system - the industry appears to have the power to decree who shall not participate in the gains from the compensation scheme, thus, by proxy, deciding who shall. Crutchfield (1982) and Pollnac and Littlefield (1983) both contain a discussion on possible effects on part-time fishers and social impacts. Indeed, as Scott (1979, p.731) suggests "arbitrary expulsion of part-timers and sport fishers with low catches should take a prize for high-handed, inefficient discrimination". Non-operated permits have also been cancelled, thus penalising another sector of the industry.

Having made some preliminary decisions on who shall not be allocated quotas, the next major question is, how should the quotas be allocated. Given that quotas are freely transferrable, any initial distribution can be altered to achieve an optimal allocation. This is because holding a quota represents an opportunity cost to the fisher and will be a factor in the perceived revenue flow (Clark, 1982). Options to trade a quota can be included along with all other decisions open to an individual. Once allocated, quotas will have some value accrue to them, thus the distributional issue problem is the initial allocation (Moloney and Pearse, 1979; Crutchfield, 1982). This is the same issue addressed by Gardner with respect to re-distribution of Federal Lands in the United States. He concluded "once this initial re-distribution effect worked itself out, equity would cease to be so important an issue with market traded goods, since presumably no free market exchanges would occur unless both buyer and seller believed the trade would make them better off" (Gardner, 1983, p.223).

Several systems exist for initial allocation of these rights. These include a tendering system coupled with a buy-back scheme, allocation based upon historical catch, or allocation based upon either investment or productive capacity in the industry (NAFMAC, 1983). One suggestion cited in Scott (1979) is for every active fisher in the industry to be allocated a portion of the quota, and fishers to be given an incentive to trade quotas to a suitable size to catch a profitable amount of fish. Such a system takes care of one aspect of the distributional problem, but leaves unanswered the question of the taxpayer's rights in such a scheme. Some economic rent could be extracted by setting a price on quotas to start at some predetermined date. Some short term adjustment problem would occur, and this is recognised in the current debate. Allied with these decisions is the question of the form of the quotas - size of the parcel, maximum holding for any individual or company, time length of the allocation. Over-riding some of these considerations is the possible question of compensation. The New Zealand Federation of Commercial Fishermen has submitted a proposal for effort reduction which includes a compensation clause for those prepared to withdraw from the industry. However, this should be balanced by a fee system for quotas allocated to those remaining, as one would expect a rent value to accrue to the permits. This approach of a tendering buy-back agreement and a quota allocation based upon historical catch is the option under consideration by the Industry (MAF, 1984). As pointed out by Anderson (1983), the maximum rent will not accrue until the industry has had time to adjust to a cost minimum situation. This compensation problem is recognised by New Zealand managers (Duncan, 1984, MAF, 1984). The question of compensation appears to be a vexing one, and the long suffering taxpayer may be excused for wondering why the rents which should accrue to the nation are, in fact, negative rents being paid to retire vessels. Current proposals do, however, address this issue with provision for subsequent taxes upon the quotas to redistribute rents back to the taxpayer.

CHAPTER 6

ECONOMIES OF SCALE IN THE FISHING INDUSTRY

This Chapter looks at the production function for harvesting (equation 3 in Chapter 3) in order to obtain some indication of economies of scale in the industry. The issue is important because indications of returns to scale in the factor inputs should indicate the operators to whom efficiently allocated quotas will eventually accrue. Economies of scale will often lead to few operators in an industry and possibly consequent problems of market power and equity considerations. Additionally, diseconomies of scale suggest that an effort transfer programme to alternative species becomes more viable, and this theme will be developed later in the report.

The Minister of Fisheries, Mr Colin Moyle, is quoted (Catch, February 1985) as being concerned about a possible monopoly situation developing from the transfer of quotas to big companies from individual fisheries. This situation has happened in Australia.[5] Following the introduction of transferable quotas for Australian southern bluefin tuna in late 1984, a very rapid transfer of quotas took place. By February 1985, some 90 percent of quotas were controlled by three Australian operators, and a geographical transfer of processing plants from Western Australia to South Australia was occurring. This is not necessarily a problem, depending upon the degree of market power exercised by the limited number of operators.

Fuel and labour are assumed to be the factor inputs in equation 3. Ex ante, (when building a vessel), fishers are faced with a degree of substitution between capital, fuel, and labour but there are likely to be limited substitution possibilities ex post (after the vessel has been built). In fact, zero substitution possibilities are assumed to exist ex post between factor inputs in subsequent analysis.

Duality theory and Sheppard's Lemma enable us to estimate returns to scale from cost data (Lau and Tamura, 1972). The general cost function is represented by

$$C\ (Y;\ P) = \sum_{i=1}^{m} hi\ (Y)\ pi \qquad (5)$$

where Y represents output, P prices for both output and inputs, and there are m inputs. Corresponding to this cost function is the dual production function with constant and equal (to zero) elasticities of substitution (CES), i.e. a Leontief function. This function is a special case of the CES family of functions. A set of derived demands for the inputs X_i can be given by

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[5] Pers Com, Robert Bain, Department of Primary Industries, Canberra, Australia, February 1985.

$$X_i = g_i (Y), \quad i = 1, \ldots, m. \qquad (6)$$

The function g( ) is assumed to be a positive, real-valued and non decreasing function.[6] Using the form:

$$X_i = L_i Y^{\beta} \qquad (7)$$

where Li is a constant and i, also constant, is the scale coefficient enables us to estimate the Li and i by re-expressing (7) as

$$\mathrm{Ln}X_i = \mathrm{Ln}L_i + \beta_i \mathrm{Ln}Y \qquad (8)$$

for each input. Economies of scale are indicated by $\beta i < 1.0$, constant returns by $\beta i = 1.0$, and diseconomies by $\beta i > 1.0$ (Lau and Tamura, 1972). The standard economics definition of returns to scale is a measure of the change in output obtained from increasing all inputs by a constant proportion. This production function allows differential returns to scale of each input.

Data to test for returns to scale were obtained from the New Zealand Fishing Industry Board. Cross-sectional observations for the 1983 year for 56 trawlers in the 9 to 29 metre category with figures for sales, fuel costs, and crew wages were available. Results are therefore applicable to trawlers of this particular class size, and cannot be used to compare alternative harvesting techniques to trawling. Output is measured by the value of sales, and the assumption of a homogeneous fish catch across all sizes of vessels is made. Results may be biased to the extent that fish species and product quality vary between vessels. Labour is paid as a share of total sales, and the quality of labour can expect to be rewarded by a higher factor return. Fuel prices were constant during 1983, thus no problems with changes during the study period were encountered.

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[6] One peculiarity of this system of derived demand functions is that they are independent of input prices. This is because of the zero substitution possibilities that are assumed to exist ex post between the inputs. Thus subsequent analysis is valid to the extent that zero substitution does, in fact, exist between labour and fuel. Another important assumption made in duality theory is that fishers are operating on a minimum cost curve.

TABLE 1

Returns to Scale in the Fishing Industry

	Labour	Fuel
Coefficient (βi)	1.27	1.06
$\underline{t}_2$test B	13.95	15.60
$\bar{R}^2$	.77	.81
F	194	243
Observations	56	56
Ho βi = 1.0 (constant returns)	rejected	cannot be rejected
standard error	.0909	.06796

Estimations[7] of (8) are shown in Table 1. Using statistical t test (Koutsoyiannis 1977, p.84) we are unable to reject the hypothesis that Bi = 1.0 for the fuel input, but we can reject this hypothesis for the labour input. Accordingly, we conclude that constant returns to scale are indicated for fuel in the trawler fleet but diseconomies of scale exist to labour. Two implications arise from these conclusions.

(a) Diseconomies of scale to labour suggest that the effort transfer option to be discussed later becomes more viable. The larger vessels are probably better able to harvest alternative species because of safety factors involved with harvesting further from the coast, and efficiency is enhanced by reducing labour input in the traditional species.

(b) The existence of diseconomies of scale to labour and rejection of economies of scale to fuel lessen concern about the final distribution of quotas being held by few operators, given a free quota market. Thus the efficient solution of quotas may not necessarily have any long-run inherent tendency towards market concentration on the supply side.

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[7] The Ordinary Least Squares (OLS) technique was applied to data supplied by the Fishing Industry Board. As cross sectional data is used, the validity of OLS requires an absence of heterosecedasticity. Using the Soldfeld and Quandt test (Koutsoyiannis, 1977), the observed F-statistics for labour and fuel were 0.2790 and 0.5947 respectively compared to the F critical of 2.19. We concluded that heterosecedasticity is not present in the model.

CHAPTER 7

EFFORT TRANSFER

One of the major problems facing the inshore fishery is overcapitalisation. This problem may not be significant if financial resources could be diverted to other uses. There are two major economic reasons which tend to restrict the individual from transferring resources to alternative species - the opportunity cost incurred and the initial cost of developing a new industry.

Without a system of quotas, an individual fisher harvesting alternative species faces an opportunity cost in foregoing harvest of the traditional species. Even though this fisher is contributing to the problems of overfishing a species, the individual knows harvesting that species is the most profitable use of the vessel. Foregoing this income may represent a considerable opportunity cost. However, if ITQ's are introduced, the individual can only harvest up to the quota level. Additional harvest of prime species must be matched by an acquisition of quotas on the market. Thus, there is no longer an opportunity cost involved in not harvesting the prime species. The question to both society and the fisher now is, "what is the best alternative use of vessels not being utilised"? The answer to this question can be obtained by looking at the potential to transfer effort to non-traditional species. Effort can be transferred by taking a particular class of vessel away from the traditional species, by transferring all vessels at a particular time, or by some combination of these possibilities. This of course raises questions of why the "non-traditional" species is not being harvested now. The answer may be a combination of factors, including the individual fisher's opportunity cost and the so-called "infant industry" cost.

Research and development costs facing an individual in any new industry can be substantial. These costs involve information gathering, development of harvesting techniques, on board handling methods, processing technology, and marketing of the fish. Once these initial problems have been overcome, the cost structure for both the pioneer and others would decrease. Indeed, Samuelson et al. (1967) consider that fisheries effort transfer is a classic example of the infant industry problem:

> "Thus, a school for fishermen might become feasible when the industry grows to a certain size: and this training might cause a downward shift of every firm's cost curves as the industry Q rises", p.499.

This section looks at some of the non-traditional species where effort may be transferred to, and discusses specific market failure cases where financial encouragement may be needed to either develop these species, increase the quality of existing catch or combinations of both of these concepts.

Potential species include discarded inshore species such as anchovy, barracuda, small red cod, conger eels, frostfish, small hoki and gemfish (< 80 cm), grenadier, kahawai, jack mackerel, small monkfish (< 25 cm), grey mullet, yellow eyed mullet, sea perch, pilchard, southern blue whiting, spiny dogfish, skates - small (< 45 cm) and large (< 80 cm), rays, seadragons, seahorses, octopi, scampi, jellyfish, and crabs. Additionally, potential exists in fisheries which have traditionally been regarded as offshore, despite their proximity to the coast. Species include squid, southern bluefin tuna, skipjack, orange roughy, hoki, big eye tuna, yellowfin tuna, East Coast albacore and ribaldo.

The squid fishery is very large. It is being managed to an estimated Total Allowance Catch (TAC) of 90,000 tonnes/year. At an average f.o.b. export price for 1983 of NZ$1.62/kg the resource is worth nearly NZ$150 million annually. It should be noted that this year the jigging fleet has extracted an extra 30,000 tonnes of squid over the theoretical TAC. Moreover squid prices are continuing to rise (Kitson, 1984). Thus the squid fishery alone is nearly as valuable as the total inshore catch. There has been little research into developing a method that is suitable for inshore vessels although fishers are convinced that profitable methods exist. But their cash flow cannot support sustained research. There are undoubtedly problems such as handling on board for quality and restricted quota access to the Japanese market (O'Donnell and Ting, 1984). Fishers also complain that the lights of the foreign and co-operative venture fleets draw the squid out to sea for distances of up to 20 miles. Two major methods of capture are used, jigging and bottom trawling, with the jig-caught squid usually commanding a premium on the Japanese market (Mattlin, 1983). The squid caught by jigging are relatively costly, and more research needs to be conducted on New Zealand's participation in this industry. On the other hand, Colman (1983) considers that New Zealand has a major potential for developing our squid resource, with trawl squid becoming the basis for a substantial onshore processing industry.

Southern bluefin tuna catches by Japanese longliners have been declining. However, it is still a very valuable fishery in the order of NZ$25 million f.o.b. in 1983 (Gibson, 1984 pers. comm.[8]). New Zealanders on the West Coast have since 1979 developed a highly efficient method of catching bluefin which has not yet been transferred to the larger east coast fishery. By comparison, in 1982 the large 23 crew Japanese longliners caught on average 5.6 bluefin/day. The small three crew West Coast trolling and handlining vessels landed 6.5 bluefin/day of comparable quality. Developing an east coast, New Zealand catching operation has the dual effect of conserving both the inshore and the bluefin fisheries. On the one hand it transfers effort out of the inshore fishery and on the other it gives New Zealand fisheries managers a lever for reducing foreign effort. Harvesting of juvenile fish off the east coast of Australia and possible effects of El Nino have contributed to the catch decline in the latest season for southern bluefin in New Zealand. O'Donnell and Sandrey (1983)

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[8] D.J.M. Gibson, Scientiest, Fisheries Research Division, Ministry of Agriculture and Fisheries.

estimated the value to both fishers and the nation of developing this resource. They concluded that providing fishers with information and organising an initial catching and marketing operation resulted in potentially substantial returns to both individuals and the nation.

The declining catch is a classic "user cost" problem - the small migratory fish are harvested by Australians for low value canning before they reach New Zealand waters at maturity. It is only carefully handled mature bluefin which are highly valued on the Japanese market. Recent research (Meuriot and Gates, 1983) show that foreign nations fishing in the U.S. 200 mile zone are enjoying a substantial wealth transfer as measured by willingness to pay. If these results are applicable to New Zealand and some of the surpluses can be captured by producers, later mature species may be profitable. Kennedy and Watkins (1984) developed a dynamic programming model to find optimal quotas and quota prices for harvesting of the southern bluefin tuna off the Australian coast. Results indicated that restricting or eliminating the Australian catch of under four year olds would benefit both Australia and Japan (New Zealand was not included in the analytical model, but would also benefit). Financial inducements should be able to be offered to Australian fishers by New Zealand fishers to reduce or eliminate fishing of southern bluefin.

Orange roughy is currently being harvested off the Wairarapa Coast by Wellington trawlers, despite doubts that inshore vessels could harvest at 900 meters depth. This new glamour export fish was "known locally from only a few museum specimens until 1975" (Robertson and Grimes, 1983, p.15). Ribaldo has been successfully gillnetted by Kaikoura fishers at 700 meters, and they now plan to try gillnetting at 900 meters for orange roughy. There is also a considerable resource of slender tuna, particularly off the Otago Coast.[9] The D.S.I.R. is currently researching consumer acceptable ways of using this oily fish.

Jack mackerel is an example of a so-called less preferred specie. Robertson and Eggleston (cited in Jones, 1983) revised the New Zealand estimated yield of mackerel to between 48,000 and 187,000 tonnes annually, and although Jones cautions that these estimates are "dubious", he considers that a large resource exists. The 1981/82 average annual domestic inshore catch was 2,350 tonnes in contrast to a long term inshore yield of 30,000 tonnes (Jones, 1983). The use of a project manager to co-ordinate information and development may be a less costly alternative policy than vessel buyback schemes.

Barracuda has topped domestic landings by volume in recent years (NAFMAC, 1983), and has an estimated long term yield of 30,000 tonnes annually. This specie earned $10 million in export receipts for 1983 (N.Z. Dept. of Statistics, 1984), and has considerable potential in South Island regions. A 15 month price subsidy was introduced in 1980, and this contributed to increased catches in the subsequent year (Hurst, 1983).

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[9] D. A. Robertson, Scientist, Fisheries Research Division, Ministry of Agriculture and Fisheries.

Perhaps the greatest potential resource (excluding squid) available to New Zealand fishers is hoki. While traditionally a deepwater specie Patchell (cited in New Zealand, FIB Bulletin, 1984 (79)) stresses that hoki is not simply a deepwater fish. He believes that hoki could in fact yield 300,000 tonnes per year if the stock size is as large as surveys estimate. This compares to an estimated 1983/84 catch of some 37,000 tonnes, mostly deepwater. Hoki represents a major fishery for vessels in the 20 - 35 metre size range (New Zealand, FIB opp-cit.), but the same report cautions that correct marketing is required before the resource can realise its potential.

7.1 Quality Improvement

Allied with the effort transfer concept is quality improvement (value added) in both traditional and non-traditional species. Once again, we need to ask why this is not currently being undertaken if it is profitable. The answer in many cases is that individuals either do not have the knowledge or lack the resources to develop new markets. This implies a need for extension services in the first case, and some co-ordinating programme in the second.

Higher prices for better quality is possible. The iki-jime technique (spiking the brain) coupled with meticulous handling has been widely used in Northland, Auckland and the Bay of Plenty. Current price schedule to the fishers is $4.90/kg for first grade iki jime snapper compared with $2.30/kg for trawl caught snapper (Peters, 1984, pers. comm.[10]). Other species can also be prepared for the sashimi market, notably trevally, albacore and jack mackerel (Scott, 1984, pers. comm.[11]). Improvements in the general level of fish quality could be a result of efforts in establishing quality control programmes, quality assurance programmes, peer group pressure, better staff management, improved infrastructures, price differentials for quality or education programmes. Some programmes have been undertaken by the N.Z. Fishing Industry Board and the Fishing Industry Training Council.

The D.S.I.R. Division of Horticulture and Processing carry responsibility for research into fish processing, and an estimate of an increase in "added value" of from 20% to 40% in the current returns from fishing is forecasted to occur by 1990. This "added value" will primarily come from a higher percentage of the "favoured species" catch sent out in prime quality and secondarily by the development of much more highly processed end-products (pers. comm. Dr R.L. Bieleski, Director, Division of Horticulture and Processing, D.S.I.R., December 1984).

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[10] T. Peters, Managing Director, Kia Ora Fisheries.

[11] D Scott, Scientist, Fish Processing Research Group, Department of Scientific and Industrial Research.

The catching method has a major impact on quality. Trawling generally lands a higher volume of lower quality fish with a shorter shelf life than lining. It is also relatively fuel intensive and capital intensive. A move to more benign catching methods would conserve stocks and is likely to increase the price.

Hikurangi Fisheries gives a dramatic comparison. From January 1 to March 1 1984 each of their pair trawling vessels caught over 15 times the amount of snapper as the longliners and over 1500 times the amount of trevally. Despite this, current legislation prohibits them from transferring their licences from pair trawling to longlining. Yovich (1984, pers. comm.[12]) says the trawlers would be just as profitable if converted to longlining because of lower costs and higher fish quality.

In some ports poor quality is severely reducing the price. One extreme example is the quality of blue cod in Southland where it is regarded and used as rock lobster bait.

Value is added to fish by maintaining it in a state as close to live as possible. Care in handling, processing, thawing, and transporting are the main concerns. However, special processing techniques such as brain ablation, cold anaesthesia and modified atmosphere packaging are available. There is a wide range of fish processing options such as free flow fillets, breaded fish pieces, compounded fish minces, and fermented, salted, brined, pickled, marinated, smoked, half dried and dried products. There are country specific products such as smoked jack mackerel for Europe, squid snacks for Asia and stranger still dried shark fin soups and ling bladder isinglass. Product development has been occurring rapidly although it is still only the tip of the iceberg. Increased government input is evidenced by the jump from two to seven fish processing scientists since 1979. One research project with exciting potential is a method to keep the fish muscle alive.

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[12] A Yovich, Managing Director, Hikurangi Fisheries Limited.

CHAPTER 8

APPLICATION OF PROPOSED POLICY TO SNAPPER

The option of doing nothing and letting attrition of resources from the industry occur is one policy that needs to be considered. It has been dismissed by managers: "this particular option cannot be seen as realistic" (NAFMAC, 1983, p.11). Under some conditions, a "do nothing" option may be less costly than the proposed compensation scheme. The following would lessen the need for an intervention policy:

1. Slow growth rate of the species.
2. High discount rate imposed by society.
3. Price not responsive to changes in supply.
4. Decreasing real prices over time.
5. Positive external effect resulting from a prey-predator relationship.
6. Low opportunity value to excess capacity.
7. High enforcement costs.
8. High intervention costs.
9. Large social impacts caused by a forced displacement of resources.
10. Increased marginal cost from declining stocks.
11. High level of catching skill required.
12. High natural attrition rate.
13. High levels of uncertainty regarding biological factors.

Impacts of each of these conditions upon the economically optimal policy will be discussed in turn. The objective of this section is to show the differing effects that each will have upon either the economically optimal harvest rate or the net gains from intervention. Snapper will be used to elaborate upon some of the conditions, as snapper is a major species with some concern being expressed about its biological overfishing. Since different biological characteristics will often lead to different harvest policies, the generalisations discussed using snapper may not necessarily be valid for all fish species.

Snapper is the main inshore specie by value, for which NAFMAC (1983) suggest a 44% interim and 24% long term reduction in yield is needed. Regional differences are more dramatic - a 77% interim and 46% long term reduction are suggested for the Bay of Plenty region. Major concern has also been expressed over the Hauraki Gulf snapper fishery. This area landed 40% of the New Zealand snapper catch for the 1981/82 years, but in spite of concern over the species, only a 10% long term yield reduction is proposed (NAFMAC, 1983).

The total long term yield has been revised upwards from 8,100 tonnes/year (NAFMAC, 1983) to 8,500 tonnes/year (MAF, 1984) with no explanation as to why these figures have been altered. This latest long term yield of 8,500 tonnes is only 250 tonnes less than the actual 1983 catch, and represents a decrease of some 3% (MAF, 1984). A reduction in yield of 3% would, at first glance, suggest that management have a very clear indication of both the biological and economic relationships operating to enable a target yield to be administratively set so close to the current open access yield! Table 1 shows the historical catch of snapper in recent years, together with the proposed interim yield and long term yield. It is this fall in yield which is raising concerns about biological overfishing in the industry.

TABLE 2

Reported Domestic Landings and Resource Estimates for New Zealand Snapper

Year	Reported Landing (tonnes)
1974	13,733
1975	11,638
1976	14,346
1977	12,559
1978	17,660
1979	16,379
1980	12,073
1981	11,940
1982	10,683
1983	8,729
Interim Yield	6,000
Long Term Yield	8,500

Source: MAF, 1984

8.1 Biological Growth Rate

Economic efficiency is achieved when marginal costs are equated to marginal benefits. Costs include the opportunity cost of earlier capture and reinvestment of the funds received as well as direct fishing costs and normal profit. Benefits include changes in value of future harvest if the stocks are left and the value of retained stocks in breeding, which is termed the user cost. Individuals will only recognise the user cost and changes in value of future harvest if they have an incentive to do so. This incentive is lacking in an open access situation.

Snapper are a long lived species which are thought to live for 50 to 60 years. Using data from Vooren and Coombs (1977) the following rate of change in average weight for snapper was estimated.

TABLE 3

Snapper Growth Rates

Age (years)	Rate of Change (%)
0-1	-
1-2	300
2-3	100
3-4	50
4-5	30
6-7	20
7-8	12
8-9	10
9-10	9
10-11	8

Source: Vooren and Coombs (1977)

Table 2 gives some indication of possible changes in value, assuming a homogeneous price of snapper. Incorporating both a mortality rate and price changes over time into the analysis would allow the optimal harvest age to be calculated. The problem of selective harvesting to maintain breeding stocks is unanswered in this report.

8.2 Discount Rates

Most public projects in New Zealand are required to pass the criteria of a 10% real discount rate. This is a high real rate, and would probably have a devastating impact upon fish stocks if the same criteria is applied to the fishing industry. However, some positive rate of interest must be used, suggesting that economically and biologically optimal yields will differ (Larkin, 1977).

Suggested snapper interim yields are 5,950 tonnes and long term yiels of 8,100 tonnes annually on a national basis (see Table 1). Given a positive discount rate and slow biological growth rate for snapper, it is difficult to see the justification for divergence between interim and long term yields. Social adjustment costs and a possible low opportunity value of vessels would further question the logic of diverging interim and long term yields. A high adjustment cost incurred early in the programme is likely to outweigh future benefits if those benefits are discounted.

8.3 Price Responsiveness

Factors likely to influence the price of snapper are supply of snapper, cross elasticities with substitutes such as other fish, chicken and red meats, marketing effort, and New Zealand's relative share of exports. Exports to the year ended December 1983 were $19,022,535 for snapper, suggesting that foreign markets determine New Zealand's domestic price. However, New Zealand's influence on the world snapper market is only slight.

Snapper has many substitutes, both alternative fish species and other protein forms, which would increase the elasticity of the domestic market. Any reduction in supply will initially reduce consumers' welfare. Whether that welfare will be reduced in the medium to long term will depend, amongst other factors, upon substitutability of alternative species. If the export market is the residual market then foreign consumers will bear the full loss in consumer surplus, the extent depending on the effect of the reduction on the world market.

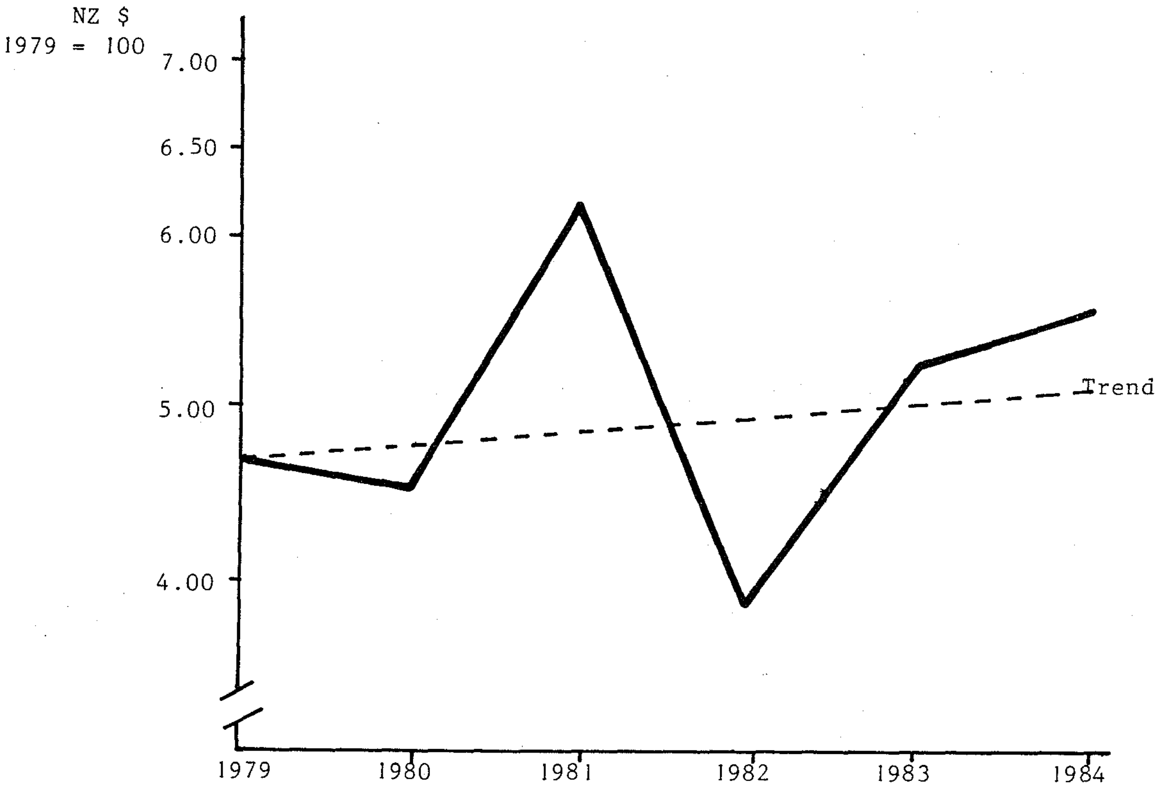
The current policy proposals do not seem clear as to possible price effects of supply control. In one section (page 13), the MAF report argues "it is considered that the effect of sale restrictions on the industry and consumer should be minor", while later (page 18) it is argued that "both local and export markets can expect increases in unit values of inshore species". Some estimate of price effects would enable both the true cost of supply control and the sectors bearing that cost to be better identified.

8.4 Changes in Real Prices Over Time

Snapper prices, as measured on the Japanese market, have been increasing in real terms over the 1979-1984 period. These prices are shown in Graph 1. Increasing real prices negate the effects of a discount rate, and reduces the optimal harvest level. Conservation is encouraged. For the same reason, continual depreciation of the New Zealand currency vis a vis major trading partners would also act as an incentive to conserve snapper for future harvest.

GRAPH 1

Average Snapper Auction Prices Tsukiji/kg
Expressed in Real N.Z. Dollars



Source: New Zealand F.I.B. Bulletin July/August 1984, (77)

8.5 Prey-Predator Relationships

Snapper predation may be harming mussel beds in the Marlborough Sounds. Although this example is a regional problem, it is an example of prey-predator relationships. Paddle crab predation on toheroa beds and octopus predation on rock lobster are further examples of this. If strong predation is occurring, then it is beneficial to increase the harvest rate of the predator to increase harvest of the prime species.

8.6 Opportunity Value of Excess Capacity

Overcapitalisation by size of vessels in the fishing industry would indicate that larger vessels should be withdrawn from the industry, in contrast to the management option of withdrawing smaller vessels. Prospects for transferring effort to alternative species are also enhanced. Some preliminary work on catch rates by size of vessel are discussed in the NAFMAC (1983) report, and concludes that "40% of the fleet comprised of trawlers greater than 18 meters may incur significant losses". Alternative uses of smaller vessels may be limited - the only other usage of vessels already excluded may be as pleasure craft. However, even if vessels have no alternative use, it may be better to scrap equipment than to consider overfishing.

Alternative usage of capacity is a stronger argument for transferring effort than for continuing to overfish a particular species. If vessels have a high opportunity value in an alternative usage, then restricting effort becomes more attractive. The cost of supply control is reduced.

The preliminary analysis discussed in Chapter 6 on economies of scale supports the view that larger vessels should be transferred to alternative species, and a major thesis of this report is that effort transfer should be encouraged along with supply control.

8.7 Enforcement Costs

To be effective, a system of individual transferable quotas must be enforceable and effectively enforced. Specification of penalties for violations must be made clear. Randall (1981) considers that Pareto Efficiency is ensured where a set of nonattenuated property rights includes specification, exclusion, transferability, and enforcement. Thus although individual transferable quotas are relatively cost effective, they are nevertheless high and may negate the benefits derived from legislation. We must concur with both the Treasury Report (page 88) which states: "However, it is not completely clear as yet whether the costs of implementing ITQ's would outweigh the benefits in the New Zealand inshore fishery", and Dasgupta (1982, p.29) who writes: "Endowing private property rights on what was once a common-property resource is not necessarily a move towards greater welfare". Larkin (1983) expands upon this issue in a cost-benefit framework, and concludes that "expenditures on management should be justified by the contribution they will make to increasing the net social and economic revenue from the resources".

8.8 Intervention Costs

Enforcement costs are only one aspect of the total intervention costs. These costs can, for example, include the cost of specifying the wrong harvest level. In a complex biological system, such as the New Zealand multispecie fishery, these intervention costs may be substantial, and the reader is referred to Wilson (1982) for further discussion.

8.9 Social Costs

Social impacts of displacing fishers by arbitrary measures can be considerable. This problem has not been addressed in the current debate, particularly with respect to part-time operators. The snapper fishery is particularly affected by social impacts because it is harvested by a large proportion of recreationalists, part-timers and small operators. Social costs arise from displacement in many sectors of the economy, and as Wilson (1982) concludes, it is not clear that management imposition of property rights gives rise to greater net social benefits than the current system. In a period of relatively high unemployment, as exists in New Zealand, should emphasis be given to labour enhancing technologies such as the iki-jime longliners.

8.10 Impact of Declining Stocks on Harvesting Costs

Natural market forces operate to protect the species where effort per unit of harvest increases as stocks decrease. However, some species are relatively easy to harvest at specific times and locations such as during spawning. Often trawling catches large volumes of spawning snapper on the trawl grounds, a situation which may need consideration. It is important to emphasise that intervention is only justifiable in the event of market failure. In the case of fishing, this failure occurs if harvest costs do not rise as stocks decline. Given that costs do rise, then we do not need to become so concerned about biological overfishing. An answer to the question "what happens to marginal harvest costs as stocks decline?" will provide much insight into the need to regulate a fishery.

8.11 Acquired Skills

Individuals' skill and knowledge acquired over time may also alter catch to effort ratios. This is the cost of acquiring knowledge on the location of fish at any time, and the skill factor involved may be high. If this skill factor is high, less justification can be made for restricting entry into the fishery because skill acts as a natural barrier. Snapper in the north eastern waters of New Zealand does not have this skill barrier compared to other fisheries and regions.

8.12 Natural Attrition Rate

Attrition can be rapid from the fishing industry. In June 1984 alone, an estimated $4 million of vessels sank off the New Zealand coastline. Does this revise the $28 million buy-back costs downwards by a corresponding amount. Restricting further entry into the industry may be adequate to ensure protection in the medium term if attrition is high.

8.13 Uncertainty

Uncertainty has scarcely been addressed in this paper. Some species have much more information available with a greater degree of certainty than others. Snapper is one of the species where there is relatively more knowledge, and therefore intervention is more easily justified.

All of the above factors need to be considered before it can be concluded that benefits will accrue to society from intervention. Many authors are concerned that net benefits to justify intervention cannot be demonstrated. Wilson (1982) concludes with "there is no reason to believe, ... in strong contrast to standard theory, that fisheries resource property rights or their bureaucratic simulation provide a clearly superior and socially economical institutional context for the management of fisheries" (p.433). If biological overfishing is taking place, then this will impose a cost to society in the form of a "user cost" whereby present harvest is at the expense of future consumption. Correcting for this overfishing will result in a change in the expected benefit stream accruing to society. Given that the change in this income stream increases the discounted present value expected from the resource, we have to look at administration and other costs involved in moving from the present system. Only when the benefits can be shown to clearly outweigh the costs involved can we affirm that a change away from the present system is economically efficient.

The current debate has, until now, focused on two parties - larger, full-time fishers and management agencies. Small part-time operators have been dismissed . Neither consumers nor taxpayers have been considered. Other participants include processors, displaced workers, and the citizens of New Zealand as owners of the resource.

CHAPTER 9

CONCLUSIONS

Overfishing is occurring in some inshore species of fish in New Zealand waters, although the problem varies by region. The problem is shown to be the almost inevitable result of a common resource where the individual fisher has no direct incentive to maintain fish stocks. This overfishing imposes a cost in the form of reduced future harvests, the present value of which is known as the user cost. Several policy options are available to restrict current harvest. Each of these policy instruments have different adjustment mechanisms to achieve the same goal.

Taxes on either inputs or output are an appealing solution. The externality costs are internalised, and the individual fisher's marginal cost curve is moved to the left in the event of input taxes or the marginal revenue curve is moved to the right if the tax is placed on output. Effort is reduced in both cases. Difficulties of the tax system include the lack of flexibility and the problem of adjusting the system to adapt to stochastic changes in the biological resource. Also, there is a major political problem. If taxes are increased, then the result will be that fishers' incomes will be reduced. Thus overcoming the original problem of overfishing leads to the more sensitive issue of low incomes in the industry. Accentuating this overfishing and low income problem is asset fixity - capital tied up in the industry has nowhere else to go, and forcing one fisher to leave the industry allows another to operate on a lower cost curve because the vessel has been "written down".

Licensing either operators or vessels is not addressing the cause of the problem, and technological change allows effort to be maintained or even increased. Artificial methods such as gear restrictions or season closures may work to protect the fish stocks, but at the cost of an inefficient industry. Operators must be allowed to move to a least-cost situation in order to ensure a correct allocation of societies capital and labour resources.

The final option of quotas, and specifically transferrable quotas has much to offer from a theoretical point of view. An open market system allows entry and compensated (by selling quotas) exit from the industry. Economic efficiency is ensured as fishers can adjust to a least cost operation within the quota system. However, a word of caution must be sounded about the costs of ITQ's. These costs include administration and enforcement costs. Given many small operators and numerous market channels these may be significant.

Several distributional issues need to be addressed if ITQ's are introduced. One of these has already been decided, as part-timers have been excluded from the industry. The allocation of quotas raises two questions, how should the allocation be made and to whom should rents accrue. The proposed tendering and buy back system is equitable if the rents are captured by the residents of New Zealand as owners of the fish stock and not distributed as windfall gains to fishers.

Once some measures have been put in place to restrict overfishing, the other major problem of excessive capacity in the industry has, by definition, occurred. Transferring effort to alternative species will help to alleviate this. Two factors combine to lessen the economic incentive to currently harvest these less preferred species - the opportunity cost to the fisher of harvesting prime species and the infant industry problem of initially obtaining expertise in capturing, handling, processing, and marketing these species. Introducing ITQ's soves the first problem, and a major extension and marketing programme may be needed to use the excess capacity created by restricting the harvest of prime species in some alternative way. While recognising that ex ante determination of likely winners is difficult, expenditure on research and development may alleviate the need for a buy-back scheme. Harvest costs are initially lowered if resources withdrawn from the traditional species are used, and initial development expenditure may be needed to achieve economies of scale in new areas. Consideration needs to be given to the impact of supply control upon those other than the harvesting sector involved in the industry. Transferring effort to non-traditional and under-utilised species provides an excellent opportunity to ensure that any overcapacity resulting from supply control is productively used.

Many possible alternative species exist, from previously discarded species to squid and relatively new species such as hoki and orange roughy which have been thought of as deep-water species. Although the introduction of ITQ's and a programme to divert the industry into alternative species may appear to be two separate policies, they are in fact related by the use of the excess capacity. A preliminary analysis of the factor inputs used by fishers suggests on economic efficiency grounds that larger vessels should be diverted from the traditional species, and this would also enhance the feasibility of an effort transfer programme.

Before any intervention policy is adopted it must be demonstrated that clear economic benefits result from a change in the present system. The paper has argued that the presence of biological overfishing is not clear proof for the need to restructure the industry. Intervention can only be justified where market failures are demonstrated, and the economically optimal harvest may well be different from the biologically optimal harvest. Several factors can cause this divergence. They include discount rates, changes in the real price of a species, the growth, reproductive, and mortality rates of a species and stochastic influences. Additionally, the nature of a fisher's cost curve, total costs of adopting and administrating a supply control policy and the opportunity cost of excess capacity generated need to be considered before it is clear that intervention to change the present harvest level is justified.

However, the final word should be that if supply control is introduced, then ITQ's are an economically efficient system provided that enforcement and administration costs are not excessive. Equity is ensured if rents accrue to the residents of New Zealand, and the industry in general need not suffer if consideration is given to an effort transfer programme.

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