INDIVIDUAL TRANSFERABLE CATCH QUOTAS

THEIR ROLE, USE AND APPLICATION.

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FISHERY REPORT NO. 11

DEPARTMENT OF PRIMARY PRODUCTION

FEBRUARY 1984

ISBN 0725-0887-2 I.T.C.Q. REPORT

FOREWARD

While the introduction of limited entry requirements in Australia's major fisheries means that these fisheries no longer operate as open access fisheries, they do continue to operate as shared access fisheries. It is therefore necessary for government to have a continued involvement in fisheries management. Given this involvement by government in management, it is important that the objective of management is clearly recognised, and that the most efficient means of achieving that objective is identified.

In this development of the need for change in existing management practices and the role that catch quotas may play in management, economic welfare has been identified as a suitable management objective. Such a management objective has distinct advantages over those objectives based solely upon biologic or economic efficiency criteria.

This Department is actively reviewing the concept of economic welfare as a fisheries objective, and the use of individual transferable catch quotas as a means of attaining that objective. For instance, an earlier version of this report was presented to the seventeenth meeting of the Northern Prawn Fishery Advisory Committee, in Alice Springs, and to the twentieth meeting of the Standing Committee on Fisheries, in its review of northern prawn management.

While this report is not a complete review of the Individual Transferable Catch Quotas management tool, it does provide a substantial base from which further review of this management tool can be carried out.

PAUL JONES
Deputy Secretary

ACKNOWLEDGEMENTS

This report has been written with assistance and support from the staff and executive of the Department of Primary Production, Northern Territory and Mr E.A. Purnell-Webb of Purnell-Webb and Associates.

Many of the thoughts presented here were enriched by discussion with staff of the Bureau of Agricultural Economics, when the author was there.

Any inadequacies which remain, however, are the fault of the author.

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SECTION ONE

This Section provides some of the background to Individual Transferable Catch Quotas. It is not necessary reading for an understanding of Section Two of the Fishery Report dealing with Individual Transferable Catch Quotas.

1.1.0 Introduction

World and Australian fisheries have been characterised as having outcomes which are socially non-preferred. That is, most fisheries are economically inefficient and waste scarce resources. The purpose of this paper is to identify what a preferred outcome is, how a non-preferred outcome may come about, and to examine the promise of Individual Transferable Catch Quotas (ITCQ) to achieve a preferred outcome.

While the initial purpose of the enquiry presented here was to examine the application of ITCQ, it was soon realised that the rational application of such a fisheries management tool depended on the response to certain questions:

- What is a preferred outcome; before we go looking at alternative management tools, what is it we want to achieve?
- Is there a problem; that is, are fisheries sufficiently removed from the preferred outcome as to warrant a change in fishing participation rules?
- If there is a problem, can the cause of the discrepancy between actual and preferred outcomes be identified, and will ITCQ act to remove or sufficiently mitigate the cause of the discrepancy?
- Can ITCQ be applied to a fishery without causing unwarranted disruption to other management considerations?

These questions are responded to in this first section. While this section provides an important background to ITCQ, as well as to some of the earlier and more recent literature, the second section does not depend on a knowledge of what is here to be understood.

Depending on the response to the above, and partly in responding to the above, it will be necessary to define ITCQ, what they involve, how they are an advantage over existing and alternative management tools, and what the practical considerations are in their application. This material is covered in the second section, and can be read on its own.

While it is impossible to adequately review all factors relating to the use of ITCQ at this time, this report does provide a basis from which additional examination of this management tool can be carried out.

1.2.0 What is a Preferred Outcome

The Senate Standing Committee on Trade and Commerce in its report on Development of the Australian Fishing Industry, (1982) (the Archer Report) recommended inter alia,

> "The Minister for Primary Industry, in consultation with the State and Northern Territory Ministers responsible for fisheries matters and all sectors of the industry, develop and implement a national fisheries policy defining the objectives and strategy for the rational utilisation of Australian fisheries resources and devise clear guidelines for the management and conservation of those resources" (para 2.33, p.19) (emphasis added).
>
> In considering the objective for future management in fisheries the Industries Assistance Commission Act is particularly relevant. Section 22(1) "... draws attention to the the Government's desire to promote the well-being of the community at large. In particular the Act requires that regard be given to the Government's desire, inter alia, to improve the efficiency with which the community's productive resources are used, to facilitate adjustment to change, to recognise the interests of consumers and consuming industries, and to ensure that assistance measures are integrated with national economic policy as a whole" (IAC Report, 1983, p.8) (emphasis added).

The Act identifies the Australian Government's concern's regarding the use of our national natural resources in the most efficient manner possible for the well-being of the community at large. Such requirements are economic, and involve maximisation of economic welfare.

Winch (1971) observed

> "Welfare economics to be the study of the well-being of the members of a society as a group, in so far as it is affected by the decisions and actions of its members and agencies concerning economic variables. These variables include the extent and nature of the use of factors of production, the types and quantities of goods and services produced both individually and collectively, and the distribution of the benefits and costs resulting from economic activity among the members of society" (p.13)

It is therefore put forward that a suitable management objective for fisheries is

maximisation of economic welfare under the constraint of maintenance of the biological viability of the fishery.

Such an objective concerns itself with both the distribution of benefits to be enjoyed from a fishery and the allocation of resources within a fishery. Generally economists are willing to leave the question of distribution of benefits to the political process, confining most of their comments to questions relating to allocation, or, that is, economic efficiency. Although a review of the economic literature will reveal some firm views relating to the distribution of rent earnings (as can be obtained from fisheries) they shall not be discussed here.

Welfare economics is sufficiently extensive and flexible to implicitly include a wide range of social concerns. Indeed, if society requires "maintenance of the biological viability of the resource" to be a concern, then implicitly it will be so accounted for in economic welfare maximization. Its inclusion as a constraint is merely to make the inclusion of this often expressed concern explicit.

1.3.0 Is there a Problem

Before Gordon's (1954) paper the only resource input that fishery managers were concerned with was fish stock. As long as the stock was protected and management methods moved the annual yield towards Maximum Sustainable Yield (MSY) managers and fishermen were satisfied. As a consequence of Gordon's paper, fishery managers became aware that the management of a public resource and the efficient use of all of a nation's resources required that they take all inputs in the production of fish products into account. These inputs included fixed inputs such as the boat, yearly inputs such as fishing equipment, and trip inputs such as fuel and labour. In addition fishermen and managers needed to be aware of time as a dimension in evaluating the management of a fishery. This was first pointed out as a consideration in fisheries management by Scott (1955) one year after Gordon's paper, although he had made the point in general resource use terms one year earlier in his paper "Conservation Policy and Capital Theory" (Scott, 1954). As a consequence of the identification of time as an important dimension, managers became aware of the need to compare the return that the harvesting of any age class would give this year against the discounted return that same age class would make available in following years.

While input and timing concerns were old hat to many economists and in some industries*, it was all very new to those involved with fisheries. While many fisheries suffered constraints on inputs in addition to those identified to protect the biological viability of the fish resource these constraints were implemented to decrease catch efficiency under the expectation that such action would act to spread the benefits of the fishery over a wider number of people+.

The response of managers to Gordon's paper was to establish limited entry as a fisheries management tool. In the trawl fisheries an opportunity existed to respond to Scott's observations by adjusting the mesh size of the cod end and by so doing control the age of fish capture. Turvey (1964) showed how both cost of effort (cost of other inputs) and time could be integrated.

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* Gray, L.C. (1914) in his paper "Rent Under the Assumption of Exhaustibility", examined the optimal rate of mining of coal over time so that the present value of the mine is maximised. Bunce (1945) examined the depletion of soil quality over time.

\+ In eighteenth Century Great Britain factories were destroyed with the belief that such action would maintain work opportunities. Fortunately for the now developed world this view did not hold sway - although examples of such thinking can still be identified in fisheries.

In 1979 Crutchfield verbalised the requirement for an efficient fishing operation:

> "From the stand point of economic-wide efficiency the following specific elements emerge:
>
> A. The right level of catch - at which the marginal social value of the harvest is equated to the incremental social cost required to take it (including management costs).
>
> B. The right size (age) composition of catch. No net economic gains can be allowed by allowing smaller fish to grow (ie where marginal increments to revenue from growth are just offset by marginal losses to natural mortality and costs of programme implementation).
>
> C. The right number and configuration of vessel-gear-fishermen units to minimise the aggregate real cost of taking any given catch (ie optimal factor combination).
>
> D. Optimal fleet development; no increase in yield and/or reduction in cost can be achieved by altering the area or time fished.
>
> Management measures that increase net economic returns in any or all directions are regarded as steps towards rationalisation" (p.743).

Although there is a scarcity of studies of limited entry fisheries, a review of the fishery economics literature shows limited entry (or to be more general, limited inputs) management systems have had little success in controlling effort and cost. In the South Australian Southern Zone, southern rock lobster fishery, Copes (1978) noted that while positive rent earnings of $736 000 existed in 1971-72, by 1975-76 costs exceeded returns by $708 000. This meant a fall in fisherman's net earnings of $1 444 000. In the limited entry South Australian prawn fisheries, average fishing effort per permit holder was estimated to have increased by 50 per cent in Spencer Gulf and over 100 per cent in Gulf St Vincent from 1970 to 1978 (Bryne, 1982).

While such control as exists in these fisheries may have slowed down the rate of rent dissipation, and consequent savings, positive rents will continue to attract additional investment and effort - as the increase in effort in the South Australian prawn fisheries have demonstrated.

At the top end of the continent the soon to be published results of the Bureau of Agricultural Economics' study of the northern prawn Declared Management Zone, will show that limited entry has not protected rents in that fishery. Such an outcome is consistent with MacLeod's (1980) earlier observations.

The existence of excess effort is identifiable in the studies discussed above because of the failure to take "The right level of catch", as social marginal costs exceeded social marginal

benefits. In addition, because of the controls on fishing inputs in limited entry/input fisheries, there is a failure to establish "the right number and configuration of vessel-gear-fishermen units to minimise the real cost of taking any given catch".

The failure of limited entry to achieve the results intended should not be surprising; while it is understandable that fishery managers, who in most part had a biological background, had not predicted such an outcome there is no excuse for the failure of economists to recognise the long-run consequence of limited (but still shared) entry - dissipation of all resource (Ricardian) rent*. It is only where limited entry is seen as a temporary constraint to increased effort that its use may be argued on economic grounds. In the long-run rent will act to attract additional effort in the fishery.

A necessary condition for economic optimality is that marginal social returns and marginal social costs are equal. In considering entry to a fishery, fishermen are only concerned whether their average returns exceed average costs. It has been observed that fishermen will continue to enter a fishery as long as expected average returns exceed expected average costs (Gordon, 1954). When average costs and returns are equal a "stable"+ industry equilibrium exists.

Figure 1.1 shows the two cases: economic optimality, and industry equilibrium. As effort equals E_1 the marginal cost equals marginal return as the slope of OC and OR are equal. At this level of effort total returns (OS_2) exceed total costs (OS_1) by (OS_2) - (OS_1), and average returns exceed average costs. That is OS_2/OE_1 exceeds OS_1/OE_1.

When Average costs and returns are examined average osts (OS_3Y) equls average returns (OS_3) when effort equals OE_2. At this point an industry equilibrium exists as average returns and average costs are equal.

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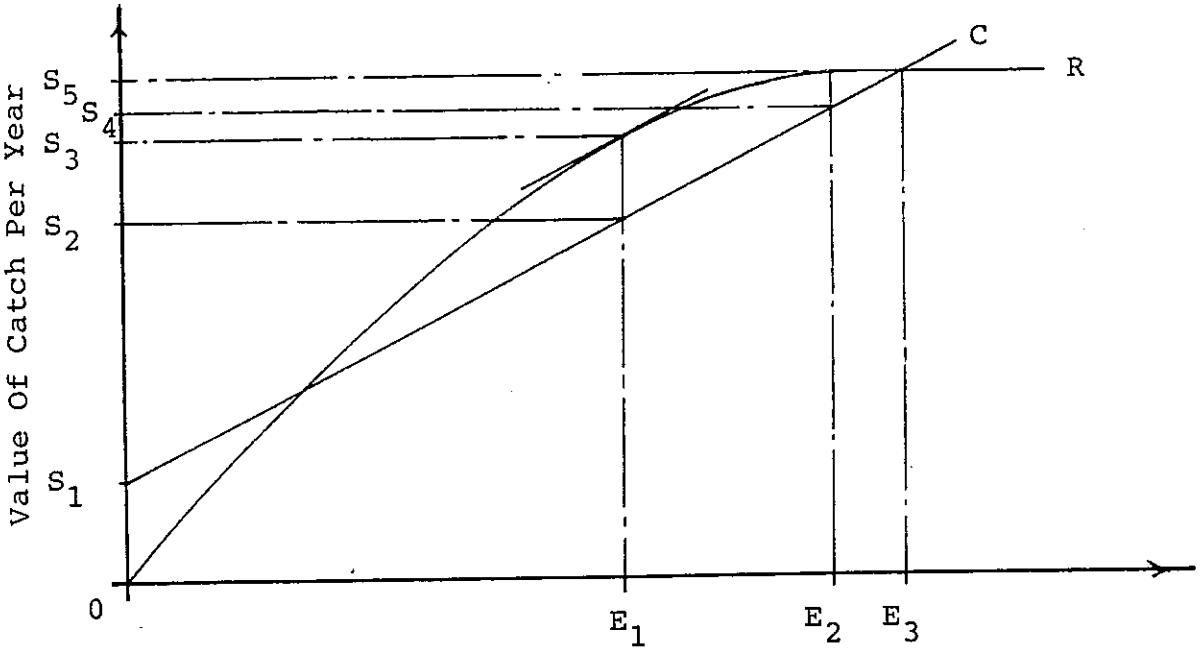
* Economists try to separate those rent returns due to temporary shortage - until the supply function is not perfectly elastic and are called quasi-rents, and where resource rents are due to the indestructible but finite characteristic of the resource, are called Ricardian, or true resource rents. While economists may be able to separate these two different types of rent, market participants can not.

\+ 'Stable' in this case does not mean that industry costs and returns will not move away from where they are equal, but simply that they will tend to move back to this point.

Figure 1.1 Estimation of Economic Optimality.



As well as the limited case studies cited here there is an increasing volume of overseas literature which is coming out strongly against the use of limited entry as a management tool. Many fishery economists, including Gordon, Scott and Crutchfield, and who in the past argued for limited entry, are now re-examining limited entry against the objective of economic efficiency. On empirical and theoretic grounds these writers are finding limited entry as having little or no relevance*.

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* The set of Technical Reports put out by the Economic Council of Canada under the general heading The Public Regulation of Commercial Fisheries in Canada is a good starting point for anybody wishing to examine some of this literature.

1.4.0 Identification of the Cause of Discrepancy Between Actual and Preferred Outcomes

Cheung (1970) in his presentation at the H.R. MacMillan Lectures in Fisheries, at Vancouver, observed that any growing (biological) asset requires decisions on "planting" as well as harvesting. He noted that:

> "In general, decisions will need to be made on the product to be produced, the method of production, and the amount and type of investment over time, the financial maturity of the catch, and the investing and method of harvesting. With private property rights these decisions will result in stipulations mutually negotiated by the contract participants (for example, the fishing-ground owner, the boat owner, and the fisherman)" (p.99).

The pivot upon which all these above production decisions hinge is the existence of adequate property rights. In a recent article on the contractual nature of the firm Cheung (1983) described a productive input as private property if, and only if:

> "..., within well defined limits, its owner has (1) the right to exclude others so that he alone may decide on its use, (2) the right to extract exclusive income from its use, and (3) the right to transfer the property (including labour) to or to exchange with anyone he sees fit. The right to exchange implies the right to contract and property rights may be transacted through a wide variety of contractual arrangements. When these rights are exchanged it is, of course, for the purpose of yielding higher income to the owner, and the choice of contracts will be constrained by the costs of transaction" (pp.4-5).

Obviously a limited entry fishery is not one which gives the participant an exclusive property right to the fish resource. Although others who do not have a limited entry licence are excluded from the fishery, the licence holder has no exclusive right to fish. Indeed the licence holder has a shared right. Thus he is unable to (1) exclude others from the resource, he is (2) unable to extract exclusive income from its use, and he is (3) unable to transfer the property to or to exchange with anyone he sees fit.

Because of this failure in private property rights the required decisions on harvesting of the fish resource are not carried out.

It will be noted that while we are primarily concerned with harvesting of fish in this report, that required decisions on the planting of stock are not carried out. It is whether decisions on the planting of a biological resource are appropriate that separates natural (or wild) populations from commercial (managed) populations. Fisheries is concerned with the harvesting of unmanaged or natural populations.

1.5.0 Application of ITCQ and other Management Considerations

Given the preferred outcome, what then may these other management considerations be? This rhetorical question is responded to in terms of economic efficiency and the disruptive affect of technological externalities on economic efficiency.

Economic inefficiency occurs when marginal social returns and marginal social costs are not equal. This failure of marginal social costs and returns to be equated can arise due to a number of different causes. When examining inefficiencies in a fishery, however, the major concern is often with the affect of technological externalities.

1.6.0 Forms of Externalities

The economic literature describes two forms of externality:

- pecuniary: and
- technological

Pecuniary externality occurs during the normal working of the market. If market prices currently represent marginal social costs, then the market will give clear messages as to the relative costs of inputs and the relative returns of outputs. If there is an excessive amount of a good being produced (analogous to excessive effort in a fishery), then individual producers will have to lower their prices to ensure that they will be able to sell all of their product*.

It is likely that such a lowering of price by some producers will force other producers, whose variable costs are above the new price, to stop producing (note, there has been no effect on the productive process of these other producers). Consequently such market action will cause supply to decrease, and the market to move towards an efficient outcome where marginal social costs and returns are equal.

Technological externalities result in a distortion to the normal working of the system. In this case, market prices do not truly represent marginal social opportunity costs.

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* A necessary short-run condition for an individual producer to continue producing, is that prices need only equal or exceed variable costs; this means that prices may temporarily fall below average costs. In the long-run, for an individual producer to continue producing, it is necessary that average returns at least equal average costs.

1.7.0 Technological Externalities in Fisheries

The problems which arise from the inadequate shared property right structure of fisheries result in:

- Stock technological externalities, where such an externality is observable in the relationship that as one individual catches fish and the stock of fish decrease, the catch efficiency of other boats will decrease and marginal costs of capture will correspondingly increase;

- mesh (capital) externalities, arise, because fish by growing and spawning supply resources in time and are thus no different to any other piece of capital whether a ewe, or a lathe. The problem arises as fish may be harvested and thus become a commodity or be left in the water and continue to grow or be lost through natural predation. The question is at what age should fish be harvested? A necessary condition for keeping a piece of capital is that as long as the expected flow of services is equal to or exceeds the interest rate, then that piece of capital should be kept (or left in the water), otherwise it should be sold off (harvested).

  The externality arises in the shared access fishery in that while the harvesting of undersized fish, where the expected growth rate exceeds the interest rate, may be in a single fisherman's interest, it will decrease the value of the whole fishery; and

- crowding technological externality, which arises when the cost of fishing for individual boats increases as a direct result of the number of boats fishing at that time and place. An example would be in the Northern Prawn Fishery when boats get in each other's road while trying to trawl through a 'boil' of prawns (Smith 1969).

The two forms of externality which have generated most discussion between and within Government and industry are the stock and mesh (capital) externalities. The stock externality involves excessive amounts of fishing effort. The mesh externality involves the question of at what age-class should fish be harvested.

If management measures are directed towards overcoming stock externality, it will overcome the problem of excess fishing effort. If management measures are directed towards overcoming the mesh externality it will constrain harvest so that the present value of harvestable stock today and into the future is maximised. In addition, for most fisheries that meet such an economic requirement, the biological viability of the fish resource will be protected. This appears to be the case with the prawn fishery.

In the past managers have used different tools to try and overcome these two classes of externality. While results arising from the application of management tools directed towards preventing the mesh externality, such as protection of spawning grounds, seasonal closures, size limits, net mesh size restrictions, and trap escape openings, were reasonably successful, the management tools directed towards preventing the stock externality, and which were based on some form of constraint on inputs were not as successful.

In spite of these difficulties in meeting management objectives within the classes of tools, there was no conflict in the use of these management tools. That is, the use of those tools used to prevent or mitigate mesh externality did not exclude the use of those used for and to prevent or mitigate stock externality. In fact, in many cases, there was confusion in the minds of managers and fishermen alike as to what exactly a management tool was directed at achieving.

There is no reason to expect the situation to be any different with ITCQ. In fact, while it has been important to use management tools in the past to control mesh externality, it will be no different with the implementation of ITCQ.

> Management tools directed at preventing and mitigating mesh externalities will be compatible with ITCQ, and will need to be continued with ITCQ.

1.8.0 Brief Discussion on the Literature on ITCQ's

The idea of using catch quotas as a management tool is not new. The most widely known example of a managed fishery in which quotas have been used is the Pacific halibut fishery in which global quotas were introduced in 1930. As fishermen were free to catch up to the global before the quota was reached, then a race developed between fishermen and the closing of the season. The consequence was an ever decreasing season, and ever increasing costs (Crutchfield, 1981)*.

It is possible that because of this well documented failure researchers, managers and industry have been reticent to examine the promise to fisheries management that quotas offer. Individual quotas, however, are substantially different to global quotas. Individual quotas guarantee the individual operator access to their catch, thus removing this incentive to race.

In 1973 Christy presented a paper on the possibilities of Fisherman Quotas as a management tool. While this paper, no doubt, was not the first on the subject, it presents a useful starting point. Christy did not see individual quotas as

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* In spite of the Pacific halibut experience with global quotas, global quotas were introduced as a management tool to the New England groundfish fishery in 1977 (Bockstael 1980).

necessarily being transferable, but he did not put forward the suggestion that the quota should be given as a percentage of some allowable catch, rather than a fixed allowable catch of so many units. In later papers the author recognised the advantages arising from transferability (Christy, 1977, 1980).

In his 1977 publication, Christy was ambivalent over the use of individual catch quotas. He thought that if:

> "..., fishermen place [a] high value on the gambling element in fishing or on achieving status as a "high liner" then a proposal for fisherman quotas, limiting their catch would not be readily accepted" (p.147).

Maloney and Pearse (1979) suggested that this concern could be overcome by allowing a percentage of the total allowable catch to be undistributed leaving fishermen free to compete for this residual.

There appears to be little rational for such an argument unless the authors wish to forego the profit maximisation assumption, an assumption which is implicit in much of their discussion. Even if fishermen are using their catch as a measure of their operating success, individual transferable catch quotas would encourage fishermen to maximise profits - a course which most other management systems do not leave them free to follow - while, by allowing fishermen to enter the market for quotas, fishermen are still free to increase their catch.

There are other problems in the ITCQ system as developed by Maloney and Pearse. In their proposal they envisaged fishermen as receiving marketable quotas for a fixed quantity of fish. To allow adjustments in the allowable global catch, according to changes in the available catch, the authors suggested the establishment of an authority which would enter the market to buy and sell quotas according to the availability of catch. This way flexibility would be built into the quota system to allow for adjustment in the allowable global catch according to annual available catch. They suggested that such a procedure would be self financing, and that it offers advantages over quotas based on a percentage of the allowable catch - which they argued is inflexible.

There would be strong doubts, however, whether the system would be self financing, as the authority would be entering the market as a buyer when catches are down and the likely price of fish is up, and entering the market as a seller when the likely price of the fish is down. In addition a percentage quota system will automatically adjust to annual changes in total available catch without the need to create a buying and selling authority (Christy, 1980).

Christy (1977), Crutchfield (1979) and Copes (1981) have argued against the introduction of individual quotas because those receiving the quotas will likely receive a windfall gain. While this may be so - although the allocation of quota by bid will remove much of this windfall gain - it is not an argument against the allocative or efficiency advantages of quotas. The presence of this concern does highlight the fact that the distributional question is left hanging.

In a recent series of technical reports on different Canadian fisheries put out by the Economic Council of Canada, a number of fishery economists argued against the adequacy of limited entry in preventing or mitigating excess fishing effort. At the same time these authors perceived advantages in the introduction of some form of individual quota (Campbell, 1981; MacDonald, 1982; Munro, 1981; Scott, Tugwell, 1981; Wilen, 1981).

Other writers have written favourably of ITCQ. Clark (1980) using mathematical modelling examined a number of management options for the economic regulation of commercial fisheries. He found ITCQ and taxes to be equivalent in terms of economic efficiency, though taxes would act to reallocate some of the available rents. Shepherd (1981) in his examination of management options to achieve a matching between fishing capacity and available catch came out strongly in support of transferable individual quotas. The same conclusion was reached by Cunningham (1983) in his review on the increasing importance of economics in fisheries regulation.

SECTION TWO

2.1 Introduction

The need to examine the introduction of Individual Transferable Catch Quotas arises from the failure of alternative management tools to control excessive effort.

2.2.0 Excessive Fishing Effort

On the basis that excessive fishing effort has been the real major problem in fisheries management it is necessary to define excessive fishing effort. Fishermen may see excessive fishing effort occurring at the level where their returns from the fishery are below their expectations. Biologists may see excess effort as being below the maximum sustainable yield - although in most cases excessive effort has little or no bearing on the level of sustainable yield if the fishery is protected by adequate age of capture constraints. Economists may see excessive fishing effort occurring when the returns to society of a marginal increase in effort are less than the social cost of that marginal increase.

In responding to the problem of excess fishing effort, fishery managers have been faced with the uncertainties of what definition of excess effort to use and which tools to use to overcome this excess.

It is maintained that the only definition which should be applied is the economic definition originally applied to fisheries by Gordon (1954). The fisherman's definition can be met at a point where excessive economic fishing effort still exists - that is, society would be better off by further decreasing effort. The biologist's definition is one which involves the efficient use of one input and, as observed, effort need not have an effect on the total amount of sustainable catch depending on the characteristics of the fish and the existence of other management controls.

2.2.1 Available Management Tools

There are two classes of management tools available to the fishery manager. These tools, when they may be applied, and the form in which they may be applied are presented in Table 1.

Table 1. Available Management Tools and Their Application

Management Tool	Where Applied	Form
Intervention and application of property rights	On inputs	Gear limitations, mesh size, and size limits.
	On outputs	Fishermen's quota
Taxes and subsidies	Inputs	Effort taxes on inputs (eg licence fees).
	Outputs	Landing tax

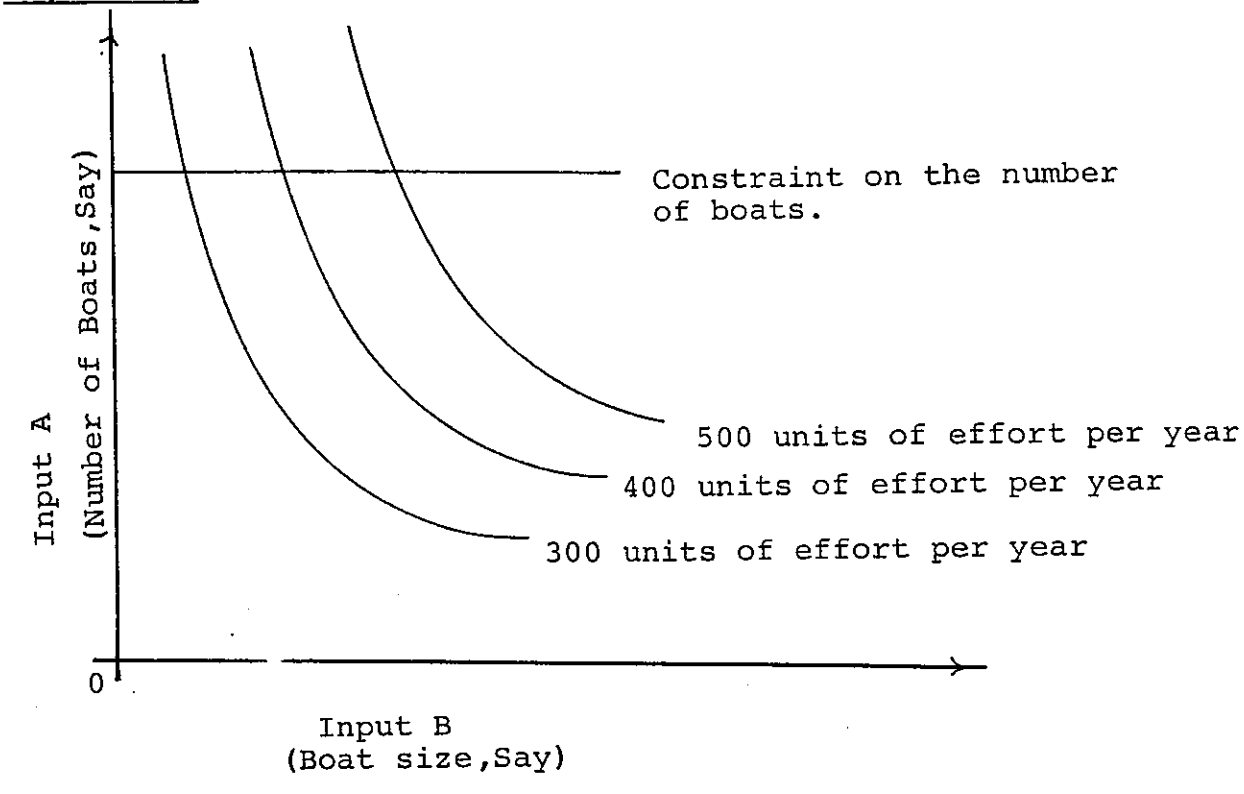
2.2.2 Management Tools in Use

The response of managers to excess effort has been largely applied to property right inputs such as number of boats, boat size, engine power, underdeck tonnage and amount of net. Such constraints, however, have seldom reduced excess effort in the long term.

2.2.3 Why Restrictions on Inputs Have Failed

Figure 2.1 shows a mapping of isoquant curves constructed by plotting points of equal value. It is possible to move along these curves by increasing the input of one factor while decreasing the input of the other. For this purpose isoquant curves join points of equal fishing effort, therefore each isoquant curves measures the combination of inputs required to maintain a defined level of fishing effort.

Figure 2.1 Economic Efficiency.



2.3.0 Advantages and Disadvantages in Applying Individual Transferable Catch Quotas, with Particular Emphasis in Relation to the Northern Prawn Fishery

The advantages and disadvantages of introducing ITCQ will depend on how the quotas are defined.

One definition of a quota (or proportional share), system in a fishery involves the establishment of an allowable annual catch and the apportioning of the allowable catch among individuals. In such a system the quota is for a percentage of the total allowable catch. Although such a property right may be for a specific period, it would function best if it were permanent, and enjoyed all the rights and responsibilities of ownership as in any other asset.

The introduction of ITCQ would be an important development in the establishment of property rights to fisheries and would allow the owner of that right certain privileges and responsibilities. While 'common property' means that all members of society have equal access to the benefits of a resource, 'common property' has come to mean that two or more persons claim the right to jointly exploit the same resource. Where entry is not limited, both access and share of the resource are unrestricted. In limited entry only a restricted number of individuals have right of access (a property right). However shares are still unrestricted - as all individual fishermen are free to race the rest of the fleet to the resource. The application of a quota is a natural progression along this property right continuum in that it involves not only a restriction on access, but also, on shares (Moloney and Pearse, 1979).

2.3.1 Estimating Total Allowable Catch

There are a number of criteria by which TAC can be calculated. It is expected though that maximum present value*, under the constraint of protection of the biological stock, is the criteria that would be selected. For short lived species, such as prawn, this would be the same as rent maximisation.

Figure 2.2 represents for some year, say year 1, the annual gross returns and costs for a fishery such as the northern prawn Declared Management Zone. The curve SC is the cost curve giving the cost of harvest for a fleet of a given size (for the northern prawn Declared Management Zone this was 265 boats in 1982). As this is a short-run analysis it will be noted that a cost of 0S, will be incurred in year 1 even without any fishing; OS, being the fixed capital cost of the fleet of 265 boats. As the fleet begins fishing, costs accordingly rise. These costs will consist of items such as maintenance, repair, fuel and labour. These are the marginal costs.

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* Maximum present value involves maximising the discounted value of the flow of future earnings back to the present.

The line OR is the gross returns curve. It is constructed from the total yields curve by multiplying the yield at each level of effort by price receivable. OS_5, maximum available gross return, is equivalent to annual available catch. As effort and marginal costs increase, gross returns correspondingly increase. These returns are marginal gross returns. In addition, as gross returns increase, they do so at a decreasing rate. That is marginal gross returns are decreasing.

Having described the relationship within the figurative representation of our hypothetical fishery, it is now possible to show how the total allowable catch for year 1 can be estimated. As indicated in Section 1, a necessary condition for economic efficiency is that marginal costs and marginal gross returns are equal. That is, that the rate of increase in costs and that the rate of increase in gross returns are the same. As the slopes of the two functions give the respective marginal relationships, all that is necessary is identify where the slopes are equal. This is at where effort equals OE_1. At this point gross returns are OS_3, and costs are OS_2. This gives a net return (rent) of $OS_3 - OS_2$. Dividing OS_3 by the price payable will give the total allowable catch*.

There are several relevant points to be noted with this outcome that the figurative model of the fishery shows. First, that the TAC estimated using an economic criteria will mean that less than the annual available catch is allocated. Second, even if maximum available catch (which for a prawn fishery will approximate MSY) is taken, net returns will be available to the fishery. In this case effort will equal OE_2 and net returns will be $OS_4 - OS_3$. Thirdly, without the imposition of individual quotas, effort will be OE_3, total cost and total returns will be OS_5 and gross returns will be OS_5 and net returns will be zero.

One outcome of using maximum present value as a criteria to estimate TAC is that even if a TAC is allocated which is in excess of that indicated by the model, then industry can still make the allocated catch, and net returns will exceed zero. The only requirement is that TAC be less than the available catch.

2.3.2 Consequences of Incorrect Estimation of TAC.

The estimation of the total allowable catch is an important input to the establishment of individual allowable catch. The three possible outcomes to estimating TAC are:

- correct estimation of the allowable catch;
- overestimation of the allowable catch; and
- underestimation of the allowable catch.

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* The same result could have been obtained by not using the gross returns curve but a catch per unit effort curve.

The likely result of an overestimation of TAC could result in some fishermen not meeting their quota. If fishermen do not meet their quota there may be a loss of faith in the system and fishermen will concentrate fishing effort at the beginning of the season to ensure taking their catch quota. The outcome would likely still be more efficient than that for a limited entry management fishery.

If the TAC is underestimated, then some of the available resource will not be taken and thus wasted. However, fishermen are more likely to have higher net returns in this case than would occur in a fishery with limited entry alone. If it becomes apparent that the TAC has been underestimated, then upwards adjustments could be made during the season.

After examining the consequences of each outcome, it is obvious that the correct estimation of the TAC provides the best outcome for the fishery. However, it would be better to underestimate TAC's than to overestimate.

2.3.3 Initial Allocation of Catch Quotas.

The allocation of quotas or shares can be carried out according to a number of criteria. As with the establishment of any system of restrictive property rights, the inclusion of some individuals will involve the exclusion of others, and the alteration of one system of property rights to another will result in a change in relative shares between fishermen. This change in relative shares will occur regardless of the form of property right change, including the institution of controls on under deck tonnage, and shaft horse power.

2.3.4 Allocation Criteria

There are a number of quota allocative mechanisms. Just which one is chosen will depend on the criteria established, the characteristics of the fishery and how well the allocation mechanism meets the criteria. The criteria to be used in allocating shares is a political one, although questions of equity, cost effectiveness, flexibility, and minimisation of social disruption would need to be addressed.

2.3.5 Allocative Mechanisms

The options available include:

- individual catch quotas according to participation. An example would be according to the catch taken over the past three years (or one, or five, etc years). As an individual may have possessed an endorsement for less than the period of time being reviewed, it may be more equitable to allocate the quota according to the catch taken on that endorsement over the period being reviewed.

A problem in relation to the northern prawn fishery is what to do with those endorsements which have not been used over the past few years;

- individual landing quotas allocated equally among all DMZ endorsements holders. Such a system is not consistent with the intentions at the initial establishment of restricted entry. When restricted entry was introduced to the DMZ, boat replacement was according to the size of the boat being replaced - which implies that all endorsements were not considered equal. This means of allocation would respond to concerns over the distortions caused by the boat building subsidy;

- individual quotas determined according to a formula equating quota with allowable boat size of that endorsement at the time of initial establishment of DMZ (February, 1977) to total allowable catch. It must be noted that all boats under twelve metres were allowed to be upgraded to twelve metres. To allow for dimensions in addition to length, some measure such as under deck tonnage may need to be used - if the required historical dimension can be established.

  The formula would be

$$\frac{\text{Initial Allowable Size of Subject Boat}}{\text{Aggregation of Initial Allowable Size for all Endorsed Boats in the Declared Management Zone}} \times \frac{100}{1} \times \frac{\text{Annual T.A.C.}}{1}$$

  = subject boat's catch quota.

Such a method of allocation appears consistent with intensions at the initial declaration of the DMZ, and would remove the increased distortions due to the boat building subsidy. The difficulty would be in tracing endorsements back to the time of their original allocation in 1977.

- individual landing quotas based on existing individual catching ability, such as under deck tonnage and/or shaft power. Such a system offers no advantage over actual catch, while it does result in problems in identifying what measure of 'catching ability' should be used. Initial results from the BAE's study of the northern prawn fishery indicate that there are few, if any, single technical measure of catching ability;

- individual catch quotas be opened up to bidding. Such a system has strong support according to economic efficiency (resource allocation) criteria. It is likely, though, that such a system would result in sudden distributional changes. Due to distortions in the capital market, access to financing may not be according to ability to efficiently run a prawning operation. Even if the bidding was restricted to those already in the fishery those individuals who are better able to organise their financing will enjoy an advantage over others;

- allocate catch quotas according some mixture of the above. For instance a proportion of the TAC could be allocated equally among all endorsement holders, with the remainder being allocated according to

    - bidding, or
    - past catches, or
    - a quota based on allowable boat size in 1977, or
    - some other method.

Such a method would guarantee a quota to those endorsements not currently being used, without giving them as much as those participating in the fishery as well as evening out some of the disparities due to the boat building subsidy.

2.3.6 Individual Catch Quotas

It is important that catch quotas are allocated to individual operators. Where this has not been done, such as in the Anglo-American west coast halibut fishery, fishermen continue to compete to get their share of the TAC.

2.3.7 Transferability

To obtain the full benefit of the proposed management scheme it is essential that catch quotas be transferable.

If fishermen are able to treat catch quotas the same as any other productive input factor then they will be able to sell all or part of their quota, or buy additional quota allowance. This flexibility will allow fisherman to arrange their inputs in the most efficient manner.

If individual boat operators wish to up-grade operations they would be free to enter the market and buy an additional quota allowance. As operators approach retirement and their financial responsibilities lessen, they can sell or by leasing out part of their quota continue to operate but at a diminished level. In a fishery, such as the northern prawn fishery, when there is excess fishing effort the, existence of ITCQ's will result in adjustment of fishing effort without the need for the introduction of a buy-back.

2.3.8 Benefits

The benefits which arise from the use of ITCQ's include:

° securing the fisherman's equity in the resource

- Although the annual catch credited to each fisherman will vary according to the estimated TAC, the proportion of the TAC will be secure;

° allowing fishermen to adjust their quota according to need and ability

- Fishermen will be able to build up their quota allowance by buying ITCQ's in the market, adjusting their quota according to their other inputs such as the condition of the boat, financial status and physical ability. If a boat is lost or is out of use for a long period the fisherman can lease his quota to another operator while a new boat is being built or transfer his operations to another boat. As a fisherman's circumstances change he can lower his quota by selling or leasing out part or all of it;

° a longer season and freedom from the frantic competitive race of most other management systems

- Thus fishermen are free:

  .. to arrange their inputs to minimise costs, instead of arranging their inputs so as to out compete their co-fishermen,

  .. to deliver fish to processors over the whole season according to market demand,

  .. to direct a greater proportion of their catch to high value uses such as fresh and chilled fish, and

  .. to supply fresh fish markets over a longer period, with the likelihood that public fish consumption patterns may be maintained and improved;

° the maintenance of boat and equipment can be carried out in a rational manner;

° health and safety concerns can be responded to;

° ability to adjust the total allowable catch

- The total allowable catch can be adjusted as more information becomes available. If, as is suggested, the quota is a proportion of the TAC, this would mean that the actual quantity that each individual would be allowed to catch would vary. Fishermen would not be under the same incentive to chase their share of the available catch but may act to reduce their costs in taking the reduced allowable catch;

° setting bench marks against which demands for alternative uses of the resource base could be compared;

° allows new technology to be developed which will improve the efficiency of fishing operations.

- At the present time restrictions on inputs, while not decreasing costs, do inhibit the form in which fishing maybe carried out.

2.3.9 Disadvantages

Possible disadvantages in the use of ITCQ's, include:

° difficulties in prediction of total allowable catch

- The management consequences of these are greatest when TAC is overestimated (as discussed above).

  Those populations which are the most difficult to estimate are those with short life spans and those for which TAC is independent of the previous seasons breeding population. On both accounts prawns are a difficult species for calculating TAC. Given the relationship between TAC and the size of the breeding population for northern prawns, the biologic consequences of miscalculation of the TAC are minimal;

° fishermen on exceeding their quota would be forced to throw their catch overboard.

- This consequence does not necessarily follow if arrangements are made for those who have exceeded their catch to lease unused quotas for that year, or sell their excess catch to somebody who has unused quota entitlement;

° the constraint of the ITCQ's against individuals wishing to enter the fishery.

- It is possible that a fishery in which ITCQ's are freely transferred would be easier to enter than a limited entry fishery in which there are restrictions on transferability;

° such a system would allow a few individuals to buy up all of the quotas.

- It is suggested that this is unlikely. It can be argued that the present northern prawn management regime creates conditions in which large operators have an advantage. In the competitive race for prawns those with the largest and technologically best equipped boats enjoy an advantage over small operators. As big operators are likely to have better access to finance, they are therefore likely to have larger and more modern boats.

  With ITCQ's optimal boat size and operation will depend on profitability. If there is continued concern over concentration of ownership, there is nothing to prevent the establishment of a limit on the quota endorsement that any operator can hold. New Zealand has done this with its offshore trawl fishery;

° that it would be difficult for fishermen to sell their boat without a large quota.

- Boats are the same as any other input. If a boat which has been put up for sale is in good condition and better than that owned by other operators, there would be an advantage for one of those operators to sell his present boat and buy the boat offered. Indeed if the price is right there is an incentive to do so. If ITCQ were introduced into the DMZ there would be an initial movement of boats out of the industry.

  If the boat offered for sale is at the end of its useful life in the DMZ, it will not be bought regardless of the associated catch quota;

° the distribution of shares on the establishment of a ITCQ system would be difficult and would result in inequities between recipients.

- Any changes in a management system are likely to result in inequities including eg., the introduction of UDT's and engine power. However under ITCQ's, while some individuals may do better from the distribution of quotas than others, all operators can immediately organise their operations to increase profits, and at least, introduction of ITCQ's is more likely to make one person better off without making another worse off;

° that such a system is likely to result in a spill over into other fisheries.

- This would arise if it was seen as an advantage by an operator in the fishery using ITCQ's to do so. Such a response need not depend on the fisherman being in a fishery having ITCQ's - although increased profitability may increase an operator's ability to move into another fishery. In addition operators selling out of a fishery in which ITCQ have been introduced may enter another fishery. They would only sell and enter another fishery if it made economic sense;

° that such a system would act as a barrier to diversification.

- As quotas would be freely transferable operators would have greater freedom in structuring their fishery operations;

° that such a system would work to the advantage of processors.

- It may be - that is in any one port, the market is dominated by a single buyer. However, it can be argued that such a a system is already in existence in the northern prawn fishery. Onboard processing, however must surely work against such a market structure. In addition, as ITCQ will work towards evening out the catch of prawns, it would be easier for smaller processors to enter the market;

° That the establishment of ITCQ's will remove a competitive element.

- Under the present management regime it is necessary for operators to compete to establish a property right over available prawns. In part it is this competition for a catch share which results in fishermen making low profits and in wasting public resources. Under ITCQ fishermen are still free to compete in carrying out more cost efficient operations and thus increasing profits and saving public resources;

° that such a system will work to the advantage of larger boats.

- This argument is a continuation of the general argument of wealth concentration. If there is an economic advantage in having large boats which can fish over a wide area then this will be the outcome. In the northern prawn fishery, however, there are indications that the free working of the market would result in smaller boats then those operating now;

° that such a system would not work as there would be marketing abuses.

- There is a strong incentive for fishermen and processors not to report all of the catch. This is an area which will require a thorough examination. A suggestion that the total allowable catch estimation should allow for under-reporting is inequitous as it would reward cheats, while destroying the acceptance of the system.

  The northern prawn fishery may be easier to police on this account than most other fisheries, as there is a limited number of available ports.

2.4.0 Overseas Experience

Over the past few years individual quotas have been introduced into a number of fisheries. Possibly the country to have made the most extensive use of individual quotas is South Africa, in that all the major fisheries, ie., demersal, pelagic, rob lobster and abalone, are managed using individual quotas (Mathews, pers. Comm. 1983).

Unlike Australian fisheries South African fisheries are dominated by public companies. These companies are the prime holders of the proportional (record percentage of annual TAC) quotas. The quotas vary in their management of specific species according to the fishery. In the off-shore sea demersal fishery the quota applies solely to hake, in the in-shore demersal fishery it applies to hake and sole. In the pelagic fishery specificly there is a specific quota for anchovy and for pilchard, with all other species covered under the global quota.

In the rock lobster fishery the companies have divided their quotas amongst a fixed number of boats, some of which are owned by the company, some of which are privately-owned. While individual boat "landing quotas" are transferable, the number of boats is fixed. The situation with the pelagic fishery is similar to that of the rock lobster fishery, except that a global hold capacity is also in force. In the abalone fishery the "landing quota" is allocated to a particular diver. The company quotas may be "transferred" through change in control of the companies.

In terms of enforcement South Africa has had no difficulties. Except for abalone boats, which have a limited range, all boats have to land at individually designated landing sites. Assized scales are used to weigh the catch at these sites, or, in the case of abalone and demersal fisheries at the factories. In the off-shore trawl, while all vessels are company owned they do work to individual hake quotas. When this quota has been met, all fishing stops. In the in-shore trawl, a vessel ceases operation immediately its hake or sole quota is met, irrespective of the condition of the other quota.

There appears to have been no problems arising from the estimated TAC's. Operators and companies have tended to have either reached their quotas, or to have been reasonably close to their allocation. Occasionally weather conditions have caused disruptions. While operators would like to have higher quotas, operators apparently have faith in the calculated TAC.

While boat quotas are directly transferable, and company quotas through change in control of the company, there appears to be no aqistment, or partial lease of a quota to make up differences in catch and quota allocation between individual operators. On technical grounds the system appears to be reasonably successful (Matthews ibid). It would be interesting to see economic evaluations of the respective fisheries.

In the northern hemisphere there are a large number of countries which have established individual quotas. In western Europe the need to establish national quotas to the North Sea fisheries has resulted in at least some of these countries establishing individual quotas. There is little information available to me at this time on how these quotas work in the U.K. North Sea fishery quotas are adjusted according to crew size.

New Zealand has had individual quotas operations in its offshore fisheries for going on two years. Although there have been criticisms of these fisheries according to how quotas have been applied, no criticisms have been cited against the system itself. The same level of acceptance of individual quotas seems to exist for those fisheries in Anglo America which have such a system. It is possible though that distance is muffling any complaints that may be occurring.

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