Department of Primary Industry

POLICY AND PRACTICE IN FISHERIES MANAGEMENT

edited by

N.H. Sturgess and T.F. Meany

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INTRODUCTION

The Australian fishing industry is dominated by coastal fisheries whose output of species such as rock lobster, prawns, and various molluscs is highly valued on international markets. Twenty years ago a fisherman with the necessary capital and skills had free access to all these fisheries. Therefore, it was not surprising that many fisheries developed what are now well-known as the symptoms of "economic overfishing". What might be regarded as more surprising, however, was the speed with which the biological-trained administrators of the early 1960's adopted management strategies which were being suggested by fisheries economists. At that time fisheries economics, even in its North American birthplace, was still a very young discipline and debate was confined mainly to academic circles. One of the messages emerging from those debates was that restricting the number of fishermen or vessels ("limited entry") was a control measure which had the potential to improve the economic performance of a depressed fishery. Whether for this reason or others, limited entry, along with a variety of more traditional types of regulations, was quickly implemented in a number of Australian fisheries in the 1960's. Indeed, some fisheries, such as the South Australian and Western Australian prawn fisheries, are unusual amongst the world's fisheries because they began under limited entry regimes.

During the seventeen years of experience with this form of fisheries management in Australia many important changes have taken place. Our knowledge of the biology of many species of fish has increased as has our knowledge of the economic structure of the industries centred on those species. Even with restricted entry, increasing prices for fish and rapid advances in fishing technology and gear design have increased the pressure on many stocks. There has been a growing awareness amongst administrators and fishermen - although not necessarily for the same reasons or directed to the same ends - of the importance of introducing regulations which have specific economic objectives. Concomitantly, a growing understanding amongst fisheries economists of the nature of the economic problems of fisheries has produced a wider set of policy options with the potential to alleviate those problems.

These developments helped to foster continuing discussion about the purpose and effectiveness of the management regimes which operate in Australia's fisheries. In the course of this discussion it has become clear that people in various sectors of the fishing industries along with biologists, administrators and economists see difficulties and faults with present management practices. Also, while pressures for change in management exist there is uncertainty about the appropriate form that these changes might take. For example, there is evidence that the fishing effort in some limited entry fisheries remains excessive. Whether effort is to be reduced further, and if so, whether by market mechanisms or administrative mechanisms, are controversial questions with economic, social, and political implications.

Similarly controversial is the question of the distribution of the monetary benefits which flow from fisheries which are regulated in an economically rational way.

Against this background it seemed appropriate in 1980 to provide a public forum in which to review and evaluate Australian fisheries management by drawing on both local and overseas experience of limited entry programmes. To this end a grant from the Commonwealth Government's Fishing Industry Research Trust Account made it possible to conduct a National Fisheries Seminar at the University of Melbourne. This volume contains a selection of the papers given at that seminar. The major purpose of presenting these papers in book form is to involve a wider public audience, including fishermen and fisheries administrators, in identifying the short-term and long-term objectives and problems associated with limited entry fisheries. From the identification of these issues may come further and more informed debate about the ways in which these problems might be overcome or avoided.

The papers collected in the volume are grouped into three parts. Part I deals with some general issues in fisheries management. In the first paper Professor J.A. Crutchfield draws on his extensive experience as a theoretician and advisor to management agencies to outline a number of key issues which are explored in subsequent papers. Professor Crutchfield addresses the question of why the practice of management has lagged behind our knowledge of what is achievable. Two causes which he isolates are the frequent lack of a set of clear and appropriate objectives for management, and the weakness of institutional mechanisms for the effective implementation of management programmes. One of Crutchfield's important contributions is to suggest two sets of objectives; a broad set for guiding the choice among management programmes and a set of more practical objectives which relate to the implementation of particular programmes. The major instruments of fisheries regulation are reviewed in light of these sets of objectives.

In the second paper J.A. Butlin takes a detailed look at the available policy options within the context of the United Kingdom's fisheries. Butlin's major purpose is to review the economic rationale for restrictive licencing schemes and, with Crutchfield, he is concerned about the problems of implementing programmes based on restrictive licencing. He argues his preference for restricted entry regimes provided adequate information can be assembled to establish and operate the scheme, licences can be allocated by market processes, and the duration of licences is related to the planning horizon of vessel owners.

The next two papers consider the types of property rights that are used, or can be used, to utilize fisheries resources. Professor P.H. Pearse pays particular attention to management schemes which are based on fishermen possessing the right to take specified quantities of fish. He argues that such rights, if transferable by sale, provide a more exclusive form of exploitation rights than present regimes of restricted access. Also, these "quantitative" rights offer the same capability of achieving economic efficiency as a perfectly-adjusted royalty on landings. This new approach to management, Pearse argues, eliminates the incentives to waste fishing capacity and has fewer practical difficulties than other management regimes. T.F. Meany examines in detail the types of property rights embodied in the management regimes which are currently used by the various Australian agencies. He argues for some modifications to the rights bestowed on fishermen by the limited entry schemes, with particular reference to the appropriate time period over which licences should remain in force.

The final paper in this section takes an overview of limited entry policies in Australia from the standpoint of an entrepreneur with investments in a number of fisheries. T.G. Kailis is critical of these policies and favours a return to open entry. Restricted licencing, he argues, does not produce an environment of healthy competition and can lead to a slow rate of technological development. Such schemes should be a last resort and introduced only after extensive scientific and economic investigation and close consultation with those engaged in the fishery. Many economists and administrators will disagree with Kailis's argument but it is a viewpoint which must be heard and understood if members of the fishing industries are to be part of the analytical and decision-making processes.

Part II contains eight papers which allow the reader to make comparisons of the management regimes used by different agencies for similar species of fish. Many of these papers outline the history of the management policies which are used for the particular species and the ways in which these policies evolved as conditions within the fisheries changed. This historical flavour is important not just as background to the fisheries but also because the particular ways in which the problems of open access occurred, or were anticipated, helps us to understand the reasoning behind the particular management strategies. Some of the papers in this section provide forceful demonstrations of the ways in which economically rational policies can be emasculated by the failure to specify clear objectives for management. Particularly, the importance of sensitive political considerations, which frequently bear on the distributive functions of regulations, and their effect on the implementation of limited entry schemes is evident.

D.D. Huppert compares and contrasts the limited entry regimes administered by the State of California for the herring roe and abalone fisheries. Herring roe is a highly-valued commodity in Japan and the development of this fishery in North America is relatively recent. During the short time the licencing programme has been in force in California, Huppert concludes that the herring stocks have been conserved while large profits indicate that limited entry has generated resource rents for herring fishermen. In contrast, conservation of the abalone stock is less obvious and the fishery does not yet show signs of significant economic progress. Like Huppert, G.A. Fraser reviews the history of limited entry in the herring-roe fishery of British Columbia in terms of biological, economic and social objectives. Fraser suggests that the licencing provisions have been too generous because, in attempting to share the wealth as broadly as possible, the number of vessels allowed to participate is far in excess of biological availability and management capability. This generosity and the increasing fishing intensity of individual vessels is indicated by the fact that open seasons of fifteen minutes and one to two days are common for the seine and gillnet fleets respectively.

An interesting comparison with the Californian abalone fishery is provided in K. Stanistreet's history and evaluation of limited entry in the Victorian fishery. Management of the Victorian abalone fishery is characterized by close association between fishermen and the administrators. Stanistreet draws out the philosophy of management as well as the policies and conflicts which have occurred through this association.

The rock lobster fisheries which are located on the southern coasts of Australia are administered by three states - Tasmania, Victoria and South Australia. Many of the management regulations differ between the fisheries but each is subject to restricted licencing. R. Sudmalis discusses the approaches to management of the three States and presents detailed information on the costs and earnings of the fishermen. One of the characteristics of these fisheries, in common with most limited entry fisheries in Australia, is that the limitation on entry was first imposed as a moratorium on the entry of additional vessels. Since the introduction of the scheme there has been considerable growth in the fishing power of the fleets but little or no reduction in the number of vessels. Sudmalis discusses various steps which might be taken to counteract this problem including a scheme to buy-back licences and a proposal to replace the administrative procedures by which pots are allocated to boats with a system of saleable "rights to use lobster pots". E.A. Cleland and his colleagues discuss fishermen's reactions to one proposal for a buy-back scheme in the South Australian sector of the fishery. This interesting paper shows that economists and administrators must exercise great care when putting management proposals before fishermen if misunderstandings of issues and motives are to be avoided.

The rock lobster fishery of Western Australia is one of Australia's largest and most valuable fisheries. It was also the first fishery in Australia to be subject to restricted licencing. The paper by P.P. Rogers outlines the evolving management policies to counteract the increasing fishing power of the Western Australian fleet. Rogers also makes suggestions for future modifications to reduce the number of boats and the amount of fishing gear - again the idea of a buy-back scheme receives attention.

The prawn fisheries are Australia's most valuable fishery resource. In aggregate the value of the catch is about $100 million and prawns constitute about 48 per cent ($93 million) of the value of fish exports. Of these fisheries the northern prawn fishery in the Gulf of Carpentaria and the waters of the Northern

Territory is the largest. The Southern Australian fishery, discussed by J.L. Byrne, is smaller but interesting because it is a fishery whose entire development has taken place under restricted licencing. Also, in recent years the South Australian Government has extracted a significant proportion of the rent from this lucrative fishery by markedly increasing annual licence fees. Byrne presents some useful quantitative estimates of the changes which have occurred in fishing effort and operating efficiency in the fishery. A model of vessel fishing power is developed as part of this analysis. The relative advantages of some policy options with respect to effort per operator, operator efficiency, and the number of operators are also explored.

N.D. MacLeod has performed an extremely valuable task in writing the first account of the economic history of the northern prawn fishery. This fishery also falls under the jurisdiction of several management authorities and the management measures must be determined by compromise and joint agreement between the parties. The rough and tumble of administrative and political compromise, the lack of adequate biological and economic knowledge of the fishery, and the dearth of clear and consistent economic objectives are seen by MacLeod as the main causes of the slow and painful evolution of management policies in this fishery.

The final paper in this section by N.H. Sturgess, N. Dow, and P. Belin reviews and evaluates the management of Victoria's two scallop fisheries. Using the results of some bio-economic models of the fisheries the authors make some suggestions about the number of boats which would maximize rent from these fisheries. Modifications to the existing system of limited entry, including separate management of the two fisheries and a scheme to buy-back licences, are proposed.

Part III contains a set of papers which discuss the experience with limited entry programmes in selected countries. Professor G.W. Rogers presents a detailed history of the introduction, administration and continuing modification of the comprehensive programme of restricted entry which prevails in most fisheries in Alaska. Because of the complex social and economic issues involved, such as subsistence fisheries and the place of non-resident fishermen, Rogers makes a close examination of the perceived objectives of the programme. His major conclusion is that excess capacity has been stabilized but, like many Australian fisheries, the scheme has not been pushed to reduce the numbers of fishing units.

N.B. McKellar reviews the policy options available to the United Kingdom as a participant in the fisheries of the north east Atlantic. Fisheries management in this region is extremely complicated because seventeen nations, not all of which are subject to the common fisheries policy of the E.E.C., exploit a number of interdependent fisheries. Within these constraints McKellar concludes that the United Kingdom's choice of policy will depend more on regional and social criteria than on economic criteria. Nevertheless a reading of the papers by both McKellar and Butlin suggests that there is a growing interest in restrictive licencing schemes in the United Kingdom.

In the final paper, P. Riley discusses the development of limited entry policies in several of New Zealand's fisheries. He identifies four major objectives which administrators have specified at different times in this development and shows how a number of methods have been used in attempting to achieve those objectives. Riley argues that the best way to achieve biological conservation may be by setting allowable catches while restrictions on entry should be directed towards social, economic and political goals. His discussion of the management of New Zealand's scallop fisheries can be compared with the Victorian experience outlined by Sturgess, Dow and Belin.

In editing this book our policy has been not to interfere substantially with the arguments and ideas of the authors even though it is our belief that there may be some misunderstanding of economic issues. For example, not all authors share the economist's notion of rent, his distinction between social and private costs, and his distinction between the functions of a rent tax and an income tax. Some of these problems can be corrected by reference to those papers which consider various aspects of the economic theory of fisheries management. We have not consolidated these pieces of theory into a single chapter because we believe that some repetition is useful and because the way each author draws on the theory is an integral part of his paper. Because we believe a purpose of this book is to review and evaluate the practicalities of management we refer readers to the readily available textbooks on fisheries economics, such as L.G. Anderson's The Economics of Fisheries Management (John Hopkins University Press, Baltimore, 1977), for a complete discussion of the theoretical issues.

N.H. Sturgess
T.F. Meany

PART I

GENERAL ISSUES IN FISHERIES MANAGEMENT

1

KEYNOTE ADDRESS

by

James A. Crutchfield

Almost a century has passed since the myth of the "boundless productivity of the sea" began its slide into oblivion, and marine biologists began to consider seriously the possibility of severe depletion - perhaps even extinction - of important fish populations. The concern grew far more rapidly in the decades after World War II, with the tremendous growth of new fishing capacity with greater range, efficiency, and versatility in operation.

It is also about a quarter of a century since a group of professional economists began to speculate in print about the remarkably persistent tendency of commercial fisheries, of all types and in all parts of the world, to produce very poor economic results - low and unstable incomes to fishermen, large accumulations of totally unnecessary fishing capacity, and the regional economic burden that accompanied the rise and apparently inevitable decline of mature fisheries. Since then, the literature on the economics of commercial fishing has grown tremendously: in part because the theoretical issues involved turned out to be far more difficult (and therefore far more interesting) than anyone had expected; and in part because more and more natural resource economists plunged into the equally difficult task of converting economic theory to practical improvements in management objectives and practices.

Given all that time and all the splendid research that has gone into expanding our knowledge of the sea, its living resources, and the technical problems of harvesting them, the results are remarkably disappointing. The number of programmes that have actually succeeded in checking depletion of ocean fish stocks can be counted on the fingers of one hand. And those that have protected the stocks while providing some real improvement in earnings, stability of employment, and ability to withstand the usual economic jolts to which fisheries are subject can be counted by someone with no hands at all. The frustrating aspect is the wealth of wasted opportunities. We simply are not making use of what might reasonably be called spectacular growth in the past 20 years in knowledge of the dynamics of exploited fish populations; the ability to acquire reasonable assessments of stocks through acoustical surveys and improved analysis of catch data; and even the ability to forecast fleet response to various kinds of management measures. Even less use has been made of the fairly substantial literature pointing out the economic effects - good and bad - of different combinations of management measures.

The conclusion seems warranted that the basic problems of rational utilization of marine fisheries are not scientific ignorance, though fishery management will always be an exercise in skilful use of limited data. The real weakness lies in our institutional mechanisms for getting something done, and for making the regulated fishing industry itself a part of the analytical and decision-making process. We need to provide essential knowledge of how particular measures would effect particular groups of fishermen, and to drive home the fact that the fisherman himself has much to gain from choosing intelligently among management measures where some kind of intervention is essential. Why this gap between knowledge and action? Economists and an increasing number of fishery scientists argue that management programmes have been geared to the wrong objectives. A surprising number of these programmes have never had any specific stated objective at all, since most were intended to protect one group of fishermen against another. Where the objective has been made explicit, it has invariably been maximum sustained yield or some variation of that theme. The traditional measures for controlling commercial fishing - time closures, area closures, gear restrictions, quotas, and mesh size regulations - are all keyed to one over-riding concern - that is, to reduce fishing mortality to some desired level. Little or no attention was paid to the impact of different ways of controlling fishing mortality on overall economic efficiency, on the level and stability of earnings of the individual fishermen, or on the incentives to use efficient vessels and gear to develop new and better techniques.

Fortunately, that period seems to be drawing to a close. In Canada, the United States, and the European Economic Community, and certainly in Australia, the question at issue is not whether fisheries should be regulated or whether they should be regulated only through simple measures to control catches. We are now asking which among various, more complicated, methods can promise biological protection and better economic performance; and, of course, the related question, what political, institutional, or other obstacles need to be overcome if such programmes are to become a reality.

These are not easy questions to answer. The minute one turns from the deceptively simple goal of maximising yield, the objectives of the programme become more complex. Let me take a shot at defining a broader set of objectives to guide the choice of fishery management programmes (recognizing, of course, that no single programme is ever going to be completely satisfactory for all fisheries - they are simply too different, biologically and technically, for one set of prescriptions to satisfy all). First, the programme chosen must provide, with certainty, the ability to protect the basic productivity of the stocks concerned. The inevitable variations in stock size and accessibility caused by changes in ocean parameters are beyond man's capacity to control (and, commonly, beyond his capacity to monitor). Fishery management must have the tools to act promptly and decisively when unanticipated changes in stock size and composition make planned levels of catch dangerously high.

Second, to make any sense in today's world, the programme must provide both incentive and pressure for efficient harvesting, processing, and marketing. From the standpoint of the fishing sector, this breaks down to five requirements. (1) The right level of catch - in economic terms the catch level at which any further expansion of effort would bring greater costs (including management costs) than the value of the additional fish. (2) The right size composition - no further gains can be achieved by changing gear selectively to alter the minimum size at first capture and therefore from "investment in further growth". (3) Fishing units that are as efficient as the state of the art permits - no possible reductions in the real cost of taking any given catch can be achieved by changing the size, gear, or labour force on the vessels used. (4) Optimal deployment of the fleet by area and over time. (5) Progressiveness - both incentive and opportunity for the industry or for public agencies supporting the industry to develop new and better techniques that can be incorporated without disturbing the other objectives cited above.

At a different level another set of objectives concerned with the practicality of the programme must be considered. In no particular order of importance these include the following: (1) Acceptability - regardless of the theoretical interest involved, there is little point in discussing, for a particular fishery in a particular country, management programmes that will be totally unacceptable either to government or to the industry. This may be altered if a patient, time consuming effort to work out the details of such a programme could eventually win acceptance, but the costs of that effort must then be taken into account. (2) Flexibility - again, theoretical niceties must be tempered by the fact that the number and accessibility of fish is highly variable from season to season. The basic management programme must be flexible enough to take timely decisions when something goes very wrong. (3) Distribution effects - even the best of fishery management programmes are unlikely to produce winners without also producing some losers. In terms of both equity and acceptability, the programme must be able to identify groups that benefit and suffer from both short-term and long-term effects, and provide some mechanism for minimizing adverse impacts. This may, for example, require a slow, measured reduction of excess capacity rather than an all-out effort to move the fishery to an efficient configuration in a short period of time.

What tools are available to use to achieve these objectives? I do not propose to spend much time on the traditional techniques of time closures, area closures, gear restrictions designed to prevent efficiency, and quotas. All of them demonstrably have the effect of increasing the cost of any given catch to the point where no overall net economic benefits remain to the fleet. None can deal with the basic problem of incentives that lead individual fishermen, on a perfectly rational, businesslike basis, to invest to the point where serious overcapacity is inevitable. And many of them have proved incapable of dealing with the stock protection problem. With enough excess capacity, even the biological objectives of management may be unobtainable.

The conclusion seems inescapable. If biological benefits of regulation are to become actual economic and social benefits, some method of restricting fishing mortality or limiting the number of fishing units is essential. Moreover, the programme must aim not only at fleet efficiency (the correct number of vessels) but must offer incentives to make the individual fishing unit as efficient as possible. The choices boil down to three. Since the basic reason for the unpleasant results that follow from open access result from the fact that a real cost imposed on the fleet as a whole is not seen by the individual vessel operator, we could, in theory, substitute taxes for the missing element of cost and bring social and private costs into agreement. Thereafter, we could leave the ingenuity of the fisherman and the market mechanism to produce an efficient industry. Second, we can limit the amount of inputs directly - by licencing vessels, fishermen, or both (and perhaps by putting additional constraints on length, tonnage, horsepower, or other elements that affect the productivity of a licenced boat). Third, we can control catch directly by establishing an overall quota (or total allowable catch) and divide this into individual fisherman "quotas" which can be used to take fish in any non-destructive way that the fisherman chooses. The first two are obviously indirect ways of controlling catch, relying on the effect of taxes on costs of fishing or on control over the number of fishing vessels to limit total catch to desired levels. The latter is direct, with control exercised over output of the individual fishing unit, leaving the question of how, when, and where to take the catch largely to the initiative of the individual vessel owner.

It seems useful to draw these distinctions sharply, although there is no reason at all why they could not be combined to arrive at the most workable management programme in a given fishery. I have separated them only for purpose of a preliminary look at their more obvious advantages and disadvantages. It should also be emphasized that none of these techniques are capable of providing the fast response mechanism needed in the event of unexpected and really drastic changes in availability of fish (or perhaps in the area deployment of a large portion of the fleet). Any sensible management programme must include the authority to shut the fishery down, in part or entirely, in any area and over any period of time necessary to deal with these unforseen contingencies.

In the rarified atmosphere of static theoretical economics, all three methods of regulating to achieve both biological and economic goals are essentially the same. The choice among them rests, therefore, on the practical questions of their political acceptability; the effectiveness with which they can be instituted and administered; the demands they place on the industry, fishery scientists, and the resource managers with respect to data; and their enforceability.

First, then, a look at taxes (or royalties, if one wants a more agreeable word) as a means of reducing or eliminating the economic waste that characterizes open access fisheries while providing the desired level of fishing mortality. The theory behind this approach can be stated very briefly. Under open access conditions each fisherman who enters an already developed fishery imposes costs on other fishermen by reducing the available catch, but these costs are not reflected in his own calculations. Consequently, rational behaviour on the part of potential new entrants to a profitable fishery could easily lead to serious over-capacity even though the earnings to individual fishermen are still as good as could be earned in any other occupation. Presumably, then, if the fishery would remain in completely stationary equilibrium, taxes could be devised that would impose on the individual fisherman costs that represent the true cost of his actions to society. The simplest and most effective proxy for this cost-correction approach would be a tax on landings. Thereafter the choice of fishing method, the level of fishing effort, and its distribution over area and time could be left to the judgement of the individual fisherman. In effect, we would have restored the market conditions that prevail for the use of any other natural resource for which complete property rights can be established. The theoretical neatness of this approach is certainly attractive - but its application to real world fisheries seems to me to raise very serious difficulties that my fellow economists tend to gloss over (largely, I suspect, because of the entrenched tendency to analyze the economics of commercial fisheries in terms of long-run stable relationships).

The reasons for my concern are three-fold. First, there is a world of difference between the use of taxes as a means of preventing (or at least slowing down) the usual sequence in development of a new fishery - a surge of new entry, collapse, and a long dragging period of recovery - and the use of taxes to correct a situation in which severe excess capacity (and probably depletion of the resource) has already occurred. There is, after all, no comparison between the ease of not breaking eggs and the difficulty of unscrambling them once broken. But surely history tells us that there will be precious little support for any programme to control entry into a promising new fishery; the pressure for restricted entry, if it develops at all, normally comes after the situation reaches the crisis stage of over-fishing.

How could an already heavily overcapitalized fishery be rationalized by the imposition of a landings tax? There will be some level of tax sufficiently stiff to reduce the capacity to a level which approximates the efficiency conditions sketched out above and provides an adequate safety margin for protection of the stocks involved. But this would require inflicting losses on all participants in the fishery, since economic theory and common sense tell us that prices must be driven below out-of-pocket operating costs before anybody will really be induced to leave. Moreover, the nearly universal use of share agreements to compensate labour in fishing makes the necessary price reduction even greater. If a meat axe is to be used to solve an over-fishing problem, it would appear that a "negative tax" or subsidy could accomplish the initial reduction needed without the brutal impact of a tax on fishermen and related activities.

My second concern with taxes as a control device is probably more serious. Fluctuations in the availability of fish from a marine population are not only likely but inevitable. Since it is not always possible to monitor and predict the changes in oceanic factors that affect recruitment, growth, and naturally mortality, both the fishing industry and management must expect major changes in permitted catches from year to year. Taxes would seem a poor device to determine the correct level of fishing effort in a real world situation in which changes in allowable catch must be made every season. Uncertainty about the right level of tax, industry response to the tax level chosen, and the time required for the tax change to take effect all suggest that the necessary degree of flexibility simply cannot be achieved. Quite apart from this, I know of very few cases, none of them in fisheries, where legislative bodies have been willing to delegate this degree of flexibility in tax determination to a body representing the executive branch of government. I do not think I need to elaborate on the reaction of industry to this approach. Somehow I would feel uncomfortable addressing a large body of fishermen and telling them that the cure for overcapacity, declining landings, and restricted earnings is to tax them heavily!

A third reason for concern about use of the tax device as a means of achieving better allocation of fishing inputs is the problem of information. Fish are taken in different areas, at different times, and - in different degrees - jointly with other species. The gear and vessels can usually be diverted to other fishing operations if the incentive exists. This means that the proper tax level must be established each year not only for the overcapitalized fishery of direct concern, but in related fisheries as well. This requires a great deal of detailed financial information from the industry or industries affected - something that gets more difficult every year if it has to be undertaken on such a regular basis.

It should be emphasized, however, that the arguments above refer to the difficulty of using taxes as a <u>short term</u>, <u>flexible</u> means of controlling fishing effort. Over <u>the longer term</u>, any successful programme for rationalizing fisheries is likely to generate substantial amounts of economic rent - money returns over and above the amount necessary to provide a very satisfactory return to all fishermen - and the distribution of that surplus is a matter of legitimate public concern. And, as noted below, a landings tax can be a most useful - even necessary - complement to limited entry schemes.

The second major alternative to traditional forms of fishery regulation is the control of inputs - in more common parlance, limited entry. This is, of course, the only technique that has been tried on more than a very limited basis. The idea was first developed in the fishery economics literature, but its roots can be traced back to far earlier writings (many of them by fishery scientists) and it has grown very rapidly in the past six or eight years. Your own path-breaking efforts in Australia; the salmon programmes in British Columbia and Alaska, followed by more limited but still significant entry control measures in the states of Washington, Oregon and California; small scale but quite sophisticated limited entry techniques in some of the Great Lakes states in the United States; and the venerable control of sardine fisheries in South Africa are examples.

Perhaps more intriguing is the change in attitude toward management goals. For example, both Canada and the United States have specified improvement in economic performance of the fisheries in recent statements of national objectives, and Canada has made it clear that rationalization, whether by limited entry or some other means, will be the order of the day for all marine fisheries subject to Federal management. The acute problems of the European Economic Community pond make it essential that at least the larger types of distant water vessels be removed from the fishery, given its depleted condition and the closing down of traditional distant water areas.

Doubtless other examples could be cited. The point is that the change in attitude from fishing as a God-given right of every (insert your own nationality - Australian, American, Canadian, or Senegalese) is slipping away rapidly. The question at issue is no longer whether management regimes aimed at producing both biological security and sound economic performance for fishermen and the public are theoretically desirable. The issue now is how to do it with a minimum of unnecessary disturbance and additional regulatory apparatus and personnel, and with a reasonable promise of success.

The fact that most nations concerned with rationalizing their over-capitalized fisheries have chosen the limited entry option rather than the use of taxes as a direct measure for controlling effort doubtless reflects one principal advantage: it is the easiest to introduce, since it must, of necessity, be used in parallel with other methods of regulation and involves the least disturbance to existing ways of organizing and operating a fishing venture. In addition, its tightness can be varied from a very modest moratorium approach to one in which significant reduction of unnecessary inputs is undertaken as a matter of policy. Whatever the route chosen, a limited entry programme can be phased in a manner which minimizes the amount of compulsion that must be exerted to trim the level of fishing effort to desired levels.

It is, of course, no panacea. A limited entry programme (particularly in its early phases when substantial excess capacity, though no longer growing, is still a problem) offers no protection to resource productivity of itself. It must be accompanied by other direct measures (quota, time closures, area closures, gear restrictions, or some combination thereof) to keep total catch at desired safe levels. In defence of the approach, however, it seems equally obvious that as the phasing down process proceeds, the burden placed on other methods of controlling fishing mortality is reduced, and in the long run the administrative job should become more manageable. Similarly, the cost of mistakes in management goes down steadily as the amount of gear in the water during any open period or in any open area is reduced to more sensible levels. In a negative sense, a limited entry programme has the virtue of preventing things from getting worse - an outcome that would most certainly follow in the case of a valuable fishery whose real prices are rising at a rate which would attract new entry long after any possibility of increasing catches has been exhausted.

But clearly this is not enough. Limited entry, particularly in the milder form of a moratorium, is not likely to improve overall efficiency as much as one would desire. As Australian and Canadian experience demonstrates so clearly, the initial effect of a moratorium that does not include measures to prevent "upgrading" leads to a rapid transformation of the inefficient vessels into more efficient ones with greater capacity, and the casual inefficient fisherman finds it more profitable to sell his licence to a competent man who will use it effectively. Total potential fishing power is some multiple of the level at which the moratorium is first imposed.

In addition, each fisherman has an incentive to increase the size, speed, electronic equipment, or any other element of his vessel as long as the expected increase in catch exceeds in value the additional cost to be incurred. Obviously, if all fishermen undertake the same kind of reasoning, all of these expectations will be defeated and the fleet will end up having invested a considerable amount with no net gain to any participant.

The theory of this type of efficiency-reducing reaction to a limited entry programme in which at least some elements of fishing power are uncontrolled is beyond dispute. Moreover, experience in Australian and British Columbia fisheries confirms the fact that it will take place. The question of how serious it might be is an empirical one that simply cannot be answered in generalizations. It depends, first, on how readily inputs can be substituted. A fishing vessel is, after all, a platform for the handling of catching gear, and there are only so many things that can be done to increase its catching power per unit of fishing time before additional costs for any further increment in catch increase very rapidly. The amount of "unnecessary investment" that can be undertaken may therefore be limited by the technical nature of the vessel and gear employed. This limitation can, of course, be sharpened by imposing additional constraints on length, tonnage, horsepower, units of gear fished, or other elements of the fishing unit. But this raises the spectre of freezing the technology of the industry and making it difficult, if not impossible, to provide both incentive and opportunity for improvement and innovation.

In looking at specific cases, numbers can be misleading. For example, it has been argued that total investment in the British Columbia salmon fishery actually increased during the period after the imposition of limited entry (with a tonnage restriction on replacement) although the total number of vessels participating dropped from 7,000 to about 5,300. But there are two threads to untangle. On the one hand, it may be true that building larger boats with more horsepower and equipped to carry two or more types of fishing gear represents a wasteful, self-defeating effort to catch a larger share of a given available catch. But it is also plausible to argue that when the limited entry programme was initiated a large part of the fleet consisted of small, over-age, technically obsolete boats. The limited entry programme raised fishermen's incomes substantially, gave them far better access to normal financing channels through commercial banks than they had had before, and thus made it possible to purchase vessels and gear that were actually more efficient than that which was replaced. Clearly, fishing power has not been reduced by anything remotely resembling the reduction in the number of vessels. But the conclusion that the investment is wasteful may be only a half-truth. If at least some of the additional investment reflected better combinations of vessels and gear, previously unavailable because of financial stringency, the answer is not to prevent that type of upgrading but rather to accelerate the rate at which the number of vessels is reduced. It can also be argued, with some plausibility, that some of the additional investment (for example, in radar, sonar, direction-finding equipment and the like) was an investment in human comfort and safety in an industry in which hardship and the threat to life are all too common.

Obviously there is a bit of truth in both sets of arguments. The fact that British Columbia salmon licences now bring a very high price on the open market seems to be irrefutable evidence that the programme has generated substantial increases in fishermen's incomes and that these are expected to continue.

This raises a set of important issues with respect to the complementarity of a limited entry programme and a properly scheduled tax programme. Most economists argue that there are several good grounds for increasing taxes over time, as a limited entry programme begins to generate incomes that are, by any standard, sufficient to yield more than a fair rate of return (including compensation for the inherent riskiness of fishing). In effect holders of limited entry permits have a privileged position in harvesting a public resource, and it does not appear unreasonable that the public should recover at the very least the cost of research, administration, and enforcement of the management programme and perhaps some additional amount above that if returns are sufficient. Second, and perhaps more important, the right kind of tax - that is, a tax per pound of fish landed - would act as a definite deterrent to unnecessary and self-defeating efforts to expand shares of the catch discussed above. Finally, if rising incomes in a limited entry fishery cause licence prices to increase substantially (as has been the case in Alaska, British Columbia, Washington State, and perhaps others) a landings tax would have the effect of reducing the cost of a licence to any prospective new entrant by reducing the after-tax income available from use of the licence. I'm not sure that it makes any great difference whether one pays a higher entrance fee and then enjoys a higher income or purchases the licence at a more moderate price but pays landings taxes thereafter. In any event, if the problem appears to be a significant political one it can be dealt with in this way.

In conclusion, licence limitation alone is somewhat suspect as far as its impact on efficiency of individual vessels and the fleet are concerned. British Columbia and Australian experience tends to bear out the suspicion that the incentive to over-invest will be a problem. A significant set of questions then must be addressed. Is this tendency severe enough to outweigh the ease of implementing a licence limitation programme? Can it be controlled without excessive cost or complication by nailing down some of the more obvious ways of expanding the catching power of the individual vessel that clearly are not aimed at improving efficiency? Will those restrictions, in turn, have an unnecessarily stifling effect on the fishermen's own ingenuity in improving gear and fishing techniques?

On balance, it would appear, on the very limited evidence available to us at present, that limited licence schemes have much to recommend them only if two additional steps can be undertaken. First, a programme of reducing the number of licences steadily must be pursued if we are to make room for continued increases in the efficiency of the individual boat that technical progress makes possible. Second, that process will become impossibly expensive unless some of the rising income of the remaining participants is siphoned off by a landings tax, which can be used not only to cover management costs but to fund a gear reduction buy-back programme. Thus far, largely for political reasons and on the basis of some distinctly dubious objections, governments that have undertaken limited entry programmes have been very reluctant to follow through on these logical further steps. There is then, a real danger that the potential usefulness of this approach, imperfect as it is, is understated simply because it has not been pushed hard enough to yield its full benefits.

The third method of managing fisheries to achieve more rational economic performance involves restrictions on outputs of the individual vessel rather than inputs. Specifically, it contemplates the establishment of overall quotas which would then be broken down into small shares. These would be distributed to existing fishermen who qualify as active in the fishery (probably on the basis of historical participation or by auction) and which would be freely saleable. Since the total catch would then be determined, there is no reason why the fishery authority could not allow the choice of vessel, gear, and fishing area and time to the individual operator (subject only to the usual limitation on destructive gear).

The technique has a great deal of theoretical and practical appeal. Of the various measures suggested it would provide the firmest control over catch and therefore the most certain protection of stock productivity. It would require no more information than most other management schemes and substantially less than most. There would be an obvious and continuing incentive for individual vessels to improve efficiency of their operations, and the effect of that, by bidding up the price of the individual quotas, would bring about the necessary reduction in the number of fishing units without any action by the management authority. It would also seem to permit much more flexible operations by fishermen who choose to participate in more than one fishery seasonally in order to realize fuller utilization of the capital investment in vessel and basic equipment. Presumably, he would purchase only the number of quota rights required for each of the several operations in which he proposed to engage. This would be much more flexible than a limited entry programme in which the cost of a licence might well be beyond the capability of a fisherman who only intended to use it seasonally and for a relatively short time.

Unfortunately, the old saw about "no free lunch" applies here as well. Perhaps the major obstacle to even attempting to manage on this basis is its strangeness to fishermen themselves. To operate on the basis of individual quotas would require a totally different method of organizing the fishing venture - something that would require a long, careful period of investigation and education. It is also fairly obvious that if the scheme is to have any effect in reducing excess capacity in a fishery it will do so with ruthless effectiveness - that is, the price of the shares will be bid up rapidly to the point where substantial numbers of marginal fishermen will be forced out of the fishery rather abruptly. While this has obvious advantages from the standpoint of efficiency alone, it may raise really serious social and equity problems unless the process can somehow be slowed down. There might also be enforcement problems. If the fishery normally funnels through a few centralized ports, monitoring should not be overly difficult. But since both buyer and seller would have the incentive and opportunity to understate the individual fisherman's catch, the possibility of widespread violation might be an important barrier if fish are marketed through many small landing ports.

Finally, in common with all other rationalization schemes, including taxation and limited entry, the individual quota system would work efficiently only if it were applied to all fisheries to which the gear can be shifted. Otherwise, successful reduction of excess capacity in one operation simply passes the problem over to another.

Let me conclude by dealing quickly with a number of topics which would apply to any of the rationalization schemes discussed above. I have assumed, without much explanation, that rights to go fishing or rights to particular amounts of fish would be freely transferable (subject only to the approval of the appropriate fishery agency to maintain adequate records and to filter out persistent violators). There are, I believe, sound grounds for this assumption. Making the licences freely transferable removes, once and for all, the charge that a licence limitation or individual fish quota system creates a privileged monopoly in the fishery. Quite the opposite: it creates rights which enable the individual fisherman to harvest in the public domain on a basis much more closely attuned to the requirements of a private enterprise economy. It offers him, potentially, the opportunity to enjoy an improved income; to sell out whenever it suits his convenience and realize the present value to his family or any other beneficiary when he passes on.

By the same token it means that there will be inevitably a steady flow of licences available for new people wishing to enter the fishery. True, they will enter on less favourable conditions than those who were fortunate enough to be initial recipients; but they are no more barred from participating in fishing than anyone who wishes to enter farming, logging, retailing, or any other economic activity that uses natural resources or space. In addition, having licences freely transferable has an inevitable tendency to shift fishing into the hands of the more skilful, the more dedicated, and the more professional fisherman. This raises problems with respect to casual and part-time participation that are more social than economic and with which I do not propose to deal. But on grounds of long run viability and efficiency of the industry, it would seem desirable to have it operate under conditions that will attract and hold hard working, intelligent, and ambitious young men. These are precisely the ones who will be able and willing to purchase rights to participate in the fishery and carry it forward.

The chief opposition to licence limitation seems to come from potential entrants rather than those actually excluded. In my experience, the principal gripe seems to be that they were not fortunate enough to have been in the fishery when the programme was initiated. It is true that almost any kind of gear reduction programme will create a definite economic advantage for those on the spot at the right time. Thereafter, however, there seems to be little merit in the argument that such schemes "make the rich richer and the poor poorer". Any fisherman entering a system which involves limited rights will have to pay a price that measures roughly the economic value of access to the resource. Consequently, he can expect to earn on his total investment in licence, vessel, and gear only a satisfactory competitive return consistent with the kind of effort that he puts in. If one is too uncomfortable, politically, or on moral grounds, about the initial gift of a valuable licence to those presently engaged in the fisheries, a simple tax measure could be devised to shift part of that windfall to the public treasury.

A point noted in passing above should be repeated with emphasis at this point: any system of rationalization focusing on one particular fishery must be extended to others as well if gear reduction in the initial operation tends to spill over into excess capacity in related fisheries. Not all programmes need to be initiated simultaneously, but we must be prepared to move in advance of the time such shifting begins to present really serious problems.

Finally, it is worth repeating Professor Scott's point raised in a recent article (Scott, 1979) that governments are really not very interested in rationalization programmes in fisheries when the principal benefit consists of additional output of other things that can be turned out with the previously redundant labour and capital trapped in the open access fishery. Indeed, they might look at the additional employment and additional local income generated in an overcapitalized fishery as a distinct political advantage, particularly if the benefits accrue in their electoral districts.

Hence, a logical question is: what's in it for the industry? There are a number of reasons why the industry could look to considerable long term benefit from programmes designed to remove excess capacity and to keep it from developing further. One is the promise of longer term income security, and with it the incentive and opportunity to invest in safer, more comfortable boats and to make fishing a more professional occupation. That in turn will provide much greater attraction to the kind of young, efficient workers who can be attracted to the industry with the expectation of achieving independent vessel ownership with a future. Any kind of sensible rationalization programme should permit the dismantling of some of the more obnoxious efficiency-reducing regulations that now plague fishermen everywhere and give them greater opportunity for technical innovation.

We have come into the age of coastal state fishery management. Obviously, this new view of control (and, for all practical purposes, ownership) of living marine resources does not eliminate the need for multilateral agreement in many areas. Witness, for example, the unproductive cat fight that has been going on for several years in the European Economic Community in trying to define a common fishery policy and translate it into effective management programmes within the Community pond - an effort which still has failed to produce a workable regime. Even two countries with a long history of co-operation in fishery management, Canada and the United States, have found it very difficult to adjust to the new regime where transboundary stocks are involved.

But for very wide areas, the 200-mile limit concept has brought the possibility of unified government control over fisheries, and with it a solution to at least part of the problem of uncontrolled entry and an unparalleled opportunity and obligation to rethink the whole of fishery management, from objectives to methods to distribution of the potential gains.

It is the change in attitude, clearly reflected in the fishery policies of a surprisingly large number of nations, that makes this conference exciting and challenging. In looking over the agenda for the conference, it is particularly intriguing to find the wide range of experience papers now available to us. Obviously, there is no single set of management measures that will be applicable to all fisheries - there are simply too many variations in the populations themselves, the makeup of the fleets that exploit them, and the social and institutional environment in which they operate. But basic principles are beginning to emerge, and, together with what we have learned from our first fumbling attempts at rationalization of commercial fisheries, it should be possible to come up with guidelines that would permit practical application of sound economic and biological models to real world cases - to the considerable benefit of mankind.

REFERENCE

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FISHING RIGHTS, REGULATIONS AND REVENUES

by

Peter H. Pearse

INTRODUCTION

Any contemporary discussion of regulation policy for fisheries will benefit from a reminder of the remarkable changes that have been taking place recently in the world of fisheries management. One of the most conspicuous is the dramatic advances in fishing technology and expansion in fishing power since the second World War. This growth has been widespread and has opened virtually all the oceans to exploitation. Coupled with rapid developments in fish processing and marketing, this revolution in fishing capability has made the world smaller, the marketplace for its products global, and the resources starkly finite. Today, in contrast to attitudes of only a few decades ago, there is wide recognition of the threat of resource depletion and acceptance of the need for governmental intervention to control rates of exploitation.

A second major change, closely related to the first, is the contraction of the oceans lying outside national jurisdictions. This can be interpreted in part as an effort by coastal states to keep pace with the increasing range of fishing fleets and their exploitive power; in less than a century from inshore waters, to three miles, to 12 or so, to the present emerging world regime of 200 mile fishing jurisdictions that enclose most of the world's richest fish resources. As a result, the newly recognized need for fisheries regulation is focusing on the obligations of governments which now have a much broader responsibility for resource management.

A third fundamental revolution is now taking place in the theory and practice of fisheries regulation itself. Until very recently, the problem was regarded by regulatory authorities as almost entirely one of regulating the level of catch of each stock, with maximum sustainable yield as the universal objective. The economists' insistence of the social superiority of the alternative goal of maximizing resource rent has never achieved such wide acceptance. However, in an increasing number of countries the economists' related conclusion about the economic desirability of restricting entry has been adopted, partly no doubt simply because it complements the efforts of regulators to control fishing pressure. But the yield target to be pursued through regulation is being questioned anew. Traditional models that relate sustainable yields to stock size are being found inadequate as a guide to management of highly fluctuating stocks and of fisheries that involve mixed species that interact biologically (Dickie, 1979; Larkin, 1979; Sissenwine, 1978).

This recognition has begun to undercut the debate between advocates of yield maximization on the one hand and rent-maximization on the other, both of whom cast their arguments in terms of stable relationships between stock size and production (Christy and Scott, 1965). In Canada and the United States the new official objective is "optimum yield" which, as far as it goes, is unassailable, but the meaning of optimality in this context so far has not been defined clearly (Larkin, 1977).

While this debate about yield targets continues, much more crucial developments are taking place with respect to the regulation of fleets and their access to resources. The persistent tendency of commercial fleets to expand beyond the capacity required to harvest efficiently the available catch is now widely recognized (Crutchfield, 1979; Scott, 1979). During the last few years advanced fishing nations around the world have begun experimenting with various kinds of controls on fleet development, and the literature on alternative approaches is burgeoning (Mundt, 1974; Pearse, 1979). The urgency of this type of fisheries regulation is exacerbated by the aforementioned trends in fishing power and in governmental management responsibilities.

This problem of designing a framework of regulatory policy that will forestall these perverse tendencies in fleet development, and promote efficiency in the industrial structure of fisheries, is the subject of this paper. More specifically, it deals with the relationship between this problem and the nature of fishing rights used to provide fishermen with access to the natural resources, and some implications for fisheries policy that flow from this relationship.

FISHING RIGHTS AND FISHERIES ORGANIZATION

Both theory and experience demonstrate that in the absence of regulation a profitable fishery is unstable. If access is unrestricted, profits will, in the long run, attract new entrants into the fishery and encourage established fishing units to expand their fishing power until the cost of labour and capital rises, or yields fall, or both, and all returns in excess of the costs of fishing are eliminated. Sometimes this inexorable adjustment toward an equilibrium between revenues and costs leads to resource depletion, but even if it does not, or if the catch is carefully regulated at the desired level, the fleet will inevitably expand beyond the capacity required to harvest efficiently the catch and all potential net yields (or resource rents) will be dissipated (Pearse, 1980). Thus we observe that high incomes in fishing are only temporary phenomena. They are associated with the development of new resources, price increases and technological innovations, and persist only until incentives to expand capacity are manifested. Clearly, if governments are to ensure that the full social and economic benefits to be derived from fisheries resources will be realized, this wasteful process must be checked.

The root cause of this economic inefficiency in primary fishing industries is the common property status of the resources under traditional fisheries organization. Individual fishermen who expand operations in response to profit opportunities exhibit normal and rational economic behaviour, but fishermen, unlike the exploiters of most other natural resources like timber or minerals, do not have any legal control over the resources upon which they depend nor over the activities of the other fishermen with whom they compete for the available catch. The aggregate result is irrational industrial development, manifested in inefficiency and waste. It was only during the second World War that Michael Graham identified this phenomenon as his Great Law of Fishing, "Fisheries that are unlimited become unprofitable" (Graham, 1949), and a couple of decades later Garrett Hardin characterized this phenomenon as the "tragedy of the commons" (Hardin, 1968). Inefficiencies in production and the threat of depletion may occur whenever resources are subject to common property usage, not only in fisheries but also on common rangelands, on common water supplies, in common forests and on oil reservoirs with fragmented extraction rights. Correspondingly, it is well established in economic theory that one of the prerequisites for efficiency in production is that producers be able to control all their inputs, without extra-market interference from others (Coase, 1960).

It is therefore appropriate to examine carefully the kinds of property rights that are used, and can be developed, to allocate fisheries resources. The literature on the law of property is vast, and legal forms of property rights applicable to natural resources are found in rich variety (Megarry and Wade, 1966). One of the most important qualities of property rights for the efficiency with which economic activity can be conducted is the degree of exclusiveness with which the resources available to the holder are defined, thus establishing the extent to which he has an enforceable claim over others and the control that promotes efficient use. Property rights vary widely with respect to their exclusivity, and for present purposes it is helpful to consider the range of possibilities applicable to fisheries.

At one extreme is the traditional freehold, which provides exclusive possession and therefore the right to exclude all other users. Less comprehensive are various forms of rights, such as licences and easements, that convey rights to use the property of another, including the Crown, in specified and limited ways. Any of these can convey a sole right to exploit a fishery, and examples are found on lakes and rivers in many countries, including Canada, as private titles, Crown leases and licences and other usufructory rights. They typically convey rights over a defined area, and among commercial fisheries they are most commonly applied to shellfish and other sessile species. Scott has labeled the situation in which the rights to an entire fishery are held by the one user as "sole ownership" (Scott, 1955). This most exclusive form eliminates the common property regulatory problem altogether and permits the holder to organize the fishery without external regulation. Obvious political and technical circumstances constrain the potential scope for this arrangement in commercial fisheries, but it is probably wider than usually assumed.

At the other extreme is the absence of property altogether, the traditional situation on the high sea, where no fisherman can enforce rights to exploit fish over any other (except as both may be constrained by specific inter-governmental treaty). This arrangement can be consistent with efficient resource use only if the resources are so vast in relation to the demands on them that users do not impinge on each others' production.

Between these extremes of exclusive possession on the one hand and no property on the other is a group of forms collectively referred to as common property where rights to exploit the resource are held by persons in common with others. This is the usual case in commercial fisheries. But there are varieties of common property, and these warrant special attention here.

Common property rights exist in three general forms. Closest to the no property case is that of traditional unrestricted access, where anyone has an enforceable right to use the resource but, concommitently, no power to exclude other potential users, at least within a particular jurisdiction. Until recently, this was the usual regime in fisheries under national jurisdiction; the government allowed any of its citizens to participate under general fishing regulations, and individually to take whatever share of the catch they could under the rule of capture.

The second general form of common property involves restricted access, meaning that access is limited to those holding explicit rights. The owners of these rights, which may be in the form of licences, heritable rights, or common law privileges based on residence or appurtenances to other property, collectively can claim the right to the specified resources and thereby have power to exclude others. But the rights are co-equal and do not define or limit the amount of the resource that they entitle the individual holders. During the last couple of years, this has become the main form in Canada's important commercial fisheries, the traditional unrestricted access having ended abruptly through the introduction of limited entry policies involving various forms of restrictive licencing. It is also the current arrangement in some of the fisheries of Australia, the United States and certain other countries. In Japan and some less developed countries, exclusive rights to fisheries are sometimes held by local organizations or communities.

The third form, which might be regarded as a sub-category of restricted access, is that in which the right of each holder is stinted, or specified with respect to the quantity of the resource he may take. This characteristic is found in a wide variety of natural resource rights - in grazing rights on public rangelands, in water-taking rights, in "unitized" oil and gas ventures, pollution discharge rights and so on - although it is rare in fisheries. In terms of degree of exclusivity of the rights held, it is closest to sole property, where the number of holders is reduced to one.

Various forms of rights can thus be ranked according to their exclusivity, or the specificness with which they define the holder's claims over resources. Those identified above are only the major categories; there is a considerable variety of intermediate cases that can be gleaned from property law.

IMPLICATIONS FOR ECONOMIC REGULATION

A well-known theory of property rights explains how exclusive rights develop in response to increasing scarcity and value of resources, and hence also the costs associated with the inefficient use of those resources (Demsetz, 1967; Krier and Montgomery, 1973). As long as resource values are low, the benefits of adopting elaborate forms of property rights are not likely to be worth the disruption and social cost of introducing them, and regulatory arrangements are suitably crude. But when resource values rise, increasing the potential gains from more efficient use, more sophisticated property and market arrangements can be expected to be adopted.

The circumstances of commercial fisheries provide a pertinent context for this hypothesis. In the last few years, the "scarcity" of many of the most valuable fish resources has become painfully apparent, and with advancing technology and rising real prices the potential economic rents in well-managed fisheries has increased dramatically. Significantly, these trends have been accompanied by developments in rights of access to fisheries, particularly with respect to the exclusiveness of rights described above. Vast coastal resources have been removed from the no property regime of the High Sea to be exploited as common property by the nationals of coastal states. Regimes of unrestricted access to fisheries within national jurisdictions are increasingly being replaced by arrangements that limit fishing to those holding explicit rights. The remainder of this paper is concerned with the implications of further progression in the exclusivity of fishing rights, specifically from the now familiar form of restricted access with unlimited rights to take fish under the rule of capture to a system of quantitative rights.

The following discussion is limited to the circumstances of fisheries involving a large number of independent fishing enterprises dependent on a common stock under a single regulatory authority. This eliminates consideration of sole property situations (although the potential adaptations of this form for commercial fisheries deserves investigation) and focuses attention on the types of common property identified above.

The economic literature on fisheries regulation has been converging on three general approaches to the management of fleet development, each of which has the theoretical capability of ensuring an efficient industrial structure. These are (i) restrictions on inputs, (ii) royalties on the catch, and (iii) quantitative rights or fishermen's quotas.

RESTRICTIONS ON INPUTS

As already mentioned, some governments have recently put an end to open access to important fisheries, in favour of restricted access. Indeed, nearly all the attempts to control expansion of fishing capacity so far have involved access restriction (McKeller, 1977).

Restricted access calls for some means of identifying the authorized participants, and so governments have usually invoked some form of licencing. But while limiting the number of holders of such rights creates a restricted access regime, it is insufficient to control fleet capacity because each licencee might alter the size of his fishing unit. Hence licences often restrict not only the number of participants, but also one or more dimensions of fishing capacity that each may engage - the number of vessels he is authorized to use, vessel tonnage, units of gear or engine horsepower. But these are only proxies for fishing capacity, and the practical impossibility of restricting all dimensions of fishing power simultaneously leads to the most serious deficiency of this method of controlling fleet capacity.

The importance of this issue derives from the fact that, in most fisheries, the technology of fishing is flexible. In economic terms, the factors of production are substitutable and can be combined in widely varying proportions and configurations, so that restriction of one or two dimensions of fishing power will lead to more intensive use of others. Thus if fishermen are limited by fishermen's licences and the programme is successful in raising profits, strong incentives will arise for the licenced fishermen to equip themselves with larger vessels and more gear to increase their catching power; or if vessels are the restricted factor, incentives will exist to increase their size and catching power, and so on.

Because of this flexibility in fishing technology, both theory and experience suggest that restrictions on one or a few factors of production are not likely to succeed, in the long run, in preventing expansion of fishing capacity. The result of such measures has been, instead, to distort the structure of fishing units through additions of whatever dimensions of fishing power are left unrestricted. Thus, limitation of the number of vessels in the Western Australian rock lobster fishery led to expansion in the size of vessels (Meany, 1979). A similar restriction in the early years of Canada's Pacific salmon fleet control programme had the same result (Fraser, 1979). The Canadian authorities subsequently restricted the total tonnage of the salmon fleet, but this has not prevented further growth in capital and further increases in redundant fishing capacity (Pearse and Wilen, 1979). Limitation of the tonnage in Japan's tuna fleet also failed to control expansion of fishing power.

And restrictions on engine horsepower in France's Mediterranean trawl fleet resulted in expansion in other dimensions of catching power, including techniques to enhance traction. In short, the available documentation provides very little convincing evidence that restriction of one or a few inputs can succeed in preventing expansion of fishing capacity and continuing tendencies to dissipate resource rents.

Theoretically, a licence might be designed to restrict all dimensions of fishing effort simultaneously, and theoretical demonstrations of the capability of this approach in achieving an efficient result are based on this notion. However, the factors contributing to fishing effort are numerous and diverse (involving vessel size, power, crew, time spent fishing, all aspects of finding, catching and holding gear and so on) and such restrictions would impede technological advance as well.

Clearly, restrictions on inputs do nothing to alleviate the incentives to expand fishing power and effort in a profitable fishery. These incentives, coupled with technological flexibility and the ingenuity of fishermen, do not augur well for the long run effectiveness of this approach to economic regulation of fisheries.

ROYALTIES ON THE CATCH

A popular proposal in the academic literature is to rationalize fisheries by means of a royalty or tax on landings (Anderson, 1977; Scott, 1962, 1979). It can be shown that an appropriate levy of this kind would reduce private returns from fishing sufficiently to force the fleet to adopt the most efficient number and scale of fishing units and to operate them at the minimum possible cost. This approach does not imply any one of the property rights forms described earlier; indeed, it does not depend on property rights at all but rather on removing all financial incentives to expand fishing capacity.

This approach presents daunting practical difficulties however. To the extent that any potential economic rents were not completely appropriated by these levies on landings, they would eventually be dissipated in higher costs, yet to maintain the fishery in a condition of maximum efficiency the charges would have to be perfectly adjusted to force all fishing units to operate at minimum possible costs (Clark, 1979). This would, of course, call for different charges on species of fish of differing market value and catching costs (which vary with density, time and location). It would also necessitate continual "fine tuning" of the rates in order to maintain the level of efficiency in the face of changing prices, costs and technology. This approach would undoubtedly put very heavy demands on the regulatory authority in the form of data collection, econometric analysis, surveillance, administration, and revenue collection. Since the charges would have to prevent any of the financial benefits of rationalization from accruing to fishermen, compliance and enforcement would present obvious difficulties.

Two disadvantages of this approach to economic regulation are probably independently sufficient to prevent its wide adoption. One is its administrative impracticality; it calls for precise and continuous analysis of the potential value of fish in the sea in all circumstances, discriminating rates, and accurate responses to every change in prices and costs, all of which are beyond what can reasonably be expected of regulatory agencies or of fishermen to accept. The other is that it precludes any financial gains to fishermen. Thus, while royalties are a theoretically appealing device for regulating fisheries, no government (as far as this writer is aware) has attempted to depend on them for this purpose. However, because a levy on landings will reduce profits, it will always dampen incentives to expand capacity and so be a useful adjunct to other control measures. Such charges may also serve a desired purpose in raising revenues and capturing resource rents for the government, and for this reason are sometimes levied on foreign fishermen.

QUANTITATIVE RIGHTS

During the last couple of years, increasing attention has been directed to the possibility of promoting efficient industrial organization of fisheries by providing fishing enterprises with a more exclusive form of exploitation rights than they hold under present regimes of restricted access, namely, rights to take specific quantities of fish (Maloney and Pearse, 1979; Pearse, 1979a; Christy, 1974; Clark, 1979; Scott, 1979). Quantitative or "stinted" rights have the same capability of achieving efficient results as a perfectly-adjusted royalty on landings, yet they present few practical difficulties. The unique appeal of this approach is that it eliminates the fundamental incentives to expand wastefully fishing capacity. And because it encourages efficiency in production it can be largely self-regulating.

In the simplest case, the rights held by fishermen would be in the form of transferable and divisible rights to take fish, in total amounting to the allowable catch. They might be limited in term (for example, seasonal) or, to reduce the administrative burden and enhance the security of fishermen, perpetual. Regardless of how these rights were initially allocated, market transactions could be depended upon to redistribute them, through voluntary sales and purchases, among the fishermen who can take the catch most efficiently, because they will be able to offer the highest price. Each owner of a fishing enterprise would be encouraged to acquire rights to the quantity of fish that can be harvested most profitably by his fishing unit, and in the long run to adjust his unit to the most efficient scale in light of current technology. Financial incentives would thus stimulate the development of an efficient fleet in terms of its capacity and technology, and the price of rights would reflect the full value of the resources.

The regulatory power of this form of property right derives from the fact that it removes the incentives of individual fishermen to protect and increase their shares of the catch by defensively and competitively increasing their fishing capacity and effort. It thus encourages efficient organization of production, rather than the over-capacity and waste associated with other common property regimes. In comparison with unstinted rights it has other advantages as well. It substantially eliminates the risk and uncertainty that fishermen otherwise face with respect to their prospective catch, and so can be expected not only to enhance their security but also to improve their financial and operational planning. In addition, it is uniquely resilient to changing conditions. If costs fall or fish prices rise, no automatic tendencies to expand capacity will result; the value of rights will simply increase. If the catch can be increased, the authorities can sell additional rights, and if they stand ready to purchase rights the catch can be reduced without loss to fishermen. Moreover, fishermen will always be expected to respond efficiently to changes in technology. Thus, by engaging incentives for efficiency, by encouraging progressivity in technological change, by discouraging competitive interception of the stock, by reducing enterpreneurial risk, and by more easily accommodating complex fisheries involving varying types of fishing units and mixed catches, it seems likely that a high level of industrial performance will often be achievable most readily and reliably under a regime of stinted exploitation rights.

But the most conspicuous attractions of this approach to regulation are twofold. One is its simplicity, which derives from the fact that the property right itself creates economic incentives for fishermen to behave efficiently in their own interests. As a result, it is unnecessary, except in special cases, to encrust fishing rights with supplementary restrictions and regulations on how operations may be conducted. Moreover, the rights provide a direct mechanism for regulating the catch, enabling managers to concentrate their attention on resource management and determination of the total allowable catch rather than on its distribution and the activities of fishermen.

The other outstanding appeal of this approach is that it lends itself to any desired division of the benefits between fishermen and the licencing authority. If the rights are issued without charge, the gains will accrue entirely to the recipients, as profits if they exercise the rights or as capital gains if they sell them. If the issuing authority sells them at their competitive market value, it will capture all the benefits. And between these extremes, the system of rights can be supplemented with a variety of licence fees, annual charges, taxes or royalties which can divide the gains in any desired way without necessarily affecting incentives for efficiency.

Stinted rights are rare in fisheries, but they are commonly used for other natural resources, especially in North America where public ownership is widespread. Water rights, timber quotas, grazing rights on public rangelands, oil and gas rights on "unitized" reservoirs, and waste discharge rights are all usually based on some form of licence which provides a specified quantitative right, in contrast to the rule of capture that applies in most fisheries. In fisheries, the use of quotas has been limited mainly to international agencies responsible for allocating national shares of allowable catches. However, some examples of quantitative rights for individual fishing enterprises have recently emerged (Pearse, 1979). The Canadian government has recently introduced a licencing system for the shrimp fishery off the coast of Labrador that provides each licencee with a right to catch a specified number of tons, and a similar arrangement is being considered for the scallop fishery on Georges Bank. Licenced herring fishermen in the Bay of Fundy have organized themselves into a "club" through which the allowable catch is allocated among the members as vessel quotas. On Canada's Pacific coast the small abalone and herring roe-on-kelp fisheries are also regulated in this way. And a couple of months ago, Italy introduced a new management system for its clam fishery which involves a quota for each licencee. There are probably other examples, and more to come. These experiments have raised certain issues relating to the implementation of this general approach to fisheries regulation which are addressed in the remaining section of this paper.

SOME SPECIAL CONSIDERATIONS IN DESIGNING SYSTEMS OF QUANTITATIVE RIGHTS

It would be naive, of course, to suggest that a single regulatory mechanism will be most suitable for all fisheries. The circumstances of different fisheries and the objectives of government vary too widely. The position taken here is rather that the circumstances of fisheries management are changing rapidly in profound ways, and new policies that will be both effective and practicable must be designed urgently to meet these challenges. In this context, quantitative rights systems must be regarded as among the most promising possibilities and therefore deserve careful consideration.

The advantages of the stinting approach, noted above, would seem to be strongest for fisheries in which there are many enterprises, where the potential resource rents are high (and hence the incentives for distortions and waste under other arrangements are strong), where a high performance level is sought, and where flexibility in the distribution of resource rents is important. Significantly, all of these are becoming increasingly important considerations in fisheries policy. But combinations of systems, involving stinting, royalties and other devices, suggest themselves in rich variety, and the complications of regulatory objectives and fishery circumstances may often make some such combinations of instruments preferable to any single measure. Some possibilities are suggested below.

SUBSTANCE AND TERMS OF RIGHTS

The form of quantitative rights is crucial to the achievement of a high standard of economic performance. First, the desired flexibility in market adjustments referred to above requires that the rights be transferable, and they must be either divisible or denominated in small units which can be aggregated to suit the varying requirements of licencees.

Second, the system will be more manageable and effective if the rights are denominated in absolute numbers, pounds or tons of fish, rather than as percentage quotas or fractions of the total allowable catch, as some have suggested (Christy, 1974). This issue is important wherever catches must be varied over time (Pearse, 1980). A right to a certain absolute quantity of fish clearly affords the holder with greater certainty and security (and hence is more valuable) than one that guarantees only a fraction of a variable total. Moreover, it will involve less difficulty when catches must be adjusted downward. Under a percentage quota, each holder's rights would be reduced whenever the allowable catch was lowered. But experience with various kinds of resources indicates that regulatory agencies find it difficult to reduce rights below the level that users have previously enjoyed; timber quotas, water rights, grazing rights and allocations under international fisheries conventions all provide evidence of the difficulties of reducing the privileges of resource users, especially at short notice.

In contrast, rights expressed in absolute amounts would not necessitate any involuntary reductions in users' allocations; the regulatory authority could purchase or sell in the market for rights to effect needed adjustments in the total catch, much like a central bank's open market operations in bond markets and foreign exchange markets. For stocks that fluctuate very widely and unpredictably, or where for other reasons such market adjustments might prove burdensome, a more expeditious way of accommodating needed changes would be to issue basic rights which amount in total to roughly the minimum foreseeable allowable catch. Then the authorities could auction or otherwise issue supplementary rights at the beginning (or even during) each season to make up the difference between the basic rights and the desired catch for that season.

The terms of rights must also be decided. In Canada, at least, terms of quantitative rights have so far been limited to one year. This is unnecessary and undesirable; longer, or even perpetual terms would not only reduce the annual administrative burden but would also improve the holders' security, and as long as an active market in rights is permitted, there would be little loss of administrative flexibility. The main difference would be that the price of rights would be higher, reflecting their longer life (Maloney and Pearse, 1979; Pearse, 1980a). In the interest of promoting efficient investment planning, a case can be made for terms that are at least as long as the period required to depreciate the capital in a fishing unit. Thus at an early stage of policy development, a government might well choose to issue licences with terms of a decade or so, which would provide this security as well as afford an opportunity to make fundamental revisions to the nature of the rights after some experience.

INITIAL ALLOCATION

As long as the rights are transferable, the way they are initially allocated will have little lasting significance. It can be expected that in most cases a quantitative rights scheme will be built onto a restrictive licencing arrangement. As has been done in the few cases so far, the rights to engage in fishing (or to engage prescribed inputs) will simply be converted to rights to take specific quantities of fish. These rights might be divided equally among licencees (as in the Labrador shrimp fishery), in proportion to the licencees' catches in prior years, or according to some more complicated formula (as in the Bay of Fundy herring fishery). The choice is properly a political one, since it will affect only the initial distribution of benefits.

TRANSFERABILITY

Probably the most crucial feature for the efficacy of a quantitative rights scheme is the transferability of rights. It also appears to be a feature that certain governments, including that of Canada, have been most reluctant to adopt. In Australia, Canada, the United States, this has been an issue of much confused debate, and restrictions have often been put on transfers of rights (Meany, 1979a).

One argument for prohibiting sales of licences is that the established fishermen who receive initial licences might otherwise succumb to cash offers for their fishing rights to their subsequent regret. Thus the Alaskan limited entry programme incorporates stringent restrictions on transfers of fishing rights held by native Indians in order to prevent them from losing their traditional fishing opportunities and creating social problems. But except in unusually paternalistic political environments, such concern to protect licencees from their own decisions is not likely to be compelling, at least in the relatively sophisticated entrepreneurial environment of most industrial fisheries. Another concern is to prevent monopolization of licences or (as in South Africa) their concentration in the hands of processing companies. However, if necessary, this can readily be prevented by other means, such as a simple limitation on the number of licences that may be held by any party.

A third argument is based on the conviction that private parties should not be permitted to appropriate, through sales, the value of a right to exploit public resources. This argument, which has undoubtedly been influential, involves some confusion, because the question of transferability and the question of who is to enjoy the benefits of effective control are not necessarily linked. The distribution of any financial gains from rationalized fishing between the licencees and the government will depend upon the charges made for fishing rights. A variety of possible fees or taxes enable a government to extract some or all of the value of a fishing right. In any event, this concern should be focused on the way in which rights are distributed in the first place; if licencees are to be left to appropriate the financial benefits, it is only the initial recipients, and only to the extent that they are granted rights with a value in excess of the charges for them, that will receive any capital gains. Subsequent entrants to the fishery will have to pay for the full value received.

Moreover, the benefits to be gained from transferability are substantial. Purchases and sales will establish a market for rights that will enable fishermen to adjust their holdings to the particular needs of their fishing units and to adjust the scale of their enterprises in light of changing technology. The ability to purchase rights will also blunt fishermen's incentives to exceed the legal limits of the rights they hold. Such a market is necessary also to secure the assets of vessel-owners, in both their fishing rights and invested capital; only with the freedom to sell his assets can a fisherman realize the value of his assets in the event that he retires or dies. And an active market in licences provides a convenient mechanism for the regulatory authority to increase or reduce allowed catch through sales or purchases, without causing involuntary dislocation.

It should be added that restrictions on transfers lead to awkward administrative problems as well. It is difficult to prohibit transfers of assets from father to son, to a wife or other kin. Problems arise also in the treatment of partnerships when one dies or retires, and of corporate enterprises which can effectively transfer rights through sales of shares.

But most importantly, transferability is the main determinant of the extent to which the system can achieve efficiency through self-regulation. It implies taking advantage of normal market mechanisms to allow fishing enterprises to organize and maintain their operations effectively.

CHARGES FOR FISHING RIGHTS

Charges for fishing rights redistribute the value of exploitation rights from licencees to the government, and by reducing the profitability of fishing will lower the market value of rights. Such charges can take various forms: annual licence fees, taxes on the value of rights or royalties on landings. Any of these can be accommodated under a system of quantitative rights.

The share of resource values that the government should collect is a political question. The total value can be captured if rights are allocated by competitive auction, and any desired division can otherwise be achieved by subsequent taxes or charges. Royalties will, in most cases, ensure the closest proportional relationship between the licencee's payments and the resource benefits he receives, but they may also be the most burdensome to collect.

ENFORCEMENT

Probably the most serious difficulty with a quantitative rights system is that of ensuring that the holders of rights do not exceed the limits of their authorizations. This calls for reliable records of landings, and the administrative problem will depend largely on the circumstances of each fishery and in particular the arrangements for landing and marketing fish. It should be noted that a free market for rights will reduce incentives to avoid reporting, and any royalties charged on landings will exacerbate them.

To alleviate this difficulty consideration should be given to arrangements that introduce offsetting incentives to report catches fully. For example, it was suggested earlier that the basic rights held by fishermen might approximate the lowest expected allowable catch, and supplementary rights auctioned each season to bring the total to the desired catch for that year. If fishermen were given the privilege of receiving some of these supplementary rights free, or at a preferred price, in amounts equal to some proportion of their reported catch in the previous year, they would have strong incentives to report their catches fully.

POSTSCRIPT

Probably the most attractive feature of quantitative rights is the way that they eliminate the tendencies for over-capacity and waste inherent in other forms of common property, and instead harness incentives for efficient organization and production. Well directed financial incentives of this kind are likely to be more effective than compulsive administrative controls and regulations that attempt to stifle normal economic behaviour. Because of the well-known difficulties which administrative agencies encounter in designing and executing rules and regulations, there is much to be said for regulatory systems that complement the self-interest of the participants.

Probably the greatest obstacle to wider acceptance of quantitative rights is the unfamiliarity of this approach in fisheries, and a lack of appreciation among those involved in fisheries with the widespread and successful use of such systems in connection with other natural resources. This paper began by drawing attention to a number of currents of change that are converging to create new and urgent problems for fisheries policy-makers. These unfamiliar problems may call for unfamiliar solutions. The intent of this paper has been to suggest that the most promising approach to some of the most basic problems of fisheries management may not lie in ever more stringent and restrictive administrative controls but rather in unshackling the industry from its burden of regulation, and freeing it to conduct itself efficiently in the public interest, through a simple but fundamental reform in the structure of fishing rights.

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RESTRICTIVE LICENCING AS A TOOL IN FISHERIES MANAGEMENT: AN ECONOMIST'S TOY, OR A PRACTICAL ALTERNATIVE

by

J. A. Butlin

INTRODUCTION

The decade that has just closed raised a series of confusing issues for the fisheries economist. One of the possible approaches to the open-access problem in sea-fisheries, namely national appropriation of the fishing grounds adjacent to particular countries, was adopted by almost every nation with a coastline. In many instances, however, the anticipated gains in management (in the form of more secure and reliable supplies) have not been realised. Even with unilateral extensions of coastal limits, excessive effort has continued to be applied to fisheries, and the traditional short-term responses to over-fishing, quotas and closed seasons, have been redeployed.

In the mind of the fisheries economist, the failure to follow the private-property solution through to its logical conclusion, that of limiting the number of producers who have access to the fishing grounds, is difficult to understand. The theoretical solution, once extension of the coastal limit has provided one nation with jurisdiction over a particular fishing ground, is to put the rights to fish out for competitive tender. In the absence of collusion on the part of vessel owners the private market for rights will ensure that the most efficient vessels will submit the highest tenders. Therefore, the market will ensure that the resource rent will be as high as possible; that the question of allocation of effort between home and foreign fleets will be resolved; and that by-catch problems can be resolved. The purpose of this paper is to survey the rationale for restrictive licencing as a fisheries management tool, to investigate the economic issues that underlie the problems of implementing management programmes based on restrictive licencing, and to understand the need, in at least some cases, for ancilliary measures to supplement the licencing programme. The remainder of the paper is structured as follows: in the second section the problem of overexploitation of common-property fisheries is reviewed, and the lack of success of other management measures is noted. The third section argues strongly that a successful licencing programme needs to identify and measure fishing power, and reviews various ways in which this can be done. The fourth section discusses the implementation of licencing schemes, including such matters as whether licences should be allocated by auction (whether by oral-bidding or competitive sealed-bid tenders), and whether licences should be vessel-specific or should be transferable. The time-period over which the licences apply is also a matter of some concern, and is discussed in the final section.

THE FUNDAMENTAL ECONOMICS REVIEWED

The economic theory of the exploitation of open-access, or common-property resources has received increasing attention over recent years. It is not the purpose of this study to survey thoroughly this literature, much of it of an abstract and abstruse nature. Rather, the essence of such papers as have policy relevance needs to be distilled.

The heart of the problem associated with open-access resources is the absence of any private title to ownership of the resource (Cheung, 1971). For a natural resource for which there is exclusive title, such as agricultural land, the rate of use is managed to yield a stream of benefits both to the landowner and to the tenant (where the two differ) over a period of time. The presence of exclusive title provides an incentive to spread the realisation of these benefits over a period of time. This conservation incentive - the incentive to manage the resource so as to ensure that it yields economic profits both to the landlord (profits for the resource) and to the tenant (profits to his enterprise and management) over a period of time - is precisely what is absent in the case of the fishery. The absence of a "landlord" means that the economic profit that would have accrued to a private owner of the resource becomes an extra source of surplus to fishermen. The competition to maximise his share of this residual surplus gives every fisherman an incentive to apply more inputs to the fishery (large vessels, more extensive gear, with the consequent increased labour requirements) than he would in a situation of private ownership with the fisherman renting the resource. Because the conservation incentive is missing in an open-access fishery, any attempt by an individual to leave some of the stock for him to catch in future seasons would fail. His reduction in catch would increase the probability that other vessels would have a larger catch. Overall, the catch would be about the same, but its distribution amongst participating vessels would have changed. Without management by the "landlord" of the resource, there is no incentive for individual fishermen, acting in their own self-interest, to act in such a way that their collective efforts represent an optimal pattern of fishing either for themselves, or for the society consuming the fish caught.

This is the fundamental theory of unlimited exploitation of a common-property resource, such as the sea-fishery. The regulatory problems raised are both short-run and long-run: in the short-run, the problem is essentially whether current catch-rates can be sustained given the current stock-size. In the long-run, the problem is to determine the desired size of stock and the associated rate of catch. The solution to this problem depends on the expected demand for this species, the expected demand for related species and the consequent expected prices, given the catches that particular stock levels could be expected to produce. A further long-run problem relates to the size of the fleet required to fish the stock in the future. It follows that the problem of adjusting the fleet is intimately related to the state of the market expected for fish in the country concerned. Accepting that there is a great deal of uncertainty about the sizes of stocks and associated catches, attempts to manage the industry must relate both to the demand and supply side of the fish market.

However, the fundamentals of common-property exploitation do need some amplification. The simple assertion that the socially-optimal size of a stock would be that size from which the difference between current costs of, and current returns to, fishing effort, are maximised (Gordon, 1954) can be shown to be appropriate under a very limited set of circumstances. Technically, the Gordon prescription holds only if society's rate of time preference is zero, that is, if society is prepared to forego almost any level of the catch in order to ensure adequate supplies for future generations.

Clark (1976, chapter 4) and Clark and Munro (1975) have shown that the more general decision on the optimal size at which the stock should be maintained depends on the extent of the current sacrifice if catches are reduced to build up the stock; the return to this sacrifice (or investment) in terms of the value of the extra catches gained; and the general preference of the current generation for current over future consumption. These theoretical concepts are complicated in themselves while attempts to apply them face three serious problems of measurement. Firstly, what is the current sacrifice if catches are restricted below the current amount? If catches are in excess of the catch sustainable at the current stock size, is the sacrifice the whole reduction in catch, or only that part that represents the difference between the current sustainable catch and the actual quota? Secondly, what will be the future returns to the investment of stock into growth rather than catching it for current consumption? Predicting these returns requires both the ability to forecast the increase in the stock from the earlier catch reductions, and the ability to forecast the price at which they will be sold in the future. In other words, both biological and economic predictions are required.

The third measurement problem is to determine the social rate of time preference, that is, the general preference for current consumption over future consumption. This is difficult and most assessments are indirect. It is common in many countries to use the convention of "test discount rates" on major public works projects, although these often reflect administrative convenience, and seem to bear little relation to the concept of social time preference (the "test discount rate" in the UK is presently 10 per cent). Another approach is to use the central bank's rediscount rate as an indicator of the rate of social time preference. The extent of fluctuations in this rediscount rate suggests that its use as a reflection of the general preference for current over future consumption is limited. It is hard to believe that societal preferences vary to the same extent as this rate. A third approach is to examine the preferences revealed by the proportion of government expenditure going to investment rather than current consumption. Again, there are problems associated with this measure. For example, the ratio is susceptible to manipulation for political purposes. Also, government expenditure may not be an accurate indicator of the optimal allocation of current output to consumption and investment for the whole economy.

Apart from the difficulties due to time effects there are other problems associated with the static analysis put forward by Gordon. That analysis:

* is concerned with fisheries based on one species;

* presupposes that effort can be defined clearly and measured;

* presupposes that the only "externality" is the common property nature of the fishery. Other "second-best" problems, such as imperfect biological or economic knowledge about the fishery, and market power of producers or consumers, have received little attention.

This discussion has shown that the problems facing the makers of policies for the restructuring of a fishing industry are clear although the solutions may be evasive. In summary, the major problems are the long-run ones; in the short-run, the only decisions to be made are the total allowable catch to safeguard the stock, and the allocation of this amongst vessels currently participating in the fishery. In the long-run it is necessary to determine the size of the fish stock to maintain the desired catch and the capital stock, or fishing capacity, to capture efficiently this total catch. It is in this longer-run context that the question of industry restructuring should be placed.

MANAGEMENT MEASURES TO REGULATE A FISHERY

The observation that a particular fishery would be threatened if current catch rates persisted has led many governments to attempt to reduce catch rates.[1] However, most of the management measures recommended or implemented are short- run measures only. The short-run measures actually taken fall into two categories; namely, direct regulatory measures, and measures related to the demand or supply sides of the market for fish products.

DIRECT REGULATORY MEASURES

Direct regulatory measures are usually of one (or more) of three kinds:

* those relating to the volume, weight or numbers of fish caught, that is fishing quotas;

* those relating to the duration of the fishery;
* those relating to the equipment used.

The merits and limitations of each regulation have been discussed widely, but these are summarised for the sake of completeness.

Fishing quotas, in terms of a total allowable catch for the individual national fleet in a fishery, or for individual vessels in a fishery, are a widely-used policy instrument for fisheries management and regulation. They have the attraction of apparent administrative simplicity. The measure is usually implemented after a time of some concern about the fishery, and the quota implemented is designed to aid the recovery of the fishery. The successful implementation of a quota depends on the number of vessels participating in the fishery, the number of ports where catches are landed, and whether the catches are landed in more than one country. The more vessels there are in the fishery, the more difficult it will be to implement and enforce the quota system, and the more expensive it will be to achieve any level of enforcement. The same is true as the number of ports increases. In the case where the catch is landed in more than one country, enforcements of quotas can be particularly difficult. Even if there is some form of supernational jurisdiction to ensure that a multinational fishery can be regulated properly, national short-run considerations and concern about short-run domestic employment may outweigh longer-run considerations about the state of the fishery. Recent experience with North Sea herring exemplifies this situation. Thus it can be seen that the costs of administering and monitoring quota policies are high, and that the possibility of the quota being exceeded is significant, particularly in the case of multinational fisheries.

Quotas also have disadvantages at the level of the individual vessel. By reducing the catch over the whole fishery in the short-run, a reduction in catch for each vessel means that the unit costs of fishing are increased. If the quotas are applied per vessel rather than across the whole fishery, the current inefficient structure of the fishery will be temporarily frozen. There is no direct incentive for the fishery to become more efficient. If the quota is applied to the whole fishery rather than to individual vessels, there is a strong incentive for every vessel to maintain its catch at the pre-quota levels. Therefore, the likelihood of the quota being exceeded is again quite high.

Closed seasons may not be so difficult to enforce, but in other ways they are an inefficient regulatory measure for an overfished fishery. The closed season can perpetrate the excess capacity in the fishery. Each vessel has an incentive to catch at least the amount it caught before the closed season existed. With a shorter season, it is most likely to do this by increasing its catching power. The more likely effect of a closed season will be that the catch will be maintained at or around the pre-closure quantity, but that the costs of catching will have increased significantly. Again, past experience shows that in fisheries where closed seasons have been implemented, catches have actually risen. The ongoing saga of the halibut fishery off the north-west coast of the United States and the west coast of Canada is possibly the most dramatic example of the failure of a management policy using a closed season. Successive increases in the length of the closed season have been matched by increases in fishing capacity, accompanied by increases in onshore chandlering, processing and transport facilities and by increases in the catch.

There is some evidence that closed seasons may result in the diversion of fishing effort from the fishery, but this diversion of effort appears to depend on the fishing in nearby grounds. An example of this is the apparent reduction in fishing effort that accompanied the closure of the Manx herring grounds for part of the traditional season in 1973. The number of vessels participating in the fishery fell, but closer investigation shows that the fall in effort was a temporary phenomenon. The particularly good white fishing off the east coast of Scotland had detained more vessels than usual. The vessels that fished the Manx grounds did so more intensively than previously. The prediction that the closed season would have failed had effort not been diverted was shown to be accurate in subsequent seasons when the number of vessels on the Manx grounds increased. The evidence from the use of closed seasons as a tool of fisheries management policy appears conclusive: enforcement and implementation costs are low, but efficacy is limited.

Using gear restrictions as a tool of fisheries management amounts to imposing inefficient technologies on an industry, thereby raising the costs of fishing to the vessel owner. Gear restrictions, as the name implies, usually relate to the equipment used for catching. There are, however, fisheries in which the technology restrictions have been imposed on the vessel rather than on the gear. There are two assumptions behind gear restrictions. The first is that fishing gear is highly selective, taking only those fish that it is, in theory, designed to take. The idea of "eumetric" fishing has been shown to be of limited applicability. If fish escape the gear they damage themselves in so doing and often die. Studies of the behaviour of fish in shoals shows that many of the younger and smaller fish do not escape the gear. The other assumption is that the effort in terms of time spent fishing, will remain the same after the fishery is regulated as before. However, it is now apparent that the incentive for any fisherman in a regulated fishery is to maintain his catch at the pre-regulation quantity. This implies fishing more intensively, and increasing the capacity or specification of those parts of the gear that are not controlled. Whilst the control will raise costs, there is no guarantee that the amount of effort will, in fact, be kept at or below the pre-regulation amount. A further disadvantage of gear restrictions is that effective policing and enforcement are costly, requiring frequent inspection of vessels' gear, and the need to bring legal proceedings against vessels which contravene the regulations. Where vessels from more than one country prosecute the fishery, there are political as well as economic dimensions to enforcing a policy of gear restriction.

This concludes the brief survey of direct regulatory measures on a fishery. Typically, they are easy to define, and give the appearance of going to the heart of the problem. In practice, however, they do not achieve the objective of reducing the total catch because they often leave a strong incentive for vessel-owners to overcome the measure. Whilst the measures may have some short-run success, they do nothing to solve the longer-run problem of excess capacity in the catching sector of the industry. We shall discuss below the less-frequently used economic measures as regulatory tools in fisheries management.

ECONOMIC MEASURES TO REGULATE THE FISHERY

In the literature on fisheries management there is some confusion as to what constitutes an "economic measure". I consider an economic measure for fisheries regulation to be any measure which seeks to control the catch of a fishery by directly affecting the costs of fishing (by taxes on effort, for example); by directly reducing the returns to fishermen (by taxes on the catch); by changing the price signals that fishermen receive depending on whether catches are high and low; or by selling a right to exploit the fishery (restrictive licencing). Whilst these proposals are less favoured than direct regulations as tools of fisheries policy, there is some evidence that their use is increasing.

Taxes on the catch have the effect of reducing the revenue that the fisherman receives for his catch. An <u>ad valorem</u> tax, that is, a tax which is a proportion of the gross revenue from the catch, will deter the marginal vessels in the fleet from fishing. Thus, the tax will encourage the rationalisation of the fleet to a smaller, more efficient size. Depending on the size of the tax, its deterrent effect depends on whether the owners of marginal vessels expect the tax to be temporary or permanent. In the former case vessel owners will continue to fish providing they can cover their overheads. If, however, the tax is expected to be in force for a longer period of time, then those vessel owners who cannot cover the full costs of fishing will withdraw from the fleet (although they may divert their effort elsewhere).

Therefore a tax on output seems to have promise, inasmuch as it directly encourages the reduction of the fleet to a smaller and generally more efficient one. There are, however, some disadvantages. Firstly, the tax will work best for fisheries where the catch is landed in one country. Where this is not the case there are great administrative and political problems in arranging for a tax proposed in one country to be implemented in another. Secondly, like all the other economic measures the tax on catches is oriented towards economic efficiency. The problem of what happens to the fishermen who leave the fishery is left in abeyance. The third disadvantage is that the magnitude of the response to the tax is unpredictable, both in the short-run (as fishermen vary in their decisions about whether the tax is temporary or permanent) and in its ultimate effect. Precision, both in timing and in magnitude, has obvious advantages for any policy.

The second possibility is to use a price-administering programme to change the price signals to which fishermen respond. This programme proposed by Wilson and Olson (Wilson and Olson, 1977), is based on the following reasoning:

> In fisheries...nature controls the level of productive capacity... and has shown no inclination to be influenced by market price signals...in common property fisheries, free markets do not produce a stable self-regulating system. In fact, the opposite is the case. Since biological scarcity is reflected in relatively high free market prices, the effect of free prices is to encourage overfishing and the economic destruction of the resource. (p.1)

As a result:

> The goal of the CAPP Conservation Adjusted Price Programme proposal is to adjust fishery prices so that they reflect the biological state of the fishery. In other words, we are suggesting that the regulatory agency purposefully adjust ex-vessel prices so that the production response of... commercial fisheries more closely corresponds to the conditions that normally exist in a market with well-defined, property rights. (p.3)

The situation described by Wilson and Olson can be summarised with the aid of a diagram. In figure 1, the demand for fish is shown as being relatively inelastic. For more precise measures of the responsiveness of the demand for fish to changes in fish prices see Young (1977). The supply curve for fish is atypical, being "backward sloping" over the upper half (Copes, 1972). This is because the supply curve reflects the sustainable yield curve for the fishery. Wilson and Olson are concerned about the portion of the supply curve from b to c. If supply is less than Ob', and price higher than OP2, then this market is inherently unstable. For prices below OP2, the dynamics of the market will discourage fishing effort until price falls to OP1 and catch to Oa. If prices rise above OP2, the relative elasticities of the supply and demand curves indicate that demand will fall less in response to a change in price than will supply. Hence, even in a period of excess demand, price will rise and stocks will be totally depleted. The CAPP policy seeks to replace the price resulting from the interaction of the demand curve with the biologically determined supply curve, by a price resulting from the interaction of the demand curve with the administrative supply curve AS-AS. This is shown in figure 2.

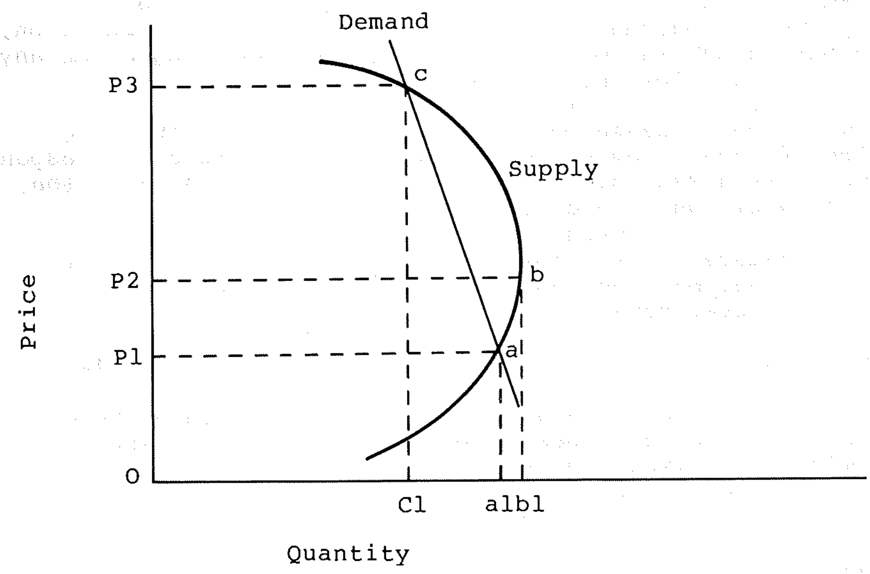

Figure 1 : Relationship between supply and demand curves

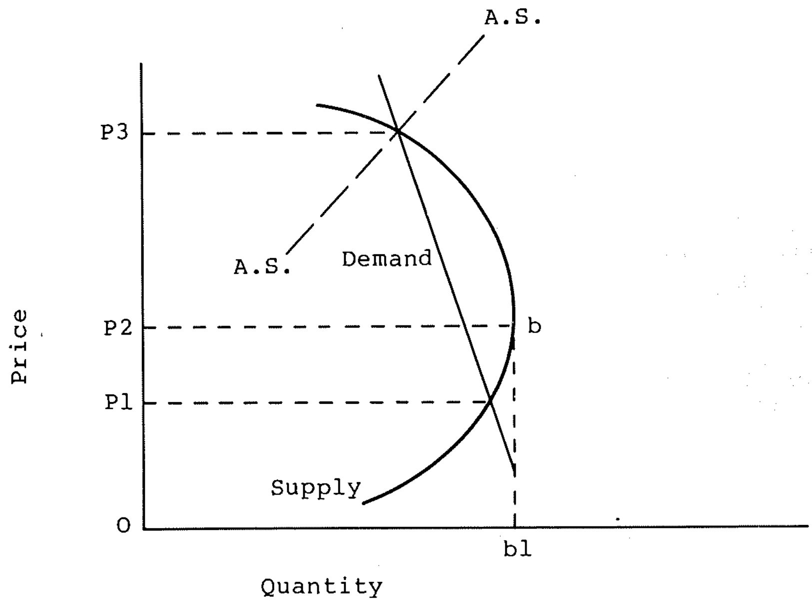

Figure 2 : Operation of the administrative supply curve under a Conservation Adjusted Price Programme.

Should the price of the species caught exceed OP2, that is, should there be excess supply for fish above the price at which the supply curve becomes backward sloping, the government would need to buy in stocks to prevent the price being pushed down to OP1. At prices below OP2 the market is stable and no intervention is necessary. If the price rose above OP3, however, stocks would be released onto the market to ensure that a situation of excess demand would not arise at a price higher than OP2. An alternative interpretation of the policy is that the government would only need to intervene at a price in excess of OP2, selling out of storage to create a situation of excess supply and reduce price. There are, however, obvious faults with a programme whereby the regulatory agency only sells out of storage, but never buys in.

Whilst Wilson and Olson discuss the principles of CAPP, they do not discuss the mechanics. As can be seen above, the mechanics provide the main stumbling block for such a scheme. The scheme is a buffer stock; however, the purchases when price is below OP2 are likely to exceed by far the sales to keep price down when it exceeds OP2. The end result of such a scheme is likely to be a net storage requirement in the long-run, which will increase over time if catches fluctuate. The current problems with agricultural surpluses in the European Community suggest that a policy whose most likely outcome is a surplus of fish has little chance of being accepted. Along with these difficulties of operating the scheme there is the theoretical problem that price is unlikely to rise to P2. This is because the instability of price P2 and the stability of price P1 will ensure that situations of excess supply (arising at prices in excess of P1) are self-regulating; price will fall back to P1 to clear the market. Therefore, the CAPP proposals do not commend themselves as a powerful addition to the armoury of management policies.

The previous two proposals have been directed towards the price received for the catch. However, when there is chronic excess capacity in the fishing industry, the measures which are most likely to succeed are those directed towards limiting fishing effort. None of the measures discussed so far do this: the direct regulations were either directed towards the catch (quotas), towards the total time spent fishing (closed seasons), or towards partially limiting effort (gear restrictions). The last two proposals to be discussed are directed towards reducing effort directly. They are: taxing fishing effort, and restrictive licencing.

The principle behind a tax on fishing effort is simple: a tax on effort will increase the costs of fishing, which will reduce the total effort in the fishery, and thereby reduce the catch. There are, however, some technical problems associated with such a proposal. Firstly, the tax would need to be on operating costs and not overheads. In the latter case, profits would be reduced but there would be no incentive for vessel owners who could pay the tax and still cover costs to reduce their effort. Effort reduction would come from marginal vessels retiring from the fleet. A tax on all the inputs whose prices comprise operating costs would act as an incentive for all vessels to reduce effort, as well as an incentive for the least efficient vessels to retire from the fishery. However, if the tax were not applied to all variable inputs, say a tax on fuel oil only or on labour only, there would be an incentive for fishermen to use other inputs more intensively, and to economise on the use of the taxed input. The net effect of a tax on selected inputs would be small.

The tax on fishing effort has one main disadvantage, and that relates to the measurement of "effort". Few attempts have been made to identify and measure fishing effort (for example, Tomkins and Butlin, 1975) and the attempts that have been relate to the fleet-wide quantity of effort, rather than that of individual vessels. The problem of measuring effort appears to be a major stumbling block for any scheme to implement a direct tax on fishing effort. The alternative of taxing all variable inputs used by fishermen is feasible, but would be extremely costly to implement, enforce and collect. In addition to the conceptual difficulty of a tax on effort, or the more pragmatic problem of very high administrative costs for an ad valorem tax on all variable inputs, there is the problem of the tax being a measure to promote efficiency. Although there is no inbuilt provision to aid those fishermen who are forced out of the fleet as a result of the measure it is, of course, feasible to use the tax yield to compensate fishermen who have been displaced.

The final tool of fisheries management which will be discussed in this paper is the concept of restrictive licencing. An excellent summary of the current practice of restrictive licencing has been given by McKellar (1977). Restrictive licencing seeks to reduce the amount of effort in the fishery by entitling only a small number of vessels to prosecute the fishery. The licences can be issued free or the vessel owners can be charged for them. In the first case the participating fishermen are given a monopoly right to the rent which results from the licencing programme. In the latter case the rent is captured for the nation as a whole rather than passing it on to the vessel owners.

RESTRICTIVE LICENCING; CLOUD-CUCKOO LAND OR A FEASIBLE POLICY ALTERNATIVE?

For some years now, the concept of restrictive licencing has been advanced as a feasible policy to regulate the over-exploited fisheries of Europe (Butlin, 1979, for example). The theoretical advances are based on the efficient regulation of an open-access fishery by a national authority to yield the maximum resource rent to the fishery. (Copes (1972) has analysed the benefits to different interest groups from management schemes.) The essence of the overfishing problem is that there is an overallocation of scarce resources both to the catching sector and, thereby, to the processing and distribution sectors. Hence, the economic surplus that could accrue to the state from managing the fishery is competed away by excess competition if there is sufficient pressure of demand. The allocation of a limited number of "rights to fish" provides a practical way of allocating a limited quantity of effort to any fishery, to ensure both its long-run survival and a supply of fish in the long-run.

Restrictive licencing is tantamount to granting a right to fish to a limited number of fishermen in any fishery. We should note that there is nothing unique in the proposal to restrict access to, or use of, a resource. In many countries, agricultural marketing boards allocate the rights to grow crops of particularly high value to only a limited number of farms. Even with other natural resources which have been appropriated by the state, the right to extract those resources is allocated by licencing or leasing. This applies to timber, oil and minerals in many parts of the world. However, there are many issues that need to be considered before a licencing scheme can be implemented. Amongst these issues are:

* The information required to establish a licencing scheme.
* Methods of allocating the licences.
* The costs of administering these licences.
* The length of time for which the licence should remain valid.

THE INFORMATION REQUIRED TO IMPLEMENT A LICENCING SCHEME

The theory of restrictive licencing is based, usually, upon a very simple model of economic behaviour. This model assumes away all the problems associated with imperfect information (about the costs of fishing, the catching power of vessels, and so forth) and the uncertainty associated with sea-fishing. These are the important practical problems faced by the designers and administrators of licencing schemes. Because of the inevitable constraints on administrative budgets a licencing programme has to be designed so that the minimum amount of information is required to operate the programme. However, it should be remembered that the implementation and operation of a licencing programme will yield a great deal of information concerning the fishery under management. Although there will be some "learning-by-doing" associated with administering the fishery, the costs of administration are likely to fall as those concerned become more experienced.

There are, nevertheless, some categories of information which are necessary to establish a successful licencing scheme. The first category is biological; namely, the relationship between the size of the stock and the growth of the stock. There is a small number of models of population behaviour for fisheries based on a single species. However, there is a great need for fisheries biologists to develop multi-species models which are more able to account for the stochastic influences that impinge upon all marine fauna and flora. An appropriate biological model for the fishery will help to specify the population target, and the associated sustainable catch, towards which management is directed.

The next information that is necessary is the political objective for the management scheme. Most discussion concerning the economics of fisheries management presumes that all management is directed towards the most efficient catching and processing of the target catch. Often, to implement such a scheme would involve a radical restructuring of the industry by laying-off more vessels than may be acceptable politically. Therefore, the criterion of management must be specified: is the purpose of the scheme to provide a supply of fish from the stock concerned as efficiently as possible? Or are there other, more socially-oriented regional objectives to the scheme? We will presume, for the time being, that the objective is to introduce an efficient scheme. However, we should note that one form of licencing, through licence fees or licence auctions, may be so designed as to yield a fund which may be used to alleviate hardship resulting from vessel lay-offs.

The third category of necessary information is that relating to fishing power. In any instance of industry restructuring it is important to know the current capacity of the industry. In the case of the processing, distribution and marketing sectors, measurement of the capacity is possible. However, in the case of the catching sector of a fishery, the measurement of the maximum catching power of the existing fleet is more difficult. In theory, there should not need to be information concerning the industry's capacity. However, in a situation of limited information, issuing licences without a check on the total fishing power of the licenced fleet could result in the target catch being exceeded, and the licencing scheme failing, unless the licences represented rights to catch a certain quantity of fish. Alternatively, if vessels are to be licenced directly, that is, if the licence permits a given amount of catching power or fishing effort, then the need to estimate or measure fishing power is linked directly to the calculation of the number of licences to be issued, given the target catch. In this case, the number of licences issued would be so restricted that the target catch would be caught only when the fleet was working to capacity. With a limited number of vessels, and the need to service onshore facilities, there would be a strong incentive to ensure that vessels did operate at or near capacity. The measurement of fishing power has the further advantage that if the aim of the scheme were to provide an efficient fleet, but one with a mixture of vessels sizes (maybe resulting from concerns about the regional problems that might arise if all the small vessels were to be layed-off) then the ability to measure total fishing power would enable licences to be issued on a proportional basis to vessels in various size groups.

The processes of measuring the fishing power of a fishing fleet, and of measuring the productivity of factors of production in the fleet, are fraught with problems. The approaches that have been used include measuring fishing power in standardised vessel days; producing indexes of fishery inputs, adjusted for technical changes (so called "hedonic indexes" of fishing effort); and measuring vessel productivity from production function estimates. Each of these approaches has both advantages and limitations. The standard-vessel-days approach (most often used as a crude index of fishing effort by those responsible for fisheries' regulation) has the virtue of simplicity. This is not to be neglected, but the approach also has the major disadvantage of not capturing adequately increases in catching power due to technological improvement. The index number approach has the advantage of being better able to capture the technological improvement in inputs into the fishing industry, but the major limitation is that such an effort index is not easily converted back into licencing a certain number of vessels with a given aggregate fishing power (Tomkins and Butlin, 1975). The use of production functions in estimating fleet productivity has both the attractions and limitations that accompany their use in any study. Amongst these, the problems of whether there are diminishing returns to fishing effort have exercised several economists. Also, the problems of separating short-run and long-run responses by the fishing fleet are difficult to handle (Bell, Carlson and Waugh, 1973).

The conclusion to this set of considerations must be that much more work is required in most countries to establish an appropriate measure of fishing power. A successful restrictive licencing scheme depends, to some extent, upon the success with which the catching power of the fleet can be measured.

THE ALLOCATION OF THE LICENCES

The question of allocating licences raises many problems although a large proportion are more apparent than real. The problems arise from two issues: whether the licences should be given away or sold, and whether they should be allocated administratively or via a competitive process.

Whether to charge for licences is a distributional issue. If the right to the resource rent is deemed to be the state's, then a licence fee can be charged, the size of the fee reflecting the portion of the resource rent due to the state. If the rent is considered to be a necessary incentive to encourage efficient vessels into the industry (or to keep them in) then the licences can be allocated on an administered basis. There are, however, other considerations: the revenue from licences could be used to help unlicenced vessels out of the industry, that is, to support "buy back" schemes. Also, if the primary objective of the scheme is efficiency, then the allocation of licences on a competitive basis, for a fee or by a bidding system, has advantages over administered systems. The rent from the fishery with a limited number of vessels will show itself in above-normal profits to the vessel owners. On average, the most efficient vessels will earn the highest of these profits, and will be prepared to pay the highest licence fee, or bid the highest at a licence auction, for the right to fish. Hence those vessels which are most efficient will (in the absence of collusion) be those that take up licences.

Furthermore the allocation of licences by auction has advantages over licence fees. Licence fees are calculated by those responsible for administering the system. Without information concerning the cost structures of particular vessels, it is unlikely that the licence fee that is calculated will capture successfully a significant portion of the resource rent. In contrast, the auctioning of licences enables each vessel-owner to bid up to the above-normal profits of his own vessel, with only the highest bids (the most efficient vessels) receiving a licence. Hence, the auctioning of licences is the most economical way of efficiently capturing the resource rent from the fishery.

In public discussion of licencing schemes much has been made of the difficulty of introducing restrictive licencing into a fishery that already has excess capacity in the catching sector, with a heterogeneous fleet and a wide variation in the age structure of skippers and crew members. In practice the difficulties are not so great. One politically feasible approach is to issue, in the first instance, licences equal to (say) ninety per cent of the existing catching capacity of the fleet. Once these initial licences have been issued they could be made freely transferable, subject to any new entrants to the fishery meeting minimum seamanship requirements, at whatever market price prevails. In order to enable fleet structure and size to be changed, the management authority should have first refusal for any licence coming on the market, at the prevailing market price. Such a scheme would have several advantages over a simple, administered allocation of the licences. Firstly, it would give a return to established fishermen, through the sale of the licence, for their investment in exploration and development of the fishery. Secondly, part of the proceeds of the sale could be appropriated by the management authority (using a resource levy, for example) as the nation's share of the economic rent accruing to a properly-managed fishery. Thirdly, the "first-refusal" provision gives the management authority a continuing control over the fishing effort applied to the particular ground.

ADMINISTRATION OF THE LICENCE SYSTEM

The claims that are made for economic rather than administrative approaches to resources management centre around the question of economic efficiency. In practice, however, all measures require real resources, usually from the public sector, for their establishment, implementation and enforcement. It is essential that these resources should not be excessive. In principle it appears that the allocation of a restricted number of licences by an auction system will minimise the resources required to establish, operate and enforce an industry restructuring scheme.

THE DURATION OF THE LICENCE

The appropriate time for which a fishing licence should run is difficult to determine. It should not be valid for a length of time that reduces the flexibility necessary to adjust the quantity of effort which the managers deem appropriate for the stock. But a licence should not be valid for such a short period that it does not provide the incentives for vessel owners to invest in new vessels or vessel improvements. To some extent the duration of the licence must be specific to a particular fishery and it must relate to the planning horizon for the vessel owners in the fleet.

Throughout this section, it has been assumed that the fishery is a single-species fishery. The problem of the multi-species fishery and the by-catch problem have not been considered. In reality the two problems are similar because they differ only in the proportions of the various species that are caught. in the multispecies situation, significant proportions of all the species involved are caught. In the by-catch or incidental catch situation one major species is caught with small or incidental proportions of commercially viable species also being caught. A scheme which restricts the number of licences has advantages in the resolution of both problems. For the multi-species fishery, the amount of effort licenced can be arranged to avoid extinction of either or any species. The licencing system then leaves the allocation of effort between the species (to the extent that this is a commercial decision) to the commercial instincts of the skippers. The by-catch problem will be regulated to some extent by a system of restrictive licencing, the by-catch being reduced to the extent that fishing effort is reduced.

The conclusion of this section is that a licence system has distinct advantages in terms both of tackling the problem of too much fishing effort, and of rationing the allowable fishing effort, particularly if licences are auctioned.

SUMMARY AND CONCLUSIONS

The reduced catches resulting from the major change in the philosophy of fisheries' management that have taken place globally during the current decade, involving the appropriation of extensive national fishing zones, and the increased market for fish, make a policy of unrestricted access for any vessel to any stock an inappropriate one, and one which serves only the immediate needs of a few large vessels.

Of the long-run effort-limitation policies that were considered, the restrictive licencing scheme was the most preferred, with an auction for licences to fish having advantages over licence fees in terms of requiring no calculation of the fee; returning a higher proportion of the economic rent from the fishery to the state (and providing a larger potential fund to help finance the adjustment programme); and probably incurring lower administrative costs. The benefits of the scheme would be the resource rent that would be gained thereby, and the savings in subsidies to the fishing fleet. The costs would be related to those involved in a vessel retirement scheme, and the extra costs of redundancy schemes, or retraining and relocation costs. The cost of the programme to the British Government would depend upon whether licence revenue could be earmarked or not, and upon the rate at which unlicenced vessels left the fishery.

The use of restrictive licencing in conjunction with a scheme of assistance to the owners and crew of redundant vessels appears to offer a fisheries policy that both encourages efficiency and makes adequate provision for the needs of the marginal fisherman who will not continue in the fishery after the introduction of the scheme.

NOTES

1. A fishery is threatened if, at current catch rates, it is likely that the stock will be reduced below the level at which the fishery can be commercially exploited.

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4

THE NATURE AND ADEQUACY OF PROPERTY RIGHTS IN AUSTRALIAN FISHERIES

by

T. F. Meany

INTRODUCTION

The realisation that the peculiar problems associated with fisheries management are related to the nature of the property rights involved dates back at least to 1954 when Gordon introduced fisheries economics as an area of separate study. Only six years after Gordon's article Coase (1960) laid the foundation for the economic study of property rights. Although twenty years have since passed it is only recently that any real attempts have been made to integrate the two branches of economic theory.

The term property rights as used in this paper refers not only to rights in what are generally termed real and personal property but to the wider structure of rights available under the law.

This paper is in four parts.

1. A brief discussion of the range of property rights available with respect to land.

2. A consideration of the shortcomings of existing schemes for the economic management of fisheries.

3. Restraints on developing property rights in fisheries imposed by existing legislation.

4. A suggested new approach to managing fisheries.

PROPERTY RIGHTS

The establishment of property rights is the legal process by which ownership of a bundle of rights is codified in order to meet some perceived greater individual or public good. In economic terms it can be seen as the legal process by which the transaction costs involved in attaining a desired objective are minimised.

> An owner of property rights possesses the consent of fellowmen to allow him to act in particular ways. An owner expects the community to prevent others from interfering with his actions, provided that these actions are not prohibited in the specifications of his rights (Demsetz, 1967, p.347).

Property rights have developed in response to changes in society and its technology. Changes in property rights may not always have occurred by conscious intent and in many cases have evolved by trial and error rather than as the result of some flash of intuitive wisdom.

In a primitive hunting society, where game was plentiful relative to the number of hunters, property rights could be expected to be non-existent or at best ill defined. A hunter may for example "own" his personal hunting implements but the concept that either he, or his particular group had any exclusive rights to the game from some particular tract or territory did not exist.

THE "TRAGEDY OF THE COMMONS"

As pressure on resources increased, usually as the result of introducing a commercial motive, there is evidence even among hunting communities of the development of property rights (Demsetz, 1967). As man developed from a hunter to a herder the scenario as seen by Hardin (1968) developed as follows:

> Picture a pasture open to all. It is to be expected that each herdsman will try to keep as many cattle as possible on the commons. Such an arrangement may work reasonably satisfactorily for centuries because tribal wars, poaching, and disease keep the numbers of both man and beast well below the carrying capacity of the land. Finally, however, comes the day of reckoning, that is, the day when the long-desired goal of social stability becomes a reality. At this point, the inherent logic of the commons remorselessly generates tragedy.
>
> As a rational being, each herdsman seeks to maximize his gain. Explicitly or implicitly, more or less consciously, he asks, "What is the utility to me of adding one more animal to my herd?" This utility has one negative and one positive component.
>
> 1. The positive component is a function of the increment of one animal. Since the herdsman receives all the proceeds from the sale of the additional animal, the positive utility is nearly +1.
>
> 2. The negative component is a function of the additional overgrazing created by one more animal. Since, however, the effects of overgrazing are shared by all the herdsmen, the negative utility for any particular decision-making herdsman is only a fraction of -1.
>
> Adding together the component partial utilities, the rational herdsman concludes that the only sensible

> course for him to pursue is to add another animal to his herd. And another; and another...But this is the conclusion reached by each and every rational herdsman sharing a common. Therein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit - in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all (p.1244).

Not all economists would support this pessimistic view of common property, it has for example been pointed out that seasonal alpine grazing has been carried out most successfully under common property rights in Switzerland for centuries (Ciriacy-Wantrup and Bishop, 1975).

The interdependency of property rights and the law, or more precisely of property rights and the ability to enforce them is evident in the development of property rights in the Middle Ages.

> The collapse of the Roman Empire and a complete disintegration of its legal structure resulted in the replacement of order by chaos. The concept of private property that was fully developed in the Roman Law and enforced by the state disintegrated. Violence became a predominant method of resolving conflict of interest among people in a world in which barbaric customs has replaced Roman Law. The cost of excluding outsiders from what one considered to be his property rose and the result was a return to a sort of property sharing by a larger group. The principal need in post-Roman Europe was for protection of family and security of its property (land). In order to survive, a weaker man turned to a stronger man and gave him the right of ownership in land he toiled in exchange for protection and a quasi right of tenancy; he held the land of the lord. The lord-vassal relationship then emerged as the basic social institution in medieval Europe. The new lord could and often did become the vassal of still another man; that is, he became both the lord of a weaker man and the vassal of a stronger man. In time, this chain between the lord at the top and the actual user of the land at the bottom lengthened and a socio-political system based on a method of holding property developed. Only the lord (King) at the top was never a vassal (Pejovich, 1972).

This quotation tells what occurred but does not explain why it occurred. Suppose an individual wished to raise a crop on a piece of land, such an exercise would be pointless unless he could keep stock owned by his neighbours away from his crop. If he had only one or two neighbours he could possibly come to some arrangement whereby they agree either as the result of the payment of some form of compensation, or alternatively because of some threat, to keep their stock off the land. As the number of persons with whom he must negotiate grows the cost involved (called transaction cost) grows. The point is soon reached at which the transaction costs exceed the expected profit from the crop and it ceases to be worth his while to plant the crop. Instead of the individual having to negotiate with all members of the community whose actions may adversely affect what he wishes to do, property rights are established. These rights are enforceable at law and specify the rights of the individual as well as those of all other members of the community. There is no longer any need to negotiate with each other member of the community, for should they transgress against his property rights he can take legal action to obtain compensation. Therefore, the establishment of property rights has the effect of reducing transaction costs.

Since the Middle Ages there has been a great refinement of property rights and the scope of these rights is continually changing and widening. For example, two of the recent areas where property rights have been developed are in the exploitation of ground-water and the use of air-space by aircraft. Looking briefly at property right with regard to land it is at once evident that these rights could conceivably cover a continuous spectrum from the individual having no rights to where a particular individual had absolute rights over a particular parcel of land.

Perhaps the closest examples to no rights would be instances where all members of the community have equal rights. That is where no member of the community has the right to stop another from doing something that each has the right to do. The air we breathe could be considered to be such a resource. Even with such a right it is, however, usual to find some activities which are proscribed to all those entitled to use the resource, for example, air pollution from factory or motor car emissions. The closest example to absolute rights would be freehold title, although such a right is today far from being absolute, freehold land being for example subject to resumption for numerous public purposes and subject to various zoning limitations as to its use. These restrictions in themselves represent developments in property rights designed to make those rights accord more closely with changing demands of society.

Between the two extremes of property rights there are an infinite variety of bundles of rights, licences, easements, and leases of various kinds. It is not the purpose of this paper to examine each of these in detail but rather to look at the elements which go to make up property rights.

The three elements of property rights with respect to land already mentioned are:

* the specified area with respect to which the rights may be exercised;

* the purposes for which the land may be used; this may be a simple right of access across the land as in the case of an

easement, or in the case of a lease it may permit some uses (for example, agriculture) while forbidding others (for example, quarrying); and

* the right to deny others the right to use the land for any or all purposes.

Each of these rights may be absolute (or nearly so) or may be restricted to some specified extent.

There may moreover be several individuals or groups of individuals who have specified rights to the same piece of land. Consider for example a parcel of freehold land, there will for a start be those restrictions on the use of the land imposed by the community through Government regulation. These would include zoning usage and restrictions against pollution. Suppose that our parcel of land has a coal seam running beneath it, the exploitation of which is subject to an agreement between the land owner and a coal mining company. The surface of the land is used for agriculture under a lease agreement with the owner while a neighbour has under another agreement with the owner a right of easement across the land. The rights of each of these interests is clearly specified in either legislation or some form of contract which is enforceable at law.

There is however another component which will form part of any property right - a component that is so closely involved with the three elements mentioned above that its importance tends to be overlooked, this fourth element is time. With a freehold title the rights, in theory at least, are granted in perpetuity. More often however rights granted in any contract are for a specified period, be it years, months or days. The importance of the time element and how it could be used in fisheries management forms the basis of this paper.

PROBLEMS ARISING FROM CURRENT FISHERIES MANAGEMENT SCHEMES

Since Gordon (1954) highlighted the peculiar economic problems involved with fisheries management, various systems have been suggested, designed in part, to prevent or at least restrict the tendency to dissipate the resource rent which should, in theory, be available from many fisheries. These systems have in fact attempted to create more specific property rights for the fisherman involved. Generally these systems have been of two types: limited entry and catch quotas.[1] This section looks at the effectiveness of the property rights created under these systems.

LIMITED ENTRY

Restrictions on inputs, particularly in the form of limited entry has been used extensively in Australia. However in most instances the objectives behind the introduction of this form of fisheries management had little to do with rationalising economic inputs but was seen as a biological control designed to limit the increase in fishing effort.

In Australia limited entry has usually been introduced by placing an embargo on the entry of additional boats, or in the case of the abalone fishery, additional fishermen, thus effectively "freezing" the number of boats or fishermen in the fishery to that existing at a particular point in time. This procedure has been only partly successful in preventing the dissipation of any potential resource rent. For example in the Western Australian rock lobster fishery, rent dissipation has continued as the result of the use of increasingly more expensive boats, both in terms of capital and running costs (Meany, 1979). Such observations have not been limited to Australia, a similar pattern has also been evident in the British Columbian salmon fishery (Fraser, 1977; Pearse and Wilen, 1979).

By contrast the same dissipation of resource rent has not occurred in the prawn fisheries of Shark Bay and Exmouth Gulf (Meany, 1979). Limited entry was introduced into each of these fisheries from their very beginning and additional licences were issued only as more information about the fishery became available. However, this does not appear to be the reason why rent dissipation has not occurred to any great extent. Both the Shark Bay and Exmouth Gulf prawn fisheries cover a relatively small area and the ownership of licences is concentrated in the hands of a few companies and individuals. There are therefore a restricted number of decision-makers involved, each of whom can recognise that their own interest is best served in not attempting to increase their share of the catch. Increasing the fishing power of the boats by one company or individual will cause their competitors to do likewise and as the total catch will be subject to little if any increase, such action would result in all ending up worse off. Similarly in the Bay of Fundy herring fishery in Canada, licenced fishermen have by mutual agreement decided to allocate the available quota among themselves on a 'predetermined basis'.

The basic difference between the Shark Bay and Exmouth Gulf prawn fisheries and the Bay of Fundy herring fishery on the one hand and the Western Australian rock lobster and British Columbian salmon fisheries on the other is the size of the groups involved. With the salmon and rock lobster fisheries the high transactions costs involved in getting the fishermen together and having them recognise that the best interests of all would be served by mutual restraint render this impossible. With the prawn and herring fishery however, transaction costs are much less because of the smaller numbers involved and some form of agreement, formal in the case of the herring fishery and tacit in the case of prawns has developed.

Limited entry creates property rights which are much more specific than those available under open entry. However, as fishermen still share in the exploitation of a common resource the effectiveness of limited entry from an economic viewpoint is largely determined by the transaction costs involved in having all fishermen act in a way that is in the common interest of all. In most limited entry fisheries transaction costs are so high that each fisherman pursues his own rather than common goals. To improve the economic efficiency of these fisheries requires the development of a system which will create property rights which effectively minimise transaction costs.

CATCH QUOTAS

Interest in the use of individual catch quotas is growing. The basis of such a proposal is to allocate to each fisherman an annual quota. He can then decide for himself how and when he will take the quota. In theory this should remove most of the competition which exists with a single quota or in a non-quota fishery where each fisherman attempts to take as many fish as possible before his competitors.

Such a scheme would allow for the sale or even the leasing of quotas (Christy, 1973). If a fisherman found that his catching capacity exceeded his quota he could buy additional amounts of quota until his catching capacity matched his catching rights. A fisherman selling his quota to another established fisherman would result in there being one less fisherman in the fishery. As fishing technology improved and more efficient boats entered the fishery, individual quotas would become larger and boat numbers would be reduced. Under this form of property right there is a natural trend towards equilibrium between catch and catching power and the tendency to dissipate the resource rent is greatly reduced. It then becomes a matter for political decision as to whether fishermen are allowed to retain all of the resource rent thus generated.

Whether such a system is workable in a particular fishery will again depend on transaction costs. These appear to be of two main types, namely those associated with determining quotas, and those involved with policing quotas.

The costs of determining quotas would be related to the state of biological knowledge of the resource and the variability of catch from the fishery. Where the biology of the target species and the extent of the resource were well understood and where there were relatively minor annual variations in catch, individual quotas would have their greatest use. Quotas require the ability to predict expected catches, so that excessive fishing effort is not expended in years of reduced catch availability and available catch is not wasted in above-average years.

If quotas in a particular year are set at levels higher than the available catch, one of the great advantages of individual quotas is lost, that is, the freedom it gives the individual fisherman to plan his fishing strategy through time. If there is a fear that he might not actually catch his quota in a particular season he will almost certainly attempt to catch it in the shortest possible time with the resultant waste of resources this involves.

If quotas are set at a level lower than the available catch then part of the potential catch could be wasted. The seriousness of this will depend on the target species. With a one year life span, like most prawn species, this could represent a considerable loss of income. With a longer lived species there may be little if any loss, if the surviving fish are caught in following years. It may also be possible to adjust quotas upward during a season as a better understanding of the available catch becomes available.

It would seem that individual catch quotas would be of limited use in a fishery where the season was short and characterised by large but unpredictable individual catches. Such fisheries do not lend themselves to planned fishing strategies by individual fishermen. Each fisherman must give maximum effort during the season, so as to maximise his chances of "the big catch". If he is lucky he could exceed his quota in one or two days fishing.

Policing of individual quotas can also be very expensive, the two most significant aspects in this regard being the marketing channels available and the unit value of the catch. Where the fish is subject to processing (for example, canning) before sale, or where it goes principally for export, it usually goes to one of a small number of buyers. As there are few sales outside these channels the costs involved in recording catches by individual fishermen will not be great. However, where there are a multitude of buyers and especially where cash sales are prevalent, the costs of policing are likely to be prohibitive.

It must be remembered that there would be a considerable financial incentive for fishermen to sell catch through outlets where it was not recorded as part of his quota. There would be the existing incentive of avoiding income tax, to which would be added the incentive of what would in fact be the sale of non-quota catch. Where a product of high unit value was involved a fisherman could find it quite profitable, probably with little risk, to sell small quantities outside the quota system. In fisheries where selling direct from the boat is an established part of the marketing system the introduction of individual quotas could require the restructuring of the marketing system.

QUOTAS ON INPUTS

Catch quotas are directed toward the output side of the fishery; there are some fisheries where quotas on the input side could also work. These are fisheries where effort is related to the number of gear units involved, and would appear most appropriate for trap fisheries. In both the western and southern rock lobster fisheries the number of pots which each boat can legally use is already restricted. The number allocated to each boat is determined partly by the size of the boat. If this nexus between pot numbers and boat length were broken and if the entitlement for pots were made fully transferable, the basis for a self-adjusting system would already exist.

However there would still be one major problem. That is the need to reduce pot numbers as the fishing efficiency of each pot increased (and initially at least to reduce total pot numbers to bring them more into line with the available catch). If the nexus between pot numbers and boat size were broken, adjustment by a progressive, across-the-board percentage decrease in pot numbers would be feasible. Alternatively if the sale of pots were permitted, approval for the sale could be conditional on the surrender of a certain percentage of the pots proposed to be sold.

Quotas represent very specific property rights in that they give each fisherman "title" to a specified proportion of the catch from (or inputs into) a fishery. If the transaction costs involved are less than the economic benefits obtained, the introduction of individual quotas would be justified. In many fisheries, however, transaction costs are likely to be quite high.

IMPACT OF EXISTING AUSTRALIAN LEGISLATION

This section looks at examples of existing Australian fisheries legislation and attempts to assess their appropriateness from a property rights view. The examples of legislation chosen are those of the States of New South Wales and Western Australia and the Commonwealth of Australia.

EXAMPLES OF LEGISLATION

New South Wales and Western Australia were selected as representing quite different philosophies to fisheries management. In New South Wales the basic policy has favoured open entry, whereas in Western Australia limited entry has been widely introduced during the past fifteen years and virtually free trading in boats with licences in these fisheries is permitted.

Commonwealth Legislation

Provisions governing the granting of licences are covered by Section 9 of the Fisheries Act 1952-78. This section states that the "Minister or the Secretary may grant" licences for fishermen or fishing boats subject to conditions specified in the licence, it also authorises the endorsement of licences for boats to operate in limited entry fisheries.

The section also permits the transfer of licences. It also specifies that licences may be granted for a maximum period of one year. There is no provision for the renewal of a licence. A new licence is issued each year. Section 9A authorises the cancellation of a licence for breaching of its conditions or the provisions of the Act.

Other than the implied "may not" in the proviso that "the Minister or Secretary may grant" licences, the Act is silent as to the right to refuse to grant a licence. To a degree this is not surprising as there are still many open entry fisheries in Australia and licences for these are freely available. With respect to transfers of licences the wording is again unspecific, "The Minister or Secretary may" permit transfers. This gives no indication as to the possible circumstances under which permission to transfer a licence may be withheld.

Western Australian Legislation

Fishing in Western Australia is regulated by the Fisheries Act 1905-75. A noticeable feature of this Act is the amount of discretionary power vested in the Minister. Section 17 governs licencing and Section 32 deals specifically with limited entry fisheries while Regulations 2 and 3 govern the issuing of licences.

The Western Australian Fisheries Act does not specify the time period for which a licence may be issued. Regulation 2 requires annual renewal of boat licences and although the period covered by a fisherman's licence is not specified these are in practice also one year licences.

Although the Act makes provisions for the transfer of licences the method of effecting transfers is not addressed in either the Act or Regulations. However, transfers of boats and licences in limited entry fisheries are permitted (Meany, 1979). The premiums paid on transfer of licences in limited entry fisheries are accepted as a consequence of limited entry and no attempts are made to prevent this practice.

New South Wales Legislation

The New South Wales Fisheries and Oyster Farms Act 1935-79 has recently been completely overhauled and extensively amended. As such it represents the most modern fisheries legislation in Australia. Many of the amended sections of the Act have yet to come into force and regulations implementing the amended Act have not yet been promulgated.

Under section 24A(6) the term of licences are to be fixed by regulation. This has yet to be done. At present licences are issued for one year. If licences are issued for longer periods (with the possible exception of abalone) it is likely to be for the sake of convenience (both that of the licensor and licensee) rather than with the intention of creating a more specific property right.

Section 25(8) provides that a fisherman's licence is not transferable but the Act makes no mention of whether or not boat licences may be transferred. Under Section 24A(4) (boat licence) and section 25(6) (fishermen's licence) the Minister may cancel or suspend a licence but only in circumstances prescribed under the regulations. The Minister may also refuse to issue or renew a licence (section 24A(2) for boat licences and section 25(2)(b) for a fisherman's licence). The circumstances under which he may exercise this power are not specified, but unlike the Commonwealth and Western Australian Acts the New South Wales Act provides for an appeal to the District Court (Section 119) against this provision and also against the suspension or cancellation of a licence.

Discussion

From the foregoing it can be seen that the property rights of fishermen are very poorly defined. Under Commonwealth and New South Wales legislation a licence can be cancelled only for offences under the Fisheries Acts. Under the Western Australian legislation a conviction for an offence does not appear to be a pre-requisite for cancellation of a licence.

Also each set of legislation specifies, or past practice dictates, the issue of licences for a maximum period of one year. In each case the renewal of the licence (or in the case of the Commonwealth Act the granting of a new licence) is at the discretion of the Minister. Only in New South Wales is the right of appeal provided in the fisheries legislation.

Oyster Leases

In sharp contrast to the ill defined property rights available under fishing boat licences and fishermen's licences, are the very specific property rights established for oyster farming under sections 58 to 87 of the New South Wales Fisheries and Oyster Farms Act. These rights and responsibilities include the term of the lease, the determination of rent, renewal of the lease, mechanisms for settling disputes, penalties for infringements, health requirements, and matters related to the types of improvements which may be undertaken and their ownership.

The provisions of the Act are supplemented by Regulations and in individual lease agreements. Therefore the oyster farmer has his property rights and his responsibilities under those rights much more clearly specified than does the fisherman.

LEGAL PRECEDENTS

In the interpretation of fishermen's rights under the law we in Australia also lack the support of a substantial body of case law which might help to codify the limits of Ministerial power. Australian fishermen apparently are not litigious by nature.

Some administrators argue that the advantages of the flexibility available under the present legislation outweigh any gains which could be expected from a more rigidly specified set of property rights. It is also argued that administrative practice is such that fishermen need to have no fear of capricious action which would adversely affect their property rights. This line of argument would claim that the present system allows the conditions attaching to a licence to be continually reviewed and if necessary updated annually (which would seem to contradict the claim that the property rights of fishermen were not under challenge). Looked at in this light the present system can be seen to be directed more to satisfying the needs of administrative convenience than to establishing a bundle of property rights which are appropriate for today's fishing industry.

The present legislation evolved in the period when open entry fisheries were universal and it still reflects the attitude that every citizen has the right to exploit the oceans and to obtain a licence to do so. In this context the issue of annual licences is not unreasonable.

The advent of limited entry fisheries introduced fundamental changes to the property rights involved. By giving exclusive rights to exploit the resource to a selected group of fishermen others were excluded. Moreover, there was the clear understanding that this privileged position was not just given for the period of the one year licence. There was an implication to fishermen, and an understanding by government, that licences of the privileged fishermen would be renewed and continue to be renewed. This is demonstrated by the fact that it has proved almost impossible to reduce the number of boats licenced in limited entry fisheries or even to restrict the increase in fishing effort or capitalisation in already fully exploited fisheries. Yet under the law it would appear that such could easily be achieved by simply declining to renew the licences of that number of boats considered to be in excess of the number required in a particular fishery. This inability to act is related to political realities rather than to legal restraints. Therefore, it seems that political realities reflect the true nature of the property rights involved more accurately than does the existing legislation.

More specific property rights in fisheries have been slow to develop for two chief reasons; firstly, the difficulties of defining and marking boundaries; and secondly, the impossibility of keeping fish within these boundaries. The transaction costs involved in attempting to overcome these difficulties are such as to render the establishment of property rights, as we know them with respect to land titles, uneconomic at least as far as most fisheries are concerned. The New South Wales Fisheries and Oyster Farms Act, however, demonstrates that where these problems can be overcome as in the case of oyster farming, where shallow water and a sessile organism make the problems solvable, specific and well-codified property rights can be developed.

It is probable that the nature of property rights as established with respect to land has somewhat blinkered our thinking with respect to property rights in fishing. We have found the system of land property rights inappropriate to fishing but have not considered the full range of possible options.

THE TIME FACTOR

There is one element in all property rights which has been largely neglected as far as fisheries are concerned. This element is time. In our present property rights system in fisheries, we have in law, a system of one year titles while the political reality in most instances means that a given fisherman has a perpetual right to exploit the resource.

Why is it that the legal system of a one year licence is not enforced? The answer is that unless a fisherman understands that his licence will be renewed and continue to be renewed for a considerable number of years he is unlikely to invest substantially in any fishing enterprise. For an investment to make any economic sense the investor must expect a period of operation which will be sufficient to make his investment economically viable. It is the recognition of this reality that ensures that a licence must in practice (if not in law) be renewed by the various licencing authorities each year. If, for example, the letter of the law was followed and the discretion to renew or not renew a licence was exercised in an unpredictable fashion then investment in that fishery would decline rapidly because fishermen would no longer have confidence in their ability to recover their investment.

When viewed in this light it becomes clear that for most fisheries a one year licence is completely inappropriate. For investment in a fishing boat to be forthcoming the fisherman must expect a tenure in that fishery at least equal to that necessary for him to recover his investment. Logic suggests that this is the minimum time for which any right to fish should be granted. However, a fishing boat is a deteriorating asset with a finite economic life. The economic life will depend on the rate of physical deterioration, the cost of maintenance and the rate of obsolescence which, in turn, will be determined by the rate of technological change. Therefore, it would seem feasible to structure a system of property rights in fisheries around a time period which would be sufficient to warrant the initial investment but which would not extend beyond the economic life of the vessel.

Neither the present legal system of a one year licence nor the reality of some form of perpetual right is appropriate to the existing forms of property rights in fisheries. A system which links the time factor with economic reality could do much to solve many of the present problems of managing fisheries.

USING THE TIME FACTOR

The remainder of this paper attempts to develop a system using more specific property rights and the time factor as the basis for a fisheries management regime. The suggested system is based on the development of a legal structure of specific contracts between the appropriate government instrumentality (the grantor) and each individual fisherman (the grantee).[2]

Each contract would cover the operation of a specified vessel and would be subject to an agreed set of terms and conditions. The most important of these conditions would relate to the period over which the contract would remain in force. This period would be sufficient to make the investment in the vessel economically viable but would not exceed the expected economic life of the vessel involved. For example, in a particular fishery a ten year period may be required to recover the initial investment while the life expectancy of a new boat may average 20 years. The initial contract might specify a term of 15 years, subject to review at the end of that period. If at the expiration of 15 years it was decided that the boat still had an economic life of eight years and that the further extension of the contract would not have any adverse affect on the fishery then an extension of eight years, or a lesser period might be negotiated.

At the expiration of the contract the vessel owner would retain his vessel but would cease to have the right to exploit that particular fishery. Alternatively the conditions attaching to the contract might specify that at the expiration of the contract ownership of the boat passed to the grantor (as do improvements on oyster leases under N.S.W. legislation) or require that the boat be scrapped in order to prevent these cheap but obsolete boats becoming a problem in some other fishery.

Under the system envisaged these fishing contracts would be transferable (with the vessels) and the purchaser would enter the fishery on the same conditions as applied to the original grantee. As the legal right to exploit the fishery would be for a pre-determined period it could be expected that the period of the contract remaining would be reflected in the price paid on such transfers. This in itself should act to restrain the size of the transfer value which might attach to the right to fish.

FEES

One of the problems associated with existing limited entry fisheries has been the tendency for rent which may be generated to be dissipated by fishermen in excessive capitalisation in replacement vessels. As the proposed system of contracts provides a control over the number and size of boats in a fishery and permits a reduction in boat numbers as existing contracts expire it should be possible to leave a proportion of the rent with the fishermen without too great a fear of over-capitalisation. This would mean that the level of resource rent extracted by the grantor in the form of fees would be dependent on the particular governmental policy objectives being pursued.

Under the system proposed a contract would be with the individual fisherman and bargaining as to the value of the right to fish would be on an individual basis. This would mean that the willingness to pay an appropriate price could represent one of the main criteria in deciding with whom a contract would be negotiated.

It is envisaged that conditions in the contract would provide for the renegotiation of the charges, fees and other conditions, other than the term of contract, at intervals specified in the contract, for example every five years. In this way changes in the relative profitability of fishing could be reflected in the payments made.

These payments could be in the form of an annual fee, or a combination of an annual fee and a royalty on catch, or as a royalty on catch only. A royalty on catch would of course present the same policing problems as individual quotas and would be inappropriate for many fisheries.

OTHER CONDITIONS ATTACHING TO CONTRACTS

Besides conditions relative to the payment of fees and the periodic reappraisal of fees a contract would also contain a variety of other conditions, foremost among which would be to identify the boat to which the contract referred. Depending on the type of fishery and its degree of exploitation, conditions relevant to items such as the equipment carried and engine horsepower, might also be required. Other conditions might merely be restatements of existing legal requirements such as the provision of catch returns or requiring the operator to comply with closed seasons.

Of more importance would be conditions which were specific to the operation of that particular boat; these could include such things as the geographic description of the area in which it could legally operate, the types of gear it could (or could not) legally use and the types of fish it was allowed (or not allowed) to take. The agreement might also specify penalties for various breaches of conditions, for example, cancellation of the contract, suspension of the right to fish or fines. However, it is more probable that these penalties would be specified in the legislation under which such a scheme operated.

INTRODUCTION OF A SYSTEM OF CONTRACTS

Contracts could be introduced into a fishery on a progressive basis, and could be run concurrently with an annual licence system. In the latter instance such a system would be a true annual licence with the grantors' rights not to renew the licence clearly defined. It may, for example, be decided to introduce such a system progressively as new (probably replacement) vessels entered a fishery. Existing boats would be permitted to operate on annual licences for the term of their economic life. At the end of this period the owner could apply to enter into an agreement to operate a replacement vessel, this application might or might not be granted depending largely on whether it was considered desirable to reduce effort and/or investment in the fishery.

Alternatively contracts could be negotiated with all operators in a fishery. In this case contracts would be for various terms linked to the remaining economic life of each vessel. In other words the older the boat the shorter the term of the contract. Such a system need not completely replace a licencing system, as mentioned previously the two systems could run concurrently in the introductory stages. In certain fisheries, for example abalone and estuarine fisheries with relatively low capital investment an annual licence system might still be more appropriate.

With a resource subject to considerable fluctuations in size it might be desirable to allow a temporary increase in fishing effort in very good years. This could be achieved by issuing licences (or short term contracts) to additional boats (probably fishing under agreements in other fisheries) to fish in the under-utilised fishery for a specified period of time.

REPLACEMENT OF BOATS

As agreements would be specific to a particular boat and linked to the life of that boat, the question of boat replacement would not be one that frequently occurred. Inevitably there would be mishaps which would render consideration of the replacement of a boat subject to a current agreement essential, as for example when the boat subject to the contract had been destroyed or sunk.

There would be several ways in which this situation could be addressed. Each of which might be appropriate in different circumstances. For example, where the boat lost was nearing the end of its working life it might be appropriate to terminate the contract. In other instances it may be possible to replace with a boat of similar size and characteristics in which case the existing contract could be continued with minimum alteration. If, however, such a boat was not available or for one reason or another replacement with a boat of different characteristics was felt to be desirable then the appropriate course of action might be to re-negotiate the existing contract.

ADMINISTRATION OF THE SYSTEM

The contracts envisaged give the fishermen much more specific rights and responsibilities than are found under the existing licencing system. The terms and conditions attaching to contracts would be negotiated with respect to the operation of a specific boat and be more "personalised" than existing licencing conditions. Disagreements between the grantor and grantee as to what these conditions or fees should be are likely to be more common. It would seem reasonable that there should be some form of "court of appeal" which could arbitrate on questions in dispute and possibly have the responsibility of imposing penalties for breaches of conditions.

As existing agreements expire or as resource information indicates the entry of more boats is desirable, the question of whether or not to negotiate new contracts would need to be considered. When existing contracts expire the opportunity presents itself to review the level of effort and capitalisation in a fishery. Over time these can be expected to increase due to increasing efficiency of a fleet of a fixed number of boats. Therefore, it is to be expected that fewer new contracts will be entered into than there will be contracts expiring, thus expiring contracts will be used as a method of reducing boat numbers.

The allocation of new contracts could be determined in a number of ways, for example simply by negotiation with the highest bidders (an auction system) or by ballot among those who qualify under a certain set of pre-requisites, such as holding the relevant certificates of competency and experience in the fishery. If a legal tribunal were established to arbitrate in disputes about conditions attaching to agreements, it would appear reasonable to give that tribunal responsibility for determining the allocation of new contracts; though not necessarily in fixing the number of such contracts.

In view of the lead time necessary to have a boat constructed it is not unreasonable to expect that decisions on new contracts would be made up to two years before existing contracts expired and the new contracts come into effect. This would also give fishermen whose contracts were expiring and were not being renewed time either to negotiate the purchase of an existing contract or to sever his connections with the fishing industry.

CONCLUSION

This system of "personalised" long term rights is seen as one way of overcoming some of the problems associated with current limited entry schemes. It gives the fisherman a much clearer title to his activities and a more definite basis on which to make investment decisions. At the same time it provides a mechanism whereby fishing capacity and capital investment can be maintained at a level appropriate to that required to meet a given set of policy objectives.

It should be noted that the suggested system is not seen as an alternative to transferable, individual quotas. Through market activity the transferable quotas can obtain the same balance of inputs and outputs. The selection of one or the other system would depend on the relative transaction costs, that is, the policymakers would need to consider the costs of setting and policing quotas relative to the implementation of a more complex administrative arrangement of contracts.

NOTES

1. A third type of system which does not involve the creation of property rights has also been suggested. This is the "taxation" or "royalty" system which relies on the appropriation by Government of any resource rent to prevent its dissipation. Such a system theoretically results in individual fishermen being no worse (or better) off than under open entry but results in a gain to the community as owner of the resource. This type of system has not to date been tried in practice, largely because it offers little, if any, advantage to fishermen.

2. The generic term "contract" and the terms "grantor" and "grantee" have been deliberately used. Terms such as "lease" or "profit" have been avoided because of their specific usage with respect to land, the point being to emphasise the different nature of the property rights proposed, that is, one that is specific as to time and to a particular boat, but one that does not confer any exclusive rights to fish in a defined area.

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5

LIMITED ENTRY - AN INDUSTRY VIEW

by

T. G. Kailis

INTRODUCTION

At the outset it is necessary to explain the philosophy of our organisation. We are advocates of a fishing industry based on open competition between private enterprises. In such an industry only the strong and efficient enterprises will succeed. There is no room for part-timers; that is, anyone who consistently devotes less than full-time effort to a fishery. We believe those responsible for the management of our fisheries (usually Governments) should concern themselves primarily with the conservation of resources. Fisheries managers should be qualified, capable and experienced and must liaise with industry and take note of its views. Too often managers confuse what is happening in one fishery with events in another and try to apply controls incorrectly. Management measures that may be appropriate for one species of fish may be disastrous if applied to a different species, or to the same species in a different area.

Unfortunately, and irritatingly, politics often dictate a particular management policy. What is sometimes considered to be popular or vote catching can influence government thinking rather than what is best for the industry and the nation. Unlike many other primary industries a fishery can be destroyed or millions of dollars lost before the politicians learn the error of their ways.

A number of papers have been written and much spoken about the subject of limited entry fisheries. Much of this literature has been prepared by academics or "fisheries resource economists" as they sometimes are called. Unfortunately, these people are not always blessed with practical knowledge of the fisheries they are managing and the business of fishing. To me limited entry means to limit the number. This could be the number of vessels or the number of processors in a particular fishery. But the generally accepted meaning is to restrict the number of licences or fishing vessels and it is in this context that my comments are made. Our organisation does not subscribe to any limitation being placed on the number of shore-based processors. Economics dictate the number of processors that can operate in a particular fishery and the same applies to fishing vessels but here conservation of fisheries resources must also be considered.

If limited entry or licence limitation has any merit it should be regarded as only one tool available to the fisheries manager. But no tool can be selected until the extent and usability of the resource has been decided. Use of the wrong tool often can damage the resource beyond repair and limited entry applied to a particular fishery often brings irreversible problems.

DOES LIMITED ENTRY HAVE ANY APPLICATION?

The prime responsibility of the fisheries manager is to conserve the resource and to do this he must conduct a research programme and devise systems for gathering data to determine the size of the fish stock, and an acceptable level of exploitation. Only when the manager can demonstrate to industry that the resource is endangered, that is, facing biological destruction, should restrictions on fishing effort be considered. It should not be the responsibility of the manager to decide whether a particular fishery or fishing operation is economically viable. The owner of the fishing vessel is the one most qualified to decide this. Catches may decline but fishing may still be profitable if a fisherman is efficient or prices rise.

The biggest frustration and impediment facing the fisherman is not knowing the objectives of the manager who suddenly introduces a restriction on fishing effort. The manager must make clear his objectives and communicate regularly with fishermen to keep them informed about the results of programmes which monitor the resource. When the stock level shows significant reduction the fisherman can plan accordingly. Often a fisherman will know about a decline in fish numbers before the manager and may voluntarily cease fishing for a particular species.

If after close study and consultation with industry it is considered necessary to restrict fishing effort, then the most appropriate measure should be selected. In order of priority the options are:

1. closed seasons;
2. closed areas (nursery grounds, for example);
3. minimum size limits;
4. prohibition on the taking of females in roe;
5. prohibition on the taking of females;
6. area quotas;
7. total quotas;
8. gear restrictions;
9. boat size restrictions (length and horsepower);
10. limiting the number of vessels or licences.

Measures 8 and 9 are undesirable because they can lead to inefficiency. At least measures 1 to 9 can apply to all fishermen wanting to work in a fishery whereas measure 10 (limited entry) creates an elite corps and often results in inflated values for the vessel licence.

THE DEVELOPMENT OF LIMITED ENTRY IN AUSTRALIA

Limited entry in Australia has a long history. Attempts to introduce the system in one form or another were made early this century but it was not until 1963 that it became a permanent feature of fisheries management in this country. In that year the Western Australian Government, largely as a result of pressure from industry, decided to restrict the number of vessels fishing for rock lobster in that state. This was achieved by not issuing further licences to fish for rock lobster. The background for the decision was the rapid increase in both the catch and fishing effort after the fishery was established following World War II. Many considered that these increases could lead to the industry collapsing. The catch reached a peak of 8,000 tonnes in 1958 when there were 470 boats in the fishery. This number increased to about 830 in 1962 when the catch per unit of effort and profit had declined. These events led to the introduction of licence limitation, a minimum size for lobsters, pot limits, restrictions on the size of replacement vessels, and other management measures. Despite these measures, fishing effort continued to increase and the length of the catching season was shortened by six weeks in 1977. According to G.R. Morgan, former Research Officer with the Western Australian Department of Fisheries and Wildlife further reduction in fishing effort would seem to be indicated. This would result in little change to the total catch but there would be a significant improvement in catch per unit of effort and individual operator's profitability (Morgan, 1980).

It is acknowledged that the western rock lobster fishery is one of the best managed fisheries in the world and while existing management measures may not be perfect, they are practicable. The programme was based on over 25 years of research which had produced detailed knowledge on the habitat and biology of the animal which does not reach a commercial size until it is four to five years old. Management was introduced with the support of industry, for the purpose of conserving the resource which unlike some other species - notably prawns - is very vulnerable to over fishing.

The apparent success of limited entry in the Western Australian rock lobster and prawn fisheries encouraged South Australia, Victoria and Tasmania to introduce similar management regulations in their rock lobster fisheries but to date they have had no dramatic effect on declining catches in those states. Next, limited entry was applied to the abalone fisheries in South Australia, Victoria and Tasmania and finally in Western Australia. Later it was introduced in the prawn fisheries in South Australia and more recently in the prawn fisheries of the Gulf of

Carpentaria, Northern Australia, and off the Queensland east coast. A temporary freeze also applies to licences to fish for southern bluefin tuna off New South Wales and South Australia. An attempt to lift the freeze has been postponed until March 1981.

It could be said that Australia has gone limited entry mad. Coupled with this madness is the licencing nightmare that Australian fishermen are subjected to by our fisheries bureaucrats. To fish in state waters (out to three nautical miles) and in Commonwealth waters (from three to 200 miles) a fisherman must take out two sets of licences - one for his boat, one for the skipper and one for each crew member. If you own a boat crewed by three and are unfortunate enough to be based at a port near a state border and wish to fish off two states you will need a total of 20 licences. The cost of administering such a complicated scheme surely must exceed the licence revenue.

Some resource managers and economists use the term "parallel fisheries", particularly in discussing the management of prawn resources. We believe that there are very few fisheries that can be compared because of the many environmental, geographical, geological, tidal, and species differences. This is particularly important when some of the fisheries are conducted in remote areas. For the economists, the special hardships of these fishing areas should be of special significance. The costs involved appear to be ignored when restrictions on effort are mooted without a real awareness of the economic effect of these suggestions.

In my judgement there has been too much interference by government in fisheries management in Australia. In many instances government has neglected fisheries research and done little to encourage development. On the other hand industry frequently has taken the initiative and the risk to establish new fisheries. Unfortunately once a fishery has been established the managers all too frequently step in and introduce restrictive measures, usually by way of limited entry. On many occasions limited entry has been applied before the size of the resource has been determined and usually while the fishery still is developing. Limiting the number of vessels retards development and the manager frequently is unable to police the controls. This function may be taken over by the licence holders who report the presence of vessels not licenced to fish in a particular area.

One of the most undesirable aspects of limited entry is the fact that a licence for a fishing vessel attracts a "concessional" value. Some current examples of approximate values being paid for licences in Australian limited entry fisheries are shown in table 1.

In my opinion the value of licences in some limited entry fisheries is artificially high because insufficient licences have been granted. Such "over-control" results in high per boat profitability which encourages those wishing to enter the fishery

Table 1. Licence values in Australian limited entry fisheries

Area	When introduced	Species	Average licence value (excluding vessel)	Average vessel market value	Average gear value
Western Australia	1963	Rock Lobster	$2000 per pot average 100 pots per boat = $200 000	$ 60 000	$12 000
Shark Bay Western Australia	1963	Prawns	$500 000	$300 000	$10 000
Exmouth Gulf Western Australia	1965	Prawns	$375 000	$225 000	$10 000
Spencer Gulf & Gulf St. Vincents, South Australia	1968	Prawns	$350 000	$100 000	$10 000
Northern prawn fishery	Temp.) 1976)) Perm.) 1980)	Prawns	$100 000	$450 000	$30 000
South Australia & New South Wales	1976	Southern bluefin tuna	$ 60 000	$300 000	$ 5 000
Western Australia	1971	Abalone	$ 30 000	$ 12 000	Nil
Tasmania	1965	Abalone	$ 40 000	$ 15 000	Nil

to pay inflated amounts for licences. This situation could encourage managers to impose a tax on resource rent which would be to the industry highly objectionable, and could still result in licences trading at values beyond the reach of the average fisherman. Unfortunately once limited entry licences become a valuable negotiable commodity, managers seem reluctant to make entry to the fishery open for fear of incurring the wrath of those who have paid a premium for licences. This situation appears to have arisen in the southern bluefin tuna fishery where the managers decided last year to re-introduce open entry, but under pressure from the industry have had second thoughts about it.

MORE HINDRANCE THAN HELP

Limited entry should be used only as a last resort. The security of a licence in a limited entry fishery can breed inefficiency or slow technological development and may provide little incentive to upgrade fishing operations or diversify into new fisheries.

Limited entry also encourages monopolistic tendencies which make it more difficult for individual fishermen to buy into a particular fishery. This is apparent in a fishery that calls for a high level of capital. It is difficult enough in normal circumstances to obtain finance for a new fishing venture without the extra burden of having to buy a licence at an inflated value. The Western Australian rock lobster fishery is an exception and has not encouraged monopolies to move in mainly because the industry requires a large number of small boats which are owned by individuals and manned by fishermen with a high degree of local knowledge and expertise.

One of the greatest fears experienced by fishermen with respect to very profitable limited entry fisheries is that governments might decide to impose special royalties so as to appropriate part or all of the resource rent. Fishermen feel that as they have developed the resource at the risk of their own capital and in some cases their lives, usually without any, or at best a bare minimum, of government help they have established at least de facto ownership of the resource. This being so the fishermen regard any resource rent as properly belonging to them rather than the general community. Their income tax payments which in the case of a profitable fishery can in total be very substantial should in itself be sufficient "compensation" to the community at large. So strong is the feeling of fishermen against the concept of royalties that if profits in a particular fishery were regarded as "excessive" they would prefer to see additional licences issued rather than have royalties imposed. It is interesting to note that while many economists involved with fisheries appear very keen on the idea of imposing royalties, to remove part of the resource rent, when fisheries are doing well, I am not aware of any instances where the payment of compensation to fishermen for losses suffered in poor years has been recommended.

In some limited entry fisheries in Australia restrictions are placed on the size (length) of licenced vessels, presumably as an additional curb on fishing effort. This may be acceptable for fisheries based on inshore or enclosed waters where fish stocks are not plentiful or they can be depleted by overfishing. Such controls can be dangerous and restrictive in developing offshore or distant water fisheries. Fishermen generally select a vessel size to meet safety requirements in the area in which they wish to work and according to their financial situation. They are the best judges of what size of vessel that should fish in a particular fishery.

ECONOMIC CONSIDERATIONS

It has become more common in recent years for economic grounds to be given as a reason for governments introducing limited entry regimes. Industry generally condemns any attempt by government to interfere in any way with the economics of fishing operations and to regulate capital investment in vessels. Often, so-called economic reasons are based on unsupported or outdated information. The situation in the northern prawn fishery is an example.

In 1976 an interim management plan was introduced to this fishery which restricted the number of catcher vessels allowed to fish. Economic considerations were given as the official reason for the decision. Scientific research indicated that the amount of fishing did not pose a biological danger to the banana prawn fishery in the Gulf of Carpentaria. Furthermore, this was the only area in which in-depth research had been undertaken. The economic information on which the 1976 decision was based came from a survey comparing the economics of operating large freezer trawlers and wet boats. This information was gathered at least two years previously and from these outdated data it was concluded that over-capitalisation posed a threat to the fishery. But, as I understand the position, the real reason for introducing limited entry to the northern prawn fishery was political pressure from Queensland and Northern Territory. It now has been decided that a new limited entry management plan will operate in the northern prawn fishery from January 1, 1980. It limits the number of trawlers entitled to operate to those that fished in the area in 1979. However, there still is considerable uncertainty over other aspects of the plan, particularly the crucial question of vessel replacement.

If there were to be any involvement of economists in fisheries management they should take into account more than the Australian economic factors. Because the product is sold on the world market, the economic conditions in buying countries, exchange rates, the likelihood of collusion amongst buyers, and the economic factors relating to the handling and ultimate disposal once the product reaches its destination must be considered.

COMMUNICATION

One puzzling feature of the management plan for the northern prawn fishery is the apparent lack of communication and co-ordination between different Commonwealth Government departments. The Department of Primary Industry, which is responsible for marine fisheries administration, is seeking to limit the number of trawlers in this developing fishery because it fears over-capitalisation of the fleet. At the same time the Government has accepted the recommendation of the Industries Assistance Commission to extend and liberalise both the bounty (subsidy) scheme for the building of fishing vessels exceeding 21 metres in length, and the conditions under which new fishing vessels may be built overseas and imported to Australia. As well, there is the spectacle of the Department of Trade and Resources offering attractive incentives to industry to increase exports. The northern prawn fishery is heavily export-orientated and was developed at considerable cost by the Australian fishing industry with little government financial support or encouragement. Surely industry is entitled to more say in its own destiny.

Another inconsistency in government thinking is in the way it has gone about developing fisheries in the newly-introduced Australian fisheries zone which covers the area out to 200 nautical miles from the coast. At the same time as the government is placing more restrictions on Australians fishing in established fisheries it is encouraging foreigners to exploit grounds it thinks will not be fished by our fishermen in the near future. The government seems to be doing this with little regard to the numbers of vessels involved and the capacity of the grounds to withstand heavy fishing. The north-western trawl fish grounds and the south-east squid fishery are examples. In both areas large numbers of foreign vessels are being allowed to fish - admittedly on a short-term basis - without any requirement, in many cases, to land their catches in Australia so we can obtain economic benefit. Compared with most of the countries with fishing vessels working in these feasibility ventures in the Australian fisheries zone, Australian fishermen are receiving little government incentive to diversify into new fisheries where limited entry does not apply. This inevitably raises the question: are we giving away our fisheries to the foreigners?

If economic considerations are to be the yardstick for introducing limited entry regimes the current quality of scientific and economic research on fisheries in this country will need to be much more professional and up-to-date than has been the case in the past. People undertaking this work become the fisheries managers and some of the questions they will have to answer are: will the number of licences be increased if the market prices or catches go up, thereby improving the economics of a fishery? Conversely, if prices and catches decline will the number of vessels be decreased? Who will decide what is a satisfactory return to fishermen? This can vary enormously. If a fisherman finds his catches are declining or his income is falling, he instinctively works harder, improves the presentation of his catch or searches for alternative fishing grounds.

Another consideration that the manager must take into account when making decisions is the type of vessel working in a fishery. Some vessels are simple platforms capable of landing catches in a wet form. Because the catch must be transported quickly to a shore-based plant the owner has little opportunity to sell to an alternative source. Other vessels can be larger, more sophisticated trawlers equiped with refrigeration. These are capable of processing their catches at sea and marketing them at the highest prices ruling at the time. It seems obvious that a common limited entry plan cannot sensibly be applied to both types of vessels to achieve one objective.

Too often managers expound the virtues of limited entry in one fishery and imply that a similar scheme should be used in another area. There have been suggestions that if limited entry works, for example, in the Canadian salmon fishery, it should work in an Australian prawn fishery. Sometimes a set of regulations that apply to a developed fishery are tried in a developing fishery with disastrous results. Fisheries which are conducted off coasts which are a long way from large centres of population often impose their own limitations on entry, such as the high costs and risks associated with long distances between ports, limited unloading points, primitive repair facilities without slipways, shortage of crew replacements and unreliable fuel supplies.

Also managers appear not to take into account the life histories of different species of fish. For example, the life span of a prawn is only about one-fifth as long as that of a fish and if the number of boats fishing for prawns is reduced then large quantities will die from natural causes or be eaten by predators.

SUMMARY AND CONCLUSIONS

Limited entry has been in force in some Australian fisheries for more than 15 years but it has not proved to be a miracle management measure. Limited entry can breed inefficiency or slow technological development, and it can encourage monopolistic tendencies due to the unrealistic values attracted by licences. Before management measures are introduced to limit effort it should be demonstrated clearly that the fish stock is in danger. Limited entry should be a last resort and should be applied only after extensive scientific and economic investigation and close consultation with those engaged in the fishery.

Those responsible for management of our fisheries should be qualified and experienced professionals. Fishermen for their part must upgrade their skills and education to comprehend the reasons why management measures are needed. Political considerations of vote catching should not be allowed to over-ride the welfare of those who risk their lives and economic future in the fishing industry. There is an urgent need for managers and governments to tackle the problem of undesirably high payments for licences to fish in limited entry fisheries. Buy-back or superannuation schemes have been suggested as solutions but would need to be carefully thought through before being implemented.

I have been involved with limited entry fisheries since their introduction to Australia. Our organisation holds limited entry concessions worth millions of dollars which we would happily forego for the sake of reverting to more sensible management measures if they can achieve the healthier climate of an open entry system.

REFERENCE

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PART II

THE MANAGEMENT OF SELECTED FISHERIES

6

CALIFORNIA'S MANAGEMENT PROGRAMMES FOR THE HERRING ROE AND ABALONE FISHERIES

by

Daniel D. Huppert

INTRODUCTION

California's fisheries rank among the most valuable in the United States. The tuna fishery is California's most important fishery by far in terms of both landed value and weight landed (table 1). In landed value, tuna is followed by groundfish, salmon, anchovy, mackerel and bonito, and crustaceans (primarily Dungeness crab). Further down the list in terms of both landings and gross dockside value are the two subjects of this paper - the herring roe and abalone fisheries. These two fisheries are, nevertheless, significant for several reasons. Both yield products of relatively high value per unit weight, thus attracting far more fishermen than is reasonable on economic grounds. Also, environmentalist controversies have arisen in the management of both fisheries. But most important for purposes of this paper is the fact that they represent the only two fisheries in California that are currently managed, in part, through limited entry programmes.

Table 1. Landings and landed values for selected California commercial species, 1976.

Species	Landings (Tonnes)	Landed Value ($US '000)
Tuna	203 311	133 562
Ground fish	38 813	12 391
Salmon	3 533	10 707
Anchovy	113 357	4 627
Mackerel, bonito	24 566	3 657
Crab, lobster & shrimp	9 481	1 531
Abalone	786	1 454
Herring	2 187	482

Source: Preliminary data from California Department of Fish and Game.

Fisheries management in the United States has recently undergone an upheaval due to the Fisheries Conservation and Management Act of 1976. Although this Act extended Federal authority over living resources to 200 nautical miles at sea, it specifically exempts from Federal control the fisheries for highly migratory species (tuna) and the fisheries taking place substantially within "State waters", essentially the three-mile territorial sea (see H. Knight, 1978, for a description of management proceedings under the new law). Both the herring and abalone fisheries come under the second of these exemptions. As a consequence, the State of California continues to exercise management control over both of them.

The State Legislature has constitutional authority to manage the fishery resources within California for purposes of conservation. This authority is often exercised directly through laws which govern methods of catch or set annual catch quotas. When the fishery in question is particularly controversial or in need of rapid management response, the Legislature frequently delegates authority for rule-making to the State Fish and Game Commission, a body of five members appointed by the Governor of California. The Commission holds frequent public meetings and can modify fishing regulations in a matter of days if necessary. Whether the Legislature or the Commission is actively managing a fishery, the Department of Fish and Game provides essential technical advice and operates the enforcement arm. It is often the Department of Fish and Game which suggests that a given resource is in need of management and drafts a set of regulations for consideration by the Legislature or Commission. For simplicity, I will often refer only to the "State" or "management agency", rather than distinguishing between the various agencies. The reader should keep in mind, however, that there are several layers of authority and operational responsibility as well as substantial public input in any fishery management decision in California.

The paper is divided into three main parts, the first covering the herring roe fishery and the second the abalone fishery. Each of these two parts contains a short summary of the resource characteristics, the harvest history and the management programmes adopted by the State of California. A provisional evaluation of the limited entry regulation is offered in the concluding part of the paper. Because the limited entry programmes were so recently enacted, any attempt to evaluate them suffers from both data deficiencies and lack of sufficient passage of time to promote objectivity. Nevertheless, I propose a set of evaluation criteria and use the available data to assess the effectiveness of the current programme. My audacity in attempting the evaluation is perhaps explained, in part, by the reasonable expectation that a paper appearing in Australia has little chance of reaching my potential detractors in California. But I hope that the provisional evaluation presented herein will stimulate others, both within and outside of California, to begin collecting and analysing the comprehensive data which a more thorough evaluation requires.

THE HERRING FISHERY

The Pacific herring, Clupea pallasi, is widely distributed on both sides of the north Pacific ocean. According to Frey (1971), there are a series of interbreeding populations along the coast from the Bering Sea to San Diego in the eastern Pacific. Most of the herring spawned in a given area tend to return to that area to reproduce. Spawning areas are generally bays and estuaries, especially those influenced by river runoff. During winter and spring spawning periods, the fish attach their clusters of eggs to rocks, seaweeds and eelgrass. The eggs hatch after six to eleven days, if they survive the predation by gulls, diving birds and fish. They mature as two-year-olds at a size of about 160 mm in standard length, and herring as old as nine years, averaging 239 mm in length, appear in the catch in trace amounts (Spratt, 1979).

The spawning biomass of herring in the two major Californian spawning areas of Tomales Bay and San Francisco Bay has been estimated regularly by Department of Fish and Game personnel since 1973 (table 2). This is done by surveying known spawning beds to assess the density and extent of roe deposits. With the resulting estimates of total eggs spawned and the known fecundity of female herring the spawning biomass can be back-calculated. Over the five years for which both Tomales and San Francisco Bay estimates are available, 1974-1978, the average total spawning biomass was roughly 27,000 tons. Although the fish may intermingle during their oceanic feeding forays, scientists have concluded that the two bays support stocks of fish which are

Table 2: Spawning biomass and roe herring fishery quotas in San Francisco, Tomales and Bodega Bays

(tonnes)

Year	Tomales/Bodega Bays Biomass	Tomales/Bodega Bays Quota	San Francisco Bay Biomass	San Francisco Bay Quota
1973	4 719	681	*	1 361
1974	5 898	408	5 535	454
1975	4 265	454	24 319	544
1976	7 169	544	24 500	2 722
1977	4 537	1 044	24 138	3 630
1978	19 691	1 066	7 895	4 537
1979	*	1 090	23 230	4 537
1980	*	1 098	*	5 445

* No published estimates available.

Source: Spratt (1976) and J. Spratt (personal communication, 1979), California Dept. of Fish and Game, Monterey.

largely separate. This separation is reflected in the management approach which sets separate quotas and permits for the two fishing areas.

The fishery for Pacific herring in California has gone through three periods of increased activity, each of which has evoked a scientific assessment of the herring population (see Scofield, 1918; Miller and Schmidtke, 1955; and Spratt, 1976). From 1916 to 1920 the herring were canned or reduced into fish meal. The peak annual harvest for this fishery was 3,600 metric tons in 1918. After the passage of the California State Reduction Act of 1919, which prohibited the reduction of herring into fish meal, the annual harvest did not again exceed 1,000 metric tons until 1948 following the collapse of the California sardine fishery. An annual average harvest of 2,422 metric tons was taken during the 1948-1953 period. The canned herring, intended as a substitute for canned sardine, proved to be an unpopular product and the fish harvest returned to a low level until 1973.

A very small quantity of herring eggs on algae in San Francisco Bay has been taken annually since 1965 to be sold as a delicacy known as "Kazanoko Kombu" in Japan. The California Fish and Game Commission regulates the egg harvest by quota, season restriction, and limited entry. An annual quota of five short tons was set in each of the two major spawning areas, but the Tomales Bay quota was discontinued after 1970. The fishing season for the herring egg harvest runs from November 1 to April 30. The unique feature of this fishery, and the one making it worth mentioning, is the use of a sealed bid auction to choose participants. The quota is divided into two equal allotments, and bidders may bid on one or both allotments. The great value of herring eggs on seaweed is probably accurately reflected in the 1979 winning bid - more than 2,000 dollars per ton (Petrovich, personal communication, 1979). This method of limiting the fishery takes advantage of the theoretical efficiency of free markets for limiting participation, revealing a fair value for the public resource, and returning a fair proportion of the value to the public till from which the research and administrative expenses come. Because of its extremely small size, however, no independent analysis of the herring egg "fishery" has been carried out, and no further reference to it will be made in this paper.

The California fishery for roe-bearing herring was prompted by the sudden shortfall in supply of herring roe in Japan, which was caused, first, by the ouster of Japanese fishermen from the Sea of Okhotsk by the USSR in 1971, and second, by the failure of the 1972 Japanese winter herring fishery in the Bering Sea (Petrovich, 1979a). Canadian and Alaskan herring dealers were quick to accept bids at rapidly escalating prices. California's industry was not far behind. Vessels attracted to the fishery were primarily small lampara and purse seine vessels and, later, gill net vessels. Both purse seine and lampara vessels encircle fish schools with a wall of net, thus the generic name "round-haul". The purse seine net has a pursing cable through rings at the bottom of the net which allows the operator to "purse" the net. Lampara nets are of similar, but older, design, not having a purse cable or rings. A lampara fisherman relies on the ocean bottom in shallow water to enclose the fish school from below. During the seven years of the fishery, regulations regarding gear have varied substantially. Originally, only drift gill nets were allowed, along with both types of roundhaul net. In 1977 set gill nets were authorized, and the fishery began to be dominated by gill nets. After 1977 roundhaul nets were prohibited in the Tomales Bay fishery. These and other gear regulations explain some of the changing patterns of participation evident in table 3.

As a general rule the gill nets are able to take a more valuable catch. Gill nets operate in the very shallow areas where the herring spawn, while the roundhaul nets operate in deeper water. Consequently, the gill nets more accurately target on the fish actually spawning or just about to spawn. They get a higher proportion of female fish, and get female fish which have a higher roe content than the roundhaul-caught fish. Roe content is frequently 15 to 20 per cent in the gill net fishery, while eight to ten per cent roe is usual for the purse seine and lampara vessels. Since the value of roe-bearing fish increases with roe content, the gill net vessels are generally paid a higher price by the Japanese buyers. Roundhaul vessels, on the other hand, are capable of taking much larger volumes of fish per day. Lacking detailed cost and catch data at the individual vessel level, I cannot determine which gear type is the more profitable or rational. But the high prices and easy access to the fishing grounds suggest that all types of vessels are profitable.

An appreciation for the pressures brought to bear on the fishery managers requires an understanding of the economic conditions. During the first seven years of the fishery, a supply shortage in the Japanese herring roe market forced prices higher and higher, leading to greater efforts to obtain herring roe from the United States. A metric ton of salted herring roe in the Tokyo Central Wholesale Market sold for $16,552 in October of 1974; $19,836 in 1976; $33,060 in 1978; and $57,304 in October of 1979. Although exvessel prices in California did not equal these spectacular heights, the initial offer of $55 per metric ton (10 per cent) more than tripled to $176 in 1975, averaged $289 in 1977, topped $1,322 in 1979, and at the start of the 1980 season was $2,200 plus $200 for every one per cent of roe content in excess of 10 per cent (Spratt, personal communication, 1979). Considering the small amount of investment needed to operate a skiff with a gill net, or to bring a purse seine or lampara vessel to San Francisco for the short season, most of the gross income becomes profit to the crew and vessel owner. The highlining seine vessel in 1979 reportedly brought in more than $120,000 in little more than two weeks. With this kind of profit in prospect and without effective legal restraints, every able-bodied fisherman in the State (and from as far away as Bellingham Bay, Washington) would show up on opening day of the herring season. The resulting congestion and chaos alone would have made

Table 3. Number of licensed vessels in California herring roe fisheries, 1973-1979.

Season	Bay	Gear type				Total
		Lampara		Purse seine	Gill net	
1973	Tomales	5		-	-	5
	San Francisco	12		-	-	12
1974	Tomales	5		-	-	5
	San Francisco	12		-	-	12
1975	Tomales	3		1	1	5
	San Francisco	5		5	2	12
1976	Tomales		5*		4	9
	San Francisco		24*		24	48
1977	Tomales		5*		7	12
	Bondega**	-		-	24	24
	San Francisco	27		39	165	231
1978	Tomales	-		-	33	33
	Bodega**	-		-	30	30
	San Francisco	29		30	226	285
1979	Tomales/Bodega***	-		-	67	67
	San Francisco	31		27	220	278
1980	Tomales/Bodega***	-		-	69	69
	San Francisco	25		24	194	243

* Lampara and purse seine vessels combined.

** Bodega Bay fishery provided separate permits in 1977 and 1978 seasons.

*** Bodega and Tomales Bays fisheries combined.

Source: J. Spratt (personal communication, 1979), California Department of Fish and Game, Monterey.

a mockery of any reasonable management effort. It is within this context that the California management programme must be viewed.

Also, the sudden emergence of the fishery for spawning fish in 1973 provoked a public controversy regarding the effects of commercial herring harvests on the salmon stocks. Sportfishermen who regard the salmon very highly were instrumental in getting the State to propose a management regime that was implemented by emergency legislation before the 1973 season got underway. The main concern of the sportsmen was that a commercial fishery might reduce the forage stock for salmon in Tomales Bay. Although the herring are known to be a forage species for salmon, the quantitative impact of a roe herring fishery upon the salmon populations in the California area has never been reliably estimated. Nevertheless, the State of California embarked upon a management programme which now encompasses several fishery management tools: season restrictions, limited entry, gear restrictions, area restrictions, and quotas allocated by area, gear type and vessel. Further, gill net vessels are split into two groups fishing every other week, and roundhaul vessels are on a daily catch limit.

A thorough history of California's management programme is available in Petrovich (1979a and 1979b) and will not be recounted here in great detail. The figures of tables 2, 3, 4 and 5, however, tell much of the story. Annual harvest quotas were immediately employed to prevent the rapid depletion of the herring stocks. The steady increase in quotas in San Francisco Bay after 1975 and the increase in Tomales Bay in 1977 were in response to the estimates of spawning biomass made by the scientists of the Department of Fish and Game. No straightforward formula has been adopted for setting quotas based on biomass, but one biologist has suggested recently that the objective was to keep the quota in the "neighbourhood" of 20 to 25 per cent of the biomass. The increasing trend in the quotas is perhaps also attributable to pressure from the fishing industry and increasing confidence on the part of the biologists and managers that the fishery was not decimating the stock.

The State did not impose any limit on number of participants during 1973, when 17 vessels ventured into the herring fishery. Before the 1974 season began, however, the State managers and representatives of sportfishing groups found themselves embroiled in a legislative controversy. To forestall legislation which would have forbidden the herring roe fishery entirely, the State adopted lower fishery quotas and a limited entry programme. Clearly, California's action did not reflect knowledge of the economic theory of optimum utilization of the fishery nor adherence to economic goals such as "efficiency" or increased net income. For the 1974 and 1975 seasons the State limited participation in the two herring roe fisheries to the number of vessels that fished in 1973. The limited number of fishing permits were allotted to applicants by public lottery. To be eligible for the lottery, a fisherman had only to possess a valid California commercial fishing licence and a boat currently registered in California.

Table 4: Annual harvest of roe herring in San Francisco and Tomales/Bodega Bays by gear type

(tonnes)

Season	Bay	Gear type				Total
		Lampara		Purse seine	Gill net	
1973	Tomales	543		-	-	543
	San Francisco	396		-	-	396
1974	Tomales	473		-	-	473
	San Francisco	1 752		-	-	1 752*
1975	Tomales	475**		-	-	475
	San Francisco	469**		-	-	469
1976	Tomales		110		20	130
	San Francisco		1 283		277	1 560
1977	Tomales		186		105	291
	Bodega	-		-	230	230
	San Francisco	1 256		1 645	911	3 812
1978	Tomales	-		-	586	586
	Bodega	-		-	64	64
	San Francisco	1 428		1 276	1 820	4 524
1979	Tomales/Bodega	-		-	405	405
	San Francisco	414		1 417	1 902	3 733

* Includes 1364 tonnes of "bait" caught by vessels not licensed to fish herring roe.

** Reported catch was not broken down by gear type, but most was roundhaul.

Source: J. Spratt (personal communication, 1979), California Dept. of Fish and Game, Monterey.

Table 5: Catch and estimated gross earnings per vessel San Francisco and Tomales Bays herring fisheries.

Season		Tomales and Bodega Bays		San Francisco Bay	
		Roundhaul	Gill Net	Roundhaul	Gill Net
1973	(tonnes)	109	-	33	-
	(US$)	6 006		1 818	
1974	(tonnes)	95	-	32	-
	(US$)	18 848		6 385	
1975*	(tonnes)	95	-	39	-
	(US$)	16 758		6 891	
1976	(tonnes)	22	5.0	53	11.5
	(US$)	4 851	1 654	11 687	3 803
1977	(tonnes)	37	10.8	44	5.5
	(US$)	10 693	3 923	12 703	2 387
1978	(tonnes)	-	10.3	46	8.1
	(US$)		11 351	35 335	8 926
1979	(tonnes)	-	6.0	32	8.6
	(US$)		13 330	41 734	19 055

* Reported catch not broken down by gear type. Total assigned to roundhaul since 4 of 5 permittees used roundhaul vessels.

Source: Catch per vessel is derived from Tables 3 and 4. Revenue is catch times price received by fishermen. Price data is from various sources including Spratt (personal communication 1979), Petrovich (personal communication, 1979) and preliminary data available to National Marine Fisheries Service.

In 1976 the quotas were increased and the number of permits to fish for herring roe was increased from five to nine in Tomales Bay and from 12 to 48 in San Francisco Bay. Again, the participants were chosen by lottery from the eligible applicants. California regulations acted to "spread the wealth" by limiting seasonal catches by roundhaul vessels to 91 metric tons each and by gill net vessels to 23 metric tons. Following the 1976 season the State management agencies were repeatedly criticized for limiting the catch of individual vessels and for using a lottery to distribute permits to fish. In response to this criticism, the State removed all restrictions on the number of permits for 1977 in San Francisco Bay. The quota was increased from 2,722 metric tons to 3,620 metric tons in San Francisco and the entire group of 231 qualified applicants was licenced to fish. In Tomales Bay the limited entry programme was continued as twelve permits were issued by lottery among the 92 applicants. Another new feature of the management programme in 1977 was the division of the annual catch quota into separate portions for each gear type. In San Francisco Bay, for instance, the gill net vessels were assigned 40 per cent of the quota and the purse seine and lampara vessels were assigned 30 per cent each.

After the startling growth in fleet size during the 1977 San Francisco Bay fishery, the State decided to re-introduce a limited entry scheme. All 1977 participants were immediately qualified for the non-transferable, revocable roe herring permits, and an additional 155 new permits were issued. There is no apparent formal reason for the choice of this particular number of operators to enter the fishery; the intuition or political sense of the management agency personnel must have governed the number. The new permits were distributed to applicants based upon a "point system". The number of points assigned to each new applicant depended upon the number of years he held a valid California commercial fishing licence and the number of previous years of participation in the herring fishery. Also, the new permits were assigned to specific gear types; 150 were to be for gill net permits, and five for purse seine or lampara permits. The maximum number of points was 20, and all applicants with 20 points were given permits. Permits were issued to successively lower point totals until the point category was reached in which the number of qualified applicants exceeded the number of permits still available. At this point a lottery was held to fill the remaining permits.

For 1978 the San Francisco catch quota was increased from 3,630 to 4,537 metric tons with the entire increase being assigned to the gill net fleet under the continuing allocation of quotas to gear classes. During the 1978 season the great number of gill net operators in San Francisco Bay became an obvious problem. Principally due to the new permittees who did not have experience with gill nets or the tricky currents of the Bay, and to the very limited area over which the fishery could be profitably executed, there was a great deal of congestion, tangled nets, nuisances to navigation and lost tempers. One emergency action by the State to address these conflicts required that gill nets be weighed down by at least 16 kilograms and be lighted at each end. Gill nets are also required to have meshes of not less than two inches (5.1 centimeters) or more than two and one half inches (6.35 centimeters) in length. And finally, each permittee can have no more than 130 fathoms of gill net in San Francisco or Tomales Bays.

For the 1979 season the participants from 1978 were again eligible and no additional permits were issued. To solve the congestion problem, the gill net vessels have been divided into two groups - one with odd-numbered and one with even-numbered licences. The two groups fish on alternate weeks until the gill net portion of the quota is taken. And for 1980 a catch limit on individual boats of 91 metric tons per season applies to all permittees. In addition to these seasonal limits, single load limits have been put in place for the 1980 season. Roundhaul vessels are not allowed to harvest more than 36 metric tons in any given load.

A final bit of information on the herring roe fishery is the catch and revenue per vessel which I have estimated and placed in table 5. Gill net vessels in both the San Francisco and Tomales/Bodega Bays and the roundhaul vessels in San Francisco Bay have enjoyed a steadily increasing gross revenue per vessel. Clearly, this is due to the increasing price for herring roe and not due to any increasing trend in catch per vessel. By the usual reasoning applied to free access fisheries, this growth in potential profit should be absorbed by an ever-increasing number of vessels. That the apparently high rate of profit in the herring roe fishery should survive for even the short period that is suggested in table 5 must be attributable to the California limited entry programme.

The absolute magnitude of the "economic rent" being earned by the licenced participants in the fishery is not calculable with great accuracy from the available data. Nevertheless, a rough estimate is obtained by applying a variation on the method adopted for Pacific salmon by Crutchfield and Pontecorvo (1969, pp.110-117). In brief, the method attempts to estimate the difference between gross earnings and minimum necessary costs of harvest assuming that the annual harvest, H, is determined by fishery managers independently of fish prices. The amount of fish which could be caught by an efficient vessel, y, in the absence of the existing gear and season regulations is estimated, and then the amount of unnecessary gear is computed as the difference between the amount used in any year and the minimum necessary. Algebraically, number of surplus vessels in year t is given by:

(1) $$S_t = V_t - (H_t/y)$$

where V_t is number of vessels operating. Further assuming that with free access total revenue, R, is completely absorbed by fishing costs and that costs are proportional to number of vessels, the potential rent is:

(2) $$\text{Rent} = R_t \cdot (S_t/V_t)$$

The rent, of course, will appear as vessel profits if the fleet is restricted to the minimum necessary size without levying any fees or royalties.

In the herring roe fishery it is reasonable to follow Crutchfield and Pontecorvo in taking total revenue as given. But the limit on permits prevents us from assuming that revenue equals cost as implied by equation (2). Thus we can use equation (1) to determine excess gear, but we must estimate minimum necessary cost of harvest. Given total revenue and the cost estimate, we can compute potential rent. One approach would be to estimate a cost per ton harvested with the assumption that costs are independent of fleet size. With this approach the net returns from the fishery would not depend upon the limitations on gear in the fishery. For the herring roe fishery, however, fixed costs per vessel should be a large part of the total cost. That is, the cost of outfitting vessels with the proper gear, transporting the vessel to the fishing site, and covering opportunity costs of the crew during the month or so occupied with the fishery are the major components of total cost. Fuel and operating expenses on the fishing grounds are not great in the herring fishery since very short travel distances are involved. Thus a fixed total cost per season per vessel is assumed.

Lacking detailed cost data for the various gear types and locations, I infer the cost per vessel from earnings data in table 5. Also, to determine minimum size of fleet needed to harvest the reported catch, the potential catch per vessel is inferred from table 5 by choosing an appropriate base year in which crowding and gear regulations had the least influence on a vessel's performance. The two required parameters - minimum cost and potential catch rate - for gill nets in Tomales and San Francisco Bays and for roundhaul nets in San Francisco Bay are summarized below.

	Minimum Cost	Catch Per Season
Tomales Bay, gill net	\$ 3,923 (1977)	10.8 tons (1977)
San Francisco Bay:		
gill net	\$ 2,387 (1977)	11.5 tons (1976)
Roundhaul	\$12,703 (1977)	53.0 tons (1976)

The average earnings per vessel in 1977 are taken as an estimate of cost per vessel for the following reasons. In San Francisco Bay the limited entry programme was abandoned, and the number of vessels entering may have approached the number required to absorb all profits into costs. Given this, the average gross earnings are a rough indicator of costs. In Tomales Bay and Bodega Bays, 1977 was the first year in which a significant number of gill net vessels entered the fishery. Whether or not the earnings per vessel were driven down to equal costs is unknown. In all three cases discussed, the cost estimates are more likely to be over-estimates than under-estimates of true costs, leading to understatement of profits and resource rents.

As with the cost estimate, the potential catch for gill nets in Tomales/Bodega Bay is taken to be the observed catch per vessel in 1977, because 1977 was the first year of substantial gill net participation and because catch per vessel fell in succeeding years. For San Francisco Bay, the 1976 catch rates are used to estimate potential catches, because the fleet had not yet been swollen by the 1977 free-entry policy, and because the catch rates were relatively high. To the extent that gear, season and other regulations enforced harvest inefficiencies in the base years chosen, the potential rent calculations will understate the true potential.

The true minimum cost of harvesting the fish would be achieved only by choosing the minimum cost gear as well as controlling all other regulated facets of the fishery to minimize extra expenses. Rather than attempt to follow this treacherous course, I assume existing gear and season regulations continue in effect and that the existing division of catch among gear types will prevail. Thus the estimated potential rent is the maximum only in one of the many dimensions of policy - the fleet size dimension. The actual level of profits enjoyed in 1978 and 1979, and the potential profit assuming 1979 catch levels and prices are as follows:

Year	Profit in Tomales/Bodega Bay	San Francisco Bay Roundhaul	San Francisco Bay Gill net	Total profit
	($1,000)			
1978[1]	$448.9	$1,277.5	$1,436.3	$3,162.7
1979[2]	$573.5	$1,524.7	$3,553.5	$5,651.7
Potential profit[3]	$714.2	$1,887.0	$3,712.0	$6,313.2

[1]To account for inflation, costs are increased by 7.7 per cent over 1977.

[2]To account for inflation, costs are increased by 21 per cent over 1977.

[3]Equals 1979 profit plus the minimum cost per vessel times the number of surplus vessels in the 1979 fishery as calculated in equation (1).

The estimated increase in profit for the fleet as a whole from 1978 to 1979 is entirely due to the increased price at dockside. Also, because costs were such a small portion of total revenues in 1979 to begin with, the potential profit is not much larger than the actual profit. This is perhaps a surprising result considering that State officials did not claim profit maximization as an objective. For 1980 the prospects are for even greater actual and potential profits. During the first part of the 1980 season reported prices were up around 50 per cent. This, coupled with a 20 per cent greater quota, suggests that roe herring fishermen may earn $10 million or more in profits in 1980.

As noted by Fraser (1979) and others, the existence of large potential profits provides a strong incentive for each vessel owner to invest in additional gear to increase vessel productivity. In other words, with number of permits being in absolutely fixed supply, each profit-seeking vessel owner should economize by using more of other inputs with his single vessel permit. In the limit, it may be possible for such "capital-stuffing" tendencies to completely absorb potential rents. In the California herring roe fishery, however, the seasonal catch limit per permit and the single load limit on roundhaul vessels may partially eliminate the incentives for "capital stuffing". With no prospect of taking more than 91 metric tons, the private marginal value of any productivity-increasing capital investment becomes nil once vessel capacity is up to this limit. Gill net vessels are generally not able to take nearly 91 metric tons. Thus only roundhaul vessels are currently affected by the seasonal harvest limit.

In summary, the management programme for the California herring roe fishery was initially introduced as an emergency plan to protect the stocks from being rapidly depleted with adverse impact on the recreational salmon fishery. Annual harvest quotas, loosely geared to annual biomass estimates, were supplemented by limited entry and gear restrictions early in the fishery's development. Despite a plethora of regulations on gear, seasons and total catch by vessel, the herring roe fishing fleet appears to have enjoyed a substantial $5.7 million profit in 1979. And the herring stocks seem to be holding up with no apparent ill effects from the catches taken to date. Further evaluation of the herring roe management effort is presented in the concluding section of this paper.

THE ABALONE FISHERY

Unlike the herring roe fishery, the abalone fishery is a long-established industry in California. Working the intertidal areas in skiffs, Chinese immigrants landed substantial numbers of abalones during the last half of the nineteenth century. More than 1,869 metric tons, shell weight, was reported in 1879. After commercial harvests were prohibited in shallow waters in 1900, the Chinese fishermen were replaced by Japanese "sake barrel" divers who worked offshore waters by free diving. According to Frey (1971) Japanese "hard-hat" divers soon replaced the sake barrel divers, and the oriental fishermen dominated the abalone fishery until World War II.

In the early 1950's the hard-hat gear was rapidly abandoned in favour of wet suits, swim fins and "hookah" gear. The "hookah" consists of a compressor and surge tank with 200 to 300 feet of air hose attached to either a regulated full face mask or the first stage of a scuba regulator. The diver swims along the bottom searching for legal-sized specimens and separating the chosen abalones from the substrate with a flat metal bar called an "abalone iron". The harvested animals are placed in a basket attached by line to the tending vessel. With this type of gear the abalone divers can operate in depths from six metres (the legal minimum depth for commercial abalone diving) to around 33 metres.

During the 1930's the average annual landings of commercially-caught abalone was 1,324 metric tons. After a substantial drop in fishing activity during World War II, the annual catch rebounded to 1,270 metric tons during 1945-1949. Landings were much greater in the 1950's and 1960's with average annual figures of 2,910 and 1,971 metric tons, respectively. But in the 1970's commercial harvests fell to an average of 1,109 per year. The species composition and geographical coverage of the fishery also changed during the postward period. Before and just after the War the larger, high quality red abalone (<u>Haliotis rufescens</u>) provided the bulk of the catch. As the best beds near Monterey were depleted, however, divers began to move further south seeking pink abalone (<u>H.corrugata</u>). As shown in table 6, the catch of pinks reached a peak in 1952. Pink and red abalones were the only species harvested in significant numbers until the mid-1960's.

During the late 1960's and 1970's green abalone (<u>H.fulgens</u>) became a significant portion of the catch. And, after the State reduced the size limit from 18.4 cm to 17.8 cm in 1969, the greens enjoyed a short period in which their landings exceeded those of pinks. The emergence of white abalone (<u>H.sorenseni</u>) as a species of commercial importance in the early 1970's is a testimony to the increasing shortage of the highly-prized reds, because of the much greater difficulty of retrieving whites from the 24 to 37 metre depths they inhabit (Cox, 1962, p.49). The last significant shift in species composition occurred in 1970 when the State removed its prohibition on drying, canning and export of abalone. This promoted a sudden interest in the smaller and lower quality black abalone (<u>H.cracherodii</u>). Annual landings of blacks rapidly reached a peak of 868 metric tons in 1973, followed by a rapid decline.

The progress of the abalone fishery during this period is perhaps best summarized by Cicin-Sain, <u>et al.</u> (1977):

> The shifting composition of the commercial abalone harvest traces a recurrent pattern of efforts to compensate for declining yields of the more desirable species by exploiting the virgin stocks of "new" species made accessible by legislative action, and marketable by the scarcity of high quality red abalones for the domestic market, or the opening of foreign

Table 6. California abalone landings, 1950-1978
(tonnes, in shell)

	Species						
Year	Red	Pink	Green	White	Black	Total	(US $1,000)
1950	-	-	-			1 794	369
1951	581	1 090	-			1 853	365
1952	531	1 506	-			2 170	431
1953	640	1 497	-			2 141	439
1954	630	1 225	-			1 860	377
1955	906	992	-			1 898	423
1956	1 099	840	5			1 443	481
1957	1 166	1 270	23			2 459	587
1958	762	1 157	-			1 916	422
1959	989	1 080	-			2 069	497
1960	1 220	712	-			1 935	496
1961	1 302	762	-			2 066	607
1962	1 116	780	-			1 897	593
1963	1 275	680	14			1 966	627
1964	1 075	730	45			1 850	573
1965	1 129	939	5			2 076	698
1966	1 207	980	64			2 251	915
1967	1 220	735	50			2 006	860
1968	807	1 030	195			2 030	1 124
1969	708	862	73	14		1 657	1 161
1970	540	640	122	5	9	1 316	948
1971	581	177	513	18	50	1 336	953
1972	501	183	193	65	460	1 403	1 248
1973	301	168	71	38	868	1 448	1 077
1974	341	207	55	52	520	1 177	1 299
1975	337	208	78	33	312	970	1 388
1976*	335	196	55	37	162	786	1 454
1977*	244	144	44	8	210	651	1 211
1978*						903	1 691

* Preliminary data from California Dept. of Fish and Game, Long Beach.

Source: Burge et al. (1975); Pinkas (1977).

markets for canned black abalones. By 1968 the skein had run out, and the temporary bonanza of smaller greens, the increased take of whites and the spectacular harvest of blacks only served to cushion the decline in total harvest that began the following year. From 1951 through 1968 total abalone landings never amounted to less than 1,800 metric tons and as recently as 1968 they fell just short of 2,000 metric tons. By 1974 total landings had declined approximately 1,300 metric tons, of which black abalones accounted for nearly 40 per cent.

The sportfishery for abalone has almost as long a history as the commercial fishery. Collecting abalone for recreation was first distinguished officially from commercial exploitation after the abalone laws in 1900 prohibited the sale of abalones gathered from intertidal areas. Shoreline collecting became the preserve of sport fishermen. According to Frey (1971), until World War II, most sport taking of abalone occurred during low tide when the fishermen waded among the rocks. The advent of rubber diving suits marked the beginning of a sportfishery in deeper waters. To protect the abalone on the Northern part of the coast, sportsmen were forbidden to use scuba gear north of Yankee Point in Monterey County. In southern California the modern abalone sportfishery is concentrated along the shoreline from Santa Barbara to San Diego and around the offshore islands of Anacapa, Santa Cruz and Santa Catalina. Many fast, commercially chartered vessels and privately owned and operated vessels take thousands of scuba divers to the most fertile abalone beds every year. The State-imposed size limit on sport-caught abalone is one inch short of the size limit for commercial take. Daily "bag limits" of five for all species combined also restrict the recreational diver. Frey (1971) reports that the annual recreational take of abalones is 1,360 to 1,815 metric tons.

In response to the concern over the declining commercial landings, the Department of Fish and Game initiated an expanded research programme in June of 1973. Objectives of the new programme were to examine probable causes of the decline, compile more comprehensive biological data, and prepare a management programme. A draft report of the research, authored by Burge, Schultz and Odemar, was completed in January 1975. Reasons for the abalone fishery decline may be summarized as follows.

1. The higher annual yields during the 1950's and 1960's were sustained by the "mining" of the accumulated populations of legal-sized abalone. After the windfall harvest of these older specimens, the annual yield had to drop to an equilibrium rate equal to the annual recruitment into the legal size classes.

2. An excessive number of sublegal abalones are killed through poaching and from unintentionally inflicted wounds when short abalones are removed from and then returned to the substrate.

3. The environmental carrying capacity for abalones was dropping due to the increasing population of predators (sea otters) and of competitors (sea urchins). Also, some portions of the mainland coast suffered environmental degradations affecting abalone recruitment.

4. Some fishing areas had been removed from the commercial fishery by State regulation, including sections of San Nicolas, San Clemente, Anacapa, and Santa Barbara Islands.

In addition to these findings, the "Burge Report" determined that the previous size limits on pink, white and green abalone were too large for optimum utilization.

Of these causes for abalone population decline, the first and third do not seem susceptible to remedy within the context of abalone fishery management. Much of the decline in yield occurring as the accumulated population of older abalones is fished out must be treated as a necessary, but transitory phase of the fishery's development. And the changes occurring in the abalone population's natural equilibrium size and range can be altered only by programme initiatives in habitat protection and control of marine mammal population. Both of these policy areas are being investigated by the State, but they obviously involve wider political and social issues than are usually successfully addressed in fisheries management. Another approach to the problem is recommended by the "Burge Report", namely the mass cultivation and seeding of abalones.

The fourth cause of declining yield, removal of some areas from the commercial fishery, reflects deliberate policy choices to appease or benefit the recreational abalone divers. Finally, the excessive kill of pre-recruit abalone was attributed to the large number of divers participating in the fishery, and the high proportion of novices among the active divers. Novices evidently pick a much larger number of sublegal animals which must then be replaced. This, combined with the fact that abalones inadvertently cut by the "abalone iron" have a 100 per cent estimated mortality rate, suggests that a more stable, professional group of divers would be able to produce a greater sustained yield from the existing abalone populations. Consequently, Burge et al. recommended that the State issue no further abalone diving permits, that the annual permit fees be increased, and that the total number of divers be reduced through attrition to 70. A limited entry programme was adopted in 1976 while several other recommendations, including catch quotas and reduced size limits, were not.

The limited entry programme authorized by the State Legislature had the following main provisions. All current divers and crewmen with abalone permits were issued permits for the first year of the programme. To qualify for a diving permit in succeeding years, each permittee must land at least 4,536 kilograms of abalone or make at least twenty daily commercial landings of at least two dozen abalone during each year. As of 1979, the State had decided that the eventual number of abalone diving permits should be 200. Thus, if the number of licenced divers falls below 200, new permits may be issued to qualified divers. Divers are qualified by either three years experience as an abalone diver or crew member, or by passing a proficiency test. When more applicants are qualified than can be issued permits within the total of 200, a drawing determines who receives a permit. Permits may be revoked if the holder violates Fish and Game regulations pertaining to abalone fishing. Also, the annual permit fee, which was set at $100 in 1970, was increased to $200 for divers and $100 for crew members. Permits for crew members are not limited.

In addition to the new requirements and provisions contained in the limited entry programme, abalone fishing continues to be governed by (1) size limits (19.7 cm maximum diameter for red abalone, 17.8 cm for green, 15.9 cm for pink and white abalone, and 14.6 cm for black); (2) gear requirements (divers must have a compressor and air hose of 100 feet, "abalone iron" not to exceed 90 centimetres and an accurate measuring device); (3) a closed season in August and February; and (4) several closed areas (primarily the coast north of Point Lobos and areas within a short distance of the recreationally important Channel Islands and mainland coast in southern California). Except for the season closure, all these were in effect before the new 1976 programme.

The rising level of participation in the commercial abalone fishery experienced during the 1960's was stemmed in 1970 when the State first began to collect a $100 annual fee from each permit holder. As shown in table 7, the number of permit holders dropped by about 42 per cent, from 840 to 486 in the first two years following the establishment of the permit fee. By 1974, however, the number once again exceeded 500. Since 1974 there has been a steady rate of attrition, and the rate definitely accelerated after the introduction of the limited entry programme in 1976. Since the real gross earnings per permittee have actually increased moderately during the 1976-1978 period, financial disincentives probably do not account for the decline. It is almost certainly a case of casual and part-time divers being eliminated from the programme due to failure to meet the minimum annual landings requirements.

The dearth of available data prevents a close check of the limited entry programme's success in promoting a more stable, professional fishery. But preliminary analysis of survey data from John Moore and his asociates in the Deparment of Political Science, University of California at Santa Barbara sheds some light on the issue. In their 1977 report, Cicin-Sain et al. found that licenced abalone divers averaged 86 months of experience in the fishery. In 1978, J.Moore (personal communic-ation, 1980) found that the level of experience had increased to 105.4 months. A continuation of this trend should have the desired effct on the level of competence of the divers.

Table 7. California abalone fishery; size of fleet and productivity of divers, 1960-1978.

Year	Number of permit holders	Number of Vessels*	Landings per permit holder (tonnes)	Gross Landed value per permit holder (US$)	Deflated gross value per permit holder (US$)
1960	418	106	4.57	1 187	1 688
1961	505	124	4.09	1 202	1 691
1962	582	150	3.26	1 019	1 415
1963	532	128	3.70	1 179	1 620
1964	574	145	3.22	998	1 354
1965	686	164	3.03	1 017	1 356
1966	880	213	2.56	1 040	1 347
1967	853	206	2.35	1 008	1 268
1968	839	223	2.42	1 340	1 614
1969	840	213	1.97	1 382	1 587
1970	530	195	2.48	1 787	1 951
1971	486	191	2.75	1 961	2 041
1972	448	207	3.13	2 786	2 786
1973	487	212	2.97	2 211	2 086
1974	554	230	2.12	2 345	2 008
1975	517	230	1.88	2 685	2 102
1976	499	218	1.58	2 914	2 160
1977	371	-	1.75	3 264	2 278
1978	300	-	3.01	5 637	3 653

* Number of vessels recording landings in any amount.

Source: Burge *et al.* (1975) and M. DeLong (personal communication, 1980), California Dept. of Fish and Game, Long Beach.

One of the responses that may be observed in tentative analysis of the post-1976 fishery is the increasing intensiveness with which the diving permits are used. Economics of the firm suggests that abalone diving businesses would find it desirable to economize on more expensive or scarcer inputs. That is, an input which is suddenly found to be more scarce would have more of other complementary inputs used with it; the scarce input would be used more intensively. During the 1976-1978 period this tendency to economize was displayed by the increasing number of crew members licenced per diver. Although a three-year trend is not particularly meaningful, the fact that this reversed the trend of the previous two years lends more credence to the suggestion that abalone fishing firms will react as economic theory predicts. A summary of the pertinent data follows.

Year	Number of Divers	Number of Crew	Crew per Diver
1972	330	118	.358
1973	346	131	.408
1974	390	164	.421
1975	392	125	.319
1976	397	102	.257
1977	272	99	.364
1978	196	104	.531
1979 (prelim.)	146	91	.623

Abalone fishing firms can be expected to use more capital per diver also. But data series, such as number of vessels or size or value of vessels used, are either not up-to-date or they are non-existent.

Interpretation of the trends in catch per permit holder and landed value per permit holder for the abalone fishery is more treacherous than the interpretation of similar figures for the roe herring fishery. In the herring case, it is reasonable to assume that most of the participating fishing operators participated for the duration of the fishing season, or at least for as much of the season as the regulations and equipment would allow. In abalone fishing, however, there was a great deal of turnover in the participating population and a high proportion of casual and part-time divers before 1976. Since the latter divers are much more likely to have been "weeded out" by the State's permit requirements, the increasing trend observed in the catch per permit may simply reflect the deletion of those divers who would have been catching less than the average. The average continuing diver did not necessarily enjoy an increase in catch rate.

Further information on this aspect of the fishery is, again, available in preliminary form from the survey work undertaken by John Moore. In 1976 Moore estimated that the catch rate was 3.94 dozen per dive day and in 1978, 3.75 dozen per dive day. Some doubt is cast upon this evidence of decreasing abalone abundance by the poor weather in 1978 that may have retarded the abalone divers. Nevertheless, the author has found no convincing evidence that the desired increase in abalone yields has been accomplished. Several reasons for this can be tendered. First, improvements in the size of the abalone stock must be slow in appearing because the abalone is a slow-growing creature. According to the "Burge Report", for example, a pink abalone 15.2 cm in diameter is eight to eleven years old and will require at least two more years to grow to the legal minimum size of 15.8 cm. Second, the other main sources of increased abalone mortality during the preceding decade (that is recreational take, predation by sea otters, competition from sea urchins, and reduction in habitat through pollution) have not been resolved or controlled. Given the many unknown factors influencing abalone growth, reproduction and survival rates, any proposed augmentation through fishery regulation must be considered problematical.

Assessment of economic performance in the fishery is uncertain. A moderate increase in real landed value per permit since 1976 was caused by the previously-mentioned increase in catch per permit. The real price per metric ton actually decreased by about 11 per cent from 1976 to 1978. Since the increase in catch per permit may simply reflect a falling number of casual divers, abalone fishermen are probably not enjoying rising real incomes due to the limited entry programme. As with abalone abundance, economic improvements may eventually result from the management programme, and the current performance is probably better than it would have been without the programme. Thus, even though available data are inadequate for a satisfactory assessment of small absolute changes in performance, California's abalone regulations are probably helpful in slowing the decline in stocks of abalone and in maintaining the earnings of licenced commercial abalone divers.

SUMMARY AND EVALUATION

A public regulatory programme must be judged with respect to some accepted set of standards. But the standards to be applied in fisheries management are unsettled at present. Concepts like "optimum yield" are still evolving. But most recent papers on the subject (for example Crutchfield, 1972; and Cicin-Sain, et al. 1977 and 1978) agree that economic, social and ecological factors must be introduced as objectives of management, thus making the now old-fashioned "maximum sustainable yield" (MSY) one part of a complex formula. With multiple objectives no single management measure is likely to be sufficient. Similarly, no management measure can be properly judged by only one criterion. To evaluate California's limited entry programmes, therefore, we would want to compare the actual programme accomplishments to a comprehensive set of objectives. An ideal programme evaluation such as this would require that the programme be closely monitored by comprehensive and up-to-date information.

This ideal is impossible to achieve, however, because management objectives are not often explicitly stated and because the requisite data are not being recorded, summarized and distributed. The procedure I adopt for this paper is to select a small set of generally accepted management objectives, rather than attempt to infer a complete set of criteria from available evidence. And the success of California's limited entry programmes in meeting these objectives will be judged using only the data and descriptive information presented in the preceding two sections of the paper.

The management objectives to which limited entry can contribute are:

1. The Biological Objective - to control the rate of harvest to maintain stock size and annual yields at high levels;

2. The Economic Efficiency Objective - to maintain the level of costs incurred in fishing, processing and administering the management programme to near minimum necessary levels;

3. A Social Objective - to assure that benefits from the fishery are distributed "fairly".

Clearly, other social aspects could be included, but this set of objectives is sufficient for this summary. Each objective is discussed below in the context of California's two limited entry fisheries.

THE BIOLOGICAL OBJECTIVE

Limited entry in the herring fishery was not explicitly addressed to the biological objective. But, as Stokes (1979) and others have noted, a reduced fleet size puts an upper limit on fishing effort and helps to spread out the effort during the fishing season. Both of these effects can help to control overall harvest rates and impacts of the harvest on the fish stock. In view of the rapidly increasing herring roe prices, the limited entry programme has certainly restricted the potential fishing effort and, at the very least, this simplifies the administration of the harvest quota. Also, to the extent that the sequence of herring spawning periods during December, January and February represent genetically distinct groups of herring, the spreading out of fishing effort may contribute to a genetically more balanced harvest. And this will probably help to preserve genetic diversity and to maintain a larger and more stable stock. The apparent success in stock maintenance to date, however, must be attributed primarily to the annual harvest quotas and not to the limited entry provisions. In herring, limited entry plays a secondary role in the achievement of biological objectives.

In contrast, limited entry was introduced in the abalone fishery specifically to assist in maintaining stocks of abalone. A reduction in number of divers, and the associated increase in average levels of experience and professionalism among divers, was expected to reduce the mortality rate among sub-legal abalones. This reduced mortality would then result in a higher annual recruitment to the legally fishable population. As noted in the earlier discussion of abalone fishery management, however, it is too soon to assess the extent to which the anticipated stock enhancement has occurred or will occur in the future.

In summary, the success of California's limited entry programmes in contributing to biological objectives of management is unclear. As a general proposition, the smaller fleet size should help to maintain spawning stocks of herring and to reduce prerecruit mortality of abalone. Supporting evidence is not available for herring, and whether abalone stocks will be significantly enhanced is not yet apparent.

THE ECONOMIC EFFICIENCY OBJECTIVE

Although economic objectives are not explicitly a part of either herring or abalone management programmes, limited entry has made possible the $5.7 million net profit estimated for the roe herring fleet in 1979. Without limits on number of vessels participating, the high profit rates would have attracted many more vessels, each of which incur additional costs in acquiring gear, compensating crew members, and travelling to the site of the fishery. Thus the programme was extraordinarily effective in keeping the fleet size, and the fishing costs, below the levels that would otherwise have occurred.

The gains in economic efficiency, however, are far from secure, because the fishing fleet is still in a process of adjustment. Although current permits are restricted to specific gear types, with most going to smaller gill net vessels, continued high prices and correspondingly high prospective profits can be counted on to encourage vessel owners to invest more and more capital in ways which increase the potential catch for their vessels. More electronic equipment, faster vessels, better gear-handling equipment and larger crews are some directions that the upgrading of vessel capacity might take. California's auxiliary regulations on individual vessel harvests and on quantity of gear used by gill netters (130 fathoms of net) may impede, but will not eliminate, the incentives to further overinvestment. For roundhaul vessels the 91 metric ton limit on seasonal landings and the 36 metric ton single load limit acts to dilute the incentives for building greater capacity. These limits do not have the stabilizing effect that an assured "fisherman quota" would have, because the total harvest quota is too small for each roundhaul vesel to get 91 metric tons. Consequently, competition to take as much of the individual vessel limit as rapidly as possible still dominates the fisherman's behaviour. At the beginning of the 1980 herring season in San Francisco Bay, for example, the purse seine vessels took 50 per cent of their 1,361 metric ton quota in the first 30 hours of fishing.

Since gill net vessels currently do not catch enough individually to be constrained by the seasonal and single load limits, there is substantial economic incentive to upgrade vessels. The limit on quantity of netting per vessel, however, disallows the most obvious means to increase capacity. Other avenues will undoubtedly be sought by vessel owners in order to maximize their profits in the gill net fleet. Whether or not such competition will eventually destroy the profits being enjoyed depends upon physical production factors which are unknown to the author at present. The continued existence of economic rents in the herring fishery, however, would be more assured if the State would adopt specific measures to deal with the overinvestment incentives. Such measures as landings royalties and the assignment of the entire quota to vessels through individual allotments (that is "fisherman quotas") are some noted possibilities in this direction (see Stokes, 1979, for further details).

Limited entry in the abalone fishery is apparently not a great success from an economic standpoint. Although total costs of harvesting have probably been reduced simply because fewer units of gear are now in service, continuing abalone divers do not seem to be enjoying greater net earnings since the limited entry programme went into effect. But the abalone fishery is a difficult case to assess. No harvest quotas are in place and the other sources of mortality (sea otters, recreational fishing, poaching and environmental degradation) are largely unchecked. Hopefully, the reduced fishing pressure will result in a future surge in abalone abundance which supports higher catch and profit rates.

Economic efficiency can be sought also in administration of the management programme. Fewer vessels to monitor and fewer special regulations to enforce should bring lower costs of management. But in both the fisheries discussed here the whole gamut of traditional fishery regulations are imposed <u>in addition to</u> limited entry. Enforcement costs could undoubtedly be reduced by putting more reliance on restricting total participation and less reliance on detailed rules of conduct for the licenced fleet. Fishing costs are likely to be lower too under a regime that encourages, rather than hamstrings, productivity-increasing innovations. But the advantages to improved management and fishing efficiency can be bought only by taking the politically difficult course of reducing fishing fleets to much lower sizes than currently prevail.

THE SOCIAL OBJECTIVE

Like economic objectives, social objectives in California's fisheries are largely undocumented. Still, I think that most State decision-makers would agree that they try to avoid measures that radically alter the fisherman's lifestyle, and that they attempt to "spread the wealth" among a large group of participants in the fishery, whenever possible. This attitude is reflected in the herring fishery regulations which allowed free entry in 1977 and which placed seasonal and single-load limits on permittees. The latter provision was directly aimed at the apparent "unfairness" of a very few extremely successful purse seiners each taking over 100 metric tons of roe herring. Also, the division of the quota into segments for each gear type reflects a sense of "fair play". Without the special reservations for gill nets, for instance, the roundhaul fleet would take nearly all of the annual quota within a few days.

But the definition of "fair" is debatable. As my estimate of profits makes clear, the vessels allowed into the herring roe fishery enjoy a substantial economic advantage over the excluded vessels. And entry into the fishery is based simply on tenure. The rich get richer. Whether or not this is "fair", I leave to the reader to judge. An alternative concept of "fairness" would treat the herring stocks as a State or national asset, and would favour spreading the wealth to the citizenry in general rather than to the participants of the fishery alone. To follow this concept of social fairness would require that participating fishermen give up a substantial portion of the profits in excise taxes, licence fees, or royalties.

I am not able to conclude that the current fishery regulations promote the social objectives of fishery management. I believe that the fishery managers in California have failed, however, to examine the basis for social objectives in fishery management by implicitly assuming that distribution of benefits beyond the small group of participating fishermen is irrelevant. Acceptance of the two propositions that no fishermen should be allowed continued enjoyment of excessive profits and that only fishery participants need be considered in the distribution of fishery benefits will ultimately leave the fishery manager no choice but to open the fishery to as many vessels as can fish without incurring financial losses. But such an action emasculates any limited entry programme and prevents the economic objective from being addressed. Because they do not explicitly face up to the difficult problem of choosing coherent social objectives, the California limited entry programmes threaten to fail by default.

In summary, California's application of limited entry to the herring roe and abalone fisheries must get mixed reviews. Economic gains seem to be developing in herring but are not yet evident in abalone. Similarly, the biological objective of maintaining stock sizes sufficient for reasonably large annual yields is more clearly being met in herring than in abalone. In both fisheries, however, the elapsed time in the programme is still too short to allow firm conclusions to be drawn. The State of California has not taken advantage of its opportunity to eliminate many of the detailed, direct restraints placed on fishermen's gear and behaviour, but has instead added a myriad of direct fishing regulations to the limit on permits. Both limited entry programmes suffer from lack of specific, consistent economic and social objectives. One consequence of this is the lack of reconciliation between the understandable goal of distributing the potential income from the fishery "fairly" and the need to limit participation in order to achieve some degree of economic efficiency. Although the State has made a strong beginning in the new field of limiting entry to commercial fisheries, further progress in achieving the economic objectives of management may be inadvertently sacrificed to political whim unless non-biological objectives are explicitly adopted as legitimate goals of public management in fisheries.

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7

LICENCE LIMITATION IN THE BRITISH COLUMBIA ROE HERRING FISHERY:

AN EVALUATION

by

G. Alex Fraser

INTRODUCTION

Limited licencing in the British Columbia salmon fishery has received a good deal of attention since its implementation in 1969 (Pearse, 1972; Fraser, 1979; Pearse and Wilen, 1979). This programme represented a major break with traditional Canadian management practices, and a broadening of management objectives to incorporate an important economic dimension which had long been neglected. As one of the earliest and most comprehensive of its kind, this programme has provided both some useful precedents and significant insight into the variety of practical problems involved in pursuing this type of management strategy. This is important, for the salmon programme has not remained an unusual aberration, but rather was the first step in a general shift in management orientation. Many of Canada's fisheries at the present time are subject to some form of limited entry controls.

In particular, for several years now, another major British Columbia fishery has been subject to licence limitation. In 1974, limited access was instituted in the British Columbia roe herring fishery. The experience with this programme offers some new insights into the effectiveness of licencing as a control mechanism in fisheries management for this programme was not a blanket copy of that in the salmon fishery. In response to a variety of perceived problems with, and criticisms of, the salmon programme, a number of differences in both the form and content of the regulations were instituted. Also, the social and economic characteristics surrounding this fishery were different from those surrounding the salmon fishery. At the time that licencing was instituted, the roe herring fishery was a new fishery and one which was neither subject to gross over-capacity in the fishing fleet nor over-exploitation of the resource. Limited entry was instituted as a means to prevent the occurrence of these traditional problems rather than as a mechanism to redress an already awkward situation.

In the following pages an evaluation of the roe herring programme is presented. Before proceeding to this, however, some effort is devoted to detailing background regarding the resource, the product, and its market. In all these aspects this fishery is unique and this has important implications for fisheries management.

A SHORT HISTORY OF THE BRITISH COLUMBIA HERRING FISHERY

Commercial herring fishing on Canada's West Coast began in 1877, and continued on a minor scale (less than 1,000 short tons) until 1902. Exploitation increased during the early part of this century with the opening of a market for dry salted herring in the Orient. Between 1902 and 1935 catches rose as high as 78,000 short tons. In 1935, a meal and oil reduction industry was introduced and continued uninterrupted over the next 33 years (Fisheries Statistics of British Columbia, 1977). As prices for reduction products improved and technological advance lowered fishing costs, the exploitation of herring increased accordingly. By the 1950's a small but relatively mobile fleet of purse seiners swept the coast averaging record high landings of 178,000 short tons during this decade (Hourston, 1978).

Until this point in time, catches were effectively limited by market prices and costs of production such that the stocks were not biologically endangered. As a consequence, few restrictions were necessary or actually applied to this fishery. While overall catch quotas existed for various sections of the coast, extensions were frequently granted (Hourston and Haegele, 1980). Also, the fishery was only closed during the peak of the spawning season, and gear restrictions were virtually non-existent. However, during the 1960's as the prices paid for herring products continued to increase, and as technological innovation continued to improve the efficiency of the fleet, a conservation crisis inevitably occurred. Record catches between 1962 and 1965 in excess of 260,000 short tons were followed by dramatic declines to 181,000 and 135,000 short tons in the following two seasons. Fishermen had increasing difficulty in locating quantities of fish, while spawn deposition was down in many areas of the coast. Finally, when the downward trend continued in 1968 the fishery was indefinitely closed. During the subsequent three years, only a negligible fishery for local food and bait purposes was allowed (Hourston and Haegele, 1980).

By 1971, the herring stocks were partially rebuilt, and at the same time an event of great importance for British Columbia's fishing industry occurred, namely, the relaxation of Japanese import restrictions on foreign roe herring products. In response to declining domestic catches of herring and consequent domestic supply of highly prized herring roe, a new and lucrative Japanese market became available to British Columbia producers (Fraser and McKay, 1976). In 1971, a small experimental roe herring fishery (of approximately 8,000 short tons) was allowed. In subsequent years this was gradually expanded as the stock recovered and by 1976 the roe fishery had reached major proportions with a catch of 87,000 short tons.

From about the beginning, this new industry has dwarfed in value terms its reduction predecessor. Even at its peak the reduction fishery generated products valued at $12 million in wholesale value; in comparison, by 1973 the roe herring fishery generated $35 million in wholesale value, and by 1979 an astounding $170 million. The implications for resource management of this gigantic leap in resource value forms the basis for much of the comment which follows.

THE RESOURCE AND THE PRODUCT

With the development of the roe herring market, a completely new fishery was introduced in British Columbia. The previous reduction fishery took place on feeding stocks off the coast or during an annual pre-spawning migration of the stocks towards in-shore waters. Until the late 1960's the closed season for this fishery encompassed only the height of the spawning season itself. In effect, the new roe market has reversed this situation with the fishery now concentrated in the six weeks between late February and early April of each year. This, too, gives a somewhat deceptive impression of the fishery because the effective spawning period in any given area of the coast is considerably shorter. Over the six week period, spawning moves from South to North along the coastline, that is, from warmer to colder waters. In any given area the main spawning period is usually less than a week and in many instances it is as short as one or two days. Consequently, the effective fishing period for the new roe fishery is an extremely short period of hectic activity.

Unlike their Atlantic counterparts (*Clupea harengus harengus*), Pacific herring (*Clupea harengus palasi*) are shore spawners and the consequent ease of identification of spawning areas is a major factor in making this fishery possible. Early in their life cycle, Pacific herring migrate out of coastal bays and inlets and onto feeding grounds in the productive waters overlying the off-shore banks. When they become reproductively mature in their third or fourth year, the herring leave these rich off-shore feeding grounds in late autumn and winter and migrate back to in-shore waters. In some instances they remain in dense schools off the coast for some months until their reproductive organs ripen while in other instances they arrive in in-shore waters coincidentally with reproductive maturity. In any event, at spawning, the herring move close to the shore and deposit their eggs on vegetation in and immediately below the inter-tidal zone. Following spawning, the adults then migrate back to their feeding grounds and a repetition of the cycle (Hourston and Haegele, 1980).

The commercial roe fishery takes place on and adjacent to the spawning grounds. Unlike the reduction fishery which was a purely purse-seine operation, two gear types are used for roe herring. A gillnet fleet operates in the shallows over and immediately adjacent to the spawning grounds, while a seine fleet operates off-shore in holding areas. To satisfy the Japanese market the roe herring must be taken at a relatively ripe stage, that is, almost immediately prior to spawning. As a result of the herring's life cycle difficult problems of management must be faced during the very short season. The basic trick is to hold the fishery at a point where sexual maturity is greatest, while spawning has not yet occurred. Under the present system of openings, the gillnet fleet is generally allowed into an area first. Due to regulations affecting the size of net mesh, the gillnets are relatively selective in that small immature herring will escape, and they fish closer to the actual spawning areas where the mature fish tend to congregate. As the off-shore stocks mature later in the season, the non-selective seiners are allowed to operate (Fraser, 1976).

The harvested roe herring are unloaded on the grounds onto large packers or barges and are rapidly transported for processing. After a brining or freezing process in order to firm the roe, the eggs are removed through a manual "popping" process and graded on the basis of size, firmness and shape. Recovery can fluctuate anywhere from ten to sixteen per cent of the total weight of the herring captured. The female carcasses after processing and the males are generally reduced for fish meal. There is little alternative for this by-product as the fish make poor quality food due to low oil and fat content at this time of the year.

The primary product is a traditional Japanese seafood "Kazunoko" which was historically a relatively common item in the family diet. However, during this century the product has become much more of a specialty item. From the mid-1950's until trade liberalization, the total available supply of herring roe averaged approximately 4,000 metric tons per annum. As a result, the price of herring roe rose to luxury levels. For example, in early 1972 top grade herring roe was quoted on the Tokyo Central Wholesale Market at 6500 yen per kilo or approximately $10 Canadian per pound at the then current exchange rates. This represented consumer prices in the range of $15 - $16 Canadian per pound (Fraser and McKay, 1976).

Subject to the relaxation of import restrictions, between eight and fourteen thousand metric tons of roe have been imported to Japan every year, implying a 300 to 500 per cent increase in total market supply. While real prices have dropped substantially as a consequence, consumer attitudes towards the product apparently have not changed. Currently the major demand for the product is as a traditional food during the New Year celebrations. On the basis of 1974 data, approximately 60 per cent of the total product clears the market during this season of the year. Due to this special characteristic, demand tends to be relatively stable in spite of prevailing price levels and economic conditions (Fraser and McKay, 1976).

MANAGEMENT OF THE FISHERY

In response to the conservation crisis of the 1960's, when large scale commercial herring fishing was re-instituted, a relatively conservative management regime was implemented. Catch was restricted through aggregate quotas and area quotas to quantities considered exceptionally low relative to biological availability. Also, to ensure that these quotas were adhered to, the fishery was very closely monitored. This basic management framework remains unchanged to the present day.

The biological basis for management is an annual assessment of the abundance of stocks. The runs to individual fishing areas are forecast each year in advance of the fishery on the basis of estimated spawners in the previous year, attrition, and average recruitment. Allocations to the small local food and bait fishery and recently a small fishery producing food for export are deducted from the forecast runs. The estimated requirement of spawning fish is also deducted to give the catchable surplus in the roe fishery. Immediately prior to the roe fishery in each area, the projections are cross-checked by echo sounder to estimate the tonnage of fish present and test catches are sampled for their age composition to determine if recruitment was average. If deviations from the forecast situation are apparent the "target" catch is adjusted accordingly (Hourston, 1978).

A massive and detailed effort by field managers and staff is necessary to ensure that total catch does not exceed the target and that spawning escapement is adequate. The fishery itself is generally opened when maturity in the sample reaches ten to twelve per cent (total roe weight divided by sample weight). For the gillnet fishery, the sampling takes place close in-shore while for the seine fishery sampling is carried out in the holding areas. Once open, the fishery proceeds until the target catch is taken. Landings are checked daily and hourly through "hailed" figures and on-site estimates. In most cases the actual opening is set to a time period in which it is estimated that the available catch will be exhausted by the given fleet capacity in the area (Hourston and Haegele, 1980).

This management strategy proved adequate during the 1972 and 1973 fishing seasons. In 1972, a highly successful fishery with a fleet of 106 seine vessels and 58 gillnetters produced 38,000 short tons of round roe herring. In the following season, the catch quota was increased and a larger fleet of 161 seine vessels and 223 gillnetters produced 56,000 short tons of round roe herring. At the same time, however, the British Columbia roe was proving highly successful on the Japanese market, and almost immediately began receiving consumer acceptance as a prime-quality product. As a result, the landed value of the resource jumped from $2.1 million in 1972 to $9.1 million in 1973. While average gross returns for seine vessels increased from $19.6 to $56.4 thousand for the extremely short roe season, those for gillnet vessels increased even more impressively from $1.1 to $5.7 thousand (Sinclair, 1979). The stage was set for substantial entry to the fishery and for increase in the fishing capacity of the fleet.

By the fall of 1973, preliminary indications were that several thousand fishing units would participate during the following season (Meyer, 1976). Under these circumstances, it was apparent that the management regime as constituted would be unable to ensure conservation of the stocks. Against this background, a licencing programme was conceptualised. The initial objectives of this programme were threefold:

1. to provide a device whereby fleet size could be controlled below levels that might prove a serious risk for the herring stocks;

2. to provide a return at least appropriate to the covering of costs for the fishermen;

3. to provide a revenue return from the resource for the Crown. (Meyer, 1976).

While these objectives bore much in common with those of the earlier licencing programme for salmon, they also encompassed some interesting differences. In particular, the first objective reflected a situation where fleet capacity had not yet reached excessive levels. Unlike the salmon programme herring licencing was never aimed specifically at reducing fleet size. Similarly, the second objective reflected a situation where the initial participants were earning handsome returns, and consequently the emphasis of this programme was not on increasing fishermen's incomes but rather on preventing a marked erosion of returns through excessive entry.

At the same time, a number of concerns about income distribution were evident. The roe fishery was a bonanza for the West Coast fishing industry, and, as a consequence, the Minister of Fisheries was reluctant to pursue a hardline policy with respect to entry. Clear indications were given that he was unwilling to deny access to the resource to any "bonafide" fisherman (Meyer, 1976). Implicitly, a desire for job creation and dispersed income distribution lay behind the Ministerial position. Given this rather powerful imperative, the licencing plan that developed treaded a careful line between opposing objectives.

The resolution of the Ministerial position with the perceived management needs of the fishery was effected by a licencing plan which allowed initial entry by all applicants who so desired. The actual limitation was effected through a schedule of fees which were initially considered to be exceptionally high. Licence fees of $2,000 per seiner and $200 per gillnetter were established. The relative size of these fees to historic and even recent similar charges can be gathered from comparison. In 1973, following a record salmon season, salmon seiners were generally faced with $400 levies, that is, one-fifth of the roe herring level. While salmon gillnets were faced with levies in the range of $100 to $200, these vessels and their expected catches (in dollar terms) were considerably larger than their equivalent in the roe fishery. Finally, in all other British Columbia fisheries, the only levy for participation was a nominal $10 registration fee.

Other features of the licencing plan for the roe fishery were made in response to perceived problems with the licencing programme in the salmon fishery, and, to some extent, political pressure. For example, in the initial implementation of salmon licencing, no special provisions were made for Native Indian fishermen. Native Indians had been an important element in the commercial salmon fishery for close to a century, and the salmon fishery was of unique social and cultural importance to coastal natives. Also, there was a lack of employment alternatives and relatively depressed economic conditions in many native communities. Although the neglect of these factors in the salmon programme had been eventually countered by the institution of special Indian licencing and an Indian Fisherman's Assistance Program, the criticism received in regard to this issue was still fresh in many minds. As a consequence, special provisions for natives were worked into the herring licencing programme at the very beginning. A special licence fee of $10 for both seines and gillnets was instituted for natives, but undoubtedly of more importance free entry to native Indians continued until January 15th, 1977 even though entry was closed to all non-natives on January 15th, 1974. While the herring fishery itself was not a traditional native fishery, the creation of native employment was a major element in policy during this period.

The herring licence was made a non-transferable personal licence rather than a transferable vessel licence. The United Fishermen and Allied Workers Union, the major fishermen's organization on the West Coast had consistently criticized the salmon licencing plan for its insistence on transferable vessel licencing. The major points raised by the Union were the potential for excessive speculation in the licence and vessel markets, and the potential for corporate or other private concentration of vessel ownership. Another feature of the plan intended to counter these tendencies was the addition of an "owner-operator" clause. Strangely, however, this clause was not made universal, applying only to vessels first entering the fleet in 1974. Also, surprisingly, in light of the numerous provisions to prevent excessive speculation in licences, no "participation" requirement for retention of the licence was implemented. The only requirement for licence retention was continuous payment of the licence fees. This feature was apparently targeted at a possible failure of the halibut fishery at some future date. There was a desire to leave an option open for these potentially dislocated fishermen.

Regardless of the validity of the Union's complaints regarding transferable vessel licencing, it should be noted that the general experience in the herring fishery with personal licencing has not been good. The non-transferable stipulation presents perhaps the best evidence of the futility of attempting to regulate such a natural market. Alternative means were developed to conduct the transaction. The mechanism of the vessel "lease" was brought into being; rather than outright sale, agreements to rent vessels on both short and long term bases became commonplace. While these were illegal transactions for a large proportion of the fleet due to the owner-operator provision noted above, enforcement was largely impossible. First, the owner-operator clause applied only to new entrants for the 1974 fishing season (and later for native Indians). Second, unlike a vessel licence which can be checked through a cursory glance of a field officer, validity of personal licencing can only be checked through on-board inspection. In a short and intense fishery such as roe herring it is impossible for field officers to enforce such individualized regulation.

In summary, the various measures purportedly to prevent speculative excess in licences, windfall gains and concentrated control of the fleet, while implemented with best intentions, have proven more cosmetic than real. At the same time, these measures have seriously complicated both the implementation and administration of the licencing programme. This was a significant price to pay especially in light of the lack of clear, concrete evidence of the validity of the Union's complaints.

AN EVALUATION OF THE PROGRAMME'S EFFECTIVENESS

The primary objectives of the programme fall under three headings: biological management or conservation; preventing serious reduction in fishermen's incomes; and generating a crown revenue. These objectives are not completely compatible. In particular, crown revenue can only be generated at the expense of fishermen's incomes. At the same time no specific targets were identified under each of these headings against which the achievements of the programme can be evaluated. To overcome this difficulty we use a relatively loose framework of achievement, concentrating on both absolute and relative impacts.

In terms of absolute vessel numbers, the programme cannot be considered an outstanding success. As shown in table 1, although only 161 vessels participated in the seine fishery in 1973, 252 seine licences were granted for the 1974 season. Even more dramatically, 1579 gillnet licences were issued, about a sixfold increase over the active fleet in the preceding year. In terms of active vessels, the increase in fishing capacity was less dramatic; however, the seine and gillnet fleets did increase by 40 and 400 per cent respectively. The comparatively high licence fees apparently did not act as much of a disincentive to entry. Also, the number of inactive licences gives a clear indication that the various licencing provisions intended to prevent speculative activity in licences were not working at this early stage.

However, in relative terms, the programme was not considered a complete failure. Conjecture in late 1973 indicated a potential fleet of 5,000 vessels participating in the fishery in the absence of licencing provisions (Meyer, 1976). In addition, in following years the licenced fleet did decline, as perhaps the initial speculative activity cooled and as potential problems due to the non-transferable nature of the licence were realised. In spite of open access to native Indians, the licenced seine and gillnet fleets had declined to 214 and 1285 vessels respectively by 1976.

The total catch for 1974 and 1975 had been set at 50,000 short tons and the actual catches realised were 48,000 and 59,000 short tons respectively. For the 1976 season, in response to optimistic biological data, the overall quota was set at 70,000 short tons and better than anticipated performance on the spawning grounds resulted in an actual catch of 87,000 short tons. Table 2 outlines the relevant production data. These figures give the best indication of the qualified nature of the programme's performance until 1976. Although the number of licenced and active vessels had increased substantially since the implementation of licencing, any judgement about a problem of excess capacity must be muted by the substantial increase in catch.

In summary, by 1976 the licencing programme was considered a qualified success. With respect to the conservation objective of management, the fleet was considered "relatively" manageable. A potential risk was recognized if the fleet were to concentrate in a particular area, but this was not perceived as a serious possibility in either the intermediate or long term (Meyer, 1976). With respect to the income objectives of the programme, average returns had undoubtedly declined by 1975, however, the fishery still provided a very handsome return. Conservative estimates for the 1975 season indicated seine crews were earning approximately $10 per hour relative to an average provincial wage rate of $6.00 (Meyer, 1976). While returns to gillnet fishermen lay substantially below those for seine fishermen (at an estimated $4.25 per hour) there appeared little problem that could not be handled through some judicious redistribution of the catch between gear types. Finally, with the implementation of limited entry, licence fees generated between $600,000 and $700,000 in revenue per annum. Since annual management costs were about $0.5 million, the roe herring fishery was unique among Canadian fisheries in both paying for its administration and generating a small surplus for the public purse.

While this optimistic assessment of the programme's effectiveness applied in 1976, that year marked an important transition in the fishery. At that time a price spiral began which increased the value of the fishery to unprecedented levels. Table 3 shows that the landed value of roe herring climbed from $13.8 million in 1975 to $122.3 million in 1979; an astonishing 1,000 per cent increase over a four year period. The reasons for this phenomenon were related to both the supply situation on the Japanese market and international exchange rate movements.

Prior to 1975, the major producer for the Japanese roe market was mainland China. In 1974, the Chinese supplied approximately 50 per cent of total Japanese imports, while in comparison, Canada supplied approximately 35 per cent. Inexplicably, in 1975 the large Chinese supplies failed to materialize, resulting in a drastic shortfall on the Japanese market. In the interim, few other sources of supply have been found and British Columbia producers have been left with a virtual monopoly on the market (table 4). This, in conjunction with relatively poor catches of British Columbia roe herring in both 1978 and 1979 have increased prices. International exchange rate movements have dramatically magnified these trends. Over a two-year period

Table 1. Number of licences issued, by method and active fishing vessels 1972 to 1979

	Seine		Gillnet	
Year	Licensed	Active	Licensed	Active
1972	-	106	-	58
1973	-	161	-	223
1974	252	229	1 579	992
1975	232	185	1 249	1 054
1976	214	199	1 285	1 060
1977	245	217	1 329	1 065
1978	251	240	1 295	1 072
1979	249	249*	1 302	1 302*

* Estimates

Sources: 1972-1977 - Sinclair (1978).

1978-1979 - Department of Fisheries and Oceans Canada.

Table 2. Landings of roe herring by gear type, 1972 to 1979

(short tons)

Year	Seine	Gillnet	Total
1972	37 600	500	38 100
1973	49 500	6 600	56 100
1974	31 000	17 000	48 000
1975	36 100	22 600	58 700
1976	51 100	35 800	86 900
1977	47 700	33 600	81 300
1978	28 100	41 500	69 600
1979	20 600	20 500	41 100

Sources: 1972-1977 - Sinclair (1978).

1978-1979 - Fisheries Statistics of British Columbia.

between mid-1976 to mid-1978, the Canadian exchange rate shifted from a stable 300 yen/Canadian dollar to 176 yen/Canadian dollar. Consequently, even in the absence of supply shortfalls, this 40 per cent devaluation of Canadian currency would have almost doubled the Canadian dollar price of herring roe.

Against the background of these phenomenal increases in the value of the resource, a "gold fever" hit the fishing grounds. It was inevitable that substantial problems would be created for the licencing programme. These took the form of extensive capital investment in gear and equipment and more intensive fishing of the individual units.

The equipment used in the early days of the gillnet fishery was extremely simple. Fishing was carried on from a small 20 ft to 25 ft open aluminium "punt" especially designed for the task (table 5). The net was pulled aboard manually and shaken so that the fish dropped to the bottom of the vessel. It was a slow, tedious and backbreaking job at a time of the year when the weather is harsh. In 1976 the estimated replacement value for the basic equipment of net and punt was approximately $6500 ($1500 and $5000 respectively). The actual average value of the equipment used in the fishery at this time was approximately $4000 as reported by the participants. By 1977, the average value of equipment had increased to approximately $7500, and a

Table 3. Landed and wholesale value of roe herring products, 1972 to 1979

($Can. M)

Year	Landed value	Real landed value *	Wholesale value
1972	2.3	2.2	10.2
1973	10.5	9.3	28.6
1974	11.9	9.5	26.5
1975	13.8	10.0	29.9
1976	23.3	16.7	58.6
1977	29.5	18.3	74.7
1978	52.9	30.2	134.7
1979	126.9	67.1	192.5

* Adjusted by Consumer Price Index (1971=100) - Statistics Canada - Consumer Price and Price Indices - Cat. #62-010.

Source: Leitz and Proverbs (1979).

Table 4. Japanese imports of herring roe, by country of origin 1972 to 1979 (tonnes)

(tonnes)

Country of Origin	1972	1973	1974	1975	1976	1977	1978	1979
Canada	2 394	3 960	4 427	4 369	7 661	8 661	7 589	5 107
China	3 900	4 793	6 072	1 118	1 446	300	700	858
U.S.A.	525	670	630	1 108	1 201	700	670	1 090
All others	795	1 805	1 476	1 032	1 789	1 800	657	670
Total	7 615	11 228	12 605	7 627	12 097	11 461	9 616	7 725
Percentage of total imports from Canada	31	35	35	57	63	76	79	66

Source: Canada Department of Industry, Trade and Commerce (1972 to 1977) Japan Marine Products Importers Assoc. (1978 to 1979).

1979 survey indicates that the value has further increased to $12,000 with the latest additions to the fleet ranging up to $25,000 in value. The major elements of this phenomenon are the addition of a variety of power equipment, including rollers and shakers, and some electronic gear such as sonars (Leitz and Proverbs, 1979). It can be convincingly argued that many of these additions (particularly power equipment) reduce the cost of operating the individual vessel, and may even be necessary given the rudimentary nature of the initial technology employed. However, in terms of the entire fishery, there has been a substantial increase in the capital costs of fishing since 1976 while there has not been an equivalent increase in physical output.

Surprisingly, in light of the increased mechanisation of the gillnet operation, labour input to the fishery does not appear to be declining. Data from 1977 and 1979 surveys of herring operators show a marginal increase in crew size per punt from 2.3 to 2.6 individuals. It appears that because of the increased value of the resource, operators are attempting to guarantee a crew size capable of fishing continuously during the season (Leitz and Proverbs, 1979). A similar trend is indicated by the intensity with which each vessel is fished over the season. In the initial years, most gillnet vessels fished in only one or two areas, but a trend towards fishing in many areas has developed. In order to facilitate this a number of ingenious methods have been devised. The major problems for gillnet mobility lay in both weather conditions and time. The punt itself was incapable of more than local movement and required some form of transportation between areas. Early in the fishery this was usually provided by small vessels such as salmon gillnets or trollers, however, due to both weather conditions and the running time required to reach widely separated areas, this implied that many openings were simply out of range. Some instances of large mother ships carrying multiple punts and running a form of "dory" operation have now appeared in the fishery. In addition, the use of road transport facilities to haul punts between areas has become relatively commonplace. The end result has been a general increase in the ability of the gillnet fleet to concentrate in any given area for the roe herring opening.

Within the seine fleet the various trends are much less clear. The reason for this lies in the fact that 90 per cent of the roe herring fleet consists of licenced salmon seiners. As a result, it is difficult to isolate phenomena that are specific to each fishery.

Tables 6A and 6B provide a summary of trends in selected average vessel characteristics in the salmon seine and the herring seine fleet. While it is clear that the average herring vessel is larger than its salmon counterpart in terms of a variety of basic measures, such as net and gross tonnage, vessel motive power and vessel market value, the trends over time do not indicate substantial differences. Although there has been capital investment in the herring seine fleet, there appears to be little evidence that these trends have been spurred specific-

Table 5. Estimated average vessel characteristics of roe herring gillnet punts 1973 to 1979

Average Vessel Characteristics	1973	1974	1975	1976	1977
Length in feet	22.0	24.1	24.2	24.9	24.2
Gross tonnage	3.6	4.5	4.7	5.5	5.9
Net tonnage	2.2	3.0	3.0	3.3	3.4
Horsepower	28	31	28	33	32
Age in years	0.5	1.0	1.9	3.4	3.7
Percent rebuilt	1	2	2	3	5
Vessel market value ($ Can '000)	4.0	4.0	4.1	6.9	7.5

Source: Sinclair (1978 Vol. II).

Table 6A. Average vessel characteristics and days fished of all licensed vessels reporting herring seine landings 1972 to 1977

Average Vessel Characteristics	1972	1973	1974	1975	1976	1977
Length in feet	65.2	65.0	63.2	67.7	64.3	66.6
Gross tonnage	74.3	73.6	66.8	73.4	69.9	77.3
Net tonnage	44.3	50.3	46.4	48.8	43.5	46.6
Horsepower	259	265	253	276	288	319
Age in years	25.8	24.6	26.5	23.0	23.1	22.0
Percent rebuilt	23	27	27	26	25	25
Vessel market value ($ Can '000)	95.0	131.6	189.9	203.4	214.8	263.0
Days Fished						
Herring seine	9.4	7.8	9.1	6.9	8.2	10.0

Source: Sinclair (1978 Vol. II).

Table 6B. Average vessel characteristics of licensed salmon seiners - 1972 to 1977

Average Characteristics	1972	1973	1974	1975	1976	1977
Length in feet	54.2	55.8	56.7	57.7	56.3	57.7
Gross tonnage	40.9	43.6	45.3	46.9	45.9	49.0
Net tonnage	27.2	29.7	31.3	31.5	29.4	29.7
Horsepower	170	185	194	206	221	232
Age in years	32.5	30.9	30.2	29.0	28.8	29.1
Percent rebuilt	20	20	22	25	25	27
Vessel market value ($ Can '000)	50.9	75.1	137.4	139.7	155.6	175.0

Source: Sinclair (1978 Vol.II).

ally by events in the roe fishery. The evidence seems clearer with respect to labour input. In 1975, the average vessel fished 6.9 days on seine gear in the herring fishery. By 1977, this had increased to 10.0 days and evidence since that time indicates further increases. As with the gillnet fishery, the increased value of the resource has meant increasing concentration of the fleet for any given opening.

These events have important implications for the various objectives of the herring licencing programme. With respect to the conservation objective the trends have been particularly dangerous. The increasing ability of the fleet to concentrate for any particular opening, and the increasing intensity with which gear in the gillnet fishery is utilized, have provided some serious field management problems. In certain areas the concentration of gear for the opening is so great relative to the availability of fish that the field officer is unable to open the fishery and the catch must be foregone. In all cases there is an increasing danger for the stocks in an open fishery; the rapidity of fleet operation is now such that the consequence of even minor management error may be disaster. In part, this problem is reflected in the decreasing length of open seasons. Some years ago gillnet openings lasted several days and sometimes a week or more in particular locales, now it is unusual for a fishery to last more than one or two days. With the seine fleet, the ultimate extreme has now been reached, with the phenomenon of fifteen minute openings relatively commonplace.

There is some indication that the herring stocks may be already over-fished. Catches in 1979 were only 50 per cent of those in 1977 (see table 2). The figures for the 1980 season are still preliminary and analysis is complicated by an industry strike, but the evidence points to even lower stock abundance in this year. While it is not conclusively proven that these events result from over-fishing, and may simply reflect a cyclical trough in biological availability, the pattern is ominous.

With respect to the fishermen's income objective of the programme, an assessment at this point in time is difficult. In 1978 and 1979 both net and gross returns from the fishery were exceptionally high, but in 1980 the bottom fell out of the roe market. Throughout this entire period, the market was in serious disequilibrium. In 1979, exceptionally short supplies of roe led to cut-throat price competition among Japanese importers, and some alleged attempts to manipulate the market. The result was a tendency towards over-pricing of the final product and consequent consumer intransigence which culminated in an organized consumer boycott during the critical New Year period. As a consequence there was a carry-over of roe product into 1980 estimated at between two and three thousand metric tons or fully one-third of total 1979 roe imports. One of the major importers, Hokusho, was pushed into bankruptcy with large inventories of product and most of the major participants withstood substantial financial shocks. Both the carry-over and the general retrenchment in the market resulted in the downward pressure on 1980 prices for roe herring.

These low prices reverberated in British Columbia. The landed prices offered by processors in their annual negotiations with the United Fishermen and Allied Workers Union were in the region of $600 to $700 per short ton down from an average realized price of close to $3,000 in the preceding season. The Union refused to accept these prices, and eventual failure to reach an agreement resulted in a fishermen's strike. As a result, fully 70 per cent of the licenced fleet remained tied up throughout the 1980 fishing season.

It is difficult to avoid a relatively pessimistic scenario regarding future roe prices. While it is possible that 1980 prices were unusually low, it is clear that 1979 prices were artificially high. What the future will bring depends upon two unknowns. First, over the last few years British Columbia has faced a market almost devoid of competing supplies and it is unlikely that this situation can continue. Apparently, suitable stocks of roe herring exist in the Bering Sea under United States jurisdiction and recently exploitation has begun. Also, there is the question mark of China. It is unknown why the previously significant Chinese supplies of herring roe failed to materialize after 1974. However, even with a scenario of gross over-fishing of the Chinese stocks, the British Columbia experience of rapid stock recovery does not bode well. The second unknown lies in exchange rate movements, and already the Canadian dollar has recovered somewhat in relation to the Japanese yen. In mid-1980, exchange rates lay between 200 and 225 yen per Canadian dollar.

All of the above is evidence that future roe prices will be lower and perhaps more stable than during the late 1970's. The effectiveness of the roe licencing programme with respect to its income objective depends crucially upon the level at which prices stabilize. In response to the immense increase in value of the resource over the late 1970's there was substantial capital investment in the fleet. While the trends are much clearer with the gillnet fleet, undoubtedly this also occurred to some extent with the seine fleet. As a consequence, if the landed value of the resource were to decline towards its pre-1976 level, it is unlikely that the fleet could survive at its current size with adequate returns to cover costs.

During the late 1970's there is little reason to be satisfied with the performance of the programme with respect to the revenue objective of licencing. The initial licence fees were adequate in 1974 when applied to a $10 million fishery, but these fees remained completely unchanged in spite of immense increases in the value of the resource. The direct consequences of limited licencing was to create a privileged group of individuals with the right to exploit a publicly-owned resource. The failure of the licencing programme to appropriate at least a part of these benefits in the form of a resource rent is undoubtedly a significant failing. The vast increases in resource value completely accrued, in the form of windfall gains, to that select group of individuals licenced in 1974. While there is a pre-disposition on the part of politicians and the political system towards leaving the rents of marine resources within the fishery for distributional reasons, the level of returns in this case goes far beyond any rationalization in this direction.

Many analysts do not appear to take this type of failure particularly seriously (for example, Scott, 1979). After all, many natural resource, such as land, were alienated to the benefit of private owners long ago, and this is simply the continuation of a well-developed process. This argument is intuitively appealing but it fails to account for numerous exceptions and recent trends. In the context of British Columbia, the alienation of natural resources from public control has not been common practice for over a century. Oil and gas, minerals and even forests have for the most part remained in the public domain. All of these resources are subject to suitable fees and taxes which provide a large share of the public revenue of the province. There are few convincing arguments for this fishery to receive any exceptional treatment.

CONCLUSION

The salmon fishery was a traditional fishery; one which had been pursued on a consistent and continuous basis for close to a century on Canada's West Coast. It was a fishery which was already well developed and severely over-capitalized when licence limitation was implemented. In contrast, while the British Columbia herring fishery had been carried on for many years, the new roe fishery bore little relation to its reduction predecessor, and the closure of the reduction fishery in the late 1960's had effectively cleaned the slate. Some entrepreneurs had moved or sold their vessels into the East Coast herring fishery or had utilized the lax provisions of the licencing scheme for the salmon fishery to participate in that industry. There were few vested interests to be protected, and due to the relative novelty of the fishery it could not be defined as over-capitalized. In effect, this fishery represented a unique opportunity to implement rational management policies before substantial deterioration occurred.

A too-harsh judgement of the programme is clearly inappropriate. Given the ten-fold increase in the value of the resource over the late 1970's resource management would have been untenable some time ago under open access conditions. In a very definite sense it was fortunate that limited licencing was implemented. However, it would be wrong to describe the programme as an overwhelming success. Serious problems of biological management have occurred due to increasing investment in individual vessels and more intensive fishing of these individual units. An evaluation of the programme with respect to its income objective must await a longer test of time. Certainly in the short term the programme generated substantial benefits, but the longer term outlook is not optimistic given both the uncertain biological situation and a realistic assessment of market conditions. Finally, with respect to the government revenue objective, the programme must be considered an abject failure. While licence fees have generated adequate revenue to cover management costs, and this is unusual in the context of fisheries, there were substantial rents accruing in this fishery over the late 1970's. No attempt was made to appropriate any part of these revenues for the public purse.

In the light of the above situation, it is evident that additional management measures will be necessary in the near future. Prior to the 1980 season allowable gillnet gear was halved from 150 fathoms to 75 fathoms of net per vessel. Also, a variety of unsuccessful attempts were made to obtain agreement among seiners to "pool" in groups of two thereby halving the active seine fleet. While this reflects the anxiety of management regarding the current status of the roe herring stocks, these are stop-gap measures that fail to address the fundamental problems. Although it may be necessary to implement such measures before the situation deteriorates further, it is equally necessary that a long term strategy be implemented as soon as possible. It is a sad fact, but it is obvious that the original licencing proceeded on a too-generous basis. In attempting to share the wealth as broadly as possible, the number of vessels allowed to participate is far in excess of both biological availability and management capability and this may have driven the resource to the verge of catastrophe.

There is a variety of potential long term directions for the management of this fishery and while this is not the place to examine these in great detail, some general comments are appropriate. Individual vessel quotas have recently received considerable attention (Scott, 1979; Pearse and Maloney, 1979). This general approach is knowledgeably outlined by Dr Crutchfield and the case in favour of vessel quotas is convincingly presented by Dr Pearse in the proceedings of this conference. The approach has considerable theoretical appeal, and if implementable, would undoubtedly solve the variety of problems plaguing the roe herring industry. However, some words of caution are necessary. A basic problem with any attempt to manage fisheries on the basis of individual vessel quotas is the unavoidable uncertainty about the availability of stocks. The more variable the stock, the more significant are the ensuing problems and the less practical are individual vessel quotas as a management technique. Furthermore, the problem of quota distribution among individual fishermen is not easy, and in this writer's mind is the fundamental problem with the quota approach. No equitable and politically acceptable mechanism for allocation of fishing rights comes easily to mind.

An alternative approach is to build on the basis of the current licencing system. The problems in the roe herring fishery have not arisen due to problems with licence limitation as such, but from a failure to proceed far enough and to carry through additional necessary steps. A limited entry programme which allowed the active fleet to triple in size was not a particularly forceful measure. In addition, there were neither replacement restrictions on the vessels which were allowed to participate, nor appropriate licence fees to cool the tendency towards increased investment within the restricted fleet during the late 1970's. Such steps are an absolutely necessary part of any attempt to rehabilitate the licencing programme. Also it is evident that some means must be found to reduce the fleet from its now over-capitalized level. Within the context of the current licencing programme this implies some form of "buy-back" plan. In addition to the distributional considerations commented upon earlier, this also has important implications for the future level of licence fees. As noted by Dr Crutchfield, the failure to appropriate at least part of the rising incomes of the remaining participants as the fleet is reduced, will imply that buy-back becomes unrealistically expensive.

While these latter measures are not as theoretically elegant as the proposed quotas for individual vessels, they may be more feasible in the immediate future. It must be admitted, however, that they are no panacea. They do not eliminate, but simply control the perverse pattern of competition among fishermen for a share of the limited resource. In this light, perhaps a high priority should be given to developing the preconditions necessary for the implementation of individual vessel quotas. Perhaps both approaches should be viewed as complementary rather than competitive.

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8

LIMITED ENTRY IN THE ABALONE FISHERY OF VICTORIA

by

Kingsley Stanistreet

INTRODUCTION

The fishery began in the summer of 1963/64. Following several years of rapid development, it was decided that the abalone resource was being subjected to excessive exploitation which in turn led to licence limitation being introduced in 1968. Licences were issued to all divers who were then engaged in the fishery. Since that time the number of divers in the fishery has declined as divers have voluntarily left and not been replaced. When considering whether to grant or refuse a licence the Director of the Fisheries and Wildlife Division (FWD), Ministry of Conservation, is required to have regard for the welfare of the fishery and those working in it. In renewing a licence he is required to consider whether the fisherman has been regularly, substantially and actively engaged in fishing.

Zoning was progressively introduced into the fishery and there are now three zones; a Western Zone which stretches from the South Australian and Victorian border to Warrnambool, a Central Zone from Warrnambool to Lakes Entrance, and an Eastern Zone from Lakes Entrance to the border of Victoria and New South Wales. Following the implementation of licence limitation in 1968 a number of divers immediately left the fishery, presumably because of the relatively high licence fee. Because the FWD has not replaced divers who retired from the fishery the numbers have been further reduced.

In 1968 there were about 200 divers in the State but these had been reduced to 100 by late-March 1979 - 32 in the Eastern Zone, 52 in the Central Zone and 16 in the Western Zone. Recently, eight divers were removed because they were unable to show active, regular and substantial involvement (known as the "show cause" provision), and one diver retired leaving 91 licence-holders.

Abalone are collected by divers using a hose with compressed air pumped from a compressor on the boat. The divers swim along the seabed searching and then prising the abalone from the rocks on which they are attached. When they have filled the large meshed bags they carry, the divers bring the catch to the surface where it is hauled into the boat. Under the existing practice the abalone are stored alive on the boat for subsequent transport to a shore-based establishment where they are processed. The divers operate at all depths down to about 30 metres but most commonly at depths between 10 and 20 metres. They average about six diving days per month and on each of these days they spend about six hours in the water. Using neoprene wetsuits the divers are able to operate during all months of the year subject only to weather conditions.

The boats used by the divers are typically fast runabouts about seven metres long, equipped with powerful outboard motors. Other equipment on the boats consists of an air-compressor and some means of storing the catch and lifting it aboard. As the abalone catch is destined for export the storage facilities must enable the abalone to be maintained in a manner specified by the Commonwealth Department of Primary Industry.

In the 11 years since limited entry was introduced into the abalone fishery there has been time enough to assess the merits and demerits of the measure. Unfortunately there has not been the money and resources available to make an indepth, scientific study of this valuable experience, although more scientific work has been done in this fishery recently than any other fishery in Victoria.

THE PROBLEMS OF LIMITED ENTRY

There have been several attempts to come to grips with the problems which have arisen during the course of the programme. In the early days of the fishery these problems resulted in a good deal of suspicion and heated discussion between fishermen and the managers. The basic issues were the optimum utilization of the resource and, through that, the efforts to increase the number of operators, especially to replace those retiring.The fishermen were opposed to any new or replaced licences because they claimed the fishery was over-exploited. One of the most important events in trying to solve these problems was a "Workshop Paper" produced by a group of FWD officers in 1973.

THE "WORKSHOP" PAPER OF 1973:

The purpose of the "Workshop" was to discuss a particular problem of the licencing scheme which was concerning the FWD, namely, that they felt the resource was tending to be under-fished. The FWD argued that this was arising because licenced fishermen were exerting less effort as they grew older or became more affluent through rising prices and stable conditions in the fishery. This in turn raised the question of "how to get new entrants into a limited entry fishery?" Conversely, if prices collapsed or the fishery declined, "how to get licences out of the fishery?"

The "workshop" paper was produced by officers of the FWD with no input from the fishermen. As a result it was a theoretical paper which presented an idealized solution to the problem while ignoring many practical difficulties. The paper was based on the notion that the optimum number of divers could be obtained from the following relationship:

$$\text{Optimal number of divers} = \frac{\text{Optimal sustainable production x unit price}}{\text{gross allowance per diver}}$$

where;

Gross allowance per diver = Fixed costs + variable costs (type A) x days fished + variable costs (type B) x quantity caught + an "acceptable" allowance for divers' labour

Type A costs; costs which vary with time spent fishing

Type B costs; costs which vary with quantity caught

It was noted that the use of the formula was dependent on obtaining a considerable amount of information and it was decided that the values for insertion into the formula should initially be as follows:

a) Optimum sustainable production: pending the completion of the present research programme the optimum sustainable production should be taken as equivalent to the mean annual production over the past three years.

b) Catch per diving day: the mean catch per diving day for the previous year should be used in the formula. This information can readily be obtained from diver, co-operative and processor records.

c) Unit price: the mean price for the past six months should be used. This information is also readily available, particularly from co-operatives and processors.

d) Fixed and variable costs: it was agreed that this information should be obtained by an economic assessment of the fishery which would then be subjected to scrutiny and verification if necessary by the industry prior to insertion in the formula.

e) Acceptable allowance: because it was anticipated that the fixing of an acceptable allowance may be particularly controversial it was decided that the value should be determined jointly by government and industry representatives. It was recognised that the initial choice of the acceptable allowance could not be exact and that the allowance should be linked with the consumer price index (or some index of average prices).

This paper raised a storm of protest among fishermen because they saw it as giving public servants power to fix and control the incomes of fishermen, tying those incomes to consumer price indexes, and issuing or removing licences according to this model. In addition the paper suggested establishing "provisional licences" which could be issued and revoked as prices, cost and consumer price indexes varied. In the view of fishermen it was easy to get additional divers into the industry but impossible to remove them without a buy-back scheme.

FISHERMEN STUDY MANAGEMENT PHILOSOPHY

To counter the ideas of the FWD officers, fishermen began to delve into the works of Gulland, Copes and many others in an effort to understand the mysteries of biology and management, and to meet the scientists on their own ground and with their own arguments and language. Out of this fermenting of ideas and the struggle by fishermen against the concepts of the "workshop paper", developed the Seminar on Licence Limitation held in Melbourne in September 1974. This was not only the scene of the greatest show of united strength by fishermen in Victoria, and confrontation with Fisheries Officers, but also marked the emergence for the first time of a theoretical platform in a number of the papers presented by fishermen. No problems were solved by the Seminar but it crystalised the ideas of both fishermen and the managers and pointed to the problems awaiting solution which had arisen out of the experiences of limited entry up to that time. It rejected the "workshop" theory of management although some of the "workshop's" ideas were later incorporated in the management strategy in a modified form.

Victoria was fortunate to have an interested and practical Minister of Fisheries (W.A. Borthwick) who could see the stand-off situation existing between his Department and fishermen. He acted to resolve it by going out to the fishing ports and speaking to fishermen's leaders. Out of these meetings was born the Victorian Commercial Fisheries Management Committee.

VICTORIAN COMMERCIAL FISHERIES MANAGEMENT COMMITTEE

The Act to set up the Victorian Commercial Fisheries Management Committee also established a Licencing Panel and an Appeals Tribunal.

On all these committees fishermen had equal representation with Government. The foundation of the Management Committee has been the turning point in management of limited entry fisheries in Victoria, and a turning point in relations between fishermen and managers. I believe that both now see and understand far more of each other's problems and point of view than ever before. The advent of the Committee has not changed the nature of the problems but has turned them into total industry problems and not just managers' problems. As a result their solution is a continuing and developing practical process. One might say a uniting of theory and practice; through the constant examination of how theory works in practice, knowledge is extended and theories remoulded.

As I see it the central issues of limited entry as a means of achieving the best use of a community resource are:

* determining the "right" number of divers to ensure the "right" quantity of effort;

* maintaining those "right" numbers;

* compensating the community for the use of its resources and for the privilege of belonging to an "exclusive club".

All other problems of limited entry are, I believe, derived from these basic issues or created by various tactics used to solve them. Thus, various parties associated with the fishery have raised such matters as the sale and transfer of licences, buy-back schemes, auctions or ballots for licences, licence fees and royalties - all of which are attempts to come to grips with the key issues of limited entry. An important meeting of the Victorian Commercial Fisheries Management Committee took place in December 1976 when it passed a number of resolutions for the future management of the abalone fishery.

RESOLUTIONS OF THE MANAGEMENT COMMITTEE 1976

LICENCE LIMITATION

The Committee resolved that licence limitation in the abalone fishery should continue. The justification for this decision was the committee's responsibility for the welfare of those engaged in the fishery while at the same time ensuring the stocks are not over-exploited. The Committee recognised also that the past, and still then existing, policy of not re-issuing licences when they were retired could not be continued indefinitely as this would lead to the fishery being under-exploited and manned by progressively fewer divers of progressively higher age - the "grandfather fleet" syndrome.

The Committee accepted the concept of a "right" number of divers for the fishery which would alter from time to time with the availability of abalone and the economics of fishing. It resolved to undertake the task of determining the "right" number at each review of the fishery and to recommend adjustments to the number of divers if and when the number within the fishery was substantially different from the "right" number.

DETERMINING THE "RIGHT" NUMBER OF DIVERS:

Amongst the many possible management objectives for the fishery the Committee resolved that the following two were the most desirable:

1. obtaining a high level of production in the fishery (defined arbitrarily by the Committee as 90 per cent of the maximum sustainable yield);

2. obtaining the maximum economic return to labour and capital for the fishery.

The Committee noted that these objectives could conflict and it was unlikely that they could be achieved concurrently. Therefore, the Committee resolved that in the process of determining the "right" number at each review of the fishery, it would choose a number which attempted to achieve the "best" compromise between these two objectives. This left room, after studying all available data, for value judgements by the Committee, which while being subjective were likely to take account of social considerations.

In recognition that the fishery was divided into a number of zones, each of which was unique in its productivity and economic viability, the Committee resolved that the process of determining the "right" number of divers should be undertaken for each zone independently. The Committee examined the available information for each zone and noted that the numbers of divers licenced in each were presently close to what it considered were the "right" numbers. Rather than recommend minor adjustments at that stage the Committee resolved that the number of divers in each zone should remain unchanged until July 1977, when the position would be reviewed.

In making the above resolutions the Committee recognized the uncertainty about future market demand for the Australian product arising from a discovery of "low priced" abalone-like shellfish from Chile (Locos). Furthermore, the Committee felt it was wise to allow sufficient time to assess the effect of its other resolutions, such as the application of the "show cause" provisions, before adjusting the number of divers. It was also resolved that any divers leaving the fishery before the next review of the "right" numbers should not be replaced.

In practice, the way the problem of maintaining the "right" number of licences has been tackled is best seen by examining an actual case in detail. In the Eastern Zone of Victoria there were 32 divers in 1978. Of these four worked hardly at all and six worked very little. In fact overall effort equalled only 22 "active" divers. Yield and cost curves (figures 1 and 2) were produced for the number of licenced divers, and then produced for 22 divers, making the assumption that the total fishing effort was appilied only by these 22 "active" divers. This assumption effectively lowers the cost curve and increases the efficiency of the fleet. These curves show more accurately how many "active" divers there should be in each zone.

The approach used by the managers in recognizing the variability in the "right" number of divers is to consider two "goal posts". The point of maximum economic yield (MEY) is taken as the left-hand post, while maximum sustainable yield (MSY) minus ten per cent is taken as the right-hand post. The managers then have the option to kick towards one goal post or the other after taking account of influences such as data on size of fish,

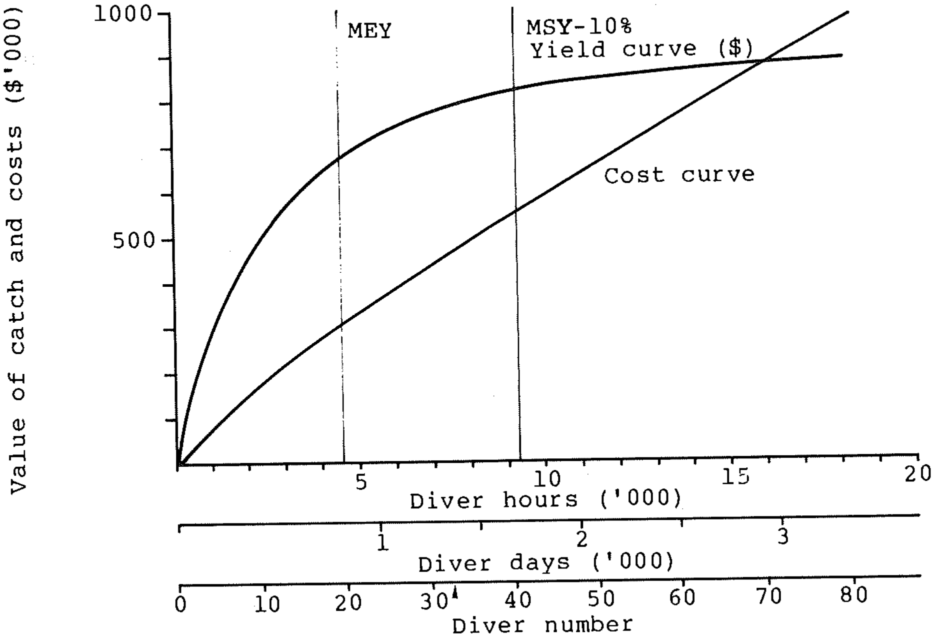

Figure 1 : Eastern Zone (32 licences)

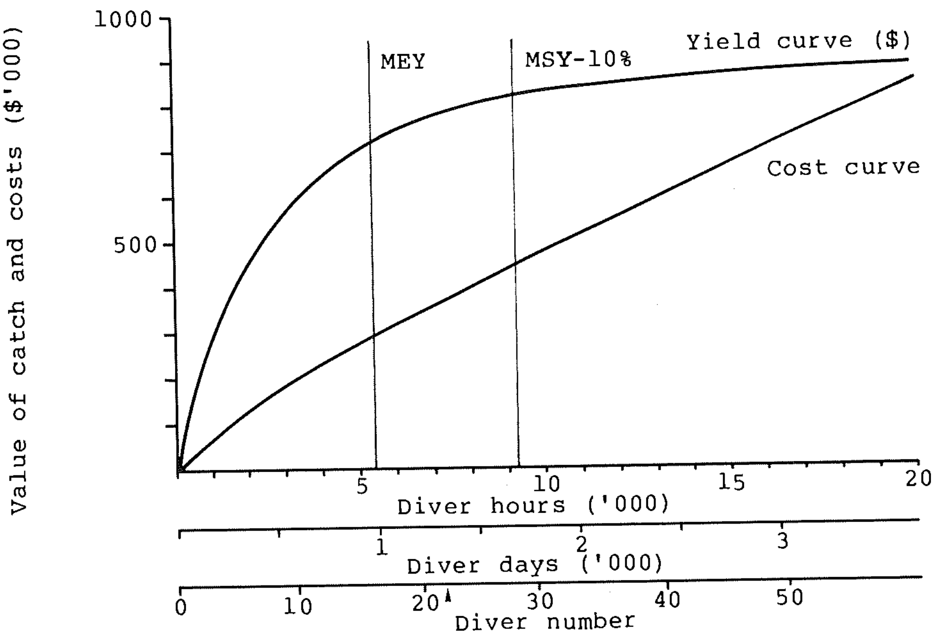

Figure 2 : Eastern Zone (22 licences)

future prices, future trends in effort and catch per unit effort, and trends in recruitment.

In figure 1 (32 divers) the "goal posts" vary from 20 divers at the point of MEY to 40 at the point of MSY minus ten per cent. In figure 2 (22 divers) the numbers vary from 12 divers to 28. The current figure of 22 "active" divers is, therefore, just about a straight goal scored.

When examining these curves for each zone the Committee took account of the above influences and decided to kick towards the right-hand goal post of 90 per cent MSY. History will show whether this was correct, but the number involved cannot have a major affect on effort or the resource.

APPLICATION OF THE "SHOW-CAUSE" PROVISION

In recognising that a number of divers now licenced for the fishery had either ceased diving or were diving very little, the Committee resolved that during 1977 all such persons should be identified. Unless there were acceptable mitigating circumstances, they should be asked to "show cause" why their licences should be renewed on March 31, 1978 (the next date of renewal).

In considering the criteria for judging whether to invoke the "show-cause" provisions the Committee noted that the requirement of the Fisheries Act (1958), namely, to be "actively" engaged, had little relevance to abalone divers because it was not legally possible for any other persons to be actively engaged on behalf of the divers. For the purposes of applying the provision, however, the other requirements were defined as follows:

1. to be "regularly" engaged, the diver should have fished at a level similar to other fully active divers for at least six months during each of the years in question;

2. to be "substantially" engaged, the number of days fished and the catch of the diver should not be less than half the average values per diver derived from the records of all the divers operating in that zone during the years in question.

It was resolved that the application of the "show-cause" provision should take place at three-yearly intervals. Also, that persons who may enter the fishery in subsequent years should be subjected to the "show cause" provisions at the end of their first year in the fishery and thereafter at the same time as other divers in the fishery.

The Committee resolved that the administration of the "show-cause" provisions should include the following procedures:

* at the completion of each three-year period the Fisheries Licencing Panel should prepare a list of those divers who should be required to "show-cause":

* each person on the list should be interviewed by a Fisheries and Wildlife Officer to determine if any mitigating circumstances had led to the "low" level of activity;

* on the basis of the reports from the Fisheries and Wildlife Officers and any other relevant information, an amended list should be prepared by the Panel and forwarded to the Director of the FWD with a recommendation for the listed persons to be requested to "show-cause";

* responses arising from these requests should be examined by the Panel and recommendations to the Director to refuse licence renewal of those considered not to have "shown-cause".

Subject to the acceptance of these resolutions the Committee decided that the first application of the "show-cause" provisions on March 31, 1978, should relate to the three years to December 31, 1977. As an interim measure until the next review of the "right" number of divers, none of the divers who fail to "show-cause" should be replaced nor should any licences be held in reserve against appeals before the Tribunal.

CRITERIA FOR CHOOSING BETWEEN FUTURE ENTRANTS

The Committee resolved that future entrants into the abalone fishery should meet prescribed standards (yet to be determined) of health and diving competency as well as be "fit and proper" persons as is now required. Furthermore, it was resolved that applicants should possess an appropriate Certificate relating to boat handling as prescribed by the Victorian Marine Board.

Recognising that the number of vacancies within the fishery at any one time is likely to be exceeded by the number of persons wishing to enter, the Committee resolved there should be a quantitative method of choosing between those who meet the pre-requisites. This method should be based on the potential diver's relative merit. For this purpose the following scheme for assessing relative merit was drafted with the intention that the vacancies be allotted to the applicants with the highest scores;

1. Fishing Industry Experience (Maximum score : 30 points)

* applicants score six points for every year during the past five years they have engaged in a commercial abalone fishery either as divers or shellers;

* applicants who do not meet the above requirements score three points for every year during the past five years they have engaged in a commercial diving fishery other than the abalone fishery;

* applicants who do not meet the above requirements score two points for every year during the past five years they have engaged in commercial fishing;

* applicants who meet none of the above requirements score no points.

2. Age (Maximum score : 20 points)

* applicants aged 20 years or less score 20 points.

* applicants older than 20 years score 20 points, less one-half point for each year in which their ages are in excess of 20 years.

* applicants aged 60 years or greater score no points.

3. Residence (Maximum score : 20 points)

* applicants residing in or near the zone for which there is vacancy score 20 points.

* applicants who do not meet the above requirements score no points.

4. Time on the Waiting List (Maximum score : 20 points)

* applicants receive one point for every quarter-year from the date of receipt by the FWD of their licence application.

5. Filial Relationship to a Fisherman (Maximum score : 10 points)

* applicants belonging to the immediate family of an abalone diver score ten points;

* applicants who do not meet the above requirement but who belong to the immediate family of a commercial fisherman score five points;

* applicants who meet none of the above requirements score no points.

The Committee resolved that if it were necessary to choose between applicants having an identical score, this should be done by means of a ballot.

INTER-ZONE TRANSFERS

The desirability of allowing divers to transfer from one zone to another was discussed and the Committee resolved that transfers would be permitted only when a vacancy occurs as a result of a diver leaving the industry and relinquishing his licence. In such a case, divers in other zones should have priority over applicants from "outside" the fishery. If there were more divers wishing to transfer than there were vacancies, the successful applicant should be chosen by means of ballot.

Due to technical and administrative reasons, it was not until the re-issue of licences on April 1, 1979 that the "show-cause" provisions were finally applied. When it was done, it was found that 23 of the 100 divers in Victoria had failed to meet the criteria, that is, had caught less than half the zone average, or had fished less than six months in each of the preceeding three years at a rate equal to the average rate. The Licencing Panel investigating these cases recommended that the Director refuse to issue licences to only eight of those asked to "show-cause". These divers had worked on average only seven days in each of the preceeding three years and had taken only 1000 kg live weight of abalone each year valued at around $2000.00. In addition each had received his major income from another source, ranging from hotel manager to slaughterman. The remaining divers who avoided cancellation of licences averaged 4500 kg in each of the preceding three years valued at round $9000.00. Their net income from abalone fishing probably would have been in the vicinity of $5000.00.

The basic explanations given by all these divers for their low activity were:

(a) life style;

(b) illness;

(c) both life style and illness.

On each of these counts it would be very difficult to mount a convincing case for the cancellation of their licence, or to sustain it in the inevitable appeal which would follow. However this should not create great concern provided the effort is increased by recruiting new effort proportional to the decline in effort on the part of the "sub-average group". For example, if this sub-average group in any zone numbers (say) ten divers who equal, over the preceeding three years, only three "average" divers in diving days and total catch, then by increasing the numbers by seven this should restore the balance and vigour of the fishery.

GRADUAL RECRUITMENT AND REPLACEMENT

The bonus in this type of management is that new divers are recruited gradually and adjustments can be made after studying the effects of previous additions. One thing is certain, being human we will make mistakes. The bigger and more hasty the decision, the bigger and more damaging will be the mistakes. Therefore, where possible the considered, step by step approach has much to recommend it.

The humanitarian aspect is also important. That is, those whose life style is satisfied by relatively low incomes and low work input are not flung out of the industry but are allowed to "do their own thing". These divers have little effect on the resource and its management and do not prevent new recruits entering from the waiting lists. The "grandfather fleet" syndrome is avoided. Similarly, those who are ill but whose illness is not serious enough to prevent them from working at a reduced level, are able to do so without fear of losing their licence.

Under such management one would expect the "original" force of divers to be turned over in a relatively short period; the major effort being exerted more by the newer entrants to the fishery. Ipso facto, this gradual process of renewal would be a continuous process. The points system for entry gives an almost certain position at the top of the list for a young person, of the immediate family of a fisherman, who has spent five years on the waiting list, has worked in the industry for three years as crew and who lives in the zone where the vacancy occurs.

SLOW RECRUITMENT AND RETIREMENT

There are two main reasons for the slow retirement of divers from the abalone industry and the consequent slowness of recruiting new fishermen. Firstly, almost all the divers came into the industry fifteen years ago as young men in their early to mid-twenties. Therefore, most are now in their late thirties to early forties. There are notable exceptions, at least one is over sixty and several over fifty. However, as a group the movement had been to diversify gradually into other occupations rather than retirement, as the heavy and demanding work of diving made its impact. Secondly, the carrot of possibly being able to sell their licences has kept people in the industry who otherwise would have allowed their licence to lapse and seek other occupations.

SALE AND TRANSFER OF LICENCES

It is noticeable that as the average age of divers increases and the effort of the "sub-average effort" section declines, the clamour for sale of licences increases. It is particularly strong now; I would estimate that if licences suddenly became saleable about one-third of all licences in Victoria would change hands at prices I believe, up to $50,000. The latest licence to be sold in the Tasmanian fishery changed hands at $120,000.

Much has been said for and against the sale of licences. I am unashamedly opposed to the sale and transfer of licence attaching to the person, such as abalone licences. On the other hand, I support the sale of licences attaching to a boat. I have two main reasons for this belief. Firstly there would be a sudden influx of new, mostly young and fit men with a high debt structure above them and the consequent impelling desire to work harder. In the main, they would replace the "sub-average effort" group which comprises one-third of the diving force, resulting in extra effort which the resource could not handle and which, unlike other fisheries, would be impossible to control. This in turn would force other, older persons under pressure of competition to sell, and in two years the position would be aggravated to a point where the entire diving force could be replaced. Based on present day "low effort" numbers the resultant effort would be in excess of the "right" quantity. Management would be extremely difficult and the excess effort could only be removed by extraordinary and possibly harsh measures.

My second reason for opposing saleable abalone licences is that they would bring unproductive over-head costs on the industry. This amount would possibly reach $1,000,000 a year for the payment of principal and interest on loans in Victoria (and it could be much higher depending on how many licences sold and for how much). This would be beyond the capacity of industry to pay without hardship and would be against the interest of future generations of fishermen. Similarly, to licence only sufficient divers to fish to the point of MEY before allowing sale of licences would, I believe, bring in its train either an increase in licence fees or some other method of skimming-off the surplus.

The effects of these increased costs on the industry, as with the borrowing of money to purchase licences would in the long term depress the industry, remove initiative and create difficult problems for management. The setting of amounts of royalty or super-high licence fees to skim-off surplus would again involve the concept of fixing and controlling average incomes in the fishery, and would be a return of the "workshop" concept of incomes discussed earlier.

A buy-back scheme, which ultimately has to be financed by industry, has only to be posed to be answered. There were, at April 1979, 100 licences in Victoria. If this number were to be reduced to the number required to fish to the MEY, the "right" number would be 84 (or less). Therefore, sixteen licences would be subject to buy-back, each conservatively valued at $50,000. This would require $800,000 to "buy-back", plus boats and gear at (say) $15,000 each or $240,000 in all. The grand total, therefore, would be in the order of $1 million. At 10 per cent interest over, say, 10 years this equals $200,000 a year spread over 84 divers, or $2380 a year extra overheads per unit, in addition to the amount paid for licences in the first instance.

This assumes that the "right" number of 84 remains constant. However, many of the 84 divers are peforming at less than their peak, and sale of licences would ensure that more vigorous, younger men would put in more effort and result in a requirement for more licences to be removed. The number of 84 would be reduced like the four minute mile - continually. Society would not gain an extra kilo or an extra dollar from the exercise as total catches would remain the same.

CONCLUSION

The "right" number of licences is never "right" for very long. Because people change, as do costs, prices and the fishery, the only constant thing about the "right" number is its variability. The Management Committee believes that the flexible approach more accurately reflects the realities of the fishery than any fixed methods of regulation, and it does so with humanity and understanding.

Whatever criticisms may be levelled at the pragmatic philosophies of management of the Victorian abalone fishery they are working. The fishery is stable, profitable, and the resource and those working in it are in good shape. This is more than can be said for many other fisheries.

9

ECONOMIC ASPECTS OF LIMITED ENTRY IN THE SOUTHERN ROCK LOBSTER FISHERY

by

R. Sudmalis

INTRODUCTION

The southern rock lobster *Jasus novaehollandiae*, the principal rock lobster species of southern eastern Australia forms the basis of a major fishery which is exploited by about 850 fishing enterprises located in Tasmania, Victoria and South Australia. These enterprises have a total investment in boats, gear and equipment in excess of $60m and a catch of rock lobster worth around $15m annually which is normally between 20-25 per cent of the value of Australian rock lobster production. The fishery is particularly important as a large part is based in scattered communities where fishing is a major economic activity.

The fishery has had limited entry management since 1966-68 as a means of halting the expansion in fishing effort and improving the economic situation of the fishery (Harrison, 1978). However, while the limited entry policies have succeeded in providing stability in boat numbers, the economic situation has not improved and over recent years it has been the cause for some concern in parts of the fishery.

Concern as to the future of the fishery has led to economic studies in 1973 and 1979; a consultant study of the future management of the South Australian sector of the industry by the Canadian resource economist Professor P. Copes and a socio-economic study of the southern zone of South Australia by the Centre for Applied Social and Survey Research of the Flinders University in South Australia.[1]

The aim of this paper is to examine some of the management and economic problems of the fishery with a view to providing some suggestions for rationalisation in the industry.

DEVELOPMENT AND MANAGEMENT

The catching sector of the industry has undergone rapid development since the early 1950's spurred on by high prices from a buoyant market for frozen tails in the United States. The nature of the fishery changed with the entry of new boats and the adoption of new technology, particularly the use of larger more "seaworthy" boats, marine engines, mechanical pot hauling, synthetic ropes, echo sounders, radios and improved gear which greatly increased the investment and fishing capability of the fleet. A notable example was the combined use of mechanical pot hauling and synthetic ropes which greatly increased the number of pots a boat could utilize.

The result was a growth in fishing effort which exceeded the growth in total production with a declining catch rate as accumulated stock was removed from the population. Production and effort in the fishery reached a peak in 1966/67 with effort increasing by 90 per cent and catch by only 26 per cent from the two previous years (table 1). By this time it had become apparent that the annual increase in the number of boats in the fishery was causing a depressed economic situation and had produced the potential for over-exploitation.

In October 1966, Tasmania limited the number of boats in the fishery to 420. Similar action was taken by Victoria in 1967 and South Australia in 1968, generally with the objective of restraining the growth in effort and stopping the decline in profitability of boats through the excessive entry of new boats in the fishery. In Victoria boat numbers were limited to about 200 and in South Australia to 437. These boats belonged to fishermen who had an intended or previous history of participation in the fishery.

The fishery was divided into five management zones, two each in Victoria and South Australia and one in Tasmania, which are managed by the relevant State fishery authorities in conjunction with the Commonwealth (see figure 1). The more traditional conservation measures such as closed seasons, legal minimum lengths and a prohibition on the taking of egg-bearing females were in force long before the restriction in boat numbers. These have been retained with alterations being made particularly with respect to the lengthening of closed seasons.

The total number of pots in the fishery was also restricted by the application of "pot allocation formulae". These formulae vary according to the zone and are based on boat length and crew size. If an owner replaces his boat with one of larger size he is restricted to his original pot numbers. If he decreases his boat size, a lower pot quota applies with the difference going out of the fishery. In Tasmania and South Australia (more recently) there can be amalgamation of pot allocations as long as they remain within the respective pot/boat length formula. The pot allocations themselves, however, are not divisible which would indicate that the policy is really aimed at amalgamation of only the very small allocations.

These formulae, when established, were not aimed at any optimum number of pots per boat but rather to give an equitable distribution of pot numbers and a reasonable income potential for boats of different size. While this seemed reasonable at the time, the combined effect of the restriction on boat numbers and rigid pot allocation formulae was to freeze the structure of the fishery and limit the types of adjustment fishermen could make in response to the economic pressures they faced. It cannot be expected that because 900 boats could receive a reasonable living

Table 1. Annual rock lobster production, effort and catch per unit effort for Victoria, Tasmania and South Australia 1964/65 to 1978/79

Year	Victoria			Tasmania			South Australia		
	Tonnes	Potlifts x10^3	Kg per Potlift	Tonnes	Potlifts x10^3	Kg Per Potlift	Tonnes	Potlifts x10^3	Kg Per Potlift
1964/65	353	274	1.29	1 685	1 180	1.43	2 237	1 242	1.80
1965/66	456	355	1.28	1 935	1 433	1.35	2 753	1 720	1.60
1966/67	428	398	1.08	2 138	1 584	1.35	2 837	3 152	0.90
1967/68	449	450	1.00	1 981	1 478	1.34	2 160	2 180	0.99
1968/69	520	549	0.95	1 867	1 598	1.17	2 289	2 466	0.93
1969/70	604	654	0.92	1 552	1 373	1.13	2 078	2 394	0.87
1970/71	601	673	0.89	1 687	1 250	1.35	2 308	2 386	0.97
1971/72	581	766	0.76	1 703	1 252	1.36	2 217	2 425	0.91
1972/73	581	807	0.72	1 954	1 242	1.57	2 711	2 619	1.03
1973/74	557	706	0.79	1 714	-	-	2 342	2 396	0.97
1974/75	379	544	0.70	1 593	1 045	1.52	2 030	2 228	0.95
1975/76	407	530	0.77	1 285	1 000	1.29	2 248	2 364	0.82
1976/77	302	-	-	1 177	-	-	1 891	2 298	0.84
1977/78	307	-	-	1 192	-	-	1 857	2 204	0.83
1978/79*	300	-	-	1 270	-	-	1 938	2 337	0.99

* Preliminary estimates by Department of Primary Industry

Source: South Eastern Australian Rock Lobster Fisheries: prepared by Rock Lobster Research Group of the South Eastern Fisheries Committee. 1978.

from the fishery in 1968 that this would be so at some future date.

ECONOMIC SITUATION

The economic situation in the fishery has been monitored by two economic surveys conducted by the Fisheries Division of the Department of Primary Industry, one covering the years 1970/71 to 1972/73 and the other 1975/76 to 1978/79. This type of information is important to both fishermen and managers. As a major objective of each fisherman is to organise his resources into the most profitable unit, a knowledge of industry profitability may be of considerable help. For managers, information on fishing operations and performance is useful for monitoring and evaluating the success of a management programme.

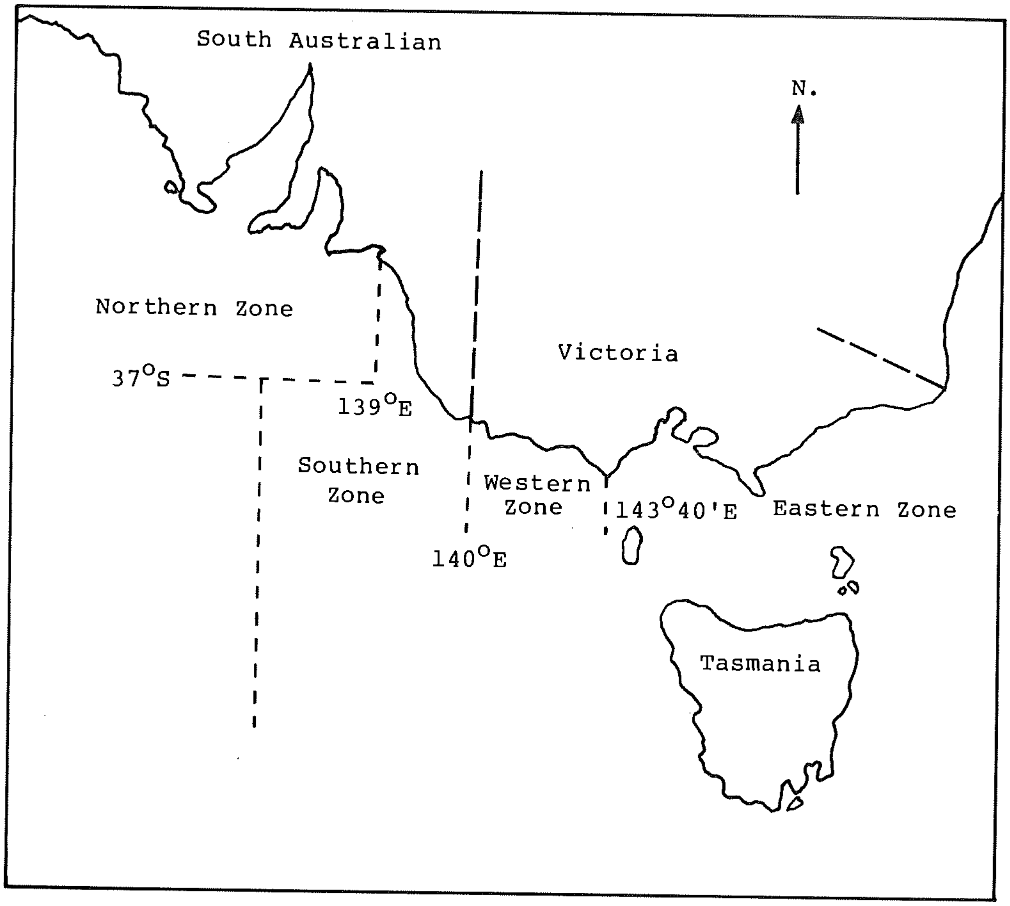

Figure 1 : Management zones in the southern rock lobster fishery

The economic surveys were conducted in 1973 and 1979 on a randomly selected sample of about 20 per cent of all southern rock lobster fishermen (see table 2 for the size structure of the fleet). Owners and/or skippers were personally interviewed and information was obtained on vessel characteristics, fishing income and costs. In addition, with permission from the individual fishermen, information from market outlets and catch and effort data were also obtained. The following sections examine the performance of the fleet and the changes which occurred in incomes and costs between the two surveys.

GROSS INCOME

Gross incomes have shown a continued upward trend in all zones between the two surveys (table 3). A more than doubling of the price of rock lobster, which has kept ahead of the rate of inflation, is largely responsible for the rise in gross incomes (table 4). The differing size of the increase in particular zones reflects the impact of variable reductions in catch per boat, the increasing importance of other species in gross income, and the ability of fishermen in some areas to take advantage of buoyant prices in the local market for rock lobster.

The greatest increase in gross incomes was in the western Victorian zone where between 1970/71 and 1978/79 the average rose by 175 per cent. The lowest increase was in the eastern Victorian zone where gross income increased by only 38 per cent over the eight year period.

Table 2. Population Structure of Southern Rock Lobster Fishery as used in 1979 Economic Survey

	Under 6m	6m and under 9m	9m and under 12m	12m and over	All Boats
Tasmanian Zone	-	28	78	186	292
Southern SA Zone	6	86	106	57	255
Northern SA Zone	9	19	39	40	107
Eastern Victoria Zone	-	42	40	14	96
Western Victoria Zone	-	11	42	37	90
Total	15	186	305	334	840

Table 3. Summary Costs and Returns 1970/71 to 1978/79

	1970/71	1971/72	1972/73	1975/76	1976/77	1977/78	1978/79	Change 1970/71-1978/79
	$	$	$	$	$	$	$	%
Southern SA Zone								
Gross Income	18 759	18 129	17 509	21 954	24 174	25 323	26 323	40
Operating Costs	5 198	5 115	5 428	7 336	7 812	8 565	10 682	106
Total Costs	10 415	10 665	10 680	13 272	14 575	15 198	15 213	46
Net Income	8 344	7 464	6 829	8 682	9 599	10 125	11 051	32
Net Income at Constant Dollars	8 344	7 036	6 043	5 168	5 026	4 821	4 868	-42
Northern SA Zone								
Gross Income	19 907	22 085	21 506	29 071	32 392	36 546	34 986	76
Operating Costs	4 973	5 737	6 538	8 996	11 013	11 727	13 398	169
Total Costs	12 883	14 309	13 432	18 883	22 506	22 367	24 182	88
Net Income	7 024	7 776	8 074	10 188	9 886	13 179	10 804	54
Net Income at Constant Dollars	7 024	7 336	7 145	6 064	5 165	6 276	4 759	-32
Eastern Victorian Zone								
Gross Income	13 278	14 255	14 971	17 948	15 977	15 567	18 358	38
Operating Costs	2 856	3 367	3 471	5 262	5 805	5 430	5 466	91
Total Costs	6 597	7 715	8 059	9 878	10 044	9 591	10 297	56
Net Income	6 681	6 540	6 912	8 070	5 933	5 976	8 061	21
Net Income at Constant Dollars	6 681	6 170	6 117	4 804	3 106	2 846	3 551	-47
Western Victorian Zone								
Gross Income	12 997	15 082	12 279	22 078	25 383	29 813	35 788	175
Operating Costs	3 967	4 015	3 656	7 717	7 669	9 854	11 986	202
Total Costs	7 618	7 795	7 629	14 086	14 938	17 905	22 155	191
Net Income	5 779	7 287	4 650	7 992	10 445	11 908	13 633	136
Net Income at Constant Dollars	5 779	6 875	4 115	4 757	5 469	5 670	6 006	4
Tasmanian Zone								
Gross Income	18 050	18 988	18 240	25 234	29 854	34 374	36 033	100
Operating Costs	4 237	4 886	4 471	7 517	8 501	10 418	12 835	203
Total Costs	10 264	11 288	11 301	15 287	17 470	19 899	23 821	132
Net Income	7 786	7 707	6 939	9 947	12 384	14 475	12 212	57
Net Income at Constant Dollars	7 786	7 271	6 140	5 920	6 483	6 893	5 380	-31

COSTS

Operating costs are costs associated with the running of the fishing boat and include trip costs, boat costs and administration costs. The total cost is the sum of depreciation, crew payment and operating costs.

The increase in operating costs in the fishery has been quite pronounced, increasing to a much greater extent than both revenue and total costs. The increase in operating costs ranged from a low of 91 per cent in the eastern Victorian zone to a high of 203 per cent in the Tasmanian zone. It has been the trip costs which have had the greatest impact in the increasing costs of fishermen. In particular, increases in fuel price have resulted in expenditure on fuel in the fishery rising threefold from $546 per boat in 1970/71 to $1772 per boat in 1978/79 (table 5). On the whole, operating costs are influenced greatly by price increases in the economy and are difficult to contain. Partly to contain this item many fishermen have used more of their own labour, postponed expenditure on maintenance to later years, and dropped discretionary costs such as boat insurance.

Total costs have not increased as much as operating costs because of the reduction in importance of crew payment in the total cost structure. In the eastern Victorian zone crew payments actually declined by 20 per cent over the period. This was mainly due to a reduction in average crew size from 1.8 to 1.5 (including the skipper) and the use of crew for only part of the season when fishing is more profitable. In the southern South Australian zone, where average crew size also dropped from 1.9 to 1.7, crew payments increased by only five per cent. Because there are maritime regulations regarding the number of crew on boats and because the number is used for calculation of the pot allocation, there is little scope for further reductions in this item.

NET INCOME

This important indicator of the economic situation in a fishery represents the return to management, invested capital, and the operator's labour. However, it cannot be interpreted as a measure of welfare as there is an increasing number of fishermen who are forced to derive a proportion of their income from other sources.

The overall trend in the fishery has been for cost increases to outstrip increases in income. The greatest disparity between cost and revenue increases was in the eastern Victorian zone which is reflected in the net income increasing by only 21 per cent throughout the eight year period. The western Victorian zone fared much better with the net income increasing by 136 per cent but only to a level which is now equivalent to that in other zones.

Table 4 Averages prices paid to fishermen for rock lobster 1967/68 to 1977/78 ($/Kg)

Year	S.A.	Vic.	Tas.	Average for fishery	CPI*	Real price	Index of real price
1967/68	1.41	1.47	1.58	1.49	100	1.49	100
1968/69	1.54	2.02	2.04	1.79	103	1.74	117
1969/70	1.54	1.85	1.75	1.66	106	1.57	105
1970/71	2.01	2.20	2.18	2.10	115	1.83	123
1971/72	2.38	2.49	2.58	2.47	122	2.02	136
1972/73	2.14	2.	31	2.24	130	1.72	115
1973/74	2.36	2.79	2.50	2.46	147	1.67	112
1974/75	2.51	3.30	2.28	2.49	171	1.46	98
1975/76	2.85	4.02	2.99	3.02	193	1.56	105
1976/77	3.47	5.46	3.99	3.83	220	1.74	117
1977/78	3.60	5.12	4.00	4.07	241	1.69	113
1778/79**	4.50	5.30	4.64	4.59	261	1.76	118

* Consumer Price Index, All Groups, Australian Bureau Statistics various issues.

** Preliminary estimates by Department of Primary Industry.

Table 5. Impact of fuel price increases by zone 1970/71 to 1977/78

		Vic.		S.A.		Total for
	Tas.	East.	West.	South.	North.	fishery
Average fuel costs 1970/71	$ 560	426	630	568	523	546
As % of expenditure*	% 6.5	7.8	10.2	6.2	5.0	6.5
Average fuel costs 1978/79	$ 1 893	965	1 868	1 609	2 476	1 772
As % of expenditure*	% 9.2	11.5	10.5	12.4	12.6	11.1

* Does not include depreciation.

However, because of inflation, purchasing power has not remained constant over the eight year period. If net income is adjusted to reflect these changes in purchasing power (that is, net income is expressed as equivalent to 1970/71 purchasing power) a decline in the real value of net income in all zones is evident. The greatest decline over the period was in the eastern Victorian zone where real net income declined from $6681 to $3551, a decline of 47 per cent. In the southern South Australian zone real net income declined by 42 per cent. Only in the western Victorian zone did returns keep pace with the effects of inflation.

CAPITAL INVESTED AND RETURNS TO CAPITAL

Values for capital invested were obtained from fishermen for the years 1973 and 1979 (table 6). Market values have generally had the larger rate of increase in the zones (Tasmania, western Victoria) which had not suffered as large a deterioration in economic returns. However, in all zones the increases in market values were less than the increases in the general price level and the increases in the replacement cost of the boat. The implied licence values generally increased to a lesser extent than the market value and replacement cost increases. In real terms the licence values have declined considerably.

Table 6. Capital invested, by zone 1973 and 1978

	Tasmania	Victoria East.	Victoria West.	South Australia South.	South Australia North.
1973	$	$	$	$	$
Purchase price	19 400	11 900	14 700	13 400	21 500
Market value with licence	29 000	20 000	25 100	24 700	44 000
Market value without licence	25 100	19 000	21 500	17 400	21 300
Replacement cost	41 900	27 300	32 400	28 700	51 200
Implied licence value	3 900	1 000	3 600	7 300	12 800
1979					
Purchase price	25 800	13 300	24 100	15 000	29 000
Market value with licence	50 300	29 500	49 000	39 600	73 000
Market value without licence	44 900	24 000	43 000	27 600	54 000
Replacement cost	81 000	45 000	68 000	53 000	87 000
Implied licence value	5 400	5 500	6 000	12 000	19 000

After making an allowance for the skipper's labour equal to average male earnings ($11,807) only in the western Victorian zone (three per cent) and the Tasmanian zone (two per cent) were there positive returns to capital in 1978/79. By comparison, in 1972/73 the percentage return to capital ranged from eight to eleven per cent in all the zones. Thus, there has been a serious deterioration in returns in this fishery and it would not be unreasonable to assume that this downward trend will continue.

RATIONALISATION IN THE FISHERY

The traditional management measures and controls on entry appear to have been successful in stabilizing the level of production and protecting the resource. However, the industry has faced considerable economic pressure, a large part of which is outside the control of fishermen. While many industries are able to adjust to economic change by adopting cost-saving or productivity-increasing technology, amalgamation into more profitable units, or changed production mixes, the rock lobster fishery lacks these adjustment possibilities because of the structure of the management system and the very nature of fishing.

The structure of the fishery is effectively fixed as a result of the restrictions on boat numbers and the application of the pot allocation formulae. Thus, any economies which might come from altering the scale of the fishing units are prevented and there are few potential gains from technological change. In fully exploited fisheries such as this the gains from technological change are few because fishermen try to improve their profitability by taking larger shares of the catch. This often results in an individual fisherman increasing his share of the catch but because total catch is fixed this is usually at the expense of other fishermen who will also adopt the new technology to maintain their share of the catch. Therefore, the adoption of productivity increasing technology can be largely self-defeating with a higher cost structure prevailing because of the more expensive equipment used. Because of the restrictions imposed by the pot allocation formulae there is a limit to the advantages that can be made of technological developments. Copes (1978) in his report emphasised the effect of this on the profitability of operations in the southern South Australian zone.

In many of the States one of the few options by which rock lobster fishermen might attempt to increase their incomes is to move into other fisheries. However, most other established fisheries also have limitations on entry so that fishermen must try risky new fisheries. The continued decline in the profitability of the fishery has meant that some fishermen have had to adjust by seeking additional employment to supplement their income. The percentage seeking shore based work varies according to boat length (and enterprise size) with high participation rates by operators of the smaller boats. It has been estimated that this is in the order of 20-25 per cent of the fishermen. However, the actual time involved is mainly seasonal and sporadic and would not contribute much to a fisherman's income. Additionally, many of the fishing ports are isolated communities with limited part-time employment opportunities. Also the mobility of many fishermen is restricted because they have close ties with their communities and attach importance to the "way of life" as a fisherman.

As time has progressed, for many operators at least, the pot allocation formulae and the restrictions they impose have constrained their operations to a point where they could be considered inadequate to provide a reasonable income base for the future. This concern has been greatest in the southern zone of South Australia where a buy-back scheme has been put forward as the main mechanism for rationalisation following the study commissioned by the State government and conducted by Professor Copes (1978). Using estimated cost and revenue curves Copes demonstrated the benefits of economic reorganization of the fishery. An examination of these curves showed that many pots utilized in the southern zone were competing against each other and that reducing the number of pot lifts would result in a similar production level at a lower overall cost. In principle this suggested "that it is possible to reduce excessive fishing effort by compensating a portion of fishermen who are induced to retire, while leaving all fishermen (much) better off than before" (Copes, 1978, p.63). Copes saw two main avenues of possible action to improve economic viability; by decreasing the costs of fishing and by changing the level of effort to a position yielding greater net returns. These two means are related as there would only be a lasting benefit of a lower cost curve if the industry is allowed to move along this curve to a lower level of fishing effort (that is, by reducing boat numbers).

To achieve an economic optimum position in the fishery Copes estimated that the number of boats in the southern zone should be reduced from 265 to 75. However, after considering factors such as consumer and producer surpluses, the effect on the processing and marketing industries as well as boat building, repair and supply industries, he reached a "complex" optimum of 127 boats. For the first phase of the programme there was to be a reduction of 100 boats. The reduction was recommended to take place through a buy-back scheme which, after an initial loan, would be financed by a "resource use fee".

The major means of reducing the cost of fishing would be by manipulating pot allocations so that there was an optimum number of pots for each fishing unit. Copes suggested that this take place by reallocating pots to a minimum of 70 per unit (which he considered optimal) within a buy-back framework. In his management plan for the northern zone, where no buy-back was involved, Copes suggested a minimum of 55 pots per unit compared with the current average of about 43 pots per unit. However, part of his overall plan was that licences were to be non-transferable which was a radical change from existing policy.

While fishermen in the industry generally accepted the need for a reduction in boat numbers they found some aspects of the management plan to be unacceptable, particularly those relating to the non-transferability of licences, financing aspects of the scheme, and the socio-economic effects of the management plan on small communities and business and on those fishermen who would have to leave the industry. Industry asked government to delay implementation until an assessment could be made of the current economic situation, the socio-economic effects, and the likely success of a buy-back scheme. A socio-economic study was undertaken by the Centre for Applied Social and Survey Research of Flinders University financed by the Fishing Industry Research Trust Account. The researchers examined a wide range of issues from information obtained from a census of fishermen, including deckhands, and a sample of fishing families and businesses. This survey provided an important data base on which to formulate a successful buy-back scheme.

Another policy option, not given detailed consideration by Copes, would be to permit licences to be freely transferable, to fix the total number of pots in the fishery but abolish the formulae used to allocate pots to boats. This option has the major advantage of allowing each fisherman to find his own economic number of pots by buying or selling the "rights to use pots". By separating these tradeable assets from the "right to use a boat", a fisherman wishing to leave the industry may sell all his pot entitlements and his licence. A fisherman wishing to reduce his size of operation may sell some of his pot entitlements. Conversely, the buyers of pot entitlements would be those fishermen who could profitably increase their use of pots. The total number of pots might be reduced by having a "surrender policy" such that on transfer of the rights to use pots a certain percentage was withdrawn. Alternatively, a time period of, say, five years from now (which allows time to adjust) could be given after which all pot holdings would be reduced by a certain percentage. Another possibility, which may give the managers greater flexibility, would be for the management authority to enter the market either as a buyer or a seller of pot entitlements in the event that it became necessary to adjust the total number of pots either downwards or upwards.

This scheme for a market in pot entitlements, which involves trading in the smallest unit of production capacity (pots), could be operated either as an alternative to, or in conjunction with, a buy-back programme for licences. Because the latter programme affects a much larger and "lumpy" unit of capacity (boats), the simultaneous operation of the two programmes may permit both greater flexibility of management and the opportunity for finer adjustment in fishing effort. As a single management programme a market in the rights to use pots would avoid the large costs of borrowing and administration which may be required to operate a buy-back programme for licences. On the other hand, the speed of adjustment in effort, and the degree of control over effort, would be lower. A further option available to the managers would be to commence operation of this scheme when a buy-back programme had been completed.

This suggestion that the formulae for allocating pots to boats be replaced by a market mechanism adds another option to the set of options which is being considered by the managers of the fishery. The proposal would remove one of the structural rigidities of the present regime by allowing the industry to adjust in an economically efficient way without increasing effort. At the same time, removing the pot allocation formulae would allow boat operators to seek improvements in fishing technology. Given these advantages, further research into the operation of this proposal and its relationship to a buy-back programme seems worthwhile, as does its consideration by both managers and fishermen.

NOTE

1. See Cleland et al., this volume.

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10

SOCIO-ECONOMIC CONSIDERATIONS IN FISHERY ADJUSTMENT: THE SOUTHERN ZONE OF THE ROCK LOBSTER FISHERY, SOUTH AUSTRALIA

by

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INTRODUCTION

For a number of years there has been concern about the longer term economic viability of the rock lobster fishery in the Southern Zone of South Australia. Productivity has been declining while costs are on the increase. It is a widely held view that measures to reduce effort are required.

The Department of Agriculture and Fisheries commissioned a report, Resource Management for the Rock Lobster Fisheries of South Australia (Copes, 1978), which recommended, amongst other things, that a buy-back authority be set up initially to remove one third of the vessels operating from the six ports in the Southern Zone. (See figure 1 for a map of the area, and the appendix for a list of Copes's recommendations.) The Australian Fishing Industry Council (AFIC) successfully petitioned the government to delay implementation of recommendations relating to a buy-back authority until its possible effects on fishermen and the fishing communities could be studied.

The Copes Report (1978) was a scholarly document directed to a professional audience within a government department. Some copies of the report were made available to fishermen. What most received, however, were extracts of selected pages from the original with no explanations of the meanings of the terms that were used nor any rationale given for the parts that were selected.

A research team at the Flinders University Centre for Applied Social and Survey Research (CASSR) was commissioned by AFIC to conduct a socio-economic survey of the fishery. Funds for this research were provided by the Commonwealth Government by way of a grant from the Fishing Industry Research Trust Account. In particular, it was asked to investigate the likely success of measures to reduce effort such as a buy-back scheme and the social impacts of it on the displaced fishermen and port communities. A central concern was to collect data from the fishermen so that AFIC and the industry could take an informed position on future management of the fishery.

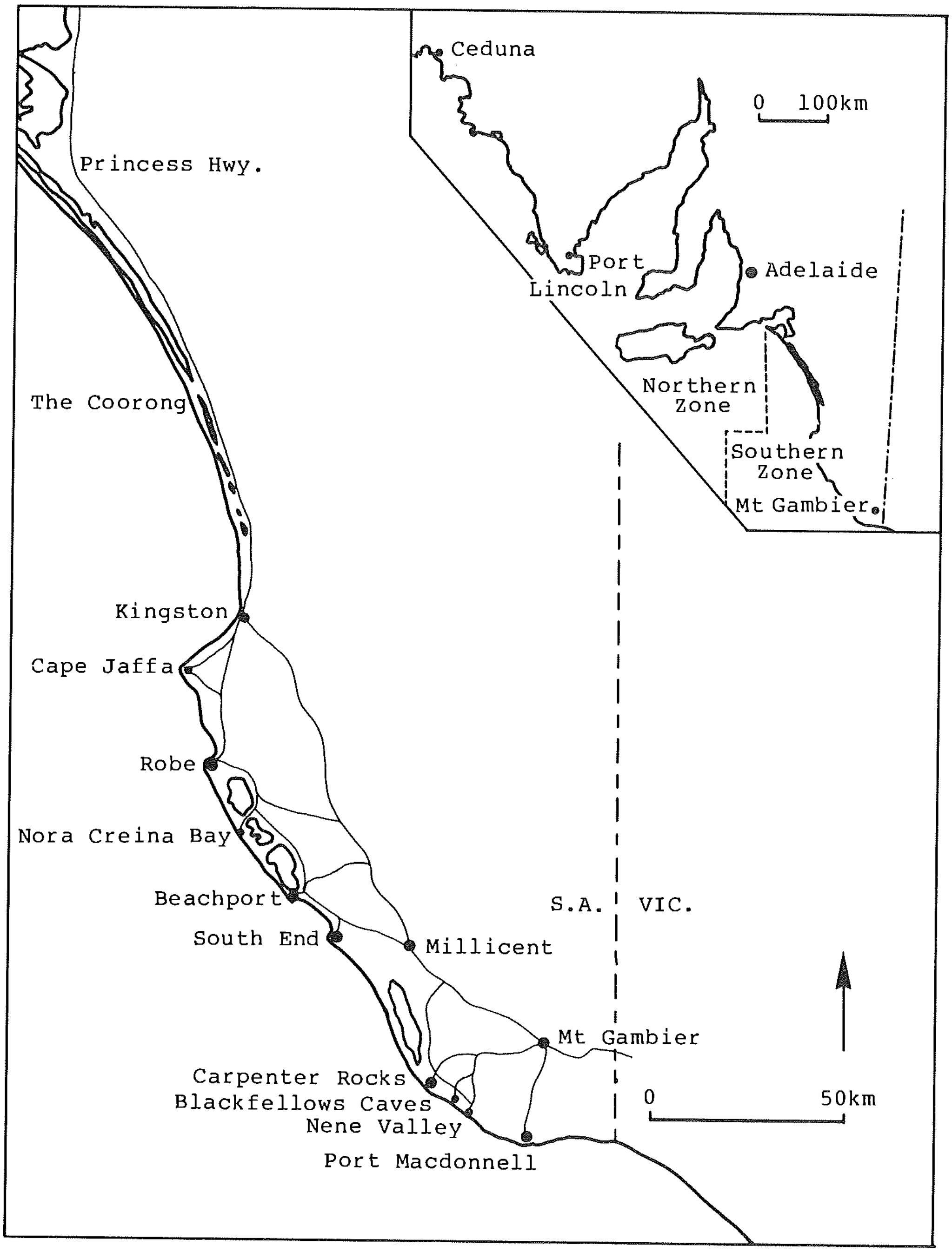

Figure 1 : Location of fishing ports in the Southern Zone

Details of the methodology employed have been presented elsewhere and will not be repeated in detail here (Cleland, *et al.* 1979). In summary, panel discussions were held in each of the ports so that fishermen could raise and discuss the issues that were important to them. A questionnaire was constructed, based on these issues, and it was pilot-tested in the Northern Zone. An attempt was made to get a complete census of fishermen operating in the Southern Zone. Some 251 skippers and owners were interviewed and 97 per cent of the boats in the Southern Zone were represented. A similar approach was adopted with deckhands.

FISHERMEN'S ATTITUDES TO THE REPORT AND ITS RECOMMENDATIONS

Fishermen were asked if they had read the Copes Report. A positive response was recorded if they indicated that they had made some attempt to do so. In spite of this fact over 20 per cent of skippers had not read the report and three said that they had not even heard of it. Responses to this question tabulated by ports are shown in table 1.

The report created a considerable amount of discussion. However 16 per cent claimed that they had not entered into any discussions on the topic. This figure reached 25 per cent in Robe.

Opinions of the report varied a great deal from port to port (table 2). Over one-quarter of Robe fishermen favoured it. Little support was found elsewhere and interviewers in every port stated that it was common for fishermen to refer to the report as a "communist" or a "socialist" document. Many described it as "too technical" or "too complicated".

The report was never intended for an audience of fishermen. Colleagues who teach economics have stated that many students of economics in universities have problems grasping such notions as "externalities", "common property" and "economic rent". When it is considered that 75 per cent of fishermen in the Southern Zone left school at age 15 or earlier - without having had the opportunity to study economics - their reaction against the report, in the form presented to them, is not surprising.

Thus, even at the risk of sounding patronising it must be stated that the action of releasing the report in the form that it was and without sound extension work, a negative reaction by fishermen was guaranteed. How else would a person be expected to react to recommendations that are only partly understood but which potentially could remove his livelihood? This point is further reinforced by the fact that, while generally opposing the report as a whole, most fishermen agreed with most of the more important issues raised in it. For example, 87 per cent of fishermen agreed with the proposition that there were too many boats in the Southern Zone (table 3). Further, 57 per cent agreed that one-third or more of the boats should be removed and

Table 1. Numbers and percentage of fishermen who had read the "Copes Report" by port

	Kingston		Robe		Beachport		Southend		Carpenter's Rocks		Port MacDonnell		Southern zone	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Had read report	19	61.3	40	83.3	18	78.3	32	82.1	29	85.3	56	77.8	194	78.5
Had not read report	12	38.7	8	16.7	5	21.7	7	17.9	5	14.7	13	18.0	50	20.3
Had not heard of report	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	4.2	3	1.2
Total	31	12.6	48	19.4	23	9.3	39	15.8	34	13.8	72	29.1	247	100.0

Table 2. Attitude of fishermen to "Copes Report", by port by number and percentage

	Kingston		Robe		Beachport		Southend		Carpenter's Rocks		Port MacDonnell		Southern zone	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Agree with recommendations	3	14.3	11	26.8	1	5.2	0	0.0	3	10.4	1	1.8	19	9.4
Agree with some recommendations	16	76.2	25	61.0	6	31.6	18	50.0	12	41.4	29	51.8	106	52.5
Oppose all recommendations	2	9.5	4	9.8	9	47.4	16	44.4	13	44.8	23	41.0	67	33.1
No opinion	0	0.0	1	2.4	3	15.8	2	5.6	1	3.4	3	5.4	10	5.0
Total	21	10.4	41	20.3	19	9.4	36	17.8	29	14.4	56	27.7	202	100.0

Note:- Number of missing observations = 45

Table 3. Attitude of fishermen to the idea that there are too many boats in the rock lobster fishery, by port, by number and percentage

	Kingston		Robe		Beachport		Southend		Carpenter's Rocks		Port MacDonnell		Southern zone	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Agree	26	83.9	45	93.7	19	82.6	32	82.1	30	88.2	63	87.5	215	87.1
Disagree	5	16.1	2	4.2	4	17.4	7	17.9	3	8.8	9	12.5	30	12.1
No opinion	0	0.0	1	2.1	0	0.0	0	0.0	1	3.0	0	0.0	2	0.8
Total	31	12.5	48	19.4	23	9.3	39	15.8	34	13.9	72	29.1	247	100.0

Table 4. Attitude of fishermen to a buy-back scheme as the appropriate way to reduce boat numbers, by port, by number and percentage

	Kingston		Robe		Beachport		Southend		Carpenter's Rocks		Port MacDonnell		Southern zone	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Agree	22	71.0	41	85.4	15	65.2	22	59.5	24	70.6	52	73.2	176	72.1
Disagree	7	22.6	6	12.5	7	30.4	13	35.1	9	26.5	14	19.7	56	23.0
No opinion	2	6.4	1.	2.1	1	4.4	2	5.4	1	2.9	5	7.1	12	4.9
Total	31	12.7	48	19.7	23	9.4	37	15.2	34	13.9	71	29.1	244	100.0

Note:- Number of missing observations = 3

72 per cent agreed that a buy-back scheme was the appropriate way to reduce the size of the fleet (table 4).

It is important to note, however, that only 16 per cent were interested in selling to a buy-back authority and, on average, they would need to be offered $50,000 to leave the industry. A breakdown of those interested in selling out by ports is shown in table 5.

It should also be noted that fishermen did reject some aspects of the report such as recommendations relating to financing a buy-back and the non-transferability of licences. Only one-third agreed with the proposition that a buy-back would be more effective if licences were not transferable and only 14 per cent would agree to non-transferability if introduced. Fifty per cent stated that they would refuse to pay additional fees to remain in the industry following the introduction of a buy-back. In summary, the notion of a buy-back is accepted by the fishermen but few actually wish to sell out. The notion essentially is this: "A buy-back is a good idea so long as it is not my boat and I don't have to pay".

There was an interesting reaction to Copes's recommendation that a proportion of the pots removed as a result of a buy-back should be made available for redistribution so that units remaining in the industry could operate at a more economic level. Copes had argued that to attain maximum potential returns, the average boat would need to work 70 pots. Sixty per cent of fishermen claimed to use less than this number and nearly 40 per cent believed that some number less than 70 was ideal for their purposes. The majority (80 per cent) of fishermen rejected the notion of redistributing a proportion of pots removed by a buy-back. Biological rather than economic reasons were typically given for their answers, again demonstrating the need for extension work. In spite of their rejection of redistribution over one-third stated that they would buy additional pots - generally because they thought others would do so and they were in competition with them for the limited stock.

FISHERMEN'S SATISFACTION WITH PAST PERFORMANCE

There are many sound economic reasons why a government should intervene in an uneconomic industry. There are also sound social reasons for doing so - particularly where individuals are receiving very low returns from the industry. Is this really the case in the lobster fishing industry?

Many fishermen are willing to say that they would be "better off on wages". However, contrary to Copes's assertion, it does not seem that the fact that they are not receiving "economic returns" from fishing will encourage them to sell out. Evidence of this assertion is discussed later but may be derived from the fact that 54 per cent of fishermen who would definitely sell to a buy-back caught more than 150 bags of crayfish in 1978-79 when a "bag" was worth approximately $200 (32 per cent caught more than 200 bags).

It should be noted that individual fishermen vary greatly in their perceived needs. Nearly 20 per cent for example claimed that they required as a minimum level of catch less than 100 bags of crayfish to make it worth their while to remain in the fishery; therefore, it would seem possible that if fishermen were not satisfying this requirement they may be more inclined to sell, regardless of the level of catch. To examine this view a little more closely each fisherman's stated catch for 1978-79 was compared with the minimum catch he considered to be required by him to keep him in the industry. Thus, each fisherman could be classified as having caught less than his minimum requirement (low satisfaction), caught about his minimum (middle satisfaction) or more than his minimum (high satisfaction). Data relating to this measure of "satisfaction" are shown in table 6.

Beachport fishermen are particularly interesting in that they have the highest percentages of both those who are Low and High on this measure of satisfaction. It will be noted that Robe has the fewest fishermen who have not reached their perceived necessary level of performance and Port McDonnell has the most. However, intention to sell to a buy-back authority does not appear to be related to this measure of satisfaction with performance as is shown in table 7. Of those fishermen who would definitely sell to a buy-back authority, 17 achieved their minimum required catch and nine exceeded it. By far the greatest proportion of those who rated low on this satisfaction scale stated that they would definitely not sell.

WHO MIGHT SELL TO A BUY-BACK AUTHORITY?

Copes (1978, pp.176-77) stated that while the purpose of a buy-back scheme would be to reduce effort, the programme is not to persuade fishermen in general to leave the industry, but to persuade a proportion of the fishermen to retire from the industry earlier than they would otherwise plan. Thus the incentives for withdrawing vessels would need to be strong enough to entice some of the fishermen to give up their licences. The target in the "first phase" should be 100 vessels representing about 5,800 pots, one-quarter of which would be allocated as authorised replacement vessels and a further one-quarter of which should be allocated among operating vessels with a low allocation of pots to raise them towards his optimum of 70 pots per vessel. Thus, the "first phase" would amount to withdrawing 75 vessels and 2,900 pots, representing a reduction of 17.4 per cent in total effort (measured in pots). At 1976-77 prices this would generate rents in the fishery of about $1.5 million per annum (Copes, 1978, p.165). Copes considered that the characteristics of fishermen who should be persuaded to withdraw be recognized by three main criteria, namely:

1. Fishermen with particularly low earnings in the lobster fishery (except where this may be remedied by the new

Table 5. Interest of fishermen in selling to any buy-back authority, by port, by number and percentage

	Kingston		Robe		Beachport		Southend		Carpenter's Rocks		Port MacDonnell		Southern zone	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Would sell	1	3.2	13	28.9	5	22.7	7	18.4	2	6.9	10	14.3	38	16.2
May sell	4	12.9	7	15.5	1	4.6	11	28.9	14	48.3	20	28.6	57	24.2
Would not sell	26	83.9	25	55.6	15	68.2	18	47.4	12	41.4	40	57.1	136	57.9
No opinion	0	0.0	0	0.0	1	4.5	2	5.3	1	3.4	0	0.0	4	1.7
Total	31	13.2	45	19.1	22	9.4	38	16.2	29	12.3	70	29.8	235	100.0

Note:- Number of missing observations - 12

Table 6. Fishermen's assessment of satisfaction with their fishing performance in 1978/79, by port, by number and percentage

Satisfaction rating	Kingston		Robe		Beachport		Southend		Carpenter's Rocks		Port MacDonnell		Southern zone	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Low	4	14.3	3	8.6	4	22.2	7	19.4	4	12.1	16	26.7	38	18.1
Medium	19	67.8	20	57.1	7	38.9	16	44.5	18	54.6	36	60.0	116	55.2
High	5	17.9	12	34.3	7	38.9	13	36.1	11	33.3	8	13.3	56	26.7
Total	28	13.3	35	16.7	18	8.6	36	17.1	33	15.7	60	28.6	210	100.0

Note:- Number of observations missing = 37 minimum pot allowance). These are the men who are less effective as lobster fishermen, for one reason or another, so that a good bonus may persuade them to quit the fishery.

2. Fishermen who have particularly good alternative employment opportunities. A guarantee that they can get their investment in vessel and gear back, plus a good withdrawal bonus, may be all they need to switch to another occupation.

3. Fishermen who are close to normal retirement, for example, because of age or failing health. Recognising that if they retire immediately they will get a large licence withdrawal bonus, which may not be available if they wait a few more years, may persuade them to accelerate retirement. (p.165.)

From the surveys it is possible to develop profiles for those fishermen who are potential participants in a buy-back scheme. On the assumption that boat owners would get a satisfactory price for their boats, licence and pot authorities, a total of 41 boat owners or 17 per cent would <u>definitely be interested in selling to a buy-back authority</u> if established. The number of boat owners who <u>may be interested in selling to a buy-back authority</u> was 57 (23 per cent). Table 5 gives the numbers in these categories in the six ports. The proportion of boats in each port that would "definitely" or "may" be interested in selling to a buy-back authority is not strictly proportional to the size of the port; however, it is interesting that in the biggest port, Port MacDonnell, just under one-third of the boats could be candidates for a buy-back, while in the next biggest port, Robe, almost 40 per cent may participate. In Southend a little under half of the boats may be candidates for a buy-back scheme. At Kingston only about 15 per cent of boat owners have any interest at all in a buy-back scheme. At Beachport, the

Table 7. <u>Relationship between willingness to sell under a by-back scheme and satisfaction with 1978/79 performance. Southern zone, by numbers and percentage</u>

Willingness to sell	Performance satisfaction					
	Low		Medium		High	
	No.	%	No.	%	No.	%
Would sell	1	3.7	17	63.0	9	33.3
May sell	10	19.2	29	55.8	13	25.0
Would not sell	25	21.2	65	55.1	28	23.7
No opinion	0	0.0	1	33.3	2	66.7

smallest of ports, about one-quarter of the boat owners have a potential interest in buy-back. Carpenter Rocks (which includes boats fishing out of Nene Valley and Blackfellows Caves) has the peculiar situation of a large company fleet, but even so almost one-half of the boats are possible sellers in a buy-back scheme.

Despite this large number of potential participants in a buy-back, it is another question whether they would sell; however, it is highly likely that at least a considerable number of boat owners would sell to a buy-back authority. The number of actual sellers in a buy-back scheme would, of course, depend on a whole range of factors, particularly whether such an authority would be able to pay the price these potential participants were to ask for their boats and authorities. Thus the financial incentive to sell is of vital importance. Potential participation rates would depend on the additional disincentives that existed for people to stay in the fishery, these being determined by the financial contribution that they would be required to make to pay for a buy-back scheme.

Those who are potential participants in a buy-back scheme were mainly fishermen who had been in the industry since before 1969 (34 out of 41 "definite" participants, 41 out of 56 of the "may be" interested). Two-thirds had had a job prior to becoming a fisherman. They tended to be the older fishermen, about half were born in the Southeast, almost all were married, and mostly their wives had no job. They either owned or were purchasing their homes. One-quarter had qualifications for jobs other than fishing. About one-third of them still owed money on their boats, but mainly under $10,000.

The type of fishing units that are potential candidates for a buy-back scheme is interesting. Most of the boats are longer than nine metres, with about one-third of those "definitely" interested in selling being large boats over 12 metres. Over one-half were conventional hulls. It is significant that almost one-third had upgraded their boats in the last three years. Most of them fished over 60 pots, and they tended to fish 100 to 150 days in the 1978-79 season. Of those "definitely" interested in selling to a buy-back authority, over one-third had their boats on the market at the time of the survey. About one-third of those "definitely" interested in selling out had catches of 200 bags or more during both of the last two seasons, and well over half of them had caught at least 150 bags. Relatively few of these potential participants had small catches of under 100 bags. About one-third thought that they needed to catch a minimum of 200 bags to make a season profitable, and nearly 60 per cent thought that they had to catch at least 150 bags. About half of them expect to supplement their income in the 1979-80 season by fishing for shark and/or tuna.

When asked what they would want for their boats and authorities, fishermen tended to be realistic about the market value of their fishing units. Of the "definitely" interested, three owners would want over $80,000, six between $60,000 and $80,000, six between $40,000 and $60,000, nine between $20,000 and $40,000, and five under $20,000. It needs to be remembered that a large proportion of these potential participants in buy-back are experienced fishermen with good catches and seemingly efficient fishing units. The big majority of owners who may be interested in selling to a buy-back authority would want $20,000 to $60,000 for the boats and authorities. Table 8 shows the number of potential participants in a buy-back scheme, both those "definitely" interested and those that "may be" interested, classified by selected characteristics of their fishing units.

On this evidence it would seem that Copes was not entirely accurate in his definitions of criteria for fishermen who are most likely to sell to a buy-back authority. In summary, there is no evidence to suggest that it will be most attractive to the less effective fishermen with low earnings. Few fishermen have good alternative employment prospects and very few of those who are potential participants have trade or other qualifications; furthermore, not many fishermen are in the pre-retirement age group and a minority would see buy-back as a means of retiring. However, it is true that buy-back is seen as an interesting prospect by a large number of fishermen (almost the 100 which Copes suggested for the "first phase" of the scheme), and that substantial incentives and bonuses would be necessary to operate the scheme.

ALTERNATIVE EMPLOYMENT OPPORTUNITIES

Overall very few fishermen have income sources outside lobster fishing, although it is not unusual for some to supplement their income with sharking and tuna fishing. Farming was undertaken by eight per cent. Income was derived from investment in property and/or enterprises related to fishing (such as processing, gear and boat maintenance) by 10 per cent. Only four fishermen had investments in property related to tourism. Investments in property and business were held by a further 17 per cent, but many of these were small holdings of shares. Many of the fishermen with earnings from outside fishing had investments in a range of activities.

It is a common belief that fishermen want to be fishermen until they retire. However, respondents were asked to consider what they would do if they left the rock lobster fishery either voluntarily (as at present) or were enticed to sell to a buy-back authority. Naturally enough, many fishermen had never thought of this possibility and some chose not to! Twenty per cent said that they did not know what they would do if they sold out. Retirement would be an alternative for 10 per cent of fishermen. Just under 30 per cent would seek to enter an alternative fishery. Only six per cent would seek to go back to their former trade or area of work, and 13 per cent would take up farming fulltime. A further seven per cent would live off investments or go into a business venture. Table 9 shows that there were big differences in these employment options between the ports. In Carpenter Rocks, Port MacDonnell and Beachport more fishermen

Table 8. Number of potential participants in a buy-back scheme, by characteristic of the fishing unit.

Characteristic	Definitely interested in selling	May be interested in selling
Size of boat,		
Under 6 m	2	3
6 and under 9 m	10	17
9 and under 12 m	17	27
12 m and over	13	10
Av. no. pots fished		
Under 50	7	9
50 to 59	3	7
60 to 69	10	18
70 to 79	14	13
80 and over	4	7
No. of days fished 1878-79		
Less than 100	5	5
100 to 135	10	17
135 to 150	6	18
151 to 199	6	10
200 and over	4	1
Boat currently on market		
Yes	14	3
No	17	54
Price expected for boat and authority		
Up to $20,000	5	10
$20,001 to $40,000	9	26
$40,001 to $60,000	6	10
$60,001 to $80,000	6	3
over $80,000	3	4
Bags caught 1978-79		
Less than 100	8	11
100 to 149	8	20
150 to 199	5	12
200 and over	9	9
Minimum bags required for profitable operation		
Less than 100	7	10
100 to 149	11	22
150 to 199	8	10
200 and over	14	14

Table 9 Most likely alternative employment activity if fishermen left rock lobster fishing, by port, by number and percentage

Other Employment	Kingston		Robe		Beachport		Southend		Carpenter's Rocks		Port MacDonnell		Southern zone	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Retire	4	12.1	5	10.4	2	8.7	6	15.3	4	11.8	5	6.7	26	10.4
Other fishing	6	18.2	12	25.0	8	34.8	8	20.5	13	38.2	24	32.4	71	28.3
Former trade	1	3.0	4	8.3	1	4.3	1	2.6	1	2.9	6	8.1	14	5.6
Farming, etc.	6	18.2	5	10.4	6	26.1	4	10.3	2	5.9	9	12.2	32	12.7
Investment/ business	3	9.1	3	6.3	0	0.0	0	0.0	2	5.9	8	10.8	16	6.4
Other	6	18.2	7	14.6	1	4.3	6	15.4	9	26.5	15	20.3	44	17.5
Don't know	7	21.2	12	25.0	5	21.7	14	35.9	3	8.8	7	9.5	48	19.1
Total	33	13.2	48	19.1	23	9.2	39	15.5	34	13.5	74	29.5	251	100.0

were likely to want to go into another fishery than at Kingston and Southend. At Kingston and Beachport more were likely to favour farming than elsewhere, while at Port MacDonnell relatively more would seek to enter a business or live off investments. It is interesting that a much greater proportion at

Southend than at the other ports had no idea what they would do, due perhaps to the relatively large number of fishermen of Italian origin in that port who had always been fishermen.

When we consider just those fishermen who skipper boats and who are potential participants in a buy-back scheme, somewhat different results were obtained (table 10). A greater proportion would retire or go into business, but still a sizable proportion would seek to enter another fishery.

If they were to leave the industry, 32 per cent of fishermen in the Southern Zone would expect some form of government assistance, the percentage varying from 27 per cent at Port MacDonnell to 53 per cent at Carpenter Rocks (table 11). Rather surprisingly, of those who would be "definitely" interested in selling to a buy-back authority, only 23 per cent would want government assistance, while 33 per cent of "may be" participants would do so.

The type of government assistance fishermen would want varied. A retraining scheme for alternative employment would be wanted by 14 fishermen. Subsidy to establish in another fishery or a business venture would be wanted by 26 fishermen. Only two

Table 10. <u>Most likely alternative employment for potential participants in a buy-back scheme, as a percentage</u>

Other employment	Definately interested in selling	Possibly interested in selling
	%	%
Retire	17	12
Other fishing	24	29
Former trade	8	4
Farming, etc.	17	11
Investments/ business	7	9
Other	17	19
Don't know	10	16
Total	100	100

Table 11. Extent to which fishermen would expect government assistance if they left the rock lobster fishery, by port, by number and percentage

Would expect govt. help	Kingston		Robe		Beachport		Southend		Carpenter's Rocks		Port MacDonnell		Southern zone	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Yes	7	24.1	13	27.6	11	50.0	9	25.0	16	53.3	19	27.2	75	32.0
No	19	65.5	18	59.6	10	45.5	24	66.7	14	46.7	50	71.4	145	62.0
Don't know	3	10.4	6	12.8	1	4.5	3	8.3	0	0.0	1	1.4	14	6.0
Total	29	12.4	47	20.1	22	9.4	36	15.4	30	12.8	70	29.9	234	100.0

Note:- Number of missing observations = 17

fishermen would want both subsidy and retraining. Other forms of assistance would be wanted by 18 fishermen. Often this type of help related to assistance to sell their home and relocate elsewhere, and/or long term low interest loans to enter another fishery or undertake a business venture often relating to tourism or a small shop. Of those who were "definitely" interested in selling to a buy-back scheme, only one fisherman said he would definitely want retraining for alternative employment, three would want a subsidy, one would want both, and three would want some other form of assistance. Only 16 of those who "may be" interested in selling to a buy-back scheme would want any government assistance.

As most fishermen had not really entertained the possibility of selling up and going elsewhere to work, it was difficult for them to indicate where they thought they would go to live if this were to occur. The majority would wish to stay where they now live. Indeed lobster fishermen in the southern zone are not highly mobile as 71 per cent had lived at the same place since 1968. Obviously there are greater employment opportunities in the southern end of the coast near the major urban centres of Mt Gambier and Millicent. A total of 92 fishermen indicated they thought they would have to move house, but of these one-third thought it would be to elsewhere in the Southeast, either to fish at another port in another fishery or to work in one of the larger towns. Only eight indicated that they would go to Adelaide. A total of 15 indicated that they would go interstate or to another country to fish. A total of 22 did not know where they would seek to go. Of those who were "definitely" interested in selling to a buy-back authority, only 16 said that they would have to move house, many of them preferring to remain in the Southeast or wishing to go interstate to fish. It was similar for those who "may" be interested in selling.

COSTS OF A BUY-BACK SCHEME

An estimate of the total costs of a buy-back scheme to reduce effort in the Southern Zone was obtained from the survey data. Those "definitely" interested (41 boats) and those who "may be" interested (57 boats) in selling were asked to indicate the price they would want from a buy-back authority to sell both their authority and boat. The notion was to give a "fair and reasonable price".

The prices required by the 41 boats in the "definite" group totalled $2.12 million and was, on average 6.5 per cent higher than their assessed market value for boat and authority. The prices required by the 57 boats in the "may be" group totalled $2.79 million and was, on average, 15.4 per cent higher than their assessed market value. Apparently the mark-ups are the incentive payments necessary to entice fishermen out of the industry. Whether such payments constitute a measure of the non-market benefits that fishermen receive, or whether such payments are necessary to compensate for disruption to family, work and earnings is unknown. It is likely that the mark-up contains components of non-market benefits and compensation for disruption.

If these potential participants did sell, then on the basis of the present pot allocation of boats, there would be a reduction of 2,795 pots (or 18.1 per cent) if those "definitely" interested sold, and a reduction of 42.7 per cent of pots if all of them sold.

In evaluating the cost of a buy-back, it would be expected that an aggregation of the prices given by the individual fishermen would be sufficient. Such an outcome, however, would depend on the buy-back authority acting as a discriminating monopsonist. Thus, it would differentiate between individual fishermen according to the minimum price needed to call forth the respective authority and boat. It is unlikely that a buy-back authority would be able to wield this power even if it were the only buyer.

The model best depicting the relationship between potential participants in a buy-back scheme and a buy-back authority is akin to the economic supply schedule. To be able to construct such a model, it was assumed that the two classes of possible participants varied only in the price that they would want. This difference is reflected in the higher mark-up wanted by the possible participants. As such differences are inherent in a supply schedule, it is not inconsistent to aggregate the two groups.

The supply schedule was constructed from fishermen's responses by arranging the responses according to increasing price per pot, and keeping a running total of the number of pots available at each price. A curve was fitted to this data:

$$Q = 1246.38\exp(0.0011716669P)$$

where Q is the estimated quantity of pots bought out (quantity supplied), P is the price in dollars, and exp is the exponential function.

From the supply curve, the average cost (marginal price) per pot, the number of pots and the total cost function can be estimated. Conversely, if we wish to find the price needed to be paid to withdraw a certain number of pots, we need to take the natural logarithm of both sides:

$$\ln Q = \ln(1246.38\exp(0.0011716669P))$$

and solve for P

$$P = (\ln Q - \ln 1246.38)/0.0011716669$$

Table 12 presents a summary of the costs and benefits in removing effort from the fishery through a buy-back scheme on the basis of the estimated supply schedule. It shows the marginal

Table 12. Cost of implementing and benefits to be derived from buying-back different numbers of rock lobster pots

Price per pot (1)	No. of pots bought out	Cost of fishing effort $ (2)	Gross revenue $ (3)	Net revenue $ (4)	Change in revenue $ (5)	Total cost of removing pots $ (6)	Incremented cost of removing pots $ (7)	Econ. benefit $ (8)	Annual payment over 6 years (9)	No. of pots remaining	Annual payment per pot rem. over 6 years (10)	No. of remaining author.	Annual payment per author. over 6 years (11)
0	0			-921 882				0	0	16 649	0	254	0
213	1 600	6 781 832	6 543 982	-237 850	684 032	341 067	341 067	6 840 320	78 311	15 349	5.1	234	334
404	2 000	6 601 572	6 534 730	-66 841	171 009	807 233	466 166	8 550 410	185 347	14 949	12.4	228	812
559	2 400	6 421 312	6 525 478	104 167	171 008	1 342 140	534 907	10 260 490	308 165	14 549	21.18	222	1 388
691	2 800	6 241 052	6 516 226	275 175	171 008	1 923 213	592 073	11 970 570	444 110	14 149	31.39	216	2 056
805	3 200	6 060 792	6 506 974	44 183	171 008	2 575 223	641 010	13 680 650	591 290	13 749	43.01	210	2 816
905	3 600	5 880 532	6 497 722	617 191	171 008	3 259 020	683 797	15 390 730	748 295	13 349	56.06	204	3 668
995	4 000	5 700 272	6 488 470	788 199	171 008	3 980 828	721 808	17 100 810	914 027	12 949	70.59	198	4 616
1 077	4 400	5 520 012	6 479 218	959 207	171 008	4 736 832	756 004	18 810 890	1 087 612	12 549	86.67	191	5 694
1 151	4 800	5 339 752	6 469 966	1 130 215	171 008	5 539 915	787 083	20 520 970	1 268 332	12 149	104.4	185	6 856
1 219	5 200	5 159 492	6 460 714	1 301 223	171 008	6 339 480	815 565	22 231 050	1 455 591	11 749	123.89	179	8 132
1 282	5 600	4 979 232	6 451 462	1 472 231	171 008	8 181 333	841 853	23 941 130	1 648 875	11 349	145.29	173	9 531
1 341	6 000	4 798 972	6 442 210	1 643 239	171 008	8 047 592	866 259	25 651 210	1 847 787	10 949	168.76	167	11 065

Note: The product from multiplying the values in two columns, need not necessarily give the value in the third column due to rounding error.

(1) Derived from supply schedule Q = 1246.38 exp .0011716669P (see text)
(2) Estimated total annual fishing costs for boats remaining.
(3) Estimated gross value of catch.
(4) Equals gross revenue (3) less cost of fishing effort (2).
(5) Increase in net revenue resulting from removing last 400 pots.
(6) Number of pots bought out times cost of buying them.
(7) Cost of removing last group of 400 pots.
(8) Present value of future benefits from accumulated changes in net revenue, assuming a social discount rate of 10.0% per annum.
(9) For repayment of total cost of removing pots plus interest at ten per cent per annum.
(10) Annual repayment over 6 years divided by the number of pots remaining.
(11) Annual repayment over 6 years divided by the number of remaining authorites.

and total adjustments in costs and benefits for removing initially 1600 pots and (in 400 pot increments) eventually 6,000 pots. An interest rate of ten per cent has been used in the calculations. At the time of the study this was the opportunity cost of capital to fishermen.

A caveat must be added to this evaluation as no cost for administrating a buy-back has been included. In addition the price recoverable for boats bought out through placing them on the open market has not been included (it is likely that this would be very low). Finally, the supply function estimating the quantity of pots supplied with price overestimates the cost. When pots are bought out, the authority would be receiving a joint commodity, namely, pot authorities and boats. While the pot authorities are homogeneous - a pot authority to put twenty pots in the water is the same regardless of its source - the boats are not. Because of the difference in boat values we would expect to find that the price paid to the intramarginal fisherman need not be as high as that paid to the marginal fisherman. Furthermore, it should be realised that the analysis is static and is only likely to be applicable if a buy-back were implemented instantaneously. If a buy-back were implemented over a number of years, then as the catch for those remaining in the fishery increased, so too would the price required by participating fishermen increase.

CONCLUDING COMMENT

In spite of their general opposition to that "socialist" document it seems that fishermen agreed with most of the important recommendations of the Copes Report. There was one recommendation from the report that few would disagree with - that any buy-back scheme should be administered by close co-operation between government and the industry.

It is hoped that the lesson will have been learned that intervention in a fishery by government to reduce effort requires more than establishing the economic rationale for such moves. Experience elsewhere (Cicin-Sain, 1978; Orbach, 1978) has shown that fisheries management is mainly a political question, in which economic, social and philosophical criteria are involved. People are prone to misunderstand issues that are cloaked by jargon and are fearful of the consequences of intervention. Because of the way the report was presented to fishermen and their initial reaction to it, one must be concerned that, in spite of its acknowledged merit, attempts to initiate a buy-back may fail because of inability to achieve co-operation.

This study has demonstrated that the majority of fishermen want effort reduction in the fishery and that a buy-back scheme is an appropriate means of achieving this. The costs and benefits of one such scheme have been demonstrated. It is now up to the industry to decide what it wants to do.

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APPENDIX

Copes considered that it would be possible for increased net returns to be obtained by fishermen with appropriate management of the fishery. He suggested that the present division of the fishery into Northern and Southern Zones be continued, and that separate management strategies be applied in each zone. Any management strategy for the rock lobster fishery should also include:

* An Effort Management Authority (E.M.A.) made up of industry and government representatives, to establish a management programme to control fishing effort and achieve a satisfactory balance between fishing effort and yield.

* That, in the Southern Zone, the E.M.A. should achieve a satisfactory balance through a "buy-back" scheme which would get some boats out of the industry by means of "generous licence withdrawal bonuses and guaranteed compensation for retired vessels and gear".

* That this "buy-back" scheme be financed by a resource use fee levied on individual pots. Initial bonuses and compensation being financed through loans.

* That, in future, authorities are not transferable on the open market, but that a proportion of retired licences be made available according to the length of time an individual has spent in the industry.

* That smaller units should be made more efficient through the allocation of additional pots.

The crux of Copes's recommendations was the voluntary "buy-back" scheme. He claimed that a "buy-back" scheme would result in substantial returns to those remaining in the fishery by progressively reducing the number of boats, and increasing the average pot allocation to those remaining. An amount of $2 million to $3 million would be required. The "buy-back" would, over time, be financed by those remaining in the industry. Due to the uncertainty of participation and outcomes, it was recommended that effort be reduced by one-third initially. Most subsequent debate in the industry has centred on these recommendations. The proposal was the interim change, the least drastic of three strategies Copes recommended (table A.1).

TABLE A.1

STRATEGIES RECOMMENDED BY COPES (1978)

	Present	Rent Maximization*	Complex Optimum*	Interim*
Number of boats	265	75	127	190
Net Return	-708,000	3,175,000	2,765,000	1,412,900
Catch kg.	1,633,000	1,480,000	1,590,000	1,633,000

*Involves some re-allocation of pots, bringing every boat to 70 pots.

11

BOAT REPLACEMENT POLICY IN THE WEST COAST ROCK LOBSTER FISHERY - AN HISTORICAL REVIEW AND A FUTURE OPTION[1]

by

P.P. Rogers

INTRODUCTION

The western rock lobster fishery is Australia's most valuable single fishery producing approximately 12,000 tonnes in 1978/79 worth $60m to local fishermen. Local sales account for approximately two per cent of the Western Australian catch whilst the majority is processed for export as tails for sale mainly in the United States. Total export earnings in 1978/79 from rock lobster was an estimated $63m (f.o.b. Fremantle). Approximately 810 vessels, currently employing 1,800 men, fish principally between Shark Bay and Bunbury from November 15 to June 30 each year. These boats take rock lobster from 76,000 baited rock lobster pots which are fitted with escape gaps. Fishermen are restricted in their operations to one of five designated fishing zones during the currency of the rock lobster season (figure 1). The fishery has been managed as a limited entry fishery since 1963, when the number of boats and the amount of pots allowed to operate in the fishery were fixed.

Commercial development of the rock lobster fishery commenced between 1895 and 1897 in shallow waters surrounding Rottnest Island off Fremantle (Brownfield, 1953). Commercial exploitation before World War II was undertaken from regional centres, principally Geraldton and Fremantle, by fishermen using sailing boats equipped with wells in which to bring live lobsters to the local market. Demand for rock lobster in those years was low by present standards because there was no canning and no export market. Early attempts to establish a cannery at the Abrolhos (1931) and Geraldton (1933) failed after a short period of time but the Geraldton cannery was revitalized in 1941 to provide canned rock lobster meat for the defence forces.

Immediately after World War II, markets were established in the United States for frozen rock lobster tails and there was a major investment in processing establishments at Geraldton, Fremantle and Lancelin. Also, there was investment in freezer boats as mobile refrigerated processing plants. With the availability of marine engines, disc power winches and the organisation of fishermen by new processing companies to supply lobsters under contract, there was rapid expansion in the rock lobster fishery during the 1950's. The commercial catch of rock lobster increased from 272 tonnes in the 1944/45 season to 8,709 tonnes by 1959/60. The average number of fishermen increased from 42 to 1173 during the same period (Sheard, 1962). The number of freezer vessels had also increased from 10 at the end

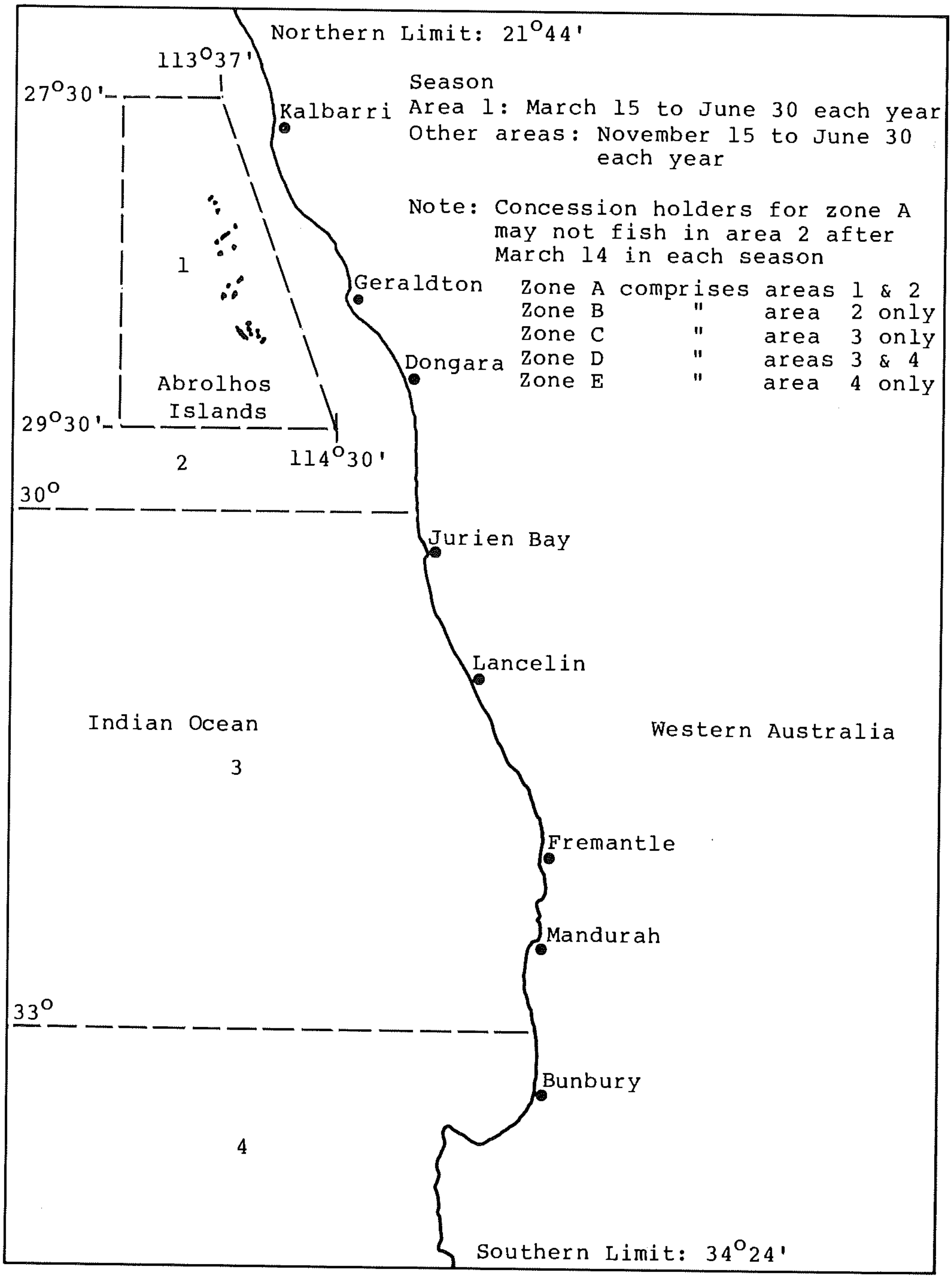

Figure 1: Western Australia rock lobster fishing zone.

of 1953 to 42 by 1960/61. By the early 1960's, the rock lobster fishery was fully exploited with catches increasing only marginally despite a large increase in pots used. Between 1955/56 and 1961/62, catches increased by only eight per cent whereas the number of pots used for the same period increased by 60 per cent (Bowen, 1973).

Regulations of legal minimum size at first capture, a closed season, protection of females carrying eggs externally and fishing zones were in operation by 1963 to conserve rock lobster stocks from overfishing. Furthermore, the need to prevent further expansion in fishing effort which could lead to the biological and economic collapse of the fishery, received wide support from both the industry and government.

Four months notice was given to the industry before the number of rock lobster boats in the industry was fixed at 830, the number fishing or under construction at March 1, 1963. In November 1963, the number of pots was fixed at three pots for each foot of length of vessel but vessels of sixty-seven feet and over were restricted to two hundred pots each. This restriction had the effect of reducing the total number of pots in the water from 97,000 in the 1962/63 season to approximately 76,000 in the 1963/64 season (Bowen, 1971). The prime objectives of the 1963 restrictions on entry to the fishery were to limit further growth in fishing effort and to stabilize production. Economic and social considerations covered fairly broad objectives such as orderly fishing; the establishment of management rules that reduce conflict arising from concentrations of boats and pots on preferred grounds, and fishermen obtaining reasonable economic returns (Bowen, 1980; Meany, 1979).

The development of management policy for the rock lobster fishery since 1963 has been primarily concerned with constraining further expansion of effort and even reducing it where politically possible and practical to do so. However, despite the management measures taken, effective fishing effort continued to expand. To counteract this expansion the fishing season was shortened by six weeks during the 1977/78 season. Although introduced as a trial this shortened season has remained in force since that time.

BOAT REPLACEMENT POLICIES 1963-1979

The boat replacement and ownership policy within the West Coast rock lobster fishery has evolved in a sequential way. The policy of limited entry introduced in 1963 did not specify a boat replacement policy beyond that of not approving replacement except in circumstances where boats were considered no longer seaworthy. It soon became apparent that under this provision smaller inefficient boats were being replaced by larger more efficient boats with a greater quota of pots. This led to an increase in the number of pots in the water and a potential for greater expansion in fishing effort.

From May 8, 1965, although fishermen could still replace their boats with larger ones they could not gain extra pots. As a consequence those fishermen who built larger vessels, with associated lower catching power and thus lower returns on capital, tended to become involved in "overpotting", that is, illegally using more pots than their entitlement (Bowen, 1971). On December 14, 1965, a new boat replacement policy was brought into effect to offset the increase in fishing effort. This limited the size of a new boat on replacement to that of the boat replaced. However, for reasons of safety at sea, boats less than 7.62m (25 ft) in length could be replaced with a boat of 7.62m at any time.

If a fisherman replaced his vessel with a new boat which was smaller than the original boat, he was only entitled to use the number of pots that the ratio of three pots per foot of new boat length would allow. In some instances this led to boats being licenced to use less pots than the maximum entitlement of their original vessel. Over the subsequent years, the replacement of very large boats by smaller boats has resulted in a gradual build-up of unused pot entitlements. These unused pots could potentially come back into the industry at the time of future replacement of the smaller boat by a boat having equivalent length to the maximum entitlement of the original boat.

Despite these measures effective fishing effort, expressed as pot lifts, has increased beyond the amount used in 1963/64. This has resulted from improvements in boat efficiency, by boats fishing more days each month and by fishing longer into the season (Morgan, 1977). Concern for the safety of small and old fishing boats led to the relaxation of replacement rules in 1968 for boats 7.62m in length or greater, such that they needed to reach the age of eight years before replacement was approved. In order to encourage the owners of small boats to build safer and larger vessels, an incentive scheme was introduced which provided a bonus of one pot for each 20cm increase in boat length (or 1.5 pots per foot) to fishermen who chose to replace their vessels with a larger boat up to the limit of 7.62m.

Both of these rules have since disappeared, the former because the age of a boat did not appear to have any effect on the catching efficiency of pots. Also the rule limited severely the financial flexibility of fishermen in making business decisions within the scope of fluctuating incomes and the investment allowances for taxation purposes introduced by the Commonwealth Government in 1975/76. The rule stipulating one pot per 20cm rule was removed on March 1, 1976, at the request of industry as a conservation measure.

The only other major change to the boat replacement policy of 1965 took place in August 1979. This change altered the relationship between boat length and the quota of pots. Historically, the measurement of boat lengths for the purposes of registration has been undertaken by surveyors of the Harbour and Lights Department who act independently of the Department of Fisheries and Wildlife. Between 1968 and 1979, the basis for measuring boat length was the horizontal distance between the stem post and rudder post of a fishing boat. This method of measuring meant that the overall length and deck space for vessels of the same surveyed length could be altered by changing the position of the rudder and the rake of the stem.

Some fishermen built vessels with the largest deck space permissable so that they could shift their pots on the fishing grounds each day and thus compete more effectively with their fellow fishermen. By bringing the rudder forward and having a gentle rake on the stem, the overall length of a vessel could exceed the surveyed length by up to 32 per cent. These so-called "stretched" boats had the appearance of a "Chinese Junk". They were not fuel efficient and proved to be unsafe in following seas.

At the same time, the administration of the 1965 replacement rules meant that if a boat was replaced, every 10cm (4 inch) change in boat length caused a difference in the quota of pots. Thus, fishermen wishing to purchase second-hand boats as replacements were restricted in their choice by the narrow size range, unless they were prepared to accept a smaller quota of pots. In some instances fishermen purchased boats which were larger than the permitted size. These boats could not be licenced in accordance with the rules of replacement except in a temporary capacity. The requirement to build a different size of boat for every increment in pot entitlement also meant that many fishermen were unable to take advantage of cheaper "off-the-shelf" vessels.

The planned adoption of a measurement of overall length by the Harbour and Lights Department in accordance with the standardized procedures for Australian marine survey provided an opportunity to remove the anomalies of the 1965 replacement rule. The changes also provide fishermen with increased flexibility in their business decisions at the time of boat replacement. The rules introduced on 31st August 1979, were:

* boats with a pot quota of 70 or less could be replaced with a vessel of any length up to 10.0m overall;

* boats with a pot quota in excess of 70 pots could be replaced with a boat in the length range calculated by dividing the pot quota by 7 and 10. For example, a boat with a pot quota of 84 pots could be replaced by a boat of 8.4m to 12.0m in overall length.

Compared with the 1965 rules, fishermen now have the choice of replacing with a smaller boat and effectively increasing the ratio of pot numbers to boat length to provide a more economic unit, or building a larger boat which could be used in diversified fisheries.

BOAT TRANSFERS

The policy of limited entry has increased the administrative work load. Each replacement of a boat and each sale requires the approval of the Department of Fisheries and Wildlife. In order to minimize litigation, oversight on approvals must be given to matters of probate and clearance of bills of sale agreements. In recent years individual fishermen have become more sophisticated in their taxation planning by creating family companies and trusts, all of which increases the amount of oversight required.

The Government has not attempted to allocate licences to fishermen because of the innate difficulties of the allocation problem. Instead it has allowed the market for licences to do the job. Prior to the introduction of limited entry in 1963 the value of owning a rock lobster licence was not recognized. However, by 1967, and possibly earlier, fishermen recognized the property value attached to the ownership of a rock lobster boat with a licence and at the time of transfer were willing to pay a price greater than the combined value of boat and gear. Between 1967 and 1979 the effect of high profitability in the fishery (tables 1 and 2), resulting in part from the increasing value of rock lobster landings, has caused the capitalized value of the licence to increase from $160 per pot entitlement to 1979 values of $1,300 to $1,500 per pot (table 3).

Table 1. Average gross income, total cost and returns to owner/skipper and capital 1966/67 to 1968/69, 1972/73 to 1974/75 and 1977/78

Year	1966/67	1967/68	1968/69	1972/73	1973/74	1974/75	1977/78
Zone A							
Gross income	15 864	20 423	23 096	27 459	27 407	29 720	73 564
Total costs	9 136	8 976	9 924	16 426	17 107	18 358	42 823
Return to owner/skipper and capital	6 728	11 447	13 172	11 033	10 300	11 362	30 741
Zone B							
Gross income	14 310	19 210	22 365	19 466	19 860	22 532	78 516
Total costs	8 472	8 880	10 513	12 228	11 836	13 329	39 768
Return to owner/skipper and capital	5 838	10 330	11 752	7 238	8 024	9 203	38 748
Zone C							
Gross income	18 792	25 916	23 650	24 890	22 253	30 039	64 579
Total costs	11 798	13 165	12 614	16 633	16 647	18 139	37 268
Return to owner/skipper and capital	6 994	12 751	11 036	8 257	8 257	11 900	27 311

Source: Meany (1979)

Table 2. Average catch, income expenditure and returns by zone, 1977/78

	Zone A	Zone B	Zone C
Average catch	14 438 (kg)	15 629 (kg)	12 705 (kg)
	$	$	$
Gross income	73 564	78 516	64 579
Total costs	42 823	39 768	37 268
Return to owner/skipper and capital	30 741	38 748	27 311
Boat capital (market value)	39 195	42 683	40 156
Licence value	72 990	74 600	90 986
Return on boat capital after deducting skipper's allowance	50.9%	65.5%	41.4%
Return on boat and licence capital after deducting skipper's allowance	17.8%	23.8%	12.6%

Source: Meany (1979)

Table 3. Estimated market values of licences, 1967 to 1979

Year ending June 30	License value per pot $	Adjusted license value per pot* $	Real price of rock lobster* $/kg	Adjusted value landings* $'000
1967	160	160	1.32	11 344.1
1968	160	155.5	1.63	16 329.1
1969	170	161.1	2.07	16 873.1
1970	200	182.8	1.59	11 073.9
1971	210	184.0	1.95	15 810.7
1972	210	174.0	2.21	18 379.4
1973	280	219.9	1.94	14 079.7
1974	270	192.0	1.88	12 699.1
1975	280	168.6	1.44	11 998.4
1976	330	174.0	1.78	15 508.3
1977	550	250.7	2.17	20 083.8
1978	950	390.8	1.94	20 870.8
1979	1,500	570.8	1.90	22 831.0

* All values have been adjusted by CPI to 1967 prices.

In early 1980, the asking price for a rock lobster boat worth about $80,000 which was licenced to operate 100 pots was around $270,000. The real prices (after taking into account inflation) paid for licences in the last three to four years have increased much faster than the real value of landed catch. It seems that the record landings in 1977/78 and 1978/79 resulting from high levels of recruitment have fuelled a speculative element in the market. Current prices for licences seem high if assessed solely on the current earnings of fishermen. It appears that expectations of large increases in the price of rock lobsters, and thus expectations of increasing values for licences, is generating much of the present optimism.

When catches return to average levels (8,540 tonnes since 1961/62) there will be a substantial new group of rock lobster fishermen with heavy long term debt commitments. It is inevitable that some of these fishermen will fail, and the net result may be that rock lobster fishermen will increase their fishing effort so as to service their debts. If this extra effort is not applied in the rock lobster fishery it will be used in the wet fishing sector.

Economic theory suggests that dissipation of economic rent from the fishery can be prevented by charging fishermen fees sufficient to drain the surplus profit. In political reality this proposition has proven to be impractical for a number of reasons. Fishermen are fiercely independent people and consider the "rights of competition" as part of their way of life. Any constraint placed on their income beyond what they consider reasonable is seen as an affront to their rights to earn a living. In any event, many argue that society is already compensated by the high income taxes paid by rock lobster fishermen and any endeavour to extract additional rent in the form of higher licence fees is to be resisted. Although this argument confuses the separate issues of a rent tax and an income tax, it is an argument with political persuasion - at least in the short term.

The process of policy formulation by Government involves consultation with industry through the Rock Lobster Industry Advisory Committee as well as industry organisations.[2] Thus, the ability of fisheries administrators to extract a resource rent from the fishery is limited by historical precedence and political reality of the time. Currently, annual licence fees charged for the west coast rock lobster fishery are set at $3.50 per pot. This fee is revised annually.[3]

GROWTH IN FISHING PRESSURE

The introduction of the entry restrictions in 1963 had the immediate effect of reducing fishing pressure within the fishery and stabilizing catch in the medium term. However, between 1963/64 and 1974/75 (table 4) the effective fishing effort continued to expand largely as a consequence of boats fishing longer into the season and more days each month. Also, part of

Table 4. Total catch, fishing effort and catch per unit of effort, 1944/45 - 1976/77

Season	Catch ($kg x 10^6$)	Fishing effort ($x 10^6$)*	Catch/ unit effort	Men engaged in fishing	Boats fishing **	Days fished per month ***
1960/61	7.790	3.777	2.062	1 111		
1961/62	8.744	5.700	1.534	1 499		
1962/63	9.324	7.500	1.243	1 745		
1963/64	8.119	4.648	1.747	1 367		
1964/65	7.486	4.798	1.560	1 252	551	15.2
1965/66	8.120	5.036	1.612	1 378	581	15.2
1966/67	8.635	5.147	1.678	1 349	575	15.4
1967/68	9.853	5.173	1.905	1 475	603	15.1
1968/69	8.078	4.292	1.882	1 294	613	15.6
1969/70	6.918	5.771	1.199	1 522	613	16.0
1970/71	8.013	7.888	1.016	1 620	650	16.8
1971/72	8.171	7.536	1.084	1 731	670	16.6
1972/73	6.606	7.187	0.919	1 642	648	16.2
1973/74	6.780	7.127	0.951	1 824	667	17.0
1974/75	8.877	8.035	1.105	1 778	663	17.6
1975/76	8.873	8.100	1.095	1 811	659	17.0
1976/77	9.117	8.432				
1977/78	10.742 (est))	Not yet available				
1978/79	12.000 (est))					

Source: Morgan (in press).

* The measure of effective fishing effort involves the adjusting of raw data on pot lifts according to seasonal changes in vulnerability. Full details of the methodology of calculating effective fishing effort for the western rock lobster fishery can be found in (Morgan 1979).

** Mean number of boats fishing per month.

*** Mean number of days fished per boat per month.

the increase in effort occurred because more boats were using their full quota of pots for longer periods during the fishing season (Morgan, 1977).

This growth in effort cannot be attributed solely to the failure of the boat replacement policy. It is more a consequence of excess capacity existing within the fleet in 1963 being utilized more fully as economic pressures demanded. It is probable that the value of licences and the rising debts of fishermen during periods of low catches due to poor recruitment, provided much of the driving force which caused fishermen to work harder in the following years.

The problem of rising fishing effort together with the observed high rate of exploitation and decline in the observed numbers of breeding females, tended to make industry and Government leaders nervous about the population status of the rock lobster fishery. Population studies undertaken in 1965 (Bowen and Chittleborough, 1966) estimated the long term average yield of the fishery to be 7,257 tonnes p.a. Further studies undertaken by Morgan (1977, 1979a and 1979b) estimated the maximum sustainable yield to be in the range 8,000 to 8,600 tonnes at 5.6 to 5.9 x 10^6 units of effort. By 1974/75 fishing effort had exceeded the 1962/63 record levels to reach 8.035 x 10^6 units (table 4) which was considerably beyond what could be considered as desirable, with little indication of stabilizing. The population models developed for the rock lobster fishery, however, could not be used with confidence in predicting catches in the event effort expanded beyond that already experienced (Morgan, 1979).

In 1978, the rock lobster season was closed six weeks earlier, on June 30 instead of August 14, as a trial measure to contain fishing effort. This period of closure has been continued to the present time. Preliminary indications are that in the two seasons with record catches (1977/78 and 1978/79) total effort in the fishery was partially reduced. However, part of this decline in effort probably resulted from fishermen stopping fishing earlier than normal in the season because of record catches and high taxable incomes. The earlier closure of six weeks was expected to reduce fishing effort by six to eight per cent but compensatory fishing was responsible for a lower figure. The choices open to Government for further reductions in effort are to shorten the length of the fishing season with all of its social and economic costs, or to look at some means of reducing boat numbers and the total number of pots used.

FUTURE POLICY OPTIONS

Given the decision to manage the west coast rock lobster fishery under a limited entry regime, the policy makers have chosen to modify policies as problems evolved. Feasible new policies have mainly been incremental modifications of existing policies because the effects of marginal change are easier to forecast and because it is easier politically to persuade other people to agree to them. Policy making by Government in a wide array of responsibilities rarely involves massive changes in direction. It consists mainly of altering the cutting edge of existing policy, adding new ones or shifting priorities between them.

In pragmatic terms, Governments can very rarely respond quickly enough when a major change is needed because of inbuilt institutional momentum. Governments and their institutions have heavy commitments to existing administrative practices, organizational structures and facilities. Major shifts in the direction of fisheries policy requires substantial support from politicians as well as industry for successful implementation. Where substantial support is required from Government, for example, in the provision of financial assistance for industry, the Government rarely responds to the symptoms of policy going astray until they manifest themselves as serious political or economic problems.

Industry leaders and fisheries administrators within Western Australia have been considering the need to reduce the number of boats in the rock lobster fishery. The only long term acceptable way of curtailing future growth in effort is the gradual removal of boats and their pots from the fishery. The main stumbling block for any such proposal has been the lack of money to bring any buy-back scheme into fruition. On present day values, to remove ten per cent of the pots from the water would cost a minimum of $13-14m. It is difficult to imagine those funds coming solely from Government sources unless there was a dire need to do so. When, and if, these economic circumstances arise, it may be too late.

If the rock lobster industry were to provide funds for the removal of boats and their pots from the fishery, they should, in principle, be allowed to reap the benefits. Towards this objective a suggested scheme is outlined in broad detail for industry consideration and discussions. It is not the intention of this paper to provide or cover all the options available but provide a stimulant for future discussion. The scheme to be suggested includes trading of pots within the existing boat replacement policy and fishermen's use of property rights; the means of raising revenue; and the need to consider closely some aspects of the ownership of boats and licences.

TRADING OF POTS

Under the recently revised rules for boat replacement a person may build a replacement boat of a length within the range of seven pots and ten pots per metre. At the present time trading in pot entitlements is not allowed and the only adjustment to pot entitlements permitted is that resulting from adjustments by a single owner of two or more vessels at the time of replacement. Since the 1979 amendments to the replacement policy were introduced, a number of fishermen have approached the Department seeking ways to increase their entitlement on their existing vessels up to a maximum figure of ten pots per metre. They argue correctly that this strategy improves the earning capacity of their fishing units because they are more able to offset rising costs especially fuel costs.

There are no obvious reasons why fishermen should not be able to adjust pot entitlements as they require. The trading of pot entitlements could be used by individuals to adjust to their economic needs. The administration of this policy of open trading in pot entitlements requires that Government, through the Fisheries Authority, approves the transfer of entitlements. This action on behalf of Government is deemed essential so that the fisheries authorities are able to identify clearly the participants in the fishery for purposes of enforcement of fisheries management rules, the collection of catch and effort statistics and fisheries administration.

The objective of rational economic management, that is optimising resource rent, is rarely achieved due to the need to accommodate other political and community requirements.

These requirements may include:

* maintaining current level of employment within a fishery - at least in the short term;
* placing an upper limit on boat size due to the increasing costs of fishing harbour development with increasing boat size;
* policies favouring decentralization and thus smallness in size of fishing units ensuring the dispersion of the fishing fleet and viability of small coastal communities;
* the introduction of management rules which permit a gradual change in the composition of the fishing fleet in order to minimise social and community dislocation.

It could be argued in the interest of these requirements that limits on the scheme be imposed such that:

* owners of boats with less than 70 pots should not be entitled to sell pot entitlements unless they redistribute their total pot entitlement at the time of approval;
* owners of boats having pot quotas larger than 150 pots should not be entitled to purchase additional pot entitlements;
* the only persons to be allowed to purchase pot entitlements would be licenced rock lobster fishermen so that at the time of approval, pot entitlements could be transferred from one vessel to the next.

The creation of a market for pot entitlements would allow the Government to enter the market to purchase licences without the necessity to purchase boats with licence attached.

RAISING REVENUE

Earlier in this paper it was mentioned that any attempt to raise revenue by increasing annual licence fees is likely to be resisted, particularly by those fishermen who have recently entered the fishery. An alternative method is to charge a "stamp duty fee" equivalent to, say, ten per cent of the total transaction price at the time of transfer in ownership of boat and licence together or transfer in pot entitlements. The revenue collected could be administered from a specific trust account for the sole purpose of reducing the number of pots in the water. This stamp duty would have the effect of discouraging speculation in pot entitlements. As an incentive, it could be waived in the event of sales of pot entitlements being made to the Government authority.

OWNERSHIP ANOMALIES

The scheme as suggested raises various anomalies concerning the transfer of ownership and whether there should be exceptions or exemptions on the payment of stamp duty at the time of transfer. The following are examples of some circumstances which would need to be considered:

* In the event of the death of a member of a husband and wife partnership, should the ten per cent levy be charged on the transfer in ownership of boat and licence to the remaining partner?

* Should fishermen legitimately changing the legal entity of their business for taxation purposes be charged the full ten per cent levy or only part of that levy?

* How far should company shareholdings be traced to register a change in ownership? Should there be a legal limit as to the number of holding companies between the legitimate legal owner and the holding company of the rock lobster boat and licence? The legitimate legal owner in the sense used is the physical person.

* Should public companies as distinct from private companies be allowed to own a rock lobster boat with an attached licence?

* Should the addition of members to a family discretionary trust which holds a licence be considered a partial transfer in ownership?

These are just some of the questions on transfer and changes that morally, legally and administratively need to be answered in order that the proposed stamp duty is equitable in its collection and effect.

In conclusion, it is important to note that these proposals are not made because the fishery is on the brink of disaster. The west coast rock lobster fishery is both biologically and economically overfished. The level of fishing effort has again reached a level beyond which no certainty on catch predictions can be made. How much the level of fishing effort should be reduced is an exercise in political and economic judgement which can only evolve from discussion with industry.

The main single long term problem in the management of the west coast rock lobster fishery is the stabilization of fishing effort and eventually effort reduction. A reduction in the length of the fishing season will simply shift the problems of overfishing to other valuable fisheries. The long term interests of the fishery would best be served by a reduction in the number of boats and fishing gear, for which industry must pay.

NOTES

1. A background paper on this fishery was given at the seminar by Mr F.A.L. Connell, President of the Australian Fishing Industry Council. The two footnotes to this paper are based on comments made by Mr Connell.

2. The Rock Lobster Industry Advisory Committee consists of: the Chairman (the Director of Fisheries); three active rock lobster fishermen; two members from the processing sector; a person not affiliated with the industry; an officer from the Department of Fisheries and Wildlife. The Committee has access to scientific and technical information and advice from the research section of the Fisheries and Wildlife Department, CSIRO, and the Western Fisheries Research Committee. Industry's participation in this Committee permits a close and understanding liaison with fishermen. Annual visits to coastal ports and discussions with fishermen to seek their views on current and proposed management measures has helped the management process. The Rock Lobster Industry Advisory Committee has contributed to the development of management plans and, at the same time, imparted a knowledge and a sense of awareness and responsibility to the fishermen and the industry generally. Many regulations and management plans have been initiated by industry and recommended to Government through this body.

3. The fees and the formula for calculation for 1980 are:

Total value of production (based on five year average production and valuation for 1978/79)	$43,767,000
Three-quarters of one per cent of the total value of production	$328,253

Proposed fee structure (with 1979 fees in brackets)

Zone A	$4.30 per pot	($3.50 per pot)
Zone B	$4.30 " "	($3.50 " ")
Zone C	$4.30 " "	($3.50 " ")
Zone D	$4.30 " "	($3.50 " ")
Zone E	$2.50 " "	($2.00 " ")

After accounting for the allocation of pots, this would provide for approximately $328,000. This contribution by industry is in turn used for research and development in the rock lobster fishery and other developmental work.

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THE SOUTH AUSTRALIAN PRAWN FISHERY: A CASE STUDY IN LICENCE LIMITATION

by

J. L. Byrne

INTRODUCTION[1]

It is now generally accepted that restricting entry by licence limitation is introduced to improve the economic state of a fishery. Biological aims such as maximisation of the sustainable catch or ensuring the survival of a fish stock are normally better achieved by other strategies such as closed seasons, catch limits, gear restrictions or a minimum capture size or weight.

Limited entry affects both the amount and the distribution of the net income generated by a fishery. This net income, which comprises the total value of the catch less the costs incurred in taking it, including the value in the next best use of capital and labour employed in the fishing operation is sometimes referred to as above-normal profit or economic rent. An effective programme of limited entry will increase net income because it reduces the wasteful competition which occurs in the open entry situation. Of course, consideration should be given not just to the effect on the fishing operation itself, but also to the more subtle implications for regional employment, industry diversification and worker satisfaction. The ways in which access rights are allocated and the conditions associated with these rights in turn determine how these benefits are distributed between current and future participants and non-participants.

The choice of economic goals, because it involves complex value judgements, must ultimately be made in the political arena. However, given a desired economic outcome it is still difficult to devise strategies for achieving it because detailed knowledge is required about the fish stock, the fishing operation and the interaction between the industry and the rest of the economy. Here the fisheries economist, together with the biologist and sociologist, can make a contribution.

This paper examines the economic consequences of the types of management strategies applied in the South Australian prawn fishery. The fishery has several unusual features which make it especially worthy of study:

* it has been subject to limited entry virtually since its inception, hence facilitating analysis of the effects of this type of regulation over the life of a fishery without the complication of an initial period of open-entry;

* it is based on exploitation of a highly valued species and as a result is capable of yielding significant resource rents;

* the prawn species is not considered to be self-regulating, that is the level of regeneration from a given spawning season is largely independent of the size of the parent stock (Walker, 1975). This means that biological overfishing is highly improbable, and hence regulations should be based almost entirely on economic considerations.

DESCRIPTION OF THE FISHERY

The South Australian prawn fishery exploits the adult stocks of a single species of penaeid prawn (Penaeus latisulcatus), commonly known as the Western King Prawn (Olsen, 1975). Commercial exploitation commenced in early 1968 after a number of unsuccessful attempts (Olsen, 1975; King, 1978). Initially, trawling was concentrated in Spencer Gulf, but grounds were soon discovered in Gulf St Vincent and on the West Coast. In 1975, new grounds began to be fished in Investigator Strait. The major fishing grounds are shown in figure 1.

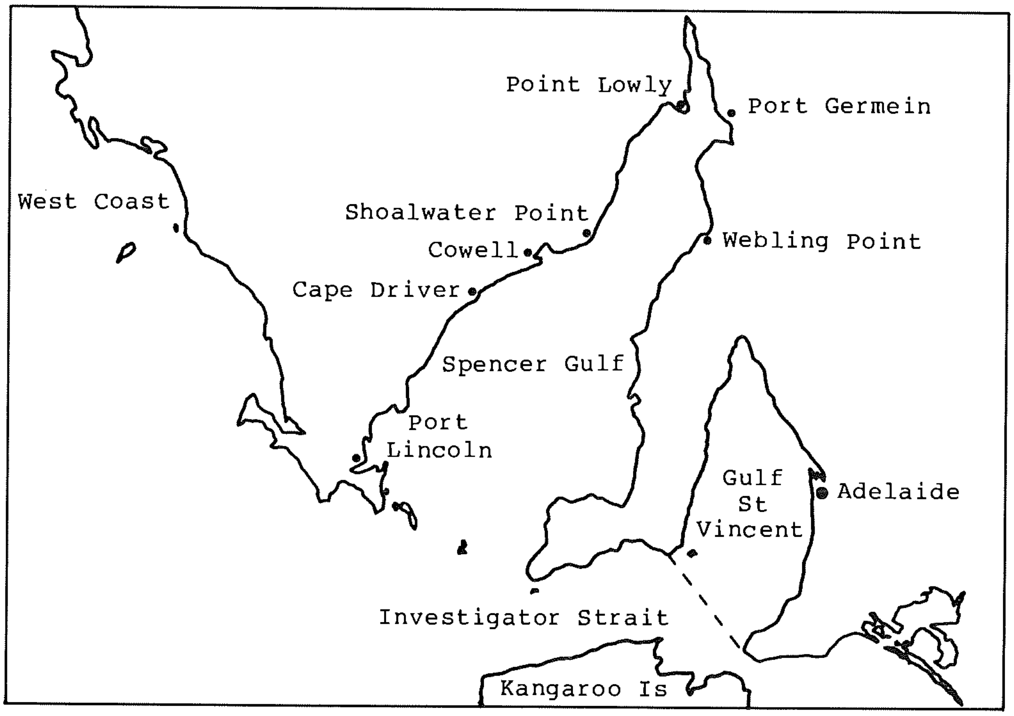

Figure 1: Prawn fishing areas in South Australia

Kirkegaard (1975) suggests that the life cycle of this species follows the mixed penaeid cycle (that is, spent partly in estuarine and partly in oceanic waters). Spawning occurs chiefly from November to March, with the majority of young adults leaving the inshore nursery areas between the following January and March. The majority of prawns are caught or die from natural causes within a year of leaving the nursery areas, therefore, it is largely a single year-class that is fished at a time. The level of annual recruitment is influenced more by environmental factors than the size of the parent stock, with fluctuations in recruitment causing large variations in the size of the potential prawn catch (King, 1978).

In Gulf St Vincent the small number of operators has allowed them to co-operate in concentrating fishing on the grounds occupied by the older and larger prawns for which there is a clear market preference. This has resulted in a very high price being paid for the product with peak catch rate occurring some months after the entry of new recruits to the fishery. The same result occurs in Investigator Strait because of the distance of the fishing zone from the Gulf St Vincent nursery areas.

In Spencer Gulf and on the West Coast, however, the large number of operators has prevented them from achieving the above co-operation, and fishing has concentrated in grounds adjacent to the nursery areas. This has resulted in a peak catch rate of small, low priced, prawns in the period immediately after the entry of new recruits into the fishery.

There is considerable variation in the type of vessel operating in the fishery. Many of the original vessels were converted tuna vessels while many of the later entrants have been converted rock lobster vessels or designed specifically for prawn trawling. Operators use the otter trawl technique developed for shrimps in the Gulf of Mexico. Trawling is generally undertaken at night and continues for up to eleven hours, with individual shots taking from thirty minutes to two hours.

Annual catches from each of the fishing areas have shown considerable fluctuations since their initial development (table 1). The yield from the West Coast increased rapidly until 1969-70, was stable until 1972-73, but has subsequently collapsed. The yield in Spencer Gulf showed a steady growth from 1968-69 until 1973-74 and has stabilised at about 2,000 tonnes per year in recent years. The trend in yield in Gulf St Vincent was similar to that in Spencer Gulf up until 1976-77, but output dropped sharply in 1977-78 and 1978-79. The Investigator Strait fishery is still in the developmental stage and it is difficult to assess the likely long-term trend in the yield from this area.

In general, the value of the catch has increased, but it has been very sensitive to changes in the size composition of the catch. For example, the value of the Spencer Gulf output more than doubled between 1977-78 and 1978-79, largely because a later start to the fishing season significantly increased the average size of prawns and hence the average price per kilogram.

Table 1. Catch and value of catch of the South Australian prawn fishery, by zone for years 1968/69 to 1978/79

	West coast		Spencer Gulf		G.St.Vincent		Investigator Strait		Total	
	Catch	Value	Catch	Value	Catch	Value	Catch	Value	Catch	Value
	'000 kg	$'000	'000 kg	$'000	'000 kg	$'000	'000 kg	$'000	'000 kg	$'000
1968/69	17	n.a.*	507	n.a.	16	n.a.	-	-	540	589
1969/70	226	n.a.	932	n.a.	101	n.a.	-	-	1 259	1 586
1970/71	151	n.a.	909	n.a.	127	n.a.	-	-	1 187	1 496
1971/72	276	n.a.	1 001	n.a.	211	n.a.	-	-	1 488	2 285
1972/73	243	n.a.	1 243	n.a.	229	n.a.	-	-	1 715	2 881
1973/74	262	n.a.	2 287	n.a.	354	n.a.	-	-	2 903	3 774
1974/75	179	n.a.	2 052	n.a.	342	n.a.	-	-	2 573	3 860
1975/76	103	n.a.	1 955	n.a.	451	n.a.	106	n.a.	2 615	7 584
1976/77	30	98	2 222	7 028	447	1 844	143	544	2 842	9 513
1977/78	20	46	1 674	4 022	397	1 593	185	652	2 278	6 314
1978/79**	19	65	1 988	9 259	287	1 378	185	885	2 475	11 586

Source: South Australia, Department of Fisheries.

* Prior to 1976-77, regional prices are not available, hence it was not possible to calculate the value of the catch on a regional basis.

** Provisional.

FEATURES OF THE LIMITED ENTRY SCHEME

The South Australian Government has jurisdiction over all the fishing grounds except central Investigator Strait, hence it has almost complete control over management of the fishery. The Australian Government has jurisdiction over the remainder of Investigator Strait and it is currently managed jointly by the State and Federal Governments.

Entry restrictions were introduced by the State Government in March 1968, only two months after the first commercial catches were taken (Byrne and Harding, 1976). This policy was considered revolutionary at the time and was prompted by a desire to prevent the fishery suffering the same fate as the South Australian rock lobster fishery, where a dramatic drop in catch rate over the preceding twenty years had accompanied a rapid escalation in fishing effort.

Control over the fishery has been shared between the Minister of Fisheries and the Director of the Department of Fisheries. The Minister can issue short-term Ministerial permits to encourage exploration of likely new fishing grounds. Prawn trawling authorities (or licences) which are more permanent and permit access to an established fishing area are issued by the Director.

Authorities and permits are assigned to individuals or partnerships, but holders must nominate and have authorised the vessels to be used for prawn trawling. Initially it was Government policy that the authority holder be on board the vessel during all fishing operations, however, this condition has been relaxed in recent years; licence-holders claim they are performing essential shore tasks and place relief skippers on their vessels. This latter state of affairs is likely to continue pending the outcome of a planned review of the owner-operator policy in all managed fisheries.

Government pronouncements on the aims of the limited entry programme in South Australia have been couched in very general terms, such as:

> Conserving the natural resource and exploiting it for the greatest public benefit. (South Australia, Department of Agriculture and Fisheries, 1976);

and to

> Seek optimum utilization of resource - both the product and the resources used to take it. (South Australia, Department of Fisheries and AFIC in S.A., 1979).

As a result, the Director has been left with substantial discretion in determining the number of authorities to issue for each area. Very few additional authorities have been issued since the allocations to the original permit holders in 1969 and

1970. Between June 1970 and June 1979 the number of authorities increased from 35 to 53 (table 2).

The only economic survey of the fishery covered the years 1968-69 to 1970-71 (Australia, Fisheries Division, Department of Primary Industry, 1974), consequently quantitative estimates of the rates of return achieved by authority-holders in recent years are not available. However, there is little doubt that this tight control over the number of participants has created a very lucrative fishery. The most obvious evidence of this has been the constant pressure by outsiders on the Director to grant additional authorities.

Historically, new authorities were granted to the applicants who best met a large number of criteria such as prior holding of a Ministerial permit, length of service as a fisherman, suitability of the nominated vessel for prawn trawling and location of the home port (Byrne and Harding, 1976). At first, the selection was made by the Director alone, but was later based on the recommendations of industry and Government representatives meeting as the Prawn Industry Advisory Committee. This Committee, however, was disbanded in late 1976, and the most recent allocation was based on a random selection from a large number of applicants who met very general criteria (drawn up jointly by industry and Government) such as nomination of a suitable vessel and possession of a Class "A" general fishing licence. The criteria which must be met to hold a Class "A" general fishing licence are listed in Byrne and Harding (1976); in summary, a person must be a competent full-time professional fisherman.

In theory, licences are non-transferable (Byrne and Harding, 1976), but in practice this has been circumvented, because the Government has automatically reissued authorities to the purchasers of authorised vessels. The Government has attempted to prevent authority-holders from taking advantage of their position when selling their vessels, by requiring a statement from the transactors that the selling price approximates the fair market value of the vessel and equipment without an accompanying authority. But as the seller can select the valuer who will supply the valuation and there is no way of ensuring that the stated and actual transfer prices correspond, the latter is effectively market determined. As a result, the resource rent associated with these licences has been capitalized into their market prices. At June 1979, almost half of the authority-holders had purchased their authorities in the open market (table 2). Because of the likely discrepancy between stated and actual transfer prices, accurate figures for the latter are not available. Informed sources, however, suggest that recent sales of authorised vessels fetched between $300,000 and $400,000, of which $100,000 to $200,000 was payment for the authority.

Until 1977, each authority-holder paid a nominal annual fee of $200 for a single-rig vessel and $300 for a double-rig vessel. In 1978, however, the Government initiated negotiations with authority-holders with a view to diverting a more significant share of the available rents to the public purse. Following

Table 2. Number of authorities and permits on issue* and number of sales of authorised vessels, by zone 1968-69 to 1978-79

Year	West coast and Spencer Gulf			Gulf St. Vincent			Investigator Strait			All zones		
	Auth.	Sales	Permits	Auth.	Sales	Permits	Auth.	Sales	Permits	Auth.	Sales	Permits
1968/69	26	0	0	5	0	0	0	0	0	32	0	0
1969/70	30	1	0	5	0	0	0	0	0	35	1	0
1970/71	37	2	0	10	0	0	0	0	0	47	2	0
1971/72	36	3	0	10	1	0	0	0	0	46	3	1
1972/73	36	2	1	10	1	0	0	0	0	46	3	2
1973/74	34	2	1	10	1	0	0	0	0	44	3	2
1974/75	39	1	2	12	1	0	0	0	2	51	2	6
1975/76	39	1	3	12	2	0	0	0	5	51	3	10
1976/77	39	4	3	12	2	0	0	0	5	53	6	10
1977/78	39	2	3	14	1	0	0	0	8	53	3	11
1978/79	39	2	1	14	1	0	0	0	8	53	3	10

Source: South Australia, Department of Fisheries.

* To avoid double counting of reissued authorities of permits, the number shown is the maximum number of concurrent authorities on issue during a given year.

heated discussion, an interim fee of $1,830 per authority was struck for 1978 in the absence of agreement on a permanent arrangement. It was subsequently agreed that operators in each zone would, in aggregate, pay an annual fee equal to 2.5 per cent of the average catch for the zone over the preceding three years valued at the price in the most recent year. As a result, in 1979, Spencer Gulf and Gulf St Vincent authority-holders paid average[2] fees of $3,200 and $2,000 respectively,[3] leading to an aggregate fee of $156,000. The anticipated 1980 fees are $5,700 per Spencer Gulf operator and $2,900 per Gulf St Vincent operator, leading to an aggregate fee of $260,000. Despite these fees, it is considered that authority-holders still retain a significant share of the resource rents resulting from the limited entry programme.

THE CONTROL OF FISHING EFFORT

So far, discussion has centred on limiting the number of fishing units in the fishery. But the resource rent generated by a fishery depends on fishing effort and the cost of achieving this effort.

Fishing effort, which can be measured in units of fishing mortality, each unit removing an equal proportion of the available stock, is a function of both the number of fishing units and the fishing pressure which each exerts. This in turn depends on the time spent fishing, the relative densities of the subsections of the stock which are exploited and the catching ability or fishing power of the fishing unit. For a detailed discussion of the concept of fishing effort, see Beverton and Holt (1957) or Ricker (1975). The function which determines effort can be written:

$$(1) \quad X = \sum_{i=1}^{N} f(T_i, D_i, FP_i)$$

where X is total fishing effort in the period, N is the number of fishing units, T_i is time fished by unit i, D_i is the relative densities of the subsections of the stock which unit i exploited, and FP_i is fishing power of unit i.

Fishermen normally attempt to minimise the cost of achieving their desired level of fishing effort. However, the decision as to what this amount of effort should be will be based on the private gains and costs of further expansion of effort. As demonstrated by Anderson (1977), in an open entry fishery each operator will operate at the quantity of effort which minimises his costs per unit of fishing effort; failure to do so would result in displacement by a more efficient outsider. However, in a limited entry fishery, operators are protected from potential entrants and are therefore able to operate in a less efficient manner. Each will in fact do so provided he considers the resultant increase in fishing effort will allow him to gain more of the available resource rent.

In aggregate this response not only increases the cost of reaching each level of effort but also causes a jump in the effort level itself. Both these forces lead to a decrease in the potential benefits of the limited entry programme. However, the benefits from limited entry will not be dissipated completely. This is because each operator faces increasing costs per unit of effort; hence average costs will be below marginal costs at the point at which the latter equals his marginal (and average) revenue.

To prevent this tendency towards higher amounts of effort and higher cost, management needs to control all the factors which affect each participant's fishing effort. At the same time, however, it should permit each fishing unit to operate in the most efficient manner so as to minimise the cost of achieving the desired amount of total effort. In a dynamic situation, this may require that management alter both the permitted methods of operation to take advantage of cost-reducing technological changes and the number of participants. The latter measure will be necessary to contain effort when such technological changes necessitate increases in the effort of each participant. How well does this model apply to the South Australian prawn fishery?

FISHING TIME

The average yearly number of trawling hours per authorised vessel increased by 31 per cent for Spencer Gulf and 95 per cent for Gulf St Vincent between 1970 and 1978 (table 3). This has been facilitated by the introduction of stabilisers which allow vessels to fish in rougher weather than was possible previously. Another reason is the increased use of skippers to relieve or even replace the actual authority-holders on board the vessels.

There is scope for further increases in hours trawled, especially in Gulf St Vincent, where average hours are well below those in Spencer Gulf. This is illustrated by the hours achieved by the hardest worked boats in each Gulf which were 38 per cent and 50 per cent above average for Gulf St Vincent and Spencer Gulf respectively.

During 1979 and 1980 several partial and complete closures were imposed in Spencer Gulf (table 4). Although the banning of fishing in the area adjacent to the nursery areas was aimed at improving the value of catch, the total closures (in aggregate almost one-third of the year) were introduced specifically to contain the expansion in average hours trawled. Gulf St Vincent authority holders also implemented a voluntary total closure covering August and September 1979 in an attempt to prevent what they considered to be excessive effort.

RELATIVE DENSITY OF THE EXPLOITED STOCK

It is impossible to quantify changes in the relative densities of the subsections of the stock which have been

Table 3. Changes in components of fishing effort per authority holder, by zone for 1970 to 1978

Year	Spencer Gulf authority holders					Gulf St. Vincent authority holders				
	Av. hrs./ auth.*	Av. Length (Metres)	Av. BHP	% Dble. rig.	Av. Fishing Power	Av. hrs./ auth.*	Av. length (Metres)	Av. BHP	% Dble. rig.	Av. Fishing Power
1970	847	18.2	207	39	.882	475	12.7	99	0	.909
1971	761	18.1	210	49	.890	575	12.5	111	0	.918
1972	866	18.1	235	49	.924	818	12.5	128	0	.941
1973	969	18.1	246	49	.931	803	12.6	141	0	.962
1974	948	17.5	253	66	.961	798	12.9	148	0	.983
1975	1126	17.3	257	87	1.012	859	12.4	167	0	.983
1976	1113	17.3	258	92	1.026	840	12.5	163	0	.983
1977	1054	17.4	269	95	1.045	857	12.5	163	0	.983
1978	1111	17.3	279	98	1.058	926	12.4	182	0	.998

Source: South Australia, Deparment of Fisheries.

* Excludes authorities issued or withdrawn during the year.

Table 4. Closures for Spencer Gulf zone, 1979 and 1980

Period	Area
Permanent	Area north of line joining Point Lowly and Port Germein (nursery area).
15 Jan - 28 Feb 1979	Total Gulf.
1 Mar - 31 Mar 1979	Area north of line joining Webling Point and Shoalwater Point Light (fishing area adjacent to northern nursery area).
1 July - 3 Sept 1979	Total Gulf.
22 Dec 1978 - 15 Feb 1979	Total Gulf.
16 Feb - 31 Mar 1980	Area north of line Webling Point and Shoalwater Point Light (fishing area adjacent to northern nursery area).
1 April - 30 June 1980	Thirteen mile strip parallel to the coast from Cowell to Cape Driver (fishing area adjacent to Cowell nursery area.
1 July - 30 Sept 1980	Total Gulf.

Source: South Australia, Department of Fisheries.

exploited by the prawn fleet during each fishing season. There is no doubt, however, that operators' knowledge of the behaviour of the prawn stocks and the topography of the fishing grounds has improved considerably over the years. On average, this should mean that they are now more likely to fish at times and in areas where prawns are relatively more abundant or more vulnerable to capture.

VESSEL FISHING POWER

The relative fishing power of a prawn vessel is dependent on a large number of its characteristics, both human and material. That is,

$$(2) \quad FP_i = f(C_{1i}, C_{2i}, C_{3i}, \ldots.)$$

where FP_i is the fishing power of vessel i, relative to a standard vessel, and $C_{1i}, C_{2i}, C_{3i}, \ldots.$ are the values of characteristics $C_1, C_2, C_3, \ldots.$ for vessel i. Given this relationship for prawn vessels in South Australia, it is possible to estimate changes in average fishing power by monitoring changes in the relevant characteristics of participating fishing units.

In theory, equation (2) can be deduced by comparing the catch rates of fishing units with their characteristics when they are fishing stocks of equal abundance. In such a situation the relative catch rates will mirror the relative fishing powers of the fishing units. There are, however, a number of difficulties in pursuing this approach. Firstly, it is rare that two or more vessels will be fishing stocks of exactly equal abundance and that the associated relative catch rates would be available. Secondly, some characteristics, such as the skill of the skipper and crew are extremely difficult to quantify, while others, although quantifiable (for example, net headline length or mesh size) may not be readily available. Thirdly, the form of the function is unknown.

Nevertheless, an attempt was made to estimate equation (2) for every region by regressing yearly catch rates for vessels operating in the West Coast, Spencer Gulf and Gulf St Vincent in each of the years 1968 to 1976 against their length, cBHP (continuous Brake Horse Power), type of rig and fishing experience in the area. Both linear and logarithmic functions have been used in previous studies, for example, Beverton and Holt (1957), Griffin et al. (1977), Gulland (1956), Pope (1975) and Robson (1966); hence, because of the uncertainty concerning the form of the equation, both of these forms were estimated for the South Australian prawn fleet.

The equations to be estimated were therefore:

$$(3) \quad (Y/T)_{tri} = a\, L_{tri} + b(cBHP)_{tri} + c\, D_{tri} + d\, E_{tri} + \sum_{r=1}^{3} \sum_{t=1}^{9} \left[g_{rt} (R_r T_t)\ _{tri} \right]$$

and

$$(4) \quad \log\, (Y/T)_{tri} = a \log L_{tri} + b \log\, (cBHP)_{tri} + c\, D_{tri} + d\, L_{tri} + \sum_{r=1}^{3} \sum_{t=1}^{9} \left[g_{rt} (R_r T_t)_{tri} \right]$$

where

$(Y/T)_{tri}$ = the catch rate of vessel i in region r in year t,

L_{tri} = the length of vessel i in region r in year t,

$(cBHP)_{tri}$ = the continuous rated Brake Horse Power of main engine of vessel i in region r in year t,

D_{tri} = 0 if vessel i uses single rig in region i in year t,

= 1 otherwise,

E_{tri} = 1 if vessel i trawls for less than 100 hours in region r in year t,

= 0 otherwise,

$R_r T_t$ = 1 if vessel i is operating in region r in year t,

= 0 otherwise.

There were a total of 504 observations altogether with the number of observations within region-year strata varying from six to thirty-nine.

The results are shown in table 5. All of the characteristics were significant at the 95 per cent level for both equations and each equation explained approximately two-thirds of the observed variation in catch rates. Although the two equations had very similar explanatory powers, it was considered that a proportional relationship between fishing power and the values of fishing unit characteristics was more realistic than an additive one, hence equation (4) was adopted for estimation of changes in average vessel fishing power. It implies that increases of one per cent in vessel length or cBHP lead to 0.53 per cent and 0.18 per cent increases in fishing power respectively and that switching from single to double rig increases fishing power by 30 per cent.

Restrictions of a number of vessel characteristics, including some of the above, have been progressively introduced since 1970 in an attempt to control fishing effort (table 6). However, there have been significant increases in unrestricted components, namely cBHP of vessels and the percentage of vessels using double rig in Spencer Gulf (table 3).

In order to quantify the resultant changes in average fishing power of vessels, the following were adopted as standard vessels for the two regions:

Spencer Gulf: 16 metre, 250 cBHP, double rig vessel fishing more than 100 hours per year.

Gulf St Vincent: 13 metre, 160 BHP, single rig vessel fishing more than 100 hours per year.

The relative fishing powers of the average vessels each year were estimated to have increased by 20 per cent in Spencer Gulf and almost 10 per cent in Gulf St Vincent since 1970 as a result of these changes (table 3).

In addition, the current vessel and engine replacement policies would permit a further increase of 2 per cent in vessel fishing power in Spencer Gulf, assuming all Spencer Gulf vessels changed to comply with current length and BHP restrictions. If, instead, the vessels which are currently under the permitted levels adjust upwards whilst those above them remain unchanged,

Table 5. Estimated coefficients of fishing unit characteristics and coefficients of determination using linear and log linear equations of vessel fishing power

Equation	Characteristic				R^2
	L	cBHP	D	E	
(3) linear	1.13 (5.10)	.0436 (4.86)	10.78 (6.83)	-9.34 (-4.56)	.673
(4) log liner	.535 (5.26)	.178 (4.30)	.263 (6.26)	-1.39 (-6.51)	.661

Table 6. Restrictions imposed on authorised prawn vessels for 1970 to 1979

Characteristic	Zone	Restriction
Vessel length	Spencer Gulf	1970 onwards. Maximum of 17 metres for new entrant and replacement vessels.
	Spencer Gulf	1974-1979. No greater than that of vessel being replaced.
	Gulf St.Vincent	1970 onwards. Maximum of 14 metres.
	Gulf St.Vincent	1970-1979. No greater than that of vessel being replaced.
Rig	Spencer Gulf	1971-1974. No changing from single to double rig.
	Gulf St.Vincent	1970-1974, 1976 onwards. No use of double rig.
Net headline	Spencer St.Vincent Gulfs	1970 onwards. Maximum headline (in metres = 17 + .882 x vessel length (in metres).
Engine power	Spencer Gulf	1979 onwards. Maximum of 300 cBHP for all new entrant and replacement vessels and replacement engines for present vessels of length 17 metres or less.
	Gulf St.Vincent	1979 onwards. Maximum of 250 cBHP for all vessels.

Source: South Australia, Department of Fisheries.

it is possible that average fishing power could increase by approximately 20 per cent. The estimated increase in fishing power in Gulf St Vincent is 15 per cent assuming the single rig restriction were maintained; an increase of almost 50 per cent could be achieved if that policy were not maintained.

FISHING EFFORT PER OPERATOR AND OPERATOR EFFICIENCY

In summary, it would appear that average fishing effort per authority-holder has increased by at least 50 per cent in Spencer Gulf and well over 100 per cent in Gulf St Vincent between 1970 and 1978. In addition, there is potential for further significant increases in both zones. Unfortunately no recent data on the relative costs of effort are available, hence only very general comments can be made on the implications for efficiency of these changes in average fishing effort and the current restrictions on vessel characteristics and periods of operation.

Increases in the number of hours trawled spread the capital cost of an operation over more hours and hence lower capital costs per hour fished. If, as well, the direct costs of an hour's operations (such as fuel and repairs) are approximately constant for each hour of fishing, then the observed increases in fishing hours would have lowered the unit costs of effort for most operators. This is considered to be the case for the range of hours fished by almost all prawn vessels in South Australia. Of course, excessive use and inadequate maintenance will eventually lead to substantial increases in both fixed and hourly costs leading to a reversal of this downward trend in average cost. For the same reason the recent total closures (table 4) are likely to have prevented operators from making further efficiency improvements. There may, however, be some benefit from limited total closures if they encourage operators to carry out cost-reducing regular maintenance. This may otherwise be overlooked because the competitive attitudes of most fishermen dissuade them from stopping fishing while other boats are still operating. In addition, a forced interruption to fishing due to a vessel breakdown during a shortened season will have a much greater effect on profitability because the days lost will represent a larger share of available fishing days.

It is generally considered that a double rig is more efficient than a single rig. The gradual move towards the former in Spencer Gulf has probably improved vessel efficiency in that zone. For similar reasons, the continued restriction to single rig in Gulf St Vincent has hampered the efficiency of units operating in this area.

Perhaps the best indicator of the most efficient length-engine power combinations is the type of vessels operating in the equivalent open-entry prawn fisheries on the east coast of Australia. Vessels there correspond, on average to the current limits imposed for the two zones in South Australia, suggesting that the latter are reasonably sensible. However, a few of the smaller local vessels did install what appear to be inefficiently powerful engines in the period leading up to the introduction of the current limits on engine power.

Overall, it would appear that the changes in fishing operations of authority holders which have occurred have tended to lower rather than increase costs per unit of fishing effort. The only restrictions on effort which are significantly hampering vessel efficiency are the ban on double rigs in Gulf St Vincent and the extended total closures in Spencer Gulf.

OPERATOR EFFICIENCY AND EFFORT CONTROL

While some Government regulations are currently hampering operator efficiency, this has been done deliberately in order to help contain fishing effort. An assessment of the desirability of retaining, or even extending these regulations must take into account both the effort and efficiency implications of the proposed change.

It would appear that the yields in both Spencer Gulf and Gulf St Vincent are near maximum sustainable levels. There has been little expansion of the catch since about 1973-74 in Spencer Gulf, and 1975-76 in Gulf St Vincent, despite significant increases in effort per operator and the introduction of additional operators in both areas. In these situations, longer periods of fishing are undesirable since they increase overall operating costs without altering total catch or revenue. Therefore it is argued that the closures of Spencer Gulf are beneficial, despite the fact that they lead to reduced usage of invested capital.

Analysis of the likely implications of removing the single rig restriction in Gulf St Vincent is more complicated. Since changing to double rig involves some additional overhead costs and probably a slight increase in the direct costs of an hour's operation, it is not worthwhile if the present number of hours of operation are maintained. It could, however, be combined with new total closures to achieve a reduction in hours trawled and hence total direct costs, whilst maintaining present quantities of effort and catch. In this latter case the profitability of the fishery would be improved by the adoption of the more efficient fishing gear even though there would be an increase in overhead costs per hour trawled resulting from the shorter fishing season.

The analysis so far has ignored the most direct means of reducing fishing effort, namely removal of fishing units from the fishery. In terms of increasing the economic rent generated by the fishery, this is superior to either gear restrictions or closed seasons since it has no adverse effect on operator efficiency. To date, this strategy has been rejected as being too difficult to implement.

The most direct way of reducing the number of operators is not to renew the required number of arbitrarily selected authorities. This method, however, has been judged unacceptable on equity grounds. Alternatively, financial inducements could be used to persuade the required number of operators voluntarily to leave the fishery. The major problem with this option has been obtaining the necessary funds. The cost is likely to be substantial, despite the current excessive effort, because the fishery is still a very lucrative one and because the likely gain for those remaining in the fishery is substantial.

Ideally the Government should have been accumulating the necessary funds since the inception of the limited entry programme by levying realistic licence fees and extracting a significant entrance fee from each new authority-holder. In the extreme case new authorities could have been auctioned on the open market, allowing the Government to capture all of the resource rents embodied in each authority at the time of issue. Unfortunately neither of these measures have been carried out.

Given the already privileged position of authority-holders, the Government is unlikely to provide the necessary funds from general revenue. The only feasible solution would be for operators themselves to finance the buy-out by paying much higher licence fees in future periods. At present, however, they appear to be unwilling to consider this type of trade-off.

In summary, there would appear to be three possible long-term outcomes for the prawn fishery:

* each fishing unit operates in the most efficient manner, but the number of units and hence total effort is excessive;

* each fishing unit is forced to operate inefficiently and the number of fishing units is excessive, but total effort is somewhat lower;

* both the number of units and total effort are optimal, with participants covering the costs of the necessary adjustments in the number of fishing units.[4]

Currently the South Australian prawn fishery has features consistent with the first two options. From the viewpoint of economic efficiency, it is desirable that industry and Government will, in time, have the insight to move towards the last option. This presumes that the Government wants to maximise the benefits of the limited entry programme. It is feasible that the Government may deliberately issue an excessive number of authorities, even though it reduces the benefits of the programme, in order to achieve a wider distribution of these benefits amongst fishermen.

SUMMARY AND CONCLUSIONS

The limited entry programme implemented in the South Australian prawn fishery has succeeded in preventing this fishery from degenerating to the level of many open entry fisheries throughout the world. It has resulted in the fishery generating significant resource rents. These rents initially were retained completely by the authority-holders, but the Government has recently moved to divert a share to the public purse.

However, there have been significant unplanned increases in fishing effort despite the introduction of controls over a number of features of fishing vessels and their periods of operation. There is also scope for this trend to continue even under the existing restrictions. At the same time, a number of these controls are forcing increases in the average cost of each unit of fishing effort. Both of these have led to a reduction in the benefits derived from the limited entry programme.

In the long term, a self-financing buy-back scheme is necessary if the desired amount of effort in each zone is to be achieved at the lowest possible cost. Only adoption of this policy option will ensure that the maximum possible benefits are to be gained from the limited entry programme.

NOTES

1. This paper is to a considerable extent based on Byrne (1978).

2. In Spencer Gulf a slightly lower fee was paid by operators with smaller vessels but in Gulf St Vincent all vessels paid an equal fee.

3. In fact a slight departure from the formula was agreed to in the case of Gulf St Vincent for 1979 and 1980 only because of the poor catch in that region in 1977-78.

4. This is in addition to any licence fee aimed at redistributing part of the benefits of limited entry to the community as a whole.

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13

LIMITED ENTRY MANAGEMENT FOR THE NORTHERN PRAWN FISHERY: A REVIEW OF ITS DEVELOPMENT

by

N. D. MacLeod

INTRODUCTION

The northern prawn fishery (NPF) has grown rapidly since its beginnings to become one of the largest Australian fisheries both in terms of gross value and value of exports. It is also one of the most isolated fisheries, being conducted off the coast of an immense and thinly populated area. Some confusion has arisen in the past with respect to what exactly the term "northern prawn fishery" means. Initially, it referred to the fishery on several prawn species conducted in marine waters north of Bowen on the Queensland east coast, the Gulf of Carpenteria and waters beyond to Broome in Western Australia. However, with the heavy emphasis that has been placed on fishing in the Gulf and subsequent imposition of a limited entry regime, the fishery has become increasingly associated with the Gulf and marine waters off the Northern Territory as far as the Joseph Bonaparte Gulf.

Operational characteristics of the fishery are discussed in detail elsewhere (Copes, 1975; Hughes, 1972; Walker, 1975). Data relating to vessel numbers and operation are presented in table 1. Also shown are the number of vessels which actually operated in the present management zone each season. A rapid increase in the number of vessels occurred in the early 1970s. A subsequent decline in numbers followed depressed market conditions, particularly in the 1974 and 1975 prawn seasons. A strong recovery in numbers is evident to the end of the decade. The structure of the fleet has changed with an emphasis on larger freezer vessels and a general decline in the number of smaller vessels using brine refrigeration. At the same time these larger vessels appear to be more fully "committed", spending longer periods in the fishery and taking consistently larger catches than the smaller vessels. While annual catches fluctuate due to variable banana prawn catches, there is a trend toward a more stable fishery as increasing attention is being paid to fishing for tiger prawns and other species. This change in the fleet, in association with the strong growth of the fishery, prompted discussion of a need for management.

Unfortunately, prawns do not recognise man's administrative boundaries. As a result the northern prawn fishery falls within the jurisdiction of several management authorities. This situation arises because the Australian Constitution gives the Commonwealth jurisdiction over fisheries beyond the three mile territorial sea. The States and Northern Territory exercise jurisdiction over fisheries within the territorial sea. There-

Table 1. Number of vessels operating in northern prawn fishery by month: 1970 to 1979

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979*
January	32	35	40	32	17	29	17	22	40	105
February	51	40	39	28	28	31	57	28	70	158
March	102	82	68	145	106	75	120	150	178	234
April	142	174	182	173	151	105	108	173	217	310
May	155	201	194	149	150	92	93	189	222	240
June	156	182	177	173	99	84	89	165	220	294
July	161	194	199	137	82	100	88	153	204	271
August	175	179	193	151	83	95	81	180	224	272
September	149	150	165	135	66	75	106	155	225	249
October	123	111	141	124	70	64	87	138	215	260
November	91	79	90	95	34	55	86	118	188	
December	57	71	50	55	23	39	77	91	167	
Annual Fleet Size	252	292	321	291	220 **	184	192	301	389	534
Number in managed zone***	119	145	141	153	159	105	145	175	193	205

* Preliminary.

** Eleven vessels included in total for which no monthly breakup is available.

*** Estimated by CSIRO from log books.

fore, management measures must be determined by joint agreement and/or compromise by the parties involved. For the northern prawn fishery this problem is compounded by a fleet structure and historical development of the fishery which accentuates the conflict of interest between various State groupings.

A barrier to any review of management in the fishery is that no clear objectives of management have been documented. Therefore, it is difficult to assess the effectiveness of the policies which the managing bodies have implemented. In the few places where some objectives are stated, they are often cast in sufficiently vague or conflicting terms to be almost meaningless. An example arose from a workshop sponsored by the Department of Primary Industry (DPI) in 1978. Acceptable objectives for fishery management were seen to be those of adopting an administratively feasible regime which would provide for recruitment within the limits of natural variation; encouraging exploitation of the resources in an economically efficient manner; and minimum social disruption and maximum social equity. The last item would seem to be a "catchall", potentially offsetting any measures that may be required in meeting the two former objectives.

This paper does not attempt to lay down a blueprint for management in this complex fishery. Rather it attempts to review the development of limited entry management within the catching sector of the northern prawn fishery. The main thrust of the review is to consider management from an economic viewpoint. The political or social aspects of management are left to a review tailored to those needs. Similarly, limited attention is given to biological details of the fishery, an area that is by no means well documented.

THEORETICAL ASPECTS OF ECONOMIC MANAGEMENT

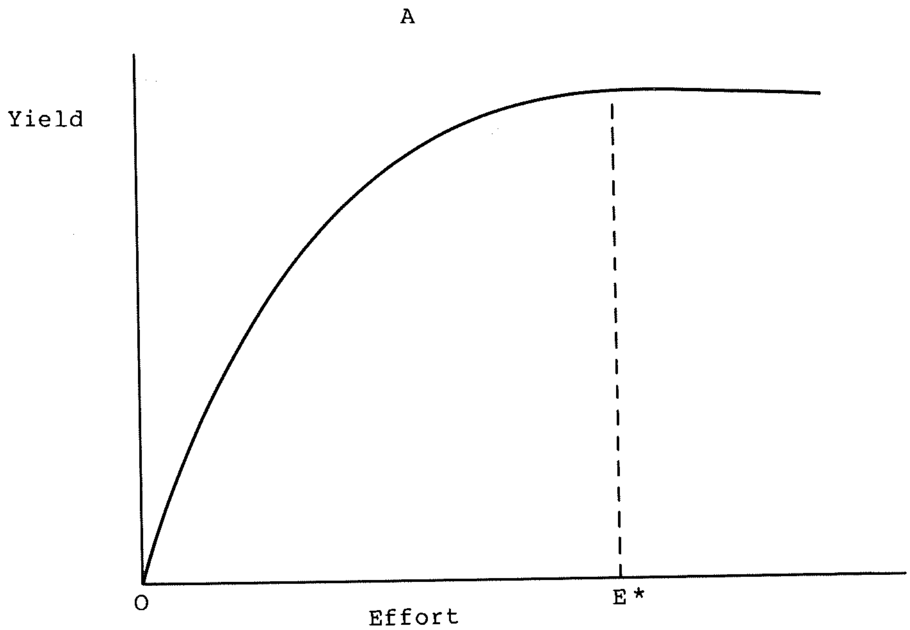
The design of an effective scheme of management for the northern prawn fishery is no simple matter. The difficulties can be grouped into three areas. The first and most important is the lack of clear objectives on which to base a management regime. The second relates to an inadequate understanding of the extent of stocks and the bio-economic relationships in the fishery. The few studies carried out to date have been hampered by these problems and the present review is no exception. The third type of difficulty concerns the problem of reconciling the interests of individual groups and society when deriving a set of management policies and regulations.

Despite these difficulties, it could not be argued that economic management of the fishery was restrained by the lack of a theoretical base. Such was provided in the early 1950's through the writings of Scott Gordon (for example, 1954) which are acknowledged as having led to an accepted economic theory of fisheries management (for example, Anderson, 1977; Copes, 1970; 1972; Crutchfield, 1961; Tompkins and Butlin, 1975). It has been suggested (Fraser, 1977, p.7) that a major effect of Gordon's works was finally to destroy the pure conservation argument for fisheries management which tended to place limited emphasis on the value of inputs used in obtaining the catch. By introducing this theory, Gordon convincingly argued for a concentration on net economic yield rather than maximum sustainable yield as an appropriate goal of management. Moreover, he provided an understandable mechanism to explain the wastage inherent in policies of free entry to a fishery.

While the logic of Gordon's model can be applied to prawn stocks the actual example used in his formal treatment cannot. Penaeid prawn species are generally short lived and highly fecund (Gulland, 1972; Munro, 1975) with life history varying from species to species. The volume of catch will generally depend on the size of the prawn stock and the amount of fishing effort. A typical relation between weight caught and fishing effort is shown in figure 1a. As the fishery develops, the sustainable catch is proportional to effort applied. However, as effort expands the rate of increase in total catch will decline until a point (E*) is reached beyond which little further gain in catch is possible. This could be considered to approximate maximum sustainable yield (MSY) from the stock. Associated with this curve will be a declining average yield or catch per unit of effort (figure 1b). This would, in the absence of continued recruitment, occur as prawns become scarce but could be disguised by the increasing efficiency of vessels.

The relationships presented in figure 1 can be used to derive a sustainable revenue relationship between value of catch and quantity of effort. This is easiest done by assuming a constant relationship between the unit value of catch and the actual quantity of landings. In the case of the northern prawn fishery, this is fairly realistic given the high dependence on world markets of which the Australian product accounts for a small proportion. However, the price does vary with the size of prawns, being higher for larger individuals. As the level of fishing increases and the prawn catch expands, average size and therefore average price will decline. Total value of catch will then follow a similar pattern to the weight of catch, but tend to fall below it at high levels of fishing (figure 2a).

Similarly, a relationship can be derived between cost and the amount of effort. The linear total cost function is based on the assumption that average cost is unaffected by the volume of landings. An interpretation is that effort is increased by the introduction of additional vessels of optimum size, each of which is operated in the most efficient manner (Anderson, 1977, p.30). A related alternative is that fishermen are "price takers" on input markets (Gulland, 1977, p.113; Tompkins and Butlin, 1975, p.109). Total costs include operating costs, depreciation, a "normal" return on capital (enough to attract capital to the fishery) and a "normal" wage to labour employed (enough to attract labour to the fishery).



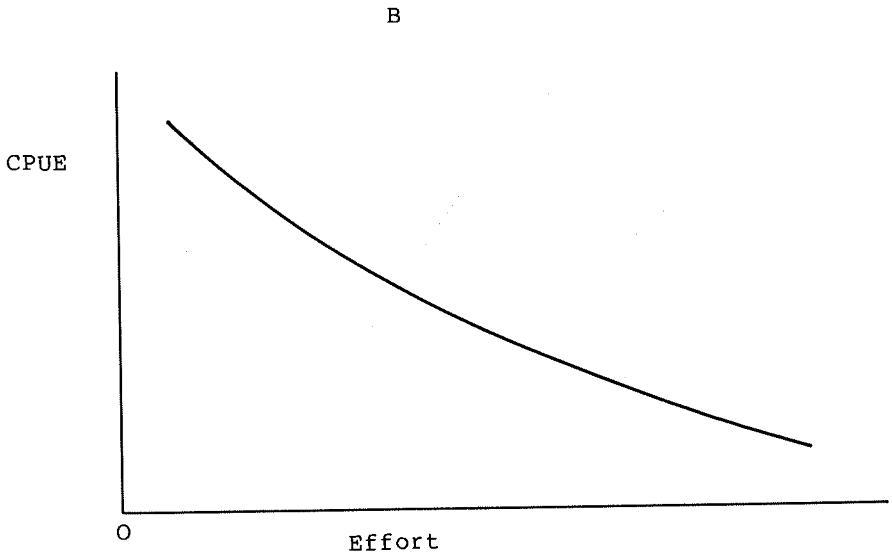


Figure 1: Sustainable yield, and catch per unit effort curves

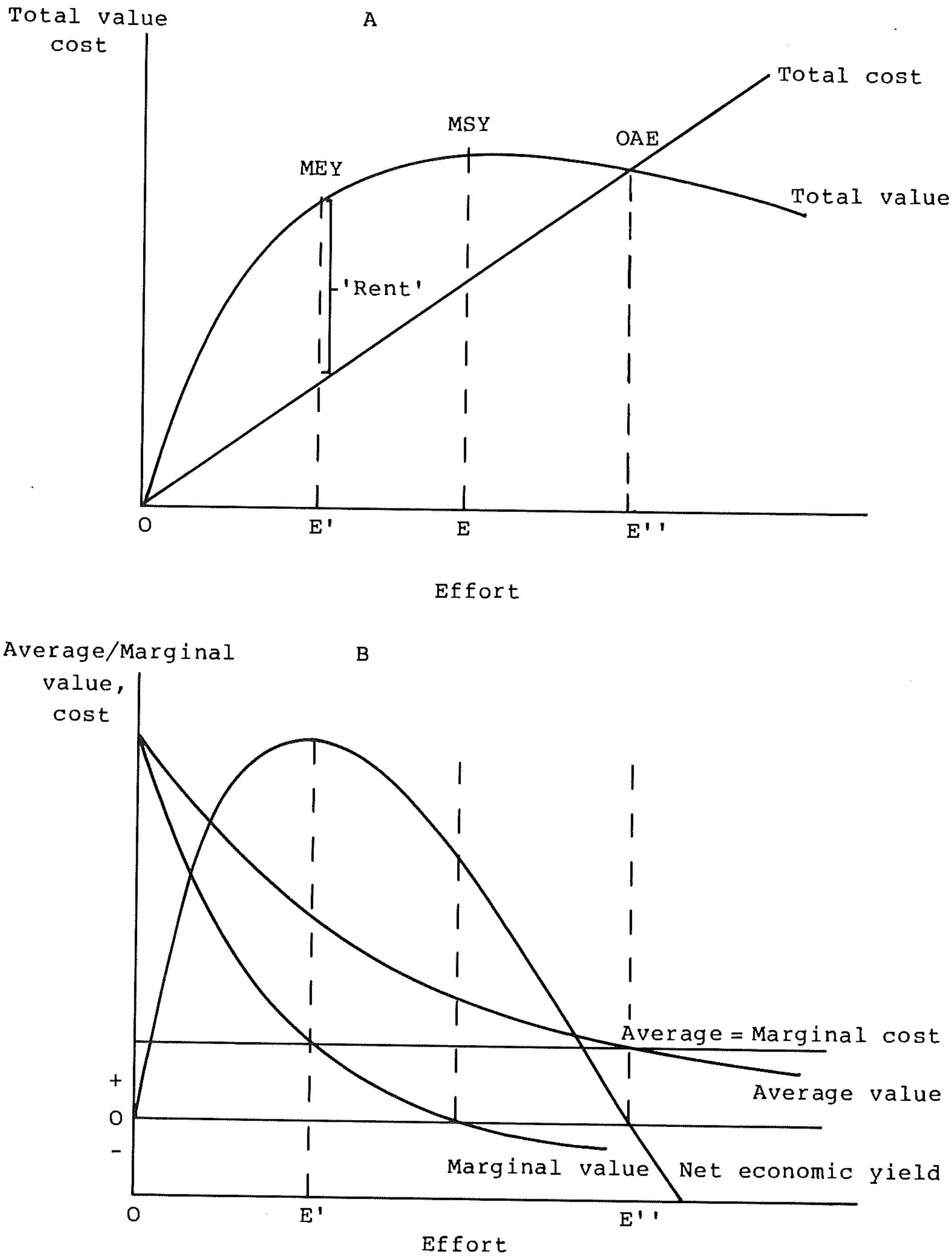


Figure 2: Relationship between value and cost curves

Other relationships important to the fishery are the average and marginal value and cost relationships presented in figure 2b. The marginal value curve (the slope of the total value curve in figure 2a) represents the net additional increase in the total value of catch derived from a unit increase in effort. The average and marginal cost lines reflect the constant cost assumption.

The net economic yield curve is derived by taking the difference between total value and total cost. Sometimes referred to as "rent", this net economic yield is a measure of the richness of the resource. In a high value fishery like prawns net economic yield may be substantial because the value of catch can be high relative to the cost of capture. The optimal level of effort from an economic point of view is that consistent with the maximum (net) economic yield (MEY). This occurs at a level of OE' in figure 2b. This corresponds to the standard micro-economic condition of maximum profit whereby marginal revenue is equal to marginal cost or the greatest difference between total value and total cost, average value and average cost (figure 2).

A pertinent but debatable question is who should get this "rent". Just about everyone will try to get a share and in the short term some will be successful. For example, fishing companies and independent owners operating vessels at above "normal" profits, crew members hoping to draw wages or crew shares higher than "normal", or even government via taxes. However, with a policy of open access to a common property resource like a prawn stock, where no individual can claim clear title to the resource, a pattern of competition emerges between fishermen that ultimately results in the "rent" disappearing.

Individual fishermen will be prepared to enter the fishery as long as the prospect of making above "normal" profits exists. Thus while average revenue exceeds average cost, an incentive will exist to expand effort. Individuals will not be interested in marginal value since average value is the major determinant of their maximum (private) yield. Theoretically the process will stop when average value and average costs coincide. This would occur at a level of effort OE" in figure 2b where it is noted that net economic yield is zero. This point (OAE) represents an equilibrium in the sense that any additional effort will earn less than normal returns and will be withdrawn from the fishery. Should it contract sufficiently for positive returns to reappear, the investment process would recommence until these have disappeared.

From an economic point of view this open access equilibrium is clearly wasteful of resources. Amounts of effort beyond that consistent with MEY cost more in terms of opportunities given up than the value of the product obtainable. Under the opportunity cost principle these costs represent the value of next best use of inputs necessary to produce the effort used to catch the prawns. Anderson (1977, p.33) emphasises that the desirable feature of MEY is not so much that "rent" is maximised but that society's resources are used to exploit the fishery only if they cannot be used to better advantage elsewhere.

The discussion to date has been in the context of a single stock of prawns being exploited by a group of fishermen. To carry the analysis a stage further a case can be considered in which several stocks of prawns are harvested by the same group of fishermen. The problem confronting economic management would be to determine the appropriate level of effort to be applied to each stock. Gordon (1954, p.131) addressed this problem in his early work demonstrating the relationship between the intensive margin and extensive margin of fisheries exploitation.[1]

In figure 3, two prawn stocks (or grounds) A and B of differing productivity are shown, each having its own sustainable yield curve (like that of figure 2). The total (and average) value to be gained from an equivalent exploitation of each ground is higher for sub-stock A than sub-stock B. For simplicity it is assumed that the cost of applying effort to each stock is identical. The maximisation problem becomes that of choosing the correct allocation of effort to ensure the maximum economic yield from each sub-stock. This occurs where the marginal yields are equal to each other and to marginal cost. In figure 3 this would occur with OE'(A) units of effort applied to sub-stock A and OE'(B) units to sub-stock B.

However, under a policy of open access to the fishery this would not be an equilibrium for similar reasons to those demonstrated with the single stock model. If positive returns were available from both sub-stocks the combined effort would increase until the average yields equalled average cost of obtaining them. This would occur when OE"(A) and OE"(B) units of effort were applied. At this point the fishery would yield nothing more than total expenditure plus opportunity income and net economic yield would be zero.

Examination of the marginal yield curves will show that a redistribution of effort between the two grounds would raise total revenue. It will also be seen that similar to the single stock example, the total effort applied exceeds that consistent with maximising net economic yield from the resource (that is, OE"(A) + OE"(B) > OE'(A) + OE'(B)). There is excessive effort and a misallocation of resources both between sub-stocks and between the fishery and other economic pursuits. This is an important concept and one that complicates the work of any management body. The northern prawn fishery currently corresponds to this scenario with the banana and tiger prawn sub-stocks.

It is possible to examine briefly the economic wisdom of a number of management policies with the above model. Firstly, a policy of fishing for maximum sustainable yield (gross value) is potentially costly because it does not fully account for the opportunity cost of catching the last unit of prawns. In figure 2a the peak of the total value curve approximates MSY. As effort is increased beyond OE' the marginal yield tends to zero while

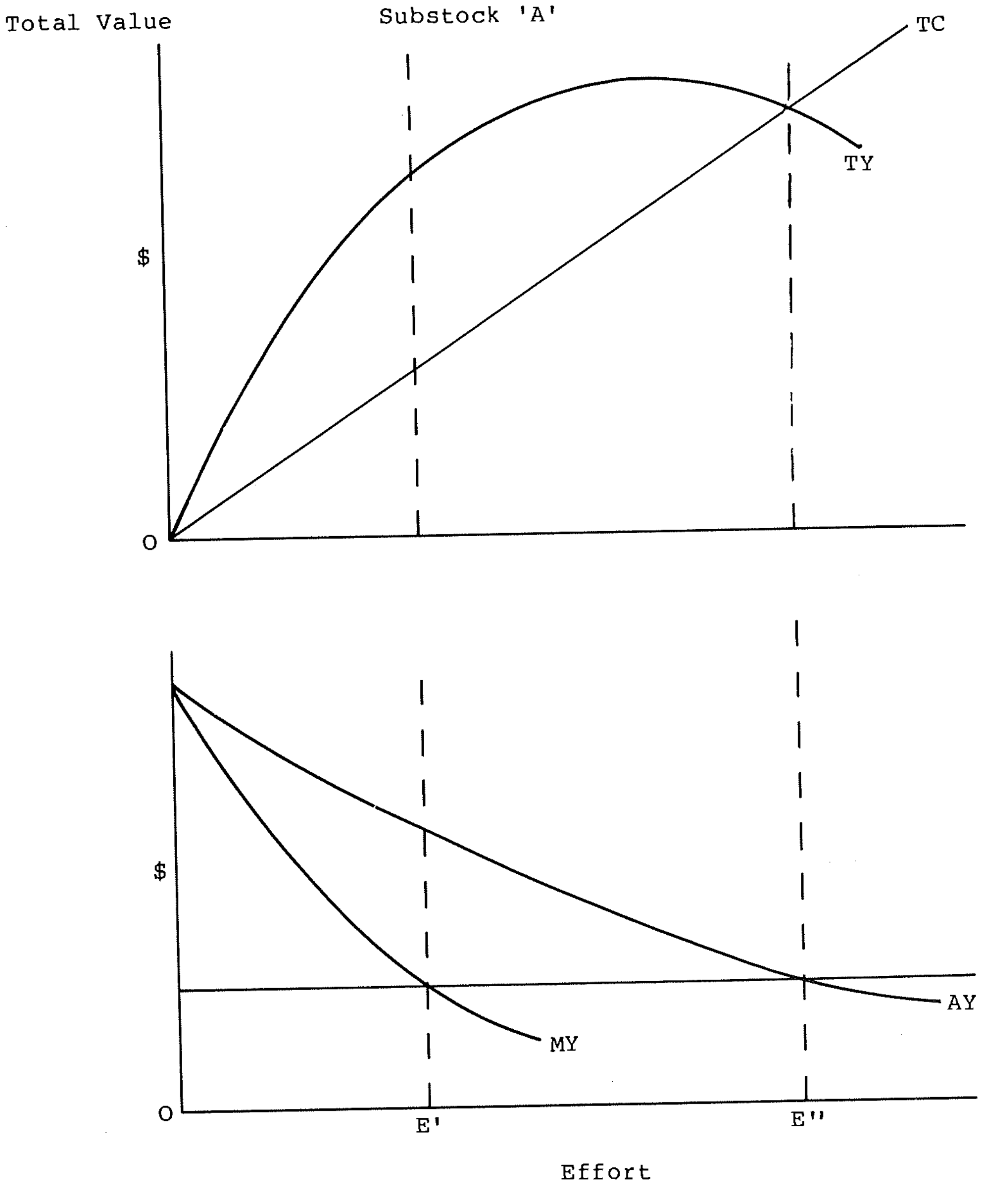
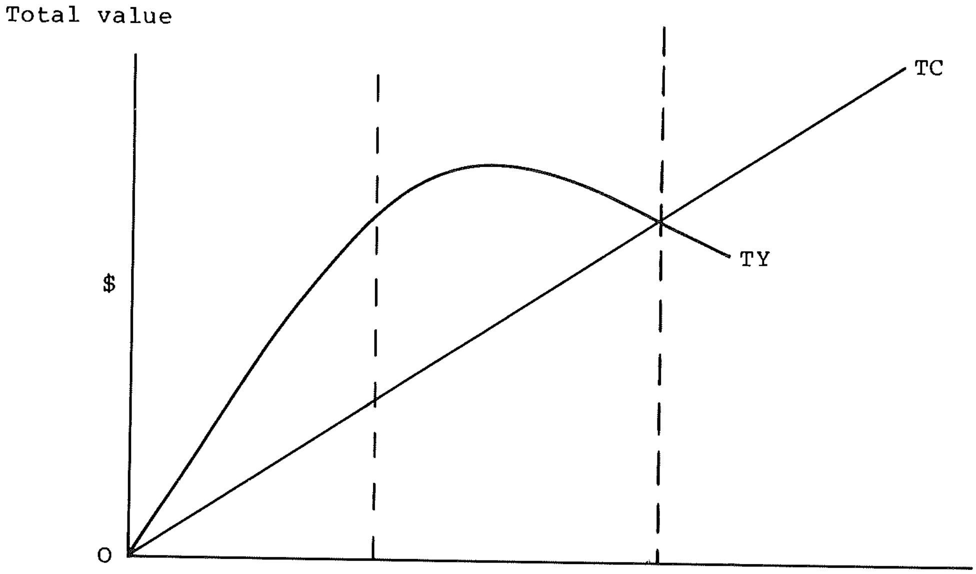


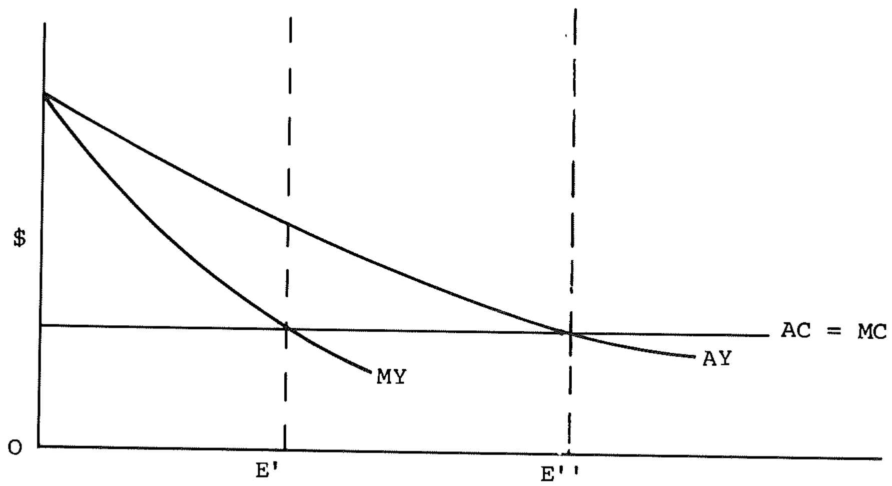
Figure 3: Cost and value curves for two exploited prawn stocks.

(Continued)

(Table 3 continued)

Substock 'B'





marginal cost is positive. Net economic yield will obviously rise if the amount of fishing were reduced. Many authors (Christy and Scott, 1965; Crutchfield and Pontecorvo, 1969; Gulland, 1972 and 1977) have maintained that the major benefit of managing for MEY versus MSY is the potential saving in costs rather than gain in total yield.

A policy of significance to this review would be that of maximising the employment of vessels subject to each earning an "acceptable" return on their investment. This policy is manifest in suggestions of minimum interference with private investment decisions while "good" profits are being made. While management can often get a sympathetic hearing when the bulk of the fleet are facing lean times, it is difficult to convince fishing interests that an economic problem exists when a significant number of vessels are earning above "normal" returns. The "break even" or "good return" management principle is depicted in figure 4.

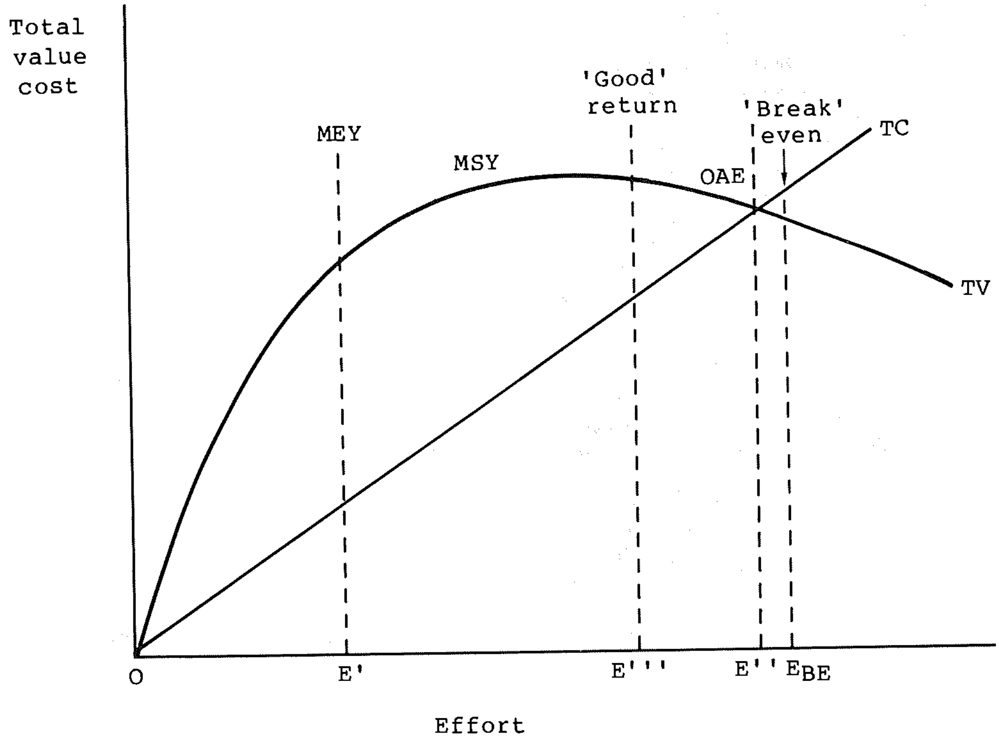


Figure 4: Relationship between cost and value curves and various levels of return

Under the open access equilibrium, all boats will just be making normal returns. A "break even" return would be lower than normal because no allowance would be made for the opportunity value of owners' labour and capital. On the other hand, a level of effort below OE" would give rise to rents and above average returns to investment, OE' being an extreme whereby "rent" is maximised (MEY). A management body wanting to maximise employment would aim for an effort level similar to that of open access or possibly a point just short of it such as OE''', at that point a "reasonable" or above average return would be earned by each participant. Similarly, an industry geared to that philosophy would consider any significant returns as justification for further vessel entry especially given the rates of return being higher than elsewhere. This policy is essentially "justified" open access and involves the same economic waste. If the amount of rent left to industry were considered excessive it could be reduced by licence fees or royalties.

These arguments demonstrate the consequence of open-access and the desirability of management for maximum economic yield. A number of measures can be implemented to reduce fishing effort so as to maximize economic yield. Several, however, will not provide a positive rent in the longer term because of their failure to promote economic efficiency.[2] Popular measures are gear restrictions, closed areas and closed seasons, licence limitation, and the use of fees or royalties. Each of these has received considerable coverage in the literature and that discussion will not be repeated (see Anderson, 1977, ch.5; Crutchfield, 1961; Gulland, 1977, ch.6). The last two of these categories control the total number of fishing units and are more effective in encouraging maximum economic yield. In the absence of long term control of effort the other categories are far less useful in this respect because they impose additional costs on the fishing units.

Before proceeding to the review of the management measures considered and finally adopted for the northern prawn fishery, the simplicity of the foregoing model is acknowledged. This model was developed to explain the behaviour of a fishery and as such consists of a series of simple relationships to approximate that behaviour. The important features are its logic and its explanatory and predictive powers, through which insight can be gained of the economic implications of pursuing various management objectives (including doing nothing at all).

The sustained yield curve (figure 1) represents a hypothetical long run production function for a single-stock prawn fishery. It shows the quantity of catch that could be taken on a sustained basis at varying amounts of effort in a "constant environment". Clearly the environment in the Gulf and related northern waters is not constant and a great many factors can affect the catch of adult prawns other than the amount of fishing effort. For example, the level and pattern of annual discharge from Gulf rivers appears to have a marked influence on recruitment of banana prawns (Lucas <u>et al</u>., 1980) although the correlation is not precise.

Similarly, while the industry appears to be a "price taker" on export markets, prices can vary markedly between seasons. Therefore, the total value of catch is a band rather than a precise curve. Under these circumstances it may be better to consider the long run relationship in terms of "expected value" where probability concepts applied to price and yield would play some part.

The linear total cost curve implies that cost increases in direct proportion to effort. Moreover, increases in effort were produced by additional vessels operating in an efficient manner and all vessels being identical with similar average costs per unit of effort. This assumption is based on competition in the long run forcing a fleet composition whereby only the least cost vessels are able to survive. At the present, the composition of the northern fleet ranges from small wooden vessels less than 15 metres to vessels of steel construction well in excess of 21 metres. It would be unlikely that all classes of vessel are equally efficient at producing effort (Somers, 1977, ch.4). The fishery is still at an early stage in its development and an optimum boat could still emerge in the longer term, especially if sub-stocks were managed separately. In the short term, under open access, the last boat to enter is the least efficient (that is, highest average cost). Vessels operating with costs below this last boat will earn a type of rent known as "producer's surplus" (Anderson, 1977, p.63). The total cost ray would become non-linear, increasing with additional effort. However, the fleet would be expected to converge to the class getting the most producer surplus, forcing out the least efficient boats. In the longer term additions to effort would be of the so-called "optimal" boat.

These considerations of precision do not alter the basic predictions of the economic model. A policy aimed at limiting effort to that consistent with MEY is still optimal. However, management will need a more detailed understanding of the bio-economic factors than if the environment were constant and the fleet of uniform class.

Against this background a management regime could be introduced in several stages, the first of which is more for administrative ease than operational efficiency. Perfection of the system is then left to the later stages. The first stage is one of doing "something", that is, to introduce some sort of interim management regime. While knowledge of the extent of the resource and its behaviour may be poor and that of the bio-economic relationships vague, the interim should be quickly instituted allowing a breathing space.

An intermediate stage takes the form of initiating research and discussion among interested bodies (government, industry and independent research bodies) with the aim of either refining the interim management measures, or if necessary replacing them with a better arrangement. It is conceivable that a "holding action" will have many faults, given the possibility of lack of consensus on the nature of the problems and a trade-off between precision and time.

With time and the benefit of research and monitoring of the results of the interim scheme, a more cohesive set of measures should evolve. This would lead to the last stage, that of introducing a permanent management regime that would secure larger net benefits from exploiting the resource in the longer term.

LIMITED ENTRY MANAGEMENT FOR THE NORTHERN PRAWN FISHERY

The question of effort control in the northern prawn fishery arose as early as the mid-1960's when requests were made to governments to impose management measures on the fishery. With the exception of ratifying seasonal closures for banana prawns, governments proved to be reluctant to introduce direct policies to control the fishery. Reasons advanced for this reluctance include the absence of detailed information on the size of the resource and the most appropriate fleet size and structure to exploit it. Other considerations were the issue of equity and lack of any data on the social profile of any groups to be disadvantaged.

The 1971 season was a record for the fishery and provided further stimulus to already active expansion of the fleet. Total catches fell in the following two seasons but were followed in 1974 by a record catch of 13,000 tonnes. During the 1973 and 1974 seasons both government and industry were concerned at the increase in catching capacity available to the fishery. Root cause of this concern was the increase in the numbers of larger freezer trawlers which it was reasoned could be detrimental to the future economic viability of the fishery.[3] These vessels had many advantages over the smaller vessels in the fleet and their continued entry tended to displace the latter vessels.

As it turned out, the concern about the number of "large" vessels was partially exaggerated in light of the size and composition of the 1975 fleet. However, the then recently formed Northern Fisheries Committee (NFC) recognised that with open access to the fishery there was no mechanism to prevent increases in the level of effort in future seasons. Concern was expressed of a potential "over capitalisation" problem in the fishery, although a clear definition of just what this meant was never provided. An outline of the operation of NFC and its relation to management decision making is provided in the appendix.

THE FIRST WORKING GROUP

The first of the working groups to consider management of the northern prawn fishery was appointed by NFC at its first meeting in November 1974. This working group, a CSIRO scientist and an economist from the Department of Primary Industry, was to assemble and examine the results of available biological and economic research on the fishery and to define the need for a review of the open access policy. Also to be considered was the need to review restrictions that had previously been placed on local processing plants as part of a general policy of northern development. The working group was to give an assessment of the likely limits of the prawn resources and the adequacy of the existing fleet to exploit these resources.

In its report to the second meeting of NFC in 1975, the working group "saw a rational management policy for the fishery as one which would encourage stability in the fishery with a high level of exploitation, without leading to excessive over-capitalisation in trawlers and processing facilities" (Report of the first Working Group, 1975, p.2).

The group concluded that annual availability of all species would be in the range of 11.5 to 24.0 million kg. Of this amount banana prawns were 7.5 to 17.5 million kg, tiger prawns 3.0 to 5.0 million kg and endeavour prawns between 1.0 to 1.5 million kg. It was felt that the banana prawn stocks of the Gulf of Carpentaria had been fully exploited since 1971 (catches ranging from 5.0 to 10 million kg) with little likelihood of new grounds being found in the region. However, potential existed for an expansion in catch in the order of 2.5 to 7.5 million kg in the western sector (Arnhem Land and beyond). The tiger prawns, with the then annual levels of catch between 1.5 to 2.5 million kg, were considered to be under-exploited. This prediction has subsequently been shown to be correct with an increasing emphasis being placed on tiger prawn fishing. In fact the predictions for banana prawns appear to have been optimistic while those for tiger prawns pessimistic. Nevertheless, the estimates were based on the best of the scarce data available at the time.

The conclusions concerning the extent of catching capacity (that is, potential effort) available to the fishery are particularly important. Those conclusions were reflected in the reasoning used in formulating the subsequent management regime and they cast light on objectives of management as many saw them at the time. A clear conflict of interest also became apparent between certain groups within the fishery. This conflict is highlighted because of its impact on the development of the limited entry regime. It is not the intention of this review to determine the merit of any group's case or to identify injured parties and would-be antagonists.

An analysis of the trend in fleet composition to 1974 (a record catch year) indicated a marked trend towards larger freezer trawlers. Generally these vessels take larger catches than smaller vessels although a wide dispersion in landings is characteristic within the fleet. Moreover, the high capital investment involved with freezer trawlers meant that these higher catches were essential for their economic viability. A substantial decline was also evident in the number of smaller vessels using brine refrigeration, a group with a high proportion of independent (that is, non-company) ownership. These vessels were predominantly owned by Queensland fishermen and designed primarily to operate in eastern Queensland waters. The freezer vessels were generally owned and operated by non-Queensland interests but specifically designed to operate in the northern prawn fishery.

The working group acknowledged a "fear" expressed in some quarters of a possible "over-capitalisation" existing within the fishery either then or in the future because of the danger of having too many "freezer" trawlers and trawlers greater than optimum size. This concept of "over-capitalisation" is important because it links over-capitalisation of the fishery with a concept of catch capacity exceeding resource potential rather than a situation in which available effort exceeds that required to obtain MEY. Over-capitalisation in this sense seems to imply that the condition of open access equilibrium was a state in which no over-capitalisation occurred.

Using the concept of over-capitalisation, the minimum catches for economic viability of various classes of trawlers were examined and these applied to the fleet expected to operate in 1975.[4] The limits to the resource presented above were used in the exercise.

It was found that the catch requirements for all classes of trawlers were highly responsive to changes in the price of prawns, break-even catches moving inversely with prices. It was concluded that estimated total catch requirements of the fleet in 1975 under a "low" price regime would be 24.0 million kg while 13.0 million kg would be needed if "high" prices prevailed. The working group noted that there were "strong indications that the fishery may be already over-capitalised if the low prices of 1974 and early 1975 persist". It also noted that "unless price situations improve uneconomic operations in a large segment of the fleet during 1975 are unavoidable" (Report of the First Working Group, 1975, p.9). The group concluded that:

> On the one hand, the current economic situation suggests that growth in the number of freezer-trawlers should not be encouraged to continue. A policy of open entry could, on the basis of available evidence of resource availability and prices, lead to a great deal of over-investment and low rates of returns.
>
> However, on the other hand, the economics of fishing are subject to considerable fluctuations, caused by price movements and changing resource availability, and there is no certainty that depressed market conditions will continue indefinitely. Should the economic situation improve (the working group) would have little justification in discouraging additional entry, particularly in areas west of the Gulf of Carpentaria, having regard to the estimates provided of the gap between the current level of exploitation of the resource and the potential level. (Report of the First Working Group, 1975, p.10.)

This final summary provides two important points. Firstly, it alluded to the economic theory that open access can lead to "over-capitalisation" and the dissipation of profits although it was not actually said. Nonetheless, it suggested that this in itself did not warrant action, especially if prices improved. The working group seems to have missed the point that the open access situation would inevitably tend to an equilibrium involving an inefficient allocation of resources. An improvement in prices would not stem the process but would in fact accelerate it. The second point of interest was the idea that the region to the west offered scope for further development and as such discouraged the idea of curbing effort to the whole fishery. Given an assessment that the banana prawn stocks of the Gulf had been fully exploited for several years and that the tiger prawn stocks were clearly under-exploited, management by region or species would seem to have been an attractive proposition.

THE "COPES" REPORT

Concurrent with the First Working Group's programme was another major study sponsored by one of the parties involved in management. Commissioned by the then Department of Northern Australia in June 1974, the study was to examine data on existing and potential fish resources around the Northern Territory and to offer advice on future development strategies in that territory. The study was conducted by Professor Copes (1975), a Canadian fisheries economist and overseen by the Northern Territory Fishing Industry Review Committee (NTFIRC).

While the scope of the study went beyond development of the prawn fishery in the Northern Territory, much of the report applies to prawns. Copes considered that the fishery should be controlled by the relevant States and the Commonwealth in co-operation and that policies should be conducive to maximising the net economic benefits from stocks or sub-stocks. His view of over-capitalisation, unlike that of the First Working Group, was one of inputs excessive to the requirement of achieving the maximum economic yield.

With hindsight, one drawback of the Copes report was the optimistic estimate of the available resource. This estimate was derived from a prior study of the Northern Territory fishing industry, known generally as the "Kirkegaard Report" (Australia, 1974). This study was intended as a background to Copes's analysis and could be considered as a briefing document. Of interest is its introductory section (Australia, 1974, pp.1-2) referring to the commissioning in 1973 of an enquiry into the Northern Territory fishing industry of which the Copes report was a major part. The suggested terms of reference of that enquiry included the resource economist advising on optimum strategies for development and to maximise economic rent in the process. In part, this explains the emphasis in the Copes report on net economic benefits. It could be concluded, therefore, that the recommendations to be advanced were a foregone conclusion. Management would aim for maximum economic yield, possibly following the common approach of limited entry via licencing with either fees or royalties imposed for fishing privileges. This is strengthened by the further suggestion in the "Kirkegaard" report that the consultant analyse and advise on the level of fees to be levied.

As a broad principle Copes acknowledged that sections of the fishery were probably under-exploited while others were highly exploited and pressures were evident which would inevitably lead to over-capitalisation of the fishery. To forestall this development, it was proposed that a comprehensive regime of entry control be established for the prawn fishery at an early although unspecified date. The distribution of fishing effort would similarly be subject to control, being diverted from over-exploited sectors to under-exploited ones. It is unfortunate that the "full details" were not available but were to be provided by future working groups.

The specific regime was based on separate exploitation of the three stocks identified in the First Working Group's report, viz:

1. the banana prawns of the Gulf of Carpentaria (Sub-stock A);
2. other prawns in the Gulf of Carpentaria (Sub-stock B) that is, tiger and endeavour prawns;
3. other prawns beyond the Gulf along the Northern Territory and northern, Western Australian coast (Sub-stock C).

Such a regime would naturally require co-operation between governments.

An immediate freeze on entry of further vessels to the Gulf of Carpentaria prawn stocks (A and B) was to be established. Both a high licence fee and royalties on the catch were to be levied on vessels fishing sub-stock A. A moderate fee and moderate royalty to be levied on participants of the sub-stock B fishery. Entry to any prawn fisheries outside the Gulf (sub-stock C) would be controlled by a licence but initially no royalty on the catch would be charged. In conjunction with a token fee on the licence this measure was intended to encourage exploratory fishing in areas where prawns might occur.[5]

The rationale of such a scheme was to remove excess effort from the banana prawn fishery thereby reducing the cost of exploiting that resource. In the event that the tiger prawn stocks (and other species) in the Gulf were under-exploited in both a biological and economic sense, then increased effort would possibly raise the total net value from that fishery and the Gulf as a whole. The same would apply to sub-stock C which was thought to be mainly banana prawns although other species could be significant. Subject to a better understanding of the bio-economic parameters affecting the fishery, scope may have arisen for additional effort being economically justified and additional vessels allowed to enter. Such would have been the case if the estimates of the available resource had proven to be correct.

The use of differential fee and royalty rates for the three sub-stocks had several objectives. As a means of distributing the effort between the sub-stocks, such a system would function in an equitable manner, given the relative profitability of fishing each sub-stock. At the same time, it would generate revenue which could be applied to research or development, or retained as a payment to society for the use of its resource. By manipulating effort according to charges, individuals would maintain the right to choose which sub-stock to fish. However, depending on the scale of the charges, the option to fish in a "high" fee/royalty fishery would be likely to be taken by the more efficient boats. This was seen as an efficient self-selection process which may not have eventuated if the distribution of effort were achieved by other means (for example, gear regulations and season or area closures). To arrive at the appropriate distribution of effort, a trial and error system of manipulating the fee and royalty rates would be necessary.

The recommendation to charge both a licence fee and a royalty was largely equity oriented. It has been shown elsewhere that one or the other can achieve the same result (Anderson, 1977, pp.174-183). Copes considered the licence fee to be necessary to achieve stability of vessel participation in exploiting each sub-stock. If the fee were large enough a vessel owner would not readily move from one sub-stock to another under normal circumstances having paid the fee, although he would be free to do so. But given the variability in catch evident in the existing fleet, a high fee in a poor year could be disastrous for some vessels. A royalty on catch, on the other hand, would distribute the burden according to ability to pay, since vessels experiencing good catches could better afford it. A major drawback of royalties is the complete freedom to switch between sub-stocks without penalty, making advance predictions of the likely distribution of effort more difficult. A combination of the two seemed to offer a reasonable compromise of the advantages and disadvantages of each. In fact the report went further and recommended that a schedule of royalty rates be determined with the rates varying in accordance with the catch of the total fleet and market prices over the season.

Licence fees were to be significantly higher for vessels exploiting sub-stock A, token for sub-stock C and intermediate for sub-stock B. Furthermore, fees were to be scaled according to capacity to harvest the resource since "rent" or profitability would accrue in the same fashion. Copes was generally against vessels being licenced by length or tonnage on the grounds that experience elsewhere showed a tendency to "build" fishing power into a given length or tonnage. This was felt to violate the best economic relationship between vessel size and equipment and as an alternative the total value of a vessel and equipment were suggested. Copes felt that if a freeze on entry were to be immediate it would be appropriate to use length or tonnage in the short term.

The process of upgrading vessels by improvement or replacement was acknowledged. To curb these developments by restrictive legislation was considered inappropriate in that it may stifle innovation and reduce economic efficiency. While such development would inevitably lead to an increase in catching capacity of the fleet the appropriate policy seemed to be that of periodically withdrawing capacity by implementing some type of "buy-back" arrangement. This would allow remaining vessels to increase their catching capacity in the process of improving their operational efficiency. This suggestion of a "buy-back" programme reflected Copes's view that the fishery was already over-capitalised.

The most unpopular recommendation of the Copes report was that licences be non-transferable.[6] When a boat retired from the fishery, the licence would be cancelled or allocated to a replacement at a nominal fee.[7] This recommendation is a popular one of Copes (see Copes, 1977 and 1978) and it is intended to satisfy two objectives. Firstly, the aim of limited entry is to generate profitability rather than attain the marginal viability of open access. Once this profitability appears it will be reflected in licence values and if licence holders are able to sell the endorsement they will charge the capitalised value of its earning potential. The purchaser of the licence would then be reduced to a marginal return on his boat and licence resulting in the profitability problem being simply transferred between generations.[8] The second objective is that a "buy-back" arrangement would be more effective if the government retained full control of licences. As vessels retired they would not be replaced. At the same time "buy back" agencies would not be faced with higher compensation claims as licences increased in value.

The concept of prior involvement or degree of "commitment" is important to most limited entry schemes, particularly at the time of their introduction. This has been a debating point with respect to the current management scheme and thus Copes' recommendation is particularly important. It acknowledged that first priority in issuing licences should go to existing <u>active</u> participants. This was in recognition of their immediate interest and dependence on the fishery. However, the operators of the Gulf fishery had traditionally been associated with a large transient sub-fleet of small boats (predominantly from eastern Queensland) who tended to use the Gulf in an opportunistic manner. Following the 1971 banana prawn season there had been a continual decline in vessel numbers in the Gulf, due mainly to a decrease in the number of smaller boats.[9]

Copes (1975) suggested that "there may be merit in recognising the process of natural selection and barring the return to the Gulf prawn fishery of those vessels that have retired from the fishery at this stage." (p.119). Copes proposed that vessels be admitted to the Gulf on the basis of having operated there <u>in the previous season</u>. The intention of this measure was to prevent a re-escalation of effort similar to that in British Columbia's salmon fishery following licence limitation in 1968

(Fraser, 1977). The danger existed of having a large pool of unused capacity available to enter the fishery when it became lucrative to do so. While some people view this as offering flexibility to the banana prawn harvest especially in good years it is arguable that it can be detrimental to progress already made in rationalising conditions for the full time fleet.

The report finally recommended that a full time/part time licencing arrangement similar to that operating in the British Columbia salmon fishery be considered. The eventual aim would be to phase out the part-time fleet by not issuing replacement licences in lieu of disposed or retired vessels.

THE SECOND WORKING GROUP

On the evidence presented by the First Working Group, NFC members conceded that there was cause for concern about the amount of investment in the fishery. A Second Working Group was duly appointed whose terms of reference were to investigate methods by which future investment in the catching sector might be stabilised. In carrying out their task, the Second Working Group was directed to seek the views of government and industry organisations. It is again of interest to note that the objective was to stabilise investment rather than consider ways of cutting it back. This could reflect the First Working Group's poor job of assessing the economic implications of open-access exploitation.

In its report, the Second Working Group considered the major conclusions of the First Working Group to be the following:

1. at low prices, the catch requirements for economic viability of the total existing fleet approximately equalled the estimated maximum available resource;

2. at high prices, the catch requirements exceeded the available resources in a poor season but were below the available resource in a good season;

3. although no evidence was found to suggest that the level of effort was affecting the level of recruitment of stocks, there was a real danger of heavy overcapitalisation;

4. the danger of overcapitalisation increased with the continued entry of large freezer trawlers which require a catch of at least five times the catch of small trawlers for viability. (Report of the Second Working Group, 1976, p.2).

This interpretation is interesting because these were not the major conclusions presented by the First Working Group. In fact, the First Working Group was hesitant in its conclusions, agreeing that investment was possibly excessive but that improvement in either terms of trade for prawns or stock availability would counter that view. The Second Working Group's interpretation is fairly forceful. Conclusion (3) acknowledges that the resource is "non-self regulating" and that management will be economic rather than biologically motivated.[10] Conclusion (4) would seem to blame the new freezer trawlers for the problems of the fishery. It was not mentioned that smaller boats from the east coast used the Gulf fishery on an opportunistic basis.

The Second Working Group expanded on the point raised in conclusion (3) as to the advantage of economic management in their presentation of a general case for control. In so doing, a margin for confusion is created about the intentions of their recommendations. For example, it saw government having a "responsibility to ensure that renewable resources such as fish stocks are developed to produce the full economic benefits from the resources while safeguarding against possible over-exploitation of stocks" (p.3). If "full" and "maximum" have similar meaning, then governments should manage renewable resources so as to obtain MEY.

Dismissing the need for biological conservation measures, significant economic benefits were seen as possibly arising from controls on investment in the fishery. Furthermore, the report contains an acknowledgement that a policy of achieving maximum physical yield can be a costly goal. Free entry was seen to lead to higher costs of harvest with little or no increase in production from the fishery as a result of additional fishing effort. Estimates made by the Second Working Group show some scope for increasing catches from the three sub-stocks, but these would be disproportionate to the effort involved. This is especially the case for the Gulf banana prawn stocks.

However, the Second Working Group did not proceed to the obvious economic conclusion (as did the Copes report) - that of managing for maximum economic yield and doing so by separate management of sub-stocks. Rather, the sequence - full economic benefit, wasted capital and labour and rapidly declining average product - ended with the following:

> the catch requirement for economic viability will quickly exceed the available catch, regardless of the price structure, if the fleet is allowed to increase, particularly by a continuation of the trend in recent years for the introduction of large freezer trawlers which are both expensive to build and costly to operate. (Report of the Second Working Group, 1975, p.5.)

The economic problem was seen once more as a situation of open access leading to an excess of harvest capacity. If left unchecked, capacity would exceed the available resource and some operators would face hard times. This excess, rather than the non-attainment of MEY, is seen as a waste of capital and labour.

In keeping with their terms of reference, the Second Working Group met with fishermen and other members of the industry to obtain views on the desirability of controlling investment and means by which it could be accomplished. While there was general agreement within the industry that a reduction in costs would be desirable, no unanimity of opinion existed on the question of management to "stabilise" investment. Generally, the majority of operators based on the Queensland east coast were prepared to accept controlled entry but preferred to have it applied to larger boats. They objected to any requirement that boats maintain any regular commitment to the Gulf particularly if this involved prolonged periods each season. The view of many northern processors and independent fishermen permanently based in the Gulf was that such a commitment be encouraged. This group was not entirely against a limit on the entry of large vessels but certainly favoured a requirement on small boats to spend a minimum period in the Gulf. The opinion of most operators based in Western Australia was that entry control was unjustified unless evidence of biological overfishing could be demonstrated. Intervention for economic reasons was premature and would likely result in the protection of inefficient operators.

Thus the overall views were along the lines of "what suits me best". No group favoured the use of higher licence fees because it was considered that these would not control investment. Unfortunately, no reason was given for this conclusion which is not in accord with traditional economic thinking.

Taking into account the opinions of industry and proposals made to it, the Second Working Group recommended implementing a scheme of limited entry for a trial of two years. This would apply to vessels of <u>all</u> sizes and would be accompanied by a "commitment" requirement. It was felt that such a policy would be effective in achieving NFC's management objective and had the advantage of administrative feasibility combined with industry acceptance. The two year trial would allow the NFC time to consider a more comprehensive management scheme, possibly including the use of some other management tools such as higher licence fees. This suggestion of licence fees is puzzling, given their dismissal of these as ineffective earlier in the report. The short term freeze and the subsequent review process is similar in intent to that discussed above - a breathing space during which a more detailed assessment of the fishery would be carried out.

The freeze was to apply to marine waters between the meridian at Cape Londonderry in Western Australia and about 142 degrees east which is near Slade Point on the north western corner of Cape York Peninsula (figure 5). This area spans the three sub-stocks and thus the resource was to be managed as a unit stock. This appears to overlook the economic benefits that could be derived from separate management of sub-stocks. Admittedly, the cost of such a scheme could be high and acceptability low, but the working group need not have confined its attention to short term objectives.

The most difficult decision was that of determining eligibility criteria for the managed area. The Working Group, in making its recommendations, wished to recognise and preserve the rights of vessel operators who could demonstrate a past commitment to the fishery. It also acknowledged that all sectors in the fishery would not be happy about the implementation of limited entry and hoped to minimise conflict by a demonstration that policies were "even handed". Basically, eligibility was open to five categories of vessels that did not have endorsements to operate in other limited entry fisheries:

1. vessels that had at any time in the past fished in the management zone;

2. vessels which had not fished in the zone before, but were owned and operated by individuals who could demonstrate previous commitment as a skipper or crew member;

3. vessels under construction prior to 15 May 1975 specifically intended for use in the fishery;

4. replacement vessels for those previously involved but lost or destroyed during Cyclone Tracy;

5. vessels to be constructed under joint venture obligations to a government.

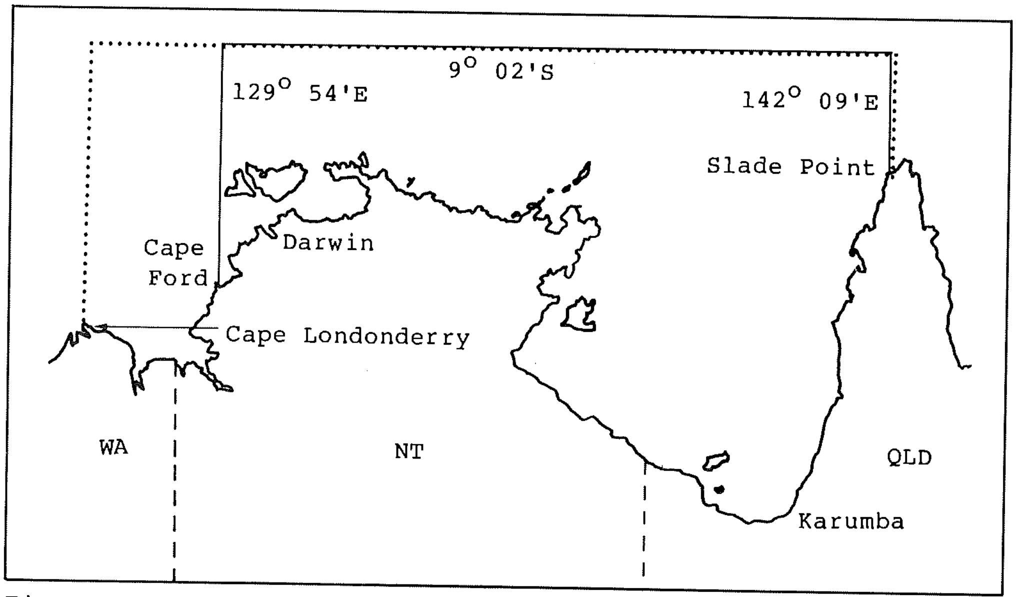


Figure 5: Proposed management zone (First Working Group) ———
Declared management zone (1977-79) ....

Almost anyone was eligible who owned a boat and had fished for prawns in the zone at any time in the past or had intentions of doing so around the time that limited entry was first seriously considered.

The "commitment" condition was to be applied for subsequent licence renewal and any replacement proposals contemplated for vessels qualifying for entry. Two classes were envisaged; Class A vessels fishing for at least 200 days and Class B fishing for less than 200 but at least 50 days in any season. In subsequent seasons any boat fishing less than 50 days would lose its endorsement while both A and B operators could choose the level of commitment they desired (that is, A or B). It is unclear what this recommendation was intended to achieve; the report states that "classification should be absolutely flexible on the basis of the previous year's performance" (Report of the Second Working Group, 1975, p.12). However, to have an effect it seems that the intended system required Class A operators choosing to remain in Class A or opting for Class B. Once in that class, they could only stay as Class B operators.

A policy for vessel replacement would apply according to the status of individual vessels. Class A vessels could be replaced on a one-for-one basis by a vessel of equivalent characteristics as could Class B. However, in the event that NFC should subsequently decide to allow an increase in effort, Class A vessels might be replaced by vessels of more than equivalent characteristics while Class B might not. The Working Group also recommended that any vessel replaced not be allowed to re-enter under the criterion of previous commitment even if it had been designed to operate in that fishery. It was acknowledged that while this policy would not necessarily curb net investment in the fleet, it did not prevent anyone replacing with a smaller vessel. Also, if effort were eventually to be reduced, Class B vessels would be first in line, a principle that would receive wide publicity. On this basis, a framework is established whereby a policy of reducing effort might be accommodated at a future date.

Accepting non-token licence fees as a management aid, while dismissed by the working group, would probably have added to the effectiveness of this dual licence proposal. Incentives to maintain a low commitment could be achieved by significant fee differentials between Classes A and B or removal of such commitment by substantial fees for both. The point remains academic, however, as the "commitment" criteria was never applied in the subsequent regime.

CONSIDERATION OF THE SECOND WORKING GROUP REPORT

A problem associated with the report was that the Working Group did not (and probably could not) estimate the potential number of vessels that would be eligible as well as apply for endorsement should limited entry be adopted. At the time it was felt that the timing of introduction would be important. Early introduction of the scheme would be at a time of poor seasons in the Gulf. Vessels with a history of low commitment may not bother to apply for endorsement. If good seasons had continued or were to re-appear prior to introduction, a different situation would have been expected to apply. This gave a basis for disagreement on the part of State representatives to NFC similar to that of their industry counterparts.

The Northern Territory appeared prepared to accept limited entry as a first step towards management. Similarly, no objection was evident to the concept of "commitment" criteria which probably would have limited impact on Northern Territory vessels.

The Queensland stance was that a brake was needed on investment but the desirability of applying it to vessel numbers was queried. A preferred solution was a limit on landings presumably by limiting vessel size. The policy of the Queensland government seems to have been to favour an opportunistic use of the banana prawn season (Copes, 1975, p.121) and as such there has been a continual reluctance to accept any "commitment" proposals which may disadvantage Queensland boats.

The Western Australian position was to question the role for limited entry because biological overfishing was unlikely to occur. At the same time prevailing poor seasons were seen to be a natural barrier to further increases in effort. A formal policy of limited entry may force uneconomic operations on the fleet in poor seasons (especially if "commitment" criteria applied) and prevent flexibility to recoup past losses in good seasons compared with free entry. This was particularly important to the larger boats in the fleet, many of which were Western Australian freezer boats.

Reasons of confidentiality do not permit a detailed review of the NFC deliberations and the subsequent "cut and paste" procedures which led to a proposal for limited entry to Standing Committee on Fisheries (SCF) and Australian Fisheries Council (AFC). While rumours abound concerning individual items, the only official clues are those derived from the final scheme endorsed by AFC and announced in October 1976. This announcement came approximately twelve months after AFC had agreed in principle to a management regime for the fishery. As such, the Working Group's recommendation for the two year trial for the 1976 and 1977 seasons were not met.

It is known that NFC met with Professor Copes prior to recommending limited entry to both SCF and AFC. Copes indicated to NFC that his report was still in draft form before the NTFIRC but that his main recommendations were to manage by sub-stock and differential fees. Copes was critical of the replacement scheme being considered on the grounds that it would not prevent capital investment and effort from increasing. He proposed to NFC an alternative involving credits based on "tonnage" which could be used for replacement purposes. This suggestion will be seen to be significant in terms of the replacement policies discussed later. It would seem that the joint meeting had little impact on NFC with respect to the management proposals in mind. Probable influences may have been the administrative procedures needed to carry out the Copes proposals and the fact that they would have been seen as "novel".

THE INTERIM MANAGEMENT REGIME

The Australian Fisheries Council announced that a three year limited entry regime would commence on January 1, 1977. The stated reason was "government and industry concern over the likely adverse economic effect on the industry of the build-up in the size and composition of the northern prawning fleet" (Primary Industry Press Release, November 1976).

TECHNICAL DETAILS OF THE REGIME

Eligibility Criteria

The eligibility criteria were similar to those proposed in the Second Working Group report. Broadly stated, a trawler was eligible if it:

1. had fished in the northern prawn fishery prior to 21 July 1976;
2. was one required to be built under a joint Australian-foreign fishing venture under contractual agreement with the Commonwealth Government;
3. had been contracted for or was under construction before May 1975 specifically for use in the fishery;
4. had not fished in the northern prawn fishery but was owned and operated by a person who had worked as a skipper or crew member in the fishery in the past;
5. was a replacement for one previously engaged in the fishery and lost or destroyed after July 1, 1974.

The major departure from the eligibility rules of the Working Group was that vessels could not be excluded if they held licences for other fisheries. This rule would have discriminated against a number of Western Australian boats and may have affected a large number of Queensland boats if limited entry had been introduced to the east Queensland coast prior to 1979.

At the same time a "commitment" to the fishery was not involved. While enforcement of the Working Group's rules would have been difficult, this change can be attributed to a refusal by Queensland to be a party to management if it were included. "Commitment" was to be achieved by a series of warnings that licenced vessels were expected to participate actively in the fishery. This participation would apparently be considered if it were decided to extend limited entry in the fishery beyond 1979.

For equity reasons the owners of vessels lost from any cause were able to apply. The construction date (May 1975) coincided with a ministerial announcement that limited entry to the fishery was under consideration.

Area and Seasonal Limits

The area comprising the declared management zone (DMZ) was officially proclaimed on 2 February 1977. The western boundary was changed from Cape Londonderry (WA) to Cape Ford (NT), effectively removing Western Australian waters from the regime. The main rationale appears to have been to remove the possibility of having Joseph Bonaparte Gulf divided with one area outside the DMZ and the other inside it. The new DMZ is shown in figure 5. Seasonal closures for banana prawns that had operated since the early 70's were to continue in conjunction with the new management procedures.

A dual licence system is involved because fishermen and vessels must have both State and Commonwealth endorsement. A notable feature is that only token fees are levied. For example, in 1979 Commonwealth fishermen's licences were $20 each and boat licences ranged from $40 to $60 depending on length. State licence fees were also nominal.

Replacement Provisions

The replacement provisions suggested by the Second Working Group were not adopted for the new regime. This stemmed from the opposition to forced commitment to the fishery. Rather than an "A/B" class system, a replacement policy for all boats was adopted. Endorsed vessels could be replaced on a one-for-one equivalent characteristic basis. Any owner with a vessel below 12 metres overall length could replace with a vessel not exceeding 12 metres.

The interpretation to be placed on equivalent characteristics was vague because tolerances were not stated, although some guidelines were suggested by the Department of Primary Industry. The Committee responsible for decisions on replacement was destined to have a rough time especially with the phenomenon of multiple replacement (leapfrogging) that arose.

REVIEW OF THE INTERIM MANAGEMENT REGIME

Because this was to be an interim measure the fishery was to be subject to monitoring and review by collecting and evaluating various biological, economic and technical data. NFC would be involved in formulating recommendations as to the form management should take beyond 1979. Unfortunately, much of the material available to NFC is either unpublished or confidential. This is especially the case for biological research on the stocks. Field work commenced for a second costs and earnings survey by the Department of Primary Industry covering endorsed vessels in mid-1977. The survey period originally covered the 1974/75 to 1976/77 financial years (rather than fishing years) but was subsequently extended to include 1977/78.

Although this information would give insight to the fishery prior to the limited entry regime, the provision of only one year's data severely limits an evaluation of the post-management fishery. Also, it is doubtful whether the type of information provided would be useful in isolation to evaluate limited entry, even if data for later seasons were available. It will be shown later that the fleet in 1979 was different from that surveyed in 1977. An additional drawback is that the survey results have not been published and are not yet in a usable form.

If the primary aim of limited entry were to limit (and possibly reduce) labour and capital inputs, then information on movements (in real terms) of these inputs would be of more value. No such series exist and vessel numbers and size will have to act as proxy measures using the assumption that capital is proportional to vessel size and that the labour/boat length ratio is variable only between narrow limits.

Profile of endorsed vessels and their operation

A brief assessment was carried out by the Department of Primary Industry (DPI) in 1978 of the first fifteen months of interim management. Much of the information was derived from application forms and as such the figures reflect the situation of all endorsed vessels and not merely those currently operating in the fishery. A tentative total of endorsed boats and the criteria by which they were eligible is presented in table 2.

It is apparent that most endorsed vessels had a history of involvement or were being constructed for the fishery. The total number of applications was approximately 360 with an implied rejection rate of 25 per cent. Approximately 58 per cent of these vessels were independently owned. The remainder were "company" vessels owned and operated in the main by processing interests. The structure of the fleet in May 1978 by size, construction, and state of origin is shown in table 3.

By 1979 the number of endorsed vessels was still about 280 and, based on boat numbers, the limited entry scheme could be regarded as a marginal success. Although the number of boats had not declined the freeze had prevented any increase. This conclusion is deceptive for at least two reasons. Firstly, not all 280 endorsed vessels operate in the DMZ each season, hence the total represents a potential fleet rather than the actual fleet. Secondly, the size and fishing power of vessels has been increasing over the period. Therefore the 280 endorsed vessels are different from those in 1978 (table 3). This development is

Table 2. Vessels endorsed for northern prawn fishery by entry criteria, as at 31 March 1978

Entry criteria	Number	Percentage
In NPF before 21 July '76	233	83
Built under joint venture arrangement	-	-
Contracted before May '75	24	9
Owned by NPF fishermen	14	5
Replacement for lost vessel	9	3
Total	280	100

Table 3. Endorsed vessels by size, home State and construction material, May 1978

Length	Home State	Wood		Steel		Total	
		No.	%	No.	%	No.	%
Under 21m	Queensland	109	89	40	52	149	75
	Northern Territory	3	2	18	24	21	11
	Western Australia	4	3	9	12	13	6
	South Australia	1	1	3	4	4	2
	New South Wales	6	5	6	8	12	6
	Total	123	100	76	100	199	100
Over 21m	Queensland	4	66	4	6	8	10
	Northern Territory	-	-	10	14	10	13
	Western Australia	-	-	37	51	37	47
	South Australia	1	17	12	17	13	17
	New South Wales	1	17	9	12	10	13
	Total	6	100	72	100	78	100
All boats	Queensland	113	88	44	30	157	57
	Northern Territory	3	2	28	19	31	11
	Western Australia	4	3	46	31	50	18
	South Australia	2	2	15	10	17	6
	New South Wales	7	5	15	10	22	8
	Total	129	100	148	100	277	100

largely the result of the replacement policy being one-for-one in "equivalent characteristics" with generous tolerances.

Potential versus actual fleet size

The 280 endorsed vessels represent those whose operators saw gain in having an "option" to participate in the fishery and were successful in meeting one of the eligibility criteria. As such not all would necessarily have planned to fish in the Gulf in subsequent seasons; in fact, only 195 (70 per cent) operated in 1977 and 150 (54 per cent) in 1978. Figures for 1979 are not available but are expected to have risen due to improved conditions and the Minister's "show cause" warning for endorsement beyond 1979. (Primary Industry Media Release 78/181.)

The decline in 1978 was largely accounted for by "independents" (table 4), suggesting a more consistent commitment by company controlled vessels. The change could also be accounted for by companies buying out independent licences with an aim to replacement with newer boats which had not yet entered the

Table 4. Endorsed vessels operating in the managed zone in 1977 and to May 1978 by type of ownership

Type of ownership	1977 season No.	1977 season %	1978 season (to May) No.	1978 season (to May) %
Company	86	41	85	47
Independent	125	59	95	52
Total	211	100	180	100

	Not fishing in M.Z. No.	Not fishing in M.Z. %	Fished M.Z. one year No.	Fished M.Z. one year %	Fished M.Z. both years No.	Fished M.Z. both years %	Total No.	Total %
Company	16	14	23*	19	79	67	118	100
Independent	25	15	55**	34	82	51	162	100
Total	41	(15)	78	(28)	161	(57)	280	(100)

* Includes 9 vessels being replaced.
** Includes 8 vessels being replaced.

fishery. Nonetheless, the number of independents operating was still absolutely higher in both seasons. While equal proportions of both company and independent vessels failed to exercise their option to fish in the zone in any year, a higher proportion of company vessels fished in both years. The 1978 banana prawn season was the worst on record, possibly explaining the reduction in independent boat numbers, although it does reflect the opportunistic fishing of smaller boats.

A more important consideration concerns the need for 280 vessels efficiently to exploit the resource. If the management objective was a "good return" to all vessels then this number could be doubted. Preliminary figures from the DPI costs and earnings survey for 1976/77 and 1977/78 (both years covering some part of the managed period) show a wide dispersion in economic performance of individual vessels (tables 5 and 6). A high proportion of survey vessels failed to break even on their annual operation, some making substantial losses. For example, in 1976/77 some 37 per cent of survey vessels made a loss, and in 1977/78 this had risen to approximately 55 per cent. Such losses were not confined to any particular segment of the fleet although the largest losses (for example, in excess of $100,000) were incurred by larger vessels.

However, some vessels regardless of size consistently achieve high rates of return on their investment. Approximately, 44 per cent made returns in excess of 20 per cent in 1976/77, falling to 31 per cent the following year. This "boom and bust" feature has been a characteristic of the fishery since its early days. For example, a previous DPI cost and earnings study covering the financial period 1968/69 to 1970/71 reported some 34 per cent of survey vessels making a loss for the period. At the same time approximately 29 per cent of the vessels surveyed achieved average rates of return over three years in excess of 20 per cent.

While this pattern of economic performance may be regarded as the "luck of the game", the magnitude of losses suggests that substantial rents are being dissipated within the fishery. While some vessels are making substantial private gains, these are being offset by substantial resource costs incurred by the losers. It is impossible to determine the extent to which "high" performance and "low" performance vessels remain within these categories from season to season. If it is not a random process then gains would exist if vessels with consistently poor performance were denied access to the fishery. In the longer term it would be expected that they will be forced to leave the fishery. If the distribution of losses were random, then a reduction in vessel numbers would still be an improvement. If allowance were made for the fact that these figures represent a subset of the 280 endorsed vessels (that is, 150 to 190) that actually do participate in any given season, then performance would be predictably worse if all 280 vessels were to operate.

Table 5. Distribution of boats, by net income, by strata, 1974/75 to 1977/78 (Percentages)

	Under 15m	15 & under 17m	17 & under 19m	19 & under 21m	21m & over	All vessels
1974/75						
Net income						
$200 000 and over	-	-	-	-	-	-
$100 000 and under $200 000	-	-	-	-	4	2
$50 0000 and under $100 000	-	-	-	-	-	-
$20 000 and under $50 000	-	-	-	-	-	-
$0 and under $20 000	27	20	17	-	4	13
$-20 000 to 0	73	70	50	-	5	37
$-50 000 to $-20 000	-	10	33	50	9	14
$-100 000 to $-50 000	-	-	-	50	64	29
More than $-100 000	-	-	-	-	14	5
No. of boats in sample	15	10	6	6	22	59
1975/76						
Net income						
$200 000 and over	-	-	-	-	-	-
$100 000 and under $200 000	-	-	-	-	4	1
$50 0000 and under $100 000	-	-	-	-	8	3
$20 000 and under $50 000	-	9	11	-	13	7
$0 and under $20 000	33	9	11	12	13	17
$-20 000 to 0	61	73	45	25	8	39
$-50 000 to $-20 000	6	9	33	50	20	19
$-100 000 to $-50 000	-	-	-	13	21	10
More than $-100 000	-	-	-	-	13	4
No. of boats in sample	18	11	9	8	24	70

(Continued)

(Table 5, continued)

	Under 15m	15 & under 17m	17 & under 19m	19 & under 21m	21m & over	All vessels
<u>1976/77</u>						
Net income						
$200 000 and over	-	-	-	-	21	7
$100 000 and under $200 000	-	-	-	15	38	14
$50 0000 and under $100 000	-	6	11	-	13	7
$20 000 and under $50 000	14	25	11	-	8	13
$0 and under $20 000	40	31	11	28	4	21
$-20 000 to 0	33	19	56	15	4	21
$-50 000 to $-20 000	13	19	-	14	4	10
$-100 000 to $-50 000	-	-	11	14	-	3
More than $-100 000	-	-	-	14	8	4
No. of boats in sample	15	16	9	7	24	71
<u>1977/78</u>						
Net income						
$200 000 and over	-	-	-	-	12	4
$100 000 and under $200 000	-	-	-	-	12	4
$50 0000 and under $100 000	-	-	29	-	12	8
$20 000 and under $50 000	22	22	14	50	6	16
$0 and under $20 000	36	11	-	-	-	12
$-20 000 to 0	21	22	29	-	6	17
$-50 000 to $-20 000	14	45	28	-	6	19
$-100 000 to $-50 000	7	-	-	50	17	10
More than $-100 000	-	-	-	-	29	10
No. of boats in sample	14	9	7	2	17	49

Table 6. Distribution of returns on capital 1974/75 and 1975/76

Return on capital	Under 15m No.	Under 15m %	15 & under 17m No.	15 & under 17m %	17 & under 19m No.	17 & under 19m %	19 & under 21m No.	19 & under 21m %	21m & over No.	21m & over %	All vessels No.	All vessels %
1974/75												
Loss	11	73	8	80	5	83	6	100	20	90	50	85
0 - 9.9	1	7	2	20	-	-	-	-	1	5	4	7
10 - 19.9	2	13	-	-	1	17	-	-	1	5	4	7
20 - 29.9	1	7	-	-	-	-	-	-	-	-	1	1
30 - 39.9	-	-	-	-	-	-	-	-	-	-	-	-
40 - 49.9		-	-	-	-	-	-	-	-	-	-	-
50 over	-	-	-	-	-	-	-	-	-	-	-	-
Total	15	100	10	100	6	100	6	100	22	100	59	100
1975/76												
Loss	21	67	9	82	7	78	7	88	15	63	50	71
0 - 9.9	3	17	-	-	1	11	1	12	6	25	11	16
10 - 19.9	2	11	1	9	-	-	-	-	2	8	5	7
20 - 29.9	1	5	1	9	1	11	-	-	1	4	4	6
30 - 39.9	-	-	-	-	-	-	-	-	-	-	-	-
40 - 49.9	-	-	-	-	-	-	-	-	-	-	-	-
50 over	-	-	-	-	-	-	-	-	-	-	-	-
Total	18	100	11	100	9	100	8	100	24	100	70	100

(Continued)

(Table 6, continued)

1976/77

Loss	7	47	6	38	6	67	4	57	3	12	26	37
0 - 9.9	-	-	1	6	1	11	2	29	2	8	6	8
10 - 19.9	3	20	2	13	-	-	-	-	3	13	8	11
20 - 29.9	2	13	4	25	-	-	-	-	7	29	13	18
30 - 39.9	2	13	1	6	1	11	1	14	4	17	9	13
40 - 49.9	1	7	-	-	1	11	-	-	3	13	5	7
50 over	-	-	2	12	-	-	-	-	2	8	4	6
Total	15	100	16	100	9	100	7	100	24	100	71	100

1977/78

Loss	6	43	6	67	4	58	1	50	10	59	27	55
0 - 9.9	2	14	1	11	-	-	-	-	1	6	4	8
10 - 19.9	2	14	-	-	-	-	1	50	-	-	3	6
20 - 29.9	1	7	-	-	1	14	-	-	3	17	5	11
30 - 39.9	-	-	2	22	1	14	-	-	1	6	4	8
40 - 49.9	-	-	-	-	1	14	-	-	1	6	2	4
50 over	3	22	-	-	-	-	-	-	1	6	4	8
Total	14	100	9	100	7	100	2	100	17	100	49	100

These indicators of performance relate to the whole fishery and tend to cloud the performance of the sub-stocks. Although financial data do not exist for each sub-stock, other performance criteria are available. For example, it is argued that excessive effort applied to a resource will lead to a shortened season (Crutchfield and Pontecorvo, 1969). Even if vessel numbers were limited, increasing efficiency of the fleet will produce this result. A similar result would be expected if, as suggested, the endorsed fleet were larger than that needed to exploit the resource. In this case, an equilibrium similar to "open access" can occur and any improvement in return will encourage additional members to participate.

This is the case with the banana prawn fishery where the season has progressively shortened from a period of several months to a little over one month. Figures supporting this, based on CSIRO analysis of log books, are presented in table 7. These figures suggest that the banana prawn stock is economically overfished and that the limited entry programme has been ineffective from the point of view of that stock. Given the 280 endorsements, the fishing intensity on that stock could be increased further.

Table 7. Fishing intensity and length of season for banana prawns, south-east Gulf of Carpentaria

	1974	1975	1976	1977
Fishing intensity *	17	18	26	53
Length of season (weeks) **	12	8	8	5
Total catch (tonnes)	3854	200	1295	2840

* Fishing intensity is the average number of vessels at sea and fishing per day during the season.

** Length of the season is the number of weeks required to take 95 per cent of the catch for the year.

Source: CSIRO

The theoretical model predicted that fishing concentrates on the stock with highest catch rates until these fall to those of the next most productive stock. To an extent this is the mechanism operating in the banana and tiger prawn fisheries. The fleet tends to concentrate on the banana prawn grounds and switches to tiger prawn fishing when banana prawn catch rates have fallen to "uneconomical" levels. This occurs around the time that the average value of catches are similar. The differing productivity need not imply that banana prawns are more prevalent than tiger prawns but rather that they are more vulnerable to gear at critical periods (CSIRO, personal communication).

In recent seasons the fleet has fished more for tiger prawns which has resulted in a longer fishing season and a larger proportion of tiger prawns in the annual catch (although the proportion is not predictable). This development seems to result from the shorter season for banana prawns and the trend to larger vessels requiring higher and more consistent levels of catch to ensure profitable operation. A gradual expansion of the tiger fishing grounds has accompanied this growth and despite a 50 per cent increase in effort in each of the 1977 and 1978 seasons (CSIRO, personal communication) the catch rates of tiger prawns have been fairly constant.

The extent to which this development can continue within the capacity of the existing fleet, without reducing catch rates and economic performance, is not certain. Because little research has been done on the tiger prawn stock the rapid increase in effort would give cause to proceed with caution, especially in light of limits to trawlable grounds in the Gulf. A development similar to that of the banana prawn fishery would be undesirable from an economic viewpoint. Further, should management decide to control effort on the banana prawn grounds by diverting it to tiger grounds, the impact on the latter could be considerable. Research on this question deserves high priority; given the trends in vessel size and commitment which have been attributed to the replacement provision.

Replacement Provisions of the Interim Regime

The one-for-one replacement policy probably created more problems than it solved. At first sight it seemed to offer considerable advantages in terms of being straightforward and administratively simple. Moreover, it appeared to be equitable in that smaller vessels could upgrade without penalty while larger vessels could be replaced with similar vessels if need be. New vessels could be slightly larger and certain features for crew comfort and safety were permitted.

However, a number of developments were not foreseen at the time the regime was introduced. The major reasons for replacing a vessel were assumed to be through loss or the old one wearing out. The prospect of a "gear rush" in response to limited entry was not considered. Even if it were, the equivalent characteristic requirement should have kept effort increases to an acceptable level. This did not prove to be the case. An examination of replacement patterns is in order, particularly since it was argued in the previous section that increasing the size of vessels reduces the economic efficiency of the fleet.

By January 1980, only 130 (46 per cent) of the original 280 vessels were still endorsed to operate in the fishery. The remainder had been or are in the process of being replaced. Prior to May 1979 some 70 to 80 replacement applications had been approved, the majority being for significantly larger vessels. Associated with these applications was an unforeseen phenomenon of multiple replacements ("leap frogging") designed to get around the tolerances set for equivalent characteristics. This process was used mostly by company operators and resulted in a small vessel being replaced by a much larger vessel via a staged process of switching endorsements on intermediate vessels. For example, an operator may apply to replace vessel A of 12 metres with vessel B of 20 metres which would be beyond the tolerances of "equivalent characteristics". As a compromise a request would be approved to replace a larger vessel C of 18 metres with vessel B. Vessel C might then replace another vessel D of 16 metres which in turn replaces vessel A. Vessel A is then sold to someone else without an endorsement. Vessel A will have in fact been replaced by vessel B since C and D were already endorsed for the fishery. The net result was that the increase in vessel size went well beyond the guideline of ten to fifteen per cent suggested by the DPI.

Other replacement policies were considered by NFC to overcome this situation. The most important, under-deck tonnage, is discussed in a following section. This accelerated the rate of replacement applications as operators sensing change sought approval in writing before anything definite arose. If approval were obtained and a new scheme came in, the operator would have a bonus in terms of prior approval for a larger vessel. NFC laid down two conditions on these approvals which were designed to restrict replacement to bona fide cases. Firstly, applicants had to be able to show evidence of progress within six months. Secondly, the replacement had to be operational within twelve months. Ministerial approval was never sought to enforce these conditions and they would seem to be easily circumvented.

The Minister for Primary Industry made an announcement on 3 May 1979 that no further applications for replacement would be considered after 31 May 1979, pending introduction of the management regime to operate beyond 1979. Some 55 replacement applications were received by DPI (personal communication) in the following three weeks setting a record of sorts. In fact, approximately 65 applications went to a single meeting of NFC, most of which were approved.

The distribution of replacement vessels by increases in dimensions is presented in table 8. The figures relate to all successful applications in the 1977-79 interim management period. It is readily seen that the bulk of replacements involved considerable increases in length and beam measurements. Only a small proportion involved decreases in overall size, any decline in length being offset by increase in beam and vice versa. While these figures suggest that the potential efficiency of the fleet has rapidly increased it is of interest to note that relatively few applications stated increased catch efficiency as the reason for replacement. Improved accommodation, safety at sea, fuel efficiency, subsidy eligibility, and the like were the commonly stated reason.

"Pyramiding", the procedure of replacing a number of smaller vessels with a large one and vice versa, was generally not approved under the replacement guidelines. However, ministerial approval has recently been given for one company to replace 10 vessels with seven new ones and another to replace two with one new one. If the concept of tonnage credits were to be accepted then pyramiding would likely become more widespread.

REVISION OF MANAGEMENT

The interim management regime was to last until December 1979. NFC was to review its progress and formulate recommendations as to the form management would take beyond that date. The final plan would go to SCF and AFC for ratification and implementation in 1980. The industry was notified on two occasions of draft proposals for a continuing regime. This took the form of circulars from DPI dated 24 April and 6 September 1979. Public meetings were held with industry to discuss the April draft. One result was that the September proposal differed

Table 8. Distribution of replacement vessels by percentage increase in length and beam dimensions 1977 to 1979

	Length						
Percentage change	Decrease	0-5	5-10	10-15	15-20	20-25	25+
Percentage of Vessels	5	8	11	14	15	19	28

	Beam						
Percentage change	Decrease	0-5	5-10	10-15	15-20	20-25	25+
Percentage of Vessels	5	14	8	7	21	14	31

from the April one. It should be noted that the various State representatives on NFC were far from unanimous about future management policies and the drafts were compromise documents.

THE FIRST DRAFT PLAN (APRIL, 1979)

A brief assessment of the exploitation of stocks was presented with a note that the present capacity of the fleet was such that it could double effective effort through greater commitment. It reiterated CSIRO research findings that the banana prawn stocks were being subjected to heavy pressure. More recent indications were that the tiger and endeavour prawn fishery was subject to considerable (and increasing) pressure. Although the discovery of new grounds had helped to prevent falls in catch per unit effort, the rate of discovery was slowing.

NFC considered that limited entry should continue on both fisheries of the Gulf beyond 1979 with the following objectives:

* maintenance of the resources at optimum levels within the limits of natural variation; and

* harvesting of the resources in an economically efficient manner.

Limited entry would remain and one objective was "economic management" although maximum economic yield was not stated. A proviso that the regime would account for relevant socio-economic factors, including the question of equity, suggested that the "good return" objective was relevant. However, the idea that limited entry would apply to both fisheries of the Gulf was a break from previous thinking, implying that management by substocks was being considered. It also coincided with the idea that prawn stocks outside the Gulf (sub-stock C) would be excluded from the regime.

The new area to be managed would be the territorial and proclaimed waters bounded by a line running from Point Napier to Cape Wessel and across the Gulf to Slade Point (figure 6). Under this plan the "northern prawn fishery" would become a true Gulf fishery. Exclusion of grounds west of the Wessels was based on a number of stated considerations including different behaviour of the prawns, limited delineation of grounds, and the low rate of exploitation (excluding Fog Bay and Melville Island). Management would be directed to "orderly development" in that area although it was not stated how that would proceed. In fact this move was initiated by the Northern Territory and not explicitly accepted by other States.

Management by species would take the form of three categories of endorsement related to those suggested by Copes. Category one vessels would have access to the Gulf for the whole year, effectively allowing a vessel to fish for all species. This corresponds to the current management. A second category included the whole Gulf but excluded a vessel from operating east of a line north of the Calvert River during the period 28 February to 31 May each year. This would be a "tiger prawn licence" since the vessel is excluded from the main banana prawn grounds during the regular banana prawn season. A third category, or "banana prawn licence" allowed vessels to operate during the banana prawn season in the area from which "tiger prawn licences" are excluded. Vessels electing for the second or third categories would not be entitled to category one status at a future date.

Differential licence fees were to operate in conjunction with the different licence categories. However, unlike Copes's suggestion, royalties on catch were not included. The actual fees would be substantial (approximately $1000 for category 1, and $500 for categories 2 and 3) and applied on a sliding scale to reflect the fishing power of the vessel. These would be based on a "fishing unit" assignment associated with another major departure from the interim management regime. The problems associated with the one-for-one equivalent characteristics gave rise to a need for a new replacement policy. This took the form of fishing units based on "under-deck-tonnage" (UDT) which appears to be highly correlated with the value of the boat.

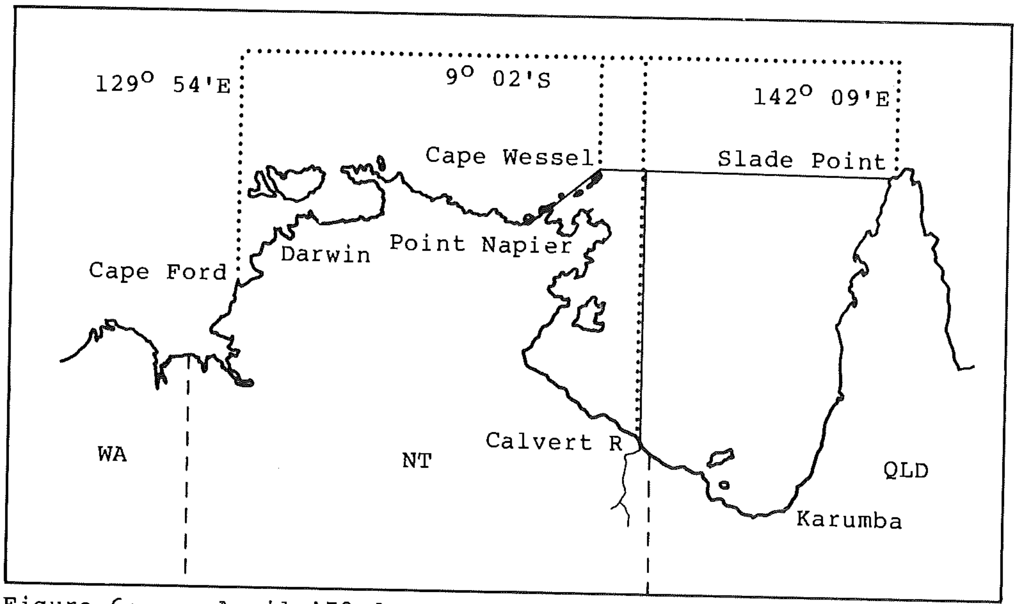


Figure 6: April '79 draft management plan, proposed Sub-Zone ———
September '79 draft management plan, proposed Sub-Zone ....

The UDT is a dimensional measure of a vessel based on its length, beam and moulded depth, but makes no allowance for factors such as engine power and net size. However, it was believed to offer flexibility in vessel design, with little opportunity to build extra effort into a given design. It also appeared to be readily measured since most vessels would need to be surveyed at some stage. The UDT would be calculated for each vessel and a register kept of ownership of individual units. If an owner wished to replace a vessel with a larger vessel he could purchase another vessel and combine the UDT for replacement purposes. However, a five per cent retirement scale was built into units, aimed gradually to reduce the aggregate fleet quota and offset gains in technical efficiency through replacement. For example, an owner wishing to upgrade from a 100 UDT vessel to one of 200 UDT, could purchase another of 110 UDT to get a 200 UDT credit. On the other hand, a 200 UDT vessel could be replaced with two 95 UDT vessels.

To provide extra flexibility compared to the previous replacement policy, the units were to be fully transferable. Fishermen could hold excess credits from previous replacements to smaller vessels, and sell these credits if they wished to. From the previous example of an operator upgrading to 200 UDT, the additional 110 UDT could have been purchased from other fishermen with excess credits, or by purchasing a boat in excess of 110 UDT and selling off the balance of the UDT credits. Under this scheme someone wishing to enter the fishery with a new vessel would not have to go to the trouble of buying and reselling an existing vessel.

As with the previous replacement policy, a need was seen to help operators of small vessels to upgrade without penalty. It was proposed that vessels under 25 UDT be able to replace to 25 UDT without actually purchasing the additional credits. It was not at this time stated what would happen if the replacement exceeded 25 UDT or were sold to another operator. A policy was also recommended whereby 200 UDT would be the maximum credit. This was to prevent the owners of very large vessels, which in the past had not contributed greatly to effort, using their UDT allocation to replace with several moderately sized vessels.

The issue of "commitment" to the fishery, which in the past had such an effect on the available effort, was still not completely resolved. The licence fee was seen as sufficient to ensure active participation without a need for time limits. Failure to pay the fee would lead to the endorsement being cancelled.

This draft was encouraging from the viewpoint of economic management. It offered a mechanism for management by sub-stock and differential fees which should have led to the desirable effect of redistributing some effort between the stocks. The fee structure would also set a precedent whereby government might eventually recoup some of the costs of administration of the fishery if not generate a surplus to compensate for the use of the resource. Moreover, the replacement policy based on UDT would be a vast improvement over the old policy. It would have to be seen whether an actual withdrawal of effort would be necessary from the combined fishery. At that stage a time commitment as well as fees may have helped since it could be argued that $500-$1000 is not a great sacrifice for holding an "option" potentially worth many thousands.

THE SECOND DRAFT (SEPTEMBER, 1979)

Many of the proposals in the April draft represented compromises to State interests. The reception it received by industry further compounded the problems NFC would have in meeting the 1980 deadline for future management. The second circular to industry in September contained a significantly revised plan, also a product of substantial compromise. In fact some recommendations of the April draft management plan could be seen to represent "straw men" with little likelihood of widespread industry approval.

Industry generally favoured an open replacement policy by arguing that this would be consistent with freedom of the individual to make investment decisions. If a different replacement policy were introduced UDT would probably be the one supported. However, it rejected differential licence categories or any move to subdivide the management zone. The main thrust of the industry argument was that the decision to invest was made on the understanding that access to the whole managed zone (including the area west of the Wessels) would continue. Partitioning the Gulf would reduce the flexibility of their operations. It was further argued that partition would have limited value because all operators would apply for category 1 licences regardless of cost. Industry was not against higher licence fees as long as the revenue was spent within the fishery, for example, on research or enforcement.

Governments, on the other hand, were divided on the desirability of separate zones for management especially a separate "west of the Wessels" policy. Majority opinion seems to have favoured conceding to the industry's "one zone" concept based on the interim DMZ. One party held out and the September draft replaced the three category licence proposal with a three zone proposal. The three zones corresponded in some aspects to the three categories. The region from Cape Wessel to Cape Ford was re-included in the DMZ as area C. The other two zones were divided by the line north of the Calvert River, A to the east and B to the west. This distribution was intended to delineate the grounds where banana prawns predominate from those where tiger prawns predominate. It would also structure management west of the Wessels; a move attractive to the Northern Territory.

All currently eligible operators would be given a once-only opportunity to apply to operate in any or all of the zones. No additional entitlements would be given for area A in the future. Consideration for granting additional endorsements for areas B and C would be dependent on fishing pressure relative to resource potential once these were better understood. The proposal for increased licence fees was retained with area A licences fees being twice that for B and C. The actual amount for a given boat would be based on a sliding scale according to UDT allotments which were to be retained as the replacement base.

While UDT would be retained, agreement on the form it would take was not universal. Transferability of UDT was still to be possible, but the five per cent retirement on transfer was scrapped. The April proposition on retirement was to demonstrate the flexibility of UDT as a future option. In the light of the varying degree of acceptance of the UDT concept it was probably dropped to make the whole package "saleable" to NFC.

Pyramiding would be approved in that several vessels could be replaced by a smaller number, but an increase in vessel numbers ("reverse pyramiding") would not be permitted. Also, unlike the April proposal, it would not be possible to enter the fishery by purchasing existing credits without a vessel attached. This would obviously impose additional costs on new entrants who may have to resell a vessel they did not particularly want. These measures would have been to placate those States which did not wish to allow any possibility that effort might increase through boat numbers.

The replacement provision for small vessels was also modified. Industry held the view that 25 UDT which roughly corresponded to a 14 metre vessel, was too small for viable operation. The new proposal was that vessels under 50 UDT (approximately 18 metres) be able to upgrade to 50 UDT. Unlike the previous proposal, if the upgraded vessel were sold it would lose the concession. A new owner would only get UDT credits for the original vessel that had been replaced. Similarly, a current owner replacing a vessel under 50 UDT with a vessel over 50 UDT would have to purchase credits to cover the total difference (for example, 35 UDT to 55 UDT would require 20 UDT credits not five UDT). This was to ensure that as existing fishermen retired from the fishery, or replaced their vessels, the additional UDT credits created by this concession would be withdrawn. The April proposal was a once-and-for-all grant whereas the revised system would create no permanent increase in capacity. An estimate of the maximum possible increase in fleet UDT resulting from the April proposal was approximately ten per cent.

As with the previous draft, existing policies relating to matters such as seasonal closures, landing zones, and carrier vessels were to remain unchanged. In fact, with the exception of items detailed above, the draft regime contained most of the elements of the interim regime. However, the divisions within NFC and industry continued to make management a difficult process. Under the heading of "review of management" a third working group was proposed which would monitor and advise on the operation of management. With the prevailing lack of concensus as to the objectives of management and the forms it should take, that review would not be simple.

MANAGEMENT OF THE FISHERY BEYOND 1980

Details of a new management plan for the fishery to operate beyond January 1, 1980 were announced in November 1979 (Primary Industry Media Release 79/190). The press release accompanying the plan noted that during its preparation, public meetings had been held to discuss aspects of the plan with fishermen, processors, and representatives of industry in the region.

During these meetings industry once more unanimously rejected the concept of managed sub-areas and the replacement policy based on UDT. A single managed area and an open replacement policy were favoured, with endorsed operators prepared to accept the consequences of their own investment decisions. The industry was, however, prepared to accept higher licence fees but maintained that these must be used within the fishery. Industry wanted limited entry but was prepared to have nothing to do with the type of economic management outlined in the theoretical section of this review.

Subsequent meetings of NORPAC and NFC produced further divisions on the plan and it comes as no particular surprise that the new management regime is a thinly disguised version of the interim management regime. The managed area remains within the old Cape Ford to Slade Point boundaries, vessels endorsed in the interim effectively remain endorsed, no annual commitment is required and a number of other existing provisions are retained. Departures from the interim regime did arise relating to licence fees and vessel replacement.

The new regime would involve higher fees, which were to be based on vessel size. New scales have yet to be announced but an average of $1000 per annum is likely, representing a major step from the current $40-$60. While it is argued that this level is "token" in comparison to the returns that some vessels can make in a season, it does represent a step towards management by fee scale. If nothing else it must be seen as one of the rare cases where an industry has voluntarily accepted such a situation.

A vessel replacement policy was not resolved prior to the November announcement. A promise was made that one which would not result in an increase in effort would be considered as a matter of urgency. In the meantime, a modification of the interim policy would operate. Vessels over 20 metres could be replaced so long as the replacement did not exceed the length of the original vessel. The policy of allowing small vessels to upgrade also continued although the definition of "small" changed from 12 metres to 19 metres. This policy could lead to a substantial increase in vessel sizes if operators choose to take advantage of it.

NFC did warn that limited entry as a management option would be subject to possible change in the longer term. One such change cited was the introduction of management by species at a later date. This suggestion, taken in association with the similarity between the "old" and "new" management regimes, is probably an admission of failure to meet effectively the 1980 deadline. The suggestion made in September to establish a third working group was adopted by NFC. This working group has a similar composition to the second working group and probably will be involved in carrying out the same task. Its stated role is to co-ordinate research and monitoring activities, provide advice on management, and recommend future research for monitoring and management. The monitoring role is probably overstated to the extent that a workable management regime will have to be effected first. This alone could keep the working group occupied for a considerable period of time.

OVERVIEW

This review has considered the economic implications of fisheries management, starting with an idealised and simple model. Clear gains to the society were seen to be obtained from sound economic management of the common property fishery. By removing the externality asssociated with freedom to exploit that resource, profits (rent) could be obtained that otherwise would be dissipated and resources (otherwise wasted) could be diverted to more productive ends. The attainment of these "good" things would seem to make economic management a worthwhile objective to pursue. Obviously, other kinds of objectives will lead to other types of management, with the risk that few if any of the economic rewards will be won.

Limited entry management has been a feature of the northern prawn fishery for some time and it seemed appropriate to review its development. In doing so, it was possible to gauge the likelihood of society obtaining the "good" things economists have promised. From the outset, however, it appears that the appropriate economic objectives were not always foremost in the planners' minds. In fact, any objectives that were present have never been easy to delineate. The various working groups had trouble coming to grips with what was needed to meet the desired objectives, probably because they were not sure what the desired objectives were. This became evident in the type of conclusions reached.

The first working group did not provide a sound appraisal of the problems associated with open access or a convincing case for economic management. The second working group appeared to accept a kind of economic management but failed to demonstrate its operation, particularly in the longer term. Subsequent draft proposals and actual schemes seemed to advance and retain some desirable policy initiatives but discarded others. It is acknowledged that many of these were administratively difficult given available resources, or were sufficiently sensitive from a political viewpoint to be uncomfortable. However, administrative and political compromise could not guarantee a management regime efficient in obtaining the economic rewards thought possible.

The present management regime has many economic weaknesses and the third working group will have a difficult task if it hopes to fare better than its predecessors. It faces the same dearth of bio-economic understanding as before, although part of its role is to attempt to overcome this problem. However, its operation will be easier if management bodies will clearly state what it is they wish to achieve and attempt more workable compromises than in the past.

NOTES

1. The extensive margin is that at which average value of catch would equal average cost at very low level of effort (that is, approaching zero). It effectively places a limit on the extent of a fishery. The intensive margin covers all grounds that are capable of generating rents.

2. Crutchfield (1961, p.131) made the point that "economic aspects of regulations have usually been neglected where possible and ignored when they become too obvious to neglect".

3. Another factor would have been that since early 1974 prawn prices had fallen almost continually on export markets and were considered "low" by historic standards.

4. The following formula can be used to determine "break even" catch requirements for any given unit price of product

$$Q = \frac{FC}{P(1-x) - (VC/L)}$$

   where Q is break even catch (kg), FC is fixed costs, P is price per kg, x is proportion of crew share, VC is variable costs and L is landings.

5. The possibility of subsidising such operations was not ruled out.

6. It could be argued that it probably had the strongest influence on the poor degree of acceptance of the report in general.

7. While the acquisition cost would be nominal, the annual fee could be quite high (especially for sub-stock A).

8. An alternative would be to place a high transfer fee on the licence in which case its capitalised value would decrease. A system of generalised fees such as those advocated earlier would reduce much of the problem Copes saw with saleable licences.

9. Factors accounting for the decline would include escalating costs and depressed markets for prawns, with a tendency for many boats to fail to break even on the trip to the Gulf.

10. "Non-self regulating" or "biologically resilient" stocks conform to the yield effort relation in figure 1. Correlation between recruitment levels and adult abundance is low.

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APPENDIX

MANAGEMENT STRUCTURE WITHIN THE NORTHERN PRAWN FISHERY

The northern prawn fishery spans territorial waters under the jurisdiction of several States as well as waters controlled by the Commonwealth. Accordingly, responsibility for decision making and management within the fishery has been fragmented. The establishment, in 1974, of the Northern Fisheries Committee (NFC) was a move towards rationalising this management structure. However, a sizeable number of organisations are still involved in the management process.

The basic terms of reference of the NFC are as follows:

* to provide a platform for the discussion of management problems faced by any of its members;

* to provide a mechanism for co-ordinating management strategies into more than one State or Territory within its area;

* to advise the Standing Committee on Fisheries on planning and implementing research programmes, methods of co-ordinating research being undertaken, and exploitation of fisheries resources.

Under these terms, NFC is the body instrumental in determining the shape of management regimes for the northern prawn fishery. Membership of NFC includes a chairman from the Commonwealth Department of Primary Industry (Fisheries Division), representatives from Queensland, Western Australia and the Northern Territory (usually the head of respective fisheries departments) and a representative from the Division of Fisheries and Oceanography of CSIRO. To assist its work, NFC has periodically appointed specialist working groups to deal with specific problems facing the fishery. The first and second working groups on management are important examples as will be a third working group which has been recently established.

As a result of industry pressure a joint government-advisory body was established in 1976. Known as the Gulf of Carpentaria Prawn Advisory Committee (GOCPAC), it was intended to allow direct consultation between NFC and industry on management policy. GOCPAC subsequently became NORPAC (Northern Prawn Advisory Committee). Membership of NORPAC includes representation from Commonwealth Department of Primary Industry, Queensland Fisheries Service, Fisheries Division of the Northern Territory Department of Primary Production and industry representatives from both Queensland and the Northern Territory, commercial fishermen and the Australian Fishing Industry Council. At present, a review is to be carried out of industry representation on NORPAC, following continued concern from some segments of industry about the effectiveness of industry consultation in relation to management decisions affecting the fishery. Nonetheless, NORPAC has had a considerable role in shaping the management regime that evolved for the fishery.

The Australian Fisheries Council (AFC) composed of Commonwealth and State ministers responsible for fisheries matters, is the body that ultimately decides on the implementation of any management policy. Such policies are recommended to AFC by the Standing Committee on Fisheries, the latter composed of the chief officers of Fishery departments in each of the states and the Northern Territory. Thus, while management policies are initiated by the responsible Ministers on advice of their senior departmental officers, these groups have limited involvement in policy formulation for the fishery. This role is handled by NFC.

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MANAGEMENT OF THE VICTORIAN SCALLOP FISHERIES: RETROSPECT AND PROSPECT

by

N.H.Sturgess, N.Dow and P.Belin

INTRODUCTION

The use of a resource that is the property of no one in particular but everyone in general may lead to economic waste. An industry based on such a common property resource may use more inputs than the social optimum because the marginal social cost of production exceeds the marginal private cost. One way of improving resource allocation in these circumstances is for the government to intervene with measures which cause marginal costs to resemble marginal social costs. The theoretical features of this problem in marine fisheries have been well documented and will not be reviewed in this paper (Gordon, 1954; Scott, 1955; Turvey, 1964; Copes, 1972; Anderson, 1977). However, there has been relatively little empirical analysis directed at determining best operating conditions (for example, Crutchfield and Zellner, 1962; O'Rourke, 1971; Bell, 1972; Tomkins and Butlin, 1974), particularly for Australian fisheries.

In the early years of its comparatively short history the scallop fishery in Port Phillip Bay was open to all who wished to fish. However, with the rapid emergence of an "overfishing" problem the State government introduced a set of regulations to overcome the problem by reducing fishing effort. As a result the scallop industry in Victoria became one of the first "managed" fisheries in Australia - with restrictions on the entry of boats into the fishery being a major method of management. The newer fishery at Lakes Entrance has been managed in a similar way since its discovery. The purpose of this paper is to review the management of the scallop fisheries in an economic framework and, using the results of some bioeconomic models of the fisheries, to suggest a strategy for future management. The central hypothesis is that the amount of fishing effort used in the fisheries remains excessive.

THE VICTORIAN SCALLOP FISHERIES

THE BIOLOGY OF THE SCALLOP

The commercial scallop, Pecten alba (Tate), a bivalve mollusc of the family Pectinidae, is found throughout Port Phillip Bay (PPB) below about four fathoms. It also occurs over a large area of Bass Strait east of Wilson's Promontory, offshore from the town of Lakes Entrance (LE), and as far south as Tasmania at depths between ten and thirty fathoms. Scallops occur on various seabeds from fine silts to coarse grain sands, but are not found on reefs or weed beds. The two fisheries, PPB and LE, can be regarded as separate stocks. Because the LE fishery is in the open ocean its boundaries are less precise than the PPB fishery. The majority of the catch at LE is taken within a radius of about thirty miles from the port, although boats venture further south and east in favourable weather. The PPB stock can be regarded as a closed population whereas the fishable stock at LE may be several populations with an unknown degree of interaction.

The two shells of the scallop, one flat and the other dished, are hinged at one end. The main edible portion is the abductor muscle which controls feeding and movement. Feeding occurs by sieving water through a curtain-like mantle to obtain suitable-sized components of the plankton. Scallops move in a series of spurts by jetting water from between the shells in the area of the hinge. This limited ability to swim and the scallop's many well-developed eyes, which are capable of perceiving shapes as well as changes in light intensity, have led to the belief that individuals could swim away from an approaching dredge. This has not been substantiated by divers.

This species of scallop is an hermaphrodite. The gonad, which is attached to the abductor muscle, is creamy white at the testicular (proximal) end but pink to red at the ovarian (distal) end. The gonads of some scallops may be red throughout. Such gonads are made up entirely of ovarian tissue as a result of the scallop being infected by the trematode parasite Bucephalid cerceriae. Large numbers of these parasitic worms make the scallop sterile. Spawning first occurs in the second year of life. It appears to be induced by a sudden small rise in water temperature. The period of spawning in Port Phillip Bay occurs from August to November, whilst scallops in the Lakes Entrance fishery may commence spawning as early as June. During this period an individual scallop may spawn on a number of occasions. When the conditions are suitable, the scallop may spawn every two to eight minutes for three hours. Fertilisation of the eggs occurs externally after contact with the actively swimming sperm. The fertilised eggs at first sink to the sea bed and then go through a number of pelagic (floating at or near the sea surface) larval stages before permanently settling on the sea bed.

The settlement process, spatfall, occurs some six to eight weeks after fertilisation. As a consequence of tidal and current movements, which are especialy strong over the Lakes Entrance grounds, the area where spatfall occurs may be remote from the site of spawning. There is a large degree of variability in the number of scallops "recruited" to the stock. Sanders (1971) has suggested that this variability occurs irrespective of the existence and amount of exploitation.

The growth of individual scallops is rapid. A shell diameter of about 9 cm can be attained at an age of two and a half to three years. The growth rate of PPB scallops has been reported to be higher than those at Lakes Entrance, possibly because food supplies and water temperatures are more favourable. Natural mortality has been estimated to be between five and ten per cent per annum until the scallop is six years old, when mortality rises. The maximum age of scallops is about twelve years. Scallops seem to have only one predator, the eleven-armed spiny starfish Conscirasteria calameria.

The sole means of catching scallops commercially in Victoria is by dredging. A single dredge is towed from the stern of the boat by a wire cable. When this is fully retracted a self-tipping apparatus empties the contents on to a sorting table. The crew remove rubbish from the catch and pack the unopened scallops in sacks for transport to the processor. Scallop boats often work in dense packs whilst dredging grounds where the density of scallops is high. Crowding externalities manifest themselves in the form of snagged dredges, collisions, abusive language and the occasional fight.

HISTORY AND MANAGEMENT

The history of both fisheries is comparatively short. The Port Phillip Bay fishery began as a commercial operation in 1963 even though the presence of scallops had been determined by the state government authority for fisheries as early as 1957. Partly as a result of the near depletion of the D'Entrecasteaux Channel fishery in Tasmania, boat numbers increased rapidly in response to attractive catch rates and incomes (Sanders and Sturgess, 1968), until 1968 when 170 boats were fishing. Production peaked in 1967 when approximately 2,000,000 kg of edible flesh were taken; only the Georges Bank of North America produced more from a single fishery. This period of expansion was followed by a slump in catch rates. Catch rates dropped to such an extent that in April 1971 only four boats were fishing. Many fishermen chose either to leave their boats idle or to fish for other species. In June 1970 one fisherman discovered that a commercial scallop fishery existed in Bass Strait just offshore from Lakes Entrance. Within five months 68 boats were involved in this new fishery, most of them coming from the PPB fleet. This transfer of effort aided the regrowth of the scallop stock in PPB and the catch increased from 18,000 kg in 1970/71 to approximately 1,000,000 kg in 1972/73. Since the beginning of the LE fishery it has proved to be of similar importance to the PPB fishery.

Jurisdiction over marine fisheries in Victoria rests with the Fisheries and Wildlife Division (FWD), Ministry for Conservation. This body exerted little control over the PPB fishery in its first five years. The exception was the introduction in 1965 of a minimum size for scallops. Based on research into the growth rates and natural mortality of scallops the size selected (9.5 cm) was judged to provide the maximum yield of flesh from a given number of zero-age scallops entering the fishery.

In 1968 a licencing scheme, designed to limit further entry of fishermen, was introduced into the PPB fishery. This action was prompted by the steady decline in catch rates and the FWD felt that such a restrictive measure was necessary to ensure the long term viability of the fishery. A scallop licence is issued to a person for operation of a particular boat. Licences were offered to all fishermen actively fishing in the industry just before December 1967. Not all fishermen chose to accept this offer; a decision which was influenced by both the bleak short-term prospects for the fishery and the licence fee of $20 per foot of dredge width (about $160 per boat). Following the withdrawal of some fishermen in 1969 the number of licences stabilised around the 79 presently entitled to fish in PPB. The introduction of scallop licences was accompanied by a policy which restricted the width of the dredge according to the length of the boat. If fishermen replaced their boat with a larger one they were not permitted to increase the width of dredge. As a further control on effort fishermen were not permitted to operate outside the daylight hours of 5 a.m. and 5 p.m.

Soon after the Lakes Entrance fishery began the FWD initiated a licencing scheme for that fishery; this followed an amendment to the Victorian Fisheries Act (1968) made in September 1971. Because many of the boats in this fishery already held PPB licences their owners were given the option of taking out an all Victorian waters licence. As the name implies holders of this licence could participate in both the PPB and LE fisheries. Those fishermen whose previous scallop fishing had been restricted to the LE Grounds were offered licences applicable to that fishery only. Thus three types of Victorian scallop licences exist at the present time; namely, PPB only; all Victorian waters; LE only. Since 1971 the numbers of licences in these categories have remained static at 23, 56 and 34 respectively. From 1977 fishermen not "actively regularly and substantially" engaged in fishing are required to "show cause" why their licence should not be cancelled. To our knowledge no licences have been cancelled by this means. Scallop licences are not freely negotiable through a market. However, because the purchaser of a scallop boat is almost assured of obtaining endorsement of the licence, the price of the boat includes an amount for the acquisition of the licence.[1]

Fishermen of the LE fishery were prohibited from taking scallops less than 9.5 cm at the widest point. This regulation was introduced on the assumption that the growth parameters and natural mortality of scallops in the LE fishery were similar to those of the PPB scallop. Dredge width was tied to boat length by the same regulation as for PPB.

Since the introduction of scallop licences for the LE fishery in 1971, some regulations have been altered and new ones added according to the state of knowledge about the two fisheries and the abundance of scallops. The size limit on scallops caught at LE was removed in September 1976 and the size limit in PPB was lowered to 8.9 cm in June 1977. In December 1978 the latter size limit was also abolished. The major reasons for the abolition of size limits were the costs of sorting and measuring imposed on fishermen, the likely damage to undersized scallops returned to the water, and the cost of enforcing the minimum size.

The regulation under which the allowable width of dredge was proportional to boat length has been replaced with one which fixed a maximum size of dredge (3.36 m) for PPB and daily bag limits were imposed on both fisheries. Bag limits were first organized on a voluntary basis by the Scallop Fishermen's Association at Lakes Entrance. Subsequently, bag limits were legislated for both fisheries in 1976 because the FWD was concerned that voluntary arrangements would break down. When first introduced the bag limits were 15 bags per day in PPB and 25 bags per day in LE. These limits have been altered downwards for PPB and up and down for LE until they now stand at 10 bags per day and 50 bags per day respectively. Bag limits would appear to make redundant the control over fishing times and dredge width, but these regulations remain.

In December 1978, along with the abolition of size limits, a closed season was declared for the PPB fishery. On a trial basis the fishery was closed from December 20, 1978 until the first Monday in April 1979. During the open season the bag limits may be altered or fishing may be prohibited for some days each week, depending on the size of scallops being taken and their abundance. These regulations were used during the first open season when the northern half of the Bay was closed in October 1979 and fishing was limited to three days per week in the southern half. Prior to October many small scallops were taken by the PPB fleet which was augmented by a considerable number of all Victorian waters boats from LE. A summary of the regulations which applied to each fishery in December 1979 appears in table 1.

AN EVALUATION OF THE MANAGEMENT POLICIES

LICENCING AND THE MANAGERS' OBJECTIVES

The set of arrangements by which the scallop fisheries are managed has evolved in a trial and error fashion to meet a complicated and imperfectly specified set of economic, social, and political objectives. Given the slow accumulation of knowledge about scallop populations and their interaction with the environment, including fishing, it is not surprising that there have been trials and changes. This section outlines some of the possible reasons why the managerial arrangements have taken their particular form; the reason why there has been complete reliance on regulations rather than market mechanisms is of notable interest. Related issues include the type of regulations used, and the nature of the rights they give fishermen. Of necessity, this involves speculation about the objectives of the participants in the managerial processes and the trade-offs between those objectives. Also, the form of the policies depends on the relative bargaining strengths of the participants. The observer can never know these relationships and objectives with certainty and our approach is to draw inference from statements made by the participants, and actions they have or have not taken.

The Fisheries Management Committee met first in 1976. This committee consists of representatives of fishermen in the various fisheries and the FWD. Its role is to advise the Minister and the Director of the FWD on management matters. This committee, the FWD and the politicians in government represent the major participants in the management process since 1976. Prior to that date fishermen were not involved directly in management.

The introduction of a limited number of scallop licences in 1968 was in accordance with the growing interest in the management of fishing effort during the 1960's, as the ideas of fisheries economists filtered through to biologically trained administrators (Sanders, 1967). In a paper to a national fisheries seminar, Sanders (1971) listed objectives for the management of scallop fisheries. This list provides an insight

Table 1. Regulations affecting the Port Phillip Bay and Lakes Entrance scallop fisheries (December 1979)

Regulation	Port Phillip Bay	Lakes Entrance
Boat licences	79:23 PPB only and 56 all Victorian waters.	90:34 LE only and 56 all Victorian waters.
Licence fee	$8.00/10 cm of dredge width.	$8.00/10 cm of dredge width.
Scallop size limit	None.	None.
Catch limit	10 bags/day.	50 bags/day.
Dredge width limits	Not greater than 3.36 m.	Related to boat length with maximum of 3.36 m.
Time limitation	5 a.m. to 5 p.m.	None.
Closed season	Mid-December to early April. Other closures as needed.	None.

into the managerial obligations as perceived by a senior member of the FWD. The objectives were:

* stability resulting from a level of exploitation which allows the production to be sustained and relatively constant,
* a satisfactory income for those engaged in the fishery, and
* a satisfactory quality and price to the consumer (p.10).

In the same paper Sanders summarized the philosophy of management as follows:

> The management of a fishery is the responsibility of both government and the persons engaged in the fishery. It is a responsibility which should at least be directed to the resource, to the industry and to the consumer (p.9).

Although the idea of sustained yield is clear the remaining objectives, with the repeated use of the word "satisfactory", might be regarded as principles without content. Or, taking a more lenient view of the philosophy behind them, they could be said to be consistent with the economic components of net social benefit (Copes, 1972). However, there is no specific mention of the idea of fishery rent or the economy-wide implications for resource use which follow from maximizing fishery rent. A responsibility directed "to the resource" is an unusual phrase but it seems to suggest that the preservation of the species is an objective of the managers. Sanders (1971) does mention "more sophisticated objectives" such as "sustained maximization of production, or maximization of profit". Without defining the profits to be maximized, he claims that these objectives "usually verge on the unrealistic and are unobtainable when put into practice" (p.9). Further evidence of the government's obligations, and an insight into the objectives implied by the licencing regulations, was given by the Chief Secretary at the time, Mr. Rylah, when introducing the relevant Bill:

> In considering whether or not further licences should be issued ... the Minister shall have regard to the welfare of the fishery concerned and of the persons engaged in the industry. This will allow the Minister to take into consideration such factors as the proper management of the fish stocks to ensure the continued productivity of the resources, the good of the persons engaged in the industry with particular reference to the man who carries out the harvesting and also to all other persons engaged in the various phases of the industry from the wharfside to the consumer. (Hansard, No.12, 1967, Parliamentary Debates)

Unfortunately, despite the creditable speed with which the FWD introduced this managerial innovation, the purpose of the licence limitation is ill-defined because what is meant by the "welfare of the fishery" or "the good of persons engaged" is not specified. In an earlier paper, Sanders (1967) acknowledged the existence of a relationship between fishing effort and fishermen's incomes stating that in an uncontrolled fishery "the economic end point ... is again a state of minimum profits" (p.3). Sanders maintained that the reason for regulating fishing was to achieve "optimum" fishing as defined by maintaining the profit margin at a desired level.

Because the "profits" remain undefined it is not clear whether the FWD was concerned about the business profits of fishermen or had in mind a social surplus (rent). Some subsequent statements were consistent with both interpretations. Fishermen's incomes will be influenced by the amount of the surplus (resource rent) which the state captures by various means and it appears that the FWD was particularly sensitive about these incomes; possibly because fishermen's incomes had decreased markedly by 1968 (Sanders, 1971, p.8). This concern with the welfare of fishermen prompted Sanders to observe that:

> licence limitation has the advantage...of facilitating control of fishermen's incomes. This in itself raises the problem of what this level should be. (Sanders, 1971, p.5)

In the event, the policy limiting the number of licences and the accompanying regulations restricting dredge width and the night-time closure of the fishery, were directed apparently at preventing expansion of effort. Although there was discussion within the FWD in 1967 that the number of licences might be adjusted by limited transferability and a "buy-back" scheme, specific mechanisms for reducing the number were absent from the legislation. In fact, it appears that the regulations affecting dredge width, boat replacement, and fishing time were not directed solely towards preventing expansion of effort. If these variables were not to be controlled, the resultant increase in the efficiency of fishing would require a reduction in the "optimal" number of licences.

> This trend could become progressive and could eventually lead to a very small efficient fleet. To overcome this problem, any system of licence limitation must incorporate restriction on the fishing power of the boats. (Sanders, 1967, p.4)

The pursuit of efficiency can only be considered a problem by those who see it as a price for the attainment of some other objectives. These other objectives remain unspecified but the fact that they existed was indicated by the judgement that any sudden reduction in the number of licences was "socially and politically undesirable" (Sanders, 1971, p.11). In the twelve years since licencing began, the only reduction in effort which took place through the number of licences was due to some fishermen declining a licence or voluntarily withdrawing in the first year of the scheme. The subsequent regulations (bag limits and a closed season) indicate that further reduction in effort was desirable. This was achieved by means other than reducing the number of licences, despite feeling within the Fisheries Management Committee that there were too many boats in the fisheries. Only recently has the FWD attempted to bring about any reduction in the number of licences. A fisherman who has not been "actively, regularly and substantially engaged" in the fishery for which he is licenced must "show cause" why his licence should not be cancelled. Like voluntary withdrawal this passive provision puts the onus on the fisherman. Also it could have the perverse effect of encouraging an increase in effort as part-timers protect their licences, as well as being a tedious and potentially costly scheme to administer. Judging by experience in the Canadian salmon fishery this provision is likely to have little effect in reducing the number of licences.

Further evidence of the policy makers' bias against actively reducing the number of boats is that when licence limitation was extended to the LE fishery soon after its commencement, an additional 25 boats from LE were issued with licences. Opinion in the FWD was that this action was justifiable because "these fishermen had a <u>legitimate right</u> to engage in this new fishery being established <u>on their fishing</u> grounds" (Sanders, 1971, p.12, emphasis added). It was not explained why these fishermen were attributed with some sort of ownership rights over these fishing grounds, theoretically a common property or state-owned resource. It appears from this and other actions that historical association with a fishery or port was judged by the FWD to give a fisherman preferential rights in limited-entry fisheries.

A similar expression of the belief in right of access by historical association may have led to the creation of the three types of licences - PPB only, LE only and all Victorian waters. To prevent the possibility of all licenced boats returning to PPB at some time in the future, it was decided that only those boats operating in the Bay just before the development of the LE fishery should be allowed to re-enter. This created special privileges for a group of fishermen whose major attribute appears to have been mobility. The 1979 experience in PPB suggests that total effort of the combined groups eligible to fish the Bay remains excessive. The fact that the FWD has considered it undesirable to create only two groups of fishermen, each confined to one fishery, adds support to the importance of historical access. The reasoning for not creating two fleets is the "inherent instability" of the scallop production at any one location and the objective of "satisfactory" level of income for fishermen. Because of the instability of production it is argued that confining fishermen to one ground or the other will cause income from scallops to become more unstable.

The pursuit of policies which have encouraged the greatest number of "legitimate" fishermen to continue operating in one or both fisheries for as long as they wish, could be said to be for the good of persons engaged in the industry. Offering licences to all fishermen and allowing all the acceptors to continue fishing allows them to fulfill the expectations on which their investments in the fishery were made. However, a significant number have since arranged the transfer of their licences to new entrants suggesting that this argument loses its force with the passage of time. Also, those policies may be consistent with unstated objectives such as preventing social dislocation, or maintaining regional employment opportunities in the individual's preferred job. However, there may be many ways of achieving ends such as these; indeed the ends themselves may be questioned. Unless the regulators clarify the extremely vague terms in the stated objectives, the least-cost ways of achieving the real objectives are left to chance. Until then, it will be recognized that the present policy is also consistent with another set of objectives which come under the umbrella of maximizing the number of minimally offended, voting producers. If the managers wish to pursue a regulatory approach it cannot be denied that deciding who is to leave the industry is difficult and the result likely to be unpopular. Licencing all fishermen, placing the onus on fishermen to withdraw or "show cause", and regulating effort by other means, tends to preserve the status quo and avoid these decisions. In a sense, preservation of the status quo may be consistent with idealized Paretian values; but those ideals may be misguided and impractical in these circumstances. To pursue this line of reasoning would lead into topics beyond the scope of this paper, namely, the emerging theories of regulation. However, Scott (1979) has suggested that these developments may find fruitful application in fisheries regulation and Sieper (1979) has argued their relevance to Australian primary industries.

BAG LIMITS AND THE CLOSED SEASON

The subsidiary regulations of daily bag limits and the closed season in PPB are also difficult to interpret in terms of the vaguely stated objectives. The closed season and area closures during the open season may impose hardship on the PPB only licence holders. Being unable to move to LE they are forced to other occupations during these times. Similarly the LE only boats will be disadvantaged to the extent that the all Victorian waters boats could fish LE during the PPB closures. It is possible that this measure may force the retirement of some PPB only boats, but there are less drastic ways of doing this. As long as the number of licenced boats which can operate in PPB remains unchanged, there seems to be no alternative to these measures; given the desire for regulation persists. Indeed, in these circumstances, it is not hard to foresee that more stringent regulation of fishing activity may be required to preserve the fishery. Even if the number of boats licenced for PPB were reduced, a closed season over all or part of the Bay may be needed for some years to allow the depleted stock of small scallops to grow and reproduce. Despite any race for scallops that may be encouraged by a closed season it may be justifiable as an emergency measure.

Daily bag limits are a simple control on output which is relatively cheap and easy to enforce. However, there are several problems associated with these limits. Firstly, as indicated above, bag limits make redundant the controls on dredge width and fishing time. Therefore, costs are likely to be greater because some fishermen may operate more efficiently after 5.00 p.m. in PPB, and because the time required to take a given bag limit could be reduced with larger dredges. Secondly, daily quotas as opposed to annual quotas for every fisherman give only indirect control over total fishing effort and may result in higher costs. For every fisherman, a daily quota multiplied by the average number of fishing days corresponds to an annual quota. However, costs may be higher than with an annual quota because fishermen's choices about the distribution of their effort over the year are curtailed by a daily limit. Also, costs may be increased and control over total effort diminished, as fishermen take greater risks to increase the number of days they fish. These problems are exacerbated by the group of fishermen which is permitted to move between the two fisheries. As they do so daily quotas would need to alter to hold total effort within desired limits. Such variations in daily bag limits in turn create an additional source of uncertainty.

Thirdly, daily quotas were introduced first by the Scallop Fishermen's Association at Lakes Entrance as a means of influencing the price offered by processors. Bag limits have been altered since they became subject to regulation, no doubt after discussion in the Fisheries Management Committee. Therefore, the regulators might be seen to have assumed a price-influencing function in conjunction with producers. This function is not new to regulators in primary industries, nor is it inconsistent with the stated objective of satisfactory incomes for fishermen. However, it is a function that is not without conflict with the management of fishing effort and the consumer-oriented objective.

TRANSFERRING LICENCES

By various means it is possible for a retiring fisherman to transfer a licence to a new entrant to the fishery. As a result a de facto market in licences exists. During a survey (Belin, 1978, chapter 6) fishermen were asked to value their boats both with and without a licence. The implicit valuations of their licences averaged \$2430, \$3350 and \$4750 for the PPB only, LE only, and all Victorian waters endorsements respectively. These figures suggest that the mobility permitted by the all Victorian waters licence enables the holders to capture rent from both fisheries and earn higher income - this was confirmed by the survey. Although it is not possible to make comparisons with published information from other fisheries these values seem low, possibly reflecting the relatively depressed state of the fisheries. Also, the values of the licences were low relative to the value of a boat at the time of the survey. Therefore boats appear to have significant value for uses other than scallop fishing.

Since their introduction the FWD has opposed a formal market for licences even though approval for "sales" is relatively easy to obtain. Some of the possible reasons for this stance were revealed at a seminar in October 1978 to discuss the sale of licences in limited entry fisheries (Sanders, 1978a, 1978b). Firstly, the sale of licences represents a windfall gain to the first generation of fishermen and imposes additional costs on the fishery. These costs are the interest payments on loans to purchase the licence, or the interest foregone on savings. While this is a cost to the individual, as it is to the purchaser of any asset, such a cost would not appear in a social cost-benefit analysis of saleable licences. From the viewpoint of the fishery there would be the offsetting gain in interest from the funds available to the seller; given a competitive capital market. Also, funds would be transferred to the purchase of fishing rights from other sectors of the economy if the gains were at least equal to the return of those funds elsewhere.

There are many examples (such as the 19th century squatter-graziers) to suggest that governments have not been persuaded by the windfall gain argument in the past. Also it is of doubtful relevance now; given that a de facto market exists on which many entrants have already traded. Also, as Sanders suggested, means such as higher fees could be used to reduce the value of licences; but these were seen "as administratively difficult and costly" (Sanders, 1978b, p.3).

Secondly, it was claimed that a market for licences would discriminate against entrants with the least ability to pay and does not necessarily give due priority to the most meritorious applicants. The common fear of monopoly control of fisheries is also evident in this reasoning. All types of rationing "discriminate" against somebody, therefore the force of this argument depends on the definition of merit. The FWD seems to believe that merit would be assessed best by a point score with high points for fishing experience, filial relationship to a fisherman, living near a port, and middle-age. This suggestion again stresses the importance of the belief in the right of access by association in the minds of the policy makers. Conversely, it can be argued that a market would encourage skilled entrepreneurs to enter the fisheries. Such people could engage skilled and experienced labour if required, and they would take this into account in determining the prices they could offer for a licence.

Other arguments against saleable licences included the possibility that some buyers would pay too much, either because of inflated expectations or because of non-monetary rewards from fishing as a way of life. The paternal attitude expressed in these reasons is obvious. It appears to stem from the major thread in Sanders' arguments, namely, the concern of the managers that fishermen earn an "acceptable" income. This objective of management sets fishermen apart from other members of the community and from producers of many other commodities. By preventing a formal market in licences (with the possibility of lower transaction costs than the informal market) which is separated from the boat market, the FWD is impeding one of the most powerful forces in producing "acceptable" incomes, namely, the mobility of resources in accordance with their opportunity costs. Also, we will argue that it is foregoing the opportunity to affect the number of licences in a non-regulatory fashion.

The final disadvantage of saleable licences given by Sanders (1978a) is that such a system would be difficult to revoke. Except to serve the political purposes of the Minister or his advisors, it is difficult to conjure-up circumstances in which a return to an administrative system would be warranted. A government may be tempted to do so if over-concern with incomes produced very high prices for licences, or if an undesirable concentration of ownership developed. In these circumstances, however, to revoke the market would be like amputating a toe at the neck.

In more fundamental terms it is possible that the government is concerned that saleability would alter the bundle of property rights embodied in a scallop licence. The present arrangement involves a partial transfer of rights to the individual under a tenure-like arrangement, with the rent being the annual licence fee. Saleability would alter the bundle of property rights more towards individual ownership. It is not hard to imagine that a government might be uncomfortable about being seen to vest ownership of a community resource in individuals - particularly when open access existed in living memory. There are, of course, many precedents for similar changes in property rights and governments always have the ability to stake the community's claim through appropriate fees and covenants - as every house-owner knows. As an aside, it is interesting to speculate if this is the reason why governments are often averse to markets which appear to "trade in paper". The rights given by the paper are often well established but the "property" is not so clear cut, for example, broadcasting and taxi licences. After all, buying and selling tangible property like land is just "trading in paper" - the title.

We have outlined some of the weaknesses in these arguments against a formal market in licences. The weakneses are amplified by the fact that the FWD has been unable or unwilling to prevent the informal market. The advantages of saleable licences have been discussed elsewhere (Anderson, 1977) and we need not repeat those arguments here; suffice it to say that we see no reasons why those advantages should not apply to the scallop fisheries. With Crutchfield we believe that:

> Efficiency in use, continuity of operation and ease of administration are eloquent arguments for relatively free and costless transferability of limited fishing rights. The price they will come to carry is both an economic barometer and an allocative device that no amount of government administrative effort could match (Crutchfield, 1979, p.745).

Rather than continue to debate the question of saleability the managers would be served better to debate the form and extent of the rights to be offered. A clear definition of the bundle of rights is necessary if buyers and sellers are to place their valuations on a licence. Also the nature of the rights will affect the costs to the managers and fishermen of policing and enforcing those rights. Similarly they will affect the cost of making a transaction. If, for example, licences were in perpetuity it is possible to envisage the need for some form of title and the involvement of the legal profession in conveying titles. Long-term or perpetual rights have the administrative advantage of reducing the number of issuings compared to short-term licences. As well, they would provide their owners with more certainty in managing their financial portfolio. Other important questions to be debated include:

* are licences to be offered to fishermen for the operation of a particular boat, and if so, what are to be the provisions for replacing the boat?

* is the set of rights to be leasable as well as saleable?

* what is to be the nature of inter-generation transfers, that is, is the licence to form part of an estate which can be willed and subject to death duties?

Judged by their beliefs and previous actions the managers may be disposed to restrict the potential buyers of licences to "legitimate" fishermen. Such a stipulation could have unfortunate consequences in terms of the economy's allocation of resources, including managerial skill and innovation in the scallop industry.

This section has reviewed the stated objectives of the managers. Broadly, the approach of the managers has been to leave the number of boats unaltered and to affect total effort by controlling the effort per boat. We have speculated about some possible motives for these strategies. If informed public discussion of the management of these fisheries is to proceed the managers must accept the responsibility of clarifying their vague objectives. This is particularly important now because some of the decisions which must be made, such as the type of property rights to be vested in fishermen, may set the future course of history for these and other fisheries.

BIOECONOMIC MODELS OF THE SCALLOP FISHERIES

INPUTS AND OUTPUTS

In the mainstream of present theories of commercial fishing, the yield (catch) of the fishery depends upon the inputs man uses to go fishing and the growth and reproductive characteristics of the stock of fish. Following the conventional Schaefer-type of logistic analysis, growth of the stock of fish is assumed to be a function of its mass (Schaefer, 1954 and 1957). In an unchanging environment with limited food supply a stock which is not fished will grow to some maximum size. When the catch taken from such a stock is greater (less) than the natural growth the mass of the stock will decrease (increase). The <u>sustainable yield</u> for a given size of stock is achieved when the catch equals the natural growth. This yield is sustainable because the same quantity of inputs (effort) applied to the stock in subsequent periods will produce the same catch. If effort changes, catch and population will change until a new sustainable yield is attained at a new equilibrium stock.

The sustainable yield curve can be viewed as the long-term production function of the fishery. It shows the quantities of fish which can be obtained on a continuing basis at various quantities of effort. Each point on the curve implies that a different size of stock is in equilibrium at that particular quantity of effort. The sustainable yield curve resulting from this model is bell-shaped over some or all of its range, indicating that a given sustainable yield can be obtained from two amounts of effort and two equilibrium sizes of stock. The mathematical and biological details of this and other models of fisheries have been discussed by Clark (1976) and Anderson (1977). In the absence of published information on growth, mortality, spawning, and the recruitment of young scallops, it was not possible to estimate stock production models for each fishery in the manner of Beverton and Holt (1957). Consequently, this study uses the type of sustainable yield-effort model outlined above.

It was mentioned earlier that there is some evidence that the size of the scallop populations may vary irrespective of the amount of fishing effort. This type of situation could arise if the growth of the population is more dependent on environmental stimuli than on the size of last year's population. Other circumstances in which the conventional model may not be appropriate are when the proportional growth rate of the species increases over some range of population size, or if there is a minimum size below which the population is not viable (Clark, 1976, Ch.1). Lack-of-fit of the conventional model may be indicative of these other hypotheses.

A major difficulty in estimating yield curves from observations of catch and fishing effort is that the actual catches in a given period are unlikely to be sustainable catches for the observed quantities of effort; particularly if there are considerable changes in fishing effort between periods. Because the scallop fisheries have been in operation for only a small number of years, it was not possible to use the methods devised by Schaefer (1957) and Gulland (1968) for modifying observed data to approximate steady state conditions. Rather than assume that actual catches are sustainable, as was done in a previous study (Belin, 1978), the approach used was to estimate by non-linear regression the parameters of various population-growth-effort models with different forms of the growth function. These models were then used to predict sustainable yield curves.

The definition and measurement of fishing effort is one of the major problems in fisheries economics. In common with most analyses of fisheries to date, we have by-passed this problem and adopted a one-dimensional proxy for the bewildering array of substitutable inputs which are capable of affecting the catch and population of a fishery in a given way. Such inputs include vessel length, tonnage, engine type and power, gear type and size, hull configuration and navigational equipment, to name but a few. We believe this approach is consistent with the overall state of biological knowledge about scallop fisheries and the accuracy of the information on which the models are based. However, it is recognized that a single proxy for a multi-dimensional phenomenon makes it difficult to suggest effective controls on effort (Wilen, 1979). A common procedure to obtain an appropriate proxy is to use the biologists' definition of effort, namely, the product of the fishing power of the gear multiplied by the time (or number of operations) for which the gear is used (Turvey, 1964; Tomkins and Butlin, 1975). Fishing power is the product of the area of influence of the gear in a single operation and the efficiency of the gear (Sanders and Morgan, 1976). The indicator of effort used in this study is in accord with this procedure. We have used the unit of effort known by the FWD as "effort A". This unit is defined as the number of hauls multiplied by dredge width and divided by one hundred. Effort measured in this unit has been collected by the FWD from records supplied by the fleet since the beginning of the fisheries. Because it attempts to measure the area swept by the dredges, effort A accounts for some of the differences in fishing power between scallop vessels. Indicators of effort which are more easily measured, such as hours fished or number of hauls, do not have this advantage.

The objective of the economic analysis was to find the quantities of effort and catch which maximize resource rent. In this simple form of static analysis resource rent was defined as the total revenue earned by the fishery (price times yield) minus the total social cost. Maximum resource rent occurs when marginal revenue equals marginal cost. It was assumed that the Victorian scallop fisheries face a perfectly elastic demand schedule for the following reasons. Firstly, there are many substitutes for scallops including oysters, lobsters, prawns, mussels and the more expensive cuts of meat. Secondly, Victoria produces around 60 per cent of Australian production and prices generally are determined on the world market. To test the sensitivity of the results three prices are used: \$2.50/kg, \$3.00/kg and \$3.50/kg. At the present time the price is about \$3.30/kg. It was considered that available data do not permit more refined analysis using less elastic demand, other objectives (Copes, 1972), and incorporating time (Clark, 1976). The objective of maximizing resource rent may be implied within the managers' set of objectives. Except for sustainable yield their other objectives cannot be quantified.

THE COST OF FISHING EFFORT

Debate exists as to the shape of the cost of effort curve for a marine fishery. Some writers assume that all inputs which comprise fishing effort are in perfectly elastic supply. In this case the cost of effort curve for the fishery would be linear and it would pass through the origin (Gordon, 1954; Tomkins and

Butlin, 1975). Other writers argue that the function should have a steadily increasing slope because ever-increasing rewards will be needed to lure away and retain labour and capital from alternative employment (Turvey, 1964; Copes, 1970). While the logic of this argument is appealing, to estimate such functions for the Victorian scallop fisheries would require detailed knowledge of the changes in the alternative earnings of labour and capital which may be attracted to the fishery, a task beyond our ingenuity. Griffin, Lacewell and Nichols (1976) have argued the case for a cost of effort function which exhibits a decreasing slope because fishermen's total costs contain some costs proportional to catch and some costs proportional to effort. Therefore, the function relating total cost to effort will reflect partially the curvature of the yield function, although the above arguments about the effort proportional component are still relevant. In their study of the Gulf of Mexico shrimp fishery, Griffin et al. found that the results obtained from using a model which differentiated between these two types of costs were different from those obtained using a linear model. However, these differences depend on the inclusion of catch proportional costs which are independent of the price of fish. It can be shown that if the only catch proportional costs incurred are those that are proportional to the value of the catch, the optimal catch predicted by the "proportional" cost model does not differ from that of the linear model (Belin, 1978, p.129). Because scallop fishermen incur "catch proportional" costs which depend on the value of the catch only (crew costs),[2] a linear cost of effort function was used. This may be written:

$$(1) \qquad TC_i = zE_i$$

where TC is the total cost of fishing in year i, E is the efort in year i and z is a constant. To estimate z a survey of scallop fishermen was conducted.

Because the number of holders of Victorian scallop licence is 113 it was considered feasible to attempt to interview them all. After accounting for those fishermen who did not fish during the survey period (29), were untraceable (24), who did not wish to particpate in the survey (29), or were unable to supply useful information (4), records for 27 boats were obtained. We attempted to obtain cost and income information from the interviewees for the three financial years 1973/74, 1974/75 and 1975/76. However not all of the 27 surveyed boats fished in every one of these years so that the number of boat-year observations totalled only fifty-two. Of these only 42 could be used to estimate unit costs of effort because ten observations were for boats which fished at both localities in the one year. This left 32 observations for the PPB fishery and 10 for the LE fishery.

Some of the reasons for non-participation require further comment. When licence holders live at localities around the perimeter of Port Phillip Bay or at Lakes Entrance, and their occupation involves movement, it becomes a difficult task to make contact with them. The fact that many boats changed hands during the survey years and that many of the previous owners had changed addresses exacerbated this problem. Included in the group which did not wish to participate were licence holders/skippers who showed no interest; those who felt that the survey was an invasion of privacy; and those who insisted that individual boat records were hidden in the aggregate costs of a larger firm and hence unobtainable. Although a Greek language interpreter was used on some occasions during the PPB part of the survey, language difficulties frequently prevented a successful interview. Apparently some people thought the interviewer was a taxation investigator. This attitude was hard to overcome resulting in further unsuccessful interviews. Twenty-nine people stated that they did not fish for scallops during the survey years. Some of these were probably exaggerating to avoid the formality of continuing with the interview. Finally, there was the small number of cases (4) where the interviews themselves were successful but the financial records were too confused by frequent changes of ownership to be useful.

There is a possibility that bias may have arisen as a result of the low number of successful interviews, particularly because of the relatively low number of interviews (for all the above reasons) with licence holders/skippers of Greek origin. Using the loose criterion of counting the names on the licence forms which seemed Greek, the proportion of Greek fishermen in the population was about 35 per cent, or twice the frequency in the survey. There is, however, no evidence to suggest that Greek fishermen, untraceable fishermen, or unco-operative fishermen operate differently from the remainder of the fleet. Nevertheless, the cost figures derived from the survey must be treated cautiously. Where necessary the sensitivity of the results to changes in the cost of effort is investigated.

To obtain a total cost for each boat-year observation it was necessary to make an allowance for the opportunity costs of labour and capital. The capital values of boats and equipment were the depreciated values of replacement costs measured in 1975/76 dollars. Depreciation schedules were estimated using the straight line method and the average life expectancies of the various types of equipment. The opportunity cost of capital was assumed to be 10 per cent per annum. Where a skipper was employed the payment made for his services was used for the opportunity cost of labour and management, otherwise $8,828 p.a. was used. This figure was the average annual earnings per employed male unit in Australia during 1975/76 (Australian Bureau of Statistics, 1976). To express all costs in 1975/76 dollars various indices of the aggregate Index of Prices paid by farmers (Bureau of Agricultural Economics) were used.[3]

Records of the effort expended by each boat were obtained from the FWD. Using these data it was possible to estimate the unit cost of effort for each fishery by adding all costs incurred by the sample fleet and dividing by the aggregate amount of effort. These estimates were $56.20 per unit of effort A for the PPB fishery and $111.70 per unit of effort A for the LE fishery.

The twofold difference in these units costs is attributable to higher costs in the LE group for the following items - crew payment, food for the crew, insurance, fuel and oil, repairs and maintenance and depreciation. Because crew costs are proportional to catch this item of cost is higher for the LE group because of higher catches. Greater insurance protection is used because of the possibility of losing a vessel in the rough conditions of Bass Strait and because of the dangers in traversing the sandbar at the entrance to the Gippsland Lakes. The greater size of the vessels in the LE group compared with the PPB group (13.1 m and 11.4 m respectively), longer travelling times, and ocean conditions help to explain the higher costs for fuel and oil, repairs and maintenance and depreciation.[4]

YIELD-EFFORT FUNCTIONS AND OPTIMAL EFFORT

Methods and Data

The basic assumption used to obtain sustainable yield curves was that catch is a function of population and effort, that is,

$$Q_i = g(x_i, E_i) \tag{2}$$

where x_i is the population at the beginning of month i, Q_i is the catch, and E_i is the total effort used in month i. The simplest form, and that usually suggested, for equation (2) is:

$$g(x_i, E_i) = x_i q E_i \tag{3}$$

where q is the constant of proportionality or the "catchability coefficient" (Clark, 1976, p.14). If the time between observations of Q and E is sufficiently large the population may change, causing (3) to predict unrealistically high catches when effort is high. A comparison of equation (3) with the exponential relationship $g(x_i, E_i) = x_i \ (1 - \exp(-qE_i))$ indicated that constant catchability was a reasonable assumption for the range of effort observed in the monthly data.

The change in the population each month was predicted using an hypothesised growth function and the current month's catch:

$$x_{i+1} = x_i - Q_i + f(x_i) \tag{4}$$

where f(x) is the hypothesised growth function. This difference equation is the discrete time analogue of the differential equation which describes the underlying process of growth and fishing in continuous time. Three forms of the growth function were used:

$$\text{Model 1:} \quad f(x) = xr(1 - x/K) \tag{5}$$

$$\text{Model 2:} \quad f(x) = nx^{m+1} - sx^2 \tag{6}$$

(7) Model 3: $f(x) = r(1 - x/K)$

Model 1 is the usual logistic growth function and model 2 is the generalized form of the von Bertalanffy growth function. Model 2 reduces to model 1 when $m = 0$. For all forms of the growth functions the population existing prior to fishing (x^*) can be predicted by solving the equation $f(x^*) = 0$, $x^* > 0$.

The first two models predict low net growth for populations which are either small or close to the maximum. Maximum growth, corresponding to the maximum sustainable yield, falls somewhere between these extremes. The assumptions which produce these effects are that growth is slow at low populations due to a shortage of breeding stock and due to a depletion of resources, such as food supply, at high populations. If $-1.0 \leqslant m < 0$ in model 2, the net growth does not decline to zero as population falls but approaches an asymptote. This implies that the population is able to regrow to a given size in a given period regardless of the reduction of initial size (Pella and Tomlinson, 1969).

When performing the regression with model 2 the estimate of "m" was found to be less than -1.0 (see below), resulting in a sustainable yield curve which is unbounded, that is, a maximum sustainable yield does not exist. While this is unsastisfactory for predictions of maximum sustainable yield, the curve is reasonable in the region of the observed data and so may provide useful information for management. This problem with model 2 and the intractable behaviour of the estimating equation (see appendix) suggested model 3. The important biological characteristic of model 3 is that the carrying capacity of the environment, expressed by K, is the only regulator on growth. As the population approaches K, growth approaches zero; growth approaches a maximum (r, the maximum sustainable yield) as the population approaches zero. Thus, the sustainable yield curve is asymptotic and the model predicts that fishing cannot exterminate the population although it may be greatly reduced in size. A nonlinear version of model 3, namely $f(x) = r[1 + (x/K)(m-1) + x^2m/K^2]$, was also tested. All meaningful values of "m" were found to be consistent with the observations, thus "m" could not be determined.

The data used in the analysis were the monthly totals of catch (flesh weight) and effort A from the beginning of each fishery to June 1977. These data were obtained from FWD records which are compiled from fishermen's returns. For ease of presentation, table 2 and figures 1 and 2 show the annual aggregates of catch and effort for each fishery. The early years of PPB show the harvesting of a previously unexploited stock with rapidly increasing quantities of effort. The marked decline in catch per unit of effort during those years indicates that the population was being depleted, and that the observed catches were far from sustainable.

Catch throughout the life of the fishery was predicted by up-dating the estimate of the population each month using equation (4). In this process catch was predicted from the old population and the growth by $f(x)$. The parameters of the growth function were estimated by regressing the predicted catches against the actual catches. This non-linear regression was carried out on Melbourne University's Cyber computer using the Fletcher-Powell subroutine of the International Mathematical and Statistical Library. The vector of parameters (β) and x^* for each of the growth functions are:

Model 1: $\beta = (q,r,K)$, $x^* = K$

Table 2. Catch and effort data for the Victorian scallop fisheries

Observ'n number	Year	Catch (kg)	Effort A	Catch/Effort A
Port Phillip Bay fishery				
1	63/64	727 826	7 989	91.1
2	64/65	1 370 064	19 391	70.7
3	65/66	1 744 398	34 875	50.0
4	66/67	2 008 856	65 085	30.9
5	67/68	1 916 821	114 406	16.8
6	68/69	679 270	71 116	9.6
7	69/70	286 143	48 864	5.9
8	70/71	18 406	3 140	5.9
9	71/72	138 980	8 029	17.3
10	72/73	977 390	30 140	32.4
11	73/74	813 932	34 044	23.9
12	74/75	219 288	14 874	14.7
13	75/76	78 027	5 064	15.4
14	76/77	330 191	19 244	17.2
Lakes Entrance fishery				
1	70/71	640 797	21 635	29.6
2	71/72	1 015 882	30 935	32.8
3	72/73	906 063	18 546	48.9
4	73/74	294 366	7 487	39.3
5	74/75	341 752	11 578	29.5
6	75/76	663 897	17 966	37.0
7	76/77	230 575	5 960	38.7

Model 2: $\beta = (q,s,n,m)$, $x^* = (s/n)^{1/(m-1)}$

Model 3: $\beta = (q,r,K)$, $x^* = K$

Examination of the series of residuals for all models indicated strong autocorrelation (between 0.8 and 0.9) which would invalidate the assumptions underlying the determination of confidence intervals (appendix). To correct for this autocorrelation the variables were transformed by constructing a new series of residuals (v_i) using the relationship $v_i = u_i - \hat{\rho}u_{i-1}$, where u_i is the residual in month i and $\hat{\rho}$ is the estimated correlation coefficient. Each model was fitted again with this transformation to estimate the parameters and the confidence intervals. This procedure for correcting autocorrelations may be subject to bias and the results cannot be guaranteed. However, we believe that some confidence is restored because there was little difference between the estimated parameters in the two stages, the confidence intervals with the transformed variables were more conservative, and the autocorrelation in the transformed residuals was reduced to between 0.1 and 0.2.

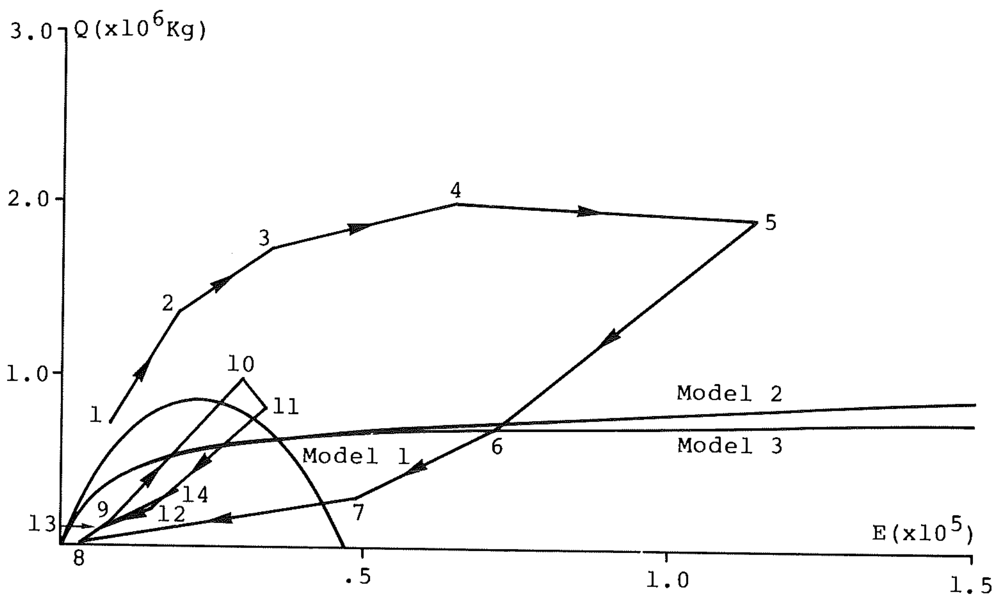

Figure 1 : PPB Catch and effort by year, and the estimated sustainable yield curves.

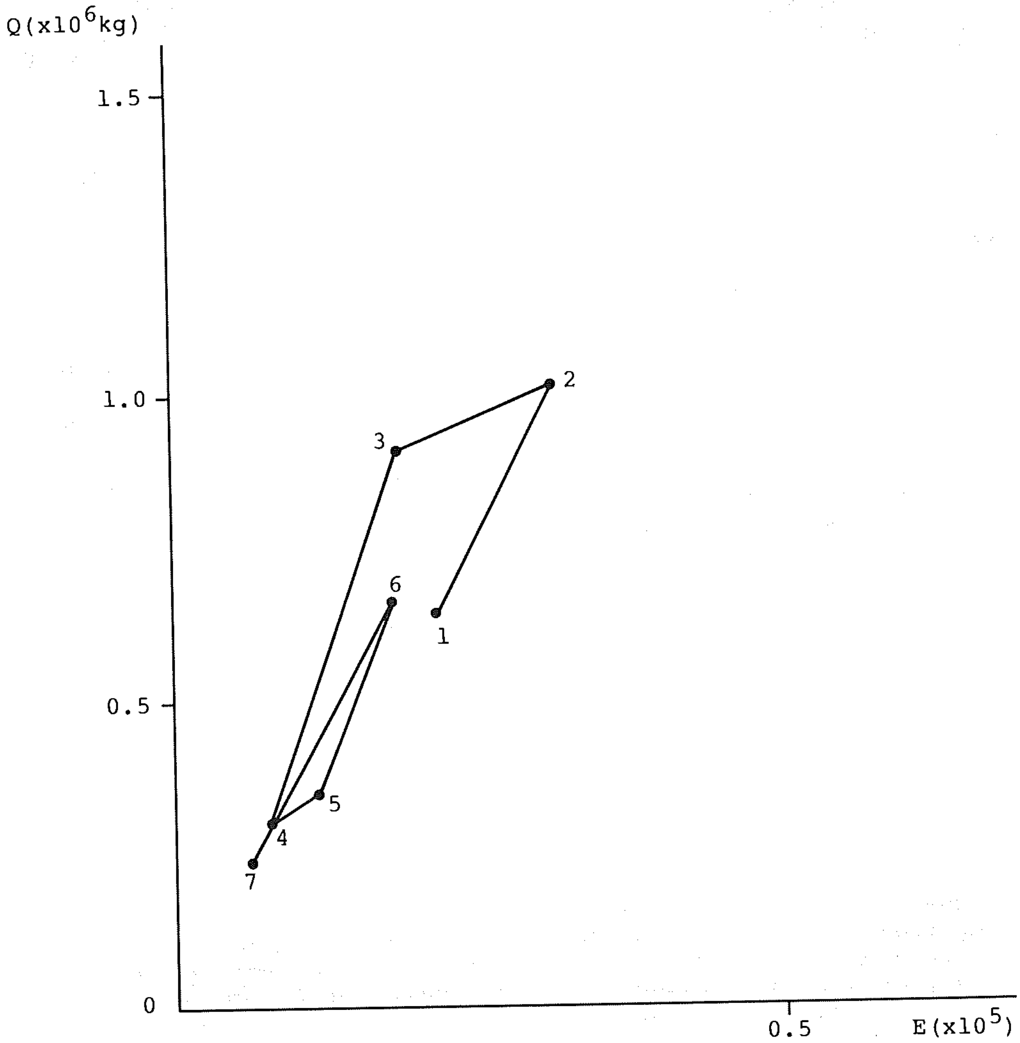

Figure 2 : LE catch and effort by year

Using the estimated parameters of the growth functions the sustainable yield curves were obtained by setting population change to zero and postulating a constant effort. This amounts to finding a size of population for which the rate of growth equals the rate of catch. Population is eliminated using equation (3) to give a yield-effort curve $Q = Q(E)$. For example, with model 1:

(8) $$rx(1-x/K) = Q = xqE$$

For $x \neq 0$, this can be re-written as:

(9) $$r(1 - x/K) = qE$$

Re-arranging gives:

(10) $$x = K(1 - qE/r)$$

Therefore:

(11) $$Q = Q(E) = K(qE)(1 - qE/r)$$

Equation (11) is a quadratic in qE. This quantity can be thought of as the proportion of the population caught. The sustainable yield curve has a maximum value of $Q = rK/4$ at $E = 1/2q$. Model 2 allows only numerical solution but the same mathematics apply.

Port Phillip Bay Fishery

The estimated parameters for <u>model 1</u> were:

$K = 6.268 \times 10^6$ $(5.290 \times 10^6$ to $7.293 \times 10^6)$

$q = 1.161 \times 10^{-5}$ $(0.950 \times 10^{-5}$ to $1.395 \times 10^{-5})$

$r = 0.046$ (0.035 to 0.058)

where the figures in parentheses are the 95 per cent confidence intervals for the parameters. To give an indication of the goodness of fit the standard error of the regression equation was computed. This figure is the standard deviation of the actual observations of catch from the predicted values and can be interpreted as an average error in predicting Q from the regression equation. The standard error of the regression for model 1 was 0.417×10^6 kg.

The sustainable yield curve resulting from model 1 is shown in figure 1. The maximum sustainable yield is 0.8586×10^6 kg per year $(0.7196 \times 10^6$ to $0.9836 \times 10^6)$ at 0.2360×10^5 units of effort A per year $(0.2010 \times 10^5$ to $0.2786 \times 10^5)$. Combining this sustainable yield curve with the cost of effort function (equation 1) permits determination of the maximum resource rent and the corresponding quantities of catch and effort. Resource rent (RR) may be written:

(12) $$RR = P.Q(E) - zE$$

where P is the price per kg of scallop flesh.

Maximum resource rent occurs when:

(13) $$Q'(E) = z/P$$

For model 1 the solution to equation (13) can be found explicitly as:

(14) $$Q'(E) = (-2K/r)(qE)(1-qE) + Kq(1-qE) = z/P$$

On re-arrangement equation (14) yields:

(15) $$qE = (2/r + 1 - ((2/r-1)^2 + (8z/P)/(rqK))^{1/2}) / (4/r)$$

The results obtained when equation (15) is solved for E, and the corresponding values of catch (Q) and resource rent (RR), are set out in table 3 for a range of prices and costs of effort. The width of the confidence intervals for E* and Q* indicate that these quantities are not highly predictable with this model. Therefore, the results suggest that "fine-tuning" in the allocation of effort to this fishery is not possible using past catch and effort data and a logistic model. However, there are some interesting features of the results. Firstly, the optimal quantities for the variables of interest are relatively insensitive to changes in price and cost over the indicated ranges. For example, for a cost of $56.20/unit effort a 40 per cent increase in price ($2.50 to $3.50) gives a 13 per cent change in E* and a five per cent change in Q*. Similarly, for a price of $3.50/kg, a 33 per cent increase in cost ($56.20 to $75.00) gives a 10 per cent change in E* and a four per cent change in Q*.

Secondly, using the average effort A per boat since the beginning of this fishery (494 units), it is possible to gain a rough estimate of "optimal" number of boats. The boat numbers shown in table 3 have been calculated at E* for each cell in the table. At all combinations of price and cost the boat numbers are markedly below the number presently entitled to fish PPB, namely 79. This remains true after allowing for the confidence intervals around the E* values. The highest upper-limit to the confidence intervals on effort occurs at a price of $3.50/kg and a cost of $56.20/unit effort, this value (0.2107×10^5) would suggest about 43 boats. Since the time of the survey, costs (noticeably fuel) have risen and price has been around $3.50. Therefore, taking $75.00/unit effort and $3.50/kg as indicative of present conditions, model 1 suggests that the "optimal" number of boats lies between 29 and 38, with the best estimate being about 34.

The estimated parameters for <u>model 2</u> were:

$q = 1.186 \times 10^{-5}$ (9.621×10^{-6} to 1.435×10^{-5})

$s = 6.203 \times 10^{-10}$ (3.636×10^{-10} to 1.102×10^{-9})

Table 3. Best operating conditions: Port Phillip Bay Model 1

Cost of effort ($/unit A)	Price ($/kg) 2.50	3.00	3.50
56.20	E* = 0.1631 (0.1412 to 0.1848) Q* = 0.7766 (0.6377 to 0.9064) RR*= 1.0249 B = 33	E* = 0.1752 (0.1506 to 0.1998) Q* = 0.8017 (0.6632 to 0.9296) RR*= 1.4205 B = 35	E* = 0.1840 (0.1580 to 0.2107) Q* = 0.8168 (0.6784 to 0.9438) RR*= 1.8247 B = 37
65.00	E* = 0.1517 (0.1299 to 0.1711) Q* = 0.7489 (0.6090 to 0.8809) RR*= 0.8862 B = 31	E* = 0.1657 (0.1424 to 0.1879) Q* = 0.7825 (0.6437 to 0.9118) RR*= 1.2705 B = 34	E* = 0.1758 (0.1511 to 0.2004) Q* = 0.8027 (0.6642 to 0.9305) RR*= 1.6668 B = 36
75.00	E* = 0.1387 (0.1182 to 0.1564) Q* = 0.7127 (0.5704 to 0.8479) RR*= 0.7415 B = 28	E* = 0.1549 (0.1330 to 0.1750) Q* = 0.7572 (0.6176 to 0.8885) RR*= 1.1099 B = 31	E* = 0.1666 (0.1430 to 0.1889) Q* = 0.7842 (0.6454 to 0.9132) RR*= 1.4952 B = 34

* Indicates optimal quantities. Units are: E(effort $Ax10^5$), Q($kgx10^6$), RR($\$x10^6$), B(boats), RR is evaluated to E*Q*; B is an approximation of E*. The figures in parentheses are the 95 per cent confidence intervals.

$$n = 3.463 \times 10^6 \quad (1.192 \times 10^4 \quad \text{to} \quad 1.747 \times 10^7)$$

$$m = -1.295 \quad (-1.422 \quad \text{to} \quad -0.903)$$

where the figures in parentheses are the 95 per cent confidence intervals. The standard error of the regression for model 2 was 0.318×10^6 kg. Although the error of prediction is lower with this model than with model 1, the behaviour of the sustainable yield curve ($m < -1.0$) suggests that it is not a satisfactory model for this fishery. Table 4 shows the optimal quantities of effort and catch at the selected costs and prices. These figures are shown without confidence intervals because of the behaviour of the estimating equation (appendix). The confidence intervals for a price of \$3.50/kg and a cost of \$75.00/unit effort were investigated in detail by the searching procedure and found to be 0.0565×10^5 to 0.1277×10^5 for effort ($E^* = 0.0843 \times 10^5$) and 0.2363×10^6 to 0.6110×10^6 for catch ($Q^* = 0.3740 \times 10^6$).

The slope and position of the sustainable yield curve (figure 1) produce smaller quantities for optimal effort and catch than model 1. Thus, for example, the number of boats indicated by model 2 for the highest cost and highest price is between 12 and 22 with the best estimate being 17.

The estimated parameters for model 3 were:

$$K = 7.270 \times 10^6 \quad (6.411 \times 10^6 \quad \text{to} \quad 8.341 \times 10^6)$$

$$q = 1.188 \times 10^{-5} \quad (9.821 \times 10^{-6} \quad \text{to} \quad 1.451 \times 10^{-5})$$

$$r = 6.524 \times 10^4 \quad (5.025 \times 10^4 \quad \text{to} \quad 8.144 \times 10^4)$$

The standard error of the regression was 0.0315×10^6. This represents an improvement of 25 percent compared with model 1 which has the same number of parameters. Model 3 has about the same standard error as model 2 but fewer parameters. The sustainable yield curve on an annual basis is shown in figure 1; the maximum sustainable yield is 0.7829×10^6 kg (0.603×10^6 to 0.977×10^6). The optimal quantities of effort and catch (table 5), like those of model 2, are about one-half of those suggested by model 1. For example, the number of boats indicated by model 3 for the highest price and highest cost is between 14 and 23, with the best estimate being 18. The nature of the sustainable yield curve for model 3 gives slightly greater sensitivity of optimal effort to changes in the cost-price ratio than model 1.

Lakes Entrance Fishery

The catch and effort data for LE are such that it is not possible to obtain sensible estimates of the sustainable yield curve. Experimentation with the models used for PPB produced maximum sustainable yields and economic optima which were so large that the degree of extrapolation from the data points makes

Table 4. Best operating conditions: Port Phillip Bay Model 2

Cost of effort ($/unit A)	Price ($/kg) 2.50	3.00	3.50
56.20	E* = 0.0805 Q* = 0.3658 RR* = 0.4619 B = 16	E* = 0.0955 Q* = 0.3965 RR* = 0.6526 B = 19	E* = 0.1098 Q* = 0.4212 RR* = 0.8573 B = 22
65.00	E* = 0.0697 Q* = 0.3395 RR* = 0.3958 B = 14	E* = 0.0834 Q* = 0.3721 RR* = 0.5741 B = 17	E* = 0.0963 Q* = 0.3979 RR* = 0.7668 B = 19
75.00	E* = 0.0598 Q* = 0.3120 RR* = 0.3314 B = 12	E* = 0.0725 Q* = 0.3468 RR* = 0.4965 B = 15	E* = 0.0843 Q* = 0.3740 RR* = 0.6769 B = 17

* Indicates optimal quantities. Units are: E(effort $A \times 10^5$), Q($kg \times 10^6$), RR($\$ \times 10^6$), B(boats), RR is evaluated to E*Q*; B is an approximation to E*.

Table 5. Best operating conditions: Port Phillip Bay Model 3

Cost of Effort ($/unit A)	Price ($/kg) 2.50	3.00	3.50
56.20	E* = 0.0870 (0.0670 to 0.1085) Q* = 0.3834 (0.2933 to 0.4782) RR*= 0.4694 B = 18	E* = 0.1040 (0.0799 to 0.1300) Q* = 0.4182 (0.3208 to 0.5204) RR*= 0.6702 B = 21	E* = 0.1196 (0.0918 to 0.1499) Q* = 0.4453 (0.3419 to 0.5536) RR*= 0.8866 B = 24
65.00	E* = 0.0746 (0.0574 to 0.0928) Q* = 0.3533 (0.2693 to 0.4418) RR*= 0.3986 B = 15	E* = 0.0903 (0.0695 to 0.1127) Q* = 0.3907 (0.2990 to 0.4870) RR*= 0.5851 B = 18	E* = 0.1048 (0.0806 to 0.1310) Q* = 0.4199 (0.3221 to 0.5224) RR*= 0.7882 B = 21
75.00	E* = 0.0632 (0.0486 to 0.0784) Q* = 0.3215 (0.2437 to 0.4040) RR*= 0.3300 B = 13	E* = 0.0778 (0.0600 to 0.0966) Q* = 0.3617 (0.2760 to 0.4519) RR*= 0.5013 B = 16	E* = 0.0913 (0.0703 to 0.1140) Q* = 0.3929 (0.3007 to 0.4896) RR*= 0.6901 B = 18

* Indicates optimal quantities. Units are: E(effort $A\times10^5$), Q($kg\times10^6$), RR($\$\times10^6$), B(boats), RR is evaluated to E*Q*; B is an approximation of E*. The figures in parentheses are the 95 per cent confidence intervals.

them highly uncertain. The confidence intervals around these estimates were so wide that they could not be computed. There are several possible reasons for these results. Firstly, there are relatively few observations with which to work. Secondly, the range of observations is relatively small, reflecting the controls which have been operating on this fishery since it commenced. Thirdly, there is a set of reasons for believing that the assumptions of the models do not apply to this fishery in aggregate. Principal amongst these is that the LE fishery is dispersed over a wide area. It is possible that these grounds are not based on a distinct self-sustaining unit but represent separate populations. If this were true then those populations would need to be modelled separately, but models like those used for PPB would not be appropriate if there were significant migration between those populations (Pella and Tomlinson, 1969, pp.425-427).

Summary and Implications

The results of all three models support the hypothesis that the amount of fishing effort which can be expended in PPB remains excessive. While the confidence intervals attached to the estimates of catch and effort for all models strengthen this support they also indicate that "fine tuning" of the fishery may not be possible with static models which rely on catch and effort data alone. A serious problem for the managers is that the optimal quantities of catch and effort are far more sensitive to the form of the growth function than to changes in the cost-price ratio. This is evident when the results of model 1 are compared to those of models 2 and 3. Even though models 1 and 3 have different postulates about the growth of the population it is difficult to choose between them on <u>a priori</u> grounds. Model 1 has the comfort of convention while <u>model 3</u> may be consistent with the scallop's method of reproduction and the observation that recruitment is variable. In the event, when the standard error of regression was used as the criterion, model 3 best fitted the data. These results indicate the importance of biological information which will help to discriminate between these models or suggest better ones.

The hypothesis of excess effort in the LE fishery can be neither confirmed nor rejected. A previous study by one of us (Belin 1978) argued that effort was excessive. However, in retrospect the assumptions of that analysis seem unrealistic. To the extent that separate populations are contained within the LE fishery, a more detailed analysis of catch and effort data by fishing area may be useful.

A MANAGEMENT STRATEGY FOR THE FUTURE

In this section we do not consider all the possible methods of managing the fisheries. The authorities have chosen to limit entry by licencing boats as a means of controlling fishing effort. Although this policy is relatively blunt and would need to be accompanied by some restrictions on the effort of individual boats, fishermen have come to accept it and, presumably, base their expectations on it continuing. As a result, radical departures from this scheme, such as an output tax or annual output quotas for individuals may be resisted by fishermen. Also major policy changes would require a cost-benefit analysis of the change-over. Such an analysis is beyond the scope of this paper, and except in the broadest qualitative sense may be beyond the limits of the available data. Indeed, the change-over costs would need to include the cost of obtaining appropriate data to implement any new policies, along with the costs of educating fishermen and the public, and differences in administration and enforcement costs. In the case of an output tax and two fishing grounds the cost of obtaining sufficiently accurate data, and developing models with superior predictive power to those discussed here, may be high relative to the other responsibilities of FWD and the small size of the scallop industry. Output taxes and quotas may be costly to enforce because of the relatively large number of processors and the proximity of a state border to the LE fishery. For these reasons we confine our attention to some modifications of the existing policy.

The major conclusion which emerged from our analysis is that the amount of effort which could be expended in PPB is in excess of that which maximizes resource rent. Our calculations with model 1 suggested that about 34 boats (less than half the present number) would be best in terms of that objective, and model 3 suggested about 18 boats. The following discussion uses the "conservative" result of model 1 by way of example. Implementation of our strategy will take time and this will allow further research on the population dynamics of the scallop. In the event that further reductions in effort are indicated by superior models (say, model 3) no structural change is required in the proposed policy.

If the number of boats operating in PPB were reduced to 34 the effect on resource rent at LE of the remaining 79 licenced boats is not known with similar confidence. Nevertheless there is evidence to suggest that the two fisheries have different capacities to produce rent and, therefore, ought to be managed separately. This cannot be achieved while the three types of licence exist.

In 1976 the Fisheries Management Committee suggested a solution to the problem of the three types of licences. All licences were to be converted to the all Victorian waters type. Every year a licencing panel would allocate boats to each fishery according to the owners' preferences. The numbers allocated to the fisheries would depend upon the results of annual surveys of the fishing grounds and up-to-date statistical information on catches and incomes. In the likely event that more fishermen preferred one fishery than the number the panel would permit, allocation would take place on the "relative merit" of fishermen. Merit would be assessed by a point score with high points for a place of residence near the preferred fishery, a long period of fishing on the preferred ground, and length of time the fisherman had held a scallop licence. The allocation made by this process would be reviewed mid-way through each year and altered if necessary. For unknown reasons this proposal, which again emphasises the philosophy of historical access and preserving the status quo, has not been implemented. Beside appearing to need considerable administration, the proposal left unresolved the question of the total quantity of fishing effort for both fisheries. Although this proposal involved only one type of licence it would have led to separate management because any movement between the fisheries was under the control of the administrators.

Our proposal to achieve separate management without the need for administrative allocation is:

* to create two classes of licence - PPB only and LE only,

* to allow existing fishermen free choice of their permanent fishery,

* to make licences freely tradeable,

* to create a "buy-back" authority with the power to purchase and dissolve licences in each fishery.

This strategy, which is a small adjustment in current practice, formalizes the de facto market in licences and offers the means to affect the long-term quantity of effort in each fishery without complete reliance on regulatory devices, such as daily quotas and closed seasons.

In the first instance, the holders of all Victorian waters licences would be permitted to choose the fishery in which they were to remain. In fact, given that few of the two resident groups would be likely to change, there is no reason why this choice could be not be extended to all fishermen. Allowing fishermen to choose their fishery probably will mean that more than the optimal number would choose PPB - hence the buy-back authority. This arrangement seems more equitable than allocating 34 boats to that fishery by a merit system. An alternative approach might be to auction 34 licences to an audience of all licenced fishermen. In this case the offer prices of successful bidders would be influenced by their expectations of the additional rent to be earned by the smaller number of boats. Given the imperfect knowledge of the fisheries this alternative may reduce the flexibility of the managers in future years. The more gradual approach suggested above permits the market, including the authority, and the managers' researchers to accumulate and utilize additional information. Any subsequent movement of fishermen between the fisheries would require the purchase of a licence for that fishery on the open market. Given that the de facto market in licences has not given rise to monopoly control there appears to be no reason to prevent the acquisition of more than one licence either within or between fisheries.

Making licences transferable would formally acknowledge that the first generation of licenced fishermen have been given their perception of the capitalized rent of the fishery for the given amount of licenced effort. However, as mentioned earlier, the relatively small amounts of money involved and the existence of the informal market make this an insignificant problem. When fishermen made their choice of fishery and the market began to operate it is likely that the value of the licences will alter. The extent of this alteration is difficult to predict but a likely result is that the value of PPB licences would rise and the value of LE licences would fall. As a result some fishermen, particularly those who had previously purchased all Victorian water licences, may feel aggrieved. Two reasons suggest that this problem need not be taken too seriously. Firstly, the amounts of money involved are likely to be small. Secondly, it is possible that, on average, holders of the all Victorian waters licences are the more efficient fishermen (Belin, 1978, chapter 6). Therefore, they may be more likely to remain in their chosen fishery and benefit as a result of the activities of the buy-back authority. In any case, changes in policy are one of the inevitable risks associated with the purchase of any asset.

Vigorous activity by the buy-back authority in PPB offers the facility to reduce the total effort in the fisheries. Because boats and licences would be tradeable separately the authority would need only to trade in licences. This seems feasible in this industry because the value of the boat was high relative to the value of a licence at the time of the survey. Since the survey licence values have increased but the same relationship with boat values exists. Therefore, in the short-term at least, scallop fishermen selling their licences should have little difficulty in disposing of their boat if they wish to do so. Scallop boats are not highly specialized in their design; in fact, older boats were converted from use in other fisheries. Similarly there was no evidence from the survey to suggest that the majority of fishermen are locked into the scallop fisheries because they lack skills which could give them occupational mobility. Some worked in other fisheries as well as scallops, many had trade skills, and some had businesses of which scallop fishing was a part.

The analysis of price in a licence market with a small number of potential sellers, an unknown number of potential buyers and one large buyer (whose purchases alter the available supply and affect the income streams of all participants) remains an intriguing matter for further research. There does, however, seem good reason to suspect that the operation of the authority will be made easier by freely saleable licences compared to the situation where the authority was the sole potential buyer. Similarly, the tactics of the authority in the timing, size and means of announcing its bids, and the amount of information it should reveal about the fisheries and its own intentions, are not immediately obvious. The effects of these variables on the operation of the market through time are researchable topics. There seems to be no set of possible answers to these questions which negates the idea of a market with a supply-influencing agent. Neither is it necessary to await definite answers before creating the market, indeed the answers may be expected only by studying the market in operation.

As the number of boats was reduced the remaining fishermen in each fishery would benefit from a greater share of the increasing rent. For example, the results of model 1 for PPB with a price of $3.50/kg, a cost of $75.00/unit effort and 34 boats, suggest that the average rent per boat would be about $44,000 per year. As this number of boats was approached there would be a considerable burden on the coffers of the authority. Also, in terms of income distribution, scallop fishermen would be seen to be privileged at the community's expense. These are good reasons for suggesting that remaining fishermen pay higher licence fees as the number of licences is reduced and that this intention be announced at the start of the programme. In the final analysis any changes in licence fees will be the result of a value judgement by the managers. By that judgement will be affected not only the rent acquired by the state, but also the prices of licences, and the wealth and income of scallop fishermen. Licence fees are levied according to the width of the dredge. Given that it would be impossible to police a fee based on the number of hauls and dredge width (both components of "effort A"), continuing to levy a fee on the latter component of fishing power is a sensible, although not necessarily a "best" approach. Manipulation of this fee may permit some rationalization of the controls on the effort of boats. For example, a sliding scale of fees in relation to dredge width may permit technical advance in dredge design which is prevented by the present limitation on dredges greater than 3.36 m in width. By itself, a policy of higher fees for dredges greater than this limit would encourage longer fishing hours and more hauls. Therefore the night-time embargo on fishing would need to continue. In the long term a reduction in the number of boats and such a change in the structure of fees could reduce, if not eliminate, the need for bag limits and closed seasons.

The far greater uncertainty about the response of sustainable yield to effort in the LE fishery suggests that the buy-back authority may be less vigorous in that fishery than in PPB. The licence values determined by the market, more detailed analysis of the catch-effort data by fishing area, and time will help it to formulate strategies for that fishery.

The managers' concern for the "satisfactory" incomes of fishermen will require careful scrutiny under separate management. If the managers were to be concerned about the distribution of income between the two fisheries, licence fees would be an important variable, given different capacities of the fisheries to generate rent. The only way to guarantee equality of incomes and to maximise the community's benefit would be for the managers to extract all the rent through unequal fees. If some rent were to be left to fishermen then all could be extracted and redistributed between the fisheries in some appropriate form, or licence fees could be manipulated further.

CONCLUDING COMMENTS

The choice of a management regime for a fishery will depend upon the objectives of the managers. This paper has reviewed the stated objectives of the managers of the scallop fisheries and found them to be difficult to interpret. The policy which has resulted from these objectives has emphasised control of the fleet's effort with little attempt to influence the size of the fleet.

The Fisheries Management Committee indicated that a reduction in the number of licenced scallop boats might be desirable (Fisheries Management Committee, 1977). However, their conviction that scallop populations are inherently unstable has prevented them from specifying any "right" number. Our study has confirmed that scallop production and populations are difficult to predict. However, using maximum resource rent as an objective, our study appears to confirm the managers' suspicion that there are too many boats - at least in the Port Phillip Bay fishery. As an upper limit it has been suggested the appropriate number lies between 29 and 38 with our best estimate being 34. No such recommendations can be made for the Lakes Entrance fishery at this stage.

Our suggestion for a means of achieving this reduction is based on separate management of the fisheries, saleable licences and an authority to buy and dissolve licences. This proposal would formalize the de facto market for licences and allow a reduction of effort in the long-term.

Although some controls on the effort per boat would need to continue this proposal may allow the set of controls to be reduced. By adjusting the licence fees resource rent may be distributed between government and fishermen as desired.

"Satisfactory incomes" seems to be one of the important objectives put forward by the managers. The meaning of this objective remains unclear and from a purely economic point of view it may be inappropriate to be concerned with ensuring "satisfactory incomes" for fishermen. Our proposals would leave unchanged the managers' options in relation to this objective.

NOTES

1. "Transfers" of licences must be approved by the Director of the FWD and in most cases approval is obtained. Technically, a "new" licence is issued to the purchaser of the boat. Most sales of boats are probably conditional on such approval being obtained.

2. In many fisheries, including the scallop fisheries, most crews are paid a share of the value of the catch.

3. In Australia there are no indices available which reflect movements in the prices paid by fishermen. It seems reasonable to believe that there is a close correlation between price movements in fishing and farming.

4. The average net incomes were $7,707 for the PPB group, $3,525 for the LE group and $8,605 for the group which fished both locations. After deducting allowances for the operator's labour and management the average percentage rates of return on capital were -0.5, -13.6 and +1.4 respectively. These rates of return are much less than those reported by Sanders and Sturgess (1968) for the PPB scallop fishery in 1964/65. Sanders and Sturgess reported their results for the following boat classes; under 36 feet, 36-40 feet, 41-45 feet and over 45 feet and the percentage rates of return were 24, 12, 27 and 11 respectively. These attractive rates of return explain why boat numbers rose rapidly in the first five years of the fishery. Conversely, the low rate of return for the PPB fishery from 1973/74 to 1975/76 helps to explain why the number of boats fishing was always less than the total number of eligibe boats. For further details of the costs and incomes of the surveyed fishermen see Belin (1978, Chapter 6).

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APPENDIX

The confidence intervals for the parameter estimates were obtained by extending standard procedures. This extension produces as asympotically exact confidence region for the parameters.

The basis of the procedure is that SSD (β) - SSD $(\hat{\beta})$ is distributed asympototically as $\sigma^2 \chi_p^2$, where β is the true parameter vector, $\hat{\beta}$ is the estimated vector, and p is the number of parameters (Shaw and Griffiths, 1979). If σ^2 is estimated by:

$$SSD(\hat{\beta})/(N-p),$$

where N is the number of years, then:

$$((SSD(\beta) \;-\; SSD\ (\hat{\beta}))/p)\ /\ (SSD(\hat{\beta})/(N-p))$$

is distributed approximately as $F_{p,N-p}$, thus defining a region of values of β for which the null hypothesis is accepted.

The confidence limits for a function of the parameters are given by the extreme values taken by the function over this region. The maximum and minimum of a function $P(\beta)$ are constrained extrema and were found by the algorithm of Nelder and Mead (1964) using a "soft" penalty function, namely:

$$5(SSD(\beta) \times \text{magnitude (gradient } P(\beta)))\ /\ \text{magnitude(gradient } SSD(\beta))$$

A step function was used for the confidence intervals on the parameters. There was evidence that the lower end of the confidence intervals for model 2 were approximate due to the existence of multiple local minima. This problem was overcome by searching the local minima using the final simplex as a guide to the constraint surface. This technique was found to be successful but very time consuming. For this reason only one set of confidence intervals was produced for the results of model 2. Models 1 and 3 did not have these computational problems.

PART III

MANAGEMENT PRACTICES IN SELECTED COUNTRIES

15

THE ALASKAN EXPERIENCE WITH LIMITED ENTRY

by

George W. Rogers

GENESIS OF THE ALASKAN PROGRAMME OF LIMITED ENTRY

The resource distribution and geographic characteristics of coastal Alaska had a strong influence in determining the technologies applied to and the organization of harvesting and processing in the Alaska fisheries. Alaska's social and economic conditions have determined the objectives of management. In combination with political, constitutional and legal institutions and systems, these physical and economic factors affected the form and nature of fisheries management in general and specifically the limited entry programme. Alaska had only recently (1959) achieved the status of being a full fledged "State of the Union" and with this acquired from the federal government full control over the management of fisheries within its territorial waters. The exercise of these powers, however, is constrained by constitutional provisions protecting the rights of non-Alaskan citizens of the United States. Beyond the territorial waters of Alaska, fisheries are under the jurisdiction of the federal government and state management must be co-ordinated with these programmes.

Because the programme was designed for a specific time and set of conditions, it is in many respects out of phase with today's conditions. The unstated assumption of the drafters of the 1973 Act was the economist's ceteris paribus, that all variables other than those addressed would remain constant. Failure to project change in the total context of the fisheries imposed a static approach on a dynamic situation. Dramatic rises in fish prices, which out-stripped general price inflation, extension of national territorial jurisdictions, and other external factors have altered the picture from that of the late 1960's for which the programme was designed.

FISHERIES RESOURCES, INDUSTRY TRENDS AND 1970 STATUS

Geographically the fisheries of Alaska extend in a curving path northwestward from the British Columbia coastal boundary, then south westward to around the Aleutian Islands, then northward to the Arctic Ocean. This is not a continuous environment but rather consists of a series of distinct regions or sub-regions, each with quite distinctive natural characteristics. The general Alaskan coastline is 6,640 miles (54 per cent of the total United States coastline) and the tidal shoreline (including islands, inlets and shoreline to the head of tidewater) is estimated at 47,300 miles. This coastline fronts on the North Pacific Ocean, the Bering Sea, and the Arctic Ocean, and is backed by a variety of land forms and river drainages that provide the spawning area and environment for the Pacific salmon in Alaska. The total land area of Alaska is 1,520,000 square km, stretching out between latitudes of 51° and 71° N and the meridians of 130° W and 173° E. The continental shelf off Alaska is about equal to its land-mass.

For management and statistical purposes, Alaska is divided into three regions - southeastern, central and western - and fifteen major areas, further subdivided into districts on the basis of resource location. The regional classification system shown in figure 1 is based upon a combination of these management units into regions embracing defineable local economies.

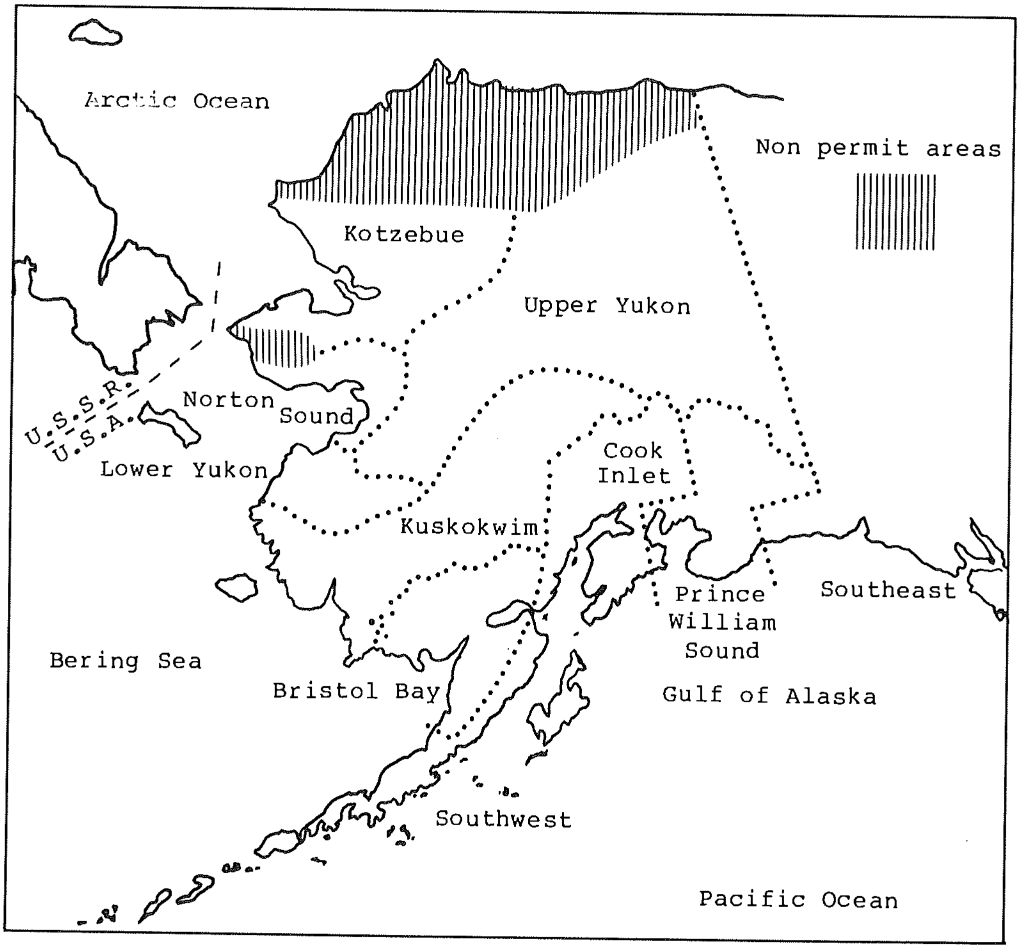

Figure 1 : Alaska, Geographic Regions

Pacific salmon has dominated the commercial fisheries. The resource is classified into five major species: red (sockeye), king (chinook), coho (silver), pink (humpback) and chum (keta). Each of these five major species has numerous racial variations in accordance with the districts, individual streams and spawning beds to which they are oriented. These variations include differences in size and other physical features, and differences in life cycles. Therefore, obtaining adequate biological knowledge of the salmon resource is not simply a matter of studying five species of fish, but an estimated 10,000 different biological units with little genetic interchange among them.

The 1970 commercial salmon catch by species and regions reflects the regional differences in resource availability and environment. Red salmon accounted for only 4.5 per cent of the total number of salmon taken in the south east region as compared with 93.9 per cent of the salmon taken in Bristol Bay that year. On the other hand, pinks accounted for 71.7 per cent of the south east catch and only 2.1 per cent of the Bristol Bay catch. Harvesting each district is by use of different combinations of seven major types of gear, each with different capital requirements, degrees of efficiency and effects upon the resource. In order of 1970 catch size, these were purse seines, drift gill nets, set gill nets, troll lines, beach seines, traps and fish wheels. The purse seine is the largest salmon operation, using a crew of five or more and vessels in excess of 50 feet in length. In contrast, gill net and troll gear tend to be one or two-man operations.

In 1970, Alaska continued to lead all other states of the union in value of commercial fish catch ($97.5 million). This harvest converted into fish products with a total value on the wholesale market of $213.9 million, giving commercial fisheries second place in the Gross State Product of natural resource products in 1970, topped only by crude oil and natural gas. Halibut has long been important and in the last two decades the harvest of shellfish has grown rapidly, but the position of Alaskan fisheries within the nation's fisheries and the state's economy has been and continues to be based primarily upon the harvesting and processing of salmon. In 1970 the value of the total salmon catch was $68.0 million, 70 per cent of the total value of fish caught, and the wholesale value of salmon products was $154.7 million, 72 per cent of total value of all fisheries products. Since World War II there has been an increase in the value of fresh and frozen salmon products, but in 1970 canned salmon still dominated with a wholesale value of $124.6 million, or 81 per cent of the total value of salmon products.

The record of resource management was one of long-term failure to control over-exploitation of the resource, with a 50 per cent drop in the average annual harvest from the peak decade of 1935-44 to the period of 1965-69 (table 1). The number of commercial fishing licences issued, however, followed an opposite trend, rising from an annual average of 7,480 for 1925-34 to 22,088 for 1970. This trend was accelerated significantly by the decline in use and eventual outlawing in 1959 of all traps except Native-owned traps on Annette Island. The portion of the total catch taken by traps declined from 54.1 per cent of total salmon catch for 1925-34 to 0.3 per cent for 1965-69. The increase in the number of fishermen licenced since the 1950's, therefore, does not represent an absolute and total increase in fishing effort, but in part represents a transfer of that effort from the highly efficient traps to more labour-intensive mobile gear.

THE FISHERMEN

The total harvest results from a combination of types of activities which are classified as subsistence, commercial, and sports fishing. The commercial harvest dominates, but the importance of subsistence fishing on a regional and more localized basis assumes greater importance than these comparisons suggest. For the Arctic-Yukon-Kuskokwim (AYK) region, the 1970 subsistence harvest represented forty per cent of total salmon taken in all fisheries. Generally, in this region the commercial and subsistence fisheries are complementary, with the same gear being used in both and the cash received in the commercial fishery being used to pay for the boat and gear used in the subsistence fishery. Sports fishing is significant only in the more populated regions, such as Cook Inlet and Southeast.

Table 1. Commercial salmon catch, licensed commercial fishermen and traps operated, 1925 to 1970

Period	Salmon catch ('000 tonnes)	Commercial fishermen licensed (No.)	Traps operated (No.)	Trap catch as % of total (%)
	(Av. Annual)	(Av. Annual)	(Av. Annual)	
1925/34	220.0	7 480	579	54.1
1935/44	229.5	8 249	431	41.3
1945/49	172.6	8 931	393	41.8
1950/54	117.2	11 268	341	31.0
1955/59	96.7	11 187	182	19.5
1960/64	116.2	15 482	11	0.9
1965/69	113.5	19 065	3	0.3
1970	157.2	22 088	5	0.2

Source: Alaska Department of Fish and Game and predecessor agencies, annual statistical reports.

Because fishermen from all parts of the United States are free to participate in the fisheries of Alaska, the first major classification of the commercial activities is between resident Alaskan and non-resident participation. This division, and the desire to limit non-resident participation, has influenced the evolution of Alaska's limited entry programme. Within the resident classification is the further division between Natives (those of aboriginal descent, namely Indian, Aleut and Eskimo) and non-Native. The position of the Native Alaskan is characterized by a higher degree of dependence on fishing re-enforced by tradition, lower educational attainment and vocational experience. This has further influenced the design of the limited entry programme to accommodate economic welfare objectives.

In 1970 non-residents accounted for 35 per cent of the holders of commercial fishing licences and 26 per cent of gear operators. (Governor's Study Group 1973, p.121). The non-resident operators also accounted for 40 per cent of gross earnings from harvesting with an average gross of $15,169 per unit of gear as compared with $7,283 for resident-owned gear. Of the total number of licences issued in Alaska in 1970, Natives accounted for 32 per cent, and 22 per cent of vessels were operated by Natives. Both Native and non-Native groups were represented in the hard core of full-time professionals, but each had a different peripheral orientation. The Native fishermen included part-time commercial and subsistence fishermen while the non-Native group included moonlighting fishermen from other areas of employment (for example, school teachers unemployed during the summers and homesteaders) and the owners of pleasure craft who paid some of their boat expenses and made tax write-offs through part-time commercial fishing. Each of these classifications of the work force and any further classifications that might be made, represented not only bundles of different characteristics and behaviour, but also different special interests seeking to influence management.

FISHERMEN - PROCESSOR RELATIONSHIPS

A study of the Pacific salmon fisheries by Crutchfield and Pontecorvo (1969) described the pre-1970's organization and the competitive relationship of the Aslaskan fisheries industry as an oligopsony. The end product is relatively durable and capable of extended storage. It is sold in national and international markets, while buying markets for raw salmon are "narrowly circumscribed by the extreme perishability of the product, the high costs of transportation, and the geographic dispersion of the fishery". This gave buyers of raw salmon a strong bargaining position in relation to the fishermen. Because of the remoteness and isolation of the fishing areas and processing sites "operations could only be sustained by firms with sufficient financial strength to cope with the high overhead costs and risks associated with operating in that environment". Furthermore, there were a limited number of good canning sites and these were pre-empted by the large packers. The resulting competitive structure is indicated in ratios of concentration of processors or purchasers of raw fish. The first four firms in the southeast region in 1965 accounted for 58 per cent of the output of canned salmon and the first eight firms for 78 per cent; the first four firms in the central region accounted for 60 per cent and the first eight firms for 82 per cent of the 1965 output and in the western region 58 per cent was by the first four firms and 82 per cent by the first eight firms (Crutchfield and Pontecorvo, 1969, pp.76-80). There were further dimensions to this oligopsony.

> Unfortunately, simple ratios do not give an adequate picture of concentration in the fishery. Control over the supply of fish has always been the crucial element in a stable, collusive oligopsony. The fish, once caught, cannot be inventoried. The canneries traditionally were dependent upon local supplies, and the key instrument in pre-empting local supply was the fish trap.....In general, these traps were "cannery" traps, and even when they were independently owned they normally had working agreements with particular owners. This extension of ownership by the processor to gear was, of course, true in varying degrees of all other fishing operations, particularly in more remote areas of Alaska. (Crutchfield and Pontecorvo, 1969, pp.77-79.)

These two means of extending the control of processors over supply through ownership of gear can be found in their most extreme form at the two ends of the chain of Alaskan fisheries regions. Prior to the outlawing of fish traps when statehood was attained, the use of this gear was concentrated in the southeast region where traps accounted for 70 per cent of the total catch of salmon for the ten-year period 1925-34, declining to 42 per cent for the period 1950-58 immediately prior to the outlawing of most traps (Rogers, 1960, p.101). A study of employment and labour conditions in the Territory of Alaska during 1939 reported that in the western region (primarily Bristol Bay at that time) only 94 or 3.3 per cent of the 2,810 fishermen identified as providing fish to the canned salmon industry were independent fishermen, the balance of 96.7 per cent being "cannery" fishermen (Bower, 1941, pp.142-145).

Between the end of World War II and 1970 the strength of this oligopsony had been considerably weakened. In 1959 statehood brought the abolition of fish traps (with the exception of the Annette Island traps) and the shift of resource management from Washington D.C., where cannery influence over managers was high, to Alaska. Restriction of manpower and travel during World War II forced the Bristol Bay canneries to rely upon resident Alaskans for their fishermen. The attempt to return to pre-war importation of most of the workforce for harvesting was countered by the organization of the Bering Sea Fishermen's Union in 1951 and in other parts of Alaska fishermen's unions and protective associations spread during the 1960's. This heritage of the pre-1970 period had important effects on the eventual form of Alaska's limited entry.

THE SOCIO-ECONOMIC ENVIRONMENTS OF THE FISHERIES

Alaskan fishing communities range from communities of more than 10,000 persons with relatively broad and varied economic bases to isolated Native villages of a few hundred persons and no alternative economy other than subsistence hunting and fishing and welfare. The cultural composition varies greatly among communities, as do the forms of local government and the tax bases. Accordingly, the local impacts of changes in fishery management are varied in terms of employment, income, tax revenues and welfare burdens.

The 1970 census data on race, poverty status and educational attainment gives an indication of the economic and social conditions of each region. Bristol Bay and the AYK region had the highest proportions of Native population, the worst poverty and the lowest educational attainment. The proportion of families with incomes less than 125 per cent of the U.S. poverty level in the AYK region was 54.8 per cent and in the Bristol Bay region 39 per cent. Median years of school completed for AYK was six for both sexes and 9.7 for males and 7.3 for females in Bristol Bay (U.S. Census 1970). If the income effects of a relatively high proportion of government employment in these regions were removed, the plight of the non-government population would have been revealed as even more dreary. The other four regions had varying racial composition of their population, but were very close to each other on the measures of relative poverty and education. The percentage of families with income less than 125 per cent of the U.S. poverty level for the southeast and Cook Inlet regions was ten per cent, for southwestern 12.2 per cent and for Prince William Sound 14.5 per cent. Median years of school completed was slightly above twelve for both sexes in all regions. These differences in economic well-being can be explained in part by the presence in southeast Alaska of the state capital and expanding timber production; in Cook Inlet the expanding oil and gas developments; in the southwest region lucrative shellfish fisheries within the region, and the off-base support population for the region's major Department of Defence stations; and the diversification of fisheries and processing in Prince William Sound.

ATTEMPTS AT LIMITED ENTRY BEFORE 1973[1]

The aboriginal fisheries were operated under closed access. From 1878 to the turn of the century they were overrun by the stampede to obtain salmon for canning and were replaced by an open access system. Between 1918 and 1921 the resource crashed. In 1919 Gilbert and O'Malley identified the problem of conserving the salmon resource with open access and the unreality of expecting anyone voluntarily to forego a profit. If fishing grounds or rights could be leased or assigned, the value of the inherent property rights would be a function of the continued yield which would be conditioned by the conservation of the resource and would assure the processors' co-operation in such efforts (Cooley, 1963, pp.107-108). The essence of these findings were embodied in executive orders creating the Alaskan Peninsula Fishery Reserve (February 1922) and the Southwestern Fishery Reservation (March 1922). The reservation concept was abolished by the passage of the White Fisheries Act of 1924. This legislation provided, among other things, that "no exclusive or several right of fishery shall be granted therein, nor shall any citizen of the United States be denied the right to take, prepare, cure, or preserve fish or shellfish in any area of the waters of Alaska where fishing is permitted." (Cooley, 1963, pp.110-127; Crutchfield and Pontecorvo, 1969, p.72 and pp.95-98).

Opposition to the reservation system in Alaska was not to limited entry as a policy, but the parcelling out of a public resource to private absentee interests which in effect required a fisherman to become a tenant of a cannery in order to engage in his vocation. The 1924 Act's prohibition of the granting of exclusive rights and privileges in any fishery was seen by Alaskans as aimed at non-resident control and was subsequently translated almost verbatim as a section of the natural resources article of the Alaskan Constitution of 1956.

The transfer of fisheries management within Alaskan waters from the Federal to the State government and the outlawing of fish traps accompanying the achievement of statehood greatly reduced non-resident influence in fisheries management. The next step was reduction of non-resident participation. Continued low yields and increasing participation led to the inescapable conclusion that some form of gear restriction was needed. The obvious group of fishermen to be reduced was non-residents, and the Legislature in 1962 and 1968 made two attempts at this form of limited entry. The legislative language of the 1962 Act provided that whenever

> the year run of salmon in any one registration area will be substantially less than the optimum run, and that under anticipated fishing conditions Alaska residents...will not catch sufficient fish to sustain them for the year, the Board may..., promulgate regulations temporarily closing the area or district to fishing by all non-residents of Alaska. (Alaska Session Laws, 1962, Chapter 62.)

Before any regulations could be issued under the Act, however, the Federal District Court declared the Act unconstitutional on grounds of violation of privileges and immunities clauses of the federal constitution as well as portions of the Alaskan Constitution.

Spurred by the Bristol Bay fishing disaster the 1968 State Legislature passed a state-wide programme of limiting the entry of net gear into the salmon fisheries (Session Laws of Alaska 1968, Chapter 186). A Board was authorized to issue a gear licence to an applicant who had previously held a licence or had actively engaged in fishing that area as a crew member for three years. In effect, this set up an aprenticeship programme whereby crewmen could qualify for a gear licence after three years. The sponsors of the bill reported that the law was

> designed to protect the interests of Alaska fishermen. The sponsors of the bill in both the House and the Senate included the three-year apprenticeship provision to discosurage part-time and vacationing fishermen from other areas of Alaska and the "lower 48" states. These fishermen could not readily have served the three years and would probably have been excluded. (Morehouse and Hession, 1972, p.312.)

This underlying purpose was obvious to the federal court, however, and in February 1969 it was determined that the law and regulations violated clauses of both the Alaskan and Federal constitutions.

The 1973 Act had its genesis in the early recognition of the need for gear limitation in an open access system and in the drive to increase resident control of participation in the fisheries. The underlying objective of all legislation generated in Alaska and relating to natural resources has been the promotion of the objective of local economic development and employment. The drive to achieve these objectives, however, has been restrained by constitutional interpretations of the courts. it has, nonetheless, not dampened, and prior to 1973 was stimulated by continued decline in yields and growing economic distress in Alaska's fishing communities.

During preparation of the 1973 legislation for limited entry, a number of statements emerged that defined the basic objectives of that programme. The traditional objectives for conservation and sustained yield were joined by a range of social and economic objectives. Objectives of economic efficiency were absent, however, for in the context of economic distress and social disruption in most of Alaska's fishing communities, talk of reducing "waste" labour and capital in the harvest would have been met with contempt and anger.

THE ACT OF 1973

WHO IS ELIMINATED AND WHY

In January 1972 the Legislature provided the Governor of Alaska an appropriation to fund a Governor's Limited Entry Study Group; Article VIII, Section 15 of the Alaskan State Constitution was appropriately amended by the electorate on August 22, 1972 to permit limitation of entry; the Governor's bill was transmitted to the Legislature on Janauary 10, 1973; and the report of the Governor's Limited Entry Study Group was published in February 1973. Although certain major provisions of the Governor's bill were retained (permits were to be issued to individuals, not vessels; only one permit would be issued to a person in a given fishery; permits would be freely transferable; and administration would be by a commission), the final bill enacted April 26, 1973, was a new product resulting from four months of continuous and intensive committee work. The objectives and structure of the current programme emerged from this highly political process.

The political pot was set boiling by the basic argument of the Governor's letter of transmittal to the Senate. The original bill was based upon two assumptions as to the cause of fisheries distress:

> (1) Excessive numbers of fishermen participating in the harvest of salmon have reached acute proportions in almost every area. (2) Without entry limitation the commercial salmon fishery will be taken over increasingly by moonlighters, sport-commercial, and part-time hobby fishermen...(who) have driven the profitability of fishing down to marginal levels for those professional fishermen who must depend upon fishing (Egan, 1973, pp.2-3).

Some group had to be eliminated if "excessive numbers of fishermen" were to be reduced, but the courts had ruled out the legal possibility of targeting the non-resident fishermen. Therefore the drafters of the bill were forced to identify another politically acceptable target group, "...the part-time fishermen with alternative primary sources of livelihood." (Egan, 1973, p.21.) Stated another way, the programme's long-range goal was "an economically and biologically healthy professional fishery". A "professional fishery" was described as one in which the participants must depend upon fishing for a major share of their livelihood. Therefore, the simple elimination of moonlighters and part-time fishermen would serve two purposes. It would create a "professional fishery" while at the same time appropriately reducing the number of units of participating gear.

The report of the Study Group issued a month <u>after</u> the bill's introduction, however, appeared to have had <u>some</u> second thoughts on the wholesale elimination of part-time fishermen.

> The definition of a professional fisherman varies greatly from area to area. In parts of the state where the seasons are short, a full-time fisherman may fish only a few weeks or months out of the year. In such areas even the "professionals" may take other jobs during the off-season, or they may go to other areas to fish. The goal of sustaining a professional fishery means fishermen who are prepared to fish full-time <u>while the season lasts</u>. (Governor's Study Group, 1973, p.21, emphasis added.)

There was also evidence that even the <u>total</u> elimination of the target group would not result in the necessary reduction of gear. For example, the report said:

> The troll fishery (of southeast Alaska) shows the widest variation of fishermen success of any fishery. This is of course due to the large number of hand

> trollers who use their boats and gear primarily for recreational purposes...The 2,356 Southeastern troll licences sold in 1971 included 857 power troll licences and 1,499 hand troll licences...the hand trollers accounted for 64 per cent of the units of gear but landed only 12.8 per cent of the pounds of the catch (Governor's Study Group, 1973, pp.156-157).

In the final version of the Act, reference to a "professional fishery" was studiously avoided. The determination of who was to be eliminated was not to be by definition of a target group (for example, non-residents or moonlighters), but rather by a process of ranking applicants for permits "according to the degree of hardship which they would suffer by exclusion from the fishery". The factors determining the allocation of permits were not be to efficiency, residence, or some other factors, but the degree of economic dependence on the fishery and the "extent of past participation in the fishery".

CONCEPTS OF ECONOMIC WELFARE AND HARDSHIP

The Alaska Commercial Fisheries Entry Act of 1973 has two sets of purposes: to promote (1) "the conservation and the sustained yield management of Alaska's fishery resource", and (2) "the economic health and stability of commercial fishing in Alaska". The first relates to the management of natural resources and the second to the welfare of an economic activity, "commercial fishing". The findings of the Legislature are that "economic welfare of the fisheries...efficiency of the harvest, and the...management of the fishery resource" all are impaired or in danger of being impaired by present levels of participation in commercial fishing. It was assumed that the limitation of entry and establishment of optimum amounts of fishing effort, as measured by numbers of units of gear, would contribute to the promotion of the biological objective. Therefore, most of the discussion and debate concerning the legislation focused on the economic objectives.

The economic factors which led to the consideration of limited entry were firmly rooted in the history of domination of the Alaskan fisheries by non-resident processors and the prolonged period of economic distress suffered by Alaskan fishermen and fishing communities. The language of the constitutional amendment clearing the way for the programme stated the purpose to be served: "...to prevent economic distress among fishermen and those dependent upon them for a livelihood and to promote the efficient development of Agriculture". The central theme of the report of the Governor's Study Group was the economic welfare of fishermen and fishing communities.

The primary economic orientation of the Act, however, is towards the health (or welfare) and efficiency of the "industry" of commercial fishing and its participants. It makes no reference to economic welfare or health of communities and does not extend its economic tests and standards to any group of fishermen other than the established gear operators. This is made specific by the definitions used in the Act; "fishery" means the "commercial taking of a specific fishery resource in a specific administrative area with a specific type of gear". The regulations implementing the Act provide code schedules for each of these dimensions of this economic activity; the species being taken, gear type and geographic areas.

A second basic definition relates to the economic condition of each fishery. An "economically healthy fishery" means a fishery (a specific combination of specific gear, species and area) that yields a sufficient rate of economic return to the fishermen participating in it to provide for both the maintenance and the improvement of vessel and gear and the opportunity to experiment with new techniques. Health is measured, therefore, in something more than mere survival of the participants. A "distressed fishery", the opposite of a "commercially healthy fishery", is a fishery for which the Commission "estimates that the optimum number of permits will be less than the highest number of units of gear fished in that fishery during any one of the four years immediately preceding January 1, 1973" (Section 230). The optimum number of units of gear for a fishery is to be "based upon a reasonable balance" of the number of units necessary and/or sufficient to maintain "an economically healthy fishery" (here defined as one which "will result in a reasonable average rate of return to the fishermen participating in that fishery"); to harvest the allowable commercial take; and to "avoid serious economic hardship to those currently engaged in the fishery" (that is, as of January 1, 1973, emphasis added). The meaning of "economic hardship" is not given in the section dealing with optimum numbers, although it is to be one of the standards to be used in estimating such numbers. Clues to its meaning, however, can be found in other sections setting forth the basic duties of the Fisheries Entry Commission.

THE COMMISSION AND ECONOMIC WELFARE AND HARDSHIP

During the legislative debate and discussion, questions were raised as to what body should implement and administer the programme. Logical candidates appeared to be existing agencies - the Alaska Department of Fish and Game and the Board of Fish and Game. In the end, a new body was created. In support of this decision, the report of the Governor's Study Group opted for a separation of the biological and socio-economic aspects of fisheries management.

> Both the Board and the Department are charged by law with ensuring the continued well-being of our fishing resources. Their primary responsibility is sustained yield management. Limited entry deals also with a separate important goal: the economic welfare of the fishermen. A regulatory programme aimed at improving the livelihood of fishermen and improving the economic efficiency of our fisheries goes much beyond biological and resource-oriented considerations. Limited entry is

primarily an economic regulatory task not a resource management task (Governor's Study Group, 1973, p.29, emphasis added).

This decision and the reasoning advanced in its support were at variance with the classical argument for limited entry, namely that it would be a means of rationalizing the management of the fisheries and implementing the theoretical formulations of bio-economic models. The administrative structure of the Alaskan programme, however, was to be one which would promote economic welfare as a separate and distinct objective of management. The Commission was established consisting of three full-time and paid members appointed for staggered four-year terms by the Governor and confirmed by a joint session of the Legislature.[2]

The Commission has three basic duties when determining the total number of units of gear allowed to fish in each designated fishery. Firstly, establishing the maximum number of entry permits for initial entry is a statistical task of calculating the highest number of units of gear fished in the subject fishery during any one of four years immediately preceding January 1, 1973 (Section 240). Secondly, the Commission determines which applicants from those currently engaged in the fishery shall receive entry permits. This is to be done by ranking applicants for entry permits according to the degree of hardship which they would suffer from exclusion from the fishery. Section 250 of the law provides that this shall be accomplished by a "reasonable balance" of the following hardship standards:

1. degree of economic dependence upon the fishery, including but not limited to percentage of income derived from the fishery, reliance on alternative occupations, availability of alternative occupations, investment in vessels and gear;

2. extent of past participation in the fishery including but not limited to the number of years participation in the fishery, and the consistency of participation during each year.

The Commission designates those applicants who would suffer significant economic hardship by exclusion and those who would suffer only minor economic hardship.

The third duty of the Commission is to establish the optimum numbers which are to take the place of the maximum numbers of units of gear licenced in each fishery. This number presumably would take the place of any estimated optimum used in the initial decision to declare the subject fishery a distressed fishery and the standards to be used have been discussed above (Section 290). As this is a reduction from the maximum number of permits outstanding, the Commission is also to institute a buy-back programme (Section 310). Although several abortive starts have been made, the Commission has yet to determine any optimum numbers and in the light of pending court challenges and the almost impossible nature of the task is unlikely to do so.

The Commission's interpretation of "economic hardship" can be traced in a review of its implementation of the first two tasks. The maximum number of units of gear for each designated fishery was determined and regulations drawn up in 1974 setting up a system of 40 possible points divided equally between economic dependence and past participation. Any applicant scoring 20 or more points was considered to have demonstrated that they would suffer "significant hardship" from exclusion. All such applicants would automatically receive entry permits even if the total permits so issued for the fishery exceeded the maximum determined by the first step.

The point system is the key to "economic hardship" as interpreted by the Commission. It was designed to determine the eligibility priority only of those who were actual gear operators as of January 1, 1973. Past participation was a measure of time invested in the fishing and economic dependence primarily in monetary investment and percentage of total income from fishing. Points were available for applicants domiciled in census divisions or counties with a 1970 population of less than 25,000 persons. This was the proxy measure for "availability of alternative occupations". It is the only standard of hardship which has any relation to something other than the fishery itself and it can only support a maximum of four points as compared with a maximum of 36 points from investment of time and money.

THE ENTRY PERMIT

The provisions of the Act are that no person would be allowed to operate gear without a valid permit. Fishermen who were licence holders for commercial gear would need an entry permit, but a permit is not required of a crewman or other person assisting in the operation of a unit of gear. This brings us to the basic difference between the programmes of British Columbia and Alaska. In Alaska the entry permit went to a fisherman and was not attached to vessels. Care was exercised to define a "person" as a "natural person" and to itemize specifically what was excluded from the definition: "a corporation, company, partnership, firm, association, organization, business trust, or society". A person could not hold more than one permit in a given fishery, but could hold more than one permit in order to fish more than one type of gear, fish in more than one area, or harvest species for which separate permits were issued (that is, to fish in more than one fishery).

Adasiak (1979) correctly reports that this choice between vessels and individuals was made as a means of shifting the balance of economic power within the industry from processors to fishermen:

> When the Alaskan legislature was considering the current limited entry law in 1973, there was a general belief that salmon processors still maintained a significant hold over individual fishermen, both through credit and financing arrangements and through

> the untrammeled power to decide whether a fisherman would fish for a particular company. The decision to issue permits to individuals was made primarily because people believed that it would strengthen the individual fisherman's bargaining position vis-a-vis fish buyers and processors. With only a fixed number of permits to go around, and with the requirement that a unit of gear may be operated only by a permit holder, the need that the processor had for the individual fisherman was increased (pp. 771-772).

Where the processors owned vessels and gear, for example, they were precluded by the law from owning permits to operate them and had to hire fishermen who owned entry permits for that purpose. The section on "terms and conditions" provided what was hoped to be further safeguards against loss of a permit by a fisherman who owed money to a processor or someone else. The permit could not be "pledged, mortgaged, leased, or encumbered..., transferred with any right of repossession or foreclosure..., attached, distrained or sold on execution of judgement."

The Act describes the entry permit as "a use privilege which may be modified or revoked by the legislature without compensation". The language of the original bill from which this was derived was that the permit was a "personal right to operate a unit of a specified type of gear within a specified administrative area" with no provision for legislative revocation. The Governor's Study Group report, however, went further: "Once a person receives an entry permit, it becomes like property" (Governor's Study Group, 1973, pp.8-9). At another place the Study Group repeated this statement with an illustration:

> It is like property and may be compared roughly with owning your own farm. It assures you that you have a right shared by a limited number of other people...Buying an entry permit will not be money down the drain like buying an expensive annual license. The cost of an entry permit represents a capital investment. A fisherman will be able to get the value of his investment when he sells to another (pp.25-27).

It was recognized that because of its nature as a capital investment, the permit would have an economic value reflecting anticipated future income. However, the Study Group naively assumed that although the price reflecting this value could rise, there was a limit

> to how high the price of a permit will go since the bill requires that only the holder can fish it...The person buying a permit will have to work it, and he will have to expect to make enough money commercial fishing to cover cost of the permit, as well as his other expenses and profits. Otherwise it would not make sense for him to buy in. Consequently, there will be some practical limits on the price of entry permits (pp.9-10).

The permit is issued by the Commission to the qualifying applicant upon payment at issuance and annual renewal fees of no less than $10 nor more than $100 (amended in 1979 to a maximum of $700). Failure to renew a permit for a period of two years resulted in forfeiture except as waived by the Commission for cause. Upon death of the permit holder the permit would be transferred by the Commission to the surviving spouse or his estate. Transfers could be made by the holder to the Commission or to another person who could establish present ability to participate actively in the fishery. Provision was made for temporary emergency transfers by the Commission.

Whether the system would be fair to future fishermen, however, would be determined by the economic forces of a "free market" for permits. This represented a basic departure from what had been the emphasis upon economic hardship as a determinant of participation. New entrants into the fisheries via permit transfers are not subject to any economic hardship test. The transferee is only required to "establish present ability to participate actively in the fishery" (Section 160). Permits are freely transferable without any further legislative or administrative regulation if the Commission agrees that such intent and ability have been established.

Free market factors determine subsequent entries into the fisheries, therefore, except those made through inheritance or gift. Because the permit is a limited asset and there have been continuing increases in the value of catch in the designated fisheries, the value of permits has risen to levels where ability to pay rather than economic hardship has become the test of eligibility for entry through purchase (see section on permit prices below). This has and will continue to be a bar to future entry of young persons and crew members into the fisheries.

DETERMINATION OF OPTIMUM NUMBERS

Two basic tasks of the Commission were to replace the maximum numbers of permits for each fishery with optimum numbers, and to institute buy-back programmes to reduce the outstanding permits to the optima. The absence of any progress on these matters is due in part to the uncertainties caused by pending court cases and lack of legislative action on appropriations for the attendant buy-back programme. The more important causes are the absence of any factual information upon which to base such determinations and the absence of any consensus about the meaning of "optimum".

From the three guidelines provided by the Act, the methodology recognized two sets of values that must be reconciled and combined in a single optimum: management optimum numbers, the number of units of gear the management biologist determines can be safely dealt with using traditional management tools (such as, area closures and varied opening lengths) in both the very good years and the very poor ones; and economic optimum numbers, the number of units of gear that will insure that each fisherman has a fair chance of making a reasonable amount of money for his investment.

Provisions of the Act establish a further characteristic of the optimum number. The number may be increased or decreased when either "an established long-term change in the biological condition of the fishery" or "in market conditions" has occurred which substantially alters the optimum number of permissible entry permits. The Commission is given ten years in which to reduce maximum to optimum numbers. Therefore, ten years can be assumed to be the definition of "long-run". The economic optimum numbers are to be determined by means of a complex probability methodology:

> Because of its long-run nature, the optimum number of units of gear could not, even if there were sufficient data to allow it, be re-estimated on a yearly basis. This means that with the extreme variability of catch from year to year in many salmon fisheries, the relatively fixed optimum number of units of gear can be expected to yield a wide range of average returns. The management goal under these circumstances should be either to set the optimum number of units of gear so that despite the variations in catch, the minimum likely average rate of return is always reasonable, or to set it so that average returns are expected to be below the reasonable level only an acceptable percentage of time (Martin, 1979, Appendix B).

Although Martin did calculate optimum numbers of a sort for the drift gill net fisheries in Bristol Bay, Cook Inlet and Prince William Sound, he advised against their use because of difficulties and inadequacies of the data from which the estimates were made. Furthermore, there were the impossible problems of determining an economic optimum with fixed units of gear for a period of a decade and widely fluctuating annual incomes, and of reconciling a management or biological long-run optimum with an economic optimum, which must also take into account the further objective of reducing economic hardship.

OPERATION OF THE ALASKA PROGRAMME, 1973-79

PROGRESS AND CHALLENGE

Beginning late in 1973 and continuing through 1974, the Commission issued interim permits to more than 11,000 fishermen, engaged in explaining the programme and gathering testimony on how it could be most fairly applied, and doing preliminary research to determine which fisheries required limitation. At the outset the Commission decided to put all commercial salmon fisheries except those in the Arctic-Yukon-Kuskokwim area under limited entry immediately. The Arctic-Yukon-Kuskokwim region was subject to limited entry in 1976, purse seine herring fisheries in southeast Alaska, Prince William Sound and Cook Inlet were added in 1977 and the southeast Alaska gill net fishery in 1978.

The Commission prepared regulations for the 1975 season embodying a system of identification codes for 13 fishery resources, 16 types of gear, 14 administrative areas and a statewide area for these resources, and eight administrative areas for king crab. The most important parts of the regulations were those devoted to a point system which would be the basis for deciding who would receive entry permits.

The programme was put into operation for 15 salmon fisheries in 1975. Immediately, it was challenged by a law suit and an initiative drawn not on conservation issues, but on limiting and allocating the right to fish. At the general election on November 2, 1976, the programme survived its first major challenge in the resounding defeat of the initiative. As of February 22, 1979, a total of about 700 appeals had been made of Commission decisions, about 70 of which were then court cases (Commercial Fisheries Entry Commission, 1979, p.6). Of these lawsuits, approximately a third involved questions of the requirement to hold a gear licence, another third were late applications, and the remainder were a mixed bag of questions, including whether applicants had been properly advised and the awarding of points.

By February 9, 1979, a total of 14,261 applications had been received for these fisheries; 9,982 were issued permits, 3,145 were denied (ineligible, insufficient points, late filing), and 1,134 were still pending the outcome of classification, review of new evidence, or hearings and judicial appeal. The thirty per cent of applicants who were or are likely to be denied entry is only a part of the total number who will be so affected. Because no non-market means of entry is available the actual or potential "outs" also include crew members who looked upon their status as an apprenticeship leading ultimately to gear ownership and operation, partners who had to change to a single operator basis, and future generations of fishermen who have no means of entry other than inheritance or purchase of the right. These means do not necessarily guarantee the fairest and most equitable allocation of present and future licences or that the programme will work toward the economic welfare objective in the future.

Because there has been no reduction in the number of gear units, the Act has done little to change the managers' reliance on traditional forms of regulation. The Alaska Department of Fish and Game still has to make full use of restrictive time and area limits as conservation devices. Stabilizing the number of persons or units engaged in the fisheries as a legally determined status quo has not had a comparable stabilizing effect on effort. Rising pressure on the resource continues as fishermen, because of increasing earnings, are able to invest in more efficient boats and gear, and as the rising value of permits increases aggressiveness in fishermen who must make their investment pay off.

In defense, the most that limited entry officials have been able to say is that things would have been worse without the programme, and given the economic condition of the fisheries since 1972, this is a significant accomplishment. The drive for the Alaska limited entry programme was carried out in an environment of long-run decline in the resource, economic hardship among fishermen, and distress in the fishing communities. Even while the bill was being debated and drafted, however, economic conditions were beginning what has since become a drastic reversal. Table 2 summarizes salmon catch and average prices by species for the period 1968-77. For the period 1968-71 prices were relatively stable and, with the exception of a large red catch in 1970, catch fluctuations were nominal. Commencing in 1973 and continuing at accelerating rates, average prices increased for the remaining period covered by available statistics. Between 1972 and 1977 red prices increased 132.5 per cent, coho prices 99.1 per cent, pink prices 95.0 per cent, and chum prices 197.8 per cent. Price and income inflation are not restricted to the salmon fisheries alone, but are found in the shellfish, halibut, herring, and some species of bottom fish. In general fish prices have continued to increase through 1978 and 1979.

These changes in external forces have made it impossible to assess the effectiveness of the limited entry programme in promoting its objectives for economic welfare. Also, the changes

Table 2. Catch and average price of selected salmon species, 1968 to 1977

Year	Red Catch (tonnes)	Red Price (c/kg.)	Coho Catch (tonnes)	Coho Price (c/kg.)	Pink Catch (tonnes)	Pink Price (c.kg.)	Chum Catch (tonnes)	Chum Price (c.kg.)
1968	22 088	57.5	9 511	56.4	67 335	30.4	25 363	27.6
1969	29 385	55.1	3 612	61.3	47 238	32.8	10 470	29.3
1970	68 408	54.5	5 397	65.0	53 397	29.1	24 717	26.7
1971	39 594	57.8	5 198	54.2	39 127	34.6	24 824	30.4
1972	19 044	69.2	5 913	94.4	27 202	39.9	29 404	40.6
1973	15 988	95.9	4 462	167.3	16 606	70.3	20 811	85.1
1974	14 627	151.2	5 815	149.2	18 177	76.5	16 862	82.9
1975	19 397	99.2	3 233	131.4	22 666	70.8	13 973	75.2
1976	34 295	131.6	4 828	188.5	46 449	79.4	21 193	92.9
1977	44 511	160.9	6 969	187.8	58 766	77.8	23 396	120.8

Source: Alaska Department of Commerce and Economic Development 1979, p. 59, Table 9.

have complicated the determination of optimum numbers and contributed to another source of attack and criticism. As reported recently by a former commissioner:

> Combining limited entry, rising prices, and a few years of generally good salmon returns has provoked the first murmers in Alaska of the charge that an exclusive "rich men's club" has been created...The Chignik purse-seine fleet is the new instant legend. Official information is not available yet, but preliminary estimates indicate that the average gross was approximately $200,000 and the high boat grossed $500,000 (in 1978)...The proposition is, does limited entry inherently allow the creation of an exclusive rich men's club? We have a few years to work out the answer, which at the moment does not seem to be simple (Adasiak, 1979, pp. 773-774).

PERMIT PRICES[3]

The annual fees levied at the outset for an interim-use or entry permit varied by type of gear from $10 (for shovels and "other") to $100 (otter trawl and pot gear on vessels over 50 feet). In 1978 different fee schedules were provided for resident and non-resident gear operators, with the resident schedules ranging from a low of $20 to a high of $200, and non-resident schedules from $60 to $600. For the calendar year 1978 the average permit fee was $70 for residents, $289 for non-residents, and $15 for those persons who qualified for a special poverty permit. These entry fees contrast markedly with the value of the permits as reflected in reported and rumored prices being paid for permits transferred from fisherman to fisherman:

> Bristol Bay gillnet permits have climbed as high as $100,000 in the wake of strengthening salmon runs in that area...Limited entry has come under increasing fire in recent years as opponents argue that it is making a small group of fishermen rich. Fortunes made off strong salmon runs in some areas of the state have played a large part in inflating permit prices, according to state officials (Southeast Alaska Empire, October 18, 1979).

The Commission's annual surveys of permit transfer have limitations; for example, coverage is not complete (the Commission reports more than 50 per cent return), no check has been made of accuracy, or whether sales were made conditional upon purchase of gear and vessels which might include a further hidden permit price in the form of over-pricing or unloading of derelict vessels and equipment. With these qualifications, the price data summarized in table 3 gives a graphic picture of the rapid inflation in permit prices. In 1978 the price surveys were made

Table 3. Permit prices 1975 to 1978
$US

Fishery	High	Low	Average	Most frequent
	Price paid			
Southeast (Including Yakutat)				
Purse seine				
1975	16 000	5 000	10 633	10 000
1976	15 000	6 000	9 222	10 000
1977	21 000	8 000	16 666	15 000
1978	50 000	19 000	30 929	25 000
Drift gill net				
1975	15 000	4 000	9 625	10 000
1976	13 000	5 500	10 212	10 000
1977	25 000	8 000	16 262	15 000
1978	50 000	10 000	34 604	40 000
Set gill net				
1975	1 000	500	750	*
1976	10 000	3 000	6 000	*
1977	10 000	3 000	7 000	10 000
1978	15 000	5 400	10 480	10 000
Power troll				
1975	10 000	300	5 303	5 000
1976	10 000	1 000	5 065	5 000
1977	15 000	1 000	8 831	10 000
1978	30 000	600	15 457	20 000
Prince William Sound				
Purse seine				
1975	10 000	5 000	8 000	10 000
1976	20 000	2 000	10 700	10 000
1977	47 000	19 000	29 800	*
1978	30 000	20 000	24 272	25 000
Drift gill net				
1975	5 000	500	3 088	2 500 and 5 000
1976	7 000	1 000	4 406	5 000
1977	35 000	7 000	13 750	10 000, 15 000 and 20 000
1978	47 050	10 000	27 742	25 000

(Continued)

(Table 3, continued)

Cook Inlet				
Purse seine				
1976	10 000	5 000	7 500	*
1977	20 000	2 000	10 625	*
1978	60 000	15 000	40 000	40 000
Drift gill net				
1975	10 000	500	3 911	1 000, 5 000 and 10 000
1976	13 000	2 500	5 551	5 000
1977	25 000	1 000	10 832	10 000
1978	60 000	6 000	36 825	45 000
Set gill net				
1975	2 500	2 000	2 250	2 000 and 2 500
1976	3 000	1 000	1 778	2 000
1977	18 500	2 000	4 820	2 500
1978	25 000	2 000	9 823	10 000
Southwest				
Purse seine				
1975	7 500	1 000	4 751	5 000
1976	18 000	6 000	9 425	8 000
1977	36 000	1 500	17 611	20 000
1978	60 000	7 000	39 627	60 000
Beach seine				
1977	30 000	5 000	15 000	*
1978	*	*	29 250	*
Drift gill net				
1976	10 000	4 000	6 333	*
1977	12 000	10 000	10 285	10 000
1978	30 000	5 000	15 000	*
Set gill net				
1975	11 000	1 000	5 380	1 000
1976	7 500	500	4 370	*
1977	15 000	600	6 689	*
1978	30 000	5 300	11 243	*
Bristol Bay				
Drift gill net				
1975	2 500	500	1 165	1 000
1976	10 000	500	2 536	2 000
1977	12 000	250	6 440	10 000
1978	60 000	1 000	21 638	25 000
Set gill net				
1976	5 000	300	2 754	5 000
1977	5 000	100	2 694	5 000
1978	30 000	1 500	8 500	10 000

(Continued)

(Table 3, continued)

Arctic-Yukon-Kuskokwim				
Gill net				
1978	10 000	900	5 814	*
Fishwheels				
1978	9 000	5 000	7 500	8 000

* Not available, insufficient data or not publishable.

Source: Commercial Fisheries Entry Commission, 1978 Annual Report, April 1979.

on a quarterly basis, and the first report by quarters indicates the continuous trend upward during the course of the year (table 4).

The most dramatic change in reported permit prices has been for the Bristol Bay drift gill net fishery. In 1975 permit prices ranged from $500 to $2,500 with an average of $1,165. By the fourth quarter of 1978 the range for this fishery was from a low of $20,000 to a reported high of $70,000 with an average of $41,867. Since 1978 prices of $100,000 and above have been rumored. The rise in permit prices has gone beyond anything anticipated in 1973 when assurances were made that there would be practical limits to how far they could go. Present prices prohibit many persons from buying into the programme without some form of financing. Of the more than fifty per cent response to the Commission survey of transfers, 38.9 per cent reported sale by cash payment for the four years 1975-78, with the remaining 61.1 per cent requiring some form of financing for the transaction.

The survey results illuminate only part of the picture of the trade in entry permits that has developed since 1975. One vigorous critic of limited entry buttressed his campaign against the programme with an 11-page appendix to his 1978 pamphlet consisting of clippings from newspaper advertisements. This document provided evidence of high prices (some above the Commission's reported prices) and illustrated the difficulties in determining the actual price of a permit because of sales conditioned by purchase of over-priced gear and old boats and offers to trade substantial real estate holdings. Two other patterns emerged from this collection. One was the apparent prevalence of non-fishing permit holders seeking experienced fishermen either to fish or to lease the permit (for example, "Have two current Limited Entry Permit holders for Bristol Bay needing experienced partners with boats"; "Southeast Alaska seine permit for lease with option to buy"; "Have Bristol Bay permit.

Table 4. Salmon entry permit prices, first and fourth quarters, 1978

$US

Fishery	First quarter			Fourth quarter		
	High	Low	Average	High	Low	Average
Southeastern						
Purse seine	35 000	20 000	25 833	*	*	40 000
Drift gill net	42 500	10 000	32 375	50 000	27 000	39 875
Set gill net	15 000	5 400	10 480	15 000	5 400	10 480
Power troll	16 000	8 500	12 342	30 000	15 500	23 045
Price William Sound						
Purse seine	23 500	20 000	20 875	35 000	27 000	31 000
Drift gill net	40 000	10 000	24 346	45 000	20 000	36 250
Cook Inlet						
Purse seine	*	*	*	*	*	52 500
Drift gill net	42 500	25 000	30 000	75 000	35 000	57 800
Set gill net	15 000	2 000	7 636	25 000	10 000	14 571
Southwest						
Purse seine						
Kodiak	40 000	20 000	35 000	*	*	57 125
Beach seine	*	*	*	*	*	29 250
Set gill net						
Kodiak						
(All quarters)	25 000	10 000	24 667	25 000	10 000	24 667
Bristol Bay						
Drift gill net	30 000	5 000	13 941	70 000	20 000	41 867
Set gill net	5 000	2 000	3 925	30 000	10 000	16 000

* Not available, insufficient data or not publishable.

Source: Commercial Fisheries Entry Commision, 1978 Annual Report, April 1979.

Seeking partners with boat or will consider leasing permit."). Some of the classified advertisements even specify the lease payment - 50 per cent of the gross value of the catch for the non-working permit holder. Despite the openness with which these illegal transactions are conducted, no action has been taken to halt the practice. The other pattern which emerges from a comparison of telephone numbers through which to make contact is the existence of an apparently extensive brokerage business. One advertiser openly identified himself as a broker (Durkin, 1978).

PERMIT TRANSFERS

Permit transfers for the calendar years from 1975 to 1978 were higher than originally anticipated. The ratio of transfers to permits issued increased from 8.2 per cent of the outstanding permits in 1975 to 12.9 per cent in 1978. For the whole four-year period, transfers totalled 3,469 or 35 per cent of the total 9,973 permits issued. The record of resident to non-resident transfers, however, was reassuring: 14.4 per cent of transfers were from non-resident permit holders to resident fishermen as compared with a 7.3 per cent transfer in the other direction, for a net increase of 239 resident permit holders between 1975 and 1978 (Commercial Entry Commission, 1979). This may be an illusion, however, for a Commissioner announced that an investigation found that several hundred non-resident commercial fishermen may have claimed Alaska residency to obtain limited entry permits (Southeast Alaska Empire, October 22, 1979). Furthermore, when the data are analysed by fishery it appears non-residents have gained permits in those fisheries with highly valued permits.

Further information was contained in the responses identifying the recipient (relative, friend, partner, other). For all fisheries only 20 per cent of the transfers were made to relatives, and 2.8 per cent to friends or partners. Most of the transfers (77.1 per cent) were to non-family and non-associated persons, a result at variance with the Commission's original position that the anticipated social value of free transfer was that it would allow a fisherman to pass on his permit to family, a crewman or a friend. This lent support to the observation and concern of some legislators that there has been an overall transfer from family holdings of fishing rights to persons who are not residents of the areas in which fishing takes place.

The annual published summaries of the permit data did not identify another important dimension of the patterns which indicated other relocations taking place in the fisheries. The non-familial transfers noted above suggested that there might be a further geographic redistribution from fishermen resident in the rural fishing areas to the urban centres of the State. Langdon (1980) recently conducted a detailed analysis of Commission records backed by field interviews to track transfer patterns other than those from resident to non-resident. Residency was further divided into five categories: non-resident, Alaskan rural local, Alaskan urban local, Alaskan rural non-local, and Alaskan urban non-local (a population of 2000 was used to differentiate urban from rural). The results of this study are too important to be summarized in this paper and should be read in their entirety. The general conclusion drawn from the study concerning intra-Alaska transfers is that "there is a clear and escalating trend since 1976 for rural residents to lose permits, particularly rural locals. There is likewise a clear and escalating trend for urban non-locals to gain permits." (Langdon, 1980, p.28). The cause of this trend appears to be linked to the high prices which can be obtained by rural permit holders with low incomes. Because these transfer trends do not appear to parallel population trends (that is, the permits are leaving but the people are not) and other employment opportunities in local regions are not expanding for rural residents, Langdon concludes that "the outflow of permits that has occurred and that potentially can occur must be regarded as a significant threat to the rural Alaskan economic base and the well-being of rural Alaskans." (Langdon, 1980, p.73).

Langdon's studies and my own observations support a conclusion that the basic flaw of the present Alaskan limited entry system lies in the free transferability of the permits after they have been issued by the Commission. Given the main socio-economic objective of the programme (to protect the welfare of the traditional resident fishermen), the market for sale of permits in times of prosperity tends to establish prices which are beyond the means of young people aspiring to be fishermen and tempt those fishermen who are most dependent on these activities to "sell their birthrights". Retention of ownership and control of transfer of the permit, which was rejected by the original drafters of the legislation, now appears to have been the more appropriate aproach.

THE FUTURE OF ALASKA LIMITED ENTRY

In attempting to generalize the accomplishments of the Alaska limited entry programme only two statements can be made with any certainty. The first is that the Act has prohibited new entry into the fisheries to which it applies. New persons can enter only by having a permit transferred to them. Secondly, the operation of the programme to date has not reduced excess capacity in the subject fisheries as optimum numbers of units of gear have not been determined. The most that it has accomplished is to stabilize this excess capacity at the amounts prevailing in the 1969-72 base period. Little has been done, apparently, to reduce the need for traditional management tools.

The time period of operation for which any data are available (1975-79) is too short to draw any firm conclusions, but statistics suggest possible trends in permit holdings which are contrary to the intent of the legislation. The high prices for permits and the income earning capacities of permits which this implies have profound implications for the optimum number of permits in the light of the economic welfare objectives of the programme. This has increased sentiment for expanding the numbers of units above the existing maximums so that the apparent wealth produced in fishing today may be more equitably shared. High prices and the free transfer system also have aroused fears of permit transfers from rural areas heavily dependent upon fishing to urban and non-resident holders who have the financial backing to purchase the permits.

In 1978 both the commercial fishing loan act and the limited entry act were amended to allow fishermen to use permits as security in obtaining State loans for their purchase. The loan law was further amended to assure that only Alaskans would be able to use this means. In 1979 the Legislature created the Legislative Limited Entry Study Group to deal particularly with the problems of the "have nots" and the transfer process. The committee had three main objectives: (1) to re-open consideration of all permit applications which were denied because of late filing; (2) to "knock out" the value of the permit completely by the Commission buying back permits or other means; and (3) to replace present free transferability of permits with some form of restricted or controlled transfer to "qualified transferees".

The Group's proposed bill would set up an apprenticeship programme to open up entry to young persons in Alaska with appropriate "predisposition and other fishery related attitudes". It would also set up other forms of transfer to assure the diversion of the flow to "favor the supply of permits to people who are responsible for the support of their families, or to favor the spreading of a limited asset, the entry permit, over as many families as possible". The Legislature has not taken action on these proposals, but the issue of reform is still alive.

Although there is no strong sentiment in Alaska to abolish the limited entry programme, it is clear that it will be undergoing a continuing process of reform. These amendments will progressively strengthen the socio-economic welfare objectives which have long been entrenched in Alaskan politics, leaving the biological management of the resource to existing agencies and philosophies.

NOTES

1. For a fuller treatment of this subject refer to Rogers (1979).

2. Governor Hammond plans to move the Commission from his office to the Department of Fish and Game on July 1, 1980, but this is a means of reducing the clutter in his office (the number of divisions in his office is limited by statute) rather than a closer integration of economic and biological objectives.

3. This discussion and analysis was done before the research findings of Steve Langdon (1980) were available. Langdon's study is considerably more detailed and complete than that presented here, but the findings are similar.

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16

THE POLITICAL ECONOMY OF FISHERIES MANAGEMENT IN THE NORTH EAST ATLANTIC

by

Neil Black McKellar

HISTORICAL BACKGROUND

In Northern Europe government intervention in fisheries goes back at least as far as the Middle Ages, with sixteenth century policy measures designed to stimulate the demand for fish by compelling the public to eat fish on three days a week in England. Later government action took the form of floating fishing companies and subsidising the fleet (Hood, 1976). This was in the context of an Anglo-Dutch war which might be seen as a 17th century attempt to establish property rights over the North Sea herring. The dispute concerned the fish tax which Charles I considered he had every right to exact from the Dutch fishing herring off the east coast of England (Toyne, 1952). Since the late 19th century, concern for conservation has provided the main impetus for government intervention in fisheries. Given such auspicious beginnings it is particularly disappointing that in reviewing the recent evolution of fisheries management in the North East Atlantic, one is bound to conclude that it has been characterised by its failures rather than its successes.

This begs the question of why the countries of Northern Europe appear to have remained near the bottom of the ladder of fisheries management when countries such as Australia and Canada have progressed variously towards rational schemes of economic management. The problems confronting developed commercial fisheries have been broadly the same throughout the world, namely those associated with unrestricted access to common property resources. If an action uses valuable resources, but no one's consent is purchased, the sacrifices caused by the action will not be fully recognised; there is an external cost. This happens in marine fisheries because the legal framework does not assign rights to anyone. The operations of each fishing vessel impose costs on other vessels by reducing the fish stock, thereby increasing average costs for all vessels. Externalities can also arise from crowding of vessels and the effect of fishing gear on the growth behaviour of the stock. As it is in no single individual's interest to restrict his effort, there will normally be excessive entry of labour and capital until all economic rent is dissipated.

In addition to these intra-national stock and technological externalities, there is also what might be described as inter-national externalities. By this is meant the extent to which one country's fishing industry is affected by the actions of others, either directly through their fishing effort or by the regulatory activities of the other countries' governments. This interdependence is particuarly pronounced in an area like the North East Atlantic where there is extensive movement or intermixing of stocks between the coastal water of more than one state. In addition to the problems of migratory or joint stocks, until recently there were 17 nations with fishing fleets actively prosecuting fisheries within the region (International Council for the Exploration of the Sea, 1979). Few of the international political conflicts which were evident during the High Seas or North East Atlantic Fisheries Convention (NEAFC) regime have been resolved or disappeared as a result of extension of national fisheries zones to 200 miles in 1977. This may be attributed to the failure to settle the Common Fisheries Policy (CFP) of the European Economic Community (EEC) together with the increased fishing pressure on home water from displaced distant water fleets and improved catching technology. Vessels of Member States' fleets continue to enjoy equality of access within one another's fishery limits, up to six or twelve milès from base lines.

This absence of exclusive jurisdiction over major fish stocks has tended to limit regulation to purely biological objectives and as will be shown below, none too successfully at that. Without single nation control over the rate of depletion of stocks it is not possible to determine economically optimum rates of exploitation. If countries with diverse economies, political objectives, and varying social preference rates all have some influence in determining exploitation rates, the problems presented by exclusive fisheries jurisdiction that have been discussed extensively at recent symposia (Pearse, 1979; Anderson, 1977) are clearly compounded. In other words, the application of capital control theory to the problems of fishing which has enriched fishery economics theory in a variety of ways (Butlin, 1974) is likely to have a much more limited impact on the eastern side of the Atlantic than on the west, where there is single state control over most stocks. Similar limitations apply to the adoption of pulse fishing of several stocks on a "rotational" basis (Hannesson, 1974).

The issue of joint stocks shared with non-Community countries such as Norway and the Faroe Islands presents a more formidable long term obstacle to determining economically optimal rates of exploitation than fisheries shared exclusively by the Community states. As integration and harmonisation of economic policies progress throughout the Community the difficulties of choosing an appropriate social rate of time preference may be expected to diminish. For the relatively few major commercial stocks which remain entirely within the coastal jurisdication of Community countries, it should be possible to calculate appropriate harvesting rates which will reduce their stocks to the level where their growth rate equals the social rate of time preference (Clark, 1972). However, the problems of comparing net benefits in one period with another and the costs of assembling the biological and economic data required as input to some of the bionomic models featured in much recent literature, raise serious practical difficulties. In this connection it will be interesting to see what contribution the introduction of microprocessing technology might make. Whilst this multinational dimension provides some explanation for lack of progress on the introduction of programmes for rational economic management in Northern Europe, it is not a complete explanation. There remains a number of discrete stocks, in particular of shellfish, which are and have been under coastal state control since the extension of fishery limits to 12 miles in 1964. A possible explanation might be found in the cost of internalising the externalities. In many instances, externalities persist because the effects have "public good" characteristics (McKean, 1968).

It is expensive to exclude non-payers from reaping benefits so that a price of admission could be charged. To achieve Pareto optimality external effects should be taken into account whenever gains from doing so exceed the costs. The emergence of some degree of exclusive property rights in fisheries will depend in part on the ratio of these gains and costs. These in turn will be affected by changes in economic values or changes in technology. While the rise in the real price of fish is usually given as an explanation in the North East Atlantic it seems to have been largely technological advances in the catching sector of the industry that have been responsible for the move towards property rights in the form of extended fishery limits. Unlike pelagic fishing the technology associated with shellfishing in European waters has remained relatively unchanged. Where technical innovation has appeared in items of equipment like pot haulers, these have tended to improve working conditions for the crew rather than to alter dramatically the catch per unit effort of the vessels. Another feaure of shellfishing in some European countries is the preponderance of older fishermen, with low opportunity costs, often using old boats, which have percolated through other uses to end their days in the less demanding inshore shellfisheries.

It is interesting to note that, in contrast with shellfisheries, the technological advances in fish finding and catching techniques associated with pelagic fishing for mackerel and herring have been much more marked over the last twenty years. The progression in gear type has been from drift net through ring net and pair trawl to purse seine. A similar sized vessel with comparable labour through with very different capital configuration using a purse seine would have a catching power 15 times greater than the drifter it replaced. In support of the contention that technologial development has been the primary driving force in moves towards establishing property rights it is perhaps significant that herring has featured so prominently in international fisheries negotiation on the North East Atlantic. This has always been in excess of its economic importance; herring accounts for less than ten per cent of the total catch in the area of the International Council for the Exploration of the Sea in recent years and much less in terms of value. There are, of course, other factors affecting pelagic fisheries, such as their relatively short life span, before they enter commercial fisheries which makes biological forecasting more difficult and their shoaling behaviour which makes them vulnerable to "Hoovering" techniques. It is nevertheless not without significance that the only two limited entry schemes that have involved British domestic fisheries have been pelagic fisheries. These are the Manx herring and the western mackeral fisheries.

MANAGEMENT STRUCTURE

NORTH EAST ATLANTIC FISHERIES CONVENTION (NEAFC)

While there was little or no economic content in the fishery control measures recommended by NEAFC it would seem to merit a very brief review on the grounds that it highlights the conflict of economic interest displayed by the contracting states and its basis for regulation looks like continuing into the new regime. It was not until 1974, some eleven years after starting work, that NEAFC states found the facts sufficiently compelling to introduce quantitative restrictions in addition to the minimum mesh and fish sizes that they had inherited from NEAFC's predecessor the Over Fishing Convention. How the necessity of using Total Allowable Catches (TACs) was finally accepted and the practical outcomes of their introduction are best illustrated by reference to individual stocks. The biologists had expressed concern about the state of the North Sea herring stock throughout the 1960s, but some NEAFC states with substantial economic interests (Denmark with its dependence on fish meal production for pig farming was a good example) found themselves prevented by these interests from accepting the consequences of the scientific advice, namely that the catch should be drastically curtailed, if it was not to fail altogether. Naturally these states did not present their arguments in stark terms of economic self- interest but rather stressed the "incompleteness" of the scientific evidence.

After the four years which followed the proposal to introduce a TAC, NEAFC members recognised that the closed seasons which they had introduced as an alternative measure had been so timid that the had no impact whatsoever on fishing mortality (NEAFC Report, 1974). Eventually, it was agreed to introduce a TAC for North Sea herring for the year 1974/75 of 494,000 tonnes compared with the biological recommendation of 270,000-360,000 tonnes. This reflected the difficulty of obtaining national quotas acceptable to the states concerned, the basis for allocation of national quotas being largely historical performance. The damage to the North Sea herring stock was by that time so great that the major participants, Denmark and Norway, fell a long way short of taking their quotas. Nevertheless, when NEAFC recommended by a majority in May 1975 that the TAC for an eighteen-month period from July 1975 be set at 254,000 tonnes and that all directed fishing for industrial (as opposed to human consumption) purposes should be banned, this failed because of objection from Denmark, Norway and Iceland. During 1976 a TAC of 160,000 tonnes for the year was eventually agreed. The North Sea herring, however, had no appreciation of the problems of international politics and this decision was not enough to produce any real improvement in the stocks. The next year saw the introduction of extended fisheries zones, covering the whole of the North Sea and full international agreement was no longer a legal necessity for the introduction of the total ban on herring fishing that was by then essential (Driscoll and McKellar, 1979). This ban has continued through until the present time.

NEAFC's failure to regulate North Sea herring fishing was repeated with other endangered stocks. The Dutch, with their very effective beam trawlers, were the principal catchers of North Sea plaice and sole and played a similar role to the Danes in disputing the seemingly irrefutable biological evidence, with the result that TACs were set well in excess of biological recommendations. These instances of the failure of NEAFC illustrate the extent to which individual states, many of whom are also in EEC, pursued policies which reflected the pressures exerted by their domestic industries which would have had to cut back or modify their economic activities if conservation were to be effective. Such changes were bound to be costly, particularly for industries like the Danish which had been developed specifically for industrial fishing. The reluctance of these industries to accept change was reinforced by the apparent absence of alternative fisheries to redeploy their non-malleable capital. In certain instances the problem of adjustment was further aggravated by national measures providing additional subsidies to assist fleet owners with depressed earnings. Governments were instrumental in maintaining total inputs to fishing even when catch levels were reduced.

Butlin (1979) concludes that even with some form of supranational jurisdiction, to ensure that a multinational fishery can properly be regulated, rational short run considerations and concern about short run domestic employment may well outweigh longer run considerations about the state of the fishery. Incidentally, the same paper makes a critical appraisal of the enforcement and cost- raising features implicit in the NEAFC quota system together with a review of the other direct regulatory measures it adopted.

Given the example of North Sea herring the welfare gains to each of the NEAFC countries from the rational exploitation of stocks they jointly fished could have been considerable. The experience of NEAFC and probably other international fisheries commissions stressed the need for a different form of organisational base particularly with respect to taking qualified majority decisions.

The conflict between industrial fishing nations like Denmark and those interested in larger fish for human consumption like the U.K. raises some interesting problems for modelling. Much of the theoretical approach in the literature assumes there is one optimal age at which the biomass should be harvested. That the age of capture can significantly affect the catch is very relevant to the debate over catches of immature fish. A further related subject, which has not received very much attention from economists is that of biological interdependence. The economic implications following a better understanding of the total eco-system (Anderson and Ursin, 1977) could be very substantial. An optimal strategy might require a poor converter like cod to be deliberately depleted in order to obtain a larger yield of similar valued haddock from certain grounds.

EUROPEAN COMMUNITY - COMMON FISHERIES POLICY

While all Member States of the European Economic Community with Atlantic coastlines individually extended their fisheries limits in 1977, this did not have the same implications for control by coastal states that prevailed elsewhere. The reason for this is the part emergence of the Common Fisheries Policy (CFP) of EEC. Much of the development of the CFP is complex and involving issues of international policies and law, which need not concern us here (see Driscoll and McKellar, 1979). However, one principle of the policy is very relevant to the kind of management regime that is gradually being formulated. This is contained in Council Regulation 101/76:

> Rules applied by each Member State in respect of fishing in (its) maritime waters... shall not lead to differences in treatment of other Member States.
>
> Member States shall ensure in particular equal conditions of access to and use of (their) fishing grounds ..... for all fishing vessels flying the flag of a Member State and registered in Community territory (Article 2.1 pp.19-20).

The maritime waters referred to are those within the 200 miles in the Atlantic claimed by EEC countries or up to the median lines where appropriate. One exception to this covers the inshore waters of U.K., Ireland, Denmark and France where a derogation in the Act of Accession Articles 100 and 101, applies to the six mile fishery limit or even twelve in certain prescribed areas, until 1982.

The European Commission has also advanced its proposals for a basic regulation establishing a Community system for "the conservation and management of fishery resources". Largely because of British disagreement with the allocative criteria proposed by the Commission, a piecemeal regime has existed since 1977. An unofficial system of TACs and national quotas operates for Member States other than the U.K., but this displays many of the characteristics of the NEAFC regime and national enforcement has led to the Commission conceding it is "far from perfect" (Booss, 1979).

The general extension of fishery limits led to a substantial decrease in the availability of demersal fish for Member States like U.K. and Germany with disant water fleets. It is argued by the Commission that due to the removal of COMECON countries, this loss was compensated in weight terms by catch possibilities within the extended fishery zones of EEC countries. One difficulty about these "paper fish", as they are sometimes referred to, is that they are mostly non-preferred species such as blue whiting and horse mackerel, which are likely to encounter technical and marketing problems, and industrial species such as Norway pout, sandeel and capelin. This contributes to the failure to resolve the allocation problem of fish resources within the Community. The British, who lost most in absolute terms from exclusion from non-Community country waters (380,000 tonnes) and whose own extended fisheries zone contains the bulk of the preferred fishing opportunities (over 60 per cent), are not prepared to accept allocations of unfamiliar species under the proposed Community system. British fishermen feel they have lost-out twice, first to non-Community states like Iceland and then to Community partners who as a result of the Common Fisheries Policy would be able to fish up to British base lines by 1982. The perception of this compounded loss and inadequate recompense has led to pressure for a broad exclusive coastal belt for British fishermen and a "dominant preference" within part of the rest of the extended jurisdiction.

An economic justification of the British position might be found in the general defence of extending coastal zones (Hanness-on, 1974). This is that extension of fishing limits might meet Pareto-based welfare criteria, that is, that every nation involved would gain from the change and that fish consumers in the rest of the world could compensate fishermen in the rest of the world for their losses. In so far as extension of limits facilitates more efficient exploitation of fish stocks, it generates benefits that will be distributed between producers and consumers through trade, resulting in a greater consumer surplus if the resource is seriously enough depleted, and economic rents for fishermen or fish exporting countries. It is, therefore, misconceived to regard extension of limits as analogous to confiscation of foreigners' property. In the case of appropriat-ion of fish stocks, where the point of departure is bionomic equilibrium under common property, it is largely a question of generating economic rent and not confiscation.

In their proposed allocation the Commission has resorted to the criterion of historic fishing performance used by NEAFC. It has also added that attention should be paid "to the vital needs of areas in which the local populations are particularly dependent on fishing and related industries inter alia Ireland, Greenland and the northern parts of the United Kingdom". A further criterion, more recently added, is the compensation of losses due to jurisdictional changes. The United Kingdom continues to press for the inclusion of a preferential growth formula.

More recently it has been made clear that biological considerations alone may not be allowed to determine the TACs that annually need to be fixed for stocks within the extended jurisdiction of Member States (Laing, 1979). The same author suggests that:

> ...it would be unsurprising if social (i.e. political) considerations were allowed to over-ride the economic;

it is not unlikely that restrictions will be placed on certain types of vessel or gear to protect certain classes of fishermen. Thus to the depression of long term yields introduced by political factors in the determination of the conservation measures and enforcement regime, there must be added the higher total economic costs of harvesting the yields available which are brought about by those restrictions on the more efficient methods of fishing that socio-political factors are deemed to demand.

Whether the regional implications of Common Fisheries Policy will materialise in this way, is difficult to judge. Certainly fisheries have tended to be given a blotting paper role in absorbing surplus labour in some regional development programmes in the past. The fisheries programme of the Highlands and Islands Development Board provides an example within the U.K. Whether a move towards defending regional rather than national interests provides an indefinite interim solution to CFP problems or whether a more co-ordinated Community regime emerges it seems unlikely that the management system will do other than allocate Member States some annual share of TACs.

While the similarities between the approach to management by the Community and NEAFC have been stressed, there are also some important differences. To begin with the exclusion of COMECON countries has reduced the participants. Also, unlike NEAFC, where negotiations were held on a stock-by-stock basis, in a poltical vacuum, negotiations within the Community on sharing TACs are much more likely to be linked to other issues and decided on the basis of a qualified majority. Once agreed such arrangements would have the backing of Community law which is in marked contrast to the voluntarist basis of NEAFC. Another feature of the Community proposals is that they include a package of restructuring measures designed to aid adjustment of the changed conditions. Whilst they envisage parts of quotas being transferable between states as the season progresses, it is unlikely that the basis for determining TACs will depart significantly from purely biological objectives (that is, maximum or optimum sustainable yield).

This then puts the onus back onto Member States to regulate and control their own industries' activities. In other words individual Member States will be free to pursue sub-optimal rationalisation policies. This may at first seem disappointing but a quick look round the world suggests that few if any countries have been able to achieve anything better. It is not easy to find current examples of fisheries with economically optimum rates of exploitation. There are not even very many examples of fisheries where the state is clawing back any economic rent at all, let alone at levels consistent with achieving more rational levels of input. El Salvador has a limited entry scheme for its shrimp fleet and an ad valorem export tax on shrimp, which serves to remove some of the economic rent, but this is exceptional and there is no deliberae policy to use the tax as a regulatory measure. On the other side, the

United States has gone so far as to write into legislation that the creaming-off of economic rent from domestic fishing fleets cannot exceed the costs of enforcement and administration of fisheries policy.

Reviewed in this light, the prospects for Western Europe countries to make progress towards more rational exploitation of their annually determined catch levels look considerably brighter.

POLICY ALTERNATIVES AVAILABLE TO THE UNITED KINGDOM

The earlier sections of this paper have dwelt primarly with the international aspects of fisheries management. This final section takes a brief look at the ways in which the United Kingdom, within the constraints already mentioned, might take steps to exploit the fish resources available to her in a more rational economic way. Particular attention is paid to the transitional stage in moving from what is essentially open access to a more controlled state.

Almost every paper on fisheries economics begins by deploring the tragedy of the commons, the absence of property rights, the inevitable tendency of unrestricted access to result at best in an over-allocation of inputs and at worst the ultimate collapse of the fishery. The biological arguments are well understood by fishermen in U.K. but there remains a reluctance to accept those associated with the economic waste. Concern with conservation has in some senses blinded them from all else. This is evident in the concern which exists about having insufficient capacity to harvest the expected improvement in stocks resulting from conservation measures. There is also an underlying feeling that if conservation measures could be made effective and the nasty foreigners could be stopped from cheating all would be made well. In some respects this view is reinforced by the experience of traditional TACs and national quotas, designed to achieve biological objectives. Under the more successful of these, there has been evidence of increased catches and stability or increased employment. Even if this has meant shorter fishing seasons, there are usually alternative fisheries available to multipurpose fleets.

TOTAL ALLOWABLE CATCHES

One policy alternative would be to continue with a national quota system perhaps with some improved enforcement. A difficulty which is immediately encountered, however, is the means by which such national quotas should be allocated between vessels in the fleet. If left to run until exhausted with a free-for-all several disortions arise. To some extent the worst extremes of this may be avoided by dividing the quota into seasons. An alternative which has been used in the United Kingdom is to limit the catch by individual vessels, usually weekly, which if based on correct predictions of catch rate and number of vessels participating will stretch the fishery to cover the normal season. Apart from the increased cost of fishing, an important disadvantage which applies to quotas, which are bought as well as those allocated free, arises through the practice of discarding fish. This goes on in most fisheries for valid reasons like complying with the minimum length size. However, under a boat quota system, it is not uncommon for a crew to select only the large or other preferred quality specimens and return the rest of the catch, dead, to the sea. In the recent Clyde herring fishery it was suggested that double the TAC was caught though not landed. Particularly where the catching potential of a vessel exceeds its boat quota, there is a clear incentive for crews to be selective in what they land. The extent to which this undermines the objective of the management scheme depends in part upon the degree of recognition that is given to the practice in setting the TAC.

Where discards are not a feature of the operation of quotas and the escapement level is predictable, it has been demonstrated theoretically that unless entry to the fishery is limited, management by escapement control will lead to an increase in the number of vessels beyond the bionomic equilibrium of the unregulated fishery (Clark, 1979). Because of the visible benefits mentioned earlier, the fact that the fishery has become more over-capitalised under quotas than in the unregulated state may be overlooked until the inevitable poor season leads to economic disaster for the expanded fishery. Factor misallocation is perpetrated by controls that do less than completely limit entry (Crutchfield, 1979).

QUANTITATIVE RIGHTS

Given the familiarity of British fishermen with individual boat quotas, or quotas per man, it is interesting to note the recent resurgence of interest in the literature (Pearse, 1979) on quantitative rights or freely transferable individual quotas as an alternative means of controlling fishing effort. This is the concept of creating a right to specific quantities of fish. As it starts at the TAC or national quota level and works back to the quantity available to each vessel it is perfectly compatible with the prescribed harvest constraint within which any British policy would have to operate. It is argued (Scott, 1979) that a system of quantitative rights is sufficient to produce a social optimum.

The advantages include flexibility, tighter control over each season's catch than by either a tax or limited entry, entrepreneurial freedom in choice of vessel and gear fishing time, and would present no disincentive to technological development (Crutchfield, 1979). There are some disadvantages, however, which do not seem to have been adequately considered. Enforcement problems include the one already mentioned about discards and also the possiblity of fishermen claiming that their catch had come from a different ground than the one on which it was caught. There may also be more difficulty in coping with major fluctuations in abundance than has been conceded in the literature. This could present problems at the level of setting the TAC and what materialised during the fishing season as the actual catch rate. If the holders of quantitative rights perceived a decline in catch rate over the expected catch rate, the tendency to compete would not be completely eradicated, especially towards the end of the fishing season. While the most obvious economic solution to the allocation of quantitative rights is an open auction, the experience with limited entry schemes strongly suggests that the preferred government policy is to distribute new forms of rights to those already participating. Given the number of mixed fisheries and the multipurpose nature of much of the British fleet this could present serious administrative difficulties. An alternative which might be worth examining would be the auctioning of blocs of quantitative rights to producer organisations, who would then allocate them between members.

LIMITED ENTRY

If it is accepted that a system of freely transferable quantitative rights is superior in most respects to a tax on the catch (Pearse, 1979) the remaining policy alternative is limited entry. The possibility of limiting entry by means of restrictive licencing, has attracted a considerable amount of interest at industry and administrative levels within the United Kingdom. Experience has been limited to an attempt to restrict the fleet fishing for the Manx herring. This involved the Isle of Man authorities placing an eligibility criterion of particpating in the fishery during the two previous fishing seasons before granting a licence for the 1977 season. The result was to allow only 100 British vesssels, 24 Irish vessels and the Manx fleet to take the 8,000 tonne TAC. Partly as a result of rising herring prices, the authorities gave way to pressure from producer groups to relax the entry conditions. There is also a proposal to limit entry to the mackerel fishery during 1980, but the details of this scheme have not been finalised. Since the exclusion of COMECON fishing fleets, this fishery has developed spectacularly in about three seasons to provide around a third of the total British catch.

However, the fleet now deployed on the mackerel includes freezer trawlers displaced from traditional grounds in distant waters and purse seine and pair trawlers no longer able to fish herring, and is greatly in excess of the capacity required to harvest the mackerel. This is symptomatic of the overcapitalisation that exists throughout the British fleet. Recent studies using a model developed by the Fisheries Management Modelling Group (comprising staff from the Marine Laboratories of the Ministry of Agriculture, Fisheries and Food, the Department of Agriculture and Fisheries Scotland, and the White Fish Authority) have indicated the extent of this over-capacity.

The model calculates the pattern of fishing effort (E_{advp}) required to catch as closely as possible any given set of

U.K. quota allocations (Q_{bs}) whilst:

a. departing no more than necessary from the historic pattern of fishing effort;

b. taking due account of minimising cost.

This is done by minimising a compound non-linear objective function (F) which has three components namely:

1. The Quota Mismatch Penalty

$$F_1 = \sum_{bs} P_{bs} \ (C_{bs} - Q_{bs})^2 \ / \ Q^1_{bs}$$

where suffices b and s indicate resource area and species, P is the average price of fish by resource area and species, C_{bs} are actual catches (by weight), Q_{bs} the quotas (that is, U.K. allocations) and Q^1_{bs} represents a modified form of Q_{bs}.

2. Disruption Penalty

$$F_2 = \sum_{advp} H_{advp} \ (E_{advp} - E'_{advp})^2 \ / \ E_{advp}$$

where a, d, v, p represent fishing area, fishery district, vessel type and period of the year, H_{advp} are the earning rates (pounds sterling per day absent) for each effort category, E'_{advp} is the new pattern of effort (in days absent) and E_{advp} is the old pattern of effort.

3. Net Cost Term

$$F_3 = \sum_{advp} (Z_v - H_{advp}) \ E_{advp}$$

where Z_v is the cost per day absent for a given vessel type. The compound objective is then constructed as:

$$F = W_1 F_1 + W_2 \ F_2 + W_3 \ F_3$$

where W_1, W_2 and W_3 are the weighting factors to be applied to the various terms in the objective. By varying the weighting factors one can put more (or less) weight on meeting the quotas or avoiding disruption or minimising cost or whatever mixed objective is desired. It would be noted that the weighting by P_{bs} and H_{advp} in F_1 and F_2 respectively serves to bring these penalty functions into monetary units so that they are roughly comparable with F_3 which is a financial objecive. However, F_1 and F_2 do not have any strict definition as financial penalties (although they are fairly plausible) and the weights W_1 and W_2

must be set subjectively (relative to each other and W_3) in order to obtain an acceptable solution. This way of defining the objective function ensures that the weighting factors are dimensionless (that is, pure numbers without units) and of the order of unity (Shepard, 1978).

The result of running this model under what were termed "cautiously optimised" control settings (where weightings were 3 - Quota Mismatch, 1 - Dislocation Penalty and 1 - Net cost Factor) for three different resources or allocation scenarios for the mid-eighties is shown in table 1.

This formed the basis for a submission to government for restructuring aid to take the form of scrapping grants, temporary lay-up and early retirement. It was also argued that this should be accompanied by a system of restrictive licencing introduced by a freeze on the existing fleet. Unfortunately, this recommendation has not yet been acted upon, with the predictable result of speculative building in anticipation of licencing or at least new investment plans being brought forward. Even without this new building the proposed freeze and modest programme of restructuring aid to withdraw some excess capacity, added to the contraction that has already taken place in the fleet which takes wet fish in distant waters which were left with no alternative fishing opportunities, would not produce the required reduction in capacity. While there are strong economic arguments in favour of letting the price mechanism resolve the allocation problem, both initially through an auction (albeit weighted to favour existing participants) and through freely transferable licences thereafter, this meets with hostility at all levels in the British industry. Even though potential rent would be capitalised in the value of the licence held by existing vessel owners, under the kind of government distribution of rights generally favoured, many of these groups are completely opposed to freely transferable licencing. This can be explained by what is an almost paranoic fear of large company domination of the traditional skipper-owner section of the fleet. Empirical studies (Meany, 1979) which demonstrate no trend toward company ownership do little to allay these fears. The kind of arguments which prevail are that large companies can use resources acquired outside fisheries to buy licences and that they are in a more favourable position to assess the market value of these licences than an inshore skipper-owner. So long as the group most likely to benefit from the introduction of restrictive licencing remains hostile, the prospects of introducing an effective scheme to control inputs are not encouraging.

USE OF MORE THAN ONE REGULATORY MEASURE

It has been suggested in the U.K. that steps should be taken through vessel licencing to restrict entry to all commercial fishing. These licences would be endorsed to indicate the fisheries in which the vessel had participated in certain previous fishing seasons. This could be used initially to limit the number of vessels allowed to participate in particular fisheries in the future. They could also be used to hasten the process of attrition, by removing the endorsement whenever a vessel was not used in a particular fishery for which it was

Table 1. Estimated size of British fleet required by mid-80s calculated from non-linear-fleet operation model

Vessel categories	Actual fleet 1977	Required fleet 1977	Required fleet in mid-80s assuming* Pesimistic	Optimistic	Optimistic + industrial fish
Less than 12m	4 601	2 171	1 308	1 377	1 451
12 and under 19.5m	1 530	1 176	1 051	1 319	1 320
19.5 and under 24m	494	447	402	459	506
24m and under 33m	108	82	71	79	91
33 and under 42m	124	114	87	110	126
42 and over					
- Freshers	59	53	28	27	28
- Freezers	38	33	19	20	21
Total fleet tonnage '000 GRT	253	210	152	179	188
Target catch '000 tonnes	-	-	1 024	1 244	1 455
Realised catch '000 tonnes	895	895	990	1 134	1 319

* The allocation scenarios corresponded to the Commission proposals, an industry view and an industry view plus an allocation of industrial species.

eligible. However, if this system were developed to the point where endorsements also specified a quantity entitlement and these were made freely transferable, a system of quantitative rights would have evolved.

CONCLUSION

This descriptive paper has attempted to apply developments in economic theory to the practical problems of fisheries management in the North East Atlantic. An important conclusion is that some developments in fisheries economics theory, such as the application of capital control theory and pulse fishing, are not really relevant to coastal states within the EEC which, despite extended jurisdiction, are not in a position to determine exploitation rates on their own. The existence of joint stocks and the equal access provisions of the Common Fisheries Policy mean that Member States can only pursue sub-optimal rationalisation programmes. While this might place them at a theoretical disadvantage, experience elsewhere in the world suggests that few, if any, other management schemes have pursued other than sub-optimal objectives. The paper closed with an examination of the policy alternatives available to the United Kingdom to improve allocative efficiency within the constraints of a prescribed harvest. The major conclusion from that examination was that the choice of policy will depend, as in most other countries, much more upon regional and social criteria than on economic criteria.

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ECONOMIC ASPECTS OF NEW ZEALAND'S POLICIES ON LIMITED ENTRY FISHERIES

by

Peter Riley

INTRODUCTION

In New Zealand's experience of limited entry fisheries an evolution of policy objectives can be seen. How these objectives were attained and the economic effects of their pursuit is the subject of this paper.

Prior to the settlement of the first Europeans early in the 19th century the Maori people were subsistence fishermen whose catch yielded marine organisms from the beaches and shores. A peaceful coexistence of man's exploitation and the regenerative power of the fisheries was maintained. However the bountiful seas became a magnet to European adventurers and traders and before long sealing and whaling became the first fishing industries in the country. The heavy slaughter of the seals took its toll and resulted in sealing prohibitions by the turn of the 20th century. The multitude of whaling stations that were established on shore gradually became uneconomic and by 1900 only five remained. One of these sited near the Tory Channel survived until 1965 but despite incentives on the export of whale products poor returns finally brought about its closure.

The development of demersal fisheries was given a boost by the visit of Professor E E Prince, an eminent Canadian fisheries consultant who undertook an extensive survey of New Zealand's freshwater and marine resources in 1913. He estimated that the sea around N.Z. provided 50,000 square miles of accessible fishing grounds. (Current technology allows the demersal fishermen access to one-third of the 1.4 million square miles of sea encompassed by New Zealand's Exclusive Economic Zone (EEZ).)

Some of the first major policy initiatives were undertaken by Mr C F Ayson who was the Chief Fisheries Inspector at the time of the arrival of Professor Prince in 1913. Mr Ayson accepted Professor Prince's recommendations of 1914 and developed a policy which encouraged fishing for species with commercial potential rather than giving top priority to conservation. This policy I would describe as "judicious exploitation of the marine fisheries" (objective No.1). In contrast, his successor Mr Hefford in his first report stated that "the principal objective of scientific administration is to regulate exploitation so that it does not cut too deeply into the resources that must be maintained to ensure adequate stocks for the future". I will call this objective No.2.

This statement heralded a new era in development, the major aim became "conservation" as opposed to "judicious exploitation" and the resulting regulations were designed to secure that aim. By 1927 existing seasonal closures for all methods of fishing, and areas in which Danish seining were completely prohibited, were extended. Trawling restrictions were recommended for Hauraki Gulf and by 1929 trawling and Danish seining were prohibited in additional areas.

Objective No.1 seems consistent with current proposals and developments. This does not imply that New Zealand's fisheries policy has remained unchanged in 65 years, rather it shows that objectives have turned a full circle during that period.

RESTRICTIVE LICENCING

One year after the licencing of the catching, wholesaling and retailing sectors of the industry under the Industrial Efficiency Act 1936, the Sea Fisheries Investigation Committee was formed following concern about the effects of overfishing. Their recommendations included the discouragement of exports and appear to have been influenced by the effects of the depression. Fisheries were seen primarily as a source of nutritious food and at that time fish formed an insignificant part of the diet of the population apparently due to relatively high prices. Fish exports were expanding aided by vigorous price cutting by the traders and were seen as a threat to increased consumption on the local market. It was generally thought that the population could absorb the production of the entire industry. If this were the case exports would deprive the people of a wholesome food in order to line the pockets of the merchants.

It would appear that the Committee seriously underestimated the potential of the fishery. In 1945, under an amendment to the 1908 Fisheries Act, licencing of fisheries which had been administered by the Bureau of Industries and Commerce became the responsibility of a one-man licencing authority. By that time licencing of the catching sector only remained in force and when reviewing licence applications the Authority considered the following criteria (S.9 Fisheries Amendment Act 1945):

1. The desirability in the public interest of conserving sea fisheries.

2. Desirability in the public interest of re-establishing discharged servicemen in civil life.

3. Such other matters as in his (the Authority's) opinion are relevant to the application.

Major reasons for introducing vessel licences were that catches were rising, landings produced smaller fish, and vessels had to steam further to find fish, due to the depletion of some inshore grounds.

One of the most significant requirements of restrictive licencing was that a licenced fishing boat could operate from, and land its catch only at, the place or places specified in its licence - usually a single port. The philosophy behind this measure was that the Licencing Authority could assess applications for licences in the light of the available stocks in the vicinity of the port. The Authority's approach to the problem of rationing licences was indicated by the fact that the majority of applications were declined on the principles of conservation. In addition to licencing, other controls were implemented, such as minimum sizes on the most popular species, gear restrictions and the continuation of seasonal and area closures.

The licencing system did not take into account the fact that the industry could change due to changing technology, costs, and market demands. In 1955 the situation was reviewed by a Caucus Select Committee. The Minister of Marine was told "that evidence was produced to the committee that a continuation of licencing was necessary". However technological changes were then occurring rapidly within the industry. Large vessels of increased horsepower were being equipped with improved fish-finding gear and refrigeration equipment. Consequently the greater range and sea-going capacity blurred the geographical boundaries between the fisheries near to the ports. Licencing as a basis of port by port rationing became ineffective. Licencing of the catching side of the industry remained in force until 1963 when it was revoked by an amendment to the 1908 Fisheries Act - New Zealand's first experience of limited entry fisheries lasted 27 years.

REASONS FOR THE REMOVAL OF RESTRICTIVE LICENCING

There were two major reasons for the decision to abolish restrictive licencing. Firstly, New Zealand had a three mile territorial limit (this was not extended until 1965 even though an extension was recommended by Professor Prince as early as 1914). As the majority of the trawling grounds were outside the three mile limit, vessels from Japan could work unrestricted while the domestic fleet observed N.Z. fisheries law. Secondly, opinions were being expressed that restrictive licencing retarded the development of the industry although strong support was expressed for restricted entry in established quarters of the industry.

Biological conservation could have been achieved by methods other than restrictive licencing. For example, by terminating restrictions on the minimum length for finfish and imposing strict gear regulations to obtain selective fishing for mature catches, thus maintaining recruitment. Also by intensified marketing, particularly for domestic consumption. The records show at most ten species were landed for sale and many of these were dumped when large catches threatened a downturn in prices. Nowadays over 50 marketable species are landed. Additional income would have been generated for the fishermen had the consumer been tempted to purchase the less well-known species which were traditionally discarded. The fact that a marketable catch could have been obtained with less effort would also have lessened pressure on the prime resource stocks. This lack of promotion of most species plus the anti-exporting philosophy constrained development of the industry.

ECONOMIC EFFECTS OF RESTRICTIVE LICENCING

Because of the strict controls on upgrading and replacing vessels it is unlikely that the economic rent generated by fishermen was eroded away by over-capitalization. It would appear that fishermen seeking to expand their operations were prevented from further investment in new vessels, and entered the wholesaling and processing sectors creating over-capitalisation and unnecessary duplication ashore (Mills, 1978).

Any individual benefits were off-set by the real costs of this system to the economy as a whole. Restricted output maintained prices at an artificially high level. I believe prices probably would have fallen had increased supplies of the less well-known species been made available in an acceptable form. Adherence to minimum length restrictions meant that undersized fish died from rapid decompression and were dumped. Wastage of the resource did not make biological or economic sense. Not all these negative effects were a product of licencing but most continued unabated under its protective shield.

ABOLITION OF THE FISHERIES LICENCING AUTHORITY

The movement in the early 1960's to generate a greater wealth from the fisheries was exemplified by a statement of the Fishing Industry Committee of 1962, "namely, that every possible encouragement be given to exporters to enable them to take advantage of the opportunities that exist for a good quality fish product in overseas markets in particular Australia". (This was a major policy proposal out of many the committee made.) I will call this objective No.3. The problems experienced under restricted entry and the drive to expand the industry lead to the Committee recommending that the existing licencing system should be abolished and replaced by non-restrictive registration in 1963. This new directive emphasised exploitation rather than conservation, in order to promote exports.

THE FOVEAUX STRAIT OYSTER FISHERY

As a result of the 1963 Amendment to the Fisheries Act, the Foveaux Strait (see figure 1) dredge oyster fishermen were no longer bound by the Licencing Authority when applying for entry. After delicencing the number of vessels in the fishery jumped from 12 in 1962 to 21 in 1963. An amendment passed in 1969 fixed the number of oyster fishing permits at 23. The permits must be renewed annually, and are issued by the Ministry of Agriculture

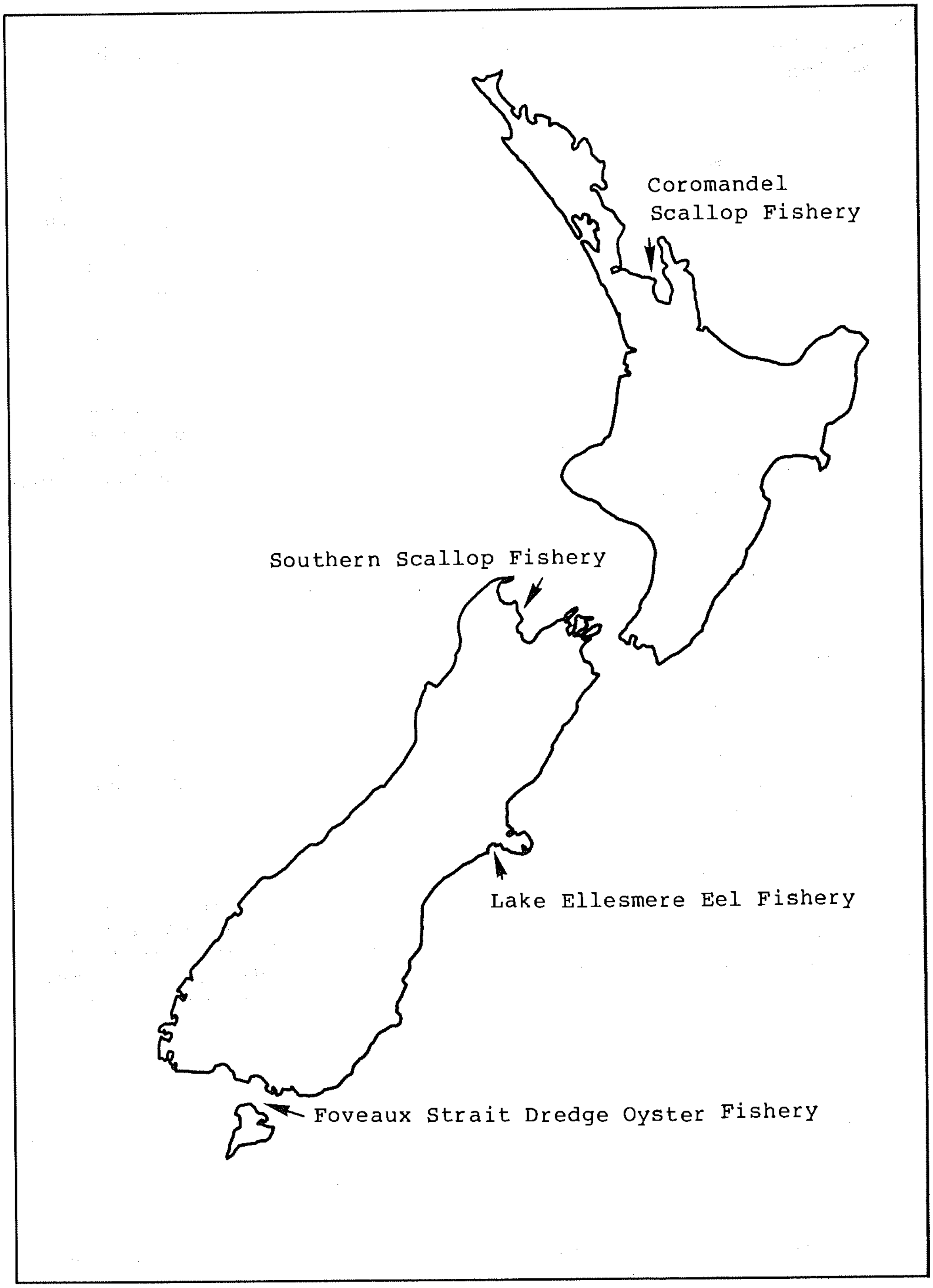

Figure 1 : Limited entry fisheries of New Zealand

and Fisheries to those fishermen who demonstrate that their vessels have been used regularly for oyster dredging in the year immediately preceding the application.

Entry to the Foveaux Strait oyster fishery was restricted not because of economic reasons but as a conservation measure under the Fisheries Act. Other controls included season quotas of 115-117,000 sacks (80 kg or 70 doz oysters per sack), vessel quotas of 5,000 sacks, gear restrictions, and area restrictions. These four measures alone could have provided safe biological yields, but by restricting the number of permits that could be granted to 23, further economic rationing was enforced.

Restricted permit numbers and non-transferability lead to the fleet being comprised largely of very old vessels. Five were built before 1920 and 16 of the 23 were built before 1960. Consequently maintenance costs are an abnormally high percentage of annual operating expenses. The costs of operating outdated vessels eats away at supernormal profits generated by the limited entry (see appendix). Because the 1963 amendment made the change of ownership of the vessels grounds for termination of the vessel permit, the fishermen are also old.

ECONOMIC EFFECTS OF THE OYSTER POLICY

The Ministry of Agriculture and Fisheries in setting a quota (currently 115,000 sacks) put an upper limit on the supply. The six-month season, usually March-August, and the restricted number of boats both protects the resource (in the biological sense) and perpetuates a static industry (protection in the economic sense). The permits, because of their scarcity, are economic goods but have no official market value. Vessel replacement has been virtually non-existent in this fishery because of the non-transferability of the permits.

The Foveaux Strait oyster fishery is the major supplier of dredged oysters on the local market with little competition at present from other sources. Demand for dredge oysters appears to be inelastic. The industry is priced on a cost-plus basis and the new season's prices which are negotiated annually are always significantly up on the previous season's, and at the new price the market is always cleared.

Technological change could increase productivity at lower unit costs. However this would necessitate the reduction in fleet numbers to maintain total effort at a stable level. Innovation is not apparent because of the non-transferability of licences and the rigid enforcement of non-transferable quotas. For example, the marginal operator would not leave the fishery because his major asset, the permit, could not be redeemed for its economic value. Despite the obvious inefficiencies this vulnerable fishery has survived where others have failed. Those fortunate enough to be associated with the fishery make profits while many fishermen in less lucrative open entry fisheries earn a subsistence income.

The apparent long term viability of this fishery is due to the planners using the appropriate Total Allowable Catch (TAC) to achieve the major aim of conserving the resource. This provides an interesting contrast with our experiences in other controlled fisheries.

OPEN ENTRY IN THE SOUTHERN SCALLOP FISHERY 1963-1977

A comparison of the Foveaux Strait oyster fishery and the southern scallop fishery provides an example of the effects of two different approaches applied to two similar types of fisheries.

In 1960 the supply of scallops was insignificant, not because of the lack of the resource but because of the lack of exploitation. Under-exploitation was caused by restrictions on entry and poor knowledge of the value of the resource. In 1979 the supply of scallops was insignificant not because of lack of exploitation but because of the scarcity of the resource. What happened in the last 20 years to bring about this state of affairs?

In 1960 the first scallop fishing licence was issued. In that year the sole fisherman concentrated mainly on experimental fishing, improving the dredge and locating the best beds. The catch of 8979 lbs of shucked meat was sold locally by the fisherman who also opened the scallops himself. Five more licences were issued in 1961 and the price dropped from the equivalent of $1.10 to 83 cents per kg. The wholesalers began opening the scallops ashore in 1962 and reduced the port price to 61 cents per kg of shucked meat. The price dropped again in 1963 to 44 cents per kg. From 1972 to 1977 the price rose from $1.32 per kg to $3.30 per kg.

With open access to the fishery in 1963 the landings of scallops increased rapidly (figure 2). The scallops provide a major source of income to most of the Tasman Bay fishermen with vessels up to 15m long, dredging also yields mussels and oysters, as a bycatch. In the off-season line fishing or trawling generally supports the full-time scallop fishermen. Whether the prospect of large catches or the lucrative prices lured additional entrants is uncertain but following the rapid expansion there was a massive downturn in landings from the mid-1970's. In the 1978/79 season the yield dropped to 38,000 cases, from 130,000 cases in the previous season (one case contains approximately 30 kg shell weight). It is yet to be resolved whether the failure was due solely to overfishing or a natural biological fluctuation or a combination of both.

CONTRASTING MANAGEMENT TECHNIQUES

The Foveaux Strait oyster fishery operated successfully for 70 years while the more recently established scallop fishery failed commercially after 15 years. Table 1 gives a summary of management techniques employed in the two fisheries. The oyster fishery operated under quotas which very effectively protected the stocks and as discussed above the rigid controls constrained efficiency. There were no restrictions on the total catch in the scallop fishery nor were there limitations on entry. The absence of controls allowed effort to escalate which probably led to the demise of the stocks. Whether the failure of the scallop fishery was actually caused by overfishing or natural mortality would make an interesting research project.

LEGISLATION TO CONTROL FISHERIES

The 1977 amendment to the 1908 Fisheries Act provides the Minister of Fisheries with the power to control a number of fisheries. This amendment stipulates that the quantity, quality or size of fish taken, and the methods used can be defined. Also, the areas fished and by whom they are fished can be determined by the Minister. Entry to the controlled fishery is by way of authorities (or licences) and these are obtained only by application to a Fisheries Licencing Authority. Many matters are taken into account by the Authority when issuing a licence,

Table 1. New Zealand's dredged shellfish fisheries, management measures used

Management measure	Foveaux Strait oyster	Southern scallop
Limited entry	Maximum of 23 boats	No
Season quota	Variable - up to 170,000 sacks depending on season	No
Vessel quota	Variable - up to 5,000 sacks per vessel	No
Size limits	Minimum size (58mm)	Minimum size 100mm
Closed season	1 Sept. to 28 Feb.	1 March to 14 July

including policies of the Minister, the standard of living of those involved in the fishery, and socio-economic effects pertaining to the individual applicant, such as boat and gear to be used, and the financial circumstances of the applicant. The Authority may specify conditions on the licence as it thinks fit.

One section of the Act states that fishing in the particular fishery must not be suspended by the licence-holder. This section was probably adopted to ensure that holders actively fish and do not obtain licences in order to achieve capital gains. However the non-transferability of licences already precludes this possibility. It is not yet clear what would happen when a licence holder does not utilise his right to fish because of the unavailability of the resource in a particular season. Would this jeopardise his eligibility to apply for a licence in the next season?

This legislation prevents any market forces placing a value on licences. For example, no goodwill may be attached to the sale of a vessel, which has been issued with an authority to fish. Perhaps market forces should have been allowed to participate in the allocation mechanism. Undoubtedly some vessel owners on seeking to leave the fishery will find that the value of their vessel may be heavily discounted if it is sold without a licence.

So far three fisheries have been declared controlled fisheries (see figure 1). These are:

the Southern Scallop fishery	(as from June 1 1978)
the Coromandel Scallop fishery	(November 1 1978)
the Lake Ellesmere Eel fishery	(December 1 1978)

Other fisheries that will be controlled within the next two years include the rock lobster fishery, the Foveaux Strait oyster fishery and the northern scallop fishery.

CONTROLLED SCALLOP FISHERIES

Besides the volatile biological behaviour of the scallop (spatfall failures often cause fluctuations in recruitment) the industry faced severe price movements during the early sixties. Fishermen's incomes were also affected by an influx of amateur and part-time fishermen competing for the rewards (see figure 2).

The Minister of Fisheries announced that as from June 1 1978 the Nelson/Marlborough scallop fishery, part of the southern scallop fishery, would become a controlled fishery. This declaration ended the moratorium on the issuing of all new permits announced in July of the previous year. Existing permits were suspended and all fishermen wishing to enter the southern scallop fishery were required to apply to the Fisheries Licencing Authority for a licence.

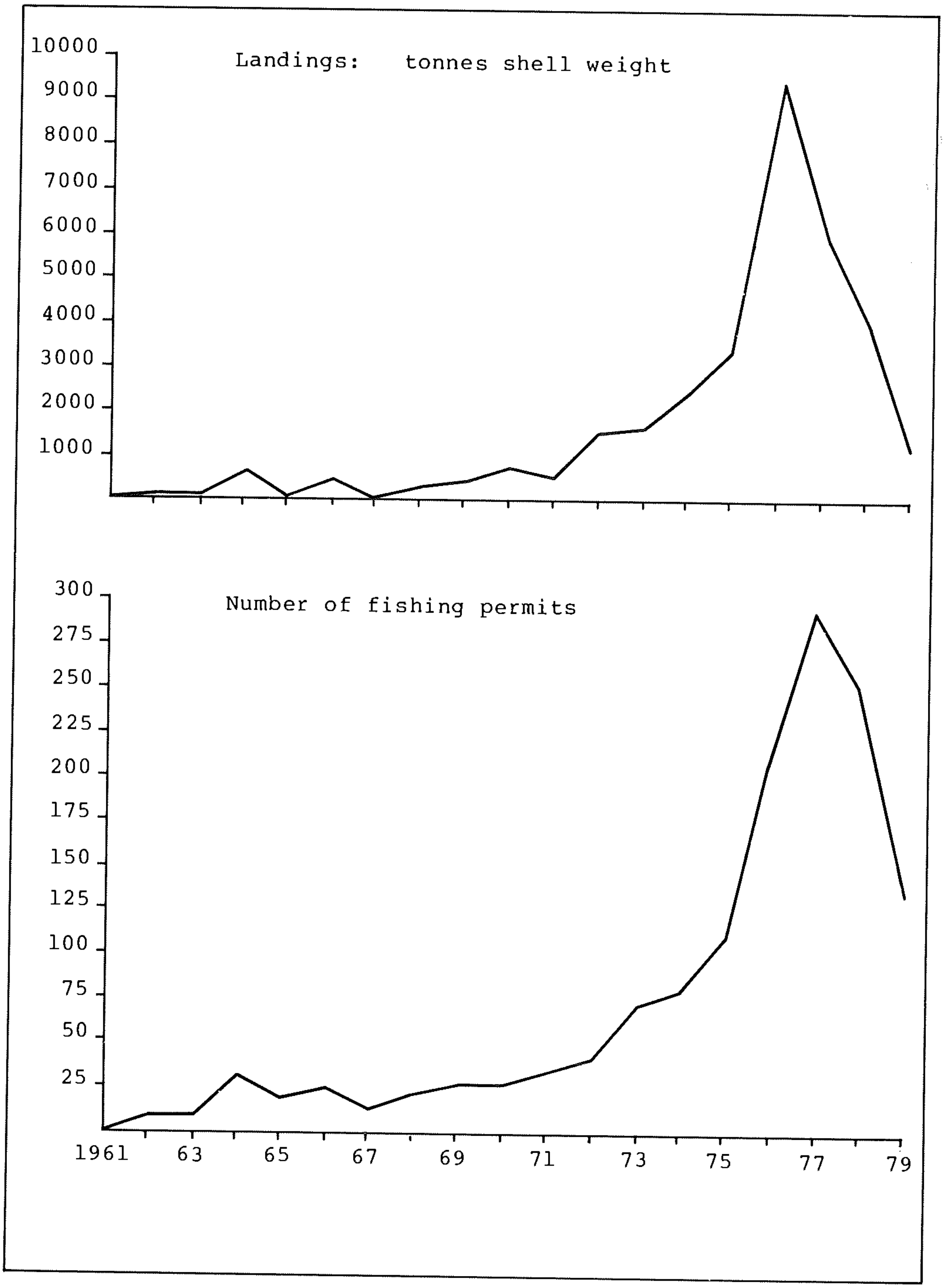

Figure 2 : Southern Scallop Fishery, 1962 to 1979

Of the 455 applications received by the Authority in 1978 the number approved was 136. This was above the "optimum" number recommended by the Ministry of Agriculture and Fisheries and the New Zealand Fishing Industry Board. The optimum number, which remains confidential, was arrived at by a cost and earnings study based on a range of resource assumptions and average catch rates and average costs. These parameters were incorporated to predict the number of entrants required to arrive at an average "acceptable" income. There were many criteria the Authority had to consider and the difference between the recommended number and the final number of approvals illustrates that biological and sociological objectives are seldom achieved by a common policy.

In the first season as a controlled fishery the number of licences was limited to 136 and this I believe was regarded as an adequate measure to provide a safe biological yield. However, the fishery failed commercially as only 38,000 cases were landed compared with over 130,000 in the previous season. In addition a major problem of holding stocks of wet fish was experienced by the on-shore processors who reduced prices on most of the species caught by fishermen in the off-season. As a result the fishermen mounted a strong lobby for Government assistance, backing their arguments with evidence of depleted fisheries and static or declining prices. The Government responded by offering financial assistance by way of deferment of repayments on Rural Bank loans.

DISCUSSION

Could the commercial failure of the southern scallop fishery have been alleviated under a more liberal policy of control? If provisions were made for a premium on the surrender of licences, a buy-back scheme may have been instrumental in tempting the marginal fisherman to relinquish his licence at an equitable value and possibly establish himself in another fishery, for example squid or tuna. As a result there may have been reduced pressure on the scallop fishery by decreasing the number of licence holders.

The Ministry of Agriculture and Fisheries in reviewing its management programme established quotas for the 1979/80 season. Strict quotas were set at 20,000 cases for Golden Bay and Tasman Bay and 10,000 cases for the Marlborough Sounds, with the catch on any one day limited to 25 cases per vessel. The start of the season was delayed as well so as to optimize meat yield. The 100 mm size limit was dropped because scientific research showed that high mortality occurred in undersized shellfish returned to the sea after being dredged. The market now determines acceptable minimum sizes.

These restrictions should provide sufficient protection for the fishery eventually to recover. However the major problems yet to be surmounted are economic ones. In my opinion, until the legislation either permits a buy-back scheme, or limited marketability of licences and quotas, then those people forced out of the industry due to declining incomes will face additional economic burdens when trying to dispose of their capital assets. To some extent these problems can be alleviated by Rural Bank loans and other financial assistance available to those fishermen who diversify into other fisheries.

The management approach adopted for the Coromandel scallop fishery is generally similar to that applying to the southern scallop fishery, except that minimum sizes have been retained and there is a maximum daily catch of 35 cases with no overall quota.

LAKE ELLESMERE - CONTROLLED EEL FISHING

Studies at Lake Ellesmere revealed that theories suggesting the eel resource was not susceptible to overfishing were wrong. Clear evidence of seriously declining catches was obtained. Demands for controls were based on the argument that an increase in fishing effort, combined with a downturn in the price of eels inflicted large reductions in individual incomes.

Following a moratorium on the issue of permits a major study was initiated by the New Zealand Fishing Industry Board to determine both the management techniques preferred by the Lake's fishermen and the economic yields for a given number of participants. The Fisheries Research Division of the Ministry of Agriculture and Fisheries stated that the lake could sustain an annual catch of 300 tonnes (the catch had been 492 tonnes in 1977/78). The problem to be resolved was how should the reduction in effort be achieved to minimise social and economic disruption. The options considered were quotas on catches, limits on the number of nets that could be used or a reduction in the number of fishermen. The Authority adopted all three options. Fishermen can only work 50 nets at the mouth of the lake and they have individual quotas ranging from nine to 24 tonnes. The number of fishermen was reduced from 25 under the moratorium to 17.

Capital costs are low, usually consisting of a 4.6 m boat powered by a 50-60 hp outboard motor and general ancilliary equipment. These assets would find a ready market even if sold to a purchaser who did not hold an eel fishing licence. Consequently licence holders will not be as handicapped by non-transferability as fishermen in other controlled fisheries with more specialized assets.

EXCLUSIVE ECONOMIC ZONE - NEW ZEALAND'S LARGEST LIMITED ENTRY FISHERY

New Zealand's Exclusive Economic Zone (EEZ) was declared on April 1 1978 and encompasses an area of 1.4 million square miles (see figure 3). The zone, which could yield in excess of 500,000 tonnes of fish on a sustainable annual basis, provides a good example of a controlled fishery established to achieve multiple objectives. These objectives, which I shall call objective No 4, include:

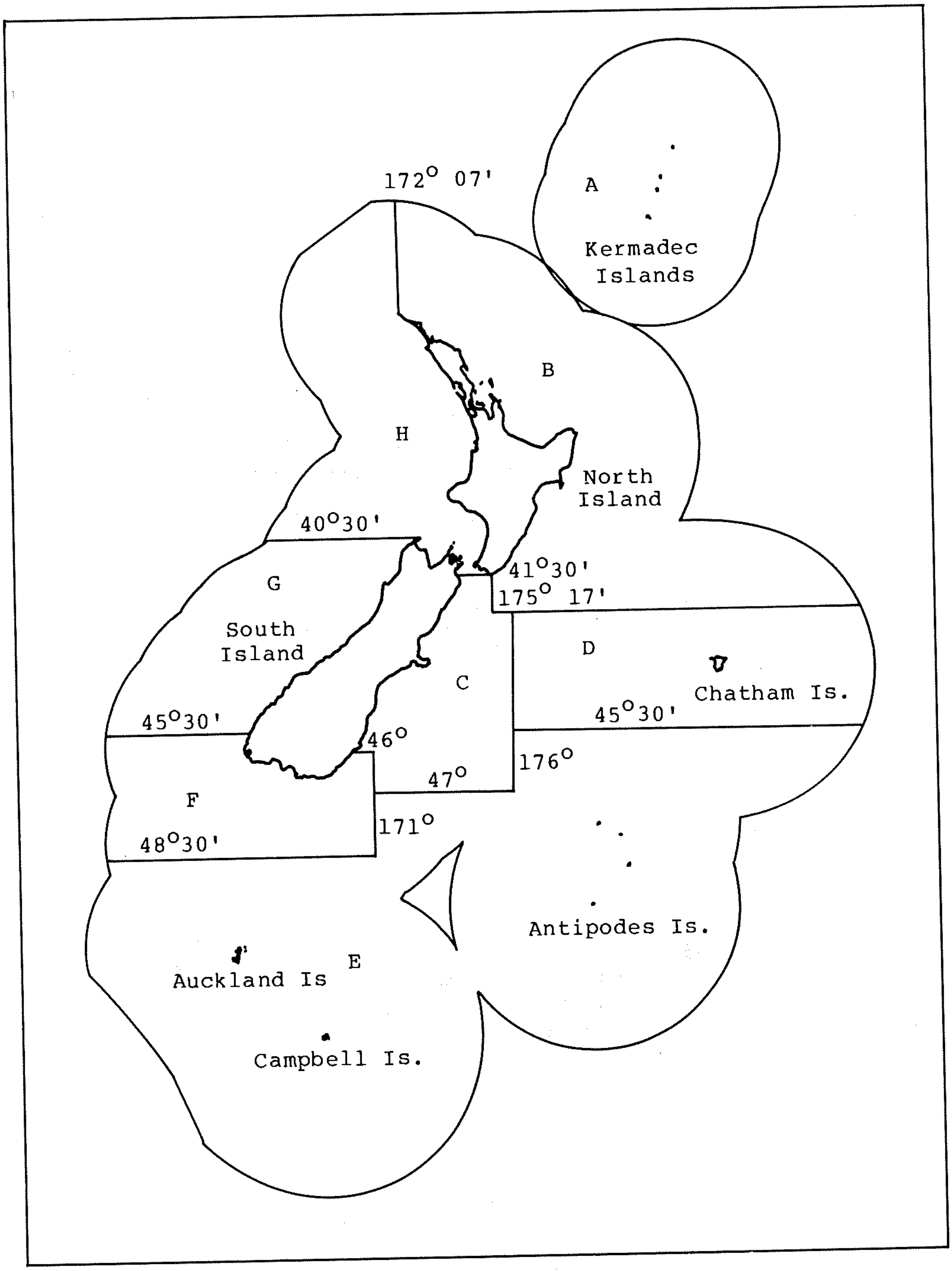

Figure 3 : New Zealand, showing limits of 200 mile Exclusive Economic Zone

* the management of fish stocks to enable exploitation having regard to the need to conserve stocks for future generations;

* to promote exports of the resource;

* to provide leverage in trade negotiations and expand goodwill between N.Z. and foreign nations;

* to accumulate scientific and economic knowledge of the commercial and non-commercial species found within the zone;

* to assist in the development of an important N.Z. industry, and to encourage employment and promote investment possibilities.

The Territorial Sea and Exclusive Economic Zone Act 1977 defines the EEZ and is the basis for the administration of the zone. Vessels fishing within the EEZ must also comply with the relevant sections of the 1908 Fisheries Act, and the conditions attached to their Government approvals to fish.

The domestic fishing industry is not yet in a position to harvest all the resources of the EEZ and under provisions of the Law of the Sea the Government makes available to other fishing nations that part of the Total Allowable Catch which we cannot catch. This is done through co-operative fishing ventures and licenced access.

Co-operative fishing ventures are regarded as a means of rapidly developing New Zealand's involvement in non-traditional fisheries. Entry is not by a market system and factors considered in approving co-operative ventures include the contributions of the foreign partner, the share of fishing and marketing risk that is undertaken by the joint venture company, net foreign earnings and the commercial viability of the operation. Licenced access to "residual fisheries" is negotiated on a Government to Government level and is regarded as a temporary means of exploiting that portion of the TAC which cannot be utilised by New Zealand interests (including co-operative ventures). There is no market for access as such, though licence fees in most instances are levied on the catch allocated to and taken up by foreign vessels.

Discussion of the management techniques applied to the EEZ is beyond the scope of this paper, suffice it to say that they are based on scientific estimation of a TAC by area and species. Once this is established other relevant considerations are taken into account in rationing the resource. The circle of evolving policies in the last 65 years has been completed with the establishment of the EEZ. Once again exploitation with the emphasis on export markets is the key factor considered in policy formulation. Restricted access is not enforced solely on the grounds of conservation but is used in an attempt to meet the often conflicting social, political and economic goals. The EEZ provides the potential to expand our exports to at least eight times that obtained in 1978 ($63 million from 34,000 tonnes) with consequent multiplier effects on the economy.

FUTURE LIMITED ENTRY FISHERIES

THE ROCK LOBSTER FISHERY

The most difficult controlled fishery to administer within the terms of the 1977 legislation will be the rock lobster fishery. As it is to be controlled nationally, different policies must be formulated for each region, of which there are 10 around New Zealand. It is expected that many problems will arise. For example, rock lobster may be the major source of income to fishermen in one area and there may be no alternative fishery for those displaced by licencing. In other areas alternative fisheries may exist. For this reason regional differences must be taken into account by the Fisheries Licencing Authority.

The key to the implementation of controls over the rock lobster fishery revolves around the management objective. Over-exploitation is a symptom of this fishery as is shown in figure 4. A reduction in effort is sought not only to protect the resource but to maximise the "economic welfare" of the fishery. At this stage the final goals have not been agreed upon, therefore, the optimum amount of effort cannot be specified.

A committee established to implement the controlled fishery has been liaising with fishermen since a moratorium was declared on the issue of rock lobster fishing permits in late 1977. In addition a questionnaire has been distributed by the Fishing Industry Board to registered rock lobster fishermen, which among other things seeks their opinions on possible management options.

Under the Act the Fisheries Licencing Authority will be the sole source of licences and each applicant may be required to appear before the Authority. Owing to the large number of applicants the rationing process is likely to take twelve months or more to complete.

Problems are likely to be experienced by fishermen who after receiving a licence seek to leave the fishery and dispose of their assets. The non-transferability of licences could probably have the greatest impact on this fishery due to the specificity of the gear and vessels, that is, the assets do not have many other uses and the owners could incur a major capital loss when disposing of them.

In theory the major objective of the Authority should be to maximise economic welfare within the industry. Alternatively, the Authority may seek to maximise economic rent and thus licence the minimum number of fishermen needed to extract the maximum profits from the fishery. This could be in the order of 500-600 fishermen or less (see figure 4). Or, the Authority may prefer to reduce employment only to the point which maximizes long run biological yield, possibly 800 licences. This number could be achieved if amateur and part-time fishermen were excluded. As these people are unlikely to have made a major commitment to the fishery their exclusion should not result in a major glut of redundant vessels and gear on the market. However, if it could be shown that part-timers efficiently exploit the fishery then there would be little economic justification for their exclusion.

The employment and incomes of those who gain access to the fishery will depend on the course of action and set of objectives the Fisheries Licencing Authority finally adopts.

THE COASTAL FINFISH FISHERIES

The fishing grounds out to 300m depth have been the traditional grounds of the inshore trawlers, seiners and long liners, and have yielded valuable catches of prime species such

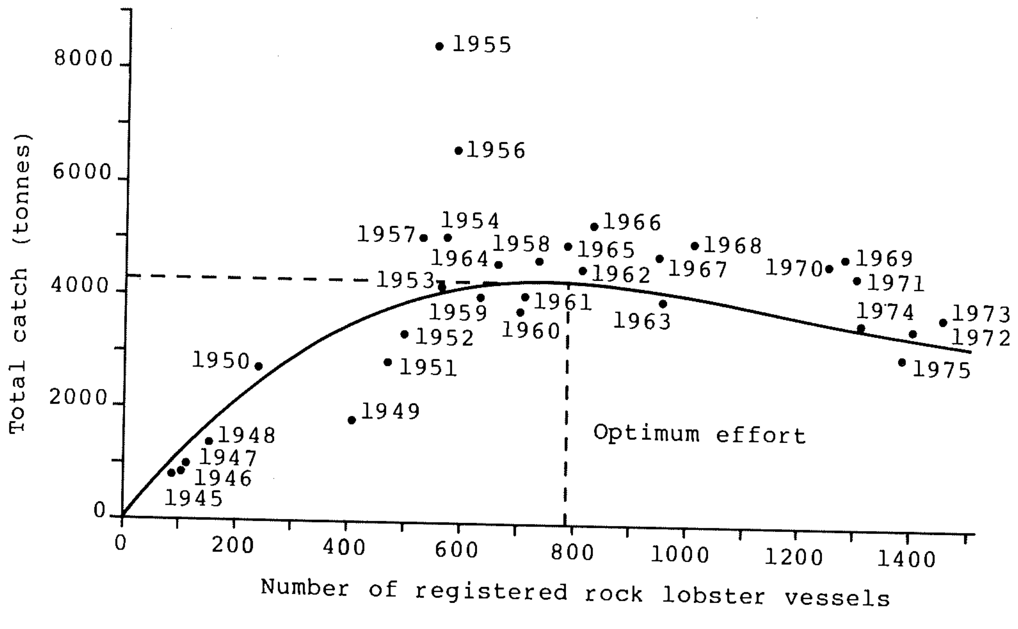

Figure 4 : Stock production model - New Zealand rock lobster fishery

Source: Fisheries Research Division, Ministry of Agriculture and Fisheries as snapper. However their long term viability has been in doubt as a result of increased fishing pressure applied by larger and more sophisticated vessels.

The problem to some extent has been compounded by the importation of larger deep water vessels under the duty free entry scheme. These vessels have fished the inshore grounds to increase the value of their catches. Companies importing vessels under the duty free scheme are now obliged to adhere to an approved fishing plan in order to reduce pressure on the prime stocks. It is likely that groups within this coastal sector will seek to protect their livelihoods and call for some of the prime inshore finfish fisheries to be brought under the controlled fisheries legislation.

IMPLICATIONS AND CONCLUSIONS

There are wide ramifications of the methods used to achieve biological and economic objectives. Our experience of the Southern Scallop fishery shows that limited entry alone may not achieve conservation. However, it is a useful tool to maintain profitability as witnessed in the Foveaux Strait oyster fishery. A licence is an economic good because it creates a scarce commodity, namely limited access to a fishery. However, this does not necessarily imply that the market is always the most desirable means of allocation if the following sorts of problems exist: international obligations under the law of the sea, trade-offs between fishing access and market access, the likelihood of the formation of monopolies, and traditional fishing patterns of indigenous groups. Policies using licencing to achieve biological aims in New Zealand have had implicit economic side effects. For example, restrictive licencing was used to achieve conservation, but it inhibited rational development and misallocated resources. Consequently it is important that limited entry be recognised as an economic tool rather than a conservation measure. When licencing is considered the economic objectives should be compared with the likely effects of its use. It is important that all management measures should be carefully tailored to the needs of each fishery to avoid such undesirable and often unexpected consequences as overcapitalisation and restricted efficiency.

If biological management is concerned with the efficient control of the resource and those species involved in that food chain, then perhaps the best means of securing optimum biological yields is to implement a quota system or Total Allowable Catch completely independent of economic, political and social considerations. This argument does not deny that licencing can perform both economic and biological rationing roles. However the use of restrictive licencing as a major method of conserving the resource can be unsuitable for dynamic industries as witnessed by our experience from 1936 to 1963, particularly if the policy lacks flexibility. The deficiency in licencing for biological reasons is the determination of the correct mix of capital and labour necessary to produce both biological and economic optimality. The selection of the optimum number of participants to produce a desired yield is a function of productivity of the participants, the prevailing weather conditions, the market demand and the presence of substitutes, as well as the costs incurred by the fishermen and processors and a host of other factors. Because our knowledge is fallible it is desirable to work within known constraints. The setting of conservative Total Allowable Catches both protects the resources and signals their relative sizes to industry. This gives entrepreneurs an appreciation of how much investment a fishery can support.

When considering limited entry, policy makers must take into account the following concepts:

* economic realities especially the likely consequences of different policy proposals;

* social realities such as the demands of those commercially involved in the fishery and the demands made by external sectors including amateur fishermen and leisure seekers;

* the realities relating to export goals, domestic consumption and trade negotiations.

I have attempted to trace the history of our limited entry experience and I have shown the development of, and the methods employed to achieve changing objectives. Over the 70 years covered I have identified four major objectives which evolved as follows:

1. judicious exploitation;

2. conservation for future generations;

3. exploitation for export;

4. multiple socio-bio-economic objectives.

Achievement of these objectives has been attempted in many ways - restrictive licencing, TAC's, open entry, gear restrictions and regulations - all with varying degrees of success.

Three important lessons have been learned from our recent experiences. Firstly, that problems occur with legislation which removes all possibility of trading or buying back licences. Secondly, that a buy-back scheme could provide economic stability in times of commercial failure in controlled fisheries. Thirdly, that it is necessary to provide human and financial resources to determine biological constraints.

Finally I would like to say that the organisations of fisheries management regimes could be arranged into hierarchies of responsibilities. Political considerations are best left to the central government. If the resource provides a significant part of national income and major externalities arise then the government or a representative authority should participate in social considerations. However, if the fishery is small and the participants have proven ability to organise their own welfare, then I suggest that the means of achieving economic goals should be left to those who represent the interests of the fishermen, or the fishermen themselves. In this case the Government should not introduce limited entry unless this is specifically asked for by the fishermen.

I think that the success of our approach to limited entry fisheries will ultimately depend on the effectiveness of the liaison between the industry, government and the Licencing Authority. The achievement of the maximum benefit to all depends on co-operation and understanding between the parties. I consider that an exchange of views at seminars such as this one is invaluable in fostering understanding amongst all those concerned, and is a vital ingredient in improving our knowledge of the intricacies of sound limited entry fisheries policy.

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Appendix. Historical cost and earnings analysis of sample Foveaux Strait dredge oyster vessels

	1975	1976	1977	1978	1979 (Fst)
Sacks landed	4 977	5 003	5 175	5 415	5 200
	$	$	$	$	$
Earnings	104 868	130 000	142 300	165 157	185 500
Variable Costs:					
Wages	37 435	43 009	47 943	59 019	70 000
Fuel and oil	2 746	3 686	3 646	3 903	4 500
Sacks and Gear	2 435	2 812	3 158	3 821	4 600
Repairs and maintenance	13 335	15 069	19 236	20 017	22 500
Handling charges	2 991	3 010	3 134	3 472	4 000
Wharfage and other	1 088	1 318	1 504	2 102	2 500
Total Variable costs	60 030	68 904	78 621	92 334	108 100
Gross margin as a percentage of earnings	43%	47%	45%	44%	42%
Fixed Costs:					
Insurance	2 238	3 935	5 385	5 104	5 500
Administration costs	1 872	3 125	4 321	7 175	9 000
Depreciation	3 340	3 399	3 032	3 331	3 000
Total fixed costs	7 450	10 459	12 738	15 610	17 500
Income (earnings before interest and tax)	37 388	50 637	50 941	57 213	59 900
Return on investment (Based on historical vessel value of $40 000)	93%	127%	127%	143%	150%
Return on investment (Based on current replacement cost of vessel)	9%	13%	11%	10%	9%

Source: Fishing Industry Board