Fisheries management report

Long term management strategies for the Western Rock Lobster Fishery

(4 volumes)

Evaluation of management options

Volume 1

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Executive Summary

This report has been written following approval by the Minister for Fisheries of a recommendation by the Rock Lobster Industry Advisory Committee that a major evaluation of future management options for the western rock lobster fishery be undertaken.

The Terms of Reference focused the report on the options for future management of the fishery in relation to (i) the continued use of input controls and (ii) the use of output controls. The Reference included a requirement to consider the optimum fleet size and its associated implications for the rules for pot transfer, pot reduction and licence splitting. The reference to pot reduction has a flow-on effect to boat replacements.

In the writing of this report, extensive use has been made of three associated reports prepared by specialists in economics, marketing and law enforcement. They are recommended reading in their own right and also in relation to a better understanding of the contents and consideration of this report. The three reports are identified in Section 1.

The report provides background information on the management strategies and principal elements of the fishery, its stock status, the use of input and output controls and the size of the fishing fleet. The report concludes with an examination of the effect of maintaining effort (input) controls and moving to a system of variable effort (TAE/ITEs) or moving to direct (output) controls on the catch (TAC/ITQs) which could vary annually, and a discussion.

The report draws attention to the principal finding of the three specialist reports and examines those findings in relation to the options for the long term management of the fishery. The cost and effectiveness of law enforcement would be a major factor to be considered if a TAC/ITQ system of management was adopted. However, the introduction of this system of management would probably increase the net returns to the industry if the number of boats in the rock lobster fishery was allowed to be reduced to a level decided purely by market forces and if there was not a required nexus between the number of pots per boat and the catch quotas after the initial allocation process.

Although the major thrust of the report is to provide information on the alternative uses of input effort and output catch controls, there is an associated question of fleet size. A decision on this subject has a flow-on effect on the lower and upper limits of either the number of pots allowed to be used or individual catches allowed to be taken. The social and regional advantages of introducing a figure for the lower limit of the number of boats in the fleet need to be judged against the financial cost to the industry resulting from imposing a constraint on the free flow of market forces and the decision-making ability of each operator.

There is a sound record of past management of the western rock lobster fishery, but it has resulted in an increasing array of input constraints. During the past decade the discussion and literature on fisheries management, both within Australia and overseas, has focussed on the ways and means of giving attention to the problems arising from rapid improvements in fishing technology as well as the desire of both government and industry to increase the economic efficiency of fishing practices. Management of the western rock lobster fishery has to take account of the changing circumstances to ensure that the measures adopted provide the benefits being sought and that its management remains one of the outstanding examples of management achievement. This will require objective analysis of the alternatives available and a high degree of cooperation between all of the interested parties.

The decisions taken resulting from a consideration of this report, and the associated specialist reports, on the western rock lobster fishery will be vital to its long term management. It is essential that all those engaged in the fishery consider the past growth in the fishing pressure, their vision for the industry in, say, ten years from now, and the most appropriate method of management in achieving that vision. There are likely to be three principal elements:-

(a) The potential to increase the value of the catch and the net return to the industry as a whole.

(b) The best long term management method, input or output controls, taking into account the overriding requirement to ensure an adequate breeding stock but also considering that there is now an increasing focus on economic efficiency in fisheries management.

(c) The fleet size and its associated implications for the net returns as well as for the minimum and maximum holdings of ITEs or ITQs.

1 Introduction

The Rock Lobster Industry Advisory Committee (RLIAC) recommended in its report to the Minister for Fisheries on 23 October 1992 "that the Minister endorse the formation of a RLIAC Sub-Committee to undertake a major evaluation of future management options for the rock lobster fishery".

The Minister's approval of the recommendation was notified by the Executive Director of the Fisheries Department to all rock lobster licence holders on 12 November 1992. A copy of the Executive Director's letter and the Report of the Advisory Committee to the Minister are part of the documentation included in Fisheries Management Paper No. 53.

The need for the evaluation of future management options has arisen as a result of a concern by RLIAC that the exploitation rate generated by continually increasing fishing effort had reduced the breeding stock to the extent that there was now a possibility of a consequential reduction in the average level of recruitment. Although the number of boats and the number of pots in the fishery had been reduced during the five years to 1991/92, the reductions to that time appeared to have only slowed the rate of increase in the exploitation rate because of the continuing increase in efficiency of each boat operating in the fishery.

The RLIAC Sub-Committee was given the task of developing a paper which evaluated the use of direct catch controls and variable effort controls as methods of ensuring the long term maintenance of the western rock lobster fishery.

The Sub-Committee was established in January 1993 with the following terms of reference.

1. To consider and evaluate the potential value and impact on future management of the fishery of:

(a) a total allowable catch (TAC) and/or individual transferable quotas (ITQ);

(b) variable effort controls in the fishery and size controls on rock lobster, ie. the existing system of individual transferable pots or effort units (ITE).

2. To assess the ramifications of fleet size changes including impacts on:

(a) administrative, economic and social factors;

(b) rules for pot transfer, pot reduction and licence splitting.

Membership of the Sub-Committee is set out in Attachment 1. This report has been prepared by Mr Bernard Bowen for the Sub-Committee, in his capacity as a consultant, but he was assisted greatly by inputs of information and suggestions from his colleagues.

Since the appointment of the Sub-Committee, RLIAC has proposed, and the Minister has approved, a significant change in the management arrangements for the 1993/94 and 1994/95 seasons: in essence a two year trial of a variable ITE system. The RLIAC Report to

the Minister outlining these arrangements has been published as Fisheries Management Paper No. 55. The principal elements of the arrangements for these two seasons are:-

(a) A temporary 18 per cent pot reduction for commercial fishermen in all zones.

(b) A change in the legal minimum carapace length from 76 mm to 77 mm for the periods commencing at the start of each season (15 November) to the following 31 January.

(c) A legal maximum carapace length of 115 mm for female rock lobsters, but with a further constraint that rock lobsters with a carapace length greater than 105 mm are not permitted to be landed north of Wedge Island.

(d) All setose and tarspot female rock lobsters to be returned to the water.

The management arrangements established for the 1993/94 and 1994/95 rock lobster seasons are expected to reduce significantly the exploitation rate so that, over time, the breeding stock is increased and stabilised at a level at which there is a reasonable expectation that there will be long term sustainable recruitment. However, RLIAC agreed that the introduction of these arrangements did not reduce the need for industry to have a review document which considered the use of variable effort controls, as an extension of the current pot controls, and the use of catch quotas as an alternative management arrangement.

The need for the document is twofold:-

(a) The current input management arrangements may be shown to be not effective (because of increasing industry efficiency or industry resistance to the concept of variable effort controls) in reducing the exploitation rate to the extent required, or which may be required in the future, and under these conditions other arrangements would become necessary.

(b) Even if the management arrangements are shown to be effective in reducing the exploitation rate, it is appropriate that the rock lobster industry and the community generally have an opportunity to consider other arrangements which may provide greater certainty in management directions as well as economic and financial benefits to the WA economy over time.

Some of the information provided in the early Sections of this report will be well known to those in the rock lobster industry. However, as the report is likely to be read by a larger audience, a description of the major elements of the fishery has been included.

In preparing this report for the rock lobster industry, the writer has had the benefit of three specialist reports prepared for the Sub-Committee on (i) marketing, (ii) economics and (iii) law enforcement. These specialist reports have been produced as separate documents, but they are essential reading for those who desire further information on some of the matters discussed in this management report. The specialist reports are:-

(a) Lindner, R. K. (1994). Economic efficiency of alternative input and output based management systems in the western rock lobster fishery.

(b) MAREC PTY LTD (1994). A market based economic assessment of a preferred management structure for the catching sector of the Western Australian rock lobster fishery.

(c) McLaughlan, N. E. (1994). west coast rock lobster fishery law enforcement considerations.

Reference is made in this report to a number of documents in addition to the specialist papers. These and a limited number of general papers about the western rock lobster fishery are listed in Section 10 so that readers can obtain further information if they so desire.

2 Management strategies

The Fisheries Department's Strategic Plan 1992/93 sets out its Mission and Key Objectives. The Department's mission is:-

> *"To manage the harvesting of fisheries resources at ecologically sustainable levels, and to manage the development of aquaculture, in order to maximise economic benefits to the state, while conserving and protecting the state's aquatic ecosystem for the benefit of the present and future West Australian community."*

The first two Key Objectives in the Strategic Plan are particularly relevant to the western rock lobster fishery. These are:-

> *"1. Ecologically sustainable resource use.*
> *To have harvesting and fishing of fisheries resources at ecologically sustainable levels.*
>
> *2. Social and economic benefits to the community.*
> *To maximise the economic, social and other benefits derived from the state's aquatic biological resources."*

The western rock lobster fishery is the most valuable fishery in Australia. It provides employment and financial reward for both the catching and the processing sectors from Shark Bay to Cape Leeuwin. It is important that the approaches to management for both the catching and processing sectors be identified so that there is a basis for understanding the strategies adopted to date and for considering the options for management in the future.

In the commercial catching sector, perhaps the two most important management initiatives have been the decision to limit entry to the fishery (in 1963) and the decision to implement and enforce controls on effort so as to maintain the rock lobster stocks. Economic and social consequences have also been given attention when determining the management strategies although they may not have been specifically identified in those terms.

The commercial take of rock lobsters accounts for between 94 and 97 per cent of the rock lobster catch. The remaining catch is taken by the recreational fishers under the rules established for this activity. Each licensed recreational rock lobster fisher is allowed to operate two rock lobster pots and take a maximum of 8 rock lobsters per day. However, there is no constraint on the number of licences issued each year.

The processing sector has been recognised as an integral part of the rock lobster fishery. Until 1966 any person who wanted to establish a rock lobster processing establishment was free to do so. However, following considerable debate during the 1960s about the number and locality of rock lobster processing factories, the Fisheries Act was amended in 1966 to require each processing establishment to hold a licence. Also, the Director of Fisheries was given the authority to grant or not to grant such a licence on the grounds of it being in the "better interests of the fishing industry".

The commercial catching sector

(a) Limitation of entry to the fishery

The rock lobster fleet expanded rapidly in the late 1950s. New boats were being built and were entering the fishery at a rate of between fifty and one hundred per year. The catch was increasing but at a rate considerably less than the rate of increase in fishing boats and rock lobster pots. The number of pots in the water increased by 66 per cent from 1958/59 to 1961/62 while the production during that time increased by only 8 per cent. Consequently,

the catch per pot was declining. This rapid build up of the rock lobster fleet became a topic of considerable debate within the fishing industry and at meetings of the then Fishermen's Advisory Committee.

The debate resulted in the development of a philosophy that entry to the rock lobster fishery should be restricted. At that time information was not available on either the exploitation rate being generated by the fishing fleet or the effect of the increasing fishing pressure on the long term maintenance of the resource. However, the rate of increase in the number of boats and pots was sufficient to cause the Advisory Committee to recommend that the better interests of the fishing industry would be served by limiting entry to the rock lobster fishery.

The date of commencement of the limited entry policy was 1 March 1963. Associated with the limitation on entry was a specification that each boat was allowed to use only three pots per foot of boat length. This was a major development in the use of input controls as a method of management. The measure resulted in there being a discrete number of boats. However, in 1963 there was no control on the length of replacement boats, thus the number of pots increased although not at the same rate as that recorded in the late 1950s and early 1960s. Controls on the length of boat replacements were introduced in 1965 which resulted in the stabilisation of the registered number of pots in the fishery. During the late 1960s and early 1970s specific law enforcement action was taken to ensure that illegal overpotting was brought under control, and the take of undersize rock lobsters was also brought under control.

In the early years of limited entry to the rock lobster fishery, the benefits flowing to the industry could be classed as both social and economic. The fleet, being fixed in terms of the number of boats, could be distributed along the coast in an orderly manner, and the owners were secure in the knowledge that there would be no further entrants. Also, there would be economic stability so long as the markets remained available and the exploitation rate generated by the fleet did not lead to over fishing.

As knowledge about the exploitation rate being generated by the fishing fleet increased during the 1970s and 1980s, it became clear to both the fishery managers and those engaged in the industry that the fishing pressure should be controlled. The limitation on the number of boats and pots had not, of themselves, been fully effective in containing growth in the exploitation rate. Action was taken to reduce the length of the season and to define the size and structure of the rock lobster pot. In later years, action was also taken to reduce the number of pots being used.

A review of the information available in 1992 showed that technological improvements had further increased the exploitation rate to a very high level, and the abundance of breeding female rock lobsters had been reduced such that there was very serious concern that the recruitment may not be able to be maintained. This is discussed in more detail in (b) below. To stabilise and then reduce the exploitation rate, attention had to focus on the number of pots allowed to be used, the times during the year that they could be worked, and the types and sizes of rock lobsters which may be legally retained.

Ideally, a reduction in the number of rock lobster pots by, say, ten percent for a season would result in a similar reduction in catch, and thus in the exploitation rate. However, this can not be expected to occur. During the 'white' rock lobster season, there is a reasonably direct correlation between the number of pots used and the exploitation rate at that time, but this has been less evident for the 'red' season because of the excess capacity of the fleet in terms of days available for fishing. Furthermore, rock lobsters which are not caught at the beginning of the fishing season because of the reduced number of pots may still be caught later in the season. However, it is the rock lobster pot which is the essential unit of fishing capacity, and control of its effective use is the principal tool available to the fisheries manager using input controls.

In summary, the management strategy adopted in 1963, restricting the number of boats and rock lobster pots, has resulted in social and economic benefits for those engaged in the fishery. However, since that time, and despite the introduction of a series of management measures, the exploitation rate has continued to increase to the extent that in 1993 it was clear that there was again a need to impose further constraints on the fishing effort to keep the catch at a sustainable level. This was given attention by the introduction of new management arrangements for the 1993/94 and 1994/95 seasons. The alternative to the use of further input controls as a method of controlling the exploitation rate is to impose by management a direct control on the catch, ie. output controls. This alternative management philosophy, and its advantages and disadvantages, is discussed later in this report. Irrespective of which method of management is adopted, the catch must not be allowed to increase beyond that which can be sustained.

(b) Stock Maintenance

Maintenance of the rock lobster stocks depends upon its reproductive capacity which requires that the breeding stock be maintained at or above a level which provides sufficient egg production for stable recruitment under the normal range of variations in environmental conditions. Recruitment into the rock lobster stocks, as measured by the relative abundance of puerulus settlement, varies from year to year. However, this has been shown to date to be associated with variations in the oceanic environment, for example the flow of the Leeuwin Current, rather than the level of egg production or the number of mature female rock lobsters along the coast.

There is a growing number of fisheries throughout the world for which it appears that the fishing pressure has been increased to such a high level that the number of breeding female animals remaining has not been sufficient to sustain recruitment, ie. there has been recruitment overfishing. While some reduction in breeding stock levels is inevitable, and can even be beneficial, if there is excessive removal of breeders there can be either a dramatic reduction or a gradual, but continuing, reduction in the recruitment of juvenile lobsters and thus the catch. Whichever the case, the implications for both industry and management are traumatic.

The specific level of breeding stock at which this "recruitment overfishing" takes place can not be known until it is reached for the first time. Clearly, considerable catches can be taken without causing recruitment overfishing. However, increasing efficiency of the fishing fleet results in fewer female rock lobsters surviving to breed, and as a consequence egg production is reduced.

The question to be addressed is the level to which a breeding stock can be reduced, as a percentage of the breeding stock before fishing commenced, and there still be sufficient egg production to sustain average recruitment. This subject is discussed in Section 4. However, the essential element is that the Fisheries Department has a responsibility to ensure that "fisheries resources (are maintained) at ecologically sustainable levels" as set out in Key Objective 1 of the Department's 1992-93 Strategic Plan. To achieve this objective, the breeding stock must be held at or above a level considered to be safe based on experience from other fisheries and assessed by the specialists in this field of research.

A decision on the fisheries management approach by which this objective can be best achieved will require a detailed examination of the options available and extensive discussion within the fishing industry and between industry and government.

The processing sector

The rock lobster processing sector has been judged to be of such importance to the state's rock lobster fishery that additional licences to undertake the full array of rock lobster processing have not been granted by the Director since the introduction of the processing licence provisions into the Fisheries Act in 1966. The decision to constrain the number of processing establishments also took into account the need for efficiency of enforcement of the critical regulations about the size limits and berried females. One additional licence was granted in

the 1970s as a result of an appeal to a Magistrate, the appellate body at that time. There are now nineteen processing establishments licensed to undertake the full array of processing western rock lobsters. However, following a rationalisation of processing centres, one of the licences is 'dormant', ie. it is not being used. This being the case, there are eighteen active rock lobster processing establishments, with receival depots along the coast.

In September 1989, the Minister for Fisheries issued a policy statement about the future licensing of rock lobster processing establishments, published in Fisheries Management Paper No. 30. This statement set out that there was merit in adopting a policy of not licensing additional rock lobster processing establishments, and endorsed the decisions taken administratively that the management philosophy in relation to the processing sector should be to stabilise the number of processing establishments. It had been judged that the existing number of establishments provided the fishing sector with sufficient opportunities for sale of their product to ensure that a purchasing monopoly situation did not arise.

The catching and processing sectors are mutually dependent one upon the other. The processing sector relies upon the catching sector to supply rock lobsters in first class condition. The catching sector depends upon the processing sector to provide high quality processing of lobsters and sales to the world market as well as providing support services, ie. bait and other essential fishing requirements. The catching and processing sectors' dependence upon each other led, in the early days of the fishery, to the formation of fishermen's cooperatives. The two cooperatives now operating successfully have a throughput of about 50 per cent of the total catch. Their method of operation has ensured that the fishermen receive the major portion of the benefits flowing from an increase in the value of the rock lobster products sold, and those benefits are passed in turn to the wider community. The processing sector generally do not hold lobster pot licences. Processing company ownership of vessels was tried in the 1960s and 1970s but was not very successful commercially.

Summary of the principal management measures and major initiatives

A summary of the principal management measures introduced and some of the major initiatives taken since 1963 are set out in the Table below.

Year	Principal management measure or initiative
1963	Limited entry introduced for the rock lobster fishery. A total of 836 vessels authorised to operate in the fishery. The number of pots allowed was set at 3 pots per foot of boat length.
1965	The boat replacement policy required that a boat be replaced with one of the same length so that the number of pots did not increase. The number of pots in the fishery was 76,623.
1966	A requirement that each pot have an escape gap measuring 51 mm X 305 mm.
1966	A licence was required before a processing factory could be established.
1968	Puerulus collectors were established at Dongara and in 1969 at Jurien.
1970	On board monitoring began so as to obtain information on the length frequency of the catch by area and depth.
1971	The first of the 45 freezer/catcher rock lobster boats left the fishery.
1972	The height of the escape gap was increased to 54 mm.
1973	Multiple entrances in pots were prohibited.
1978	The fishing season was shortened by 6 weeks from 15 November–15 August to 15 November–30 June.
1979	The boat replacement policy was amended to introduce the "7 and 10" rule in relation to the number of pots per metre of boat length.
1984	The size of pots regulated
1986	A temporary reduction of 10 per cent in the number of pots allowed to be used.
1986	The number of escape gaps required in a rock lobster pot increased to 3 or 4 depending on the type of pot.
1987	A permanent 10 per cent pot reduction commenced at 2 per cent per year. Reduction process completed by the end of the 1991/92 season.
1992	A summer closure in zone B for the period 10 January to 9 February. Closure not continued in the subsequent seasons. Legal maximum length of 115 mm. Setose and tarspot rock lobster to be returned to the water for the period 15 November to 28 February. 10 per cent pot reduction in zone B for the period 15 November to 10 January. In zone C, until April 1993, boats had to nominate a landing zone, each zone north of Fremantle being 10 nautical miles.
1993	An 18 per cent pot reduction for the 1993/94 and 1994/95 seasons. Setose and tarspot rock lobsters to be returned to the water at all times. The legal minimum length increased to 77 mm for the period 15 November to 31 January. Legal maximum length of 105 mm north of Wedge Island and 115 mm south of Wedge Island.

Note: Zone A is the waters around the Abrolhos Islands, zone B is the waters north of 30 ° S latitude and zone C is the waters south of 30° S latitude. The precise boundaries for each zone are set out in the legislation.

3 The principal elements of the fishery

The principal elements of the western rock lobster fishery, in relation to its long term maintenance, are (i) the catch, (ii) the exploitation rate, (iii) the level of breeding stock and puerulus settlement and (iv) the recruitment into the fishery.

The 1992/93 catch

The catch for the 1992/93 season, 12,303 tonnes, was one of the highest on record, with a landed value of $230 million. The table below shows that the catches for the past decade have averaged 10,600 tonnes.

Season	Zone A	Zone B	Zone C	Total
	tonnes	tonnes	tonnes	tonnes
1983/84	1,610	3,856	5,882	11,348
1984/85	1,511	3,707	4,464	9,682
1985/86	1,290	3,304	3,573	8,167
1986/87	1,573	3,274	3,682	8,529
1987/88	1,807	4,480	5,779	12,066
1988/89	1,674	4,532	6,106	12,312
1989/90	1,626	4,029	4,644	10,299
1990/91	1,583	3,973	3,664	9,220
1991/92	1,630	4,431	6,102	12,163
1992/93	1,491	3,865	6,947	12,303
Average	1,580	3,945	5,084	10,609

The high catch in 1992/93 was the result of a very successful 'white' rock lobster season followed by a successful 'red' season. The Abrolhos catch remained at about 1.6 million kg, but the coastal fishery, especially south of latitude 30° S, provided the industry with very high catches.

The level of catch each year is predicted by the Fisheries Department following analysis of the puerulus settlement occurring three and four years before. Because of past years of heavy fishing pressure, which has removed most of the larger animals, the annual catch is now largely dependent on the annual recruitment into the size population. If the puerulus numbers are low the 'red' catch will be reduced three years later, and the 'whites' catch will be low the following season. However, if the settlement is high, the catch is also likely to be high.

The exploitation rate

The exploitation rate is a measure of the number of legal size rock lobsters caught as a proportion of the total number available to be caught, and determines the number of females that reach maturity and breed. The fishery's dependence on the annual recruitment is evidence of the current high exploitation rate. Research findings estimate that about 60 per cent, and higher in some areas, of the animals reaching the legal minimum length will be caught within the first year. There will also be some natural mortality. During the following year a further 60 per cent, or higher, of the remaining animals will be caught, and so on. Accordingly, for every 100 rock lobsters reaching the legal minimum length, approximately 85 will be caught, mostly in the first two years, while the remainder will die through natural mortality at a much slower rate.

The exploitation rate depends upon a combination of the number of rock lobster pots allowed to be used, the number of days on which they are pulled, the sizes and types of rock lobsters allowed to be retained and the efficiency with which the pots are used by the fishermen.

(a) Number of rock lobster pots

The number of pots allowed to be used has been reduced permanently through the 10 per cent overall pot reduction management plan which ended in 1991/92. For the 1993/94 and 1994/95 seasons, there has been a further temporary pot reduction of 18 per cent.

A reduction in the total number of pots allowed to be used in the fishery has the effect of reducing the exploitation rate, but not in direct proportion. That is, the effectiveness of pot reductions is reduced through increased usage of pots and any increase in the efficiency of the fishing fleet.

(b) Number of days on which pots are pulled

The total number of days available for pots to be pulled is 78 during the period 15 November to 31 January and 150 days during the remainder of the season, totalling 228. The average number of days per boat on which pots were pulled for the years 1980/81 to 1992/93, for the 'white' (November to January) and 'red' (February to June) seasons and for the areas north and south of 30° S latitude are set out in the Table below.

	Average number of days per boat on which pots were pulled					
Season	South of 30° S latitude			North of 30° S latitude		
	Nov/Jan	Feb/Jne	Total	Nov/Jan	Feb/Jne	Total
1980/81	52.3	89.7	142.0	55.1	103.5	158.6
1981/82	56.7	99.4	156.1	55.2	106.7	161.9
1982/83	59.9	98.8	158.7	55.9	109.1	165.0
1983/84	59.4	88.8	148.2	58.6	107.4	166.0
1984/85	59.3	97.0	156.3	59.2	109.9	169.1
1985/86	54.4	91.2	145.6	57.8	104.5	162.3
1986/87	58.4	101.7	160.1	60.0	112.9	172.9
1987/88	63.3	105.3	168.6	60.9	113.4	174.3
1988/89	62.2	105.3	167.5	61.0	115.0	176.0
1989/90	61.5	102.6	164.1	62.0	117.0	179.0
1990/91	59.9	119.3	179.2	59.3	117.4	176.7
1991/92	66.1	119.6	185.7	62.8	123.5	186.3
1992/93	61.3	114.8	176.1	50.7*	117.7*	168.2*

* The 1992/93 season north of 30° S was reduced by one month during the period January and February.

The average number of days on which pots were pulled has increased appreciably from the early 1980s to the early 1990s. South of 30° S the increase has been approximately 19 per cent, mostly during the 'red' fishery, but also during the 'whites'. North of 30° S the increase has been about 12 per cent, again mostly during the 'reds' fishery, but also during the 'whites'. A comparison between the 1970s and the 1990s would have shown a still greater increase in the average number of days on which pots were pulled. In earlier years, the number of days on which pots were pulled was greater in the north than in the south. However, they are now similar.

An increase in the average number of days on which pots are pulled increases the exploitation rate.

(c) The rock lobsters allowed to be retained

Since the commencement of the rock lobster fishery the rules have set down that all rock lobsters brought on board may be retained except those which measure less than the legal minimum length and those which are carrying eggs on the pleopods, ie. berried females. However, further constraints have now been introduced, for part of 1992/93, and all of the 1993/94 and 1994/95 seasons, such that all setose and tarspot females have to be returned to the sea. Also, the legal minimum carapace length has been increased, commencing 15 November 1993, from 76 mm to 77 mm for the period 15 November to the following 31 January. Furthermore, there is now a maximum legal carapace length, initially 115 mm in 1992/93 for all female rock lobsters, and now 115 mm for female rock lobsters landed south of Wedge Island and 105 mm for those animals landed north of Wedge Island.

Protection of the setose and tarspot rock lobsters has the effect of reducing the exploitation rate for female rock lobsters and provides an additional degree of protection to the mature female rock lobsters and those reaching maturity.

The effect of the introduction of the lower legal maximum length is to reduce slightly the overall exploitation rate on the rock lobster resource and to reduce significantly the exploitation rate on the large breeding females.

(d) Efficiency with which pots are baited and set
A pot will catch rock lobsters consistently only if it contains appropriate bait and is set on grounds inhabited by rock lobsters.

The use of fish, hocks and hide as a bait have long been established as the principal method of attraction. Artificial baits have been produced and experiments undertaken to test their effectiveness. However, they have been found to be not as effective as the natural baits, or at least not as effective per unit of cost.

In the early days of the fishery, the fish baits were held in the pot by a skewer. However, this method has now been replaced by bait containers fixed within the pot. The quantity of bait being used has increased quite significantly, up to double in some areas, which would have occurred only if there was an understanding within the industry that more rock lobsters could be caught if more bait was used. It seems likely that the increase in the quantity of bait used has had the effect of slightly increasing the exploitation rate.

The ability of a rock lobster boat to transport the pots to areas of highest density of rock lobsters is an important factor to be taken into account in understanding the exploitation rate. There are a number of elements involved, the most important being the capacity of the boat to carry pots in rough weather, the deck space to hold pots, the speed with which pots can be transported and the electronic aids which assist in locating the rock lobster grounds and in reducing searching time.

There has been a dramatic change in the efficiency of the boats in the rock lobster industry as a result of significant increases in boat capacity, speed and the use of sophisticated electronic aids. Although it may not be possible to quantify the effect on the exploitation rate resulting directly from the increases in boat efficiency, there is little doubt that the effect has been to increase the exploitation rate. The recent introduction of the Global Positioning System (GPS), combined with a plotter, is one clear example of the change in efficiency. The use of GPS has allowed deepwater grounds to be worked with greater accuracy not only by those who have traditionally done so but also by others who did not have the skills to move into the deep water with confidence. Any action which results in an overall higher catch by the industry by shifting pots more often or locating and returning to preferred grounds more readily results in an increase in the exploitation rate .

Research undertaken by the WA Fisheries Research Institute, reported in a paper by Brown, Caputi and Barker listed in Section 10 of this report, has provided a preliminary estimate of the increase in catching efficiency (fishing power) as a result of changes in boats, gear and technology, as follows:-

> *"Our preliminary estimate of the increase in fishing power between 1971-72 and 1992-93 in shallow water was 29% (0.5 to 2% per annum), in deep water 53% (1 to 4% per annum), and for overall effort 36%."*

In summary, the exploitation rate in the rock lobster fishery steadily increased in the years to 1992/93, as a result of increases in both the number of days on which pots were pulled and catching efficiency, even though there had been a reduction in the season and a permanent pot reduction of 10 per cent. In 1992/93, and then again in 1993/94, further adjustments to the pot usage rate were introduced because of a concern about the high exploitation rate.

The breeding stock and puerulus settlement
Maintenance of the breeding stock of rock lobsters at a level which provides adequate egg production is an essential element in the management of the rock lobster fishery.

Rock lobsters in most of the coastal waters do not reach maturity until about two years after they have recruited into the fishery. Accordingly, the animals entering the breeding stock in a particular year are those which have not been caught during two previous seasons of high exploitation.

Rock lobsters at the Abrolhos Islands and in the upper north coastal sector of the fishery mature at a much smaller size (mostly below the legal minimum length) than those in the central and lower west coast, and thus form a very important part of the total breeding stock. Scientists of the WA Fisheries Research Institute have estimated that the Abrolhos Island rock lobsters now provide about 50 per cent of the total egg production.

The level of breeding stock abundance necessary to provide adequate egg production is the most important piece of information required for the sound management of the rock lobster fishery. However, for a number of reasons it is also the most difficult on which to obtain accurate data. Firstly, the abundance of rock lobsters can be measured only in relative terms, using the catch of mature females per pot lift recorded by fishermen in their research log books and by field staff as part of the commercial catch monitoring program. Secondly, the level to which the breeding stock can be reduced without affecting subsequent recruitment can not be accurately predicted before recruitment has been reduced for a number of years.

Following hatching and early development in the open sea for about one year, the young rock lobsters settle, as puerulus, on to the shallow water reefs. The success of the annual settlement to inshore reefs is able to be measured by the number of puerulus settling on research collectors installed along the coast. This index of annual settlement has varied quite dramatically since the introduction of the research collectors. Poor years have been followed by good years thus indicating that the variations in settlement have so far resulted from variations in environmental conditions rather than a lack of egg production. This variability would tend to mask any decline in settlement associated with reduced egg production. The major environmental influence appears to be the strength of the Leeuwin Current and the winter/spring storm events.

Although an index of abundance of the breeding stock is only available at present from the catch per pot lift of breeding size female rock lobsters, it is essential that these data be obtained on a continuing basis and that an attempt be made to compare the present index of abundance with the index when the fishing pressure was very light. Increasing fishing pressure will, of course, reduce the breeding stock and also change its size structure. Large mature rock lobsters produce more eggs than the smaller mature animals. Accordingly, it is not only important to know the quantity of mature rock lobsters but also the size structure.

The best research data available indicates that the egg production in 1992/93 was about 15 to 20 per cent of the level of egg production when the fishing pressure was very light, and that it has been trending downwards in recent years. In terms of quantity, the research indicates that the current total weight of the female breeding stock each season is about 2 000 tonnes as set out in Fisheries Management Paper No. 55. The adequacy of this level of breeding stock to maintain recruitment in the longer term is discussed in Section 4.

Recruitment into the fishery

Recruitment to legal size occurs approximately three to four years after the settlement of the puerulus on to the reefs. The faster growing animals may enter the fishery three and a half years after settlement.

There is a strong correlation between the numbers of puerulus settling on the research collectors, as an index of the relative strength of the puerulus settlement, and the catch three and four years later. If the puerulus numbers are low, the catch three and four years later will also be low. Alternatively, if the numbers are high, the catch is likely to be high.

The high catches of 1992/93 reflected a high recruitment to the fishery in that year following a high rate of puerulus settlement in 1988/89. The puerulus settlement was also high in

1989/90. However, in the subsequent years the puerulus settlement has steadily declined to a level in 1993/94 of about half the long term average. This will result in a series of at least three years of below average catches, ie. below 10 600 tonnes, in the mid 1990s.

4 The status of the fishery in broad terms

The catch in 1992/93 was one of the best on record even though a number of additional constraints on fishing were introduced. These included a legal maximum carapace length for female rock lobsters, a 10 per cent reduction in the number of pots for part of the season in part of the fishery and a mid season closure in part of the fishery.

The management plan for the western rock lobster fishery has been amended from time to time, but has been based primarily upon a control on the number of boats and pots, a legal minimum carapace length and closures. Its implementation has resulted in a successfully managed and very profitable rock lobster fishery. The challenge is to ensure an equally successful fishery into the future in the face of on-going technological improvements in the fishing fleet leading to an increasing fishing pressure on the stock.

Even though the catches have been maintained and increased slightly in recent years, there has been some concern that the increasing fishing pressure producing a high exploitation rate may, if allowed to continue, result in recruitment overfishing. Whilst there may be some debate about the precise level of the exploitation rate, there is no doubt that the fishing pressure has increased significantly during the past two decades and that the compensating reduction in pots has not fully accounted for the increased efficiency of the fleet.

Three inter-related issues which are important in understanding the status of the fishery are discussed below.

Reduction in the breeding stock
The fact that fishing has reduced the breeding stock to less than 20 per cent of original breeding stock is a major cause for concern. The rock lobster industry is important and successful. It should not be placed at risk by having the breeding stock reduced further to a level which may result in a reduction in the recruitment associated with that low level.

There are already two indicators suggesting that the breeding stock level might be too low. Firstly, there has been a 50 per cent reduction in the puerulus settlement over the last 10 years at the Abrolhos Islands compared with the settlement levels in the 1970s, and this can not be explained by environmental variables. Secondly, the settlement on the coast, as recorded by the research collectors, has now been falling for four consecutive years. The falls are in general accord with a weaker Leeuwin Current but on no previous occasion since data have been collected has there been the present low breeding stock levels coupled with a series of four years with poor environmental conditions.

Increase in the exploitation rate
The increase in fishing pressure has resulted in a reduction in the breeding stock. However, to address this problem, the breeding stock can not be treated in isolation. The coastal rock lobsters are subject to one to two years fishing pressure before the surviving animals reach maturity. Accordingly, the overall exploitation rate must be given attention rather than considering only the fishing pressure on the breeding stock.

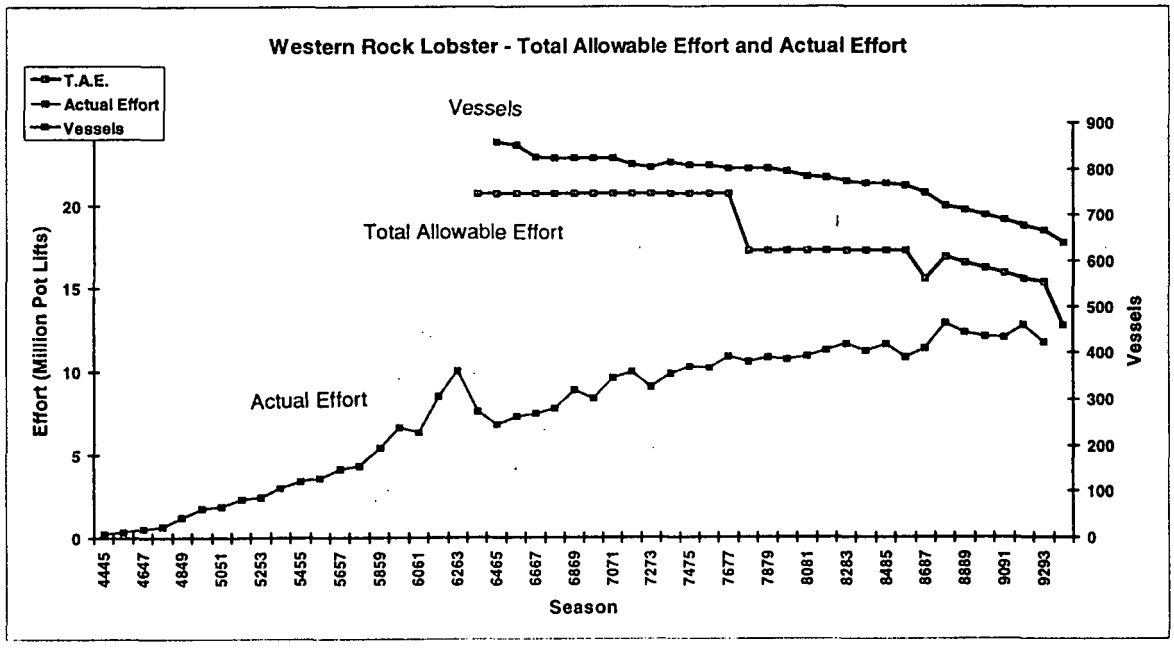
The gradual increase in the exploitation rate over the history of the fishery has been the subject of management discussions on previous occasions. There has been a general recognition that fishing pressure was steadily increasing which led to expressions of concern about the effect on the breeding stock. In earlier years, data were not available about the level of the breeding stock compared with the level when fishing was very light. Now that the low level of breeding stock has been documented, and may be being reflected in the level of

puerulus settlement, the matter of the high exploitation rate needs to be given urgent attention.

There have been four major attempts to contain the fishing pressure. The first was in the 1970s which resulted in the season being shortened from 14 August to 30 June commencing in the 1977/78 season. The second was in the 1980s which resulted in a 10 per cent reduction, spread over five years, in the number of pots allowed to be used. The third attempt was in the early 1990s which resulted in the changes introduced for the 1992/93 season. None of the three previous attempts were judged to be sufficiently effective to permanently overcome the ongoing increases in efficiency of the fleet. Accordingly, further measures, including an 18 per cent temporary pot reduction, were introduced for the 1993/94 and 1994/95 seasons. On each occasion, whilst there has been agreement on the need for conservation, there has been considerable debate and disagreement between members of the industry and those responsible for management advice, and between different sectors of the industry on the precise nature of the conservation measures.

Neither the reduction in the fishing season in the 1970s nor the reduction in the number of pots in the 1980s resulted in a sustained reduction in the fishing pressure. This was not unexpected, as there were a number of ways available to the industry to increase the fishing pressure, and the natural response to the past reductions has been for the fishermen to increase their efficiency within the constraints of the season length and the pots allowed. However, the measures taken in the 1970s and the 1980s did serve to reduce the excess (latent) fishing capacity in the fleet. Each time that pot numbers and latent effort capacity were reduced, subsequent controls were likely to be more effective. Figure 1 shows that in 1993/94, possibly for the first time, the option of simply expanding real effort to use up latent effort has not been available to fishermen. The theoretical number of pots lifts, determined by the number of pots multiplied by the number of days in the fishing season (total allowable effort), and the actual number of pot lifts during the fishing season are not very different for the 1993/94 and 1994/95 seasons. The difference is further reduced when factors such as non fishing days (because of weather or full moon) are taken into account.

Figure 1



It appears from the 1993/94 data that the measures introduced for the 1993/94 and 1994/95 seasons have so far been more successful than the past measures in reducing the fishing pressure and thus the exploitation rate. The media release Bulletin of 18 May 1994 produced by the WA Fisheries Department Research Division sets out, in relation to the impact of the 1993/94 management package, that:-

> *"However, the catch to the end of January 1994 (the whites catch) was 11.6 % below the last 10 year average. Given a good whites catch was predicted, this confirms that the pot reduction and larger minimum size components of the package had the desired effect of reducing the exploitation rate and leaving more white rock lobsters in the water. An expected catch of about 10,700 tonnes for the current season (compared to a predicted 11,800 tonnes) indicates the package is likely to achieve its principal objective of leaving uncaught an estimated 1,000 tonnes of rock lobsters. The achievement of this significant reduction in exploitation rate will enable greater flow through of lobsters to the breeding stock in the coming years"*

There remains, of course, the theoretical potential for an increase in effort as a result of fishermen attempting to increase their catches by using more of the presently unrestricted inputs, such as increases in bait usage or gear efficiency, to counter the restrictions on pot lifts.

Safe breeding stock levels

The 'safe' level of breeding stock to maintain a fishery has been the subject of a number of scientific papers in recent years. The precise 'safe' level of breeding stock cannot be forecast before the fishery declines. However, from an examination of a number of fisheries where there has been a serious decline associated with a reduction in the breeding stock, there is a general understanding that if the breeding stock falls below about 20 per cent of the pre-fishing breeding stock level, recruitment overfishing is likely to occur. The Exmouth Gulf tiger prawn fishery is an example. The fishery declined rapidly to an annual production of under 100 tonnes, from an average of 600 tonnes, after the fishing fleet reduced the breeding stock to approximately 20 per cent of the virgin level.

If the breeding stock is low, the serious nature of the problem can be masked for a time if the environmental conditions are favourable to a high larval survival rate. However, in the reverse situation of poor environmental conditions and low breeding stock, the risk of rapid decline in recruitment and further subsequent reduction in the breeding stock is very high. Some of the writers on this subject have proposed that, in the absence of specific data about a fish stock, a safe working percentage would be 30 to 35 per cent of the original breeding stock.

The WA Fisheries Research Institute has considered the question of a safe level of breeding stock and proposed that it be at least 25 per cent of the unfished breeding stock level. This figure of 25 per cent represents the level present in the fishery in the late 1970s and early 1980s. This was the period immediately prior to the introduction of new technology eg. satellite navigation, GPS and so on, and a period when recruitment was maintained in the face of a variety of good and poor environmental conditions.

The management measures adopted for the 1993/94 and 1994/95 seasons have been based on the expectation that, provided the fleet's efficiency does not compensate for the control measures, they will lead to a rebuilding of the breeding stock over time. That is, the variable pot usage tailored to the level of recruitment into the fishery each year coupled with the specific protection for animals growing into breeding sizes should enable the breeding stock to slowly rebuild across all zones to the levels of the late 1970s and early 1980s.

5 Introduction to TAEs, ITEs, TACs and ITQs

One of the principal management measures introduced into the rock lobster fishery has been a control on the number of rock lobster pots, and boats, in the fishery. This measure was adopted to operate from 1 March 1963. Since that date a number of additional measures have been adopted so as to define more accurately the pot as a standard unit of fishing effort. The pot dimensions are now regulated and so is the number of entrances, one only, and its position in the pot.

The pot lift is used as an important measure of the fishing effort exerted on the rock lobster resource. The number of pot lifts does not equate directly to exploitation rate because of variations in catchability during the season and other factors such as the changing use of electronic equipment and skipper skills. However, at least during the 'white' season, from the opening on 15 November to the end of January, the number of pot lifts permitted has a significant bearing on the total catch. During the 'red' season the number of pot lifts has a less direct effect on catch but is still closely related. The rock lobster pot is, therefore, a unit of effort, and because the management plan allows the transfer of individual pot entitlements between licensed vessels, the pot can be considered to be a unit of *individual transferable effort* (ITE). Its use in fisheries management to control the amount of fishing is termed an input control. Assuming that all pots are used on all available days of the season, the total of the ITEs reflects the *total allowable effort* (TAE).

The alternative to controlling the amount of fishing by gear constraints is to control the amount of catch allowed to be taken, termed an output control. Use of output controls principally involves the setting of an upper limit for the allowed catch, termed the *total allowable catch* (TAC). This can be allocated to licence holders as units of *individual catch quota* (IQ) and, if transferability is allowed the units of catch quota are termed units of *individual transferable quota* (ITQ).

The general concepts of TAEs, ITEs, TACs and ITQs are discussed below. The western rock lobster fishery operates on ITEs, and much of the literature about sound fisheries management using an input control system has emanated from Western Australia where this system has been used extensively in many fisheries since 1963. However, the use of ITQs and its perceived benefits are perhaps not so well understood in Australia. Accordingly, this subject of ITQs is considered in more detail than ITEs.

Total allowable effort (TAE)
The total allowable effort in the western rock lobster fishery is the total number of pots allowed to be used during the fishing season multiplied by the total number of days available to fish. As a result of the temporary 18 per cent pot reduction, all pots are now fully utilised which means that the pot usage can be regarded as ITEs which directly control the effort applied to the stock.

Individual transferable effort units (ITEs)
The rock lobster pot entitlement is an ITE. However, because of the increasing efficiency of the fishing fleet, the pot as a unit of effort can change over time. A rock lobster pot used in the fishery throughout the season in the 1990s will exert considerably greater fishing pressure on the stocks than a pot in the fishery in the 1970s. Accordingly, the exploitation rate on the rock lobster stocks can increase even though the number of pots in the fishery remains unaltered.

Much of the discussion in Sections 3, "The principal elements of the fishery" and 4, "The status of the fishery in broad terms" has revolved around the use of rock lobster pots and the increasing efficiency of the fishing fleet.

One of the difficulties arising from the historical use of controls on pot numbers in the WA rock lobster fishery to regulate the fishing pressure was that there was considerable excess fishing capacity, or latent effort, available to the fleet. Although the amount of gear remained

the same, the fishing pressure gradually increased as the fleet became more efficient and took up more of the excess fishing capacity (time). When the amount of gear was reduced, the effect was short term because the fishing vessels increased their usage of the remaining pots. This has been the case for the western rock lobster fishery in relation to the reductions in the season and in the number of pots prior to the 1993/94 season when latent effort was no longer available to the fleet.

One of the principal reasons for moving from input controls to output controls in many fisheries has been the inability of the management system, including industry acceptance and the 'political' will, to control the increasing fishing pressure through the regulation of the amount of fishing gear allowed to be used.

Traditionally, the control on fishing gear (TAE/ITEs) in the rock lobster fishery has been relatively static. This is understandable noting that if transfers are permitted, the gear, which provides an access to the fishery, assumes a value depending on the value of the fishery, and any change in the amount of gear allowed to be used is perceived by some fishermen as a reduction in the capital value of the fishing unit. However, to consider ITEs as a constant measure is likely to lead to excess fishing pressure on the stocks. Where ITE reductions have been used, the capital value of the pot entitlements have adjusted to compensate for a reduction in the total number of units left in the fishery.

For sound fisheries management, the manager needs to have the ability to vary the TAE to be used depending on the state of the fishery, and especially on the state of the breeding stock. The TAE/ITEs is usually the principal management control, but it also has to be operated within a framework of other input controls such as closed seasons, size limits and the type of animals allowed to be retained. The management system should determine the approximate catch allowed to be taken in the ensuing season, and set an appropriate TAE to achieve the required catch. Under this system, where the fishing effort is set, the catch actually achieved will vary around the expected level depending upon the actual abundance of lobsters. That is, incorrect forecasts are, to some degree, compensated for in the catch actually achieved so that lower than expected abundance will provide a lower catch and higher abundance will result in a safe higher catch than anticipated.

Total allowable catch (TAC)

A control on the total catch allowed to be taken (TAC) is, in theory, a direct method of controlling the exploitation rate provided that the TACs are set at the appropriate level in relation to the stock abundance. Use of this output control as a management measure would require not only a decision on the method of determining the TAC but also decisions on an array of other matters such as the method of monitoring the catch, the law enforcement requirements and the method of data collection for the purpose of stock assessment.

Individual transferable quota units (ITQs)

The use of individual transferable quotas (ITQs) as a principal management method is an extension of the concept of a TAC. The TAC, or TACs by zones, are divided in an equitable manner amongst those who have boats authorised to operate in the fishery, thus creating shares of the TAC or individual transferable quotas (ITQs).

There has developed an increasing interest throughout the world in the use of ITQs in fisheries management. The basis for this interest has been (i) the recognition that for many fisheries the lack of controls on access has led to over fishing and (ii) the desire to increase the economic performance of the fishery.

The Commonwealth Government's policy paper "New Directions for Commonwealth Fisheries Management in the 1990s" set out that "The Government's position is that ITQs should be the preferred method for managing fisheries. Their practicality should be examined before other management controls are considered." The southern bluefin tuna and the south east trawl fisheries are now controlled by the use of ITQs.

New Zealand has adopted TACs and ITQs as the cornerstone of its management strategy. This has resulted in the preparation of many papers and reports on the subject which provide a valuable source of information and guidance.

In the USA, the National Oceanic and Atmospheric Administration (NOAA) sponsored four studies on ITQs resulting in the publication of the National ITQ Study Report. The purpose of the studies, which used four different USA fisheries as examples spanning a wide range of situations, was to explain the general principles of ITQs and show how they might be applied to those specific fisheries.

In Western Australia, ITQs have been introduced for the snapper, pilchard, abalone and pearl oyster fisheries, and thus the WA Fisheries Department has significant experience in operating ITQ systems.

It is important to note that ITQs have been introduced mostly to overcome the problems inherent in open access fisheries. TAC/ITQ management has been judged to have benefits from biological, economic and social points of view. Dr Lee Anderson, in his 1992 overview document of the four USA studies has written:-

> *"In summary, ITQs are a regulation tool that can simultaneously address the necessary biological aspects of management and avoid some of the problems of traditional management techniques. They can provide operators with the flexibility to increase their profits by lowering their costs (by finding the most efficient way to harvest fish) and by increasing their revenues (by selling their products at those times and in those markets where prices are higher). This flexibility comes from the fact that fisheries managers do not have to tell the harvesters how to operate. The manager's job can also be easier because he or she does not have to worry about derby openings or about trying to figure out ways of keeping the catching power of a fishing fleet to a level that will not overfish the stock. By facing the allocation decisions at the outset, the dual questions of how much to catch and who can catch it are separated. This separation leads to a system which can provide incentives matching the fishing power of the fleet to the productivity of the fish stocks."*

Dr Anderson went on to say that:-

> *"This is not to say that ITQs do not have their problems. There are drawbacks, especially in certain types of fisheries. One special issue is that ITQs are a new and fundamentally different way to manage fisheries even though similar concepts are used in other types of resource management."*

Professor Parzival Copes, in a paper "A Critical Review of the Individual Quota as a Device in Fisheries Management" published in August 1986, provides a number of pertinent statements on the use of ITQs writing mainly from the perspective of moving from a TAC system of management to a TAC/ITQ system. One of those statements reads:-

> *"The deliberate application of individual quotas (ie. quotas at the operational level as distinct from country quotas) to achieve goals elaborated in recent theoretical discussions is still at an early stage of development, though there are now several fisheries – eg. in Canada, New Zealand, Iceland, Norway and South Africa – where this device is being applied. As yet there appears to be no adequate assessment of the results on which firm general conclusions may be based.*
>
> *The purported advantages of management by individual quota allocation lie in the elimination of important external diseconomics, both among those associated with open-access fisheries and those peculiar to fisheries subject to limited entry licensing. The guarantee of an individual quota – it is contended – means that fishing operators do not have to race one another to secure their share of the catch as quickly as possible before the TAC is filled and the fishery is closed. When they are assured of their quota – so it is held– fishermen can take their time, spreading their effort optimally across the entire season and using the most economical configuration of*

equipment and manpower in the process. Gone will be the need for competitive escalation of speed and fishing power, requiring large capital inputs and driving up costs unnecessarily. As a further advantage operators will find little need to fish in bad weather or under other dangerous circumstances in order to keep up their share of the catch. In addition, harvest gluts can be avoided or reduced and a higher value of sales achieved by meeting optimally the time pattern of demand over the year of both fresh fish consumers and processors."

Not all of the purported advantages of an ITQ system described by Professor Copes would apply directly to the western rock lobster fishery because of the existing tight control on pot numbers in that fishery. Moreover, Professor Copes sounds a note of warning in relation to high valued species. He writes:-

"Because of the strong incentive to engage in quota-busting, enforcement can be a serious problem in individual quota management. The problem is likely to be more serious, the larger is the number of fishing units involved, the more extensive is the geographical area over which they are dispersed, and the greater is the number of possible marketing channels for the catch. The problem may not be a serious one in an industrial fishery with few landing ports or processing facilities. The problem may be insuperable in a widely distributed small-boat fishery for a luxury species which may be sold over-the-side to a wide range of potential customers."

The above statements by Professor Copes indicate that management under a TAC/ITQ system could theoretically be very advantageous, but its implementation poses many practical difficulties.

Professor Bob Lindner, in his specialist economics report prepared in association with this report, has set out:-

"Economic theory suggests that reducing catch by reducing licensed pot numbers is likely to increase the average cost of effort because it encourages increasingly inefficient combinations of licensed and unlicensed inputs. As a result, realized resource rent will be less than potential resource rent, a phenomena known in the literature as "rent dissipation". Furthermore, any regulations which impede rationalisation of boat numbers operating in the fishery in order to meet socio-economic policy goals will exacerbate this problem of inefficient input combinations and consequential rent dissipation. Likewise, regulations which restrict the effectiveness or 'catchability' of licensed fishing gear will also dissipate potential rent. Where such regulations restrict the duration or timing of fishing effort, they may reduce the average return per unit of catch as well as increasing the average cost of effort, thereby further dissipating rent. Finally, if past history repeats itself, there will be a continuing need over time to further reduce the number of licensed pots to offset the impact of fishermen's ingenuity in exploiting technological change to further raise the effective level of effort. Such ongoing change in the regulation of the industry would involve additional administrative, managerial, and political costs.

The alternative approach is to abandon methods of management based on input controls for one based on direct control of output, or level of catch. One intrinsic benefit of catch control based management methods vis-à-vis' input control based management methods is that the effectiveness of the former in limiting exploitation rates and ensuring the desired level of escapement to the breeding stock is not compromised by advances in fishing technology nor by favourable changes in economic circumstances (e.g. higher prices and/or lower costs) which provide an incentive to increase effective fishing effort. Consequently, so long as the total allowable catch is introduced before the fishery is over-exploited, and is set at the correct level at the outset, there should not be any need for continual adjustment to fishery regulations as is the case with input control based management systems."

The experience in New Zealand indicates that the rock lobster fishermen of that nation have increased the total value of the rock lobsters catch by fishing at a time appropriate to the market requirements. However, the introduction of ITQs has not constrained the exploitation rate, and at least in some areas the TAC is not reached each year. Also, the rock lobster

fishermen in New Zealand did not have any transferable rights before the introduction of ITQs.

More recently, a TAC/ITQ system of management has been introduced experimentally into the southern zone limited entry rock lobster fishery in South Australia. However, it has not been in operation long enough to gain experience resulting from a decision to move from an existing limited entry rock lobster fishery to a TAC/ITQ system of management. One matter which is clear from the South Australian experience is that the equity of the allocation formula adopted was, and still is, the subject of ongoing and often heated debate.

There appears to be no literature describing a move from a complex transferable ITE based limited entry fishery, such as the western rock lobster fishery, to a TAC/ITQ system of management. If, however, the limited entry system in Western Australia is not permitted to provide the constraints on the exploitation rate which are needed, and the TAC/ITQ system is therefore considered a real alternative, it is important to provide information from whatever ITQ or IQ experiences are available, such as in New Zealand and Canada, to assist the industry and managers to understand the consequences of moving to that system. Consideration of a movement to a TAC/ITQ system of management should not be regarded as a "soft option". There are many difficulties in such a system which parallel those in the ITE system, particularly when there is a need for annual changes in either the TAC or the TAE.

Questions about the possible introduction of a TAC/ITQ system of management can not be adequately debated unless the issues are clearly identified and addressed in detail with specific reference to the western rock lobster fishery.

The major issues which would need to be addressed are the:-

(a) Legal protection for the TAC setting authority.

(b) Method of determining the annual TAC.

(c) Allocation of the TAC between the zones.

(d) Units of quota to be adopted.

(e) Method of allocation of the quota units to those already authorised to operate in the rock lobster fishery.

(f) Monitoring of the total and individual catches in the zones.

(g) Effective enforcement of the ITQs to the satisfaction of those in the industry and the public generally.

(h) The need to maintain the existing biological, seasonal and gear controls.

(i) Implication for the ongoing collection of research data to enable (b) and (c) to be accurately determined, and to assess the status of the breeding stock.

(j) Quota registration and transfer arrangements.

(k) Carry over of quota.

The issues raised in this Section about TAEs, ITEs, TACs and ITQs are considered in Section 6 in relation to the western rock lobster fishery.

6 The use of TAEs, ITEs, TACs AND ITQs in the fishery

The Rock Lobster Industry Advisory Committee holds strongly to the view that the risk of recruitment overfishing should be reduced by increasing the breeding stock to at least 25 per cent of the original level, which would require taking action to increase the female breeding stock from its present abundance of about 2 000 tonnes to about 2 700 tonnes at the start of each fishing season. This represents the level during the late 1970s and early 1980s. To achieve this outcome, the growth in the exploitation rate has not only to be halted but the exploitation rate has then to be reduced.

The reduction in exploitation rate does not have to be great but it does have to be real. This process was commenced some years ago, but strengthened for the 1993/94 and 1994/95 seasons. A reduction in the exploitation rate may mean a reduction in the catch, but a reduced catch may not necessarily mean a reduction in its total value. For instance, the export of live animals results in a higher price than the export of other rock lobster products. Better handling of the rock lobsters and their capture at times when the market is strongest could lead to an increase in sales at the higher end of the market such that it more than offsets any reduction in the total catch.

This Section examines the implications of some different approaches to future management of the rock lobster fishery. In each case, there must be an overriding principle that the management approach will have the ability to arrest the decline in the breeding stock and move towards its increase by about 700 tonnes. This does not mean that the average catch must be reduced by 700 tonnes, but rather that there be an accumulation of an additional 700 tonnes of breeding females over a number of years.

The reason for considering these different approaches for the future management of the rock lobster fishery can be summarised in the following manner.

The management package introduced for the 1993/94 and 1994/95 seasons, incorporating the concept of variable pot usage (TAE/ITEs) to match incoming recruitment levels, was aimed at increasing, over time, the breeding stock to about the level of the late 1970s and early 1980s. Two outcomes can be considered:-

(a) If the management package is shown to be effective in achieving its goal in relation to breeding stock abundance, a decision could be taken to either:

(i) stay with the current management system, using variable pot usage (TAEs and ITEs) and a season ending on 30 June, or

(ii) consider variations to the existing management strategies which could increase economic efficiency and the total value of the catch by fishing over a longer or at a different time when the worth of the product was higher.

(b) If the research being undertaken indicates that the management approach for 1993/94 and 1994/95 appears unlikely, for one reason or another, to produce the desired outcome, on a sustained basis, the management authority may have to act quickly at some time in the future to further reduce the exploitation rate. This could involve either a use of variable pot usage controls (TAEs and ITEs) or the use of catch controls (TACs and ITQs). However, it is likely that under these circumstances of required reduction in the exploitation rate, the use of TACs and ITQs would come under increased consideration.

It is worth noting here that, as set out in the Section 4, the 1993/94 package appears to have been successful in achieving its objective of reducing the exploitation rate.

Important elements in the evaluation of the alternative management strategies are (i) the potential for increased value, (ii) the expanded use of TAEs and ITEs, (iii) the introduction of TACs and (iv) an extension of TACs to introduce ITQs. These are discussed below in the context of the western rock lobster fishery.

The discussion on the further use of ITEs is not as lengthy as that on ITQs only because the general use of pot entitlements, its administration and law enforcement is already clearly understood by the fishing industry. The length of the discussion on ITQs should not be taken as a suggestion that the reader is being led towards this method of management for the western rock lobster fishery. Indeed, the use of pot access entitlements has served the industry well, and the further use of ITEs has the potential to be further developed and become an effective management system for the future.

The TAC/ITQ system of management may not be well understood throughout the industry. Consequently, it is necessary to take time to discuss the issues involved in that method of management.

The potential for increased value

A specialist report by MAREC PTY LTD (MAREC), prepared in association with this report, has demonstrated that the traditional catching pattern which results in very high production in December needs to be reviewed now that the industry has moved away from rock lobster tails as the principal market product. Any action which reduces the annual variations in the catch, spreads the catch more evenly over the catching months and expands the number of months in which the catch may be taken would have benefits from a marketing perspective.

Readers are encouraged to study the MAREC report in detail because the information presented in that report is important for understanding the potential for an increased value of the rock lobster catch. The report sets out that it was not the intent of the study to justify a change in the catch flow by claiming a specific economic benefit, but to show by analysis the potential for deriving economic benefit.

The findings of the MAREC report, contained in its Section 10, are included in this report. However, as an introduction to the findings, MAREC has set out that they are subject to the qualification that the base composition of the catch would be able to be maintained and that, "without jeopardising the potential of the fishery in any way", (i) the catch could be redistributed, (ii) the season could be extended and (iii) rock lobsters less than the present legal minimum size could be taken in the winter and springs months. There was a further qualification that the management system would allow the taking of the smaller lobsters in the winter and spring months and that his would be successful in reducing the catch of 'white' rock lobsters in the following season.

Principal findings of the MAREC report:-

* *Based on the 1992/93 season model the white's catch as reflected in the month of December has an extraordinary low worth yet it represented some 45% of the season's catch.*

* *The market for the high worth live lobster was not catered for in the period July to November 14th of the 1992/93 season and possibly at other times when there may have been insufficient catch to meet demand.*

* *The input control system of management as it applied in the 1992/93 season together with its season closure effectively predetermined the catch flow irrespective of the needs of the market.*

Other findings of the MAREC report:-

* *The worth of a lobster product can change at any time.*

* *It is theoretically possible at any time for any lobster export product for any size to have a greater worth than any other lobster export product for that same size although in practice certain export products have generally had a greater worth than other export products within specific size categories.*

* *Live lobster, or any lobster product, does not have to be the product with the highest worth at all times or any particular time for it to be relevant to the maximisation of the worth of the catch. Its relevance depends upon its relative worth within any catch size category and whether it is choice of processing in this product form or some other product form which has a lower worth.*

* *Live lobster in the 1992/93 season in general provided a higher worth per catch kilo for any size category than alternative products. Small frozen boiled red lobster have in general been the second most valuable product and from time to time although not necessarily in the 1992/93 season have provided a higher worth than live lobster for the same size category.*

* *To maximise the worth of the season's catch it is necessary to produce the maximum weight of those products with the highest worth.*

* *To produce the maximum weight of the products with the highest worth it is necessary to deliver a catch at the time when it has the highest potential worth.*

* *It is not possible to accurately predetermine the catch flow that provides the maximum worth for the catch although there are some changes to the 1992/93 season catch flow that could be expected to provide important benefits.*

* *Up until the 1991/92 season around 90% of lobster products have been produced primarily in frozen form and therefore if required could be stored and consumed at a later time.*

* *Live lobster production at present is normally not stored for any length of time and is understood to be consumed a short time after receival.*

* *The characteristics of live lobster and the live lobster market and the economic importance of live lobster in recent times has placed a much greater emphasis on when the catch is delivered from the fishery.*

* *The catch flow pattern of the type that occurred in the 1992/93 season is not conducive to producing a high content of live lobster from the catch.*

* *A strong Japanese demand for live lobster appears to exist in the months of July to September when the Western Australian fishery is closed and this demand is now being partially met by New Zealand exporters.*

* *The taking of that quantity of undersize red lobster in the period from May which otherwise would become white size lobster in the following whites season would seem to be an effective way to reduce the whites catch and at the same time replace that catch with a more valuable lobster.*

* *Extending the season results in an increase in some fixed costs. For the 1992/93 season these have been broadly estimated at $2.5 million to $3.5 million. Offsetting these are the benefits of lower interest rates, increased utilisation of holding tanks, market continuity for live lobster and the advantage of maintaining processing staff on a permanent basis.*

* *Extending the season may result in an additional catching cost. This is the subject of a separate study and has not been taken into consideration in this study.*

* *The 'rush to fish' results in a depleted catch in May and June and as a result the lobster industry may not be taking full advantage of market opportunities at that time.*

Further findings with regard to the 1992/93 season model:-

* *The December 1992 peak catch substantially exceeded the requirements of the most valuable lobster product markets at that time and accordingly resulted in the production of a large content of the lowest worth products.*

* *The white lobster that represented the bulk of the very large December 1992 catch and to a lesser extent the November 1992 and January 1993 catch, were commercially inferior to red lobster.*

* *The large December 1992 catch is understood to have placed cash flow pressure on the processing sector. Catch flow pressure may result in weaker processors liquidating product at less than optimum levels to obtain funds to pay fishermen.*

* *In general the high worth of the catch in the month of June 1993 resulted from a high proportion of live lobster obtained from a relatively low catch and from a higher product selling price at that time.*

The MAREC report encourages the rock lobster industry to seriously consider the potential for increased value of the catch through a change in the fishing strategy to one which reduces the catch in December and allows fishing to continue beyond June in each year. Such consideration immediately involves an examination of the expanded use of the pot controls (TAEs/ITEs) and the use of catch controls (TACs/ITQs) as alternative management methods if the fishing strategy is to be changed on the basis of a potential for increasing the value of the catch. The expanded use of pot controls or the use of catch controls also have to be examined so that industry has an opportunity to judge their effectiveness and efficiency if the management package introduced for 1993/94 and 1994/95 is found to be not effective in achieving its goal of providing, over time, an adequate increase in breeding stock abundance and a more valuable distribution of catches throughout the season.

The expanded use of TAEs and ITEs

Those engaged in the rock lobster industry have had many years of experience of operating within the limits of pot usage limits.

The decision taken in relation to the temporary reduction in the number of rock lobster pots allowed to be used by each operator in the 1993/94 and 1994/95 seasons is an example of the expanded use of TAEs and ITEs. Essentially, the TAE and consequently the ITEs (pot quotas) were used to reduce the exploitation rate, and thus the catch, in a high recruitment year so as to allow for a greater flow through to the breeding stock in subsequent years.

An expanded use of TAEs and ITEs in the future management of the rock lobster fishery would involve a decision being made each year on the number of pots allowed to be used in the fishery to take the catch, or notional TAC, judged to be appropriate taking into account the level of recruitment, the state of the breeding stock and the array of other input controls already in place. That is, there would be a variable effort to achieve a notional TAC. However, if the recruitment was found to be higher than expected the catch would be higher. Alternatively, if the recruitment was lower, the catch would be lower.

The essential element of the TAE/ITE system of management is that the number of pots allowed to be used each year could vary, depending upon the notional TAC decided upon. The use of TACs is generally considered in the context of an output control system of management. Accordingly, the discussion on the setting of TACs appears later in this report under the heading "The use of TACs and ITQs".

The adoption of this more flexible use of TAEs and ITEs for the sound management of the western rock lobster fishery would change the concept of the pots from a precise number to be used to a share of access to the available catch. For example, if the total number of pots in the fishery was 70,000, a fisherman with an entitlement of 100 pots would have an access

share of 100/70,000. This ratio of access share would then remain constant. If a management decision set the notional catch at 9,000 tonnes for a season, and it was estimated, from a knowledge of the efficiency of the pots used by the fleet at that time, that the appropriate TAE was 50,000 pots, the fisherman with 100 pots would be able to use 100/70,000 multiplied by 50,000. The important fact would be that the access ratio would remain at 100/70,000. If fishermen purchased additional pots, they would effectively have invested to acquire a greater share of the fishery.

A more flexible use of a TAE/ITE system would require a change in the perception by some fishermen of the status of the rock lobster pot entitlement. One of the factors involved in the debate on the temporary reduction in the use of pots for the better management of the rock lobster fishery has been the view that it involves a reduction in the value of the 'property' held by each fisherman. In a variable pot usage method of fisheries management, the value would still remain but be in the form of an access share in relation to the total number of pots allowed to be used. In this regard, it would be similar to the situation of quota units in a TAC system where quota units are constant but the permitted catch per unit can vary each year.

An important point to note on the use of a TAE/ITE system is that because of the ability of the fishing industry to increase its efficiency over time, and thus increase the efficiency of a rock lobster pot as an ITE, there would always remain the requirement to take into account the growth in fishing efficiency when estimating the number of pots allowed to be used. Thus, in practical terms the average number of pots allowed to be used would gradually be reduced as the efficiency of the fleet using those pots increased.

The report by Marec provides an example of the use of ITEs to increase the value of the catch if it were decided to allow fishing to occur during July, August and September. The example, using the 1992/93 catch data, shows that if the catch was reduced by about half in December, and that the quantity saved in December was distributed equally in July, August and September, there would be a considerable increase in the value of the catch, perhaps in the order of $10 to $20 million However, it has been estimated that to achieve this theoretical redistribution of catch, something approximating the following arrangement of pots in the water and legal minimum length would have needed to apply:- .

(a) A reduction in the number of pots, by about one half, allowed to be used in December.

(b) An extension of the season until 30 September.

(c) A reduction in number of pots, by about 20 per cent, allowed to be used for the remainder of the season, ie. to the end of September.

(d) A reduction in the legal minimum length from 76 to 75 mm for the months of July, August and September.

An extension of the season of this nature could significantly increase the value of the catch. However, there would also be some additional costs for both law enforcement and research.

Increases in research costs would result from the longer time period over which both the monitoring data and the catch and effort data would be gathered. Also, the managers and the industry would require the provision of advice with increasing accuracy on the number of ITEs which should be used each month to obtain the best value of the catch matched against the forecast markets. The WA Fisheries Research Institute would need to continue to gather information on changes in the effectiveness of a rock lobster pot. Accordingly, use of ITEs as the principal management method would continue to require an annual assessment of the proportion of the permanent pot entitlement allowed to be used each season.

Increased law enforcement costs would flow from the need to have the fisheries inspectors in the field, both on land and at sea for three additional months each year. This would require the appointment of approximately five additional officers to ensure continuity of field

operations over the longer period, and it would also entail increased operating costs but not capital equipment.

The use of TACs and ITQs

The alternative to an expanded use of the TAE/ITEs system of management is the use of TACs and ITQs. Their adoption would be a fundamental change in the management of the western rock lobster fishery as it would introduce output controls as the principal method of controlling the exploitation rate. Output controls are now increasingly being used in fisheries management throughout the world because of the increasing difficulty of gaining industry acceptance for controlling the growth in the exploitation rate through controls on the vessels and gear. However, the use of output controls has introduced a new set of problems for both the fishing industry and the management authority, mostly revolving around the setting of the TACs, the method of allocation of ITQs, law enforcement and the collection of research data for stock assessment. If there is not a large degree of industry support, the cost of law enforcement can be out of all proportion to the value of the fishery. If law enforcement is not effective, the use of TACs and ITQs is far less satisfactory as a management measure than is the use of TAEs and ITEs.

An introduction to the use of TACs and ITQs was given in Section 5 of this report. In the following pages, their use in relation to the western rock lobster fishery is discussed. Firstly, however, it is necessary to discuss the use of competitive TACs as a management measure, ie. TACs without the use of ITQs. This is necessary because the measure is used extensively in fisheries management elsewhere and also because the estimation of the TAC is an integral part of operating both TAE/ITE the TAC/ITQ systems of management.

Competitive TACs

The introduction of a competitive TAC or TACs would, in theory, provide a direct method of further reducing the catch, and thus the exploitation rate. Whereas input controls rely upon their effectiveness in regulating the capacity of the fleet to catch rock lobsters, output controls such as TACs, require that fishing cease when a specified quantity of rock lobsters have been taken. To this extent, output controls are theoretically more effective than input controls in controlling the exploitation rate. This, of course, assumes that there is an ability to assess accurately and forecast the exploitable biomass and to decide upon the appropriate TAC.

Because of the significantly different levels of recruitment across the range of the fishery, separate TACs would have to be established for the three rock lobster zones, (i) south of 30° S, (zone C) (ii) coastal north of 30° S (zone B) and (iii) the Abrolhos (zone A). The season for each zone would end when the TAC for that zone had been reached. Consideration would need to be given as to the most appropriate commencement date for the start of the TAC year so that the 'white' rock lobsters were given some protection from the full impact of a competitive TAC. A commencement date of 1 February in each year would, perhaps, be the most effective.

To provide an example, if the annual TAC for the western rock lobster fishery, established by the addition of the three zone TACs, had been set and controlled at around 9,000 to 10,000 tonnes over the last five years there would have been a clear reduction in the exploitation rate. The average catch over the last five years was 11,260 tonnes. To obtain an appropriate reduction in the exploitation rate over the next five years, the TACs would have to be set at levels which took into account the estimated abundance of rock lobsters following an examination of the information on puerulus settlement. Consideration would also need to be given as to the amount of 'white' rock lobsters likely to be taken and to the state of the breeding stock. It is important that these immature 'white' animals be afforded sufficient protection to enable a higher percentage to migrate offshore and reach maturity. The total management strategy would need to take this aspect into consideration.

If, as an example, the TAC for a season was 9,000 tonnes, it would in practical terms have been derived from the TACs for the three zones, south of 30° S, coastal north of 30° S and the Abrolhos. It would, of course, be easier for a TAC decision to be made for the whole of the

fishery and that there be no further division. However, noting the nature of past management by area, and being aware that it would not be in the better interests of either the conservation of the rock lobster stocks or the orderly operation of the rock lobster fleet to remove the boundary lines, there would be little choice other than to decide upon separate TACs for the three zones.

The staff of the WA Fisheries Research Institute would be able to provide data on which to make a judgement about the TAC levels for zones A and B which would be appropriate in terms of achieving the desired outcome of increasing the breeding stock over time. However, for zone C predictions are not yet reliable and a very conservative TAC would have to be provided. If the fishing strategies adopted by the fishermen in a zone resulted in excess effort being applied to the breeding stock, the TAC for that zone may need to be further divided. Whilst this is simple to set down as a process, the work involved in providing the information is complex and the degree of precision is variable.

The setting of annual TACs is probably the most important on-going management decision required to be taken. It would, therefore, be necessary to appoint a TAC Committee comprised of representatives from the fishing industry, management and research. The TAC Committee should report to the Rock Lobster Industry Advisory Committee. Depending upon the acceptance of the research data by the fishing industry, it may also be necessary from time to time to have an external review of the research methodology and findings of the WA Fisheries Research Institute. To be effective, such reviews need to be undertaken in cooperation with the research staff involved. Those who are involved in a research review need to be people of high standing in the research community. However, at the same time the fishing industry needs to have confidence that any review will be rigorous in its scope.

The methodology for providing information and establishing the TAC levels should be determined prior to the introduction of a TAC/ITQ management system. Unless this action is taken, industry pressure on the managers or industry pressure on the political process will raise the possibility of changes to the TACs as a result of perceived increases in the density of rock lobsters in some areas. There should be a major review of the methodology every five years but, following a review of and agreement on the methodology, it should endure for the next five years.

The legislation establishing an ITQ/TAC system of management would need to include adequate legal protection for the methodology agreed upon as well as for the TAC setting authority and the resultant TACs.

Stability of TACs is more likely to be maintained in those areas where the annual catches are relatively stable, such as zones A and B. However, this may not be the case in zone C. In zone A, the catch in the last ten years has varied between 1,290 and 1,807 tonnes, but most of the catches have been between 1,500 and 1,700 tonnes. In zone B, the catch in the last ten years has varied between 3,274 and 4,532 tonnes, although for most of the years the catches have been between 3,706 and 4,532 tonnes. In zone C, the catch in the last ten years has varied between 3,573 and 6,947 tonnes. In three of the years the catch was of the order of 3,600 and in three of the years the catch was over 6,000 tonnes.

The discussion on TACs has focussed on the commercial capture of rock lobsters. However, if either a TAC or a TAC/ITQ system of management was to be introduced, the commercial fishermen would certainly raise the question of the government's philosophy in relation to the future take of rock lobsters by the recreational fishers. Under the current rules, the take by recreational fishers could increase without there being an upper limit. The introduction of either a TAC or TAC/ITQ system of management for the commercial fishery would require clear legislation by government in relation to the method by which the recreational fishery would be controlled so that a TAC for the total catch, commercial and recreational, could be set and the sharing arrangements established.

The proposed procedure for the settings of TACs is set out in Attachment 2. Essentially it would follow the same basic approach as has been used for the assessment of other types of management strategies. Information on the annual puerulus settlement would be the starting point to predict recruitment. The recruitment prediction would be used in the fisheries models together with a nominal TAC to estimate the effect of that TAC on the estimates of breeding stock. The estimates of breeding stock would be compared with the target breeding stock abundance which had been accepted as an objective of management. The nominal TAC would then be varied and the process repeated in order to provide a range of alternative TACs and assessments for consideration by the TAC Committee.

A competitive TAC without effort (pot) controls would result in intense competition between the fishermen, each of whom would be endeavouring to gain as large a share of the available TAC as was possible before the TAC figure was reached for the area and the fishery was closed.

One of the concerns about a competitive TAC is that it increases the competition on a daily basis which could lead to boat skippers taking undue risks at sea in order to maximise their catch. There is, of course, competition between boat skippers under an input system of management, but this would be increased considerably under a competitive TAC. There would be a move away from the concept of fishing being undertaken in an orderly manner. It seems likely that if a competitive TAC system of management was adopted, the fishing industry would very quickly seek to have the TACs further divided into individual transferable quotas (ITQs) so as to gain the theoretical benefits attributed to this output system of management. The use of a TAC/ITQ system of management is discussed later in this report.

The Canadian Pacific halibut fishery provides an interesting example of the use of a competitive TAC system of management, although it is not suggested that all of the problems seen in that fishery would arise in the western rock lobster fishery. The halibut fishery operated under a combination of limited entry of boats and a competitive TAC during the period 1979 to 1990. A report published in 1992 by Mr Bruce Turris, Regional Halibut Coordinator for the Canadian Department of Fisheries and Oceans, sets out that the competitive TAC resulted in increasing short term effort. He writes:-

> *"The side effects of this race became increasingly worrisome and dangerous for the halibut industry. The fishery grew shorter, shrinking to a mere six fishing days in 1990 from 61 days in 1982, despite a 33 % larger TAC in 1990. Increasingly, safety was being compromised with vessels with excessive gear and crew fished twenty four hours a day in hazardous weather conditions because the financial costs associated with not fishing were too high. More and more gear was lost as vessels set too many hooks, fished in rough seas, or set over by other vessels. Lost gear continued to fish, reduced future available catches, and became an increasingly biological and economic drain on the fishery.*
>
> *The quality of the catch diminished as fishermen spent more time hauling and setting and less time properly dressing, icing, and storing the catch. Then, when the fishery closed, millions of pounds would be landed in less than a week resulting in fish sitting on the dock for days prior to being shipped to the market or placed in cold storage. Less valuable bycatch species such as rockfish, with a 100 % mortality rate, were largely discarded so as not to take up hold space for more valuable halibut. In addition to the lost economic benefit, the bycatch was rarely recorded in logbooks and not available for stock assessment purposes."*

The Canadian Department proposed that the Canadian sector of the pacific halibut fishery change to a TAC/IQ system of management instead of the competitive TAC. Eighty two per cent of the 435 halibut licence holders responded to a questionnaire and 77 per cent supported the IQ concept. Individual quotas were introduced in 1991 on a two year trial basis. The evaluation report of the trial, prepared by Mr Turris, shows that clear benefits were gained, including better quality fish, higher prices and safer fishing, by moving from a competitive TAC to a TAC/ITQ system.

The introduction of TACs in the western rock lobster fishery would require a change in law enforcement, both at sea and on land. The fishery would close by areas as the TACs were reached. This would necessitate some additional patrolling along the boundaries dividing the fishing areas. On land, there would need to be a more rigorous collection of data from the processing factories so that the total catch by area was known on a daily basis. Also, the rules for the sale of rock lobsters would have to be amended so that it was illegal for a fisherman to sell rock lobsters other than to a registered processing establishment. This could have significant law enforcement implications. Processors would have to be legally required to provide data to the Fisheries Department in considerable detail, and perhaps on a daily basis.

The use of competitive TACs as a management arrangement would introduce many of the difficulties of an output system without providing any of the advantages. For instance, competitive TACs would result in a 'rush to fish' practice to a greater extent than is the case under the current input control arrangements. Also, in the 'rush to fish', the industry could increase the fishing pressure on the deeper water resource thus placing undue exploitation on the breeding stock. Competitive TACs are considered to be an unsuitable method of management for the western rock lobster fishery, and are not discussed further in this report.

TACs together with ITQs

As set out above, the introduction of TACs would, in theory, provide the most direct method of controlling the catch in the rock lobster fishery. However, if the advantages of an output method of management are to be gained, the TACs must be divided into individual transferable quotas (ITQs). In practical terms, each licence holder would have a share of the catch, expressed as a percentage, which could be translated into a catch quota as soon as the TACs for a particular year were announced.

The setting of TACs by zones has already been discussed. The essential elements of an ITQ system which now require consideration are (i) the allocation formula, (ii) law enforcement, (iii) the need to maintain existing controls, (iv) research data for stock assessment, (v) registration and transfer arrangements, and (vi) carry over of quota from one year to the next.

Allocation formula

The major equity issue which arises whenever individual quotas are being considered is the description of the allocation formula. This is difficult enough when moving from either an open access or a competitive TAC to an ITQ system. It would be an even more vexed topic for discussion by those engaged in the limited entry rock lobster fishery because of the number of pots which have been bought and sold. Under the current arrangement, a fisherman who has a 100 pot entitlement has a capital asset as well as an ability to earn an annual income. The capital asset for 100 pots is the same for each fisherman in an area even though the success of using those 100 pots (ie. the catch) may vary greatly from one fisherman to another.

If the allocation formula under an ITQ system was determined solely on pot allocations, the fisherman who consistently caught high numbers of rock lobsters per pot, through a combination of personal competence and capital investment in a high technology fishing boat, advanced fish finding equipment and navigational aids, may deem the formula to be inequitable. The fisherman could argue that historical catch should also be taken into account.

On the other hand, a fisherman who consistently caught small numbers of rock lobsters per pot could argue that the allocation formula should be based purely on pot allocations so that his capital base was maintained. He could further argue that it was the fishermen who consistently caught high numbers of rock lobsters per pot who had caused the increase in the exploitation rate on the stocks of rock lobsters and that they should bear the burden of the reduction in the catch.

An examination of the catch per pot for each boat in 1990–91 for the three areas has shown that there is a high degree of variation between boats, but that there are no clearly defined peaks. The data are set out in Attachment 3. To take an example, for zone B fishermen (ie.

north coastal), the average boat caught approximately 150 kg per pot for the season. However, five boats caught less than 100 kg per pot and thirteen boats caught more than 200 kg per pot. The variation in the catch per pot cannot be attributed wholly to the fact that there are smaller and larger boats in the industry. An examination of the catch per pot for all sizes of boats operating in the 1985/86, 1989/90 and 1992/93 seasons (Attachment 4) shows that for 1985/86 and 1989/90 there was no statistical difference in the average catch per pot per season based on pot holdings. That is, the boats with smaller pot holdings did not seem to be either more or less efficient at catching lobsters than the vessels with larger pot holdings. In the 1992/93 season, the boats with the larger pot quotas did catch more than those with smaller quotas. However, in that year there was a very high catch from the Big Bank area which would have favoured the larger boats. An examination of the zone C catch per pot against pot quotas for 1992/93 does not show the same degree of increase in favour of the larger boats (Attachment 4).

The point being made is that the large difference in the catches per pot per season shown in Attachment 3 can not be attributed to any marked degree to the size of the boat, accept perhaps when catches in the Big Bank area are involved. It is likely, therefore, that further examination of the data would show that there was considerable variation in the catches per pot over a season for boats of the same size. This would be the source of considerable debate when the determination of an equitable allocation formula was being attempted.

The case study on the Canadian halibut IQ fishery has an interesting statement on the determination of an allocation formula. Mr Turris writes:-

> *"In January of 1990 the first Halibut Advisory Board (HAB) meeting was held and lasted four days. The focus of the meeting was the allocation formula. At one point, 17 different allocation proposals were on the table. Everything from equal shares, pounds per foot of vessel length, auctions, historical performance, and shares based on the number of crew was discussed. By the fourth day HAB members had negotiated tirelessly down to two basic allocation formulas. One formula was supported by the relatively small and historically non-productive (in terms of landed halibut weight) vessels in the fleet. The other was supported by the vessel owners historically and consistently recording the largest catch"*

Eventually the halibut industry members arrived at a compromise formula.

The important point from the halibut case study is that the formula was determined by the industry and not by Government. This is most important and should be an essential process if an ITQ system of management was to be used in the western rock lobster fishery. However, in considering the merits of each approach, industry would need to take into account the current financial arrangements in relation to the ownership and leasing of rock lobster pots.

For the purpose of the discussion on the TAC/ITQ system of management for the rock lobster fishery, the TACs for zones A, B and C have been set, by way of an example, at 1,279 tonnes, 3,334 tonnes and 4,387 tonnes respectively which provides a total TAC of 9,000 tonnes for the season being considered. In this example, the ratios of the catches in zones A, B and C to the total catch have been taken from the averages over the seasons 1988/89 to 1992/93. The TAC example of 9,000 tonnes recognises that the annual catches will be lower in the next five years than they have been for the past five years. However, the figures are only for the purpose of the discussion. If a TAC/ITQ method of management was adopted, there would be a TAC setting procedure as discussed above and described in Attachment 2.

There are three general forms of allocation formula which appear the most obvious for consideration:-

(a) Use of pot entitlements only

This approach would fulfil the advice, offered by those who have adopted a TAC/ITQ system of management, to "keep it simple".

The West Coast Rock Lobster Limited Entry Fishery Notice 1993 has defined a "total pot entitlement" as the number of pots held under a rock lobster licence. The sum of the "total pot entitlements" is the total number of pots licensed for the western rock lobster fishery. The "total pot entitlements" are registered with the Fisheries Department.

If a "total pot entitlement" for a licensee was 100, and the sum of the "total pot entitlements " was 70,000, the licensee would have a share of the fishery equating to 100/70,000. This share would become the ITQ which would not alter unless the licensee either increased or decreased the share by a market transaction. In reality, the share would equate to the number of pots held.

If there was a single TAC of 9,000 tonnes (as set out above in the example used), the allowed catch by the licensee for the year would be 12.857 tonnes of rock lobsters. However, as already discussed, there are sound reasons for the TAC being divided into separate TACs for the three zones A, B and C. If a licensee operated in zone C, the allowed catch for that licensee would be determined by adding all of the ITQs for the zone C licensees, determining the ratio of the licensee's ITQ to the total ITQs for zone C, and then multiplying by the TAC for that zone. Putting this into figures, if the total of the ITQs for zone C was 36,000/70,000 and the TAC for zone C was 4,387 tonnes (as set out in the example used), the allowed catch by a licensee operating in zone C with an ITQ share of 100/70,000 would be 12.186 tonnes of rock lobsters, ie. 100 x 4,387 divided by 36,000, for the season being considered. For that season, the 12.186 tonnes of rock lobsters would be the *annual catch allocation* (ACA) for the zone C licensee with 100 pots.

If the licensee operated in either of zones A or B, the allowed catch would be determined by adding the ITQs of the licensees and the TACs for the two zones and then proceeding as described for zone C licensees. However, there would need to be a further calculation in relation to the zone A licensees so as to determine that part of their catch which could be taken from zone A and that part from zone B. If the total of the ITQs for zones A and B was 34,000/70,000 and the TAC for zones A and B combined was 4,613 tonnes (as set out in the example used), the allowed catch by a licensee operating in zone B with an ITQ of 100/70,000 would be 13.568 tonnes of rock lobsters. If the total of the ITQs for zone A was 17,000/70,000 and the TAC for zone A was 1,279 tonnes (as set out in the example used), the allowed catch by a licensee operating in zone A with an ITQ share of 100/70,000 would be 7.523 tonnes of rock lobsters. The remaining part of the allowed catch of 13.568 tonnes by a zone A licensee would be taken in zone B, ie. the licensee would be allowed to take 6.045 tonnes in zone B and 7.523 tonnes in zone A.

Use of this allocation formula would, in practical terms, mean that the ITQ share for each licensee would equate to the ratio of "total pot entitlement" to the sum of all the "total pot entitlements". However, the conversion of this share to the actual allowable catch may result in there being different annual catch allocations (ACAs) north and south of 30 ° S for the same ITQ share.

(b) Use of a combination of pots entitlements and catch history

This method recognises that both investment, measured as "total pot entitlements", and past performance, measured as historical catch, are important in determining the future share of each licensee in the TAC/ITQ system of management. It was the method adopted by those involved in the south east trawl fishery. In terms of mathematics the system is quite simple. The catch of a licensee would be expressed as a percentage of the total catch, and the pot entitlement of that same licensee would be expressed as a percentage of the total of the pot entitlements. The two percentages would then multiplied by the weighting factors decided upon for the two elements of investment and past performance. For example, if it was decided that investment and performance should be given equal weighting, each percentage would be multiplied by 0.5. The resulting two figures would then be added to provide the licensee with a percentage of the TAC. If, however, it was decided that investment was more important than past performance the weighting could be 0.8 in relation to the pot entitlement percentage and 0.2 in relation to the catch percentage.

The data for pot entitlements would be the same as those used in method (a) described above. However, a great deal of thought would need to be given to the method of calculating catch history. If each licensee had consistent catches each year, the past performance could be measured by last year's catch expressed as a catch per "normal pot" and then multiplied by the "total pot entitlement" (see West Coast Rock Lobster Limited Entry Fishery Notice 1993 for definitions). However, this is not the case, especially in zone C, and some form of averaging over a period of years would be required. If catch history is used as part of the allocation formula, the following matters would need to be given detailed consideration:-

* The weighting to be given to catch history, and thus also to the pot entitlements.

* The method by which catch history would be determined, including the number of years of data to be considered. In essence, the greater the variability in catches the greater the number of years required to provide an equitable averaging process.

* The method by which catch history would be considered in cases where boat sale, leases or replacements had taken place.

* The method by which catch history would be considered in cases where a boat had been not operated for a season or part of a season.

* The method by which catch history would be considered in cases where the number of pots attaching to a licence had changed during the years for which catch history was being considered.

* The method by which catch history would be considered in the variety of circumstances resulting in either low catches or fishing being not undertaken.

* Acceptance that the catch data held by the Fisheries Department would be the validated data on which decisions would be made, but if this was not the case, acceptance of both the method by which the catch history would be validated and the appeal process.

* The legal implications, if any, of adopting the data held by the Fisheries Department as the validated data.

* If the data held by the Fisheries Department were not accepted as validated data, the cost involved in determining validated data, including the cost of the appeal process.

All of the matters listed above are capable of definition if it was decided to include catch history as part of the formula. However, the matters on which industry agreement would need to be reached would be substantial. Perhaps the most vexed question would be the weighting to be given to the catch history. It is unlikely that there would be unanimous agreement on this point.

(c) Use of the Adjusted Preferred Method

This method uses both catch history and pot entitlements, but allows each licensee to choose their preferred method of allocation, ie. catch history or pot entitlements. The method was developed by the Department of Primary Industries in South Australia, and has been used in the first year of allocation in the South Australian southern zone rock lobster fishery.

A licensee who caught less than the average catch per pot would opt to use the pot entitlement in the calculation of the share of the TAC, expressed as a percentage. Such a licensee with a pot entitlement of 100 would have 100/70,000, expressed as a percentage, as an initial ITQ. However, a licensee who caught higher than the average catch per pot would opt to use the catch history. Such a licensee would obtain an initial ITQ by expressing as a percentage the catch of the licensee compared with the total catch. Clearly, under this system

the total of all of the ITQ percentages would add to a figure greater than 100. Consequently, each initial ITQ would be reduced by the same fraction to reduce the total of all of the ITQs, expressed as percentages, to 100 per cent.

The advantage of this method, if catch history is to be used, is that a decision would not be required as to the weighting to be given to catch history. It also means that some of the difficulties about the use of catch history could be avoided. There could be a simple rule that where catch history caused a complication, the licensee was required to use pots in determining the initial ITQ.

Set out below are some very simple examples of the use of the three different allocation formula taking a sample of 5 boats (A, B, C, D and E) each with pot entitlements of 100 (total 500 pots) and catches of 60, 80, 100, 120 and 140 kg respectively, totalling 500 kg. The resultant ITQs are expressed as a percentage of the TAC.

Example 1. Use of pot entitlements only (Pots).

Each boat would have an ITQ of 100/500, ie. 20 % of the TAC.

Example 2. Use of pots entitlements and catch history (P&C).

(a) Using a weighting of 0.5 for pots and 0.5 for catch history.
Boat A: 0.5 x 100/500 (pots) + 0.5 x 60/500 (catch) = 0.16, or 16 % of the TAC.
Boat B: 0.5 x 100/500 + 0.5 x 80/100 = 0.18, or 18 % of the TAC.
Boat C = 20 %, Boat D = 22 %, Boat E = 24 % of the TAC.

(b) Using a weighting of 0.8 for pots and 0.2 for catch history.
Boat A: 0.8 x 100/500 + 0.2 x 60/500 = 0.184, or 18.4 % of the TAC.
Boat B = 19.2 %, Boat C = 20 %, Boat D = 20.8 %, Boat E = 21.6 % of the TAC.

Example 3. Use of the Adjusted Preferred Method (APM)

Boat A: Selects pots (low catch). The ratio is 100/500 (pots) = 0.2.
Boat B: Selects pots (low catch). The ratio is 100/500 (pots) = 0.2.
Boat C: Selects either pots or catch because each produces a ratio of 0.2.
Boat D: Selects catch (high catch). The ratio is 120/500 (catch) = 0.24.
Boat E: Selects catch (high catch). The ratio is 140/500 (catch) = 0.28.

The total of the ratios is 1.12 which has to be reduced to 1.00.
Boat A: 0.2/1.12 = 0.1786, or 17.86 % of the TAC.
Boat B and Boat C are the same as Boat A = 17.86 % of the TAC.
Boat D: 0.24/1.12 = 0.2143, or 21.43 % of the TAC.
Boat E: 0.28/1.12 = 0.25, or 25 % of the TAC.

The above examples are summarised in the following Table. Each figure is the ITQ expressed as a percentage of the TAC.

Boat	Pots	P&C, 0.5, 0.5	P&C, 0.8, 0.2	APM
A	20.00	16.00	18.40	17.86
B	20.00	18.00	19.20	17.86
C	20.00	20.00	20.00	17.86
D	20.00	22.00	20.80	21.43
E	20.00	24.00	21.60	25.00

Whatever the formula finally decided upon, it would have to be capable of precise definition in the legislation and precise calculation in terms of the data inputs. This is not only

important for the fishermen and the managers but also in relation to the appeal process available.

The final result of an allocation formula is a licensee being entitled to a percentage of a TAC. It is important that following the determination of the allocation formula, and thus the percentage for each licensee, that the licensee's share, expressed as ITQs, remains unchanged unless the licensee takes a business decision to buy or sell ITQs.

The above discussion on the allocation formulae can be summarised as follows:-

(a) Three methods have been presented: one uses only pot entitlements, and the other two use pot entitlements as well as catch.

(b) The most simple method would be to use pot entitlements.

(c) Use of catch data raises a number of questions which would need to be given detailed consideration.

(d) The three methods provide different results in relation to each licensee's share (ITQ) of the TAC.

(e) Although the ITQs would be determined for each licensee using data from the total fishery, the use of TACs for the three zones would mean that an ITQ converted to an ACA south of 30° S may not be the same as an ITQ converted to an ACA north of 30° S.

Law Enforcement

Law enforcement is one of the major issues for consideration under a TAC/ITQ system. Unless law enforcement is effective, the benefits ascribed to the use of ITQs are dissipated, especially in relation to its value as a mechanism for controlling the exploitation rate. In fact, if there is limited compliance with an ITQ system, its use is counterproductive. Two examples are set out below, one under a TAE/ITE system and one under a TAC/ITQ system:-

(a) Consider a TAE/ITE system in which the catch being expected by management is 10,500 tonnes but through heavier than expected fishing pressure the catch taken is 12,000 tonnes.

The result is that over exploitation has occurred to the detriment of the fishery, but the catch level is accurately known as it has been taken legally. The outcome is likely to be industry and management working together to reduce the exploitation rate through a more conservative use of the ITE system.

(b) Consider a TAC/ITQ system in which the TAC has been set at 10,500 tonnes but through quota busting the catch taken is 12,000 tonnes.

The result is that over exploitation has occurred because of illegal activities on the part of some of the fishermen, but the actual over run is not accurately known. The outcome is likely to be some very costly legal proceedings, and a great deal of criticism of the managers and the fisheries inspectors by those fishermen who have operated within the ITQ laws. This would lead to a lack of confidence in the TAC/ITQ system, a breakdown in corporate management between industry and government and an inability to set precisely the future TACs.

A sound compliance system which ensures that both the TACs and the ITQs are operated in conformity with the law is essential. This is not to say that some fishermen will not endeavour to operate outside the rules. However, the likelihood of an offence being detected must be high and the penalty for an offence against the quota management system must also be high.

The requirement for sound monitoring and enforcement has been identified as a crucial element by all those who have had experience in a TAC/ITQ system of management. An extract from the Overview Document entitled "Consideration of the Potential Use of Individual Transferable Quotas in US Fisheries" by Dr Anderson provides a useful summary on this subject:-

> *"A fisheries management program is only as good as its monitoring and enforcement system. This is as true of ITQs as of other types of management. However, there will be some fundamental differences in the formulation and operation of a suitable monitoring system for an ITQ program. ITQs are like any other TAC based program in that there must be a way to monitor total harvest and to ensure that it does not surpass the TAC. In addition, however, it is necessary to monitor the harvest of each participant and to ensure that it does not surpass his or her current individual quota level. With transferability, it is also necessary to keep track of the current amount of individual quota owned by each participant. While these extra burdens may seem formidable, it is necessary to evaluate an ITQ management and enforcement system relative to those of other types of management programs and relative to the potential benefits of an ITQ program. Will overall monitoring and enforcement costs be higher or lower? Even if the costs are higher, are the accomplishments of ITQ management worth it.*
>
> *The successful operation of an ITQ program requires that the monitoring system be seen as being capable of detecting abuse. Participants must be confident that others can not beat the system and thus diminish the value of their rights. In addition the participants must also know that the system will detect any misconduct on their own part so incentives to cheat will be small. However, this does not necessarily mean that every fish brought to the dock and every landing report filed must be personally inspected by an enforcement officer.*
>
> *In-person inspections will still be important aspects of an ITQ monitoring system, but its ultimate success will require a computerised system of electronic reporting and data management. For example, both the harvester and the first fish receiver must fill out independent landing forms that can subsequently be double checked against each other. Similarly a transfer of individual quota from one person to another must be verified in writing by both parties. The computer system should have a series of tests that can be run frequently to verify the accuracy and consistency of reported landings and trades.*
>
> *The work of the monitoring agents will change under an ITQ program. The emphasis will shift from checking the day to day operations of the fleet to monitoring catch levels"*

Professor Copes, in his paper "A Critical Review of the Individual Quota as a Device in Fisheries Management" sets out that quota busting as a result of inadequate law enforcement can be a real problem when output controls are used. In his lead up to the section on quota busting, Professor Copes states:- "Ironically, when it comes to promoting individual quota management, its proponents often fail to apply the sharp insights gained in exposing the deficiencies of limited entry licensing." On quota busting, he says:-

> *"For many fisheries, enforcement is likely to be one of the most difficult problems with an individual quota system. Obviously, there is a material incentive for fishermen to engage in 'quota busting', ie. catching a larger amount of fish than the individual quota allows. The extent of compliance with quota limits will be influenced by such factors as individual conscience, community culture and social sanctions, effectiveness of official monitoring and enforcement efforts, severity of penalties on conviction for infractions, and extent of gain from cheating on quotas"*

Mr Neil McLaughlan, together with senior staff from the WA Fisheries Department, has written a specialist report on the monitoring and enforcement requirements if a TAC/ITQ system was to be introduced for the western rock lobster fishery. The report should be read in detail to understand the full monitoring and enforcement implications of introducing a TAC/ITQ system of management. Mr McLaughlan has reported that the western rock lobster fishery would be one of the most difficult of fisheries to manage by way of a TAC/ITQ

system. The following extracts set out some of the essential elements in a consideration of introducing such a system:-

> *"The principal issues involved with the need to ensure individual catches do not exceed allocated quotas can be summarised as follows:-*
>
> * *Even with expected restructuring, including quota trading to produce fewer fishing units and eventual movement to more cost efficient vessels, a large excess catching capacity will continue to exist.*
>
> * *The product has a high value and has a high market demand throughout Western Australia, in the eastern states, and as an export commodity. Unlike other WA quota species, ie. tuna and abalone, rock lobsters are easy to sell over the back fence or down at the local pub.*
>
> * *Rock lobsters can be transported over long distances without any specialised equipment [in a car boot] and can be processed, even to export standards, by cooking, tailing, freezing and packing, and can be held for long periods, using simple domestic equipment. The inclusion of illegally packed rock lobsters along with legitimate export shipments occurred in earlier years.*
>
> * *Collusion between catcher and processor to under estimate sales would be to the advantage of both and would be difficult to detect without effective monitoring, surveillance and audit investigation programs.*
>
> * *The transport of illegal product to the eastern states by freezer trucks occurred during the earlier days of the fishery and would be more difficult to detect today because of the increased volume of general frozen cargo.*
>
> * *An expected outcome of ITQ management is that of increased export prices. This would inevitably push up domestic prices also and may assist to create an increased demand for lower priced black market or poached product at a time when product in excess of quota could be readily available.*
>
> * *Rock lobsters can be landed over all but two hundred kilometres of the thousand kilometre coastline adjacent to the fishery and attempts to prevent illegal landings could be further complicated by at sea transfers to recreational vessels. (There are about 50 000 recreational vessels licensed in WA). At sea transfers would also serve to distance catchers from the possibility of licence or quota loss penalties.*
>
> * *Profits from illegal activities would be sufficient to attract a criminal element. This has occurred in the eastern states abalone fisheries and in the New Zealand abalone and rock lobster fisheries where threats of violence against fishermen who complain and Fisheries Officers and their families occur. Once established illegal activities of this nature are extremely difficult to eradicate."*

Mr McLaughlan has identified the monitoring and enforcement requirements under the headings of (i) quota registration, (ii) catch and receival documentation, (iii) computer based quota records, (iv) licensing of rock lobster receivers, (v) approved landing points, (vi) approved landing times, (vii) container specifications, (viii) container tags, (ix) publicity, (x) legal costs, (xi) staffing implications, (xii) staff required and (xiii) vehicles. He set out that it would be necessary to maintain the current field inspection staff and add other staff to undertake the recording and audit requirements. Mr McLaughlan estimates that the additional costs would be of the order of $2.0 million in the first year and $1.7 million per year thereafter at today's $ value.

Mr McLaughlan has made special mention of the collection of documentary evidence in the following terms:-

> *"Experience with quota management systems in New Zealand, and with the small number of quota managed fisheries in Western Australia has demonstrated that following the implementation of quota management, enforcement emphasis shifts from relatively simple observations or investigations at sea, on the beach front, or at processing factories, which may involve the collection of evidence of a single event on a single day, such as the observed use of excess pots, to very complex investigations of quota avoidance practices.*
>
> *Investigations of quota management breaches may involve long term covert observations of product flow from vessels to processors, the need to seize and study relevant documents held by processors, transporters, quota holders, and boat skippers, and a need to study financial transactions between them for comparison against observed landings and quota records. These investigations can involve unannounced searches of business premises, and as fishing records are frequently held at home by vessel owners and skippers, the search of private residences; and can additionally involve the need to search bank and other financial institution records.*
>
> *The volume of documentary and other evidence needing to be submitted in the more complex quota management breach cases, and the increased number of issues involved, can greatly increase the length of time involved in Court hearings and, as a consequence, can increase prosecution and defence legal costs. The New Zealand authority has a budget of approximately NZ$2.0 million annually to cover costs associated with prosecution action alone"*

In summary, adequate law enforcement is an essential element of a TAC/ITQ system of fisheries management. Unless there is widespread support by industry for this type of management, adequate law enforcement would most likely be an impossible task. Even with corporate support by industry, the law enforcement cost is likely to be considerably higher than under an input control system. This has to be weighed against the advantages of a TAC/ITQ system in terms of the control on the exploitation rate and the ability of fishermen to determine their fishing strategies to a greater extent than is now possible.

Law enforcement is so important that both management and industry would have to consider the degree of independent auditing required to gauge the success of the enforcement system.

The need to maintain existing controls

One of the matters which would require consideration if a TAC/ITQ system of management was adopted is the degree to which the input controls could be reduced or removed. The literature on ITQs sets out that one of the principal benefits to be gained from the use of ITQs is that each fisherman, having accepted the constraint of an ITQ, should be allowed to take his quota in the most efficient manner possible.

Clearly, the use of escape gaps in the rock lobster pots and the protection of berried and setose animals would be retained. A legal minimum and maximum size would also be retained, although the minimum size would not necessarily be 76 mm for the whole of the fishing season. The debate would centre on the need for a season, the constraints on pot size and design, and also on the boat replacement policy and the control on the number of pots. The decision on these matters would have a significant effect on the law enforcement requirements. Mr McLaughlan has assumed in his report that the current input controls will not be changed, at least in the short term.

Although most of the controls would probably remain in place at the commencement of a TAC/ITQ system of management, the guiding principal should be that input controls would gradually be removed unless there were clear benefits to the industry in their retention. It follows, for instance, that a fisherman should be free to make a decision as to how many and what type of pots he uses, provided the escape gaps remain effective. Also, the season would need to be flexible enough to allow the catch to be taken at a time which maximises the market opportunities. In brief, the system would need to change from one in which most of

the decisions were imposed on the industry to one in which each individual had a freedom of choice, within broad limits, such that their decision-making was based upon economic efficiency.

The commencement of the fishing season for the taking of the year's quota could be retained as at 15 November so that each operator had the opportunity to take rock lobsters when they were most catchable. However, there would also be merit in commencing the season on 1 February, except for zone A if matters of transport quality are still an issue for that area, so that operators were firstly able to take 'red' rock lobsters with the knowledge that they were able to fish the 'whites' later in the season if they still had quota available at that time. There would need to be a short closed season during the year and other controls to protect breeding female rock lobsters in spring and early summer.

Research data for stock assessment

The WA Fisheries Research Institute has provided a statement (Attachment 5) on the changes to the research programs and the additional information which would be required if TAC/ITQ system of management was introduced into the western rock lobster fishery.

Under a TAC/ITQ management arrangement, the relationship between catch and the effort applied to the rock lobster stock by fishermen could be expected over time to change significantly, as fishermen modified their fishing strategy to maximise the value rather than quantity of the catch. Given that the catch per unit of effort (catch per pot-lift) is the basic measure of the abundance of rock lobsters used by researchers to assess the state of the stock (exploitation rates, breeding stock indices and so on), the expected changes in effort under TACs/ITQs dictates that alternative or additional data would be required to maintain an understanding of the status of stock. The need for additional data is strongly supported by overseas research experience following the introduction of quota management. Without this additional information the success of the management arrangements in maintaining the breeding stock could not be measured or guaranteed.

The overall impact of the introduction of TACs/ITQs to the rock lobster fishery on the research division would be likely to require an additional $900,000 per year, in the initial stages, if full precautions are taken to ensure the availability of reliable stock assessment for ongoing management.

The specific changes to research programs and the need for additional information under ITQ management have been considered by the Research Institute, and are discussed in Attachment 5. The matters of major importance, either involving a change to the research program or for additional information, and which are involved in the estimate of the additional expenditure each year, are:-

(a) Total landed catch.

(b) Compulsory catch and effort, and the voluntary research log book.

(c) Monitoring on board rock lobster boats.

(d) Fishery independent breeding stock surveys.

(e) Puerulus monitoring program.

(f) Monitoring the catches of the recreational fishers.

(g) Estimating TACs.

(h) Data processing and analysis.

Readers are encouraged to read Attachment 5 in detail so as to understand the changes in data gathering and the additional data which would be required.

Registration and transfer arrangements for ITQs

The WA Fisheries Department has provided a statement (Attachment 6) on a rock lobster register and transfer system which would apply if the fishery was to be managed by ITQs.

The statement sets out that "government and industry requirements of a quota registration system are that it be a source of accurate and timely information on quota holdings and transactions. To do this a quota registration system must be of an evidential standard in criminal prosecutions and be able to interface with all aspects of the Department's record base."

Two concepts have been set out below for consideration and discussion:-

(a) The first concept involves the use of two registers, one which records the number of units of quota owned by each quota holder, ie. the long term fishing right, and one which operates on a yearly basis recording the *annual catch allocations* (ACAs) after the TACs for the year had been set. The *annual catch allocations register* (ACAR) would record all of those short term arrangements which did not include a permanent transfer of quota units from one person to another. All arrangements recorded on the ACAR would cease at the end of a fishing year.

Neither an arrangement involving the ACAs nor the transfer of quota units would take effect until the appropriate transfer forms had been completed and recorded on the register.

The transfer of quota units from one person to another during a fishing season would involve the completion of two transfer forms: one for the transfer of the quota units, and one for the transfer of that part of the catch allocation for that year which had not yet been caught.

It would be imperative for enforcement purpose that there be a nexus between the two registers. The 'parent' quota holding from which an annual catch allocation was calculated and fished must be able to be identified at any time during the season so that quota units could be removed as a result of a successful prosecution.

(b) The second concept would involve the use of only one register, and operate in much the same way as the current pot register.

The nexus between the number of units of quota and the catch allocation would remain fixed at all times. Accordingly, unlike the concept in (a) above, there could be no temporary transfers, no matter how short the period of time might be.

Each transfer of catch allocation would also require the transfer of the appropriate number of units of quota.

Concept (a) would provide a greater degree of flexibility within the industry. However, it may be difficult to attach, back to the quota holder, penalties involving the forfeiture of quota which had been imposed on a fisherman who had leased a catch allocation.

Concept (b) would result in a quota holder having to transfer units of quota to another person even if the purpose was to allow a small quantity of catch to be taken over a short period of time. This may be particularly difficult in the case of processing companies which, under a TAC/ITQ system of management, are likely to purchase units of quota as a means of retaining or increasing their competitive edge in relation to the amount of product processed.

In considering these concepts, the advice of those with experience in the operation of a TAC/ITQ system should be headed in relation to the essential elements of law enforcement and the requirement for severe penalties. It may be the case that the value of flexibility may have to give way to the need for an unambiguous nexus between the units of quota and the penalty of quota forfeiture.

Readers are encouraged to read Attachment 6 in detail.

Carry over of quota from one year to the next

In some TAC/ITQ systems, operators are permitted to have some flexibility, of the order of 10 per cent, in relation to the take of their annual catch allocation (ACA) in any one year. That is, a fisherman would be allowed to carry over up to 10 per cent of his ACA from one year into the next. Alternatively, he would be allowed to take up to 10 per cent more than his ACA in a year and have the same amount deducted from the following year's ACA.

This flexibility is usually considered within the context of a multi species fishery because of the difficulty of being precise in relation to the quantity of each species landed. The administrative requirements of allowing an 'overs and unders' flexibility is quite complex. If a TAC/ITQ system was introduced for the rock lobster fishery, the disadvantages of adopting an 'overs and unders' policy would probably outweigh the perceived advantages. It is a matter of weighing the administrative and law enforcement difficulties against the benefits of providing each fisherman with a further degree of freedom in decision-making.

In practical terms, if an 'overs and unders' policy was adopted, it would need only to cover either the possible excess quota taken in the last pull of rock lobster pots before the quota was met or the small amount of quota still remaining on the basis of it being not worth an extra days pull of pots. This being the case, it would be difficult to present a case for an 'overs and unders' policy which involved more than one per cent of the catch allocation. Accordingly, the administrative and law enforcement difficulties may well outweigh the advantages.

On an associated matter, in some multi species TAC/ITQ systems a fisherman is permitted a lead time of up to 15 days to acquire quota if he brings into port a quantity of fish for which quota is not held. This should not apply to the rock lobster fishery. Any operator who took rock lobsters should have to possess quota to cover that catch prior to capture.

If an 'overs and unders' policy was adopted, the residual or deficit of the allocated catch would have to be transferred to the following year's Register but would not be permitted to be accumulated. As set out above, if such a policy was adopted, it would be difficult to argue that the figure should be higher than one per cent.

7 The size of the fishing fleet

The Terms of Reference require that the ramifications of fleet size changes be assessed, including administrative, economic and social factors as well as the rules for pot transfer, pot allocation and licence splitting.

The number of boats in the rock lobster fleet has been decreasing since the 1970s when it was decided that the owner of a boat would be permitted to transfer the pot entitlement from that boat to other boats authorised to operate in the rock lobster fishery. The gradual reduction in the number of boats in those earlier years has been hastened in more recent times as a result of the decisions to reduce the total number of pots allowed to be used in the fishery. The number of boats has fallen from an original of 836 to 638 as at 30 June 1994, and is still falling due to economic forces which dictate that a smaller fleet of more efficient vessels generates increased profitability.

Some members of the rock lobster industry have expressed the view that a figure should be set as the minimum number of boats in the rock lobster fleet. The view is based upon the

general proposition that the rock lobster industry is important to the state, and that the distribution of a sizeable fleet along the coast benefits regional development and provides employment opportunities.

A guide to a discussion on the fleet size can be found in the Mission Statement of the Fisheries Department and in Objective (d) of the new Fish Resources Management Bill. The Mission Statement includes the words "in order to maximise economic benefits to the state" and Objective (d) of the Fisheries Bill reads "to achieve the optimum economic, social and other benefits from the exploitation of the fish resources".

The inclusion of the words "optimum" and "social and other benefits" allows the debate on the fleet size to include such matters as regional interests and employment opportunities. However, maximising the economic benefits to the state may not be achieved by setting a figure for the minimum number of boats in the fleet.

Professor Lindner has provided information, in Table 3 of his specialist report, about the relative net return per pot under a number of options of pots per boat resulting from decisions about the fleet size. Table 3 has been repeated in this report, and appears below.

Table 3: Summary of results - accounting model (from Lindner 1994)

Scenario	0 = Base Case	1	2	3	4	5	6
	Constant boat & pot Nos.	Reduced boat & pot nos.	Reduced pots constant boats	Reduced pots more pots/boat	Reduced boat & pot nos.	Reduced pots constant boats	Reduced pots more pots/boat
Fishing season	Limited	Limited	Limited	Limited	Extended	Extended	Extended
Catch (m. Kg.)	10.796	9.000	9.000	9.000	9.000	9.000	9.000
Pots/boat	104	104	87	144	104	69	144
Days fished	188	188	188	188	230	230	230
Pot Lifts (m.)	11.435	9.532	9.532	9.532	10.449	10.449	10.449
CPUE	0.94	0.94	0.94	0.94	0.86	0.86	0.86
Pot nos.	69,613	58,031	58,031	58,031	46,264	46,264	46,264
Boat nos.	669	558	667	403	445	669	321
pot costs ($m)	$10.094	$8.414	$8.414	$8.414	$6.708	$6.708	$6.708
boat costs ($m)	$76.976	$64.169	$76.707	$46.344	$51.157	$76.883	$36.947
trip costs ($m)	$18.247	$15.211	$18.183	$10.986	$14.836	$22.296	$10.715
potlift costs ($m)	$24.013	$20.017	$20.017	$20.017	$21.942	$21.942	$21.942
catch costs($m)	$34.548	$28.800	$28.800	$28.800	$28.800	$28.800	$28.800
Total costs($m)	$163.877	$136.611	$152.122	$114.561	$123.443	$156.630	$105.112
Revenue($m)	$196.295	$163.635	$163.635	$163.635	$172.457	$172.457	$172.457
Net Return ($m)	$32.418	$27.024	$11.513	$49.074	$49.014	$15.827	$67.346
Net Return/pot	$466	$466	$198	$846	$1,059	$342	$1,456
Net Return/boat	$48,431	$48,431	$17,260	$121,774	$110,183	$23,674	$209,619

The base case for Professor Lindner's examination is a catch of 10,796 tonnes (which is unsustainable), 188 days of fishing, 669 boats and 104 pots per boat. This provided a net return per pot of $466. If the catch was reduced to 9,000 tonnes and the number of boats and pots reduced by the same proportion, to 558 boats and 58,031 pots respectively, the net return per pot lift in the fishery would remain at $466. However, if a management decision was taken to not allow the number of boats to fall below 669, the net return per pot would fall to $198. On the other hand, if the average number of pots per boat was allowed to increase from 104 to 144, and as a result the number of boats was reduced by market forces to 403, with 144 pots per boat, the net return per pot would be $846. Also, under this option the aggregate net return to the fishery of $49 million would be higher than for any of the above alternatives ($32 million for the base case with a catch which is unsustainable). Table 3 in the specialist report by Professor Lindner also provides information about the expected outcomes if the season was extended. Again, potential gains in economic efficiency through greater industry net returns would only be realised if the number of boats operating in the fishery was allowed to fall.

Professor Lindner has concluded "To sum up, there is a strong interaction between policy on boat numbers and changes in industry net returns resulting from changes in other aspects of management in the Western Rock Lobster Fishery". Accordingly, any decision to adopt a minimum fleet size on the grounds of "social and other benefits" has to be weighed against the potential loss in profits to the industry. Not only would the industry profit be less with a specified minimum number of boats, but those profits would be shared amongst a larger group of fishermen than would be the case if market forces determined the number of boats in the fishery.

The current rules set an upper limit of 150 pots per boat as a total pot entitlement. Accordingly, while this rule remains in place, the theoretical minimum number of boats in the fishery is approximately 70,000 divided by 150, which results in 467 boats. Any figure as a minimum fleet size above 467 will have the effect, eventually, of setting a reduced upper limit of pots per boat on those operators who have not moved to the 150 pot figure.

At the other end of the spectrum of pots per boat, there is a rule which sets out that a licensee shall not reduce the total pot entitlement per boat below 63. The basis for this rule was the desire by the management authority to ensure that the operator of each fishing boat had the potential to be viable. It was thought that the operator of a boat with only a few pots was more likely to over-pot than those with a larger number, thus increasing the inspection load. The figure of 63 was a matter of judgement. It commenced at 70 but was reduced when 10 per cent of the pots were removed from the fishery, and it is now less on a temporary basis as a result of the 1993/94 and 1994/95 management arrangements. The potential benefit, which had its basis in law enforcement, of having a lower limit should be examined in detail. It is likely that it will be found that the lower pot limit can no longer be justified.

The debate on a minimum fleet size, and a maximum and minimum number of pots per boat is usually reduced to one of personal philosophy and judgement. On purely economic rationalist grounds there should be no constraint on any of these matters. However, Objective (d) of the new Fish Resources Management Bill, "to achieve the optimum economic, social and other benefits from the exploitation of the fish resources" may result in other decisions being made.

If it was decided to adopt a figure of, say, between 450 and 550 for the minimum fleet size, as a result of a consideration of the economic, regional and social issues involved, it would follow that there would need to be a maximum number of pots per boat although it would be open to debate as to whether this should be expressed as a 'normal' pot entitlement or as a 'total' pot entitlement. It would also be a matter of judgement as to the continued need for a minimum number of pots per boat.

If a minimum fleet size was adopted as a strategy, one scenario could be a minimum of 450 and a maximum of 550 (after the number had fallen to this figure through pot redistributions), but within that range the number of boats could vary to be as low as 450, by pot amalgamations, or as high as 550 by the splitting of pot quotas. This would allow a degree of flexibility but at the same time ensure that the fleet size remained between 450 and 550 boats. In terms of overall management of the Western Australian fishing industry, any boat introduced into the rock lobster fishery as a result of licence splitting should already hold a fishing boat licence.

The present trend towards a smaller fleet is likely to continue under either the existing ITE system or an ITQ system of management, although it would probably be speeded up under an ITQ system. The introduction of a TAC/ITQ system would, by definition, remove the link between the catch and vessel numbers but a management decision could, and no doubt would, be taken to ensure that a link was retained and also that there was a maximum ITQ per vessel. If this was the case, pots would be replaced by ITQs in the debate. However, under a TAC/ITQ system, the argument for having an upper and lower ITQ limit per boat may be reduced. The reason for this is that a decision to move to an output method of control would have signalled a desire by government to move from a form of management in which fishermen operated under an array of management imposed input controls to one in which more of the decision-making process in relation to fishing strategy rested with the individuals or companies holding quota.

In summary, a decision on the minimum fleet size has to be a trade off between economic efficiency and social and other benefits which may be perceived to operate. In terms of economic efficiency, the introduction of a minimum fleet size rule would have the effect of reducing the total industry potential for profits compared with that which would apply if market forces determined the number of boats. This reduction in profits could be of the order of $15 million to $20 million per annum which would have to be weighed against the "social and other benefits" to be gained by setting a figure for the minimum number of boats in the rock lobster fishery. Those "social and other benefits" may include such matters as regional development and employment opportunities.

A matter associated with that of the fleet size is the boat replacement policy in relation to the number of pots held. The existing rule is that the length of a replacement boat must be within the range of the pot quota divided by 10 to determine the minimum length and 7 to determine the maximum length, but that the maximum length will not be less than 10 metres.

The introduction of temporary pot reductions, such as for the 1993/94 and 1994/95 seasons, and the concept of variable pot usage requires that there be a reconsideration of the boat replacement policy. The industry has developed a fleet of specialised rock lobster boats. Taking into account matters such as safety, comfort and the equipment required on board for the holding of rock lobsters in a quality condition, there is no merit in reducing, over time, the average length of the rock lobster fleet in line with any reduction in pot numbers which might occur.

Whilst there may be a case, based upon law enforcement considerations and perceived social equity, for retaining the current maximum size of a replacement boat calculated by reference to the "total pot entitlement", the question should be debated and determined on objective reasoning. If the decision is to retain a nexus between pot entitlement and boat size, there would be value in amending the figure of 7 in the "7 and 10" pot rule so that the fleet, on replacement, was maintained at the same general average size as currently exists. If this was adopted as a general principal, the examination as to detail should also consider the usage of pots within the context of "total pot entitlement" and "normal pot entitlement". If the extended use of a TAE/ITE system of management was adopted, which provided an access share depending on the number of pots held, the definitions of normal, surplus and total pot entitlements, as set out in the Fisheries Notice No. 620, would need to be reconsidered. The guiding principal should be to provide each operator with the maximum degree of flexibility consistent with sound management of the resource.

8 The effect of maintaining TAE/ITEs or using TAC/ITQs

Although each reader will have his or her own ideas on the effect of maintaining the use of pots as the principal controlling mechanism in the western rock lobster fishery as opposed to moving to the use of a TAC/ITQ system of management, the following discussion raises some of the important issues which need to be taken into consideration.

The timing of the decision

This report has provided information about extending the use of the TAE/ITE system of management as well as the use of a TAC/ITQ system. If, as a result of the discussions and consideration of the issues, a decision is taken to retain the use of pots as the principal method of control, the opportunity would still be available in the future to move to a TAC/ITQ system if it became evident that the use of ITEs could not be applied sufficiently to achieve the desired outcomes.

If a decision is taken to retain a TAE/ITE system of management, at least for the present, rather than move to ITQs, it is important that there be a clear statement about the use of catch data if an ITQ system was adopted in the future and if there was a possibility that catch history would be used in the allocation process. To not do so would lead to a risk that the future catch reporting in the monthly returns would be inaccurate on the basis of some fishermen positioning themselves to take advantage of an allocation process which included catch history. The ideal solution would be to establish the allocation mechanism, such as the sole use of pot quotas, in the event of the adoption of ITQs at some future date. An alternative would be to make a clear statement that if any catch history was to be used in the future it would relate only to the 1993/94 season and earlier. However, this alternative would, in practical terms, be quite unworkable and should not be considered further.

The risks involved

The adoption of TAC/ITQ systems of fisheries management has resulted from there being a general progression of decision-making from (i) open access to (ii) limited entry to (iii) controls on catch to ITQs. Some of the steps may have been passed over and there would have been various forms of input controls at all stages. In recent years considerable literature has become available on the potential benefits of a TAC/ITQ system of management, not only in relation to the control of the exploitation rate but also in relation to economic efficiency. Accordingly, when a judgement is being made about the most appropriate future management approach for the western rock lobster fishery, the debate is likely to focus on the realities of the current system, including its advantages and disadvantages, and the potential benefits to be derived from the alternative system without being sure of the strength of the advantages and disadvantages. Some of the risks involved are set out below:-

(a) Estimate of the biomass

Ideally, the management system should limit the catch relative to the total biomass of the stock such that there is sufficient escapement to maintain a safe breeding stock so as to ensure ongoing average recruitment. Where a TAE is set, with an estimated sustainable catch in mind, the actual catch and the level of escapement to the breeding stock will be a reflection of the biomass. This variation in catch will compensate (self correct), at least to some extent, for errors in the scientific estimate of the biomass on which the TAE was set.

Under a TAC/ITQ system of management, the scientists would be expected to provide information as a basis for setting the TACs. The current degree of accuracy of actual catch against prediction for the rock lobster fishery is of the order of 90 per cent overall. However, the degree of accuracy for zone C is much less than 90 per cent. Accordingly, if the scientists were requested to provide information on TAC options for the three zones A, B and C, they would have to take into account the risks involved in relation to the best estimates of biomass available.

Considering the requirement to ensure adequate escapement to the breeding stock, and taking into account the risks associated with the estimates of biomass, the likely result would be that the average total of the TACs for the three zones would be conservative and thus be less than the catch under a TAE system. Direct setting of the catch by a TAC, while allowing the effort to vary, does not have any self correcting mechanism which can be of assistance where the rock lobster biomass has been over estimated.

(b) The estimates of changes in fishing power

The discussion under point (a) above is about the risks involved in the estimate of the biomass. However, even if this risk is eliminated, other risks have to be taken into account.

Under a TAE/ITE system of management, the effectiveness of the fishing fleet in taking rock lobsters is likely to continue to increase even though the current temporary 18 per cent reduction in the number of pots appears to have been effective in reducing the exploitation rate. This would require the TAE to be varied to take into account any increases in fishing efficiency, as well as being varied to take into account the estimates of biomass available to be caught.

There is a risk associated with the use of a TAE/ITE system because of the ability of the fleet to increase its efficiency and thus increase the exploitation rate to a level higher than expected. This risk would have to be taken into account when setting a TAE.

(c) The degree to which there is compliance with the rules

The risk associated with compliance under the current TAE/ITE system of management appears to be quite small. However, until the introduction of the management arrangements for 1993/94, each action taken to reduce the exploitation rate, and hence the catch, appeared at best to be effective only in the short term. If the TAE/ITE system is used to provide a tight control on the exploitation rate, the compliance risk within the industry may increase. Also, as the price of rock lobsters increases, there is also an increasing risk of sales by 'recreational' rock lobster fishermen.

The risk of reduced compliance under a TAC/ITQ system of management is unknown but could be very high. Mr McLaughlan, in his specialist paper on compliance, has drawn attention to the additional law enforcement requirements. It is difficult to judge the costs involved in ensuring that compliance is maintained at an acceptable level and it would be difficult to develop a monitoring system which accurately measures the level of compliance or illegal catch over the TAC.

The compliance risk probably has a direct relationship with the resources of staff and equipment invested in the task. Mr McLaughlan has set out that if a TAC/ITQ system of management was introduced, additional staff and equipment would be required. He has included an estimate of the additional cost which no doubt would have to be born by industry. Mr McLaughlan has concluded his report stating:-

> *"When estimating the extent of the increased financial returns to the industry, which could be expected to result from a shift to a quota management system, it would be appropriate to ensure that allowances were made to fund further enforcement resource requirements should increased levels of illegal activity occur in the future."*

The risk of non compliance or, alternatively, the cost to industry of reducing that risk to an acceptable level must be taken into account in any consideration of the introduction of a TAC/ITQ system of management. The cost would involve not only the law enforcement aspects but also the audit system of monitoring the effectiveness of that law enforcement. In addition, a TAC/ITQ system would probably have the potential for increased activity through the establishment of an illegal marketing network involving both commercial and recreational fishermen.

If there is a high degree of non compliance with the rules for fishing, the risk of overfishing the rock lobster resource is high. For instance, a 5 to 10 per cent leakage of product from the resource additional to the TACs set for a year would very likely lead to overfishing thus negating the objective of rebuilding, over time, the level of breeding stock to a figure of about 25 per cent of the original breeding stock and maintaining it at that level. Where the catch exceeds the TAC, the subsequent legal TAC would need to be reduced to compensate if overfishing is to be avoided.

Economic efficiency

Under the current system of management, the "rush to fish" occurs to the extent permitted by the effort gear constraints, and can be controlled only by action taken by the management authority. Catching times and quantities can be controlled, but only on a fleet wide basis. In practice, such manipulation of the catch by controls on effort is not easily achieved in large fisheries, such as the western rock lobster fishery. This can be contrasted with the Western Australian prawn fisheries which are also managed under a TAE system but where there are only a few operators, and major market benefits and structural adjustments have been achieved. This is likely to be more efficient in terms of net returns to the industry.

Economic theory suggests that the use of a TAC/ITQ system of management in the western rock lobster fishery would not only provide the potential for an accelerated rationalisation of the fleet but would also allow the catch to be taken at more optimal periods of time in terms of market strength. This would lead to increased economic efficiency through greater net returns to the fishery (resource rent). A definition of "resource rent" can be found on page 1 of Professor Lindner's specialist paper.

Economic efficiency is the subject of Professor Lindner's specialist paper which compares the alternative input and output based management systems in the western rock lobster fishery. Readers are encouraged to read the full text of Professor Lindner's paper.

Professor Lindner sets out that in the western rock lobster fishery there are two major sources of rent dissipation:-

(i) Input substitution which results when fishermen attempt to increase their catches by using more unrestricted inputs, such as increasing vessel efficiency, in place of the restricted inputs.

(ii) Fleet redundancy, or excessive effort, due to the fact that the management permits more than the optimal number of restricted inputs to be employed in the fishery.

Professor Lindner has used a bioeconomic model to estimate the amount of rent dissipation in the fishery under a number of scenarios of pot lift limitations. He has concluded that:-

> *"Among the various scenarios presented in (his) Table 1, reducing effort to 10 million pot lifts, and sustainable catch to 9.4 million kg, comes closest to maximising the mean value of realised annual resource rent (i.e. minimising mean aggregate annual rent dissipation)."*

Professor Lindner has set out that even with severe reductions in pot numbers, or equivalent changes in other regulations, there will still be substantial efficiency losses in the form of rent dissipation. Any reduction in rent dissipation will be more or less offset by increases due to input substitution, or "capital stuffing". The amount of input substitution available in the fishery will no doubt be a matter for debate. If this is put to one side, the changes in net returns can be examined by Professor Lindner's accounting model. This was discussed in Section 7 in relation to the size of the fleet and demonstrated that if the number of boats in the fishery is not allowed to be reduced, the overall net returns and the net returns per pot and per boat, will be significantly smaller than otherwise.

Professor Lindner has then used a programming model to provide net return estimates for a number of scenarios under both a TAE/ITE and a TAC/ITQ system of management. These are set out in Tables 4 and 5 of his paper. The information from these two Tables as well as cost information from the specialist report by Mr McLaughlan and in Attachment 5 of this report have been combined by Professor Lindner to produce his Table 6.

Table 6 has been repeated in this report, and a brief explanation of the information in that Table is set out below.

(a) The money figures are in $ millions.

(b) The "Net Returns" figures are the net returns to the fishery.

(c) The shaded areas in the TAE/ITE row are scenarios which Professor Lindner has judged to be unlikely to be attained.

(d) Except for columns one and four, the table assumes a policy of no constraint on a reduction in the number of boats. The average pots per boat is less than 104 when boat numbers are held constant at 669 boats. Where boat numbers are assumed to be variable, average number of pots per boat equals current levels (104) in columns 2 and 5, and equals a possible 144 pots per boat in columns 3 and 6.

(e) Optimal pot numbers and pot lifts have been derived from the programming model.

(f) A judgement has been made that under a TAC/ITQ system it would be profitable to use more pots per boat, because the cost of pots would no longer be a significant factor, and thus the number of boats in the industry would be reduced at a faster rate than under a TAE/ITE system. Accordingly, under a TAE/ITE system the number of pots per boat is likely to be less than would be the case under a TAC/ITQ system.

(g) Column 1, to take an example, considers the outcome of having a policy of setting the lower limit of boat numbers at 669, which was the base case in Professor Lindner's model. The difference between the net returns for a TAE/ITE and a TAC/ITQ system would be $3 million. However, the additional direct costs to the industry for research and managements set out towards the bottom of the Table, would also be about $3 million. Accordingly, under this scenario there would be no net benefit in moving from a TAE/ITE system to a TAC/ITQ system.

Table 6: ITE/TAE vs ITQ/TAC comparison: programming model (from Lindner 1994)

Boat Nos.	Constant	Variable	Variable	Constant	Variable	Variable	UPPER BOUND ESTIMATES	
Pot Nos.	Variable	Variable	Variable	Variable	Variable	Variable		
Avg. Pots/boat	<104	=104	=144	<104	=104	=144		
Season ends	June 30	June 30	June 30	Sept. 30	Sept. 30	Sept. 30	June 30	Sept. 30
Days fished	188	188	188	230	230	230	188	230
ITE/TAE Case	2	1	11	22	21	31	1	21
Boat Nos.	669	558	403	669	445	321	558	445
Pot Nos.	58,000	58,000	58,000	69,576	46,231	46,231	58,000	46,231
Pot Lifts (m.)	9.529	9.529	9.529	10.359	10.359	10.359	9.529	10.359
Industry Returns ($m)	$ 163.6	$ 163.6	$ 163.6	$ 172.5	$ 172.5	$ 172.5	$ 163.6	$ 172.5
Industry Costs ($m)	$ 147.8	$ 135.0	$ 117.2	$ 152.4	$ 123.2	$ 109.0	$ 135.0	$ 123.2
Net Returns ($m)	$ 15.8	$ 28.6	$ 46.4	$ 20.1	$ 49.3	$ 63.5	$ 28.6	$ 49.3
ITQ/TAC Case	5	4	14	25	24	34	14	34
Boat Nos.	669	477	344	669	402	290	344	290
Pot Nos.	69,576	49,600	49,600	69,576	41,804	41,804	49,600	41,804
Pot Lifts (m.)	9.694	9.870	9.870	11.702	10.576	10.576	9.870	10.576
Industry Returns ($m)	$ 169.0	$ 164.4	$ 164.4	$ 185.0	$ 173.8	$ 173.8	$ 164.4	$ 173.8
Industry Costs ($m)	$ 150.1	$ 125.7	$ 110.5	$ 157.2	$ 118.5	$ 105.6	$ 110.5	$ 105.6
Net Returns ($m)	$ 18.9	$ 38.6	$ 53.9	$ 27.8	$ 55.3	$ 68.2	$ 53.9	$ 68.2
Extra Net Returns ($m)	$ 3.1	$ 10.1	$ 7.5	$ 7.7	$ 6.0	$ 4.7	$ 25.3	$ 18.9
Extra Enforcement Costs ($m)	$ 1.7	$ 1.7	$ 1.7	$ 1.7	$ 1.7	$ 1.7	$ 1.7	$ 1.7
Extra Research Costs ($m)	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0	$ 1.0
Net Gain ($m)	$ 0.4	$ 7.4	$ 4.8	$ 5.1	$ 3.4	$ 2.0	$ 22.6	$ 16.2

(h) The estimated net return under a TAC/ITQ system with the season ending 30 June, and which neither constrained the market driven reduction in the number of boats nor required there to be a nexus between the catch and the number of pots after the initial allocation, could be between $36 million ($39 million in column 2 less $3 million for additional enforcement and research costs) and $51 million ($54 million in column 3 less $3 million for additional enforcement and research costs). This is compared with the current net return of about $30 million based on an average catch of 10,600 tonnes. However, this catch is not sustainable. If the average catch was reduced to a sustainable level of 9,000 tonnes, as used in Professor Lindner's Tables, the net return would be of the order of $16 million.

(i) The maximum difference in net returns, if a season is set to end on 30 June, is likely to be the difference between the net return for the TAE/ITE system in column 2 (average number of pots 104) and the net return for the TAC/ITQ system in column 3 (average number of pots 144), ie. $54 million less $29 million. The minimum difference in net returns is likely to be the differences within column 2, ie. $39 million less $29 million. The additional cost of research and management (approximately $3 million) then has to be subtracted from these figures to yield an estimated net benefit of a TAC/ITQ system of between $7 million and $23 million.

(j) The maximum difference scenarios for the season ending on 30 June or 30 September is set out under the heading "Upper Bound Estimates" in columns 7 and 8. For a 30 June season the maximum difference is $23 million and for a 30 September season the figure is $16 million.

(k) Based on all of the points (a) to (j) above, and taking the average of the $7 million and $23 million figures (average $15 million) set out in (i) as the estimated additional net return, the introduction a TAC/ITQ system of management for the western rock lobster fishery could approximately double the net return to the industry, ie. the average return under a TAC/ITQ system could be $15 million additional to the net return of $16 million set out in column 1 under a TAE/ITE system. However, if a constraint on boat numbers was imposed and there was a required nexus between catch and the number of pots, there would be either zero or very little economic benefit to be gained by changing from a TAE/ITE system to a TAC/ITQ system of management.

(l) The model indicates that the option of extending the season to 30 September yields a substantial increase in net returns under either system of management, but that the benefit of extending the season would be smaller under ITQs than under ITEs. If a decision was taken to retain the input control system of management, an extension of the season until 30 September has the potential to increase the net returns to the industry by about $20 million ($49 million minus $29 million from columns 7 and 8). Under an ITQ system, extending the season increases net returns by between $14 million and $17 million. Hence, the economic advantage of ITQs over ITEs is less for the longer fishing season.

It is important that readers understand the information provided by Professor Lindner in his specialist paper, and make their judgement in relation to the potential net return benefits which could flow from the introduction of a TAC/ITQ system and also the extension of the season under either a TAE/ITE or a TAC/ITQ system of management. In making that judgement, some of the important elements are (i) the amount of "capital stuffing" likely to occur, (ii) the degree to which the number of boats will be reduced and the number of pots per boat increased, (iii) the likelihood of the nexus between boats and pots being removed, and (iv) the acceptance of the likely requirement for industry to pay up front the estimated additional cost of research and law enforcement.

The possibility of increased ownership by processing companies under ITQs
The rock lobster pots are mostly owned by individual fishermen or by family companies with a fishing background, although there is some investment in pots by processing establishments and other business interests. The concept of the catching sector being mainly in the hands of the fishermen may change over time if a TAC/ITQ system of management was introduced.

Ownership of a rock lobster pot represents the opportunity to take rock lobsters. However, the success of doing so depends on the skill of the fisherman and the efficiency of the boat and associated technology. The catch per pot for one fisherman may be as much as twice the catch per pot for another fisherman. Accordingly, if a processing company owned a rock lobster boat to be operated by a employee skipper, its return on the investment could vary considerably. However, if ITQs were introduced the situation would change in that an ITQ would represent a specific quantity of live rock lobsters, and therefore a specific value of product delivered to the processing factory.

The experience in New Zealand has been that since the introduction of ITQs for the rock lobster industry in 1990, about 30 per cent of the ITQs had been sold by April 1993 from the catching sector to the processing sector and other corporate buyers.

In Western Australia, it seems likely that the introduction of ITQs would result in some shift of ownership from the catching sector to the processing sector and other corporate buyers. This may, in turn, raise the question of foreign ownership which is discussed in a policy statement issued by the then Minister for Fisheries in 1989 and published in Fisheries Management Paper No. 30.

The attraction for the processing sector to own ITQs would be to provide leverage in terms of maintaining or increasing its throughput of product as well as well as controlling the flow of product.

Cooperative management by government and industry
The degree to which government and industry operate corporately in managing the rock lobster fishery depends on the determination of agreed objectives and strategies, equity in decision making, confidence in the stock assessment, effective compliance oversight and efficient administration. The following observations are offered on these points:-

(a) Agreed objectives and strategies
The Rock Lobster Industry Advisory Committee, which provides advice to the Minister for Fisheries, has been an effective forum for establishing objectives and determining strategies for achieving those objectives. This is an ongoing process, and would continue to be effective under either a TAE/ITE or a TAC/ITQ system of management.

(b) Equity in decision-making
One of the criticisms, by some segments of the fishing industry, of the 18 per cent temporary reduction in rock lobster pots has been that the effect has not been equitable across all sectors of the fishery. That is, while the access share, through the pot allocations, has remained the same, there has been a perception, which may or may not be a reality, that the resultant catch has not reflected that share. The future use of variable TAEs under a TAE/ITE management system may continue to raise the question of equity in decision-making. This has the potential to divide the catching sector and make more difficult the corporate management of the fishery.

A TAC/ITQ system of management provides each licensee with an established share of the total allowable catch. To this extent, the system may be judged to be more equitable in its outcome. However, the process of deciding upon the initial allocation formula, as set out in Section 6 of this report, may be judged to lack equity to such an extent that it became the major equity issue, and divide the industry for many years, thus affecting the corporate management.

(c) Confidence in the stock assessment
Irrespective of the competence of the research institute involved, debate on the state of the stocks is likely. That debate is unlikely to be a major factor in the corporate management process, but certainly has the potential to be an attributable factor. Under a TAC/ITQ system of management, the ability of the researchers to determine the state of the stocks is reduced compared with the ITE/TAE system where the unit of fishing effort remains relatively constant and standard.

(d) Effective compliance oversight
Effective compliance oversight is an essential ingredient for a cooperative approach to fisheries management. Unless the catching sector was confident that the pot allocations or the catch quotas were being respected throughout the industry, there would develop a lack of confidence in the management system and a reduction in corporate management. As already discussed in this report, the risk of non compliance, or alternatively cost of ensuring compliance, in a rock lobster fishery under a TAC/ITQ system of management is high.

(e) Efficient administration
An efficient administration would be expected. Irrespective of the management arrangement adopted, the administration is unlikely to be a major factor affecting the corporate management of the rock lobster fishery.

The long term management of the rock lobster fishery will need to include a control on the exploitation rate, and to this end either a variable pot allocation or a catch allocation system of management will be required. Either system will have advantages and disadvantages. In deciding on the appropriate management approach, it is important to take into account the past history of corporate management by government and industry and the need for this to continue into the future.

The potential to increase the value of the product by changing the season
The specialist report by MAREC Pty Ltd has drawn the reader's attention to the potential for increasing the value of the rock lobster catch by changing the season and taking slightly smaller animals. This could be accomplished by either the an input or an output method of management. However, consideration could also be given to the feasibility of holding animals at low cost past 30 June as opposed to fishing during the months of July, August and September on rock lobsters with a legal minimum length of 75 mm.

The possibility of illegal 'recreational' fishing for rock lobsters
The specialist report by Professor Lindner has demonstrated that the return to the fishery would be enhanced by reducing the number of boats and pots in the fishing fleet. This may have the effect of increasing the level of illegal activity by those not holding a rock lobster licence. The reduction in the number of boats would result in there being an increasing number of competent rock lobster skippers who did not have access to a licensed rock lobster boat. Some of these skippers may be tempted to undertake illegal 'recreational' rock lobster fishing if the potential returns were judged to be sufficiently high. This has been reported to occur in the New Zealand rock lobster fishery and also in the Australian abalone fishery. If it were to become a major issue for rock lobsters in Western Australia, the rules which would be needed to give attention to the problem may affect all recreational fishing and thus require a firm political will.

9 Discussion

The western rock lobster fishery has been managed for the past thirty years by the use of input controls, the principal measure being the number of pots permitted to be used. Even though there is a high degree of corporate management of the rock lobster fishery between government and the industry with a common goal of the long term maintenance of the fishery, the lack of consensus in management planning has allowed the exploitation rate to

increase to a level at which recruitment may be affected. This is a cause for concern, and action has been taken to reduce the exploitation rate so as to allow for the rebuilding of the breeding stock.

This concern about the breeding stock comes at a time when the market for rock lobsters has changed from the supply of frozen green tails to the USA to a market in which the highest price is paid for live and whole cooked rock lobsters. MAREC has provided a specialist report on this subject and drawn industry's attention to the potential for increasing the value of the rock lobster catch by a change in the fishing seasons.

The requirement to reduce the exploitation rate, and hence the catch, and the potential to increase the value of the catch through a different catching strategy have provided the impetus to produce this report so as to assist in the discussions on the longer term vision for the rock lobster fishery and the most appropriate management arrangements to fulfil that vision.

If the management arrangements for 1993/94 and 1994/95 are shown to be effective in rebuilding, over time, the breeding stock to a satisfactory level, the discussion can concentrate on a vision for the future management of the western rock lobster fishery either by the extended use of variable input controls, ie. pot usage and size limits, or by the movement away from input controls to output controls. If input controls are retained as the method of management, there would need to be an acceptance that variable pot usage (TAEs), or allocations (ITEs), which are the principal control units, would be varied slightly from year to year to match recruitment. Also, on average, fewer pots would be used because the effectiveness of a pot-lift is likely to increase gradually, and to offset this increase, if it occurs, the average number of pots allowed to be used would have to continue to decline.

On the other hand, if the arrangements for 1993/94 and 1994/95 are shown to be not sufficient to rebuild the breeding stock, action would need to be taken by the management authority to further reduce the exploitation rate. This could be achieved through the extended use of input controls or by the use of output controls. However, the time frame may have to be quite short. If there was considerable industry resistance to a further variation in the usage of pots, the use of a TAC/ITQ system may be considered the only alternative means of attempting to ensure that the breeding stock is protected. If this were the case, the TACs would have to be set conservatively.

The advantages of retaining the input (TAEs/ITEs) method of management are that there would be:-

(i) A clear understanding of the system by industry and management.

(ii) An effective law enforcement program.

(iii) A continuing historical data set which is so essential for the stock assessment required as a basis for management decisions.

The disadvantages of the input method of management are that there would be:-

(i) A gradual increase in effective fishing effort.

(ii) A reduction in the efficient use of the capital invested in pots and boats in the fishing industry.

(iii) An increase in the constraints imposed by management on the decision-making process of individual operators in the industry.

The advantages of moving to an output (TACs/ITQs) method of management are that there would be:-

(i) A direct control over the exploitation rate providing that the law enforcement program is effective.

(ii) An ability of operators to take their catch in a manner which maximises the market opportunities.

(iii) A potential to improve economic efficiency through an increase in the net return to the industry.

The disadvantages of moving to an output method of management are that there would be:-

(i) Difficulty in providing an equitable formula for the transfer of pot allocations to ITQs.

(ii) A period of uncertainty involved in adapting to a new system.

(iii) Uncertainty in relation to the cost and ability to provide an adequate law enforcement program.

(iv) Difficulty and increased costs in obtaining adequate data for the ongoing monitoring of the levels of recruitment and breeding stock to enable sustainable TACs to be set.

If a TAC/ITQ system of management was adopted, a necessary element would be legislation by government on the resource sharing arrangements to be adopted between the commercial and recreational sectors, both in the short term and the long term.

The specialised report by MAREC does not discuss a preference for input or output controls. However, it does set out that "the objective for the management system if it is to seek to optimise the return from lobster markets should be to provide the potential for the catching sector to deliver a catch flow which could produce the highest content of products with the highest worth".

The report proposes a management system which includes:-

* *Extending the duration of the season for as long a period as is considered reasonable but possibly to the end of September.*

* *Providing an effective mechanism to reduce the whites lobster catch by an appropriate weight and make lobster stocks available to the winter period until the duration of the extended season (subject to the requirements of Section 8) and in that respect to give consideration to the catching of undersize lobster which otherwise would become white size lobster at the following November moult.*

* *Providing the mechanism to allow fishermen the potential to take the catch to meet the needs of the high worth lobster product markets.*

The MAREC report examined the estimated monthly catch-worth ($/kg catch) for the 1992/93 catch and also under an arrangement whereby the catch of "whites" is reduced by about half and the same quantity caught during the months of July, August and September. It concluded that by reducing the "whites" and lengthening the season within the context of the 1992/93 model there was a potential to increase the net economic benefit to the industry, perhaps in the order of $10 million to $20 million. However, the model was used only to show the change in value which could have occurred if the catch flow had been able to be changed in 1992/93.

The MAREC report is perhaps best summarised by an introductory note to that report by the author:-

The Western Australian lobster fishery is limited to a specific catch - the sustainable catch. The pursuit of a catch in excess of the sustainable catch in the end is futile. Thus the opportunity for economic growth within the industry will be determined not through an increase in catch but through the increase in worth realised from the sustainable catch. The role of fisheries management is seen therefore as one which provides a structure that ensures the conservation of the fishery but at the same time acts to minimise the impediments preventing the industry (fishermen, processors and others) from optimising the worth of the catch.

Irrespective of the method of future management of the rock lobster fishery, a matter of importance to both government and industry is the optimal number of boats to be engaged in the rock lobster industry. The number has been gradually decreasing since the 1970s from a high of 836 to 665 as at 30 June 1993 and to 638 as at 30 June 1994. The setting of a figure for the minimum number of boats has implications for the potential of the industry to increase the net returns. It would also have implications in relation to a discussion on the minimum and maximum holdings of ITEs or ITQs.

A decision on the minimum fleet size has to be a trade off between economic efficiency and social and other benefits which may be perceived to operate. As shown in Professor Lindner's specialist paper, the introduction of a minimum fleet size rule would have the effect of reducing the net returns compared with that which would apply if market forces determined the number of boats. Furthermore, those returns would be distributed amongst a greater number of people than would be the case if there was no prescribed minimum fleet size. The amount of net return foregone could be of the order of $10 million to $20 million which would have to be weighed against the "social and other benefits" to be gained by setting a minimum number for the number of boats in the rock lobster fishery.

The decisions taken resulting from a consideration of this report, and the associated specialist reports, on the western rock lobster fishery will be vital to its long term management. It is essential that all those engaged in the fishery consider the past growth in the fishing pressure, their vision for the industry in, say, ten years from now, and the most appropriate method of management in achieving that vision. There are likely to be three principal elements:-

(a) The potential to increase the value of the catch and the net return to the industry.

(b) The best long term management method, input or output controls, taking into account the overriding requirement to ensure an adequate breeding stock but also considering that there is now an increasing focus on economic efficiency in fisheries management.

(c) The fleet size and its associated implications for the net returns as well as for the minimum and maximum holdings of ITEs or ITQs.

10 Papers accessed and further reading

The following list provides the reader with a reference to the papers referred to in this report as well as further information about the western rock lobster fishery and its management.

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Sheard, K. (1962). The Western Australian Crayfishery 1944-1961. Paterson Brokensha: Perth 107 pp.

Turris, B. R. (1992). Canada's Pacific Halibut Fishery – A Case Study of an Individual Quota Fishery. Department of Fisheries and Oceans, Vancouver, BC, Canada.

Membership of the RLIAC Sub-Committee

Mr P P Rogers	(Chairman) Executive Director, Fisheries Department
Dr J W Penn	Director of Research, Fisheries Department
Mr T J Lissiman	Rock Lobster Industry Advisory Committee
Mr I W Finlay	Rock Lobster Industry Advisory Committee
Mr F Taranto	Rock Lobster Industry Advisory Committee
Mr B K Bowen	Fisheries Management Consultant
Mr R H Chadwick	Banking Consultant
Prof R K Lindner	Economist Consultant
Mr N E McLaughlan	Law Enforcement Consultant
Mr P J Monaghan	Marketing Consultant
Mr M N Anderson	Executive Officer until 22 June 1994, Fisheries Department
Dr M J Moran	Executive Officer from 23 June 1994, Fisheries Department

Attachment 2

Proposed Procedure and Risks in Setting TACs and TAEs

The process used to assess a proposed level of nominal or notional TAC is likely to follow the same basic approach as has been used with the assessment of other types of management strategy. The nominal TAC may represent a value to be used as an actual TAC, or may be the equivalent catch expected to be taken with an assigned actual TAE. The proposed process is described below, and is shown in the attached Figure.

Information on annual puerulus settlement is used to produce predictions of the potential catch that might have been expected in the fishery under the current management regime, using the statistical relationships derived from historical fisheries data. The potential catch can be a fishery wide or zone statistic that represents the level of recruitment that might be expected to occur during the next season.

This prediction of recruitment is then used as input to the various fisheries models, which use the proposed level of nominal TAC to estimate the effects on the catch and survival to the breeding stock within each fishing region. The resulting estimates of breeding stock are then compared with the target breeding stocks that have been accepted as the objective for management if future recruitment is to be assured. The proposed level of nominal TAC is varied and the process repeated in order to provide a range of alternative assessments for consideration by the Advisory Committee.

The estimates produced in the assessment are to be compared with the catches, catch rates, and breeding stock that result in the fishery as a consequence of the nominal

TAC that is finally adopted. This ensures continued improvement of the various relationships and models used in the assessment process.

Where the notional TAC is being applied through an effective TAE/ITE system, the TAE is set directly to target the level of the notional TAC, since the TAE system automatically corrects to an extent for inaccuracies in the estimated incoming recruitment. That is, when the recruit biomass available is underestimated catch rates are correspondingly low and the notional TAC will not be achieved. Conversely, when the recruit biomass is overestimated, the catch rate will be unexpectedly high, and a catch larger than the notional TAC will be taken, but escapement to the breeding stock will be maintained.

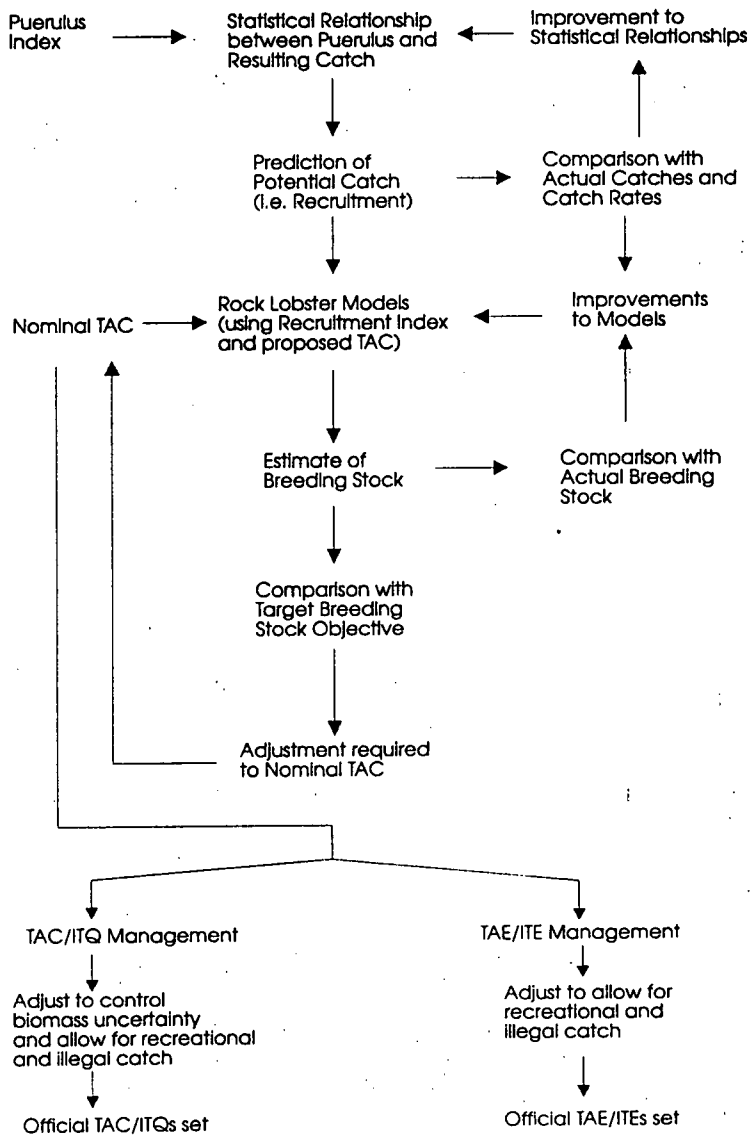
In contrast, where the notional TAC is used as an actual TAC allocated through ITQs, effort expands or contracts to achieve the allowed TAC. Where errors in recruit biomass estimates occur and the biomass is underestimated, a larger escapement to the breeding stock than expected will occur. Conversely, when the biomass is overestimated, effort is permitted to expand to take the TAC, and escapement to the breeding stock will be reduced or can be minimal. This "risk" requires that the notional TAC under this management system needs to be slightly reduced to set a conservative "safe" TAC.

For both the TAE and TAC systems, an adjustment must be made to the notional TAC to allow for recreational catch prior to determining the TAC or TAE to be set for the commercial fishery. Similarly, any "projected" illegal take of lobsters must be deducted from the legal TAC if the breeding stock is to be maintained.

A research paper is currently being prepared by the Research Division, that further examines the relative risks associated when the alternative management systems,

either using a "total allowable catch" (TAC, ITQ) or a "total allowable effort" (TAE, ITE) system, are used to maintain the rock lobster stock.

Process for Assessing TACs or TAEs *

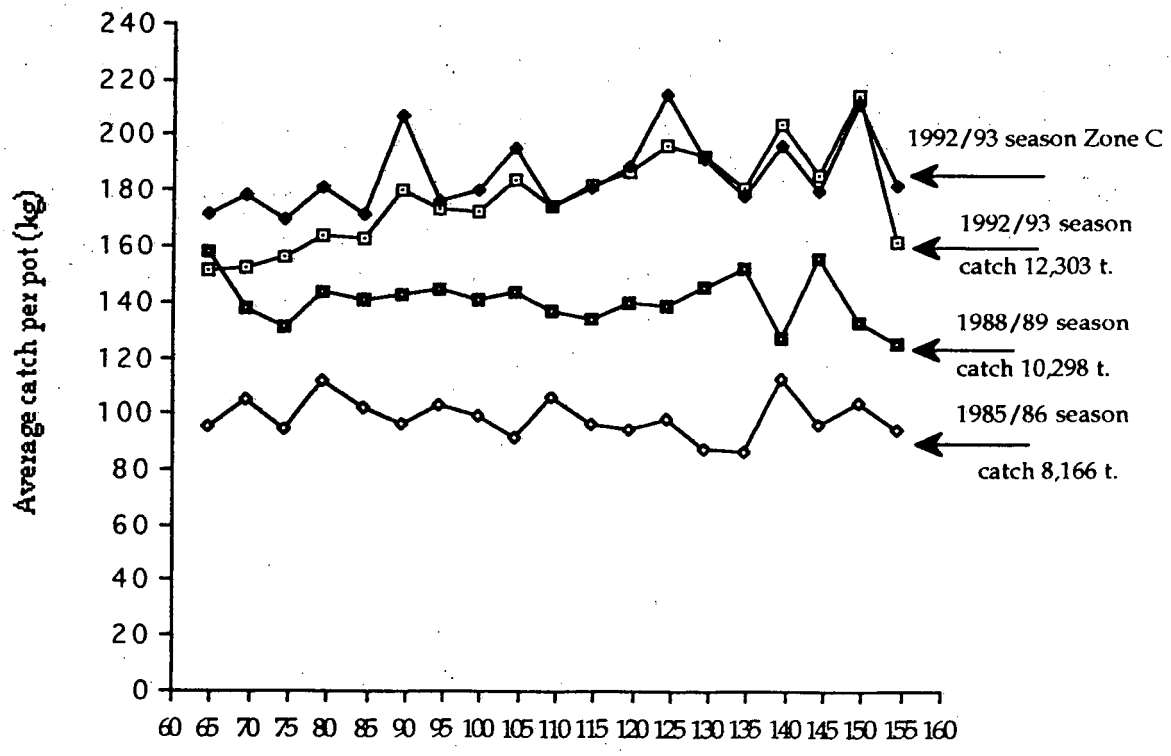


* *Note: Recruitment and breeding stock estimates will be required for each sector of the fishery.*

Catch per pot entitlement for each boat for the 1990/91 season

1990/91 season	Area		
Catch per pot	Zone A	Zone B	Zone C
kg.	Number of boats	Number of boats	Number of boats
40	-	-	1
55	-	-	6
60	-	-	7
65	-	-	11
70	1	-	12
75	-	-	32
80	1	1	35
85	1	2	31
90	-	1	29
95	2	1	31
100	2	1	29
105	-	4	23
110	4	1	20
115	5	7	18
120	10	8	16
125	10	11	12
130	7	6	8
135	5	16	2
140	12	12	6
145	8	12	3
150	8	8	-
155	14	13	3
160	12	8	3
165	8	5	1
170	12	8	-
175	6	6	1
180	11	7	-
185	11	6	1
190	7	5	-
195	8	4	-
200	5	3	-
205	3	4	-
210	2	1	-
220	1	2	-
225	1	1	-
Above 225	1	5	-

Average catch per pot per season against pot quotas for all zones for the seasons 1985/86, 1989/90 and 1992/93, and for zone C for 1992/93



Pot holdings in groups of 5 pots
(Example: 101 to 105 pots shown as 103)

Research data for stock assessment under TAC/ITQ management

Under ITQ management arrangements the relationship between catch and the effort applied to the stock by fishermen can be expected over time to change significantly, as fishermen modify their fishing strategy to maximise the value rather than quantity of the catch. Given that catch per unit of effort (catch per pot lift) is the basic measure of abundance of lobsters used by researchers to assess the state of the stock (exploitation rates, breeding stock indices etc) the expected changes in effort under ITQ's dictates that alternative or additional data will be required to maintain an understanding of the status of stock. The need for additional data is strongly supported by overseas research experience following the introduction of quota management. Without this additional information the success of the management arrangements in maintaining the breeding stock cannot be measured or guaranteed.

The overall impact of the introduction of ITQ's to the rock lobster fishery on the research division in the initial stages is likely to require and additional $900,000 per year, if full precautions are taken to endure the availability of reliable stock assessment for ongoing management.

The specific changes to research programs and the need for additional information under ITQ management have been considered and the changed requirements are set out below:

1. Total landed catch.

This data is presently obtained from the processing sector. Unreported purchases or catches are small at present as there is no incentive or need to hide catch information from researchers or enforcement personnel. Under an ITQ situation, this is expected to change (see enforcement implication section) and it must be expected that attempts to pass a significant portion of the catch go through a "black market" system will be made. This has certainly been the case with other high value, low volume species such as lobsters in New Zealand and abalone in Australia.

For measurement of this "leakage" rate, researchers will have to rely on enforcement estimates of the quantities involved and the timing of leakage. While enforcement agencies are normally concerned with minimising the "leakage" component, accurate measurement of the actual quantities, locations and timing of catch leakage is not a primary objective. In this context, additional enforcement and research resources will be required, not to apprehend offenders but to continually monitor the quantity of unreported catches seasonally and from year to year. A very approximate estimate of such a field survey process is about $50 000 per year.

2. Compulsory catch and effort returns/voluntary research log book.

Due to the requirements of ITQ management, the existing monthly returns will probably be replaced by daily quota records of landed catch by all vessels. These compulsory daily returns will also replicate and overlap the existing voluntary research log books to come extent. In practice, it is not usually feasible to require or ask fishermen to complete duplicate research records so it is anticipated that the log book system would be merged with the daily quota returns, which would then need to provide space for voluntary research data to be recorded (e.g. numbers of undersize, spawners returned, sea state etc.).

Such records will provide a more detailed spatial coverage of the fishery than at present. However, the reliability of the data will vary. That is, the catch will be under reported to

varying degrees, (black market, high grading etc) and will no longer have the degree of confidentiality available to present research log books. Effort data is likely to be recorded as normal, however the changing "application" and distribution of effort will result in an effort data set not comparable to pre-ITQ times. Radical management changes under and ITE system will also cause some distortions in the data but to a lesser extent.

Voluntary data on spawners, undersize, bait, weather conditions etc are still likely to be recorded on the daily quota forms by a proportion of the skippers. The degree to which the voluntary data will be provided, is however, unknown as the existing symbiotic relationship between skipper and researcher is replaced by an enforcement interaction. Compulsion to force all skippers to provide the presently voluntary data is not an option, as this results in a significant decrease in data quality and difficulty in separating "good" data from "poor" data. No additional costs will occur except for processing the larger volume of data and this will be partially covered by the enforcement systems needed to fund a computerised quote record system.

3. Onboard monitoring

Under ITQ's, there will need to be a much greater reliance on direct observations by research personnel. At present, this program is restricted to onboard monitoring of catches at four coastal locations and at the opening of the Abrolhos season. The data produced is used to validate and extend the detailed research log book data set. In the initial stages, i.e. first five years at least, this program would need to be expanded to cover four additional ports including the Abrolhos Is. Based on current costs, (approximately $100,000) this would require approximately an additional $150,000 per year. Should the season be extended to September, the additional cost would be in the order of $200,000.

4. Fishery independent breeding stock survey.

The existing trial program using charter vessels covers six locations and is ultimately likely to be scaled back to a smaller number of sites and used to calibrate commercial data based indices of spawner abundance. Under ITQ's it is expected that the independent breeding stock survey index will need to assume greater significance in the ongoing assessment of the status of the fishery/breeding stock levels.

Under this scenario, the survey would need to be expanded slightly (one or two locations) but increased in effort level from 10 days to 20 days to achieve a greater reliability in the index produced. Based on existing budgets, the expanded program would require approximately $500,000 per year.

5. Puerulus monitoring program.

This program would continue and is likely to expand by one or two sites in "B" zone under either ITQ or ITE management. This expansion is expected to be required to further refine regional forecasts for industry and management modelling of the fishery. The additional costs will be in the order of $5,000 to $10,000 per year.

6. Recreational fishery.

Existing methods of monitoring recreational catches are unlikely to be adequate under an ITQ management arrangement. It can be anticipated that a significant shamateur operation will develop under ITQ's. Within the existing bag limits, it is likely that some legally licensed recreational rock lobster fishermen will become a significant force for illicit landing of previous commercial product. A research/enforcement program aimed at quantifying any change in this component of the catch will be required as set out in

(1). The recreational component of the total catch is also likely to alter significantly if the commercial fleet redirects effort away from whites thus leaving a higher abundance at the time of peak recreational activity. For each of these reasons it is anticipated that the need to both quantify and control recreational catch will require a significantly greater research/enforcement program. An ongoing research program to deal with this is estimated to cost about $100,000 annually.

7. Estimating future allowable catches.

Sustainability of the rock lobster stock requires a control on catch regardless of the management system used (either input or output controls). In either case, the management process requires the setting of a notional or actual TAC which will allow sufficient flow-through of recruits to maintain the breeding stock. Since breeding stock levels have been set on a regional basis (to reduce the risk of recruitment failure) the TAC will also need to be set regionally.

The TAC setting process must be based on the relationship between puerulus settlement, recruitment to the fishery effort and survivors to breeding sizes. These data are presently available with a reasonable level of certainty, i.e. ± 20% for the fishery as a whole, based on the 25 year puerulus time series from the centre of the fishery. Reliable regional TAC's are not yet possible particularly in zone C. A further 10 years of data are required to provide a defendable basis for setting TAC's for "C zone" while the "A zone" situation probable requires a lesser period (five additional years).

Any radical alteration to the timing or distribution of catch in the fishery will probably affect the development of regional catch prediction systems which are required to develop regional TAC's. Since the "successful" introduction of an ITQ system to the rock lobster fishery will by definition radically alter the timing of catch and the effort seasonally, the timing of any introduction of ITQ's will need to take into consideration the need for a data base to set regional TAC's. Alternative solutions to this difficulty is to set a very conservative TAC in "C zone" to take into account the higher degree of risk of incorrect prediction of the recruitment in this region. For "A zone", the same strategy could be used although a slightly less conservative position could be adopted given the more consistent nature of the catches from this sector.

8. Data Processing and analysis.

The preceding supplementary data requirements and the changed relationship between catch and effort under ITQ's will require additional staff time to develop new assessment models and statistical analyses. Specifically, research will be required to overcome the changes to the indices presently available to monitor the stocks and to try to relate the parameter series from before and after the introduction of ITQ's In the short term, this would require an additional modeller/statistician over and above existing staff levels for a period of approximately five years. Annuals costs including overheads would be in the order of $70,000 per year.

ATTACHMENT 6

ROCK LOBSTER QUOTA REGISTRATION AND TRANSFER SYSTEM

The purpose of this paper is to detail mechanisms for the registration and transfer of quota in the Western Rock Lobster Fishery if a quota system of management is introduced.

Government and industry requirements of a quota registration system are that it be a source of accurate and timely information on quota holdings and transactions. To do this a quota registration system must enable efficient quota transfers. The information from the system must be of an evidential standard in criminal prosecutions and be able to interface with all aspects of the Department's record base.

The Principles for a quota registration system should include:

1. a cost efficient and timely administration regime which minimises impediments to trading quota;

2. limited liability borne by the Crown;

3. fully self-supporting, either as a cost recovery or a profit making operation;

4. accurate and certain; and

5. binding on all parties.

Uses of the information from a quota registration system include:

1. a register of owners and holders of quota on any particular day;

2. a register of the owners of annual harvesting rights;

3. a public register of both the quota right and the annual catching right which is available to prospective owners to consider before purchasing such rights.

4. an ability to conclusively ascertain available catch rights, quota and landed catch at any point of time;

5. a base for levying statutory charges (linked to Departmental accounting systems);

6. granting access to the fishery (linked to the licensing system);

both parties specifying the quantity of quota involved. The sale is completed when the transaction is entered on to the register. Quota transactions would be subject to a minimum amount that could be sold.

Quota holdings would be used to generate an annual catch allocation prior to the beginning of each season. The allocations would also be recorded against the limited entry licence owned by the quota holder but on a separate register called the annual catch allocation register.

Annual Catch Allocations Register

At a set time period before the beginning of each season the quota would generate an equivalent annual catch allocation (ACA), after the total allowable catch (TAC) for the year has been set.

The ACA would be recorded on a separate register against the licensed boat owned by the quota holder.

After the ACA is generated it would be completely separate from the parent quota units. The ACA is then the catching right for that year.

Once registered against a boat, an ACA could be fished or sold in part (subject to minimum transfer rules) or in whole to be attached to another licensed boat. As the ACA is separated from the quota any sale of ACA has no affect on the original quota holding. That is the sale of an ACA is valid only for the year in which the sale takes place. For a permanent sale both ACA and quota units would be involved If the ACA and the quota which generated the ACA are sold two separate transfers would be required.

Transfers of ACA would only be for unfished entitlements and therefore prior to any transfer occurring a reconciliation of catch and remaining ACA would be necessary. A transfer of ACA would require both parties to sign the transfer form and would not be completed until recorded on the register.

At the end of the season all records would be removed from the ACA register which would remain empty until the next season when a new set of annual catch allocations would be generated reflecting the current quota ownership.

Nexus Between Two Registers

It is imperative that quota can be cancelled for enforcement purposes. To do this a nexus between the two registers must be maintained so that an offence can be related to parent quota and the parent quota reduced when required. There are two issues:

1. The parent quota for an annual catch allocation must be identifiable at any time in the season. Providing that the limited entry licence is used to record quota holding and annual catch allocation then the nexus is

7. determining liability for overfishing; and

8. an indicator of the value of the fishery;

The Government will also use the quota registration system to give effect to management decisions, such as pro rata reductions in total allowable catches (TACS) and Court ordered forfeitures as required.

It is proposed that a registration system for the rock lobster fishery be divided into two registers which are independent for transaction purposes but linked by a common limited entry fisheries licence.

1. A quota register which provides a record of quota ownership and transactions.

2. A register of annual catch allocation (ACA) linked to boats licensed to fish in the Western Rock Lobster Fishery (limited entry fishery licence).

The reason for two registers is to separate the long-term right to fish from the annual catch to promote flexibility for licence holders. The New Zealand experience suggests that unless these two components are separated the trading of catch allocations required within a season is severely constrained by the long-term implications of selling quota. If only one register is used a separate parallel lease system is likely to result.

Quota Register

This register would be formed on that day quota is allocated to licence holders and be recorded against the limited entry licence. It would provide a record of the number of quota units owned by each quota holder. The quota would be the long term fishing right.

Whilst a limit on the number of pots is retained as a management tool in the fishery, quota would need to be linked to pots at a set ratio. Therefore the quota register would also be a record of the number of pots owned by each of the quota holders (either explicitly or by a function of the quota /pot ratio).

The total of the registered quota units would equal the total quota units for the fishery.

The limited entry licence should be subject to a minimum quota holding which would be tied to the amount of annual catch allocation held. If this was the case and quota was sold below the minimum holding the licence would not be permitted to be used. To enter the fishery a person would have to buy a limited entry licence which had attached to it the minimum quota holding and an annual catch allocation.

Quota could be sold at any time providing that the transfer form is completed by

maintained.

2. The quota holder must be required to retain sufficient quota to enable quota penalties to be implemented. A balance needs to be found between providing flexibility for quota trading and retaining adequate quota for enforcement purposes. It is not envisaged that a situation could occur where the total quota would be cancelled as a result of a prosecution. Therefore it is suggested that quota holders not be permitted to reduce their quota below a third or a half of the maximum annual catch allocation attached to the quota holders limited entry licence in any one season.

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