A BIOECONOMIC STUDY OF THE WESTERN ROCK LOBSTER FISHERY

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This article summarizes the results of a bioeconomic study of the Western Rock Lobster Fishery (WRLF)[1]. The aim of this study is to determine the extent of biological and economic exploitation of the fishery and to outline the need for change to the existing management strategy.

A bioeconomic approach to analyzing a fishery is not new to fishermen, biologists or fishery managers in Australia. Indeed, considerable debate has been generated between and within these groups whenever bioeconomic analysis and its role in management has been discussed. Because it is the most valuable fishery resource in Western Australia and Australia in terms of export income, and is also an important regional employer, this article may extend further the debate as to the validity and desirability of the bioeconomic approach to the analysis and management of a fishery.

The Bioeconomic Approach

Various aspects of the bioeconomic approach to managing fisheries have been discussed previously in Australian Fisheries (Meany, July 1975, August 1978; Crutchfield, April 1980). A bioeconomic approach

integrates the biological effects of fishing a stock, and economic effects of stock exploitation. It explicitly recognises that stock growth characterstics are altered by the removal of fish, and that the rate and extent of fish removal by fishermen is determined by actual and perceived profits.

There are two major outcomes from a bioeconomic approach. Firstly, it is possible to develop a clear understanding as to why overfishing as evidenced by declining or persistently low catches and returns appears to be an inevitable result of exploitation. Secondly, for a particular fishery it is possible to identify the biological and economic limits to exploitation and hence to determine a range of management strategies that lie within these limits.

A bioeconomic analysis is illustrated by reference to Figures 1 and 2. The sustainable yield curve (Figure 1) shows how increasing

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FIGURES 1 and 2 ABOUT HERE

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effort will lead to higher yields until the maximum sustainable yield (MSY) is reached. At higher levels of sustained effort yields will decline. Determining the exact form of this relationship has pre-occupied biologists' research efforts.

Figure 2 represents a simplified bioeconomic analysis of the same fishery. Income from the sale of all lobster is referred to as fishery total revenue (TR). The TR curve in Figure 2 is derived from the sustainable yield curve in Figure 1 and thus shows the total income that can be earnt at various levels of fishing effort. Variable costs (eg. fuel, bait), fixed costs (eg. licences) plus a skippers income

and return to capital, are fishery total costs (TC). The TC curve in Figure 2 shows that these costs rise with increased fishing effort. This analysis can only indicate long term changes at sustained levels of effort.

The divergence between TR and TC (shaded area) is the profit above that of normal profit (in simplified terms, a normal profit is that amount ~~earned~~ by both capital and labour if employed elsewhere in the economy - for capital, a 10 per cent return could easily be ~~earnt~~, and for labour, average yearly earnings would be a fair return.) As shown in Figure 2, this resource profit initially increases, then decreases with increasing effort, finally falling to zero at E_3 units of effort. Where no restrictions exist over who may fish, or what gear may be used, competition between fishermen, to gain access to or to increase their share of this profit, leads inevitably to increased fishing effort. Effort only stabilizes when the resource profit is reduced to zero. The fishery is then over-capitalized, the same catch could be made with less investment in boats and licences. In this situation, effort levels have exceeded that required to capture the MSY, yet yields are below the MSY. The ability of the population to regenerate is low at these effort levels, and accordingly biologists have urged that effort levels be constrained to E_2 (MSY). To economists, dissipation of resource profit represents an economically inefficient use of a resource and, accordingly, they have urged that effort levels be constrained to where the maximum economic yield (MEY) is harvested (E_1 in Figure 2). This effort level is economically more efficient and safer from a conservation viewpoint than that recommended by biologists.

The behaviour of fishermen in competing for the resource profit is

rational. No single person can claim ownership of the resource and each fisherman realizes that any action by him to conserve the resource (e.g. refusal to catch juveniles) will be countered by those who seek to catch everything possible. If the resource was owned by a single fisherman, there would be an incentive to ensure conservation and maximization of profits. However, society does not deem it desirable to permit any individual to own a fish resource; governments have assumed ownership rights on behalf of society and regulated all fishermen to operate within conservation limits.

Regulations, such as length of season, area fished, and gear and size restrictions aimed to limit the effort of fishermen invariably fail. Bioeconomic analysis indicates that existence of a resource profit leads to overfishing and this provides a continual incentive for fishermen to work more intensively and develop more effective gear.

Economists have argued that removal of resource profit in the form of a royalty (tax or licence fee) will, in the long term, ensure conservation of the resource. A tax calculated to equal the resource profit would increase fishery TC so that fishermen could not afford to operate beyond a chosen level of effort. It is this recommendation that has often aroused the ire of fishermen.

The Western Rock Lobster Fishery

Although rock lobster was caught for domestic consumption in the 1880s, commercial exploitation aimed at satisfying a lucrative export market began only after the Second World War. The fishery was

one of the first in the world to achieve a limited entry status. Following a trend of rapidly declining catch per unit of effort, in 1963 the number of boats was fixed at approximately 800 and each was permitted to use 3 pots per foot of boat length. The State Department of Fisheries and Wildlife, as manager of the WRL resource, has implemented regulations aimed at protecting juveniles and female spawners and restricting increases in fishing effort. A relatively small amateur fishery exists with an annual catch amounting to less than 5 per cent of the commercial catch.

Trends in catches and fishing effort

Trends in catch, fishing effort and catch per unit of effort are shown in Figure 3. They indicate that since the introduction of boat and pot restrictions in 1963 catches have, except for recent years, fluctuated between 7 and 10 million kg, while effort has risen by 80 per cent from 1963/64 to 1977/78. The high catches of recent years contrast markedly with this pattern. Catch per unit of effort has declined throughout the history of the fishery.

FIGURE 3 ABOUT HERE

Trends in prices, licences and returns to capital

Over the long term, fishing in the WRLF has been a profitable activity with periods of low returns being more than compensated for by periods of very high returns. Prices received by fishermen have risen steadily, with large increases occurring during the late 1960s and mid-1970s (see Figure 4). Moreover, as shown by the bottom curve, with price adjusted for inflation, these increases have been larger than for those for other commodities.

FIGURE 4 ABOUT HERE

Value added to a boat by the possession of a licence has shown a similar increase. Fishery licences are transferable and when restrictions on entry were applied in 1963, licences acquired a value equal to what potential entrants to the fishery perceived the capitalised value of future profits to be. Although the Department of Fisheries and Wildlife controls the transfer of licences, it does not (in effect could not) interfere with transfer of money. Because it is the licence, as a right to fish, that increases in value, and as each licence specifies a pot number entitlement, the market value of a pot is a useful index of the value added to a boat permitted to fish in WRLF.

The trend of pot values is shown in Figure 5. Again, the value of a pot, discounted for inflation, has risen. For the period 1977/78 and 1978/79, value per pot averaged $1,075 and presently ranges from $1,200 to $2,000.

FIGURE 5 ABOUT HERE

Table 1 shows average returns by zone, taken from various surveys. In all zones, returns show the same trend -- increasing steadily to 1968/69, falling slightly for the period 1974/75, and subsequently rising again. When compared with male average earnings, it appears that, except for 1962/63 and to a lesser degree 1972/73 to 1974/75, returns have been at least satisfactory.

TABLES 1, 2 and 3 ABOUT HERE

More detailed data for the years 1977 to 1979 are shown in Tables 2 and 3. After deducting a skipper's allowance, returns to boat capital ranged from 29.6 to 56.6 per cent, with an average of 35.5 per cent. Deducting a return to licence capital (valued at $1,075 per pot) the return on all capital ranged from 18.1 to 10.2 per cent with an average of 12.4 per cent. However, because of the rapid increase in licence values, most fishermen would not have paid a pot fee of $1,075 per pot, and consequently returns would be underestimated.

Returns according to boat size (see Table 3) are greatest for boats with 76 to 106 pots. Boats in this size class constitute the majority of the fleet (57.9 per cent).

Bioeconomic Analysis of the Western Rock Lobster Fishery

Sustainable yield curve

A sustainable yield curve for the WRLF, calculated from annual catch and effort data, is shown in Figure 6. Fishing effort is measured as the total number of pot lifts made during a season standardised for variation in population density and the susceptibility of animals to capture (catchability).

A MSY of 8,794,550 kg, obtainable at an effort level of 7,063,430 pot lifts, is indicated. Effort levels have reached and surpassed those required to obtain the MSY during the early 1970s. In addition, yields since 1976/77 were far in excess of the MSY; 1978/79 was 77 per cent greater.

FIGURE 6 ABOUT HERE

Research has indicated that these high catches may be attributed to the stock being temporarily swelled by an abnormally large recruitment rather than an increase in effort. Exploitation of the stock is high -- already 63% of the catchable stock is caught each year with another 18% lost to natural causes -- and consequently catches will tend to vary with fluctuations in annual recruitment to the stock.

Given this evidence and the fact that effort has exceeded the level required to capture the MSY, catches in the immediate future must decline from those recorded for recent years towards, or even below, those indicated by the sustainable yield curve in Figure 6. Because the fishery has never previously been exploitated to such high effort levels, the extent to which catches will decline with current or even higher levels of fishing effort is difficult to confidently predict from the sustainable yield curve. Permitting fishing effort to remain at, or even rise above existing levels, is undesirable from a conservation viewpoint.

Bioeconomic analysis

This analysis is shown in Figure 7. Costs were estimated from a survey of 57 fishermen (7.5 per cent of total fishery) immediately prior to the 1979/80 season. Selection of fishermen was random, and was designed to account for variations in catch according to area fished and boat size (or pot number).

FIGURE 7 ABOUT HERE

It was estimated that the average cost per effective pot lift was $5.14 (this included the cost of skipper's labour and a return to boat capital). Assuming that the stock will respond to reduced fishing effort in the manner predicted by the sustainable yield curve, the

analysis reveals that an effort of 3.66 million pot lifts will produce a catch of 7.77 million kg. and a maximum resource profit of $15.95 million.

Implications of a bioeconomic analysis of the Western Rock Lobster Fishery

It is probable that the Department of Fisheries and Wildlife's management strategy (limited entry, pot restrictions, season limitations) has aimed at limiting fishing effort to a level where only the MSY is attained, while ensuring that all participants in the fishery make a satisfactory return on investment. This study indicates that effort levels exceed those required to obtain the MSY, and that, while returns have been satisfactory in recent years, it is likely that they will fall, possibly to unsatisfactory levels.

Dissipation of the resource profit is evidence that the fishery is extensively capitalized. The shape of the TR curve in Figure 7 shows that a sustainable catch in the region of MEY would be of similar quantity to that possible with the existing effort of 8.5 million pot lifts. The resource profit is zero because it has financed the introduction of larger and more powerful boats and higher licence payments. Economic efficiency has suffered because the catching capacity of the fleet now exceeds that required to obtain the MEY. Fewer boats and fishermen could make this catch and consequently the additional fishing capacity represents overcapitalisation of the industry.

A reduction in fishing effort is a necessary conclusion of this study. If conservation of the stock is the principal concern, then effort should be reduced to the MSY; if economic efficiency is of concern as well, then effort should be reduced further towards the

region of MEY.

Effort Reduction

Simply reducing the total number of pots used in the fishery (i.e. number of pots per fisherman) or further shortening the season would firstly be economically inefficient in achieving an effort reduction, and secondly fail to prevent in the long term effort rising to similar or higher levels than at present. Restrictive gear regulations (e.g. fewer pots per boat) lead to further costs rises because fishermen work more intensively with limited gear or time in an attempt to earn the same income as they did prior to effort reduction. In recent years, fishermen have increased fishing effort, by working more intensively with the available gear and adopting more efficient equipment and techniques. It is believed that a limit to this capacity has not yet been reached.

Reducing the number of fishermen (and hence boats) permitted to exploit the resource would constitute the best form of effort reduction. However, considerable resource profit could be earned and those fishermen remaining in the fishery would compete for this profit. Given their ability to expand fishing capacity, economic theory indicates that effort and TC would again rise causing dissipation of resource profit. Expectation of higher profits could lead to licence values increasing and be another cause of profit dissipation. While a capitalised licence may not directly contribute to increased effort in the same way as increased investment in boats and gear, added indebtedness arising from buying a higher valued licence could

be an incentive to increase fishing effort.

Alternative Management Strategies

An alternative management strategy is required that reduces effort in an efficient manner and also removes the incentive for fishermen to increase their effort in competing for the resource profit. Three alternative management strategies are proposed that aim to achieve, in varying degrees, reduction and stabilization of effort and the promotion of economic efficiency. In all cases, payments for use of the resource are increased for the dual purpose of encouraging some fishermen to leave the fishery, and of removing a large proportion of the resource profit, and hence the incentive to expand effort.

To what level should fishing effort be reduced in the WRLF? The bioeconomic analysis outlined at the beginning of this article indicated that MSY does not represent the best management objective for use of a fishing resource owned by society -- considerable benefits in the form of improved economic efficiency and conservation of the stock were to be had by managing towards an objective of MEY. It is recognized, however, that economic efficiency cannot be the sole concern, as implied by operating at MEY; other benefits such as distributing fishery revenue among a large number of fishermen, do exist and a reduction in fishing effort would almost inevitably lead to social and employment disruption. Therefore, it is arbitrarily proposed that a reduction of effort to about six million pot lifts would, if implemented in stages over a period of time, minimize these disruptions while producing additional benefits in the form of resource

profit and providing a better safeguard against overfishing. A sustainable catch of 8.6 million kg (not significantly different from the MSY of 8.8 million kg) and a resource profit of $11.2 million could be realized at this level of effort. A target effort level of six million pot lifts require a 30 per cent reduction in existing levels and this corresponds to a 240-boat reduction in the fishing fleet. Once this reduction was achieved, and assuming that the stock would respond as predicted and efficiency levels were unchanged, it is estimated that each of the remaining boats could collect, on average, a resource profit of $14,000.

Each of the proposed three strategies are outlined in Table 4.

TABLE 4 ABOUT HERE

Management Strategy 1

Strategy 1 would require minimal changes to the existing management strategy and by buying up the licences of those fishermen choosing to leave the fishery and not reissuing them, it is possible for the management authority to reduce the number of boats in the fleet. Compensation would be based on existing market values and transferability of licences could be restored once the fleet has been reduced to the desired level.

Pot licence fees are not a significant cost component of lobster fishing. In 1977 to 1979 the average fee was approximately $360, or 1.8 per cent of operating costs (fuel, bait and administration). Determining the fee that would collect a sufficiently large proportion of the resource profit to minimize the incentive to expend effort is not a simple task. For 1977-79, return on boat and licence capital

averaged 12.4 per cent. If 10 per cent is considered a fair return to capital, then a licence fee equated with the additional 2.4 per cent could be proposed as a minimum fee. This was calculated as $3,530, or a pot licence fee in the order of $40 per pot. Approximately $2.8 million would be collected in the first year from such a fee and it could be used to compensate those fishermen choosing to leave the fishery.

Management Strategy 2

Dismantling the existing boat-size/pot number formula to permit the transfer of pots between fishermen and an across-the-board percentage reduction in the number of pots per fisherman is the basis of strategy 2. A policy preventing replacement of small boats with larger boats would be maintained to ensure employment equity and prevent relatively few large boats dominating the fishery. Fishermen would be able to decide what number of pots best utilizes their capital investment and fishing skill, an advancement on the first and existing management strategies.

A major feature of this strategy is that fishermen, in selling out to others, would receive compensation directly from those who gain by remaining in the fishery. Total fees could be similar in magnitude to those proposed for strategy 1 if the same revenue was desired. However, the aim of reducing resource profit as a means of minimizing the incentive for effort expansion can still be achieved if a lesser fee were struck. In buying extra pots, fishermen are transferring a portion of their share in the resource profit to those fishermen selling out.

Management Strategy 3

The third strategy has as its basis a quota system. A total allowable catch (TAC) would be calculated and divided into a number of individual quotas equivalent to the existing number of fishermen. The size of the quota would be based on each fisherman's catch history and other criteria (e.g. years spent fishing). The licence fee would be replaced by an annual payment based on the size of the quota, and paid on the weight of catch landed. Quotas would, like pots for Strategy 2, be transferable in whole or part and a boat replacement policy would be maintained. Effort reduction is achieved through fishermen curtailing their own effort because of the prospect of reduced catches and increased fishing costs resulting from higher fees and purchase of extra quotas. In addition the management authority may buy quotas.

Based on the sustainable yield curve, a TAC of 8.6 million kg would equate with the proposed effort level of 6 million pot lifts. If the same level of revenue was desired as with the previous two strategies, then a fee of 33 cents per kilogram would be struck; otherwise a lower fee could be struck for the same argument as stated for strategy 2.

Like the second strategy, a quota system allows the individual fisherman to select the quota size that best utilizes his investment of capital, labour and skill.

Evaluation of Proposed Management Strategies

Evaluation of any management strategy can be achieved by examining its ability to satisfy a set of criteria that identify the principal

areas of concern in a fishery. It is presumed that for the WRLF a management strategy would (not necessarily in order of priority):

* provide adequate protection for the regeneration basis of the resource
* promote economic efficiency
* prevent over-capitalisation of boats and licences
* result in an equitable reduction in effort
* be acceptable to fishermen
* be administratively feasible with regard to:
    (a) information needs
    (b) flexibility
    (c) enforcement
    (d) costs
* ensure that funds needed for effort reduction are derived largely from fishermen who remain in the fishery
* be minimally disruptive to employment patterns.

It is not possible, within this short article, to evaluate in detail each strategy with regard to all criteria. Each of the strategies, complemented by time, area and gear restrictions (e.g. minimum size and escape gap regulations), should reduce the capacity of the fleet to a level where better protection of the regenerative basis of the resource is afforded. Moreover, increased fees and payments for the purchase of additional pots or quotas should remove a large proportion of the resource profit generated at reduced effort levels and thereby remove the incentive for fishermen to increase effort.

Furthermore, all strategies contain an element of discrimination. If effort reduction is to be achieved through reduced numbers of

fishermen, then selecting those who must leave requires a discriminatory system. In this case, it is the ability of the individual to sustain, initially at least, an added cost that is the selection mechanism. Higher fees, of the order proposed, will increase fishing costs by less than 10 per cent; purchasing extra pots or quotas will contribute further to total costs. Economic theory indicates that following the exit of fishermen and stock adjustment to reduced fishing effort, these cost increases will tend to be compensated by an increase in the average individual share of the total catch. These cost increases could even be nullified in the short term by price increases -- higher fees constitute only approximately 2 per cent of average total income.

Because the individual fisherman is able to choose the number of pots, or size of quota, strategies 2 and 3 are best in promoting economic efficiency. This is rational because the individual, in seeking to maximize profits will move to a position of maximum efficiency. However, by maintaining a boat replacement policy, in the interests of equity, the possibility of increased efficiency from the use of larger boats is precluded.

These two strategies also better promote an equitable reduction in effort. If following increased fees a fisherman finds that fishing has become uneconomic, he does have the opportunity to adjust his level of operation by buying or selling pots or part of a quota to reach a higher efficiency level; no such opportunity exists with strategy 1. Also, those who leave the fishery are compensated by those who remain and share in the improved security and greater profits that effort reduction offers.

Strategy 3 has unique problems with regard to enforcement and acceptability. Because the quota payment is based on landed catch, an incentive exists for fishermen to evade their responsibility and sell to a 'black-market' organization. The likelihood of such an organization becoming established would be high for highly-demanded commodity such as rock lobster. Regulations would need to be even more stringent than at present. Fishermen would no doubt find all three strategies unacceptable from the aspect of increased payments; however, it is probable that a quota system would rate poorly from other aspects as well. Fishermen are unfamiliar with a quota system and removes the possibility of making windfall profits on finding a new ground, a factor that fishermen, and people in other occupations such as gold prospecting, find appealing.

It is difficult to predict with certainty the type of fishermen who would leave the fishery once a new management strategy was implemented. It is likely, however, that the new entrants would lose most if catches were to fall and would be compelled to leave because of their large financial burdens. This would probably be regarded by fishermen with a longer involvement in the fishery as equitable: a situation of 'last in, first out'. Other fishermen close to retirement may also elect to leave early rather than face the adjustment of fishing techniques following the purchase of extra pots and quotas. Economic theory would suggest that those fishermen who failed to earn at least normal profits (that is, after a return on capital a wage at least equal to what could be earned elsewhere) would leave first; however, the satisfaction that many fishermen get from fishing may encourage them to remain and operate at inefficient economic levels. Moreover, the most skilled fishermen may be less inclined to operate

for such a low return and will sell out first, leaving a fishery dominated by lesser skilled and hence inefficient fishermen.

Conclusion

The principle conclusion to be drawn is that the WRLF is biologically overfished -- effort levels far exceed those required to capture the MSY and catches are expected to decline. However, capital investment and competition between fishermen are such that a corresponding reduction in fishing effort cannot be expected.

The best long term solution is a reduction in fishing effort achieved by reducing the number of boats and fishermen. In addition it is necessary that a system of increased payments be introduced if effort is to be stabilised at a lower level over the long term.

Three alternative management strategies are proposed as a means of achieving a reduction and stabilisation of effort to a level where conservation of the resource is assured. Further, it is proposed that Strategy 2 would, for reasons of efficiency, equity and acceptability to fishermen and administrators, be the best.

Fishermen should be concerned that they are now operating in an overfished industry. Accordingly, it is necessary that they recognize the factors that lead to overfishing, and those factors that can restore a fishery to a more healthy state. Only then will fishermen accept the undesirable aspects associated with effort reduction.

Footnotes

1. This work was submitted as a thesis in partial fulfilment of the requirements for an MSc (NatResMgt) at the University of Western Australia. It was financed by a grant from the Fishing Industry Research Trust Account.

Recommended reading

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TABLE 1

Income, costs and returns by zone in the WRLF

ZONE 'A' HOUTMAN-ABROLHOS COASTAL

	1962/63	1966/67	1967/68	1968/69	1972/73	1973/74	1974/75	1977/79
	$	$	$	$	$	$	$	$
Gross income	11,737[c]	15,864	20,423	23,096	27,459	27,407	29,720	71,698
Total costs	7,246[c]	9,136	8,976	9,924	16,426	17,107	18,358	41,581
Return to owner skipper	4,491[c]	6,728	11,447	13,172	11,033	10,300	11,362	30,117
ZONE 'B' GERALDTON COASTAL								
Gross income		14,310	19,210	22,365	19,466	19,860	22,532	69,379
Total costs		8,472	8,880	10,513	12,228	11,836	13,329	34,180
Return to owner skipper		5,838	10,330	11,752	7,238	8,024	9,203	35,217
ZONE 'C' FREMANTLE COASTAL								
Gross income	12,176	18,792	25,916	23,650	24,890	22,253	30,039	73,063
Total costs	9,963	11,798	13,165	12,614	16,633	16,647	18,139	44,540
Return to owner skipper	2,213	6,994	12,751	11,036	8,257	8,257	11,900	28,523
Skipper's wage[b]	2,306	3,088	3,344	3,600	5,165	6,026	7,571	11,245

b Calculated as equal to the average annual earnings per employed male in Western Australia

c Includes Zone 'B'

TABLE 2

Average return on capital by Zone for 1977/79

	Houtman Abrolhos coastal	Geraldton coastal	Fremantle coastal
	$	$	$
Gross income	71,698	69,379	73,063
Total costs	41,581	34,180	44,540
Return to owner skipper	30,117	35,217	28,523
Boat capital	53,500	42,331	58,384
Licence capital[a]	93,310	90,193	111,048
Return on boat capital[b]	35.1%	56.6%	29.6%
Return on boat and licence capital[b]	12.9%	18.1%	10.2%

a Calculated as $1,075 per pot, the average number of pots for Houtman-Abrolhos, Geraldton and Fremantle regions were 86.8, 83.9 and 103.3 respectively.

b A skipper's allowance, equivalent to the average annual earnings for an employed male in Western Australia, $11,245 for the period, has been deducted.

TABLE 3

Average return on capital by pot entitlements for 1977/79

	Less than 75 pots	76-105	106-135	More than 135 pots
	$	$	$	$
Gross income	52,640	64,511	94,761	129,811
Total costs	29,607	34,770	63,902	85,414
Return to owner skipper	23,033	29,741	30,859	44,397
Boat capital	37,541	41,718	82,539	124,027
Licence capital	71,058	93,910	126,743	169,313
Return on boat capital	31.4%	44.3%	23.8%	26.7%
Return on boat and licence capital	10.9%	13.6%	9.4%	11.3%

b Calculated as $1,075 per pot, the average number of pots for pot classes, less than 75, 76-105, 106-135, more than 135, were 66.1, 86.8, 117.9 and 157.5, respectively.

c A skipper's allowance, equivalent to the average annual earnings per employed male in Western Australia, $11,245, for the period, has been deducted.

TABLE 4

Outline of proposed alternative strategies

Strategy 1	Strategy 2	Strategy 3
- Announced schedule of increased licence fees. - Sale and transfer of licences temporarily stopped. - Compensation for fishermen choosing to leave fishery through means of a buy-back scheme. - Full transfer rights restored when optimal effort level reached. - Government can choose to assist exit of fishermen by buying licences.	- Permission given to fishermen to sell or purchase pots from existing pot entitlements. - Yearly pot licence fee increased. - Payment imposed on pot transfers. - Announced across-the-board percentage reduction in permitted pot numbers. - Government can choose to buy pots.	- TAC calculated and divided into individual quotas for existing fishermen. - Annual payment imposed, based on size of quota. - Quotas freely transferable, in whole or part. - Government can choose to buy quotas.

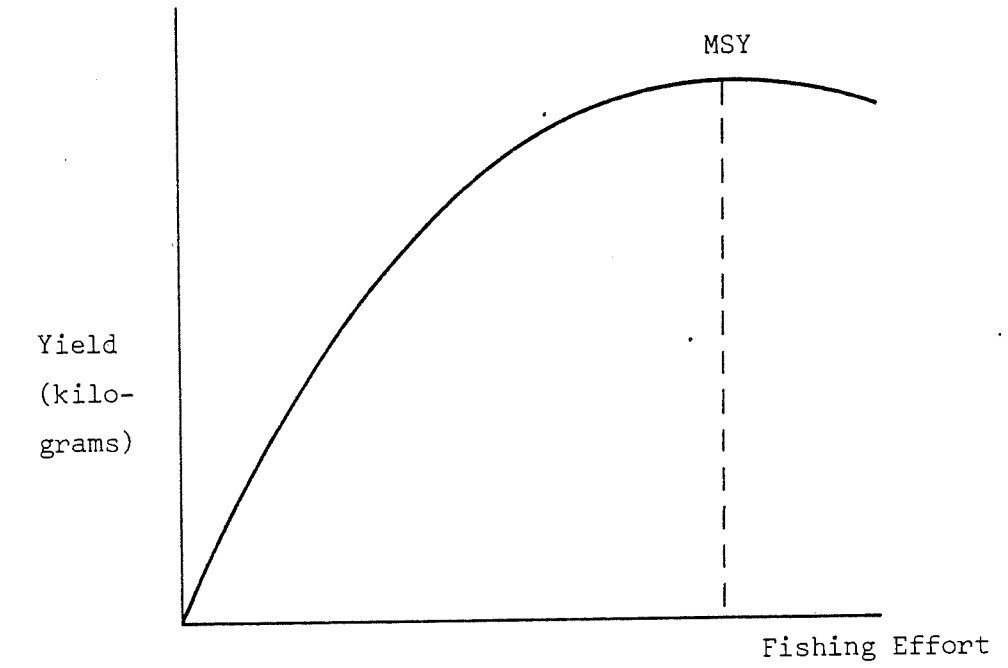

Fig. 1 The sustainable yield curve

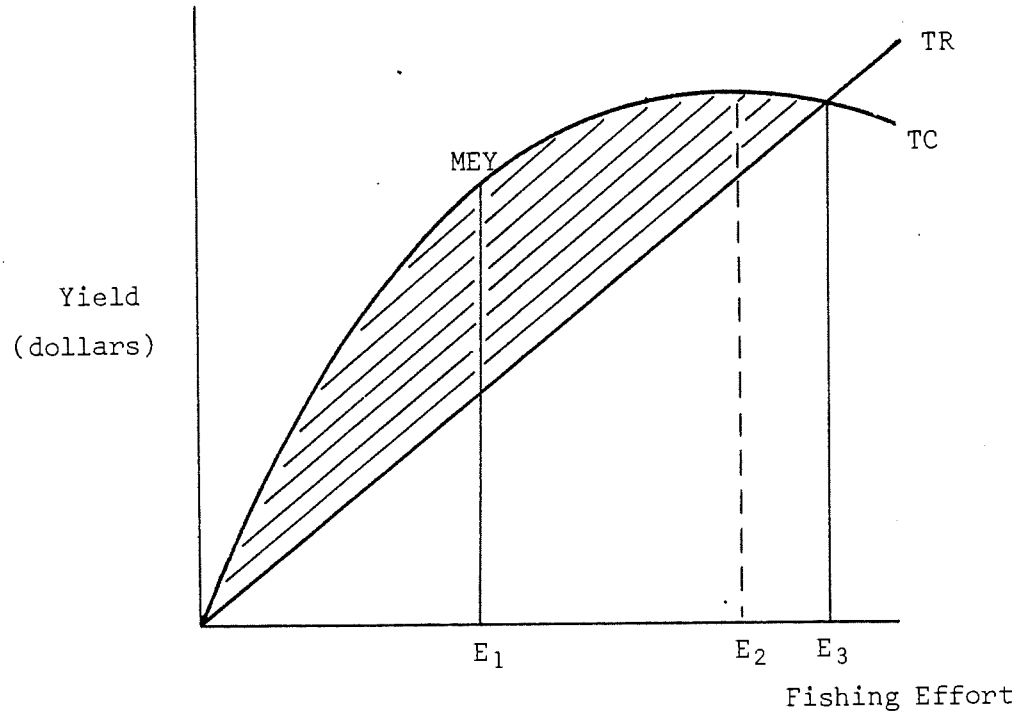

Fig. 2 A bioeconomic analysis showing total revenue (TR), total costs (TC) and resource profit at various levels of fishing effort

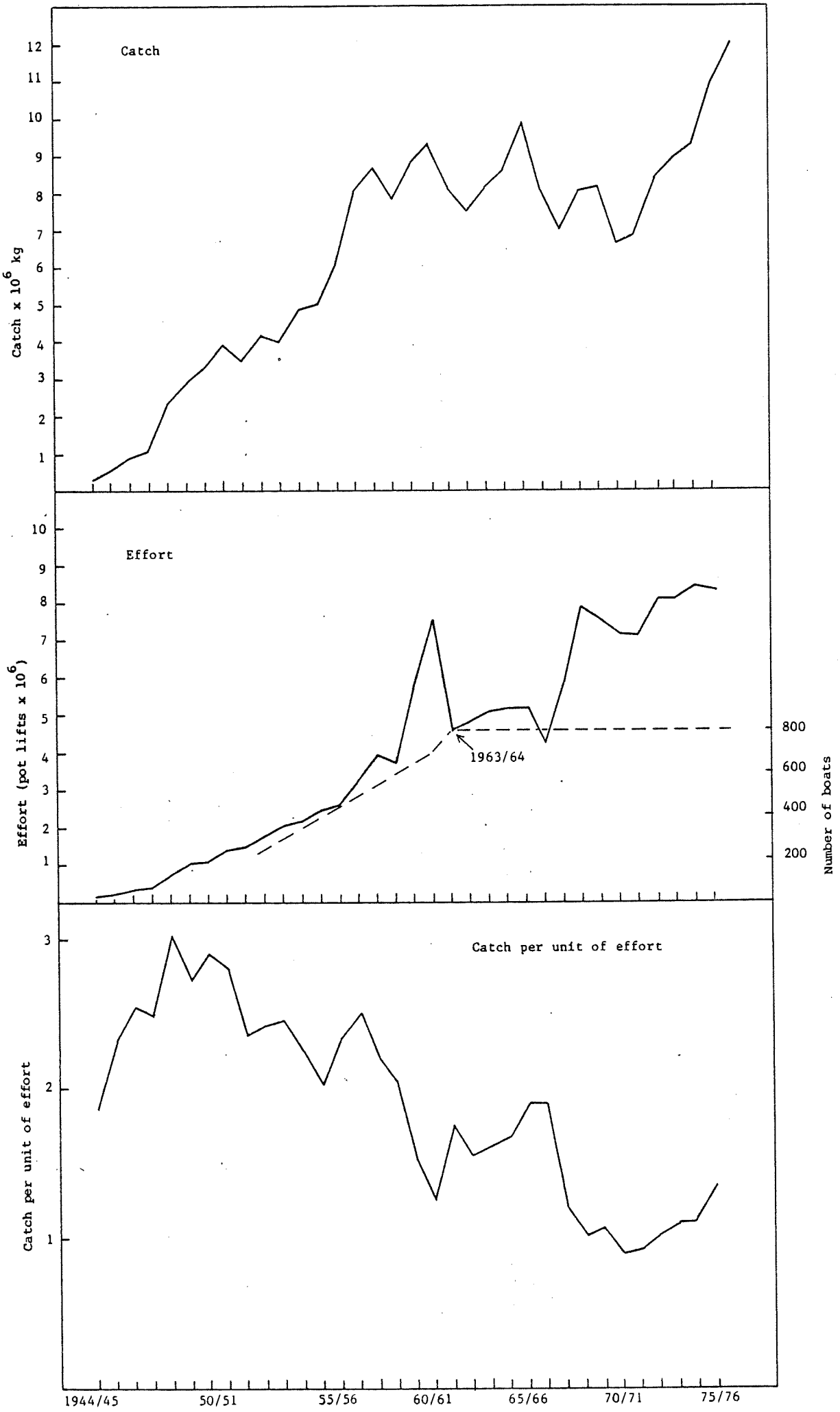

Fig.3 Catch, effort, number of boats and catch per unit of effort.

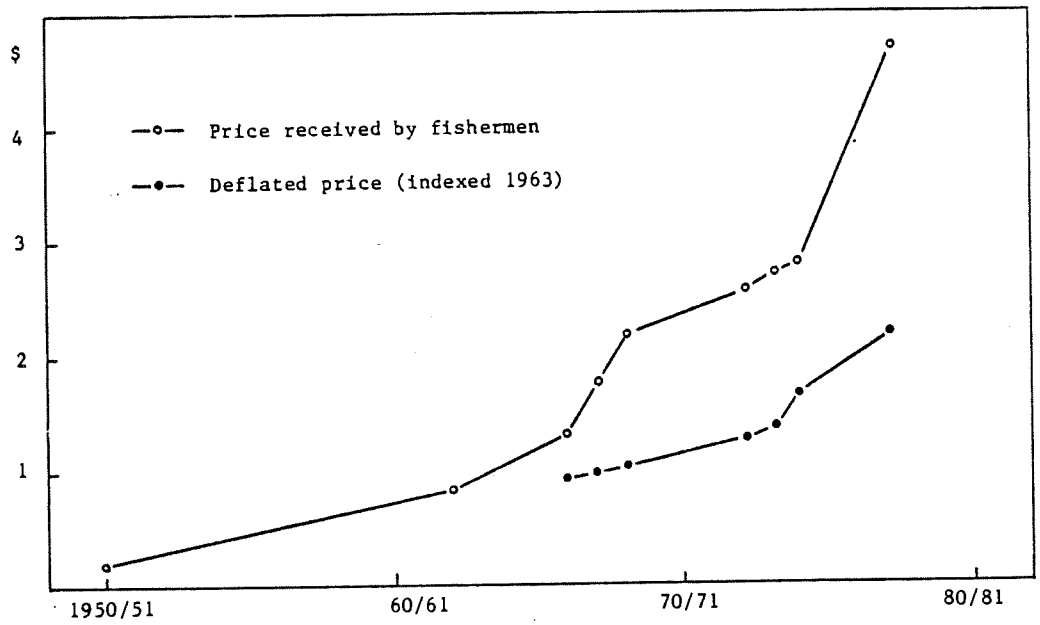

Fig.4 Average price received by W.A. fishermen and C.P.I. adjusted price.

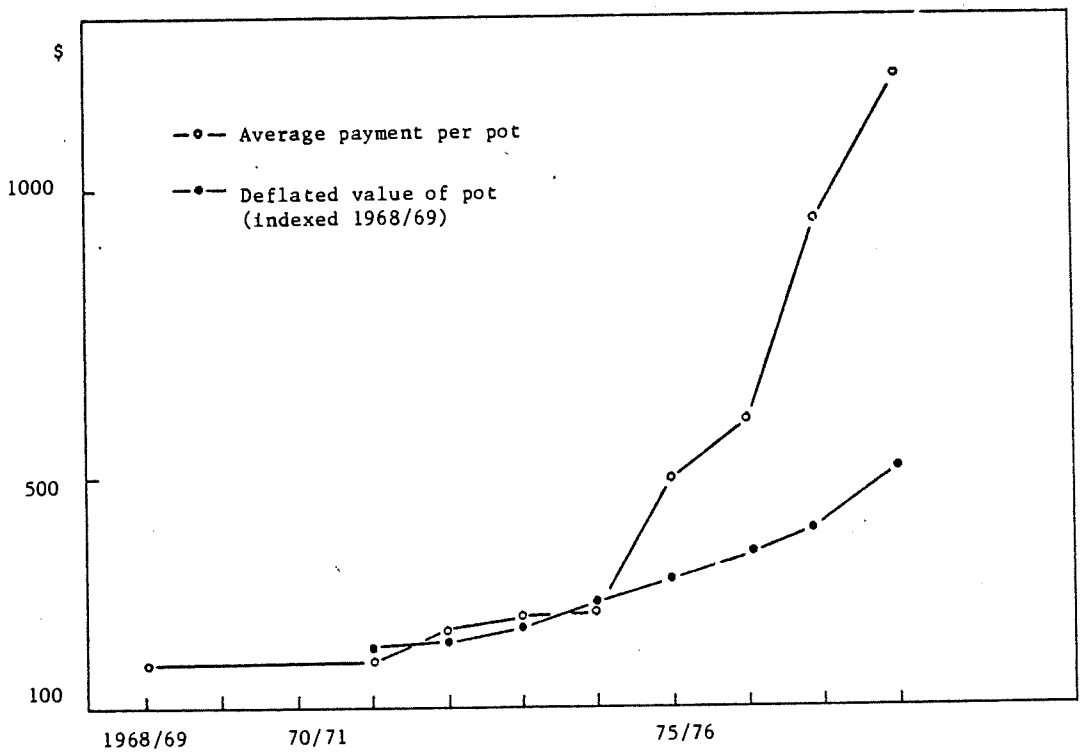

Fig.5 Average licence payment, calculated per pot, and deflated value.

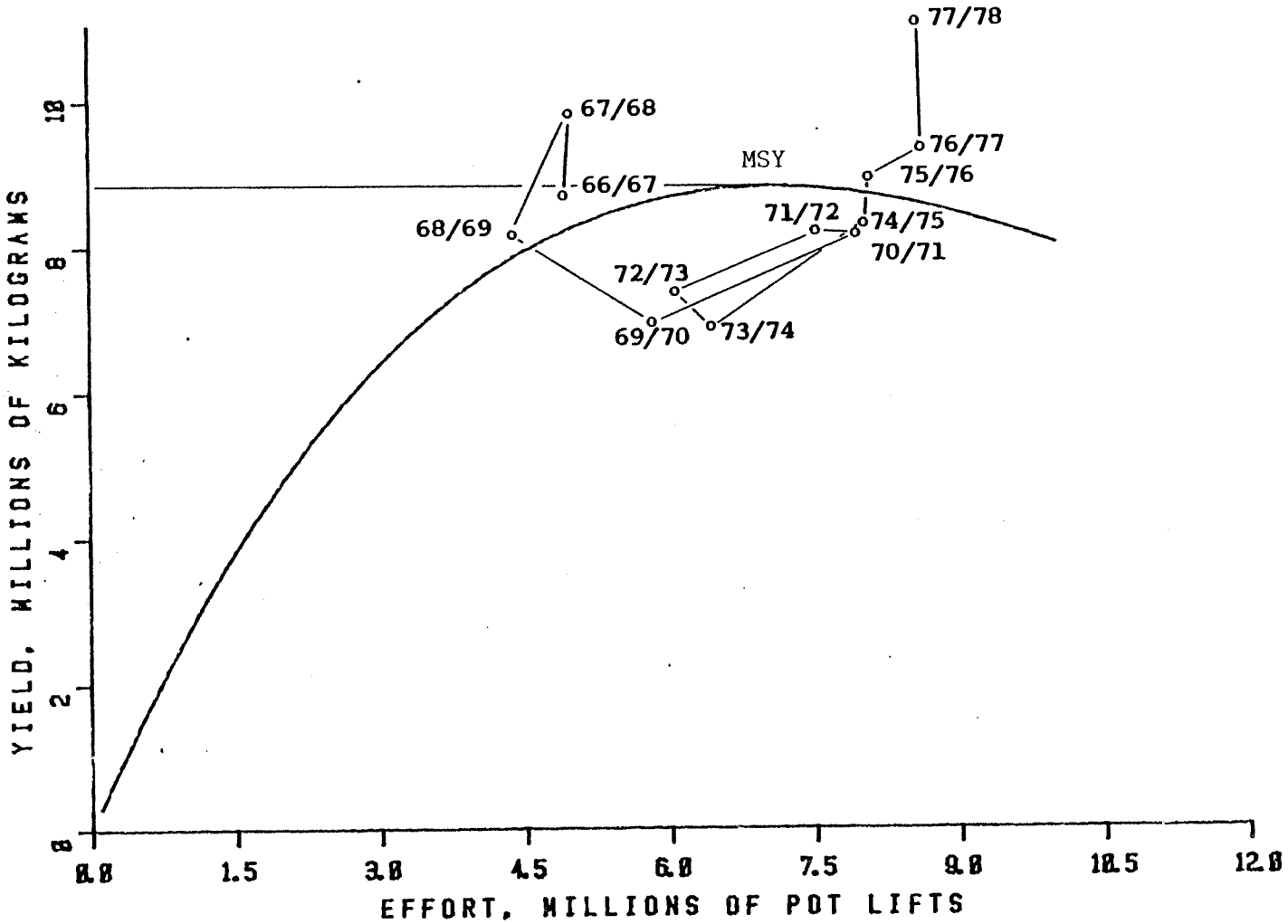

Fig. 6 Scatter of yields from 1966/67 to 1977/78 around the sustainable yield curve. The 1978/79 yield is estimated to be 11.43 million kilograms.

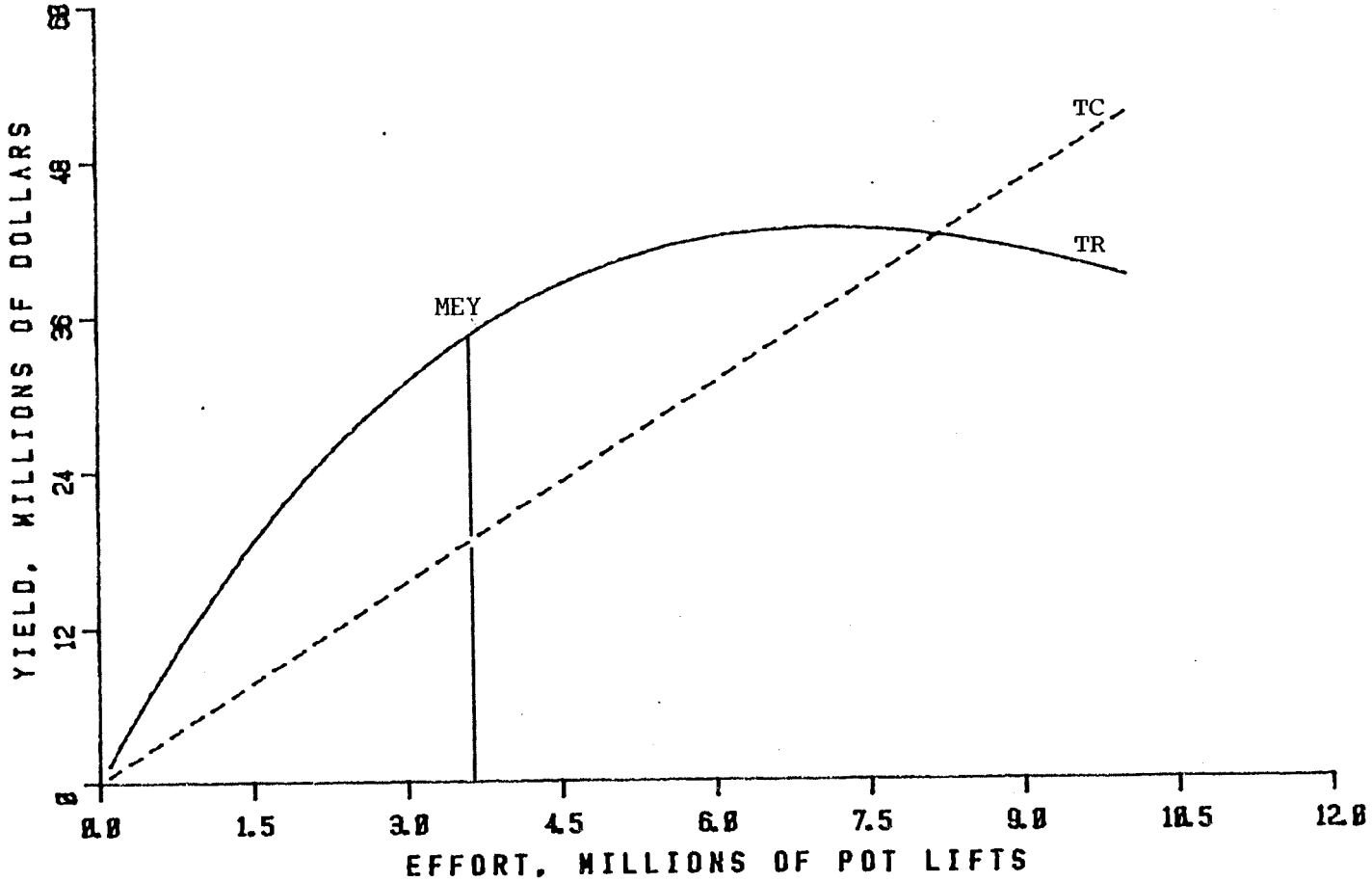

Fig. 7 A bioeconomic analysis of the WRLF