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**AN ECONOMIC EVALUATION  
OF THE 1987 BUY-BACK  
SCHEME IN THE SOUTHERN  
ZONE ROCK LOBSTER  
FISHERY**

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## ABSTRACT

A licence buy-back scheme was introduced in the Southern Zone Rock Lobster fishery in September 1987. The objective of the scheme was to reduce the number of licence holders operating in the fishery from 238 to 198. The scheme was to be funded by a levy applied to licence holders. It was anticipated that the reduction in licence holders would reduce fishing effort without reducing the long-run equilibrium catch in the fishery. Economic efficiency would increase as the cost of taking the available catch would reduce. Income to fishers remaining in the fishery would increase and be sufficient to offset the levy. The effect of the buy-back scheme on licence holders is assessed by analysing the financial performance of licence holders before (1986/87) and after (1989/90 and 1990/91) the scheme was introduced. A surplus yield model of the fishery is used to assess the effect on economic efficiency. The analysis indicates that returns to licence holders declined over the study period and that the scheme failed to increase economic efficiency in the fishery. Fishing effort applied by individual licence holders increased, reducing the potential benefits from the buy-back scheme.

## 1. INTRODUCTION

A voluntary licence buy-back scheme commenced operating in the Southern Zone Rock Lobster fishery in September 1987. The objective of the scheme was to reduce fishing effort through reducing the number of licence holders operating in the fishery (up to maximum of 40). It was anticipated that the reduction in fishing effort would enable the long-run equilibrium catch to be taken at a reduced cost, thereby increasing the economic efficiency with which the available catch was harvested (Copes 1978).

A Buy-Back Authority was established, comprising an independent chairman, elected representatives from each fishing port and representatives from the Department of Fisheries, SA Government Financing Authority and the SA Fishing Industry Council to administer the scheme, set prices for the buy-out of licences and to report to fishers on progress. The scheme was to operate until the target number of licences had been removed or for a maximum period of two years. Licence holders choosing to participate in the scheme were to surrender their rock lobster pots and fishing licence, and to receive a compensation payment calculated according to the number of pots surrendered.

The Minister of Fisheries was authorised to borrow up to \$6.5 million for distribution through the Buy-Back Authority to compensate licence holders who voluntarily surrendered their licences. The loan was to be repaid by those remaining in the industry through the levying of an annual fee on each licence holder dependent on the number of pot entitlements held. Ex ante analyses of the impact of the buy-back scheme on licence holders remaining in the fishery indicated that they would obtain higher catches as a result of the reduced number of operators in the fishery. Moreover, the additional revenues obtained by remaining fishers would be sufficient to offset the increased licence fees required to fund the buy-back scheme.

In June 1989 (three months before the expiry date for the program), a total of 41 licence holders (2455 pots) had been removed through the scheme. The scheme was terminated.

The objective of this report is to assess the economic impact of the Buy-Back Scheme. The specific hypotheses to be tested are that the program:

1. increased the profitability of individual licence holders remaining in the fishery, and,
2. increased the economic efficiency of the Southern Zone Rock Lobster Fishery.

## **2. METHOD**

### ***2.1 Impact on Profitability***

The impact of the buy-back scheme on the profitability of licence holders will be tested by comparing the financial performance of fishers in 1986/87 (before the scheme was operating) with that observed following termination of the scheme in 1989/90 and in 1990/91. Data for this analysis were obtained from a survey undertaken by REARK Research (1992). The questionnaire design and survey procedures are outlined in their report.

### ***2.2 Impact on Economic Efficiency***

Copes (1978) developed a surplus production model of the fishery to evaluate the potential for a reduction in fishing effort to increase economic efficiency. An improvement in economic efficiency would reduce the cost of taking the available catch, increasing the amount of economic rent generated in the fishery. Economic rent is defined as the difference between total fishery revenue and total industry cost.

Copes' (1978) model will be used in this paper to evaluate the impact of the buy-back scheme on economic efficiency. Data from the survey undertaken by REARK Research (1992) were used for this analysis.

Data on pot values are also used to assess the impact of the buy-back scheme on economic rent. These data are compared with the estimates obtained using Copes' surplus production model.

### 3. RESULTS

#### 3.1 *Data*

The sampling frame for the survey undertaken by REARK Research was defined as all licence holders operating in the fishery in either of the 1986/87, 1988/89 and 1990/91 years. Data were obtained by conducting personal interviews with 157 licence holders out of a total population of 194 (see REARK Research 1992).

Economic data required for the analysis reported in this paper, however, were obtained from only 30 fishers. Each licence holder participating in the survey was asked to provide financial information for the 1986/87, 1988/89 and 1989/90 years at the time of the interview (an economic survey form was left with each licence holder defining the data required). Responses were to be completed on a voluntary basis by licence holders and forwarded to REARK Research for compiling. Only a small portion of licence holders returned completed responses (19.1%). As a result, the responses with economic data form a sub-sample within the full sample.

Characteristics of the sub-sample and full sample are compared in Table 1. There is little difference between the average number of pots operated by each licence holder and the size of the boat in the sub-sample and the full sample. However, fishing days in 1989/90 and 1990/91 in the sub-sample are 3.0% and 4.1% higher than the sample. Catches in the sub-sample are also higher than the full sample (5.9% and 4.4%).

Catch and effort data for the fishery, compiled by the Department of Fisheries, are used in Table 2 to calculate the average catch per licence holder. Comparison of these data with the estimates obtained from the survey indicate that the average catch in the base year (1986/87) of respondents in the sub-sample was significantly higher than the average catch for all licence holders in the fishery (37% higher). The data also indicate that the increase in catch for the average licence holder in the fishery following the buy-back scheme was higher than that reported by the sub-sample (30.0% cf 14.7%).

From these results it is concluded that the economic survey data are biased towards the more active fishers, who obtained above average catches prior to the introduction of the buy-back scheme. It also appears that the increase in catch reported by economic survey respondents was low relative to the fishery average. This implies that the benefits from the buy-back scheme realised by the survey respondents may be lower

than that obtained by other licence holders.

The remainder of the analysis in this paper is based on the sub-sample of 30 responses.

**TABLE 1 COMPARISON OF CHARACTERISTICS OF THE SUB-SAMPLE WITH THE FULL SAMPLE**

	Year		
	1986/87	1989/90	1990/91
No. of survey responses			
Sub-sample			30
Full sample			157
No. of pots operated			
Sub-sample	62	63	62
Full sample	61	62	62
Size of boat (m)			
Sub-sample	10	NA	11
Full sample	11	NA	12
Fishing days			
Sub-sample	158	171	176
Full sample	160	166	169
Sub-sample as % of full sample	98.8	103.0	104.1
Catch (kg)			
Sub-sample	8415	9765	9540
Full sample	8325	9225	9135
Sub-sample as % of full sample	101.1	105.9	104.4

**TABLE 2 COMPARISON OF CHANGE IN TOTAL FISHERY CATCH  
WITH CHANGE IN AVERAGE CATCH PER LICENCE  
HOLDER IN THE SUB-SAMPLE**

	Year			Average increase (%)
	1986/87	1989/90	1990/91	
<b>CATCH AND EFFORT DATA</b>				
Fishery catch (kg)	1457743	1528136	1562450	
% increase from 1986/87		4.8	7.2	6.0
No. of licence holders	238	194	194	
Average catch per licence holder (kg)	6125	7877	8054	
% increase from 1986/87		28.6	31.5	30.0
<b>SURVEY DATA</b>				
Average catch per licence holder (kg)	8415	9765	9540	
% increase from 1986/87		16.0	13.4	14.7

### *3.2 Definition of Terms*

Data on financial performance are presented as averages per licence holder. All financial data are expressed in 1990/91 dollars obtained by adjusting the reported data by the appropriate CPI for Adelaide.

The survey data are summarised according to the following definitions:

#### Business Unit

The business unit to which the results refer is the individual licence holder operating in the fishery.

#### Capital Invested

Licence holders were asked to provide estimates of the market value of their boat and licence package. Separate estimates were obtained for both the boat and licence.

#### Fish Income

Fish income was defined as returns gained from the sale of rock lobster and other marine species caught. Survey data on income obtained from other sources (eg non-fishing employment or investment income etc.) were not obtained.

#### Trip Costs

Trip costs include charges for fuel, bait, ice and provisions. These costs are the variable costs associated with the fishing operation.

#### Labour

Labour payments include payments to deckies and, where appropriate, a skipper. An allowance for the wage of the owner-operator was excluded from these estimates.

#### Boat Costs

Boat costs were those costs incurred in maintaining the productive capacity of the boat and include repairs and maintenance of boat, and other gear.

#### Administrative Costs

Administrative costs include general administrative charges such as telephone, stationery, accounting services. Insurance and licence fees are also included.



### Miscellaneous Costs

Miscellaneous costs include interest charges, and any other operating costs not included elsewhere.

### Depreciation

Depreciation was estimated by licence holders.

### Cash Operating Costs

Cash operating costs were defined as the sum of trip, labour, boat, administrative and miscellaneous costs.

### Cash Operating Surplus

Cash operating surplus was calculated by deducting cash operating costs (excluding an owner-operator allowance but including payments for family labour) from fish income. It is a measure of the amount of cash available for the licence holders' consumption or investment expenditure.

### Return to Operators Labour, Capital and Management

The return to operators' labour, capital and management was calculated by deducting depreciation from cash operating surplus. It represents the monetary return accruing to capital invested in the business and the return to the labour and managerial skills of the licence holder.

### Full Equity Return

Full equity return was calculated by adding interest payments incurred by the business unit to the return to operators' labour, capital and management. It measures the return that would have been earned by the business unit if all capital had been fully owned by the licence holder. It is therefore a measure of the total returns to owner labour and capital employed in the business.

### Rate of Return to Operators' Labour, Capital and Management

The rate of return to operators' labour, capital and management was obtained by dividing the full equity return by the market value of the boat and licence, and multiplying by 100.

#### *3.3 Income*

Average catch and gross income from sales of rock lobster for each licence holder are provided in Table 3.

Average catch increased from 8415 kg in 1986/87 to 9765 kg in 1989/90 and 9540 kg in 1990/91. This represents an increase of 16.0% and 13.4% respectively. Part of the increase in catch was due to the improved seasonal conditions following the buy-back scheme; total fishery catch increased from 1458 tonnes in 1986/87 to 1528 tonnes (4.8%) and 1563 tonnes (7.2%) in 1989/90 and 1990/91 (Department of Fisheries, Personal Communication, 1993).

However, a major effect of the buy-back scheme was to reduce the number of licence holders in the fishery. Higher average catches per licence holder are also due to reduced number of licence holders achieved through the buy-back scheme.

Average gross income per licence holder, expressed in 1990/91 dollars, increased from \$128,998 in 1986/87 to \$137,197 and \$136,359 in 1989/90 and 1990/91 (an increase of \$8,199 and \$7,361 respectively). The main factor contributing to the increase in income was the increase in catch. Indeed, the increase in catch helped to offset a decline in price. Real price in 1989/90 and 1990/91 was 8.3% and 6.8% lower than that recorded in 1986/87 (Table 3). Data provided by the Department of Fisheries confirm that the real price of rock lobster declined from 1986/87 to 1989/90 and 1990/91 (Table 3). The Department of Fisheries' data indicate that the decline in real price for sub-sample was less than that observed for the fishery as a whole.

The relative contributions of changes in price and catch to average gross income per licence holder in 1989/90 and 1990/91 are identified using the method described by Staniford (1988). Using these results (Table 4), it is estimated that if real price had remained at the 1986/87 level in 1989/90 and 1990/91, the average gross income per licence holder would have been \$149,693 and \$146,244. The net benefit to licence

holders from the increase in catch would have been \$20,695 and \$17,246.

There are insufficient data available to accurately estimate the extent to which increase in income is attributable to the reduction in the number of licence holders as a result of the buy-back scheme or to the improved seasonal conditions in the fishery. However, assuming the increase in total fishery catch due to improved seasonal conditions was distributed evenly between all licence holders, between 50% and 75% of this benefit could be attributed to the buy-back scheme. This is equivalent to an increase in average gross income each year in the range of \$10,000 to \$14,000 (an increase of 8% to 11%). The actual increase received by licence holders was considerably less than this amount due to declining real prices for rock lobster from 1986/87 to 1990/91. Assuming as before that the benefits of improved seasonal conditions are distributed evenly between all licence holders, the actual increase in gross income attributable to the buy-back scheme is estimated to be between \$4,000 and \$6,000 per annum. It is concluded that the buy-back scheme did have a positive impact on average gross incomes of fishers.

**TABLE 3 TRENDS IN THE REAL PRICE OF ROCK LOBSTER (\$1990/91)**

	Year		
	1986/87	1989/90	1990/91
Income (\$)	128998	137197	136359
Catch (kg)	8415	9765	9540
Imputed price (\$/kg)	15.33	14.05	14.29
% increase from 1986/87		-8.3	-6.8
Actual price (\$/kg)	19.73	15.64	17.08
% increase from 1986/87		-20.7	-13.4

Source: Imputed price calculated by dividing income by catch.  
Actual price obtained from the Department of Fisheries.

**TABLE 4 SOURCES OF CHANGE IN AVERAGE GROSS INCOME  
(\$1990/91)**

	Year		
	1986/87	1989/90	1990/91
Income (\$)	128998	137197	136359
Catch (kg)	8415	9765	9540
Imputed price (\$/kg)	15.33	14.05	14.29
Total change in income from 1986/87		8198	7361
% change attributable to increase in catch		252.4	234.3
% change attributable to increase in price		-131.4	-118.5
Interaction (% of total change)		-21.1	-15.8
Estimated income if price remained at 1986/87 level (\$)		149693	146244
Net benefit (\$)		20695	17246

### *3.4 Expenditure*

Real total cash operating expenses in 1889/90 (\$96,214) and 1990/91 (\$90,627) were \$20,975 and \$15,390 higher than those reported for 1986/87 (Table 5). The increase in costs exceeded the increase in income reported by survey respondents due to both the improved seasonal conditions and the reduction in the number of licence holders operating in the fishery (\$8,199 and \$7,361 respectively). Thus the net income received by licence holders after the buy-back scheme declined relative to the 1986/87 year.

TABLE 5 CASH OPERATING COSTS (\$1990/91)

	Year		
	1986/87	1989/90	1990/91
Trip costs			
Fuel, oil and grease	11287	16754	13688
Bait, ice	8539	9489	9881
Other trip costs	160	133	149
TOTAL TRIP COSTS	19986	26376	23719
% increase from 1986/87		32.0	18.7
Labour costs			
TOTAL LABOUR COSTS	30681	35160	34586
% increase from 1986/87		14.6	12.7
Boat costs			
Boat repairs and maintenance	5945	8844	9720
Gear replacement, repairs	5061	4426	4068
TOTAL BOAT COSTS	11006	13271	13788
% increase from 1986/87		20.6	25.3
Administration costs			
Insurance	3014	2900	2864
Licence fees <sup>a</sup>	1854	7804	6581
General	2649	3565	3160
TOTAL ADMINISTRATION COSTS	4503	11369	9741
% increase from 1986/87		152.4	116.3
Miscellaneous costs			
Other costs	2136	1830	1410
Interest	6927	8209	7383
TOTAL MISCELLANEOUS COSTS	9063	10039	8793
% increase from 1986/87		10.8	-3.0
TOTAL CASH OPERATING COSTS	75239	96214	90627
% increase from 1986/87		27.9	20.5

- a These fees represent payments actually made by licence holders participating in the economic survey. The amount paid is dependent on the number of pots and other endorsements on the fishing licence, and include the buy-back levy.

Two alternative hypotheses can be formulated to explain the increase in costs.

Hypothesis 1: Licence holders increased fishing effort resulting in increased cash operating costs.

Hypothesis 2: The price of inputs increased resulting in increased cash operating costs.

Hypothesis 1 is based on the conventional theory of input controls as analysed by Anderson (1977). Evidence supporting Hypothesis 1 is provided by the increase in fishing effort, measured as days fished, reported by respondents in 1989/90 and 1990/91 relative to 1986/87 (fishing days increased from 158 days in 1986/87 to 171 and 176 days in 1989/90 and 1990/91). Hypothesis 2 would indicate a continuing trend of rising real costs first observed by Copes (1978).

In Table 6, the increase in cash operating costs is decomposed into the effect of increased fishing effort (measured by days fished) and increased cost per fishing day (measuring the increase in the price of inputs per day). In 1989/90, the main cause of increased cost was an increase in the price of inputs. In 1990/91, the increase in fishing days was the main source of increased cost. Thus neither hypothesis can be rejected. It is concluded that both factors contributed to the increase in real cash operating costs between 1986/87 and 1990/91.

Total trip costs increased by 32% in 1989/90 and 18.7% in 1990/91 (Table 5). The main factors contributing to the increase was an increase in fuel costs and bait costs. Labour costs also increased by 14.6% and 12.7% in 1989/90 and 1990/91. Most of this increase would be due to the higher catches and gross income, increasing share payments made to crews. Boat costs (repairs and maintenance) increased in real terms by 20.6% and 25.3%. This would be partly due to the increased fishing effort reported. Administration costs increased by 152.4% and 116.3%. This was due mainly to the higher licence fee paid by licence holders to support the buy-back scheme. Miscellaneous costs remained fairly constant.

The financial performance of licence holders is summarised in Table 7. Cash operating surplus in 1986/87 was \$55,207. In 1989/90 and 1990/91, cash operating surplus declined to \$41,078 and \$45,582. The higher gross income reported in 1989/90 and 1990/91 was insufficient to offset the increase in cash operating costs. Estimates of

return to operators' labour and capital, full equity return and return to cost ratio also

**TABLE 6 SOURCES OF CHANGE IN CASH OPERATING COST**

	Year		
	1986/87	1989/90	1990/91
Cash operating costs (\$)	75239	96214	90627
Fishing days	158	171	176
Cost per day (\$/day)	476.20	562.65	514.93
Total change in cost from 1986/87 (\$)		20975	15388
% change attributable to increase in fishing days		29.5	55.7
% change attributable to increase in cost per day		65.1	39.8
Interaction (% of total change)		5.4	4.5

**TABLE 7 FINANCIAL PERFORMANCE OF LICENCE HOLDERS (\$1990/91)**

	Year		
	1986/87	1989/90	1990/91
Total income (\$)	130600	138370	137135
Cash operating costs (\$)	76146	99217	96199
Cash operating surplus (\$)	55207	41078	45582
Depreciation (\$)	12418	13854	11400
Return to operator, labour and capital (\$)	42605	27094	33760
Full equity return (\$)	55023	35293	41431
Return to cost ratio	1.85	1.54	1.58

indicate that the financial performance of licence holders declined following the buy-back scheme.

### 3.5 *Impact on Economic Efficiency*

Copes' (1978) bio-economic model of the fishery is reproduced in Figure 1. In Figures 2 and 3, the model is used to develop a surplus production model for the 1986/87 and 1990/91 years. Fishing effort in these years was approximately the same; 1,912,558 and 1,909,474 pot lifts respectively (Department of Fisheries catch and effort data).

Total industry revenue is calculated by multiplying Copes' (1978) estimate of the long-run equilibrium yields of 1,633 tonnes by the price in each year (imputed from the survey data).

Industry cost is calculated by multiplying the total cost per licence holder (estimated using the survey data) by the number of licence holders operating each year (Table 8). Cost per licence holder is defined as the sum of the cash operating costs (excluding the licence fee and interest costs), depreciation, opportunity cost of labour and the opportunity cost on capital invested. The estimates of labour and capital opportunity costs were based on Copes' (1978) method. It was assumed that on average 10 months or 83% of the year was devoted to fishing, derived by summing the number of months spent fishing (7) and an allowance of three months for overhaul and holidays. The labour opportunity cost was calculated as 83% of the average earnings per male unit in South Australia. The opportunity cost on capital invested was assumed to be equal to the ten year Commonwealth Treasury bond rate.

Following Copes (1978), total costs were reduced by 5% and total returns were increased by 5% to adjust for inaccurate reporting.

Figures 2 and 3 indicate that in both years, total costs exceeded total revenue. This result implies that fishing effort in 1989/90 and 1990/91 was too large relative to the size of the stock (Anderson 1977). A reduction in fishing effort would be expected to reduce the cost of taking the available catch without reducing the long-run catch, thereby improving economic efficiency and increasing profitability.



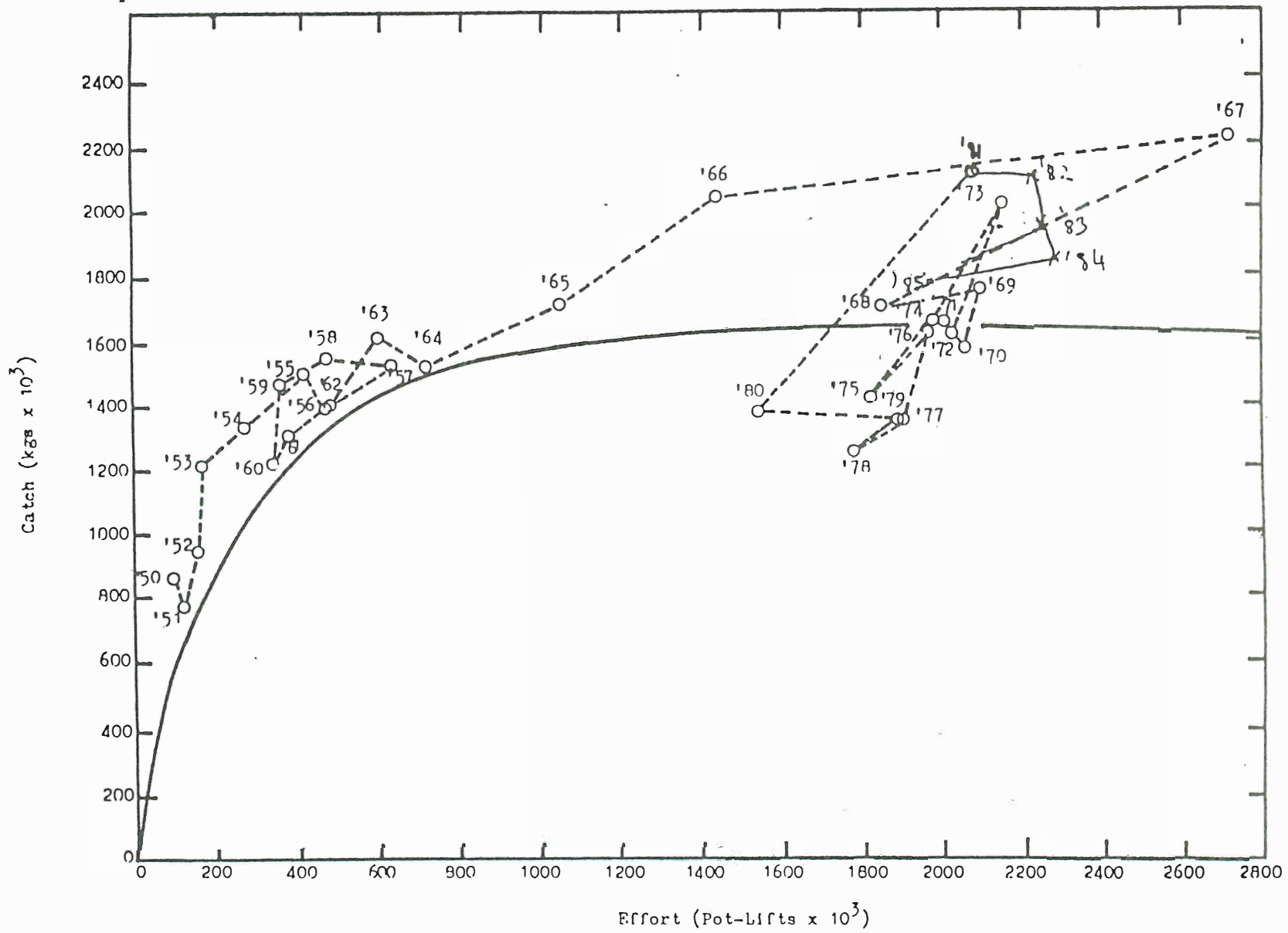


Figure 1. Yield curve for the Southern Zone rock lobster fishery.

TABLE 8 CALCULATION OF ECONOMIC RENT<sup>a</sup>

	86/87	89/90	90/91
No. of fishers	238	194	194
Average weekly earnings (\$) <sup>b</sup>	431.2	533.45	566.85
Comm. Treasury 10 yr bond rate (%) <sup>c</sup>	12.8	13.3	12.2
<b>TOTAL COST</b>			
Cash operating costs (exc interest and licence fee) (\$)	51697	78347	82235
Depreciation (\$)	9530	13045	11400
Labour (\$)	18611	23024	24465
Capital (\$)	26740	42309	39117
Total cost per fisher (\$)	106577	156725	157217
Industry cost (\$m)	25.4	30.4	30.5
5% adjustment	1.3	1.5	1.5
Adjusted cost (\$m)	26.6	31.9	32.0
<b>TOTAL REVENUE</b>			
Equilibrium catch (t)	1633	1633	1633
Price \$/kg (imputed)	11.76	13.23	14.29
Industry revenue (\$m)	19.2	21.6	23.3
5% adjustment	1.0	1.1	1.2
Adjusted revenue (\$m)	20.2	22.7	24.5
Effort (pot lifts)	1912558	1798348	1909474
Rent (\$m)	-6.5	-9.2	-7.5
Rent as % of revenue	-32.1	-40.7	-30.7

a Economic data are in dollars of the day (not adjusted for inflation).

b Australian Bureau of Statistics, Catalogue No. 6302.

c Australian Bureau of Agricultural and Resource Economics, Agricultural and Resources Quarterly, various issues.

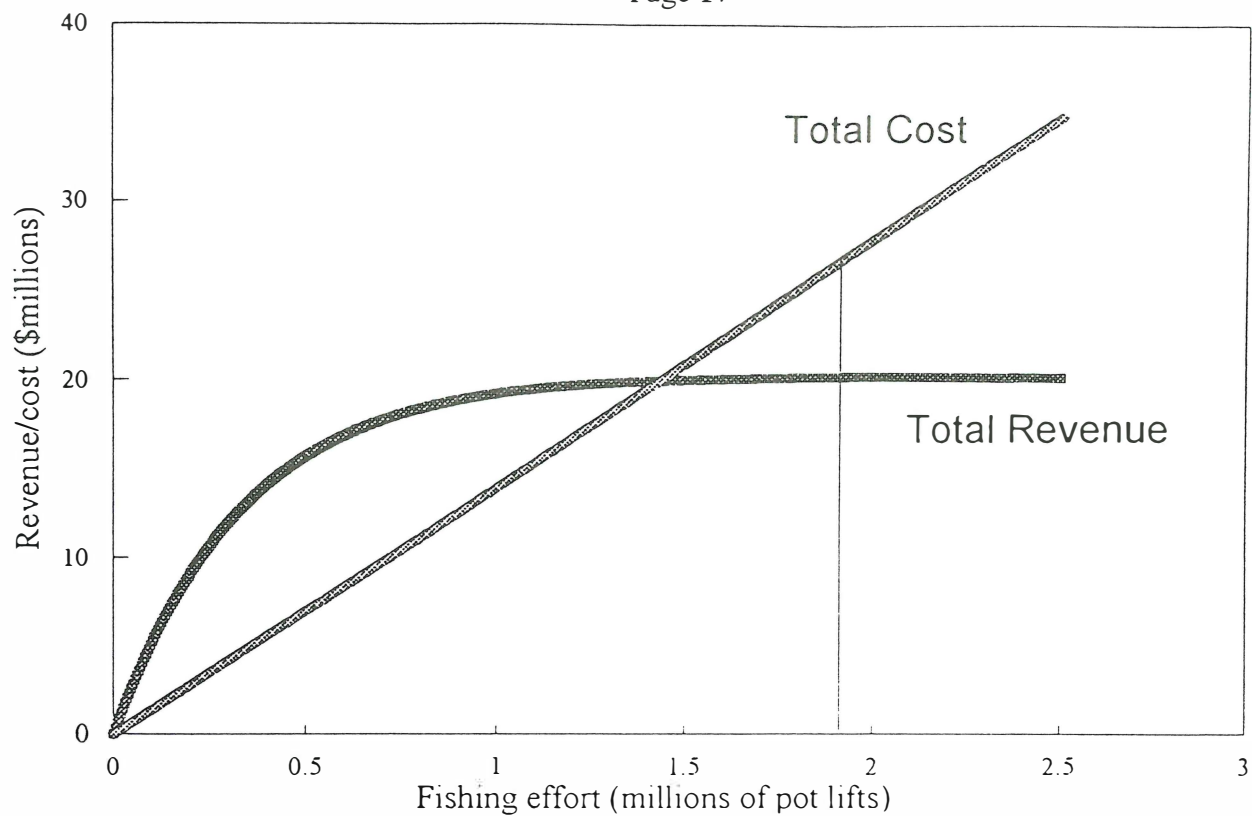


FIGURE 2 SURPLUS YIELD MODEL FOR 1986/87

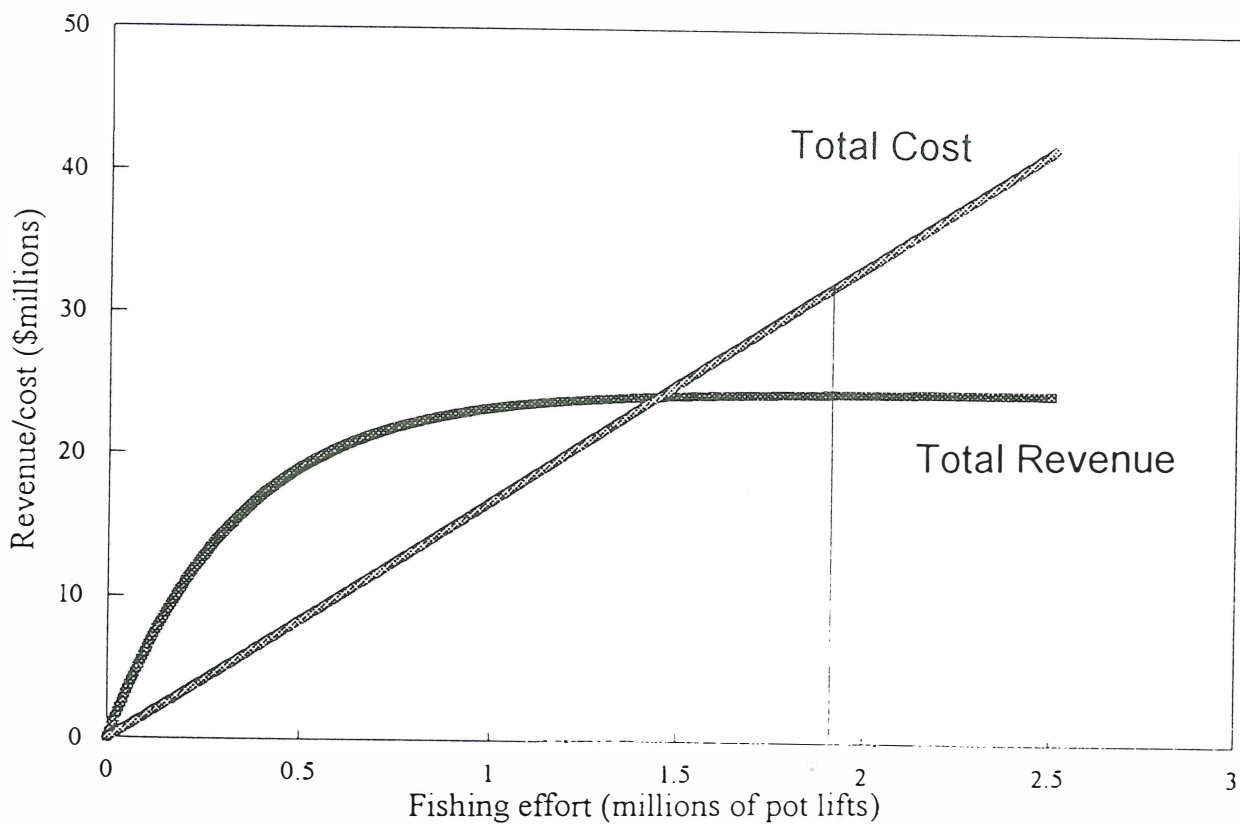


FIGURE 3 SURPLUS YIELD MODEL FOR 1990/91

Of particular significance to this study is the finding that fishing effort remained excessive following the buy-back scheme. A major objective of the buy-back scheme was to improve economic efficiency by reducing fishing effort (Copes 1978). A measure of the economic efficiency of the fishery is the economic rent generated by licence holders. Economic rent is calculated by subtracting total industry cost from total revenue (the vertical difference between the total revenue and industry cost curves in Figures 2 and 3). Comparison of Figures 2 and 3 indicates that the buy-back scheme has had little impact fishing effort and economic rent. Even though the number of licence holders was reduced by 41 (17%), fishing effort measured as pot lifts in 1990/91 was only marginally lower than the 1988/89 level (1,909,474 cf 1,912,558).

This result implies that the buy-back scheme was unsuccessful in achieving its major objective viz. improving economic efficiency in the fishery. The potential economic benefits from reducing the number of licence holders was weakened by the increased fishing effort applied by those licence holders remaining in the fishery.

### *3.6 Analysis of Pot Values*

Using asset pricing theory, it can be hypothesised that the amount fishers are prepared to pay for pots is indicative of the net rents expected from participating in the fishery. An increase in economic rent earned in the fishery would be reflected as an increase in pot values. Thus analysis of pot value data provides an independent test of trends in economic rent in the fishery. If the buy-back scheme was successful in improving economic efficiency, economic rent would increase and be reflected in the price of pots.

The previous analysis (section 3.3, 3.4 and 3.5) indicated that the net returns earned by fishers declined over the study period and that the buy-back scheme had little impact on economic rent generated in the fishery. From asset pricing theory, it would be expected that real pot values in 1989/90 and 1990/91 would be maintained at the 1986/87 level or perhaps decline slightly.

Quarterly real pot value data (\$1990/91) from 1984 are provided in Table 9. Trends in real pot values are graphed in Figure 4 using a two period moving average. From Figure 4, it is apparent that prior to the buy-back scheme, real pot values were increasing slightly. However, on resumption of pot trading when the buy-back scheme

TABLE 9 REAL POT VALUES (\$1990/91)

Quarter ending	Real value (\$1990/91)
December 1984	2623
March 1985	2727
June 1985	2905
September 1985	3308
December 1985	3896
March 1986	3842
June 1986	2735
September 1986	2910
December 1986	3456
March 1987	3247
June 1987	3124
September 1987	3220
September, 1989	4354
December 1989	4986
March 1990	4114
June 1990	4609
September 1990	5042
December 1990	4025
March 1991	NA
June 1991	4821
September 1991	6039
December 1991	4935
March 1992	NA
June 1992	2924
September 1992	5667

Source: SA Department of Fisheries

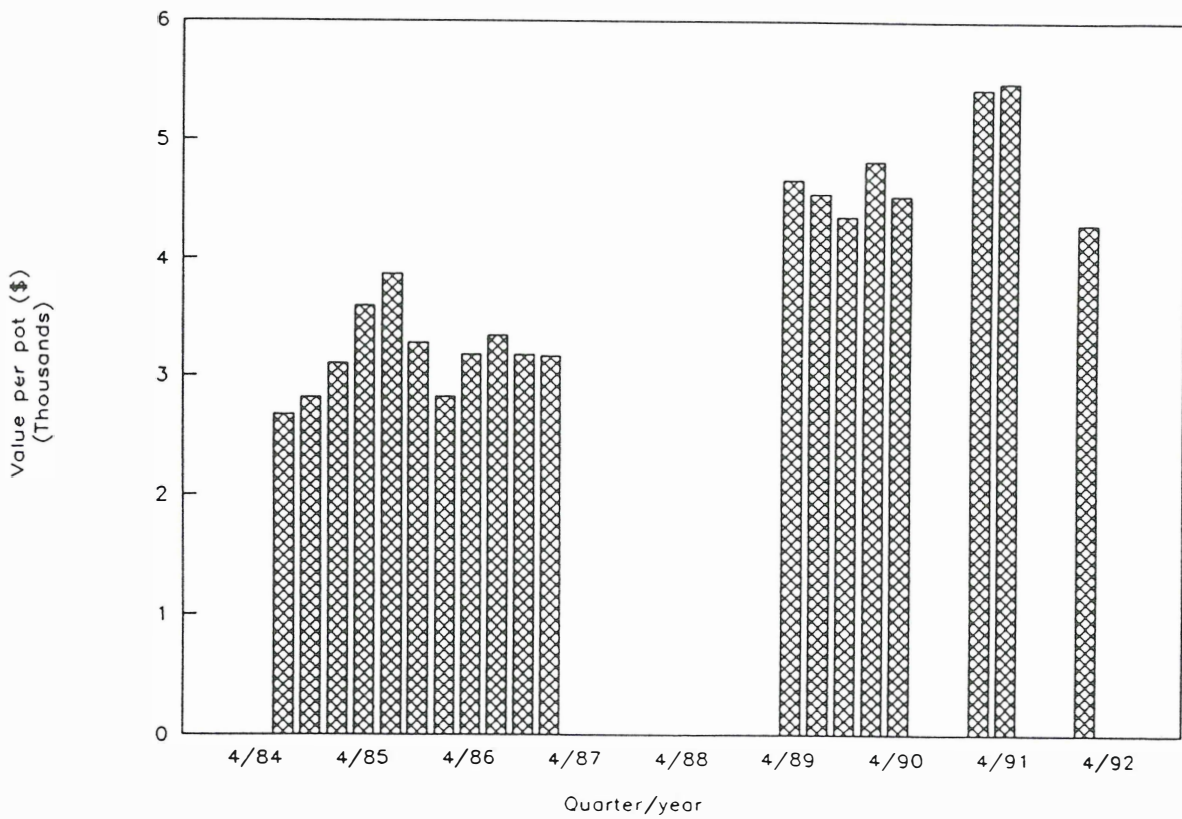


Figure 4. Trend in Real Pot Values (\$1990/91): 1984 – 1992.  
(Source: SA Department of Fisheries)

terminated, pot values jumped from approximately \$3000 to \$4500 in 1990/91 dollars. The data indicate that the buy-back scheme may have been associated with a discontinuity in pot value trends. Pot values on termination of the scheme appear to have increased relative to 1986/87, implying increasing economic rent.

Regression analysis was applied to the trend data graphed in Figure 4 to test the hypothesis that there is a discontinuity in the data. First the following unconstrained model was estimated:

$$V = a + bT + u$$

where  $V$  denotes the real value of a pot,  $T$  denotes a time trend commencing at 1,  $u$  denotes a disturbance term with white noise properties and  $a$  and  $b$  are model coefficients.

A constrained model was then re-estimated with a dummy variable added to capture the effect of the buy-back scheme on the intercept coefficient ( $a$ ):

$$V = a + bT + cD + u$$

where  $D$  takes a value of zero prior to 1989 (the date at which pot trading recommenced following termination of the buy-back scheme) and thereafter a value of one. An  $F$  test was applied to the residual sum of squares from both regressions to determine if there was a discontinuity in the pot values (Table 10).

The calculated  $F$ -value was 4.049. The critical values for  $F$  at the 5% and 10% levels of significance are 4.451 and 3.026. Thus the hypothesis that the buy-back scheme increased pot values is rejected at 5% level but accepted at the 10% level of significance. While the results are not significant at the conventional level of probability, they do provide some support for the hypothesis that the economic rent expected to be earned by fishers increased following termination of the buy-back scheme relative to the pre-buy-back period, and that this increase was reflected in increased pot values.

**TABLE 10 REGRESSION ANALYSIS TO TEST THE IMPACT OF THE BUY-BACK SCHEME ON THE PRICE OF POTS<sup>a</sup>**

	Unconstrained model	Constrained model
Constant	2767.32 (169.65)	3013.82 (201.61)
Trend	78.8 (10.05)	29.08 (27.12)
Dummy variable	–	1042.76 (534.16)
R <sup>2</sup>	0.78	0.83
Residual sum of squares	3088381.18	2494296.79
Number of constraints	–	1
Degrees of freedom	17	16
Calculated F value	4.049	

a Standard errors in parentheses.

### *3.7 Comparison of the Economic Rent Estimates Derived From the Surplus Yield Model with Pot Value Data*

The analysis of the impact of the buy-back scheme on economic rent using the surplus yield model indicated that there had been little impact. In contrast, analysis based on trends in pot values indicated that economic rents may have increased. Possible explanations for these conflicting results are:

1. the surplus yield model is a long-run equilibrium model and when used with annual data provides misleading estimates of economic rent. Estimation using annual data is inconsistent with a long run model because revenues and costs are derived from results reported at a given point in time rather than on the long run



expectations for these variables. Estimates of economic rent derived from such data may be biased either positively or negatively.

More accurate revenue and cost data could be obtained by examining trends in relevant economic variables. However, this would require additional data that are not available.

2. pot values are not directly related to income earning potential of pots. Even if income earning capacity is a significant determinant of pot values, there may be other factors that are also important.

Support for this hypothesis is obtained from recent analysis of farmland price data (Falk 1991; Clark, Fulton and Stock 1993; Just and Miranowski 1993). These analyses demonstrate that land values are poorly correlated with net returns. The authors suggest that a fundamental rethinking of the way in which land values are viewed and modelled is required. Risk aversion, future shifts in government policy, inflation and credit constraints all affect land values.

It seems likely that pot values would also be affected by such variables. For example, licence holders may be expecting benefits from the buy-back scheme to increase with time. Even though financial performance in 1990/91 deteriorated relative to 1986/87, future expectations for increased benefits would be capitalised in to the value of pots, increasing the price licence holders would be prepared to pay to transfer pots.

The price being paid for pots may also reflect expected changes in management policy in the fishery. For example, the industry is currently considering introducing an individual transferable quota (ITQ) scheme. If there is an expectation that quota will be determined according to existing pot allocations, licence holders may be encouraged to enter the pot market to increase their entitlement. The price of pots would increase and may exceed the value that would be consistent with the current income earning capacity of a pot.

More detailed analysis of the determinants of pot values is required before it can be concluded that the rise in values is indicative of increasing economic efficiency in the fishery.

## 4. CONCLUSIONS

### 4.1 *Expected Impacts of the Buy-Back Scheme*

Ex ante analyses of the effect of the buy-back scheme on licence holders indicated that the proposed reduction in licence holders would increase average gross income and that this would be sufficient to meet the cost associated with higher licence fees required to buy-back 40 licences in the fishery. These analyses also anticipated that the reduction in the number of licence holders achieved through the buy-back scheme would improve economic efficiency in the fishery by reducing fishing effort.

### 4.2 *Impact on Returns to Licence Holders*

The analysis in this paper has demonstrated that, as predicted in the ex-ante analyses, the buy-back scheme did increase the catch of licence holders. The increase in catch reported exceeded the increase that could be attributed to improved seasonal conditions. The increase in catch was reflected as increased gross income estimated to be within \$10,000 to \$14,000 per annum (assuming 1986/87 prices were maintained). As real prices for rock lobster declined during this period, the income actually obtained by licence holders was significantly lower (\$4,000 to \$6,000).

However, costs also increased markedly due to an increase in fishing effort by each licence holder and an increase in factor prices. The increase in factor prices is a continuation of a trend in the fishery that is likely to persist. The increase in fishing effort was partly due to improved seasonal conditions, manifested as a higher total fishery catch. However, the increase was also due to existing licence holders increasing fishing effort as the number of licence holders in the fishery declined.

The net effect of the buy-back scheme on returns to licence holders was negative. The increase in costs, taking into account higher licence fees, exceeded the increase in income. Cash operating surplus declined by \$14,000 in 1989/90 and \$10,000 in 1990/91 relative to 1986/87. The return to cost ratio declined from 1.85 to 1.54 and 1.58 respectively.

#### *4.3 Impact on Economic Efficiency*

Analysis based on the surplus yield model indicated that the buy-back scheme had little impact on economic efficiency in the fishery. Total fishing effort was reduced only marginally (from 1,912,558 pot lifts in 1986/87 to 1,798,348 pot lifts in 1989/90 and 1,909,474 pot lifts in 1990/91) and there was little change in economic rent generated in the fishery (Figures 2 and 3). While the buy-back scheme reduced the number of licence holders operating in the fishery, remaining fishers responded by increasing the time spent fishing, dissipating the potential gains from reduced fishing effort. This is a classic example of rent dissipation through input substitution (Anderson 1977).

Analysis of pot value trends indicated that pot values may have increased during the study period. Such a result could be caused by an expectation for an increase in economic rents as a result of the buy-back scheme. However, it was argued that pot values are affected by other factors such as expectations for prices and catch, possible changes in management policy and risk in addition to income earning capacity and changes in economic rent. As a consequence, there may not be a direct relationship between income earning capacity and pot values.

It is concluded that there is little evidence available to indicate that the buy-back scheme improved economic efficiency. While pot values may have increased (indicative of rising economic rents), this may be caused by factors other than the buy-back scheme, including possible new management arrangements for the fishery.

### **5. POLICY IMPLICATIONS**

The analysis has demonstrated that the buy-back scheme was not as effective as originally anticipated in improving economic efficiency and returns to licence holders in the Southern Zone rock lobster fishery. Also while the scheme was successful in reducing the number of licence holders operating in the fishery, remaining fishers were able to increase fishing effort by increasing the amount of time spent fishing, dissipating potential benefits. Dissipation of benefits in this manner is a characteristic of fisheries management schemes based upon input controls.

The ineffectiveness of the buy-back scheme emphasises the need to allocate increased effort to developing alternative management arrangements that overcome the deficiencies of the current input controls. This could include strengthening property rights through, say, the introduction of ITQs or the development of improved common property management regimes (e.g. Quiggin 1986).

To ensure that an efficiency maximising option is selected, it will be essential to fully evaluate the benefits and costs of the different options, including private benefits/costs to licence holders and public costs such as enforcement and management costs.

Even though the buy-back scheme did not enhance economic efficiency and returns to fishers to the levels potentially achievable, it did reduce the number of licence holders now operating in the fishery. This could be of benefit in itself because a reduced number of licence holders may increase the probability that alternative management regimes, such as ITQ systems, will be successful. Transaction costs (e.g. enforcement costs) associated with implementing these alternative policy options may be reduced.

Thus more generally, even if buy-back schemes are unlikely to improve economic efficiency, they may be useful for facilitating structural change in fisheries. The additional income accruing to licence holders remaining in the fishery as a result of the buy-back scheme could be used to fund the reduction in the number of licence holders. In this way, desired structural change could be achieved, with both licence holders who remain in the fishery and those who leave benefiting financially. In the longer run, the structural change may enable more efficient fishery management arrangements to be adopted, improving economic efficiency in the fishery.

The original justification for the Southern Zone rock lobster buy-back scheme was to improve economic efficiency. However, insufficient attention was allocated to collecting economic data in the evaluation phase of this project. Economic responses were received from only 30 fishers and there was little follow up on these data to verify their accuracy. Future evaluations of alternative management arrangements in fisheries should be conducted in such a way as to ensure that appropriate economic data and analysis is undertaken. If this is ignored, there is little chance of managing fisheries to maximise benefits to society.

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