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EX POST BENEFIT/COST ANALYSIS
PROJECT NO: 96/108

Fishery Independent Survey of the Breeding Stock and Migration of the Western Rock Lobster *(Panilurus cygnus)*

Prepared for the FRDC

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NON TECHNICAL SUMMARY

This report describes the results of an ex post benefit cost analysis of the FRDC funded project 'Fishery Independent Survey of the Breeding Stock and Migration of the Western Rock Lobster (*Panilurus cygnus*)' (Project No. 96/108). The project was carried out by the Research Division of Fisheries Western Australia.

The objectives of the project were:

- To use independent spawning stock survey techniques to validate spawning stock indices derived from commercial fisheries data and to examine specific impacts of the current management package over its full term. Specific impacts include trends in egg production and measurement of effective effort creep by comparison of fishery independent and fishery dependent spawning stock indices.
- To undertake pre-season tagging of juveniles in the shallow water of the limited entry fishery, to obtain more detailed information on the migration and growth of these lobsters to aid in the understanding of the effects of distributing catch more evenly throughout the season.
- To set in place a tagging strategy that will provide data capable of being utilised to model the tonnage of 'white' 76mm CL lobsters migrating between Zones B and C.

Egg production indices were calculated annually for each area separately and for all the areas combined, based on the number of mature females in the catch. Analysis of results showed significant increases in egg production since the introduction of the 1993/4 management package. The breeding stock was found to be above the target levels of the late 1970s and early 1980s (25% of virgin egg production), demonstrating the success of the 1993/4 management package.

Although results from the fishery independent breeding stock survey were comparable to the fishery dependent egg production index, the fishery dependent index was considered less reliable because of likely changes in fishing patterns as a result of the 1992/3 management package.

The tagging study confirmed previous research (FRDC 95/020) findings that the vast majority of recently moulted juveniles ('whites') do not undertake major movements and very few crossed zonal borders. Analysis of tagging data to establish a tagging strategy to model the tonnage of white 76 mm lobsters migrating between zones B and C had not been completed as tag recaptures were still coming in. It was anticipated that analysis would commence by the end of 2000.

The project under review built on earlier research carried out under a previous FRDC-funded project: the Fishery Independent Study of the Stock of the Western Rock Lobster (93/091). As the results of the current project cannot be effectively differentiated from those of its predecessor, the costs of both projects were included in the cost base for the benefit/cost analysis. Total research costs were $1.6 million of which FRDC contributed just under$1.2 million or 73% of the total research costs. In addition, following the completion of the FRDC-funded research, the annual survey was continued at an estimated cost of $240,000 per year (recovered from the fishing industry). Based on discussions with Fisheries WA and industry, from 2000/2001 the

survey will continue to be carried out annually at three sites at an estimated annual cost of $300,000.

Five potential benefits of the project were identified:
(1) increased certainty about the size of the breeding stock that would allow effort and catches to be higher than would otherwise be possible, at the same level of risk;
(2) increased catches if the maximum size rule could be relaxed or disbanded without threatening the breeding stock;
(3) increased average prices for lobster resulting from a premium paid by some markets in response to Marine Stewardship Council certification;
(4) increased value of the total catch by distributing catches more evenly throughout the season and by so doing achieving higher average prices and;
(5) improved management of the resource leading to a higher likelihood of a sustainable fishery.

The research was initiated following the introduction of the 1993/94 management package and assisted in monitoring the effects of that package on the breeding stock. As there have been no substantial changes to the management arrangements since 1993/4, any subsequent improvements in egg production have to be attributed to the management package rather than the results of the survey. However, from 2001/02 onwards when new management arrangements are being considered, there is opportunity for benefits to be realised from the research.

The value of increased certainty about the size of the breeding stock was estimated as the amount of revenue that would have been foregone under a more precautionary management regime. Managers, recognising the ongoing problem of "effort creep" in the fishery, would be likely to take a more precautionary approach towards the protection of the breeding stock by introducing more severe measures to reduce effort and catches than would otherwise be the case. Based on discussions with lobster assessment scientists, it was assumed that such measures would be introduced periodically, say every 5 years, starting in 2001/2. These measures would result in a 1% greater reduction in catch in that year than would otherwise be needed if there was greater certainty about the size of the breeding stock. This catch reduction represented a cost saving arising from the project and is equivalent to 105 tonnes, valued at $2.9 million, based on an average annual catch of 10,500 tonnes and an average price of $28/kg.

The research indicated that the maximum size rule had a relatively minor impact on overall egg production. Computer models of the lobster fishery developed by Fisheries WA have estimated that the catch could be increased by an estimated 290 tonnes if the maximum size rule were to be relaxed during years when catches are predicted to be lower than average. The analysis assumed that this rule is relaxed every 5 years when there is a downturn in catches. The additional 290 tonnes in catch, valued at $28/kg, represented a potential benefit of $8.1 million every five years.

In the foreseeable future, the industry does not anticipate any price premium arising from MSC certification; however, it does anticipate gaining access to more markets while maintaining existing markets, based on increased buyer confidence that supplies will be reliable and sustainable. However, such potential benefits are not quantifiable.

It seems unlikely that there will be tangible benefits realised as a result of the tagging, as there is limited support for changing minimum size rules. However, the research results have reassured some industry participants that the minimum size rules are not discriminating against them by benefiting fishers in adjacent zones.

Projected net benefits of the research investment were made until 2012/13, based on the assumption that there will be a major reassessment of management arrangements at that time (twenty years after the implementation of the 1993/94 management package). The results of the benefit cost analysis are shown in the table below.

Net present value and benefit cost ratios

Discount Rate	**6%**	**8%**	**10%**
NPV of net economic benefits	$7,801,710	$5,859,913	$4,416,094
Benefit/cost ratio[1]	11:1	9:1	7.6:1

[1]Discounted benefits divided by discounted costs

EX POST BENEFIT/COST ANALYSIS OF PROJECT No: 96/108

Fishery Independent Survey of the Breeding Stock and Migration of the Western Rock Lobster (*Panilurus cygnus*)

Agency: Fisheries Department of Western Australia, Research Division

1 Objectives

- To use independent spawning stock survey techniques to validate spawning stock indices derived from commercial fisheries data and to examine specific impacts of the current management package over its full term. Specific impacts include trends in egg production and measurement of effective effort creep by comparison of fishery independent and fishery dependent spawning stock indices.
- To undertake pre-season tagging of juveniles in the shallow water of the limited entry fishery, to obtain more detailed information on the migration and growth of these lobsters to aid in the understanding of the effects of distributing catch more evenly throughout the season.
- To set in place a tagging strategy that will provide data capable of being utilised to model the tonnage of 'white' 76mm carapace length (CL) lobsters migrating between Zones B and C.

2 Background

This project builds on the research carried out under a previous FRDC-funded project: the Fishery Independent Study of the Stock of the Western Rock Lobster (93/091).

FRDC Project 93/091 developed a fishery independent index of egg production calculated annually for six areas (Freemantle, Abrolhos Islands and Dongara, Jurien, Lancelin and Kalbarri). The original project was initiated because there was some concern about the egg production estimates using data obtained from the commercial fishery. In particular, the introduction of a new management package had resulted in changing fishing patterns which would have introduced new biases in the commercial data. The original project found that the fishery independent index produced a reliable index for egg production on a regional and whole fishery basis and the index produced similar trends to the fishery dependent index. The results also showed that

there had been a substantial improvement in egg production indices indicating that the management package was achieving its objectives. It was concluded that the project should continue for a longer period to obtain additional information and increase confidence in the indices as the survey only covered a relatively short time period (three years).

The project under review is the continuation of this survey. Coverage was extended for another two years. This was to allow for better evaluation of the type of longer term egg production index required; provide a direct means of assessing the two year (lagged) flow through of lobsters to the breeding stock over 1996/7 and 1997/8; evaluate the success of the new management package; and provide specific data on the regional movements and growth of the near legal size lobsters. In addition, because the 1993/4 management package had increased the value of catches by increasing the minimum size from 76 to 77mm carapace length (CL) in the first 2.5 months of the season (by enabling more reds to be taken than whites), there was a perceived need to explore the possibility of further variations to the legal minimum size at first capture.

During the course of the project two other needs arose which were addressed by carrying out slightly altered sampling programmes. Fishers in Freemantle and Geraldton were concerned about the fate of the 76mm CL lobsters returned to the sea under the new management regulations and there was a request by Zone C fishers (those operating south of latitude 30 degrees south) to quantify the tonnage of 76 mm CL lobsters moving across the border between zone B and C during their annual migration.

3 Research Findings

3.1 Fishery independent egg production index

Egg production indices were calculated annually for each area separately and for all the areas combined, based on the number of mature females in the catch. Five of these indices (Abrolhos Islands excluded) were combined to form a coastal egg production index. Analysis of results showed significant increases in egg production since the introduction of the 1993/4 management package. The breeding stock was

found to be above the target levels set at levels of the late 1970s and early 1980s (25% of virgin egg production).

Results from the fishery independent breeding stock survey were comparable to the fishery dependent egg production index in terms of trend, but differed in magnitude. Although both methods reached the same conclusion that egg production had increased over a short period of time, the fishery dependent index was considered less reliable because of likely changes in fishing patterns as a result of the 1993/94 management package. The independent index was considered to be a more reliable index because it had no commercial biases and had the specific objective of measuring changes in egg production. It could also be used to verify the fishery dependent index.

The management arrangements introduced in 1993/94 were aimed at increasing egg production and providing protection from fishing for mature female lobsters (the "setose" rule), a 1 mm increase in the legal minimum size from November 15 – January 31 (the "minimum size" rule) and a maximum size limit for females of 115mm for zone C and 105 mm for zones A and B (the "maximum size" rule). In assessing the impacts of these three rules on the breeding stock, the project found that, compared to the setose rule and the minimum size rule, the maximum size rule made a small contribution to the increase in overall egg production (5 – 10% over five years).

3.2 Lobster tagging

The tagging research was aimed at examining the movement of "white" lobsters (recently moulted juveniles) which migrate from inshore reefs to deeper reefs offshore where they mature and spawn a year or two later. Fishers in some parts of the fishery had argued that the minimum size rule was unfair because releasing migrating whites meant that these lobsters might move into adjacent zones and thus benefit other fishers. Lobsters were tagged in the area between Geraldton and Port Gregory where there had been no previous tagging data available. The tagging study confirmed previous research (FRDC 95/020) findings that the vast majority of whites do not undertake major movements and very few crossed zonal borders.

Analysis of tagging data to establish a tagging strategy to model the tonnage of white 76 mm lobsters migrating between zones B and C has not been completed as tag recaptures were still coming it. It is anticipated that analysis will commence at the end of 2000.

4 Benefit/Cost Analysis

There are two major components of net economic benefit in cost/benefit analysis - producer's surplus and consumer's surplus. Producer's surplus is a measure of net economic benefits created in the harvesting and processing sector from a specific research project. Although a simplified explanation, producer's surplus can be thought of as additional profits generated. In addition, if the research findings induce increases in production and employment, then to the extent that previously unemployed labour is employed, the associated wages would also be included as a benefit in producer's surplus.

Consumer's surplus is a measure of net economic benefits to consumers. For example, if a research project induces an increase in product supply that in turn results in a decrease in prices on the domestic market, then domestic consumers would be better off. Consumer surplus is simply a measure of this improvement in consumer well-being.

In simple terms, to undertake the benefit/cost analysis, it is necessary to estimate all economic benefits that flow from the research findings. Benefits are then compared to the financial cost of research, plus any economic costs that are required to capture the benefits.

4.1 Costs

As noted previously, the project under review builds on earlier research carried out under a previous FRDC-funded project: the Fishery Independent Study of the Stock of the Western Rock Lobster (93/091). As the results of the current project cannot be effectively differentiated from those of its predecessor, the costs of both projects are included in the cost base for the benefit/cost analysis, as shown in Table 1. FRDC contributed 73% of the total research costs.

Table 1 Costs of Research Investment

Project No.	FRDC	Other	Total
93/091	585,374	200,160	785,534
96/108	613,821	233,241	847,062
TOTAL	**1,199,195**	**433,401**	**1,632,596**

In addition, following the completion of the FRDC-funded research, the annual survey was continued at an estimated cost of $240,000 per year (recovered from the fishing industry). The analysis assumes, based on discussions with Fisheries WA and industry, that from 2000/2001 the survey will continue to be carried out annually at three sites at an estimated annual cost of $300,000.

4.2 Potential Benefits

There are five potential benefits arising from the results of the project:

(1) Increased certainty about the size of the breeding stock that would allow effort and catches to be higher than would otherwise be possible, at the same level of risk.

(2) An increase in catches if the maximum size rule could be relaxed or disbanded without threatening the breeding stock.

(3) Increased average prices for lobster resulting from a premium paid by some markets in response to Marine Stewardship Council certification.

(4) Increased total value of the catch by distributing catches more evenly throughout the season and by so doing achieving higher average prices.

(5) Improved management of the resource leading to a higher likelihood of a sustainable fishery.

Increased certainty about the size of the breeding stock

The rationale for maintaining egg production at 25% of virgin levels (i.e. egg production of the late 1970s and early 1980s) is based on research in other fisheries which has suggested that a decrease in egg production below 25% of the virgin level may lead to a recruitment collapse in the fishery. Although this research is based on finfish rather than crustacean fisheries, stakeholders in the WA lobster fishery have chosen to adopt this limit reference point.

Reliance on fishery dependent data alone, which are subject to commercial biases, would require a more precautionary approach to the management of the fishery as there would be less certainty about the veracity of egg production indices. The comparatively greater certainty about egg production estimates derived from the fishery independent survey, and hence the lower risk that the limit reference point has been breached, should allow the fishery to maintain a higher level of production than would otherwise be the case. This increment to production is a benefit of the research.

Relaxation or disbandment of the maximum size rule

As the research indicated that the maximum size rule for lobsters, while providing protection from fishing for a component of the breeding stock, had little overall impact on egg production, the rule could be lifted. This would allow increased production.

Increased lobster prices from Marine Stewardship Council certification

The contribution of the project to Marine Stewardship Council (MSC) certification of the Western Australian lobster fishery also has potential benefits. These may include a price premium for MSC-certified lobsters on some markets, greater access to existing markets and access to new markets demanding eco-friendly product.

Increase value of the catch by distributing catches more evenly throughout the season

The increase in the minimum legal size from 76 to 77mm for the first 2.5 months of each season when the "whites" migration is occurring was designed to increase the flow of animals to the breeding areas offshore and increase the value of the fishery because some of these animals would then be recaptured as higher valued "reds". This regulation is said to have limited impact in the southern sector, so an improved understanding of the migration of these lobsters from tagging data could yield benefits if this research showed that a change in minimum size regulations south of 30°S could increase the value of the fishery in this area.

Improved resource management

A less tangible benefit of the research may be its contribution to the long term sustainable management of the lobster resource. Increased certainty about the size of the breeding stock would lower the risk of the fisheries authority allowing excessive levels of effort and catch. The research may, therefore, contribute to the ongoing

sustainable management of the fishery, assisting the management authority to gain certification to this effect from the Marine Stewardship Council.

4.3 Realisation of benefits

The research was initiated following the introduction of the 1993/94 management package and assisted in monitoring the effects of that package on the breeding stock. As there have been no substantial changes to the management arrangements since 1993/4, any subsequent improvements in egg production have to be attributed to the management package rather than the results of the survey. However, from 2001/02 onwards when new management arrangements are being considered, there is opportunity for benefits to be realised from the research.

Increased certainty about the size of the breeding stock

In applying the precautionary approach to fisheries management, fisheries agencies should take into account the level of uncertainty about the size of the breeding stock in deciding how much fishing effort or catch to permit. The greater the uncertainty, the lower the permissible level of effort or catch.

The value of the reduction in uncertainty about the size of the breeding stock is estimated as the amount of revenue that would have been foregone under a more precautionary management regime. In the absence of the independent survey, the uncertainty associated with interpretation of the fishery dependent data would increase over time. This would mean that managers, recognising the ongoing problem of "effort creep" in the fishery, would be likely to take a more precautionary approach towards the protection of the breeding stock by introducing more severe measures to reduce effort and catches than would otherwise be the case. Based on discussions with lobster assessment scientists, it is assumed that such measures would be introduced periodically, say every 5 years, starting in 2001/2. These measures would result in a 1% greater reduction in catch in that year than would otherwise be needed if there was greater certainty about the size of the breeding stock. This catch reduction would be equivalent to 105 tonnes, valued at $2.9 million, based on an average annual catch of 10,500 tonnes and an average price of $28/kg.

Because the independent breeding stock survey gives fishery managers greater certainty about the size of the breeding stock and the associated egg production indices, this action would not have to be taken. Thus, $2.9 million represents a cost saving arising from the project.

Relaxation of the maximum size rule

The research indicated that the maximum size rule had a relatively minor impact on overall egg production. Computer models of the lobster fishery developed by Fisheries WA have estimated that the catch could be increased by an estimated 290 tonnes if the maximum size rule were to be relaxed during years when catches are predicted to be lower than average.

Relaxation of this rule in 2001/2 is currently under consideration and there appears to be a good chance that this will occur. Removing the regulation would result in accumulated stock being harvested mainly in the first season. In subsequent years, the restriction would probably be reinstated and relaxed periodically when there is a downturn in the catches, say every 5 years (based on trends in past catches). The additional 290 tonnes in catch, valued at $28/kg, represents a potential benefit of $8.1 million every five years.

Lobster price increases attributable to Marine Stewardship Council certification

Discussions with industry representatives (Brett McCallum, pers.comm.) indicate that the main focus of MSC certification was to provide a marketing edge for Western Australian lobster over its competitors, as well as access to new markets. In the foreseeable future, the industry does not anticipate any price premium arising from MSC certification; however, it does anticipate gaining access to more markets while maintaining existing markets, based on increased buyer confidence that supplies will be reliable and sustainable.

Increasing the value of the catch by distributing catches more evenly throughout the season

Analysis of the tagging data is ongoing, as tags continue to be returned. It seems unlikely that there will be tangible benefits realised as a result of the tagging, as there is limited support for changing minimum size rules. However, the research results

have reassured some industry participants that the minimum size rules are not discriminating against them by benefiting fishers in adjacent zones.

4.4 Net benefits

Table 2 shows the projected net benefits of the research investment. Projections are made until 2012/13, based on the assumption that there will be a major reassessment of management arrangements at that time (twenty years after the implementation of the 1993/94 management package).

Table 2 Net Benefits of Projects 93/091 and 96/108

	1993/4	1994/5	1995/6	1996/7	1997/8	1998/9	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13
Costs																				
FRDC 93/091	$204,425	$190,096	$190,853																	
FRDC 94/075				$300,844	$312,977	$0	$1,199,195													
Other	$66,720	$66,720	$66,720	$114,341	$118,900	$240,000	$240,000	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000
TOTAL COSTS	**$271,145**	**$256,816**	**$257,573**	**$415,185**	**$431,877**	**$240,000**	**$1,439,195**	**$300,000**	**$300,000**	**$300,000**	**$300,000**	**$300,000**	**$300,000**	**$300,000**	**$300,000**	**$300,000**	**$300,000**	**$300,000**	**$300,000**	**$300,000**
Benefits																				
Increase in catch from removal of max size rule	-	-	-	-	-	-	-	-	290	-	-	-	-	290	-	-	-	-	290	-
A. Value of increase	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$8,120,000**	**$0**	**$0**	**$0**	**$0**	**$8,120,000**	**$0**	**$0**	**$0**	**$0**	**$8,120,000**	**$0**
Catch reduction required	-	-	-	-	-	-	-	-	-	105	-	-	-	-	105	-	-	-	-	105
B. Value of avoiding catch reduction	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$2,940,000**	**$0**	**$0**	**$0**	**$0**	**$2,940,000**	**$0**	**$0**	**$0**	**$0**	**$2,940,000**
TOTAL BENEFITS (A+B)	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$8,120,000**	**$2,940,000**	**$0**	**$0**	**$0**	**$8,120,000**	**$2,940,000**	**$0**	**$0**	**$0**	**$8,120,000**	**$2,940,000**
NET BENEFITS	**-$271,145**	**-$256,816**	**-$257,573**	**-$415,185**	**-$431,877**	**-$240,000**	**-$1,439,195**	**-$300,000**	**$7,820,000**	**$2,640,000**	**-$300,000**	**-$300,000**	**-$300,000**	**$7,820,000**	**$2,640,000**	**-$300,000**	**-$300,000**	**-$300,000**	**$7,820,000**	**$2,640,000**

The discounted present values of the FRDC research investment and the estimated benefits are shown in Table 3, using three different discount rates. As can be seen, the periodic relaxation of the maximum size rule is the largest contribution to economic benefits. The net present value of economic benefits (after accounting for research costs) ranges from around $7.8 m using a discount rate of 6%, to $4.4 m at a discount rate of 10%. The associated benefit/cost ratios range from 11:1 to 7.6:1.

Table 3: Estimated net present values of research benefits

Discount Rate	**6%**	**8%**	**10%**
NPV of net economic benefits	$7,801,710	$5,859,913	$4,416,094
Benefit/cost ratio[1]	11:1	9:1	7.6:1

[1]Discounted benefits divided by discounted costs