Calculation of damages suffered as a result of catches exceeding legal limits in the South Coast and West Coast rock lobster resources in South Africa.

by

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Summary

OLRAC was contracted by the Department of Environmental Affairs and Tourism, Branch Marine and Coastal Management (MCM) to provide a basis for estimating the damage suffered by South Africa as a result of overcatches by Hout Bay Fishing Industries (Pty) Ltd of South Coast rock lobster and West Coast rock lobster stocks. The information about the size of these overcatches and the responsible party was supplied to OLRAC by MCM.

Damages suffered by South Africa due to overcatches in the South and West Coast rock lobster resources are calculated by two different methods, Method I and Method II.

Method I estimates damage as the amount of catch that the industry has to now forfeit in order to restore the resource to the size that it would otherwise be by the end of the 2004/2005 fishing season in the absence of these overcatches. It also includes the additional harvesting costs incurred by the fishing industry since the overcatches occurred until restoration of the resource in 2004/2005.

Method II considers what additional catches the industry could have taken if the present state of the resource is taken as a given, but the overcatches had not occurred. Method II involves no claim for additional harvesting costs. Method I may prove to be complicated as a basis for a claim since it involves a more complicated method of damage estimation (i.e. the harvest costs calculation) and also the claimant would appear to be both the government on behalf of South Africa, and the fishing industry. Method II is simpler in concept.

The overcatches admitted to by Hout Bay Fishing Industries (Pty) Ltd in the plea bargain in the South African court proceedings have been used for quantifying damages for South Coast rock lobster for the 1999/2000 and the 2000/2001 fishing seasons and for West Coast rock lobster for the 1999/2000 fishing season. The analysis of the damage due to these overcatches has been done using internationally accepted quantitative techniques (see this document and technical supporting documents).

Overcatches for other periods for South Coast rock lobster are based on the following:

1996/97 – 1998/99: Use of estimates in a scientific paper (Groeneveld, 2003)

1991/92 – 1995/96: Application of Groeneveld's (2003) method to available catch and catch rate data for that period

1987/88 – 1990/91: An annual overcatch rate equal to the average annual amount estimated above for 1991/92 to 1995/96.

Overcatches for periods other than 1999/2000 for West Coast rock lobster (i.e. 1987/88 – 1998/99) are based on the assumption that the amount admitted to for 1999/2000 was also overcaught annually between 1987/88 and 1998/99.

South Coast rock lobster

Damages are sensitive to the exact amount of the overcatches. For South Coast rock lobster, because of the numerical agreement between scientific overcatch estimates (see Groeneveld, 2003) and court records of overcatches for the years 1999/2000 and 2000/2001, we recommend using Scenario B overcatch estimates. These include values for 1996/97, 1997/98 and 1998/99. Damages under these conditions for South Coast rock lobster are, by time period when the overcatches occurred:

1996/97 – 2000/2001, Method I: **US$ 19 151 550-00**.

1996/97 – 2000/2001, Method II: **US$ 16 239 360-00**.

1991/92 – 1995/96, Method II for overcatches estimated using Groeneveld's (2003) scientific method for the period 1991/92 – 1995/96: **US$ 12 669 750-00**.

1987/88 – 1990/91, Method II assuming that overcatches by Hout Bay Fishing (Pty) Ltd between 1987 and 1990 were at the same annual level as the overcatch estimates for the period 1991/92 to 1995/96: **US$ 10 135 800-00**.

West Coast rock lobster

For West Coast rock lobster two different models are considered, viz. RC1 and RC2, and, consistent with contemporary scientific practice for this resource, we recommend averaging the damage results between RC1 and RC2. The Method I versus Method II estimates for West Coast rock lobster are very similar:

1999/2000 - Method I West Coast rock lobster: **US$ 9 705 500-00**

1999/2000 - Method II West Coast rock lobster: **US$ 9 780 750-00**.

1987/88 – 1998/99 – Method II, if overfishing at a level of 200 tons/year whole weight occurred, then the damage due to this, calculated via Method II (where the additional TAC's would be exactly equal to these amounts and taken at exactly the same time), and at an average present price of US$ 17-50 / kg whole weight amounts to **US$ 3 500 000-00 per year**, or **a total of US$ 42 000 000-00 for the 12 years** between 1987/88 and 1998/99.

The two summary tables which follow overleaf present the same information given above. The terms 'model based' and 'no model' in those tables refer to variants on the Method II damage calculations. In calculating what TACs could have been possible in the absence of historic overcatches, these additional TACs can be spread out evenly over a number of years, and then the 'model based' method is applicable. Alternatively, via the arguments underlying Method II, the additional TACs could simply have been at exactly the same time and in exactly the same amounts as the overcatches. Under these assumptions the damage calculation is simple and involves no model, hence 'no model'. Note that all the Method I damage calculations are model based.

For the South Coast rock lobster summary table, reference is made to Scenario A and Scenario B. Scenario A is an estimate of damages for the period 1996 – 2000 which are based only on the overcatches for 1999/2000 and 2000/2001 based on the Wynberg's Magistrates Court records, and therefore assume zero overcatches for the 1996/1997, 1997/1998 and 1998/1999 fishing seasons. Scenario B is an estimate of damages for the period 1996 – 2000 which are based on the overcatches for 1999/2000 and 2000/2001 based on the Wynberg's Magistrates Court records, and on overcatches for the 1996/1997, 1997/1998 and 1998/1999 fishing seasons based on the scientific paper by Groeneveld (2003). (see Table 2 of the main document)

For the West Coast rock lobster summary table, reference is made to RC1 and RC2. These are two different stock assessment models for the resource, which involve the same mathematical and statistical framework, but correspond to different possible views of resource biomass and productivity. Whereas Table 10 and 11 present separate damage estimates for these two models, the summary table averages the results across RC1 and RC2.

Summary Table 1.

<table>
<tr><th colspan="7">South Coast Rock Lobster Estimates at US$ 45 / kg tails</th></tr>
<tr><th colspan="3" rowspan="2"></th><th colspan="4">Damage Estimate</th></tr>
<tr><th colspan="2">Method I</th><th colspan="2">Method II</th></tr>
<tr><th>Fishing Season</th><th>Overcatch</th><th>Basis of overcatch</th><th>Metric tons tail weight</th><th>US$</th><th>Metric tons tail weight</th><th>US$</th></tr>
<tr><td>1987/1988</td><td>Not itemised</td><td rowspan="4">80% of 281.55 assumed based on 1991 – 1995 estimates below.</td><td rowspan="4">Not calculated</td><td rowspan="4">Not calculated</td><td rowspan="4">0.8*281.55 = 225.24
(no model)</td><td rowspan="4">10 135 800</td></tr>
<tr><td>1988/1989</td><td>Not itemised</td></tr>
<tr><td>1989/1990</td><td>Not itemised</td></tr>
<tr><td>1990/1991</td><td>Not itemised</td></tr>
<tr><td>1991/1992</td><td>47.54</td><td rowspan="5">Application of the Groeneveld (2003) method to catch and CPUE records</td><td rowspan="5">Not calculated</td><td rowspan="5">Not calculated</td><td rowspan="5">281.55
(no model)</td><td rowspan="5">12 669 750</td></tr>
<tr><td>1992/1993</td><td>52.96</td></tr>
<tr><td>1993/1994</td><td>47.27</td></tr>
<tr><td>1994/1995</td><td>55.89</td></tr>
<tr><td>1995/1996</td><td>77.89</td></tr>
<tr><td>1996/1997</td><td>27.7</td><td>Groeneveld (2003)</td><td rowspan="5">425.59 (Scenario B)</td><td rowspan="5">19 151 550</td><td rowspan="5">338.32
(model based)</td><td rowspan="5">16 239 360</td></tr>
<tr><td>1997/1998</td><td>14.3</td><td>Groeneveld (2003)</td></tr>
<tr><td>1998/1999</td><td>114.0</td><td>Groeneveld (2003)</td></tr>
<tr><td>1999/2000</td><td>135.16</td><td>Wynberg M’s Court</td></tr>
<tr><td>2000/2001</td><td>58.4</td><td>Wynberg M’s Court</td></tr>
<tr><td>1999/2000</td><td>135.16</td><td>Wynberg M’s Court</td><td rowspan="2">235.08 (Scenario A)</td><td rowspan="2">10 578 500</td><td rowspan="2">194.4
(model based)</td><td rowspan="2">9 331 200</td></tr>
<tr><td>2000/2001</td><td>58.4</td><td>Wynberg M’s Court</td></tr>
</table>

Summary Table 2.

West Coast Rock Lobster Estimates at US$ 17-50 / kg whole weight (RC1 and RC2 results averaged)						
			Damage Estimate			
			Method I		Method II	
Fishing Season	**Overcatch**	**Basis of overcatch**	**Metric tons whole weight**	**US$**	**Metric tons whole weight**	**US$**
1987/1988	200	As advised	Not calculated	Not calculated	200 (no model)	**3 500 000**
1988/1989	200	As advised			200 (no model)	**3 500 000**
1989/1990	200	As advised			200 (no model)	**3 500 000**
1990/1991	200	As advised			200 (no model)	**3 500 000**
1991/1992	200	As advised			200 (no model)	**3 500 000**
1992/1993	200	As advised			200 (no model)	**3 500 000**
1993/1994	200	As advised			200 (no model)	**3 500 000**
1994/1995	200	As advised			200 (no model)	**3 500 000**
1995/1996	200	As advised			200 (no model)	**3 500 000**
1996/1997	200	As advised			200 (no model)	**3 500 000**
1997/1998	200	As advised			200 (no model)	**3 500 000**
1998/1999	200	As advised			200 (no model)	**3 500 000**
1999/2000	598	Wynberg M's Court	554.6	**9 705 500**	558.9 (model based)	**9 780 750**

1. Introduction

OLRAC was contracted by the Department of Environmental Affairs and Tourism, Branch Marine and Coastal Management (MCM) to provide a basis for estimating the damage suffered by South Africa as a result of overcatches by Hout Bay Fishing Industries (Pty) Ltd of South Coast rock lobster and West Coast rock lobster stocks. The information about the size of these overcatches and the responsible party was supplied to OLRAC by MCM.

The damage that South Africa has suffered due to catches exceeding legal limits in the South Coast and West Coast rock lobster resources is that this has depleted the stocks of these resource more than was intended by fisheries management authorities. Estimates of the size of historic overcatches between the period 1987 and 2001 are based on documents obtained through legal action and court process and scientific studies. These estimates are the basis of estimates of the monetary value of the damage suffered. The underlying principles that are applicable are discussed below. Damage estimates require the deployment of mathematical models of the population dynamics of the resources in question.

The South Coast and West Coast rock lobster resources in South Africa actually refer to two entirely different resources consisting of two different species, ***Palinurus gilchristi*** and ***Jasus lallandi*** respectively. Fishing techniques differ. In the South Coast rock lobster resource fishing is conducted in relatively deep waters using a capital intensive technique involving long lines of plastic traps strung together. West Coast rock lobsters are caught less capital intensively in shallower waters using individually deployed metal framed traps and hoopnets.

2. Principle applicable to both the South and West Coast rock lobster resources

Superficially it seems that the claim that should be made is for the monetary equivalent of the overcatches that were taken from the resource [By overcatches is meant catches in excess of the legally permitted amount. The acronym TAC refers to Total Allowable Catch, a quantum of lobsters measured in terms of mass that is allocated to the industry at the beginning of the fishing season]. When viewed from the point of view of the South African government, the approach of estimating damages from the value of the overcatch leads to the question:

“What damage has been suffered?”

It is not possible to sustain the argument that the SA government has suffered a damage equal to the value of overcatches, since the government is not in the business of fishing, and in fact the government would only be able to claim damage equivalent to lost resource rentals and other taxes, not to suggest that these are not substantial. A reasonable response to a question about what damage the government and the nation has suffered is to point out that the resource has been left in a worse state than it would otherwise be in, had the overcatches not been taken. This conclusion leads to the next question:

“What is the monetary value of the damage that South Africa has suffered as a result of the resource being left in a worse state?”

One way to put a monetary value to this damage is, similar to any other damage calculation, to estimate the cost to restore the resource to the state that it would otherwise be in had the overcatches not been taken. Note that a distinction is being drawn between the question of restoring the resource to its former state, and the state it would now be in without the occurrence of past overcatches. This question can be analysed and quantitative answers can be produced, and this method of estimating the damage is referred to as Method I. This method also includes an estimate of the monetary damage caused by the additional harvesting costs incurred by the industry due to catch rates and resource biomass being worse of than was intended by the fisheries management authorities.

This method of estimating the monetary value of the damage suffered by South Africa should not be taken to imply that the government actually undertakes to restore the resource to the level defined above, it just provides a basis for estimating the scale of the damage.

An alternative line of argument follows from the point of view of other users of the resource, the fishing industry. This argument starts with the assumption that the resource has been allowed to get into its present state under the management regime that has been followed since overcatches occurred, and that therefore the present level of depletion of the resource biomass is acceptable to the fisheries management authorities. In this case, the damage suffered by the industry is that they could have been allocated much larger historic TAC had these overcatches not occurred. This method of estimating the monetary value of the damage suffered by the industry is referred to as Method II.

3. Method I – Consideration of the cost of restoring the resource to the biomass it would have reached in the absence of historic overcatches.

3.1. Background concepts

If someone steals money from your non-interest bearing account, then you should feel fully compensated if the money is returned in full. This is because the amount that was stolen is what is required to restore your account to its former state.

However, if money is stolen from your interest bearing account, then the amount that you would feel adequately compensated by, or stated equivalently, the amount that would be required to restore your account to the state it would now be in had the theft not occur, is always larger than the amount originally stolen. Furthermore, the time between the theft and the compensation would affect the amount that you would feel entitled to seek as compensation and/or which would be required to restore the account.

There are some similarities between the monetary example given above and a living natural resource like a fish stock. The similarity arises when one views the population biomass as money in the account, and a catch as an amount drawn from the account. As in the financial example, if catches are stolen from a living natural resource, then the tonnage which you should feel compensated by, i.e. restores the resource biomass to what it would otherwise have been had the theft not occurred, would depend on the time between the theft and the date of compensation. This is because something analogous to an interest rate in a bank account is in operation in the workings of a living renewable resource. However, whether the amount sought in compensation is larger or smaller than the amount stolen is not settled, since the analogue of the interest rate which operates in fish stocks is not a constant amount, but depends on the size of the population biomass, and could in fact be a negative value. (Of course it is appreciated that one will not be compensated in terms of tons of lobster or fish, but rather in terms of the monetary equivalent of this amount.)

An equivalent statement is that whereas money stolen from an interest bearing account would always have generated positive interest had it been left in the account, overcatches stolen from the sea may have generated either a positive or a negative interest had they been left in the sea. The estimation of this interest requires the application of the same population models that are routinely used in the assessment and management of the fish resource.

Whereas in the financial example, compensation can be achieved by returning stolen money into a bank account, it is not possible to return fish or lobsters to the wild stock. However, another option to restore the size of your bank balance is to reduce your drawings to allow the account to grow via interest, before resuming drawings at a level equal to before. Similarly, it is possible to reduce catches in a fishery to allow the stock to grow back to a level where it would have been without the overcatches. This will require the industry to forfeit a certain amount of catch for a period of time. The value of this forfeited catch is therefore the compensation for the damage.

A further consideration not applicable to the financial world is that there is a cost associated with harvesting a renewable resource. This cost is affected by the size of the population, since the larger the population, the larger the amount of fish caught per unit of fishing effort expended. Proper compensation would therefore involve the additional catching costs resulting from the overcatches causing the population biomass to be smaller than it would otherwise have been. Note that the longer the time that passes before compensation is paid, the longer that this additional harvesting cost is incurred, and the larger the contribution of additional harvesting costs to the total compensation due.

3.2. Note about the imprecision of estimates of the amount of fish in the sea

A further difference between fish stocks and the analogy of money in the bank is that there is considerable uncertainty about the amount of fish in the sea, for a given species. Normally one can determine the size of a bank account to the last cent. This is not true of fish or lobsters in the sea. This uncertainty about living renewable resources and their population size might be used to opportunistically try to discredit estimates of the size of compensation which is appropriate for a living natural resource, in the event of overcatches. This is a flawed argument. The amount of catch that should be forfeited to restore the resource biomass depends on the interest it would have generated in the sea (cf. money in the bank), the amount of the historic overcatch, and the time between the theft and the date of compensation. The calculation of the interest that the stolen catch would have generated in the sea is not subject to all the uncertainty about the size of the population biomass, but rather it depends on certain biological quantities that are known to a reasonable degree of precision. It is not subject, for example, to the entire uncertainty about the precise absolute tonnage of living biomass in the sea.

To illustrate this, note that if somebody steals money from your bank account, whether this is an interest bearing account or not, one does not need to know the total amount of money in the account to be able to work out how much money should be paid back to you after a specified period of time to compensate for the theft. One just needs to know how much was stolen and, if relevant, the interest rate pertinent to the bank account. Although it is not exactly the same for a living renewable resource, it is approximately equivalent.

This document therefore contains the following specific estimates for Method I:

Ia: The reduction in catches that the industry would have to suffer in the 2004/2005 fishing season in order to restore the resource to the state that it would have been in without historic overcatches. This amount of lobsters is equivalent to the damage suffered by South Africa.

IIa: Cumulative extra catching costs incurred by the industry from the time of overcatches, until the resource has been restored by the end of the 2004/2005 fishing season. These extra catching costs are expressed in terms of metric tons of lobster (tail weight in the case of South Coast rock lobster and whole weight in the case of West Coast rock lobster).

IIIa: The present monetary value of the catch amounts defined in Ia and IIa.

4. Method II – Consideration of the commercial TACs which would have been possible had certain specific historic overcatches not have been made.

This document contains the following specific estimates for Method II:

Ib: The additional cumulative catches that the South African South and West Coast rock lobster industries could have taken between 1996 and 2003 (South Coast), or 1999 and 2003 (West Coast) had certain specified overcatches not occurred during those time periods.

IIb: The present monetary value of the additional legal TAC amounts calculated in Ib which were not actually taken legally because of the occurrence of overcatches.

5. Historic overcatches – South Coast rock lobster

There are three separate estimates of historic overcatches. The first are the amounts recorded in papers before the Wynberg Magistrates Court and admitted to by Hout Bay Fishing Industries (Pty) Ltd in a plea bargain and are based on forensic investigations and documents seized, work carried out by the South African government. The estimates pertain to the 1999/2000 and 2000/2001 fishing seasons. [A particular convention is used to refer to time periods. 1999/2000 refers to the fishing season starting 1 November 1999 and ending 30 September 2000]. The second are a further set of estimates for the 1996/97, 1997/98 and 1998/99 fishing seasons and are reported in a scientific publication (Groeneveld, 2003). These estimates are based on discrepancies between the daily catches per vessel reported for vessels involved in overcatches, and daily catches per vessel for other vessels harvesting South Coast rock lobster. Groeneveld (2003) actually presents two versions of these estimates (a) and (b) and both of these also produce estimates for the 1999/2000 and 2000/2001 fishing seasons. However, version (a) estimates are best matched with the Wynberg Magistrates Court values for the 1999/2000 and 2000/2001 fishing seasons, and so the version (a) results are presented here for the 1996/97, 1997/98 and 1998/99 fishing seasons, since the method underlying the (b) estimates would therefore appear to be unreliable.

Table 1 gives the estimates just discussed for the entire period 1996/97 to 2000/2001. However, we consider that there are actually two scenarios for the overcatches, as shown in Table 2. Scenario B includes both sets of estimates (i.e. Groeneveld, 2003 and Wynberg Magistrates Court), while Scenario A excludes Groeneveld's (2003) estimates for 1996/97, 1997/98 and 1998/99. Scenario A is therefore the most conservative set of overcatches, while Scenario B is probably the most plausible set of overcatches.

We note further that the method applied in Groeneveld's (2003) paper has been extended by the by MCM to make estimates of overcatches for the years 1991/92 – 1995/96. These are the third set of estimates referred to. The estimates are as follows, in tons of tail weight:

Table of additional overcatches in earlier years resulting from the estimation method reported in Groeneveld but not reported in that paper (note – the Rock Lobster Working Group has recently agreed to include these overcatches into the reference case stock assessment model for the South Coast rock lobster resource):

Fishing Season	Estimated overcatch tons tail weight
1991/92	47.54
1992/93	52.96
1993/94	47.27
1994/95	55.89
1995/96	77.89
TOTAL	281.55

These overcatches were not included in the more detailed analyses reported here. However, the damages due to this are amenable to estimation using Method II, since the damage in tons tail weight will be exactly equal to the overcatch, if the additional TAC's that could have been taken were taken in exactly the same years and by exactly the same amounts as the actual overcatches. At a present average price of US$ 45/kg tails the damage component due to these amounts is given as follows:

Additional damage calculated via Method II for overcatches estimated using Groeneveld's (2003) scientific method for the period 1991/92 – 1995/96 = US$ 12 669 750.

We note that had overcatches between 1987 and 1990 been at the same level as the overcatch estimates for the period 1991/92 to 1995/96, then 80% of the 281.55 tons tail weight would have been overcaught between 1987 and 1990, or an additional amount of 225.24 tons tail weight, with an associated monetary value given as follows:

Additional damage calculated via Method II for overcatches between 1987/88 and 1990/91 (4 years) if the cumulative overcatch for this period is 80% of the cumulative overcatch suggested by applying Groeneveld's (2003) scientific method to the period 1991/92 – 1995/96 (5 years) = US$ 10 135 800.

6. Historic overcatches – West Coast rock lobster

A single source of historic overcatches has been used. This is the amount of 598 metric tons whole weight for the 1999/2000 fishing seasons recorded in papers before the Wynberg Magistrates Court (the plea bargain) and are based on forensic investigations and documents seized, work carried out by the South African government. [A particular convention is used to refer to time periods. 1999/2000 refers to the fishing season starting 1 November 1999 and ending at various times in different fishing zones during the year 2000]. It is important to note the distinction in the method of reporting the catches, being in terms of metric tons of tail weight (weight of the tail only) for the South Coast rock lobster resource, and in terms of metric tons whole weight (weight of the whole body) for the West Coast rock lobster resource. This is a convention that has been adopted for many years in the management of these two fisheries.

If overfishing at a level of 200 tons/year whole weight occurred throughout the period from 1987/88 to 1998/99, then the cumulative overcatch for the period 1987/88 – 1998/99 would be 2400 tons whole weight, and at an average price of US$ 17-50 / kg whole weight the damage due to this overcatch calculated via Method II (where the additional TAC's would be exactly equal to these amounts) would be US$ 42 000 000 (composed of 12 separate annual amounts of US$ 3 500 000-00).

7. General points about the quantitative methods used

1. The mathematical models used are the same as those that are used to formulate scientific advice on the management of these resources by the responsible scientific committee. The committee referred to is the Rock Lobster Working Group (RLWG) which is convened by the MCM. This body makes scientific recommendations on resource management to the Director of Research of the MCM.
2. The authors of this work have worked very closely with other researchers who attend RLWG meetings including government employed scientists. The computer code underlying the model has been subjected to a number of cross checks including (1) the independent development of the computer code for the relevant stock assessment mathematical model using three different software programmes, and (2) the numerical results have been compared to those produced by other researchers and found to agree.
3. All the biological information about the resources in question necessary for the construction of the computer models has been considered and debated at RLWG level and has been accepted and agreed to by that body.
4. All data on the fishery used in the computer models has been accepted and vetted by the RLWG.
5. Note that the overcatch scenarios A and B for the South Coast rock lobster resource give rise to two different sets of results, A and B.

6. Although in scientific deliberations a number of different versions of the model for the South Coast rock lobster are typically considered, we have used the reference case model which is uncontroversial and which normally forms the basis for the final scientific recommendations.
7. In the case of the West Coast rock lobster resource, there are two plausible models that were used to formulate the scientific management result for the resource, termed RC1 and RC2. We therefore obtain results based on these two models and hence there are two sets of output, labeled RC1 and RC2.

8. Economic information relevant to damage estimates

The general approach adopted throughout this document has been to use the mathematical models to estimate damages in terms of metric tons tail weight in the case of South Coast rock lobster and in terms of metric tons whole weight in the case of West Coast rock lobster. The presently applicable prices are used to calculate the monetary equivalents of these tonnages.

Lobsters are marketed in a variety of products and these attract different prices:

1. Live
2. Frozen tails
3. Whole raw frozen
4. Whole cooked and frozen

At present about 80% of South Coast rock lobster catches are shipped in the frozen tails product form, while the bulk (about 75%) of West Coast rock lobster catches are shipped in the live product form. We have therefore taken the average price for South Coast rock lobster tails of US$ 45/kg tail weight to represent a reasonable average price for product from that fishery. For West Coast rock lobster about 75% of the catch is marketed live at an average present price of US$ 19/kg whole weight, and the remainder is marketed at a reduced price of about US$ 13/kg whole weight. For West Coast rock lobster we have therefore used an average present price of US$ 17-50/kg whole weight to be representative of the final prices fetched for catches of this species.

The prices mentioned above are being reported at a time that prices are markedly depressed, by as much as 30% in dollar terms, due to fluctuations in the market and hence the prices are presently in a trough.

9. Method of calculating catches that need to be forfeited

In the underlying mathematical models, a version is first run which includes all historical overcatches. The model is fitted under these conditions – we refer to this as Actual. This version is then modified by only removing the historic catches, but the model is not refitted. This model is referred to as Hypothetical. Running the Hypothetical model to the beginning of the 2005/2006 fishing season shows what the resource biomass could have been in the absence of overcatches.

The catch in the Actual model for the 2004/2005 fishing season is then reduced below the value assumed for the catch for 2004/2005 in the Hypothetical model, until the resource biomass at the beginning of 2005/2006 is equal to the value in the Hypothetical model. The difference in catches in the 2004/2005 season between the Actual and the Hypothetical models is the amount that has to be forfeited. Note that the results from this method do not depend on the value of the TAC assumed for the 2004/2005 fishing season in the Hypothetical model, although we use a value of 350 tons.

10. Method of calculating catches that could have been taken but were not

In the underlying mathematical models, a version is first run which includes all historical overcatches. The model is fitted under these conditions – we refer to this as Actual. If the resource condition is regarded as acceptable, then the Actual model shows what an acceptable resource biomass is at the beginning of 2005/2006. The actual model is then modified by only removing the historic catches, but the model is not refitted. This model is referred to as Hypothetical. We now add catches to the Hypothetical model, an equal amount for each year between and including 1996/97 – 2003/2004 for South Coast and 1999/2000 – 2003/2004 for West Coast rock lobster, until the resource biomass at the beginning of 2005/2006 is the same as in the Actual model. These catches, cumulatively, represent the additional TAC that could have been taken, in the absence of overcatches. Note that the results from this method do not depend on the value of the TAC assumed for the 2004/2005 fishing season, although we use a value of 350 tons.

11. Method of calculating harvesting costs

Method I of calculating the damages requires one to estimate the additional harvesting costs due to overcatching. This pre-supposes the existence of a means to estimate harvesting costs, in particular the proportion of the costs that will increase when the commercial catch rate (i.e. kg lobsters caught per trap), also often referred to as the CPUE, decreases. There is the option of employing either a bottom-up approach to carrying out these estimates by itemizing all components of cost, or alternatively a top-down approach in which a rough estimate of the proportion of the value of a lobster which comprises the harvesting costs in a given reference year is made. The latter is the approach that has been adopted here. The mathematical model is used to extrapolate from the reference year to other years with different total catches and different commercial catch rates. This approach draws on standard concept in bioeconomics, which combines the biological concepts of fish resources and fundamental concept about the costs of fishing and its relationship to the catch rate in a fishery. These concepts are discussed in the work of Clark (1985), to name one example.

Table 3 shows results for the South Coast rock lobster resource relevant to the estimation of the additional harvesting costs. This table uses a reference year of 1995 in which 40% of the value of a lobster was due to the variable harvesting costs which are sensitive to fluctuations in the commercial catch rate. The second and third columns of Table 3 show the percentage increase per annum in the harvesting costs due to the overcatch (i.e. the resource biomass and hence catch rates were lower than they would have been in the absence of overcatches). The percentages are also shown in Fig. 1. The fourth column of Table 3 gives the total legal catch allowed for each fishing season. The fifth column gives the quota amount out of the TAC which was allocated to the company, referred to here as Company A, involved in overcatch activities. The final column is the balance of the TAC available to the remainder of the industry. Table 4 follows logically from Table 3, in which the second, third and fourth columns are repeats from Table 3. However, the final three columns of Table 4 show the harvesting costs measure in tons of lobsters, for i) the no overcatch harvesting costs, ii) the scenario B overcatch harvesting costs where in 2004/2005 the industry forfeits catches to arrive at the same situation as in the fifth column and iii) scenario A overcatch harvesting costs. Table 5 shows the additional harvesting costs for relevant fishing seasons. Table 3-5 are all based on the assumption that the harvesting costs comprise 40% of the catch in 1995. Table 6 presents the total cumulative additional harvesting costs in tons of lobsters associated with assuming that in 1995 harvesting costs could have been anything between 20% and 60% of the value of a lobster caught and exported. We refer to these as the 20% results, or the 40% results, whichever percentage is being assumed in 1995.

Further investigations were carried out to ascertain which percentage was applicable at the time of writing. Figures obtained suggested considerable sensitivity of cost/kg in the South Coast rock lobster fishery excluding interest and tax. The following estimates were obtained:

Table of total harvesting costs in ZAR (South African rands) for South Coast rock lobster expressed per kg tails of lobster, showing how this amount varies in response to difference commercial catch rates (typically abbreviated by the acronym CPUE, meaning Catch Per Unit of Effort).

CPUE kg tails /seaday	Cost/ tails kg (ZAR)
175	282.8
190	263.6
200	252.3
215	237.4
240	216.8

These indicate a surprising level of sensitivity of costs to the catch rate. They imply that the relationship between CPUE kg/seaday and Cost/kg is as follows:

Cost/kg = 42670.5/(CPUE kg/seaday)+38.97

The present price for South Coast rock lobster tails is ZAR 281-00/kg. At a catch rate of 240 kg tails / seaday (typical for the 2003/2004 fishing season, and the source of the data),

Cost/kg = 177.79+38.97 = ZAR 216.76.

The amount ZAR 177.79 is the component of the cost which is sensitive to the catch rate (i.e. the component of the cost which is inversely related to CPUE measured as kg tails / seaday), and this is in the order of 63.3% of the value of a South Coast rock lobster on the export market (i.e. ZAR 281/kg tails).

If one assumes that prices in ZAR have not changed since 1995, and that other aspects of the price model have remain unchanged, then one can work out the equivalent percentage for the reference year of 1995, using the mathematical model to link the present time to 1995. This percentage is approximately 55%.

Similar results were calculated for the West Coast rock lobster resource, but here it is assumed that in 1999 the variable component of the cost of catching a lobster (i.e. that component that is inversely related to the commercial catch rate) is between 10% and 40% of the total export value of a lobster. These results are presented in Table 9. Note that the increases in the harvesting cost as shown in Fig. 2 as a percentage in each fishing season, is much smaller than for the South Coast rock lobster resource (see Fig. 1) consistent with the fact that the South Coast rock lobster fishery is far more capital intensive than the West Coast rock lobster fishery. A percentage of 20% in the reference year 1999 has been used as a basis for computing harvest costs.

12. Results for South Coast Rock Lobster

Table 7 shows the 55% results (55% refers to the percentage of the value of a lobster in 1995 which is due to harvesting costs inversely related to catch rate) of damage estimates for the South Coast rock lobster resource using Method I. Table 8 gives the results of damage estimates for South Coast rock lobster when an equal additional catch is taken between years 1996/97 and 2003/2004, and the cumulative additional catch over all 8 years is computed, i.e. Method II described earlier.

13. Results for West Coast Rock Lobster

Table 10 shows the 20% results of damage estimates for the West Coast rock lobster resource using Method I. Table 11 gives the results of damage estimates for West Coast rock lobster when an equal additional catch is taken between years 1999/2000 and 2003/2004, and the cumulative additional catch over all 8 years is computed, i.e. Method II described earlier.

14. Recommendations

14.1. South Coast rock lobster financial calculations

Damages are sensitive to the exact amount of the overcatches. For South Coast rock lobster, because of the concordance between scientific overcatch estimates and court records of overcatches for the years 1999/2000 and 2000/2001, we recommend using Scenario B overcatch estimates, These include values for 1996/97, 1997/98 and 1998/99. Damages under these conditions for South Coast rock lobster are, by time period when the overcatches occurred:

1996/97 – 2000/2001, Method I: **US$ 19 151 550 (see Table 7)**.

1996/97 – 2000/2001, Method II: **US$ 16 239 360-00 (see Table 8)** .

1991/92 – 1995/96, Method II for overcatches estimated using Groeneveld's (2003) scientific method for the period 1991/92 – 1995/96: **US$ 12 669 750-00**.

1987/88 – 1990/91, Method II assuming that overcatches by Hout Bay Fishing (Pty) Ltd between 1987 and 1990 were at the same annual level as the overcatch estimates for the period 1991/92 to 1995/96: **US$ 10 135 800-00**.

14.2. West Coast rock lobster financial calculations

For West Coast rock lobster two different models are considered, viz. RC1 and RC2, and, consistent with contemporary scientific practice for this resource, we recommend averaging the damage results between RC1 and RC2. After averaging, the Method I versus Method II estimates for West Coast rock lobster are very similar:

1999/2000 - Method I West Coast rock lobster: **US$ 9 705 500-00 (see Table 10).**

1999/2000 - Method II West Coast rock lobster: **US$ 9 780 750-00 (see Table 11)**.

1987/88 – 1998/99 – Method II, if overfishing at a level of 200 tons/year whole weight occurred, then the damage due to this, calculated via Method II (where the additional TAC's would be exactly equal to these amounts and taken at exactly the same time), and at an average present price of US$ 17-50 / kg whole weight amounts to **US$ 3 500 000-00 per year**, or **a total of US$ 42 000 000-00 for the 12 years** between 1987/88 and 1998/99.

Method I may prove to be complicated as a basis for a claim since it involves a more complicated method of damage estimation (i.e. the harvest costs calculation). Method II is simpler in concept.

15. References

Clark, C.W. 1985. ***Bioeconomic modeling and fisheries management***. New York: John Wiley.

Groeneveld, J.C. 2003. Under-reporting of catches of South Coast rock lobster Palinurus gilchristi, with implications for the assessment and management of the fishery. ***African Journal of Marine Science.*** 25: 407 – 411.

Charge sheet in the regional division of the Cape held in the regional court Wynberg. The state versus Hout Bay Fishing Industries (Pty) Ltd and Collin Ernst Hendrik van Schalkwyk.

16. Additional technical points about mathematical models: South Coast rock lobster.

1. The mathematical model is an age structured production model (ASPM)
2. Standard priors are used for h, the steepness of the stock recruitment relationship, M the natural mortality and the ages at which 50% and 95% selectivity occurs.
3. The CPUE data has been GLM-standardised, excluding Company A's data since 1996.
4. A Beverton-Holt stock-recruitment relationship is used.
5. Stock recruitment residuals are fitted for certain years.
6. The model is fitted to catch-at-age data and to the CPUE indices.
7. The model is described in further detail by Johnston and Butterworth (2002a,b).
8. The catch-at-age data is derived by cohort slicing of catch size structure data based on growth rate information derived from mark-recapture data.
9. Separate documentation is attached which gives further technical information on the details of the mathematical model, as follows:

"**Description of basic stock assessment model Doc I.doc":** This is a technical document submitted to the rock lobster working group in 2002 and outlines the basic age structured stock assessment methodology that has been employed for the South Coast rock lobster resource. However the data are incomplete since the data used in this document is up to date as of the middle of 2004 and is the dataset that will be used in determining the TAC for the fishery for the 2004/2005 fishing season. Crucially, the catches that have been agreed to for the reference case by the South Coast rock lobster working group have changed since the production of this document, since these now include certain additional overcatches dating back to the 1991/92 fishing season.

"Preliminary proposed base case specifications for 2004 2005 TAC deliberations Doc II.doc": This document clarifies further details of the reference case analysis to be run for the 2004/2005 TAC deliberations, with the exception that the historic catches to be used were revised during the meeting at which this document was discussed, and are superceded by a further document attached hereto (see below).

"GLM standardised CPUE data used in the SCRL model Doc III.doc": This document contains the GLM (Generalised Linear Model) standardized CPUE data for use in the reference case analysis to be run for the 2004/2005 TAC deliberations.

"Catch at age proportions used in 2004 SCRL stock assessments Doc IV.xls": This document lists the catch-at-age proportion data for use in the reference case analysis to be run for the 2004/2005 TAC deliberations.

"Catch data including overcatch for use in the reference case assessments for 2004 for SCRL.xls": This document lists the historic catch data for use in the reference case analysis to be run for the 2004/2005 TAC deliberations (as agreed by the Rock Lobster Working Group), and highlights which component of these catches are overcatches.

10. In the case of Method I, the assumption is that the resource will be restored by forfeiting legal catches in the 2004/2005 fishing season, to provide a basis for estimating the cost of restoring the resource, and hence of the damage that has been suffered.
11. In the case of Method II, the assumption is that additional legal TAC amounts are equally distributed amongst fishing seasons 1996/97 to 2003/2004 (8 fishing seasons in total).

17. Additional technical points about mathematical models: West Coast rock lobster.

1. The mathematical model is a size structured model.
2. We use two separate and alternative mathematical models of the West Coast rock lobster resource which were the basis for an Operational Management Procedure for the determination of the TAC in the 2003/2004 and 2004/2005 fishing seasons. This OMP has been accepted by the scientific committee responsible for formulating scientific management advice for the resource in the the Rock Lobster Working Group (RLWG) convened by the Marine and Coastal Management Branch (MCM) of the Department of Environmental Affairs and Tourism, South Africa, and then for subsequent submission to the Director of the MCM. The underlying operating models corresponding to the two alternative models referred to (RC1 and RC2 respectively) therefore span the best available range of views on the status and productivity of the resource.
3. We note that in contrast to South Coast rock lobster, the models underlying estimates for the West Coast rock lobster resource are size structure models of population dynamics. A much more extensive set of data underlies the West Coast rock lobster assessment model than for South Coast rock lobster, although this does not necessary reflect the relative precision of estimates derived from these two model types.
4. All CPUE data has been GLM-standardised.
5. The model is fitted to CPUE data, catch-at-size data, catch sex ratio data, and data from a fisheries independent surveys.
6. Separate documentation is attached which gives further technical information on the details of the mathematical model.

'Description of the population model and likelihood functions.doc': This document describes the population model and associated stock assessment procedures for the West Coast rock lobster size structured population model.

'Generation of artificial data.doc': This document describes the methods used to generate artificial data for future years for purposes of testing different management procedures. This formed the basis of the OMP development process during 2003, which led to an agreed OMP for the determination of the TAC for the 2003/2004 and 2004/2005 fishing seasons.

'Appendix 1.doc': This document gives a description of the somatic growth rate model that was used in the West Coast rock lobster size structured population model.

'Appendix 2.doc': This document summarises all the data which were used in fitting the West Coast rock lobster size structured population model.

'**Appendix 3.doc':** This document gives the reference case model parameter estimates that were obtained when fitting the West Coast rock lobster size structured population model.

7. In the case of Method I, the assumption is that the resource will be restored by forfeiting legal catches in the 2004/2005 fishing season, to provide a basis for estimating the cost of restoring the resource, and hence of the damage that has been suffered.
8. In the case of Method II, the assumption is that additional legal TAC amounts are equally distributed amongst fishing seasons 1999/2000 to 2003/2004 (5 fishing seasons in total).

Table 1. Estimates of overcatches in the South Coast rock lobster fishery between 1996 and 2001.

Season	Overcatch estimate (metric tons tail weight)	Source
1996/97	27.7	Groeneveld, 2003
1997/98	14.3	Groeneveld, 2003
1998/99	114.0	Groeneveld, 2003
1999/2000	135.16	Wynberg M's Court
2000/2001	58.4	Wynberg M's Court

Table 2. Two scenarios, A and B, of overcatches in the South Coast rock lobster fishery between 1996 and 2001. The first contains only the amounts contained in documents submitted to the Wynberg Magistrate's Court, the second includes in addition estimates for an earlier period reported by Groeneveld (2003).

Season	Scenario A	Scenario B
1996/97	0	27.7
1997/98	0	14.3
1998/99	0	114.0
1999/2000	135.16	135.16
2000/2001	58.4	58.4

Table 3. The additional harvesting costs incurred by the industry relative to what would have happened in the absence of overcatches, expressed as a percentage for each fishing season. Also shown is the TAC allocated in each fishing season between 1996 and 2003, the quota allocated to Company A involved in overcatch activities, and the amount of TAC allocated to the remainder of the industry. Results shown are for the South Coast rock lobster resource.

Season	Scenario B	Scenario A	TAC	Company A Quota	TAC of rest of Industry
1996	0.5	0.0	415	97.1	317.9
1997	1.2	0.0	402	93.0	309.0
1998	3.5	0.0	402	80.1	321.9
1999	8.2	2.6	377	71.2	305.8
2000	12.2	6.3	365	69.9	295.1
2001	13.4	7.5	340	0	340
2002	13.2	7.6	340	0	340
2003	13.1	7.5	350	0	350
2004	6.4	3.7	350*	0	350*
2005	0.0	0.0	350*	0	350*

*** values assumed for the purpose of carrying out the analyses**

Table 4. Illustrative harvesting costs that are experienced when one assumes that in 1995 40% of the value of a lobster comprised the average harvesting cost, where in this table harvesting costs are expressed in terms of metric tons of rock lobster in each fishing season. Results shown are for the South Coast rock lobster resource.

Season	Scenario B	Scenario A	TAC for the remainder of the industry	Harvesting costs no overcatch (metric tons tail weight)	Harvesting costs for overcatch scenario B (metric tons tail weight)	Harvesting costs for overcatch scenario A (metric tons tail weight)
1996	0.5	0.0	317.9	131.6	132.2	131.6
1997	1.2	0.0	309.0	129.2	130.7	129.2
1998	3.5	0.0	321.9	134.8	139.6	134.8
1999	8.2	2.6	305.8	127.8	138.3	131.1
2000	12.2	6.3	295.1	123.7	138.8	131.5
2001	13.4	7.5	340.0	143.4	162.6	154.2
2002	13.2	7.6	340.0	145.9	165.2	156.9
2003	13.1	7.5	350.0	155.0	175.3	166.7
2004	6.4	3.7	350*	159.5	169.7	165.5
2005	0.0	0.0	350*	162.3	162.7	162.5

*** values assumed for the purpose of carrying out the analyses**

Table 5. Illustrative additional harvesting costs that are experienced when one assumes that in 1995 40% of the value of a lobster comprised the average variable harvesting cost, where in this table harvesting costs are expressed in terms of metric tons of rock lobster in each fishing season. Additional means relative to what would have occurred in the absence of overcatches. Results shown are for the South Coast rock lobster resource.

Season	Additional harvesting costs for overcatch scenario B (metric tons tail weight)	Additional harvesting costs for overcatch scenario B (metric tons tail weight)
1996	0.6	0.0
1997	1.5	0.0
1998	4.8	0.0
1999	10.5	3.3
2000	15.1	7.8
2001	19.2	10.8
2002	19.3	11.0
2003	20.3	11.7
2004	10.2	6.0
2005	0.4	0.3

Table 6. The total increase in harvesting costs when the value of a lobster in 1995 contains between 20% and 60% of the cost of harvesting that lobster, with harvesting costs expressed in terms of metric tons of rock lobster. Note that the row entitled 40% was used as the example in earlier tables. Results shown are for the South Coast rock lobster resource.

Cost as percentage of export value in 1995	Total additional harvesting cost for overcatch scenario B (metric tons tail weight)	Total additional harvesting cost for overcatch scenario A (metric tons tail weight)
20%	51.0	25.4
30%	76.5	38.1
40%	102.0	50.8
50%	127.5	63.5
55%	140.3	69.9
60%	153.0	76.2

Table 7. Damage estimates due to overcatches in the South Coast rock lobster resource calculated by Method I, which estimates the cost of restoring the resource and the additional harvesting costs that the industry suffered between 1996 and 2001 as a result of commercial catch rates being lower. Harvesting costs assume that in 1995 55% of the value of a lobster comprises variable costs sensitive to catch rate. This computes to a contemporary percentage (the time that the commercial figures were gathered to estimate this quantity) of about 63%. These results are for overcatches made in the 1996/97 to 2000/2001 fishing seasons.

Method of estimation – Method I		
	Overcatch scenario A	Overcatch scenario B
Damage estimate in metric tons tail weight (I a – forfeited catches)	165.2	285.3
Damage estimate in metric tons tail weight (II a – extra harvesting costs) – 55% results	69.86	140.29
Total damage in metric tons tail weight	235.08	425.59
Average price/kg tail weight in US dollars	US$ 45	US$ 45
Monetary value of damage (III a) – 55% results	US$ 10 578 600	US$ 19 151 550

Table 8. Damage estimates due to overcatches in the South Coast rock lobster resource calculated by Method II, which estimates the additional TAC that the industry could have landed between 1996 and 2003 assuming that the resource would have been left in its current state if overcatches had not taken place. In this case there are no damages computed for additional harvesting costs. These results are for overcatches made in the 1996/97 to 2000/2001 fishing seasons.

Method of estimation – Method II		
	Overcatch scenario A	Overcatch scenario B
Damage estimate in metric tons tail weight (I b)	194.4	338.32
Average price/kg in US dollars	US$ 45	US$ 45
Monetary value of damage (II b)	US$ 9 331 200	US$ 16 239 360

Table 9. The total increase in harvesting costs when the value of a lobster in 1999 contains between 10% and 40% of the cost of harvesting that lobster, with harvesting costs expressed in terms of metric tons of rock lobster. Results shown are for the West Coast rock lobster resource. In the final damage calculation a figure of 20% has been used.

Harvest cost as percentage of export value in 1999	Total additional harvesting cost for RC1 (metric tons whole weight)	Total additional harvesting cost for RC2 (metric tons whole weight)
10%	11.7	14.7
20%	23.3	29.5
30%	35.0	44.2
40%	46.7	59.0
50%	58.4	73.7

Table 10. Damage estimates for the West coast rock lobster resource obtained using Method I, for overcatches made in the 1999/2000 fishing season.

Method of estimation – Method I		
	RC1	RC2
Damage estimate in metric tons whole weight (I a)	482.5	573.9
Damage estimate in metric tons whole weight (II a) – 20% results	23.3	29.5
Total damage in metric tons whole weight	505.8	603.4
Average price/kg in US dollars	US$ 17.5	US$ 17.5
Monetary value of damage (III a) – 20% results	US$ 8 851 500	US$ 10 559 500

Table 11. Estimates of damages in the West Coast rock lobster resource obtained using Method II, for overcatches made in the 1999/2000 fishing season.

Method of estimation – Method I I		
	RC1	**RC2**
Damage estimate in metric tons whole weight (I b)	**518.0**	**599.8**
Average price/kg in US dollars	**US$ 17.5**	**US$ 17.5**
Monetary value of damage (II b)	**US$ 9 065 000**	**US$ 10 496 500**

Figure 1. The additional annual harvesting costs incurred by the industry relative to what would have happened in the absence of overcatches, expressed as a percentage. Results shown are for the South Coast rock lobster resource, for both the Scenario A and B overcatches.

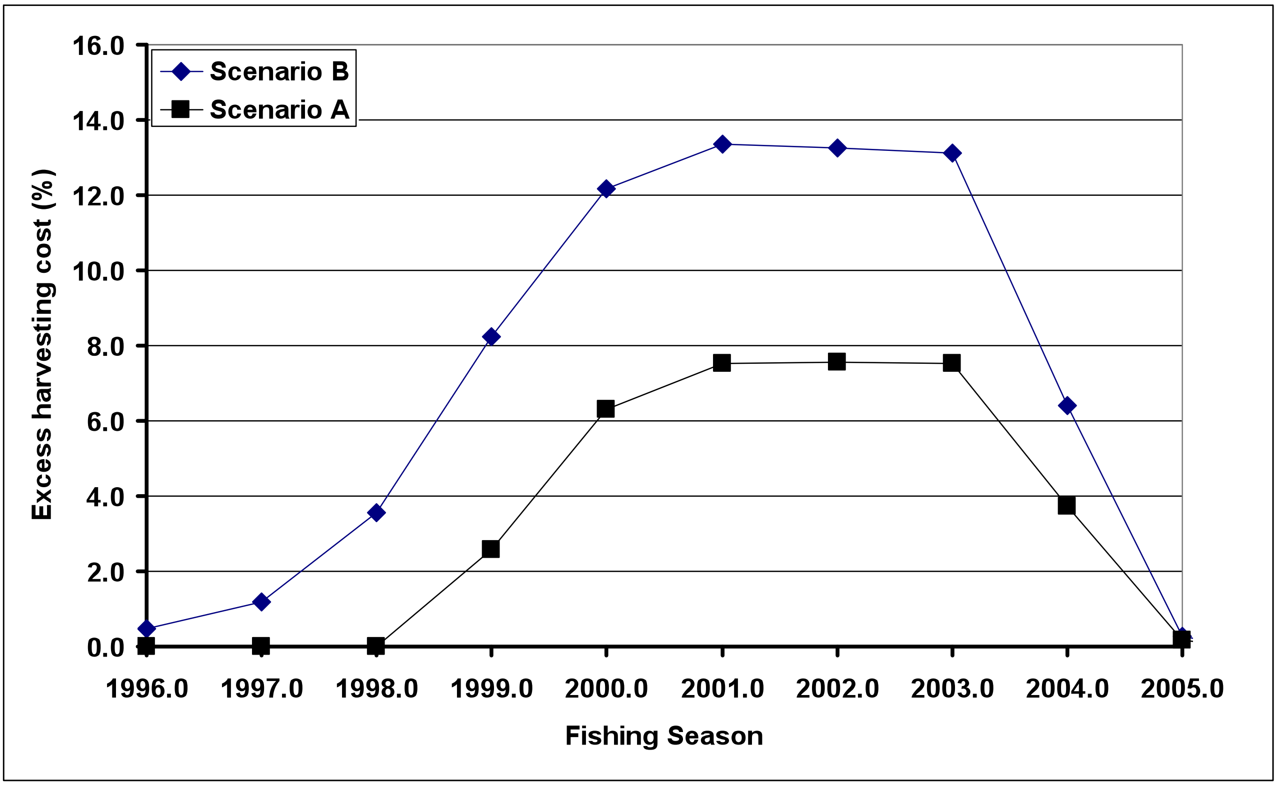
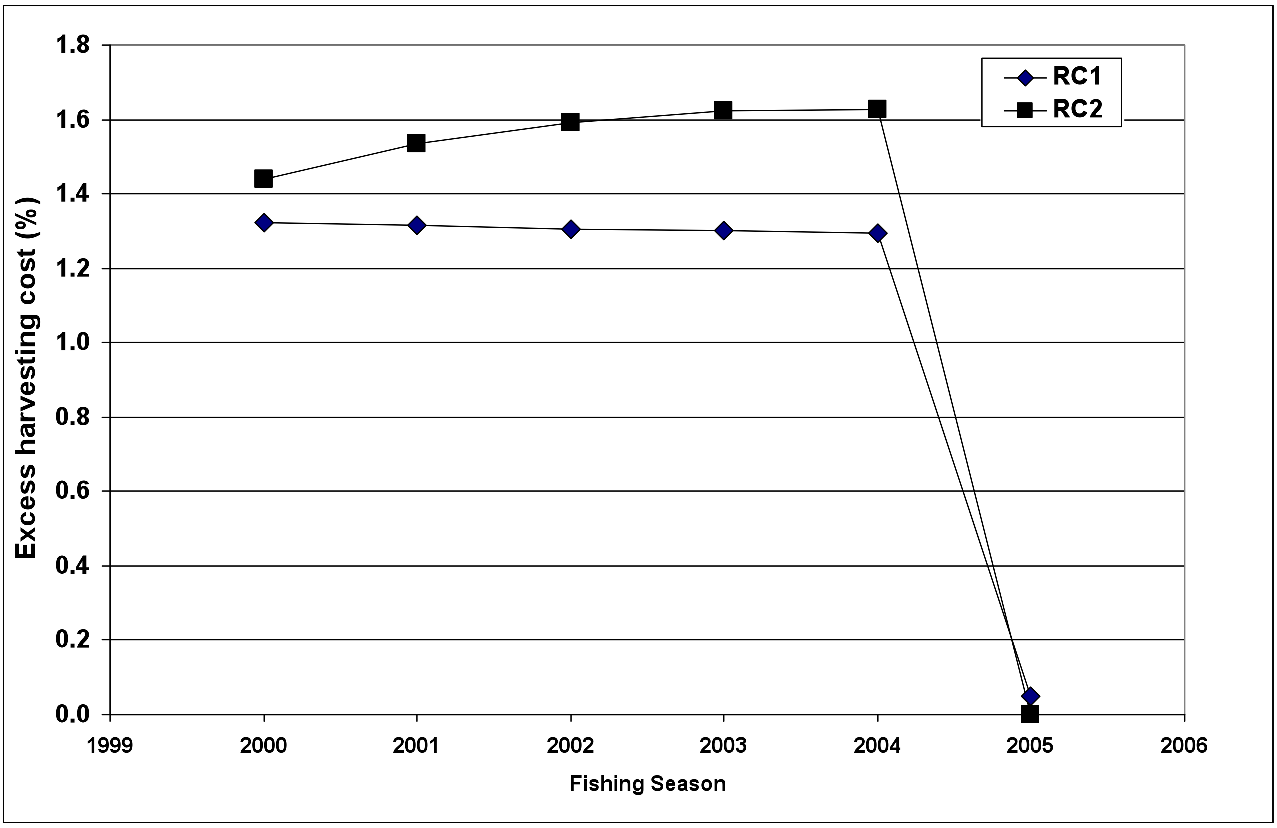


Figure 2. The additional annual harvesting costs incurred by the industry relative to what would have happened in the absence of overcatches, expressed as a percentage. Results shown are for the West Coast rock lobster resource, for both RC1.



Revision of calculation of damages suffered as a result of overcatches in the South African South Coast and West Coast rock lobster resources, in light of improved information and expert opinion.

by

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25 November 2004

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1. Summary

Expert opinion commissioned by the defendant and other information is considered and used to revise our earlier damage estimates, noting that our previous estimates were based on the best available information at the time. We also include a further method, Method III, to estimate damage in the event that there is no restoration of the resource, part response to a comment by the expert opinion for the defense.

OLRAC's expertise lies strictly at the quantitative and numerical level. Therefore, where the expert opinion referred to questions the conceptual basis of our damage estimates, we feel that such matters should be determined by the legal process. We prefer to simply present these methods as different options for consideration. Our conceptual thoughts on the matter are based on no special legal or other non-numerical knowledge, other than that these appear to us to be logically consistent, and we found them helpful in narrowing the range of numerical outputs, and ensuring that there is no double accounting of damages. The defense's experts also question the actual overcatch amounts used in our damage estimates. Similarly, we tried to present various options for damage estimation, since we acknowledge that there is uncertainty about the amounts and times of overcatches. In respect of the South Coast rock lobster resource, we provided estimates of overcatches prior to the period already admitted, based on a statistical argument, which the defense's experts question, and they ask for additional statistical information. We have provided supplementary information as requested. In particular, we submit new information on the number of seadays the HBF vessels employed over the period 1987 to 2000, and based on this and trends in catch rates in the fishery, we produce overcatch estimates by HBF. These support our earlier point (OLRAC Report, 22 July 2004) that the Groeneveld (2003) method (a) estimates coupled with assuming that the average overcatch for the period 1991/92 – 1995/96 is applicable to the 1987/88 – 1990/91 period, are conservative estimates.

We have considered some of the more conceptual points in the Bjorndal Report, particular with respect to lost taxation as a possible basis for a damage claim. We therefore include a further damage calculation method, Method III, in which the assumption is that the resource is never restored to the level it would have been at in the absence of overcatches, and instead the biomass is always somewhat less than it would have been at in the absence of the overcatches, leading to ongoing damages due to harvesting costs exceeding the level they would have been at in the absence of overcatches. This damage can be viewed as pure lost profit since all other costs involved in landing and processing and marketing the legal catch have already been met.

We note that our Methods I and III employ population models as the basis of damage estimates, whereas our Method II does not require the use of population models. Experts for the defense criticize the comprehensiveness of the documentation provided for purposes of validating these population models, and argue that we present no evidence of the reliability of these population models. We disagree with this and have summarized here in more detail which of the documents already submitted contain the necessary information.

The experts also question the extent to which the populations models underlying Method I have been subjected to critical peer review, and question OLRAC's competence to employ these models. We note that these models have received considerable critical input, and that our intimate knowledge of the evolution of these models over a 15 year period qualifies us to use them in this instance.

The expert opinion referred to also argues repeatedly and in different ways that there is no evidence of damages suffered, pointing to certain positive features in TACs or catch rates or biomass trends in the resource. We disagree with these points, since our estimates of damages are based on consideration of what would most likely have transpired in the absence of overcatches, all other things being equal.

The expert opinion suggests that the lobster prices that have been employed in our damage estimates are inappropriate and argue that these prices are at a particularly high level, causing unduly inflated damage estimates. We have carried out further research into prices and revise our damage estimates accordingly.

Our Method I damage estimates include additional harvesting costs sustained in the fishery. The defense's expert opinion argues that the conceptual basis for the methods used to estimate these additional harvesting costs is flawed and is not supported by mainstream academic thinking on the relationship between harvesting costs and stock size. We present additional references in arguing against this. They also argue that insufficient documentation on the methods employed has been provided. A further description is provided. We also present the impact on the damage estimates of certain different parameter values underlying this calculation, and the use of certain variants of the population models, to given an indication of the uncertainty of these estimates.

With reference to comments by the defense's experts, we now include uncertainty (a coefficient of variation is reported) in the damage estimates for the case of South Coast rock lobster damage estimates, where this uncertainty is due to uncertainty in population parameter estimates. This does not incorporate uncertainty due to uncertainty about harvesting costs, lobster prices or overcatches.

Method I estimates damage as the amount of catch that the industry has to now forfeit in order to restore the resource to the size that it would otherwise be by the beginning of the **2006/2007** fishing season (West Coast rock lobster) or the **2007/2008** fishing season (South Coast rock lobster) in the absence of overcatches. It also includes the additional harvesting costs incurred by the fishing industry since the overcatches occurred until restoration of the resource.

Method II considers what additional catches could have been taken if the overcatches are taken as a legal catch instead. Method II involves no claim for additional harvesting costs.

Method III is submitted in this revised report, providing estimates of perpetual damage due to the additional harvesting costs incurred since the overcatches occurred, on the assumption that the resource is never restored.

The damage estimates are (referring to options considered in the document):

1. South Coast rock lobster damage estimate, 1987 – 2000 overcatches, Base Case model, **Method I**, 64% harvesting cost option = US$ 45 027 000-00.
2. South Coast rock lobster damage estimate, 1987 – 2000 overcatches, **Method II** = US$ 32 436 000-00.
3. South Coast rock lobster damage estimate, 1987 – 2000 overcatches, Base Case model, **Method III**, 64% harvesting cost option = US$ 41 310 000-00.
4. For West Coast rock lobster, assuming an overcatch of 598 MT in 1999/2000 and 200 MT in each of the years 1987/88 – 1998/99, averaging the RC1 and RC2 model results, 15% harvest cost option, **Method I** = US$ 40 477 500-00.
5. For West Coast rock lobster, assuming an overcatch of 598 MT in 1999/2000 and 200 MT in each of the years 1987/88 – 1998/99, **Method II** = US$ 40 169 500-00.
6. For West Coast rock lobster, assuming an overcatch of 598 MT in 1999/2000 and 200 MT in each of the years 1987/88 – 1998/99, averaging the RC1 and RC2 model results, 15% harvest cost option, **Method III** = US$ 13 949 950-00.

However, there are a large number of options relating to the use of different methods, different overcatch amounts, different harvesting cost options and different models. These additional options are presented in Tables 8-12.

2. Introduction

After reading the reports commissioned by the defense, it is necessarily to clarify OLRAC's role and the scope of our input into this matter. The expertise provided by OLRAC lies in the area of the quantification of specific items related to the population dynamics of fish resources. We have a history of providing such expertise to the fishing industry, and of participation in the Working Groups, which are convened and chaired by the MCM for purposes of formulating scientific recommendations for resource management. We have no special skills in legal matters. Any comments we have made or may make about the identity of the victim or claimants is not based on any legal expertise but represents thoughts we have had to narrow the range of numerical calculations that need to be carried out, and thereby to facilitate the legal deliberations. Any legal justification for the methods of damage estimation that we have provided is based on no special legal knowledge. We felt it prudent to present various options for damage calculations. Our comments about Methods I, II and III as used by us are based on an intuitive interpretation and understanding of appropriate approaches to damage calculations.

OLRAC is a technical consulting group and consequently most of its work is not published via normal academic channels. However since most of our work involves submissions proposing alternative management strategies for commercial fish stocks, frequently with substantial commercial implications, these proposals have generally attracted special criticism and scrutiny by the southern African marine scientific community, and at times international peer review of these proposals has been sought. Many of OLRAC's studies have been subject to scrutiny at international workshops attended by respected quantitative fisheries scientists from North America, Europe, Australasia, Norway and South America. As part of its business model, OLRAC welcomes international scrutiny of its work.

This revised report should be viewed as a refinement of calculations reported in OLRAC's earlier report dated 22 July 2004. As such this revision does not repeat many of the methodological presentations made in the July report, the arguments presented in support of estimates of harvesting costs in 2003/2004 in the South Coast rock lobster fishery, the technical points made with respect to the population models employed and the attached technical documentations. It is assumed that the reader is familiar with OLRAC's July report.

3. Methods

3.1 OLRAC's damage estimates in context

We are aware that certain amounts and times of overcatch for South and West Coast rock lobster have been admitted in court. We are also aware that the issue of overcatches has been raised at meetings of the Rock Lobster Working Group over a number of years, since the scale and duration of overcatches have a bearing on the mathematical models underpinning recommendations on the annual TAC. It seems self evident that certain damages have therefore been suffered as a result of these overcatches. An important point of departure for our work is hence that there has been a finite and non-zero damage, and our efforts have been directed at obtaining numerical estimates of this damage.

Conceptually, the source of damage addressed by OLRAC revolves around the following:

1. The size of the resource is smaller at certain times than would have been the case had overcatches not occurred.
2. Overcatches result in a relative reduction in the density of lobsters on fishing grounds, hence harvesting costs per unit mass of lobster are relatively larger due to the occurrence of overcatches.
3. Overcatches could have been taken legally with financial benefits accruing to South Africa.

Both the ongoing positive performance of the West and South Coast rock lobster resources, and the existence of other additional forms of mortality in the case of the West Coast rock lobster resource (natural walk-outs triggered by red tide events), does not imply the absence of damage due to illegal overcatches. In our conceptual framework, damage is due to a relative difference between what happened to the resource biomass, and what would have happened in the absence of overcatches, regardless of actual trends in resource biomass and TACs, whether up or down, good or bad. In our view we have adopted a very conservative definition of damage. To illustrate, our definition of damage is a subset of the following four broad categories:

1) Biological damage:
   a) The resource becomes less productive.
   b) The resource becomes more biologically vulnerable.
   c) In most cases illegal fishing is associated not just with overcatch but also with other fishing regulations such as catches of undersized lobsters and females in berry, catches in protected areas (reserves) and catches during closed seasons. All these actions can under certain circumstances have a profound effect on the resource over and above the damage due to the additional mortality caused by illegal overcatches.
2) Operational damage:
   a) More fishing effort (cost) is required by other participants to harvest their legal allocation.
   b) Fishing activity is restricted due to the deployment of excessive effort in the fishery cutting off certain fishing areas and interfering with the deployment of fishing gear by other fishing vessels.
   c) It becomes necessary to increase the level of investment in capital equipment in the fishery in order to respond to a reduction in the commercial catch rate.
3) Damage to prices: The availability of excessive amounts of illegal fish to particular participants allows them certain options to manipulate the market, perhaps undercutting prices, to the detriment of other participants in the fishery.

All these forms of damage imply a monetary loss in the form either of additional cost and loss of earnings to the industry, or in the form of uncollected taxes to the state.

We note further, and with reference to Table 1 and Fig. 1, that the period over which we consider, for numerical purposes, that overcatches may have occurred, 1987 – 2000, spans a period of transition in the South Coast rock lobster fishery. Prior to 1990 the fishery exhibited relative stability under TAC levels of 450 – 475 tons. However, after 1990 the fishery entered a phase of declining catch rates, at much reduced TACs, reaching a low point in about 1998, by which time the catch rate had declined by some 50%, and the TAC had declined to 340 tons. After the removal of HBF from the fishery in 2000, the fishery then experienced a turnaround, and the CPUE (catch rate) increased by about 9% per annum for 5 years. This indicates that HBF's role in the fishery was detrimental to the resource, that the cause of the decline in the resource from 1990 to 1998 was HBF overcatches, and that the primary reason for the subsequent increase in the resource was the removal of HBF overcatches from the fishery. However, our most extreme overcatch assumptions, being those assumed in the OLRAC Report (22 July 2004) from 1987 to 2000 for South Coast rock lobster, only explain a small fraction of the decline witnessed. In other words, if one were to try to explain the events observed in the fishery in terms of overcatches by HBF, one would have to employ substantially larger overcatches than have actually been used in our damage estimates for the period 1987 to 2000. Our approach of relying only on overcatches that can be supported by direct evidence, previous admissions, or Groeneveld (2003) and its variants (see later) may therefore be a conservative view of the damages incurred. .

3.2 A review of the methods employed to calculate damage

In our earlier report, we pursued two different methods of damage estimation, the assumption being that a different authority will rule as to which of these methods are more appropriate as a basis of calculating damages. We take the opportunity to clarify some of our thinking leading up to these methods, and to propose a further method to address some of the points in the Bjorndal Report. We emphasize that our thoughts are based on no special legal knowledge, but are intended to ensure that our methods are logically consistent, and that there is no implicit double accounting of damage.

Method I (Restoration of Resource Biomass): The first method (Method I) is based on an analogy with, say, the rehabilitation of a farm which has been polluted by, say, industrial effluent. The damage suffered in such a case would be a reduction in production during the period which the farm was affected by pollution, and the cost of 'cleaning-up' the farm. In the case of the rock lobster resources in question here, overcatching rather than pollution is the agent which has caused damage. The damage is the increased harvesting costs and hence reduced profits achieved during the period over which the resource is depressed to below than intended levels (analogous to the reduced production in the case of the farm), and the amount of catch that must be forfeited in order to restore the resource biomass to the level it could have reached in the absence of overfishing (analogous to the cost of cleaning up the farm). The calculation of the amount of catch that has to be forfeited is carried out by the use of the same quantitative models that are employed by scientists in order to provide TAC (total allowable catch) and other management recommendations.

Another analogy for Method I is a situation where there is theft of a motor car, analogous to the overcatch of rock lobster. The owner of the motor car suffers damage because he/she does not have the use of the motor car, analogous to the loss of the use of the now overcaught lobsters in the sea. In the case of the rock lobster fishery however, the 'use value' of having the rock lobsters in the sea is that they would have kept harvesting costs low (for harvest of the legal amounts of rock lobsters). Return of the stolen motor car does not fully compensate the owner for his/her deprivation (perhaps he/she had to hire another car in the interim) suffered without the motor car for a period of time. Similarly, restoration of the rock lobster resource to the level that it would have reached in the absence of overcatches does not fully compensate for the damage suffered during the period that the resource was depressed below the levels that it would have been at in the absence of the overcatches. The analogies (farm pollution/motor car theft) that have been sketched should clarify why in our opinion, in the case of Method I, it is fair to claim both the value of the 'catch forfeit', and the damage due to additional harvesting costs for the period prior to which restoration occurs.

Method II (Lost Opportunity): Method II is based on the possibility that the quantum of rock lobster overcaught could instead have been landed legally, and the damage is therefore equal to the value of the quantum of rock lobster that could have been landed legally but that was instead the subject of an illegal fishing operation. With respect to the farm analogy, this corresponds to a situation in which a decision is made (by the users and/or owners of the farm) to deliberately pollute the farm, but the industrial benefits (of sub-standard effluent control) that accrue would be paid to the users and/or owners of the farm. The motor car theft analogy for Method II corresponds to a situation in which the motor car owner sells the motor car, and takes the cash as an immediate benefit. Method II estimates the damage suffered because a party has illegally exercised a valid (possibly) management option which is now no longer available to be exercised legally. The analogies (farm pollution/motor car theft) that have been sketched should clarify why in our opinion, in the case of Method II, it is not fair to claim both the value of the overcatch, and the damage due to additional harvesting costs, but only the former.

Method III (Perpetually Larger Harvesting Costs): We have considered some of the more conceptual points in the Bjorndal Report, particular with respect to lost taxation as a possible basis for a damage claim. While such an argument may lead to modifications to the quantities that we report in respect to Methods I and II, we have also chosen to include an additional method which may assist in the calculation of taxes and profits. We refer to this as Method III. For this, by analogy with the farm, we assume that there is no clean-up operation, and that the pollution continues ad infinitum. Alternatively, in the case of the motor car theft, although the thief is identified, the motor car is never returned. In the rock lobster fishery situation, the resource is never restored to the level it would have been at in the absence of overcatches, and instead the biomass is always somewhat less than it would have been at in the absence of the overcatches, leading to ongoing damages due to harvesting costs exceeding the level they would have been at in the absence of overcatches. The damage claim in this case is analogous to the ongoing loss of production of the farm in the presence of continuous ongoing pollution, or the ongoing cost of hiring an alternative motor car. That is, for the rock lobster fishery, it is the ongoing additional harvesting cost. The claim here relates to the perpetual loss of the 'use value' of the rock lobsters in the sea (i.e. their use is to keep harvesting costs low). In this case, for Method III, it seems that one cannot claim both the value of the overcaught rock lobsters, and the value of the lost ongoing 'use value' of that amount of overcaught rock lobsters in the sea (by keeping harvesting costs low). Rather, a fair claim in this case is based only on the latter, that is, on the perpetual additional harvesting costs, and hence the perpetual loss of profit. This damage can be viewed as pure lost profit since all other costs involved in landing and processing and marketing the legal catch have already been met.

The OLRAC Report (22 July 2004) contains estimates based on the best information available to us at the time. For the purpose of this report, OLRAC was able to obtain improved information, and has therefore been able to refine its damage estimates.

Methods I-III rely on comparing what was actually caught from the resource, and the consequences this had for resource biomass, with what would probably (as indicated by populations models) have occurred to the resource biomass in the absence of these overcatches. Speculation that the pattern of legal catches might have been different had the overcatches been reported earlier (as suggested at times in the Bjorndal Report) is not relevant to the comparisons that are being used for the damage calculations. The important point is that one must draw a comparison of outcomes using a model with and without the occurrence of overcatches, but with the <u>same</u> sequence of historical legal catches, in order to calculate damages.

Method II does not involve the use of population models.

3.3 The importance of estimates of overcatches to damage calculations

Although estimates of damage could have been based on allusion to problematic features in the sequence of CPUE and/or commercial catches, to speculation about what the TAC could have been if this or that had happened, or to some of the other more general types of damage mentioned in our preamble, such approaches cannot be readily supported by sound numerical arguments.

Instead we have adopted logically consistent methods which follow directly from the actual overcatch amounts. These methods highlight the importance of the duration and scale of overcatches to the estimation of damage.

Certain overcatch quantities and times have been admitted in court. We are also aware that the Rock Lobster Working Group has made the assumption of substantial additional overcatches in years prior to 1999. Therefore our damage estimates are based on additional amounts of overcatch for years prior to 1999. We present the damage estimates in a series of different options, contingent on different assumptions about historic overcatch, recognizing that this is an unresolved area.

We have included additional statistics (HBF vessel seadays per annum, 1987/88 to 2000/2001) which have a bearing on possible overcatches in the South Coast rock lobster fishery prior to the 1999/2000 fishing season (see Table 4).

Our original report presents damage estimates produced via Method I, which requires the application of population models in order to estimate certain quantities. Method I involves the estimation of a ‘catch forfeit’ amount equal to the amount of catch that should be forfeited in one year in order to restore the resource biomass back to the level it would have reached in the absence of overfishing. Method I also includes an estimate of the additional harvesting costs that are incurred whenever the resource biomass is smaller than it would have been in the absence of overfishing. In our report we also presented damage estimates based on Method II. In the initial implementation of Method II, the application of a population model was required. However, a simplified version of Method II was also presented in that report for which no population model was required. In this report we have preferred this simpler implementation of Method II.

Sections 3.4 and 3.5 of this report contain point by point responses to reports prepared by expert’s for the defense, i.e.

1) Expert Report of Trond Bjorndal, Ph.D. United States District Court, Southern District of New York, 03 Crim. 308 (LAK).
2) Expert Report by Dan Baird MSc, PhD, Pr.Sci.Nat. Professor and Chair of the Department of Zoology, University of Port Elizabeth, South Africa.

3.4 Comment on the Bjorndal Report

The following are our considered responses to the various points raised in the Bjorndal Report. We try to indicate points of disagreement, areas that we concur with and that therefore cause us to modify or improve our methodology, and areas which we feel lie outside our field of expertise:

Bjorndal Report page 3, 3rd sentence from below – Elsewhere the Bjorndal Report acknowledges the occurrence of overcatches, hence the author is implying that overcatches do not cause damage to renewable resources such as a rock lobster stock. This seems quite implausible. Poaching is recognized internationally as one of the most important factors limiting the productivity of fish stocks, and causing their depletion to dangerously low levels.

Bjordal Report, Page 3, last sentence of the page. It is unclear why this comment refers to “possible overcatches”. HBF has already admitted to fishing illegally so there is nothing to speculate about. There is also no question about the nature of the damage that was caused. As explained elsewhere in this document, damage should be calculated by means of a comparison to resource biomass trends in the absence of overcatches. In other words, would the resource and the fishing industry be better off if HBF had not fished illegally? The answer is of course, yes. Consequently the focus of technical expertise should be to calculate such damage and not to further speculate whether damage has occurred.

Bjorndal Report page 3, 2nd sentence from bottom – In no way do our methods of damage calculation assume that there has been zero damage. As pointed out elsewhere in this document, the assumption that a finite damage has occurred is one of our starting assumptions.

Bjorndal Report page 4, 1st paragraph – regarding the definition of the victim of the damages caused by overfishing, this lies outside our field of competence. Yes, we included some thoughts on this matter in our original report. However, a decision on this matter rests with a different authority and a different academic discipline, i.e. legal. Our thoughts were aimed at trying to narrow the range of numerical results to be calculated to determine damage amounts, and to verify that our methods are logically consistent.

Bjorndal Report page 4, points listed in 2nd paragraph – our responses are as follows:

(1) If a legal authority concurs that our basis for calculation of restitution damages is incorrect, and defines the broad basis for such calculations, our methods can be modified to carry out the required calculations.

(2) Documents submitted by the prosecution to the defense include documents which explore a number of different variants of the population model. The Bjorndal Report makes no reference to these even though they represent a synthesis of investigations by the South African government and by OLRAC into the validity of the models used in the management of these fish stocks. These same documents also report standard error estimates for estimates of key parameters governing stock dynamics, a further diagnostic tool for the investigation of the validity and reliability of the mathematical models being referred to.

(3) Our responses appear later, where we either disagree, or suggest that a different authority and field of expertise must make the necessary decisions.

(4) Our responses appear later where specific points appear in the Bjorndal Report.

(5) Our responses appear later where specific points appear in the Bjorndal Report.

Bjorndal Report page 4, 2nd last sentence starting "In numerous …" – in some cases we concur and where necessary we have included further methodological descriptions. However, as to the basic populations models employed, all methodology (in the form of coherent mathematical specifications) and data employed has been submitted in documents to the defense.

Bjorndal Report page 5, 1st paragraph – we feel that the criticism is too general and therefore do not agree with it.

Bjorndal Report, Page 5 in general - OLRAC's modelling work has arisen as a result of their intimate involvement in the quantitative management of the two rock lobster resources over a period of about 15 years. Many of the modelling techniques now used to assess these resources were initated by OLRAC and have been further developed over the years by scientists from MCM and the University of Cape Town through a consultative process in which OLRAC has been an active participant. Questioning OLRAC's models and credentials amounts to questioning the merits of the management of fish resources in South Africa. Considering the fact that many countries in the world regard South Africa as one of the few examples in the world where major fish resources are still in a reasonable condition, it would seem unjustified to refer to the methods as speculative.

Bjorndal Report page 5, 1st paragraph, 1st sentence – The damage calculation involves a difference calculated between population scenarios with and without inclusion of overcatch amounts. This differencing process eliminates the overwhelming proportion of uncertainty normally seen in estimates presented in support of TAC recommendations. We are therefore of the opinion that since these population models are acceptable tools for the management of the rock lobster stocks in question (to us as consultants to the industry, and to the South African government), they are adequate for purposes of estimating damages via the methods proposed in our original document.

Bjorndal Report page 5, 1st paragraph, 2nd sentence – regarding the degree of critical assessment that the population models referred to have received. We note firstly that a number of highly qualified individuals (Professors and Ph.D. and M.Sc. graduates in Applied Mathematics, Marine Biology and Fisheries Science) have been involved in the development of the population models in question over a period of many years, that various aspects have been the subject of M.Sc. and Ph.D. theses, and that various aspects have also appeared in peer reviewed publications. Secondly, the Rock Lobster Working Group has been extraordinarily active over the last 10 years spurred on by critical and opposing input due to representation by both economic and more conservative interests. Thirdly, the quantitative methodology has been intensively reviewed by specific annual workshops since 2000. These workshops have been attended by panels of quantitative fisheries scientists from North America, Europe, Australasia, Norway and South America. Finally, dual development of the mathematical models has been undertaken, by OLRAC on the one hand, and by consultants to the MCM on the other hand. OLRAC's model development work has involved in-house development in triplicate using three different software platforms – in our case FORTRAN, Excel and AD Model Builder software platforms have been used. All these computer based implementations have to date achieved very close agreement with each other, and so coding errors are not a serious concern. We are therefore satisfied that further peer review input will not substantively alter the damage calculations via the methods used in our previous report.

Bjorndal Report page 5, 2nd paragraph, 3rd sentence. We did produce standard error estimates for the damage amounts relating to the catch that has to be forfeited in order to restore the resource, but felt that such detailed technical information was inappropriate for our first report. Later in this document we include such estimates as are necessary to make an informed interpretation of the reliability of the catch forfeit amount estimates. We note that uncertainty implies that values both smaller and larger than the best estimates are possible.

Bjorndal Report page 5, 2nd paragraph, 4th sentence. It is appropriate to separate the uncertainty arising from the use of population models, from the uncertainty arising as a result of uncertainty about the precise overcatch amounts. The former can be dealt with via standard quantitative techniques, while the latter are less amenable to scientific analysis.

Bjorndal Report page 5, 2nd paragraph, 5-6th sentence – the assertion that OLRAC has not demonstrated how changes in growth rates or mass walk-outs have been dealt with in the population models is not correct. We refer the reader to sources already in the possession of the defense which sets out these aspects in some detail. We provide a separate listing of these sources in Appendices A and B of this document.

Bjorndal Report page 6, 1st paragraph. To explain the methods that have been used for calculating harvesting costs, note that we always use two stock assessment models, labeled 'Actual' and 'Hypothetical' for purpose of the damage estimates. The Hypothetical model is identical to the Actual model in all respects (i.e. model structure, input data, parameters values) except that the 'Hypothetical' omits the HBF overcatches. These two models give rise to estimates of the exploitable biomass by year. To simplify this description, we will use the following notation:

$B^{exp,hypothetical}_y$: the exploitable biomass in the 'Hypothetical' model in year y, for years after 1973,

$B^{exp,actual}_y$: the exploitable biomass in the 'Actual' model in year y, for years after 1973,

Let the harvesting costs be denoted as follows:

$H^{exp,hypothetical}_y$: the harvesting cost per kg of lobster in the 'Hypothetical' model in year y, for years after 1973,

$H^{exp,actual}_y$: the harvesting cost per kg of lobster in the 'Actual' model in year y, for years after 1973.

These harvesting costs are not the total costs, but only that portion of the costs which are sensitive to the catch rate, i.e. the CPUE. Clark (1985) refers to these as effort costs. We have information that in the 2003/2004 fishing season the harvesting cost was approximately ZAR 178/kg tails (we use ZAR as the unit for the purpose of illustration, however, for the actual damage calculations we revert to US$) for South Coast rock lobster, approximately 64% of the price of South Coast rock lobster tails (see OLRAC Report). We wish to determine the harvesting costs in other years and for the 'Hypothetical' situation, bearing in mind that the value of ZAR 178/kg tails is pertinent to the 'Actual' model. We therefore make use of equation 1.25 in Clark (1985), i.e. the cost per unit product is given by:

Cost per unit product in year y= $c/(qX_y)$,

Where in our situation $X_y = B^{exp,actual}_y$. We solve for the value of c/q by using the value of 178 for 2003/2004:

$\{c/q\} = 178 * B^{exp,actual}_{2003}$

and then for the 'Hypothetical' model for all years and for the 'Actual' model for years other than 2003/2004, we calculate the harvesting costs per kg of lobster as follows:

$H^{hypothetical}_y = \{c/q\} / B^{exp,hypothetical}_y$

$H^{actual}_y = \{c/q\} / B^{exp,actual}_y$

The total annual harvesting costs (i.e. costs of effort in Clark's terminology) associated with the legal TAC, where we denote the legal TAC in each year y by the symbol TAC_y, is given by $H^{actual}_y TAC_y$ and $H^{hypothetical}_y TAC_y$, for the Actual model and the Hypothetical model respectively. The total additional harvesting cost due to overcatches is the sum of the difference $\{H^{actual}_y TAC_y - H^{hypothetical}_y TAC_y\}$ over all years for which the exploitable biomass in the Actual and the Hypothetical models differ. The exploitable biomass in the Actual model is always equal to or less than the exploitable biomass in the Hypothetical model, due to the allowance for overcatches in the Actual model. The Bjorndal Report alludes to the possibility or probability of different harvesting costs in different years, and we take this to mean different values of H^{actual}_y in different years. The method we have adopted can be modified to deal with this by assuming that the ratio {c/q} is dependent on year, and we represent this by the extended terminology, $\{c/q\}_y$. It is a simple matter to extend the method to deal with this by noting that

$\{c/q\}_y = H^{actual}_y * B^{exp,actual}_y$

and therefore

$H^{hypothetical}_y = \{c/q\}_y / B^{exp,hypothetical}_y$

Essentially this is saying that the 'Hypothetical' harvesting costs without overcatches are equal to the 'Actual' harvesting costs multiplied by the ratio of the Actual to Hypothetical exploitable biomasses. As in the earlier simpler case, the total additional harvesting cost due to overcatches is the sum of the difference $\{H^{actual}_y TAC_y - H^{hypothetical}_y TAC_y\}$ over all years for which the exploitable biomass in the Actual and the Hypothetical models differ.

A worked example is presented in Table 2. Table 2 contains the exploitable biomasses which are estimated by the base case stock assessment 'Actual' model for the South Coast rock lobster resource, including all the historic overcatch amounts that have been agreed to by the Rock Lobster Working Group. However, for this example, we only consider the overcatches for 1999/2000 and 2000/2001 to be included in the damage calculation, i.e. only these catches are excluded from the Hypothetical model run. The <u>spawning</u> biomass for the 'Actual' model has been grown back to the level that it would have been in the absence of overcatches, by forfeiting catches in 2004 and 2005 – note that the {Legal TAC-Catch forfeit} differs from the Legal TAC in 2004 and 2005. Note that this is a difference to our previous report where we used a one year grow back procedure, since in some cases one year is not sufficient to grow the resource back to the level that it would have otherwise reached in the absence of overcatches. Hence our use of two years over which the Catch forfeit amount is calculated. Therefore the <u>exploitable</u> biomass in the 'Hypothetical' and 'Actual' models are quite close in 2006. Also note that the unit harvesting costs are ZAR 178 in the 'Actual' model in 2003. All the remaining unit harvesting costs in other years are simply 178 multiplied by the exploitable biomass in the 'Actual' model in the 2003/2004 fishing season, divided by the exploitable biomass for the year, whether 'Actual' or 'Hypothetical'. The additional harvesting costs are then the difference between the unit harvesting costs multiplied by the {Legal TAC-Catch forfeit} amounts. Note that this leaves unstated the matter of the difference between the harvesting costs for the {Catch forfeit} amount, and the harvesting costs for the same amount of catch in the same years for the 'Hypothetical' model. We argue that from the point of view of the damage calculations and the valuation of this {Catch forfeit} amount, these harvesting costs should be regarded as equal to the 'Hypothetical' model's predictions, hence there is no difference to report in this regard in respect to harvesting costs.

We note that this example is illustrative. A TAC has already been set for the 2004/2005 fishing season, of 382 tons, hence the grow back/catch forfeit can only be treated as starting in the 2005/2006 fishing season. Also, this method is easily adapted to a situation where different unit harvesting costs are inputted for each year of the 'Actual' model, and then the 'Hypothetical' unit harvesting costs are given by the 'Actual' unit harvesting costs multiplied by the ratio of Actual to Hypothetical exploitable biomass estimates.

Bjorndal Report page 9, 1st paragraph. A correction is required to the description of the TAC decision making process. The intended modus operandi is that the Working Groups advise the Director of the Research section of MCM as to their scientific recommendation. The Director submits his recommendation to the Consultative Advisory Forum, a grouping including respected persons from civil society, university and MCM scientists, members of the fishing industry, and others, who make a final judgement and recommendation to the minister. In the recent two years (2003 and 2004) the CAF has not been in operation and the Director of Research, MCM has submitted recommendations directly to the minister.

Bjorndal Report page 9, 2nd paragraph, 3rd sentence. The claim by Baird that for the South African West Coast rock lobster resource the TAC is 30% of the estimated biomass of the resource is incorrect. Estimates of the TAC as a percentage of the biomass are in the order of 8%.

Bjorndal Report page 9, 2nd paragraph, 3rd sentence. The claim by Baird that for the South African South Coast rock lobster resource the TAC in the 1990/91 fishing season was set at 458 tons is incorrect. The actual value was 477 tons (comprising 475 tons for the commercial allocation, and a 2 ton research allocation).

Bjorndal Report page 10, 1st paragraph, 1st - 3rd sentence. The reason for the difference may well be as described here. We make no distinction about the destination for lobsters exported from South Africa in our damage estimates. While such apportionment of damages may be valid, a decision on this matter is outside the scope of our report, and therefore we cannot verify whether the claim that our approach of including all overcatches in our basis for damage estimation is incorrect. We note though that the price of lobsters imported into the USA is not relevant to our methods of estimating damages, rather their average price as if they were marketed across the spectrum of markets typically reached by the South African rock lobster industry is relevant, since this is the value that we assume they could have fetched had these catches been used legally by the industry as a whole instead.

Bjorndal Report page 10, 1st paragraph, 4th sentence. We are concerned that there may be merit in the statement in this sentence, and have therefore embarked on a more detailed assessment of prices in order to verify this assertion. This information is reported in our report in Appendix C.

Bjorndal Report page 10, 2nd paragraph. We understand this information to be correct, although we understand that particular overcatch amounts were also admitted for South Coast rock lobster for the 1999/2000 and 2000/2001 fishing seasons, being amounts of 135.0 tons and 58.4 tons respectively.

Bjorndal Report page 13, 2nd paragraph, 1st and 2 sentence. We provide more information about the process of the development of the population models used in our original report. The first point to note is that in quantitative fisheries science a population model is regarded as simply a set of mathematical equations describing the dynamics of a resource, say (a). Such equations will contain a large number of parameters whose values are unknown, and which must be estimated. Typical parameters that fall into this category are natural mortality, the parameters governing the relationship between recruitment and spawning biomass, the size of the pristine spawning biomass, and the coefficients governing the selectivity characteristics of the commercial gear. Associated with the mathematical equations are a set of data relating to the fishery, such as catch-per-unit effort and catch-at-age data. We refer to these as (b). In addition, the mathematical model will refer to a set of statistical prescriptions for estimating the aforementioned unknown parameters values, referred to here as (c), which will typically involve a maximum likelihood estimation technique (a model fitting technique). Each year the Rock Lobster Working Group meets and reviews the population model in the light of recent developments in the fishery and considers whether it is necessary to introduce any changes into the mathematical equations (a), the statistical prescriptions

(b) or the data (c) (since these data are typically summarized in a particular way from raw data). OLRAC representatives are involved in these discussions and they provide critical input into any changes that should be considered. Also discussed at working group level are any sensitivity tests that should be run. Here OLRAC participates in the discussions just as any other member at the working group level. These discussions lead to agreed modifications to (a), (b) and (c). Further discussions are also held about the set of output statistics that need to be produced in order to make scientifically based management recommendations. These output statistics will often include future projections of resource performance. The actual model development process is then complete, at least in principle. All that is then required is to implement the model numerically. This numerical implementation is typically achieved using a modern desktop computer and a particular software development platform. Examples of software development platforms include FORTRAN, PASCAL, BASIC, EXCEL, AD Model Builder and C++. OLRAC will always do its own computer based implementation of all models under consideration so as to advise the industry about the direction that the deliberations on the TAC are taking. MCM scientists and/or consultants will do the same. However, initial results from the model implementation process may on the basis of first results lead to additional changes to (a), (b) or (c) or the set of output statistics desired. The process proceeds in this fashion from one year to the next, and therefore model development is an ongoing and evolutionary process. OLRAC therefore has intimate knowledge of all aspects of the models, and frequently carries out cross checks between OLRAC's and MCM's computer based implementation of (a) (b) and (c) for mutual benefit.

Bjorndal Report page 13, 2nd paragraph, 3rd to 5th sentence. OLFISH has nothing to do with the population models used in the development of damage estimates. OLFISH is a commercial product developed by OLRAC and marketed worldwide. It is an electronic logbook and fisheries data management system.

Bjorndal Report page 13, 3rd paragraph, 1st sentence. OLRAC has already submitted a comprehensive list of documents to the defense which explain inter alia what the population model has been used for. There is also a substantial body of work in the literature about stock assessment models, explaining how these are used in the management of fish stocks. We note for clarification however that in the case of the South Coast rock lobster resource, the model is used to develop predictions of the medium term performance of the resource under different future constant catch levels. These form the basis for scientific recommendations on the TAC. A number of sensitivity tests are generally also used to produce medium term performance of the resource under different future constant catch levels, and these results are compared and considered in the formulation of management advice. Generally however, the reference or base case model is the one that forms the basis of the final recommendation. In the case of the West Coast rock lobster resource, the situation is slightly different. The population models which we have used, termed RC1 and RC2, in conjunction with a variety of sensitivity tests, are used as the basis for the development of a management procedure. The management procedure is referred to as an Operational Management Procedure (OMP) in South Africa. Thus, although RC1 and RC2 span a broad range of plausible possibilities for resource dynamics, management actually takes place via an OMP which is validated by RC1 and RC2.

Bjorndal Report page 13, 3rd paragraph, 2nd sentence. Elsewhere we explain the relevance of the population models for the estimation of damages by Methods I and II. Where relevant to the damage calculation, our opinion is that if the model is appropriate for purposes of formulating scientific recommendations on the TAC, then it is ideally suited to estimating the catch that needs to be forfeited in order to restore the resource biomass to the level that it would have reached in the absence of overcatches. Both the South African government and the South African fishing industry find it to be adequate for purposes of TAC recommendations, as does OLRAC and all scientists involved in the Rock Lobster Working Group. All members of the Rock Lobster Working Group have as a group debated and agreed to a set of mathematical descriptions for the population model, and the statistical prescriptions for estimating the parameters of the population model.

Bjorndal Report page 14, 2nd paragraph, 3rd sentence. The documents submitted to the defense contain a comprehensive description of all the methods used to estimate the model parameters, although we note that the basic method employed is maximum likelihood estimation (MLE). This is confirmed by Bjorndal Report page 14, 3rd paragraph, 1st sentence.

Bjorndal Report page 14, 3rd paragraph, 2nd sentence. Both the South African government and the fishing industry are of the opinion that the model is appropriate for purposes of formulating scientific recommendations on the TAC, and therefore the model is ideally suited to estimating the catch that needs to be forfeited in order to restore the resource biomass to the level. See our comments regarding the Bjorndal Report, page 5. The Bjorndal Report reflects a lack of appreciation that the population models used by OLRAC are the result of many years of work by a group of scientists from the University of Cape Town, MCM, OLRAC and other contracted scientists. These models form the core of fisheries management in South Africa and do not represent OLRAC's specific view or home grown population models. Nevertheless we have included in our new report additional damage calculations based on some of the sensitivity variants for the South Coast rock lobster model, to give some indication of how different these results might be in the event that a different model is used as the basis for the damage calculations.

Bjorndal Report, page, 1st paragraph: All the parameters used in OLRAC's models are the outcome of intensive work over many years by a large number of scientists (see page 14 comments above). Questioning OLRAC's calculations on the basis of possible inaccuracies in model design and parameters used is equivalent to questioning the entire basis for the management of the West and South Coast rock lobster resources in South Africa, where the quantitative underpinnings of fisheries management is considered to be at a high level. OLRAC and other South African scientists involved in quantitative fisheries management do not operate in a scientific vacuum and their work is routinely scrutinised by both local and international scientists.

Bjorndal Report page 15, 1st paragraph, 3rd sentence. Clear documentation about how the parameters in the OLRAC Report were selected has already been submitted to the defense.

Bjorndal Report page 15, 2nd paragraph. The defense is already in possession of a large number of documents which report estimates of the uncertainty of the parameter estimates for the population models which have been used. Our revised report also contains estimates of the uncertainty in the damage estimates, where such uncertainty is due to uncertainty in the parameters appearing in the population model. Documents already submitted to the defense which refer to parameter estimate uncertainty are as follows:

South African West Coast Rock Lobster:

1. Assumptions regarding future projections of the West Coast rock lobster resource for baseline trials for the 2003 OMP development process. S.J. Johnston and D.S. Butterworth. WG/04/03/WCRL7. 2003
2. Results of two alternate stock assessment models for the West Coast rock lobster resource. S.J. Johnston and D.S. Butterworth. MARAM. WG/04/03/WCRL8 2003
3. Feedback on West Coast rock lobster OMP development and testing options. OLRAC. 23 April 2003. WG/04/03/WCRL10. 2003
4. RC1 and RC2 stock assessments results by OLRAC. OLRAC. 23 April 2003. WG/04/03/WCRL11. 2003
5. Final Operating models and other issues relating to the West Coast Rock Lobster 2003 OMP development. S.J. Johnston and D.S. Butterworth. WG/06/03/WCRL14. 2003
6. Initial results of some new OMPs for the West Coast rock lobster resource. S.J. Johnston and D.S. Butterworth. MARAM. WG/07/03/WCRL16. 2003
7. Further results of alternate OMPs for the management of the West Coast Rock Lobster resource. S.J. Johnston and D.S. Butterworth. MARAM. WG/07/03/WCRL22. 2003
8. Final results of alternate OMPs for the management of the West Coast Rock Lobster resource. S.J. Johnston and D.S. Butterworth. MARAM. WG/08/03/WCRL25. 2003

9. Comparison between a 10% or 15% maximum TAC change constraint for the West Coast rock lobster OMP. S.J. Johnston and D.S. Butterworth. MARAM. WG/01/04/WCRL1. 2004

South African South Coast Rock Lobster:

1. OLRAC's work to date and issues for discussion – SCRL meeting – 02 April 2003. 2003
2. Stock assessments results for the South Coast rock lobster resource – 2003/2004 TAC. OLRAC. Aug 2003. WG/07/03/SCL5. 2003
3. The 2003 age-structured production model assessments and projections for the South Coast rock lobster resource. S.J. Johnston and D.S. Butterworth. MARAM. WG/07/03/SCL6. 2003
4. Further 2003 age-structured production model assessments and projections for the South Coast rock lobster resource. S.J. Johnston and D.S. Butterworth. MARAM. WG/08/03/SCL7. 2003
5. Further stock assessment results for the South Coast rock lobster resource exploring downweighted catch-at-age data. OLRAC. 15 Aug 2003. WG/07/03/SCL8. 2003
6. The 2004 age-structured production model assessments and projections for the South Coast rock lobster resource. S.J. Johnston and D.S. Butterworth. MARAM. WG/07/04/SCL10. 2004
7. South Coast rock lobster stock assessment results relevant to a TAC recommendation for the 2004/2005 fishing season. OLRAC. WG/07/04/SCL11. 2004

Bjorndal Report page 15, 3rd paragraph. This paragraph suggests that the existence of overcatches does not necessarily imply damage to the resource (referred to by Bjorndal as "intertemporal damage"). This contention seems based on an interpretation of the word 'damage', coupled with a suggestion that impacts due to overfishing may not carry forward from one year to the next (i.e. they are not intertemporal). Our opinion is that it is not necessary to specifically prove that resource impacts are intertemporal. It is common cause that harvesting, say, more three year old lobsters in one year will lead to the survival of fewer lobsters as four year olds the following year, so any aspersion that impacts are not intertemporal are not scientifically defensible. Such intertemporality of impacts on fish stocks is in fact central to all mainstream thinking about fish stock dynamics. As to the question of damage, there is an implication here that the resource will only have suffered damage if something very bad happens to the resource, without specifying what or how bad things must get to constitute damage. We have adopted the reasonable premise that any additional illegal catch will damage the resource to some extent, to a degree dependent on the size of the illegal catch. Given this premise, any overcatch suggested by Groeneveld or anyone else for that matter suggests that there is some associated damage of a scale commensurate with the size of the overcatch. Further, even if the resource shows an increasing trend it may still have suffered some damage in terms of our premise, since the increasing trend would have been more marked in the absence of the overcatch (and so a relative damage was incurred).

Bjorndal Report page 16, 1st paragraph. It is true that the inclusion of overcatches leads to a more optimistic appraisal of the resource. It is possible therefore that had HBF reported all its catches, that larger TACs may have been recommended. A corollary to this argument is that because HBF did not report all their catches, the TACs were actually smaller than they might have been. We have seen the former effect in recent scientific deliberations where the agreement by the Rock Lobster Working Group in 2004 to make allowance for additional earlier overcatches in the fishery based on the application of Groeneveld's methods to HBF's CPUE data has led to a more optimistic appraisal of resource status. This has probably contributed to the recent increase in the TAC for the 2004/2005 fishing season. This outcome does not alter the fact that whatever was reported or not reported, a relative damage was suffered as a result of overcatches by HBF. If the TAC increases it does not mean that the resource has not suffered any damage. Damage is not a qualitatively 'bad outcome' for the resource, associated only with, say, declining catch rates, resource biomasses and declining TACs. Rather it is a relative difference between what has happened as a result of overcatches and what might have happened in the absence of overcatches.

Bjorndal Report page 16, 2nd paragraph, 2nd sentence. The TAC is not, as claimed in the Bjorndal Report, set as a percentage of the estimated biomass for either South Coast or West Coast rock lobster. In the case of South Coast rock lobster, TACs have been based on estimates of the medium term performance of the resource subject to different constant catch harvesting strategies. In the case of West Coast rock lobster an 'Operational Management Procedure' (OMP) has been adopted for purposes of determining annual TACs. OMPs are simple formula for setting annual TACs, which have been validated using extensive computer simulations based on more complex size structured population models (in the case of the West Coast rock lobster resource).

Bjorndal Report page 16, 2nd paragraph. Bjorndal seems to be developing a similar argument as is presented in the 1st paragraph (see our penultimate comment above). He speculates that, had reporting been correct, larger TACs would have been allocated. This discussion relates purely to whether the scientific estimates are correct or not, but is not relevant to the existence of a difference in the trends in actual resource biomass with or without the occurrence of an overcatch, and hence the existence of a finite damage. It is appropriate here to reiterate an earlier point, viz.:

"Methods I-II rely on comparing what was actually caught from the resource, and the consequences this had for resource biomass, with what would probably (as indicated by populations models) have occurred to the resource biomass in the absence of these overcatches. Speculation that the pattern of legal catches might have been different had the overcatches been reported earlier (as suggested at times in the Bjorndal Report) is not relevant to the comparisons that are being used for the damage calculations. The important point is that one must draw a comparison of outcomes using a model with and without the occurrence of overcatches, but with the <u>same</u> sequence of historical legal catches, in order to calculate damages."

Bjorndal Report page 17, 1st paragraph. Our point in quotes immediately above is applicable in response to this point. In addition, our revised report includes standard errors of the catch forfeit and harvesting cost damages in Methods I and III, and shows that these exhibit a very high degree of statistical significance.

Bjorndal Report page 17, 2nd paragraph. We review the evidence in Groeneveld (2003) about overcatches by HBF in our responses to the Baird Report.

Bjorndal Report page 18, last paragraph continuing on page 19. We refer to our original report in comment on the Method I damage estimates: "This method of estimating the monetary value of the damage suffered by South Africa should not be taken to imply that the government actually undertakes to restore the resource to the level defined above, it just provides a basis for estimating the scale of the damage". There is no relevance of recent increases in the TAC nor any conflict between this and the method of calculating the catch that needs to be forfeited in order to restore the resource to the level it would have been at in the absence of overcatches. This argument against the reliability of Method I is therefore not valid.

Bjorndal Report, Page 19 1st paragraph: The report refers to a trend of increasing TACs following the removal of HBF from the fishery, apparently implying that no damage has occurred. We suggest however that this is actually strong circumstantial evidence that the scale of the HBF overcatches were such that when they stopped, the resource CPUE and biomass showed a dramatic turnaround (see Fig. 1). How much better off would the resource and the fishery now be had these overcatches not occurred in the first place?

Bjorndal Report page 19, 2nd and 3rd paragraphs. We acknowledge parsimony in the description of methodology in the OLRAC Report. However we consider that the various documents attached and submitted to the defense are technically adequate for a researcher to repeat and verify our calculations.

Bjorndal Report page 20, 2nd paragraphs. We have conducted further investigations into prices and submit our results of this investigation in Appendix C.

Bjorndal Report page 20, 3rd paragraph. It is common cause that the commercial catch rate, often referred to as the CPUE (catch-per-unit-effort), has an important bearing on the economy of a fishery. A lower CPUE level implies a lower production per unit of fishing effort expended, and so it stands to reason that the economic importance of CPUE is established as a matter of common sense. It is also fundamental to the science of quantitative fisheries management that there is a direct relationship between the CPUE, and the abundance of the stock. In our opinion then, the dependence of harvesting costs on stock size (an inversely proportional relationship) via the intervening amount, CPUE, is established as a fundamental basis of the field of bioeconomics and fisheries economics in general. Our report presents certain empirical support for a dependence of harvesting costs on CPUE, and the link between CPUE and stock size is a fundamental assumption underlying the overwhelming majority of studies into fish stock dynamics and their interaction with the fishing industry. In certain fisheries, such as purse-seine fisheries, this relationship is not established as simply proportional due to the probable action of the Paloheimo-Dicke effect (see e.g. Clark, 1985), but nonetheless there is an underlying acceptance of increasing harvesting costs with decreasing stock size even in this case. However, the proportional assumption is certainly integral to all the analyses pertaining to the South African South Coast rock lobster resource.

We refer to the following pages in Clark (1985) where the inverse relationship between harvesting costs and stock size is confirmed as a reasonable basis of any quantitative assessment of the economics of a fishery:

Equation 1.25 pp 22.

We refer to the following support in Clark (1985) for the reasonable assumption of proportionality between stock size and CPUE:

Figure 1.3, pp4, equation 1.3 pp 12.

Results presented in our revised report now include the uncertainties inherent in the additional harvesting costs calculated via this method.

Bjorndal Report page 21, 1st paragraph, last sentence. Basically, we concur with the last sentence in that paragraph regarding the difference between the stock dependencies of harvesting costs for the two resources. Our damage estimates reflect this essential point by the use of different parameter values for the West Coast and South Coast rock lobster damage calculations.

Bjorndal Report page 21, 2nd paragraph. The essential information regarding the estimates of increased harvesting costs is the difference between the resource biomass trends estimated from populations models with and without overcatches. This relative difference exists regardless of the trends in CPUE that have been recorded where overcatches have in fact occurred. Our premise is that these damages must have occurred. Self-evidently we do not have the luxury of rewinding the clock to observe how the CPUE would have evolved in the absence of overcatches, hence the need to make use of mathematical models that can compare what would most likely have occurred with and without the existence of historical overcatches.

Bjorndal Report page 22, 1st paragraph. Groeneveld (2003) is only relevant to the estimation of increased harvesting costs insofar as it provides evidence of the scale and timing of overcatches. We used different sources for the West Coast rock lobster overcatches. Hence Groeneveld (2003) is not referred to in regard to damage estimates for overcatches of West Coast rock lobster.

Bjorndal Report page 22, 2nd paragraph, 1-4 sentences. Where a single unit price is applicable to lobster product, harvesting costs can be translated into kilograms of lobsters by dividing them by said unit price. Therefore, if the harvesting cost is US$ 3 million and the price per kg tails is US$ 45, the harvesting costs can be treated as US$ 3 million/ US$ 45 = 66 6666.67 kilograms of lobsters. However, we acknowledge that our practice of expressing harvesting costs in tons of fish is somewhat unconventional, and we have therefore reverted to expressing it instead in monetary terms, in this our revised report.

Bjorndal Report page 22, 2nd paragraph, last sentence. We have assumed that harvesting costs are related to stock sizes, via information provided for a reference year, 2003, as is implied by equation 1.25 of Clark 1985). We acknowledge that different harvesting costs may have applied in different years, and different prices, and our methods are easily adapted to consider these possibilities, as has been done for the actual damage estimates submitted in this our revised report.

Bjorndal Report page 22, 3rd paragraph, 2nd sentence. In response to this sentence, we reiterate the following point in our original report: "This method of estimating the monetary value of the damage suffered by South Africa should not be taken to imply that the government actually undertakes to restore the resource to the level defined above, it just provides a basis for estimating the scale of the damage".

Bjorndal Report page 23, 1st paragraph, 1st sentence. The argument seems to be that there are no damages if it is possible to restore the resource biomass to a 'but-for' condition. However, our argument is that this cost of restoration constitutes a key element of damage.

Bjorndal Report page 24, 2nd paragraph. In our original implementation of this method (Method II), it involves calculating catches (taken legally rather than illegally) which are at an equal level over a number of years (i.e. a smooth pattern of additional catches different to the pattern over time of the illegal catches), which lead to the resource in 2005 reaching the same level as it did (estimated) with the actual pattern of overcatches. In this mode of implementation, it requires the use of a population model. However, if the pattern of catches is exactly equal to the pattern of illegal catches, an assumption which we adopted at some point in our original report as a short cut method, then it is not necessary to use a model. We did indicate in our original report where we made use of a population model, and where it was not required. Where we use a model, the sum of additional catches taken legally is not exactly the same as the sum of additional catches taken illegally. We recommend in the interests of simplicity however that we stick to a version of Method II in which the additional legal catches follow the identical pattern of the additional illegal catches, obviating the need to use a population model for the damage calculations.

Bjorndal Report page 25, 2nd paragraph. We do not agree with this argument. As pointed out earlier, the damage that has been sustained in Method II is the lost opportunity of taking the illegal catches as legal instead. South Africa lost this opportunity as a result of the defendant's actions, and this lost opportunity has a value equal to the value of the illegal catches.

Bjorndal Report page 25, 3rd paragraph. Bjorndal is here speculating on what might have happened if certain events had transpired. In this regard we refer to our earlier point:

"Methods I-III rely on comparing what was actually caught from the resource, and the consequences this had for resource biomass, with what would probably (as indicated by populations models) have occurred to the resource biomass in the absence of these overcatches. Speculation that the pattern of legal catches might have been different had the overcatches been reported earlier (as suggested at times in the Bjorndal Report) is not relevant to the comparisons that are being used for the damage calculations. The important point is that one must draw a comparison of outcomes using a model with and without the occurrence of overcatches, but with the <u>same</u> sequence of historical legal catches, in order to calculate damages."

Bjorndal Report page 26, 1st paragraph. Our view on this is exactly the same as the comment made immediately above in relation to the Bjorndal Report page 25, 3rd paragraph.

Bjorndal Report page 26, 2nd paragraph. This argument refers to an apportionment of damages which we do not feel is within the scope of our expertise. It may well be correct, however we assume that this is a matter for a different authority. We should however point out that in the implementation of Method I in our earlier report, the percentage correction proposed by Bjorndal was actually applied to the additional harvesting costs calculated via that method. Specifically we only accounted for the additional harvesting costs suffered by the remainder of the fishing industry. In this report we have modified this – our Method I damage estimates due to additional harvesting costs now include the additional harvesting costs incurred by HBF for harvesting its legal allocation. Similarly our Method II and III damage estimates are for the entire fishing industry. If apportionment is required then this can be done by the method proposed by Bjorndal. To aid in this, we submit a table (Table 3) of the legal proportion of HBF quotas as a percentage of the TAC, 1987/88 to 2000/2001. These quota amounts include amounts allocated to Tradequick 62, Amandla Abasebensi, and Fullimput 2 in 1998/1999, 1999/2000 and 2000/2001.

Bjorndal Report page 26, 3rd paragraph. This point refers to the fact that, as referred to above, the original implementation of Method II involves calculating catches (taken legally rather than via the illegal pattern of catches) which are at an equal level over a number of years, which lead to the resource in 2005 reaching the same level as it did (estimated) with the actual pattern of overcatches. In this mode of implementation, it requires the use of a population model. Where we use a model, the sum of additional catches taken legally is not exactly the same as the sum of additional catches taken illegally. In our revised report we have in the interests of simplicity used a version of Method II in which the additional legal catches follow the identical pattern of the additional illegal catches, eliminating the apparent inconsistency referred to by Bjorndal.

Bjorndal Report page 27, 2nd paragraph. The Method II damages for the West Coast rock lobster resource for 1987/88 – 1998/99 were calculated via the 'simple Method II' methodology, which does not involve the use of a population model. These damages are simply the overcatch multiplied by the price. The damage due to the overcatch of 598 tons in the 1999/2000 fishing season was calculated as follows:

"In the underlying mathematical models, a version is first run which includes all historical overcatches. The model is fitted under these conditions – we refer to this as Actual. The actual model is then modified by only removing the historic catches, but the model is not refitted. This model is referred to as Hypothetical. We now add catches to the Hypothetical model, an equal amount for each year between and including 1999/2000 – 2003/2004 for West Coast rock lobster, until the resource biomass at the beginning of 2005/2006 is the same as in the Actual model. These catches, cumulatively, represent the additional TAC that could have been taken, in the absence of overcatches. These catches are however taken as a smooth equal amount between 1999/2000 and 2003/2004, different to the once off illegal harvest of 598 tons in 1999/2000. "

Bjorndal Report page 27, 3rd paragraph. We are not in a position to make a decision about whether costs should be deducted from the damage calculations, and note that there are possibly counter arguments to this. It is possible that a different authority will rule that this is indeed a more defensible approach. We have therefore attempted to assist such a process by submitting certain damage calculations via Method III which correspond to lost profits.

Bjorndal Report page 28, 2nd paragraph. There is clearly uncertainty about precise overcatch amounts. Ideally the damage calculations would be based on precisely known overcatch amounts, but by its very definition, illegal catch amounts are difficult to estimate. Our estimates in the case of West Coast rock lobster need to be adjusted in relation to whatever illegal harvests are considered plausible, by a different authority to ourselves.

Bjorndal Report page 28, 2nd paragraph, through to end of 1st paragraph on page 31. We have noted in our earlier report that:

"A set of estimates of overcatches for the 1996/97, 1997/98 and 1998/99 fishing seasons are reported in a scientific publication (Groeneveld, 2003). These estimates are based on discrepancies between the daily catches per vessel reported for vessels involved in overcatches, and daily catches per vessel for other vessels harvesting South Coast rock lobster. Groeneveld (2003) actually presents two versions of these estimates (a) and (b) and both of these also produce estimates for the

1999/2000 and 2000/2001 fishing seasons. However, version (a) estimates are best matched with the Wynberg Magistrates Court values for the 1999/2000 and 2000/2001 fishing seasons, and so the version (a) results are presented here for the 1996/97, 1997/98 and 1998/99 fishing seasons, since the method underlying the (b) estimates would therefore appear to be unreliable."

Without over-elaborating this point, the support for using the maximum catch rate, method (a), results is quite simply that this method results in estimates of overcatch for the 1999/2000 and 2000/2001 fishing seasons which are better matched with the amounts for these two seasons actually admitted to in a plea bargain. The matter of the statistical error associated with this approach is addressed in our responses to the Baird Report.

Bjorndal Report page 31, 2nd paragraph. The 'no model' in Summary Table 1 of the OLRAC Report actually means that the 'simple' version of the Method II damage calculation method was applied, which did not require the application of a population model. With regard to the method of overcatch calculation, we have addressed this in our responses to the Baird Report.

Bjorndal Report page 31, 3rd paragraph. Same comment as above.

Bjorndal Report page 32, 2nd paragraph. Same comment as above.

Bjorndal Report page 32, 3rd paragraph. See Appendix C.

Bjorndal Report page 32, 4th paragraph. Comments about the time varying nature of lobster product prices in different markets are valid, and have impacts on the different methods which have been proposed for calculating damages, viz. Method I, II and III. We have made efforts to obtain lobster price information relevant to the South African rock lobster species, products and markets over the years (see Appendix C). This information improves our previous understanding of lobster prices and requires that we modify and update our previous damage estimates, as is done in this report.

Bjorndal Report page 33, 2nd paragraph. The Bjorndal Report correctly identifies two errors in Table 8 of page 21 of the OLRAC Report (22 July, 2004), presumably legacy figures from revisions that were being carried out on the draft versions of the OLRAC Report. These two errors will be corrected in subsequent submissions, where still relevant.

Bjorndal Report page 33, 3rd paragraph. For West Coast rock lobster, the minimum size in the 1991/1992 fishing season was set to 89 mm and then reduced to 75 mm during the season. Catch amounts are kept separate for these two time periods. Although both catches refer to the same fishing season they are kept separate so that the models can correctly address this complexity. Hence the two catch values for the 1991/92 fishing season. The reason for the absence of female catch-at-size data for 1991 in Tables 5b and 6b of Appendix 2, pages 21 and 23, is that there was a ban on the harvesting of females in 1991 only, hence the absence of female catch-at-size data.

Bjorndal Report page 34, 2nd paragraph. In this revised report, we offer the Method III damage estimates which lend themselves to tax computations, albeit not in the precise terms suggested by Bjorndal.

Bjorndal Report page 35, 1st paragraph. Method II provides a basis for the calculation of the damage referred to in this paragraph.

3.5 Comment on the Baird Report

The following are our considered responses to the various points raised in the Baird Report.

Baird Report, Page 3 last sentence: Our understanding of events is that HBF has already admitted making overcatches in both the West and South Coast rock lobster resources. Therefore, the overcatches by HBF are not alleged, as suggested by the Baird Report, but rather an admitted fact.

Baird Report, Page 4-5, Conclusions. The Bjorndal Report pursues a similar argument, and in both cases we regard this as a flawed argument. Hence we offer the same response: "Methods I-II rely on comparing what was actually caught from the resource, and the consequences that this had for resource biomass, with what would probably (as indicated by populations models) have occurred to the resource biomass in the absence of these overcatches. Speculation that the pattern of legal catches might have been different had the overcatches been reported earlier (as suggested at times in the Bjorndal Report) is not relevant to the comparisons that are being used for the damage calculations. Neither is it relevant whether TAC's have increased or decreased since 2000. The important point is that one must draw a comparison of outcomes using a model with and without the occurrence of overcatches, but with the same sequence of historical legal catches, in order to calculate damages."

Baird Report, Pages 5-9: This is a brief overview of the West Coast rock lobster resource based on material in the literature. The end of this section suggests that the increase in TAC in recent years means that HBF overcatches did not cause any damage to the resource. We have argued against this and similar arguments elsewhere in the Baird Report and in the Bjorndal Report. Our comment is therefore the same as our prevous comment, submitted immediately above.

Baird Report, Page 6: The mass strandings referred to are a natural event. It is most likely that these mass strandings would have occurred had overcatches by HBF not occurred. One must therefore still infer a relative damage due to overcatches between two versions of the population model which differ only in respect that one of them omits the HBF overcatches. Both versions must make allowance for mass walkouts, or both not. The results will not be substantively different whether they are included in both models, or omitted in both models. However, what one cannot do is consider these walkouts in one model and not in the other, for the purposes of the comparison necessary to calculate damages.

Baird Report, Page 8: There is an implication here that because other sources of overcatch (catches exceeding the TAC) occurred, there is no damage due to HBF overcatches. We do not agree with this implication.

Baird Report, Page 8, last sentence: It is not clear what decline is referred to in this sentence. We at no stage suggest or claim that the entire decline of any amount is solely due to overcatches by HBF. Our damage estimates are based on a comparison of best estimates of actual resource biomass trends, with an inference from the same population model but which excludes HBF overcatches.

Baird Report, Page 9 2nd paragraph. This entire paragraph of reasoning is flawed by the erroneous assumption that the TAC comprises 30% of the resource biomass. Best estimates by the rock lobster working group put this figure at about 8%. Speculation about increasing trends in the resource biomass also have no bearing on notions of damage other than when these trends are compared with the same quantitative calculation repeated without HBF overcatches included.

Baird Report, Page 10-13. These pages critique OLRAC's recommendation to use the (a) estimates from Groeneveld as the basis of estimating HBF overcatches from 1996/97 to 1998/99, and the extrapolation of this method to the 1987/88 – 1990/91 and 1991/92 – 1995/96 time periods. An excerpt from the OLRAC Report reads as follows:

"A set of estimates of overcatches for the 1996/97, 1997/98 and 1998/99 fishing seasons are reported in a scientific publication (Groeneveld, 2003). These estimates are based on discrepancies between the daily catches per vessel reported for vessels involved in overcatches, and daily catches per vessel for other vessels harvesting South Coast rock lobster. Groeneveld (2003) actually presents two versions of these estimates (a) and (b) and both of these also produce estimates for the

1999/2000 and 2000/2001 fishing seasons. However, version (a) estimates are best matched with the Wynberg Magistrates Court values for the 1999/2000 and 2000/2001 fishing seasons, and so the version (a) results are presented here for the 1996/97, 1997/98 and 1998/99 fishing seasons, since the method underlying the (b) estimates would therefore appear to be unreliable."

The critique starts with an incorrect premise, that "According to the OLRAC Report the SCRL resource has been depleted by catches exceeding the TAC". As we have repeatedly pointed out, we assume that the resource is worse off (i.e. smaller) than it would have been in the absence of HBF overcatches, and this does not necessarily imply that HBF overcatches have caused an absolute depletion of the resource.

The main argument against the method that we propose for inferring pre-1999 overcatches by HBF is that the difference between the methods predictions and the actual admitted amounts in 1999/2000 and 2000/2001 is too large, being -17.7% and +7.4% respectively. Given the uncertainties involved, we opine that this variance is not excessive.

Baird Report, Page 11, 2nd paragraph, 1st sentence. The reason was in fact that the variance of -39% for method (b) of Groeneveld (2003) was simply too large to be able to use method (b) as a basis for extrapolating to early years.

Baird Report, Page 11, 2nd paragraph, 3rdt sentence. The sample size referred to by Baird relate to the number of sets recorded by the industry in 1999/2000 and 2000/2001. This figure would be in the order of 2000 sets excluding the HBF sets. The standard error on the catch rate is therefore the standard deviation of the catch rate divided by the square root of 2000, which would yield a CV (coefficient of variation) of only one or two percent. However, we suggest that these standard deviations do not provide a reliable estimate of the model error inherent in the assumption that method (a) is correct. It is proposed that the variances in 1999/2000 and 2000/2001 between the total annual method (a) estimates and the total annual admitted amounts provide a more appropriate basis for estimating the inherent variance of estimates based on method (a). Unfortunately two data points (the annual totals for 1999/2000 and 2000/2001) is one less than is required to obtain reliable estimates of the variances involved.

It is suggested therefore that another way of looking at the admitted overcatch information for the 1999/2000 and 2000/2001 fishing seasons is to appreciate that in the 1999/2000 fishing season, considering both legal and illegal catches, HBF was able to land 206.2 tons of South Coast rock lobster tails, using a total of 981 seadays. That is, on MCM records, HBF vessels were cumulatively at sea for a total of 981 days in the 1999/2000 fishing season.

In the 2000/2001 fishing season, considering both legal and illegal catches, HBF was able to land 128.3 tons of South Coast rock lobster tails, using a total of 704 seadays, comprising the following vessel specific records from the MCM Vessel Monitoring System.

Arctic Fox: 178 seadays
Cape Flower: 177 seadays
Eagle Star: 175 seadays
Portia: 174 seadays.

We refer the reader to Table 4. These seaday data provide another avenue for the determination of the overcatch by HBF, since they provide a very good idea of the catch per seaday that was being achieved by HBF fishing vessels. There is no reason that these vessels could not perform at a similar level in earlier years.

Provided that all time at sea was reported correctly for all HBF vessels for early years which predate the installation of VMS on vessels, one can calculate the catch per seaday in the 1999/2000 and 2000/2001 fishing season by simply dividing the sum of 206.2 tons and 128.3 tons by the sum of 981 and 639 seadays, giving a catch per seaday of 199 kg of tails for HBF vessels as an average for the 1999/2000 and 2000/2001 fishing seasons (see the figure of 0.199 MT/seaday for 1999 and 2000 in Table 4).

It is then reasonable to back-calculate the total HBF catch to earlier seasons by assuming that the catch per seaday in those seasons was comparable to what was achieved in 1999/2000 and 2000/2001, but adjusted by the scientifically determined CPUE reported in Table 1. This shows that earlier in the period 1987-2000, larger average catch rates in the fishery were applicable. These scientifically determined catch rates are quoted in units of kg tails/trap. It seems reasonable to conclude that if the overall average scientific catch rate was larger in years prior to 1999, then the daily catches by HBF vessels would also have been larger. One can extend this argument to the implementation of a ratio adjustment to the 1999 and 2000 HBF daily catch rates (as implied by the admitted overcatches) to obtain likely daily catches rates for HBF vessels between 1987 and 1998.

The additional undeclared HBF catches which are obtained by application of this method are shown in Table 4 in the following columns:

- Total estimated HBF catch: "Estimated HBF catch MT"
- The estimated overcatch by HBF: "HBF Overcatch MT"
- Overcatches estimated using Groeneveld's (2003) method (a), but setting the 1987/88 – 1990/91 estimates equal to the average of the Groeneveld (2003) method (a) estimates for 1991/92 – 1995/96. "Method (a) Overcatch MT".

The essential point is that the comparison of "Estimated HBF catch MT" with the Groeneveld (2003) "Method (a) Overcatch MT" shows that the latter are generally smaller than the "Estimated HBF catch MT" based on the seaday based calculations (as described immediately above). This supports a view expressed elsewhere in this document that the Groeneveld (2003) method (a) estimates are conservative estimates. We note that in 1995, the overcatch as a percentage of HBF's total estimated catch is as follows:

The seaday based estimates = 65/176 = 34%

The Groeneveld method (a) estimates = 77.9/189 = 41.2%,

These values are relevant to information about overcatches that is contained in affidavits to be tabled.

Baird Report, Page 12, 1st paragraph: This paragraph argues against drawing any inference about the scale of HBF overcatches from the increase in the standardized commercial CPUE from 1997/98 onwards. Such increase is evident in Table 1 and Fig. 1. Although this is not relevant to our damage calculations, we do allude to it in our preamble. The Baird Report argument hinges on the fact that HBF admitted making substantial overcatches in 1999/2000 and 2000/2001, and that therefore the CPUE should have shown a decline which continued during the 1999/2000 – 2000/2001 period. We note however that if the method (a) estimates of overcatches by HBF are assumed to be correct, and extended back to 1991 for illustrative purposes, then the pattern of total catches in the resource would follow the pattern suggested by Table 5 below:

The essential point of this table as it relates to the argument in the Baird Report is that a substantial decline in the total catch taken from the resource occurred in 2000/2001, which is when the first real increase in CPUE occurred. Hence taking these quantities at face value, there is indeed a correspondence and logic between the CPUE trends and the total catches removed, viz. CPUE increases essentially following reductions in the total catch.

Baird Report, Page 13 last paragraph running over to page 14: We used the same CPUE data that were scrutinised, verified and standardized by scientists attending meetings of the Rock Lobster Working Group. The scientific process is very critical and in-depth. We used the best data and the best methodology available in the framework of the scientific process established in South Africa for the management of fish resources.

Baird Report, Page 14 2nd paragraph: The thrust of this argument seems flawed. In May 1999 there were only 12 vessels in the South Coast rock lobster fishery. Possibly the claim in the Baird Report that there were 51 vessels in the fleet in 1999 came from a total vessel list based on vessels appearing at one time or another in the entire historic CPUE database. Many of the older vessels no longer in the fishery would not reflect use of echo-sounders, GPS and/or line plotters. If our assumption is correct, then this represents a lack of appreciation of the fishery, the CPUE database, and the arguments surrounding our damage estimates.

Baird Report, Pages 14, point 7 i: We have argued that effort saturation played a significant role in the reduction of the CPUE during the 1990s, and this theory is the subject of one of the sensitivity tests routinely run as part of the annual stock assessment process. We have included a scenario in which the Method I and III damage estimates are instead based on a model that incorporates the effort saturation process into the model, using modifications that were discussed and agreed to at the Rock Lobster Working Group. The working group has actually defined this as a standard sensitivity test to be run as a check on the stock assessment calculations. We note that the effort saturation hypothesis has never been accepted by MCM. There is a paper in print authored by MCM scientists and academics and consultants from the University of Cape Town that argues to reject the effort saturation hypothesis (see: Groeneveld, J.C., Butterworth, D.S, Glazer, J.P., Branch, G.M. and A.C. Cockroft. 2003. An experimental assessment of the impact of gear saturation on an abundance index for an exploited rock lobster resource. Fisheries Research 65: 453 – 465).

Baird Report, Page 15 ii: This is an argument which we have repeatedly responded to by the following:

"Methods I-III rely on comparing what was actually caught from the resource, and the consequences this had for resource biomass, with what would probably (as indicated by populations models) have occurred to the resource biomass in the absence of these overcatches. Comments about recent increases in resource biomass and/or TACs are not relevant to this comparison. The important point is that one must draw a comparison of outcomes using a model with and without the occurrence of overcatches, but with the same sequence of historical legal catches, in order to calculate damages."

Baird Report, Page 15 ii: This is a purely qualitative argument. It is necessary for the author to state on what basis is it being claimed that 8.45% of the exploitable biomass is not a lot?

Baird Report, Page 15 iv: The various reports and documents submitted to the defense propose that this steep decline was due to fluctuations in recruitment that occurred at that time.

Baird Report, Pages 15 – 16 7a: We note that the effort saturation hypothesis has never been accepted by MCM, and there is a paper in print that argues against this hypothesis (see: Groeneveld, J.C., Butterworth, D.S, Glazer, J.P., Branch, G.M. and A.C. Cockroft. 2003. An experimental assessment of the impact of gear saturation on an abundance index for an exploited rock lobster resource. Fisheries Research 65: 453 – 465). We quote from the conclusions in that paper:

"The central conclusion of this study is therefore that the effort-reduction experiment produced little support for the contention that increased gear saturation effects have caused reduced catch rates of a magnitude sufficient to bias the CPUE-based abundance index appreciably. Accordingly, there is little basis to cite increased effort as a reason to avoid cutting TACs in response to declines in the abundance index."

Baird Report, Pages 16, 2nd paragraph. There is an inaccuracy in this paragraph. The amount of 379.7 tons was taken in 1999/2000 (when HBF was still fully active) and not in 2000/01. The Baird Report frequently argues that HBF overcatches were minimal or insignificant since the highest values were 6.71% and 8.45% of the exploitable biomass, amounts that he argues are very small. However, considering that the entire TAC for the South Coast rock lobster resource amounts to

15% of the exploitable biomass (a 350 ton TAC out of a 2300 ton exploitable biomass), the HBF overcatch in 1999/2000 represents more than 50% of the legal TAC. It is interesting to note that for West Coast rock lobster the present estimated harvest proportion is about 8% of the total exploitable biomass. This figure is not relevant to South Coast rock lobster other than to note that 8.45% is very significant under certain circumstances (i.e. as a harvest proportion for an entire fishery in some cases).

Baird Report, Pages 16-17 7b: The increase in CPUE was not really evident between 1998/99 and 1999/00 when it was only +2.25%. In 2000/2001, when HBF was removed from the fishery we see the most striking increases in the commercial catch rate, +12.24%. There is in fact (see Table 1, Fig. 1) a clear trend of declining CPUE in the South Coast rock lobster fishery from the time that HBF introduced a number of larger vessels into the fishery until about the time that HBF was excluded from the fishery. The Baird Reports has not commented on this rather simple fact.

Baird Report, Page 18, 1st paragraph: A number of highly qualified individuals (Professors and Ph.D. and M.Sc. graduates in Applied Mathematics, Marine Biology and Fisheries Science) have been involved in the development of the population models in question over a period of many years, aspects have been the subject of M.Sc. and Ph.D. theses, and various aspects have also appeared in peer reviewed publications. The Rock Lobster Working Group has been extraordinarily active over the last 10 years spurred on by critical and opposing input due to representation by both economic and more conservative interests. The quantitative methodology has been intensively reviewed by specific annual workshops since 2000. These workshops have been attended by panels of quantitative fisheries scientists from North America, Europe, Australasia, Norway and South America. Finally, dual development of the mathematical models has been undertaken, by OLRAC on the one hand, and by consultants to the MCM on the other hand. OLRAC's model development work has involved in-house development in triplicate using three different software platforms – in our case FORTRAN, Excel and AD Model Builder software platforms have been used. All these computer based implementations have to date achieved very close agreement with each other, and so coding errors are not a serious concern. We are therefore satisfied that further peer review input will not substantively alter the damage calculations via the methods used in our previous report.

OLRAC's modelling work has arisen as a result of their intimate involvement in the quantitative management of the two rock lobster resource in question for about 15 years. Many of the modelling techniques now used to assess these resources were initiated by OLRAC and have been further developed over the years by scientists from MCM and the University of Cape Town through a consultative process in which OLRAC has been an active participant. Questioning OLRAC's models and credentials amounts to questioning the merits of the management of fish resources in South Africa. Considering the fact that many countries in the world regard South Africa as one of the few examples in the world where major fish resources are still in a reasonable condition, it would seem unjustified to refer to the methods and results as questionable.

Baird Report, page 18, Summary: We repeat comments made elsewhere, that the development of the population models for South and West Coast rock lobster was an inclusive process involving the Rock Lobster Working Group. We are unclear what is being referred to as the development of the population model, and why our supposed non-development of these models renders the results in our report questionable. The population model is simply a set of mathematical equations which are relatively easily implemented on a modern computer using standard software development platforms such as C++ or AD Model Builder or FORTRAN. We are intimately involved in all these aspects via our involvement with the Rock Lobster Working Group. We employ numerous mathematicians and statisticians to work on the various population models under discussion and these professionals are in routine contact with other population modelers, checking and verifying each others work.

3.6 Points about revised damage estimates reported here

Method I (Restoration of Resource Biomass): There are two amounts associated with this method, a 'Catch Forfeit' amount, and an 'Additional Harvest Cost' amount. The monetary value reported for the 'Catch Forfeit' amount is simply the chosen contemporary price, multiplied by the tonnage. The value reported for the 'Additional Harvest Cost' is as defined. However, it is valid to point out that this amount is pure lost profit, since it represents additional benefits that would be realized for the same catches once all other costs are covered. Note that all these costs have in fact already been covered in the course of the catching and selling of all legal TAC amounts. We recognize that the 'Catch Forfeit' amount is different in the sense that it cannot necessarily be viewed as pure lost profit in the same way that the 'Additional Harvest Cost' can. The pricing applicable to the valuation of the 'Catch Forfeit' amount is assumed to be contemporary pricing, adjusted down in recognition of the uncertainty of prices over the next few years.

Note that catch forfeits are made in the following years:

- South Coast rock lobster: 2005/2006 and 2006/2007. In other words, we make a small adjustment to the Method I methodology report in the OLRAC Report (22 July 2004), where the 2004/2005 was used as the period for the catch forfeit calculation. Here we have spread the catch forfeit equally across two years.
- West Coast rock lobster: 2005/2006.

Method II (Lost Opportunity): This method does not involve the use of population models. The amount reported is simply price (at the time of the overcatch) multiplied by the amount overcaught. The only relevance of the technical information presented here, is that we present some information additional information about overcatches for South Coast rock lobster, for 1987 – 1998, and some additional information about prices.

Method III (Perpetually Larger Harvesting Costs): The amount reported in this case is based on the assumption that the resource biomass is never restored. The amount is therefore the perpetual additional harvesting costs incurred in the fishery. However, intuitively the ability to predict a damage in the future based on information and population models available at the present time, must decrease the further one projects forward in time. We encountered this problem when we calculated the standard errors associated with the damage estimates. It would appear that beyond about 2015, the standard errors increase to the extent that the standard error exceeds the mean. We therefore limit these damage estimates to the cumulative additional harvesting costs between 1987 and 2015. As in Method I, the value reported for the Additional Harvest Cost is pure lost profit, since it represents additional benefits that would be realized for the same catches once all other costs are covered (as we assume has occurred in the course of the catching and selling of all legal amounts of TAC).

From the information gathered, the average price for tails into the USA market for the period 1987 to 2004 is US$38.3, and for the Japanese market the average is US$ 34.8. However, the information indicates a larger price in recent times (see Appendix C). We therefore used the average price for 1987 to 1993 of US$ 34.6 for those years, and a value of US$45 for 2001 – 2015. We linearly interpolated to obtain prices for 1994 to 2000, and the values are as given in the table in Appendix C.

The situation is different for West Coast rock lobster where over the last 10-14 years there has been a concerted effort to increase the tonnage sold at much higher prices in the live form, to the extent that the proportion of product sold live is currently in the region of 75%. We have therefore assumed an average price per kg whole of US$12 for West Coast rock lobster, but increasing that amount linearly to a 2004 price of US$17.25/kg whole weight, which is the average of the whole cooked and frozen price assumed of US$12.00/kg whole weight and the live price of US$ 19/kg whole weight, but weighted 25:75. For the future we assumed the prevailing price of US$17.25/kg whole weight. The year specific prices are therefore as given in Appendix C.

Note that prices quoted in Appendix C include freight costs.

We note that in all cases, we have produced the following additional options and calculations, to assist in the determination of damages.

With regard to overcatches, we have for, South Coast rock lobster, presented all damage estimates for the following four overcatch possibilities:

1) the amounts produced by Groeneveld's (2003) Method (a), plus the average of the Groeneveld (2003) Method (a) estimates for 1991/92 – 1995/96 extrapolated to 1987/88 – 1990/91.
2) the above excluding the 1987/88 – 1990/91 amounts.
3) the above excluding the 1991/92 – 1995/96 amounts.
4) the above excluding the 1996/97 – 1998/99 amounts.

For West Coast rock lobster, we present the following three overcatch options:

1) 598 tons overcaught in 1999/2000 only.
2) 598 tons overcaught in 1999/2000, and 100 tons in each season 1987/88 – 1998/99.
3) 598 tons overcaught in 1999/2000, and 200 tons in each season 1987/88 – 1998/99. Based on affidavits to be submitted as evidence we understand that this amount is a conservative figure since one of the witnesses said that, prior to 1998, 75 tons of illegal tails of West Coast rock lobster was being shipped per year. For West Coast rock lobster the tail weight is about 28% of the whole weight, so this translates to a figure of 267 MT whole weight per year, which is more than the value of 200 MT which has been used in the damage estimates for this overcatch option. Another witness refers in 1993 to about 30% of WCRL that was handled being illegal.

A further set of options with regard to harvesting costs are presented:

1. For South Coast rock lobster, we present two harvesting cost options. We relate harvesting costs to price by a percentage for each year in the 'Actual' model situation. It is then assumed that for all years of the Actual situation with overcatches present, harvesting costs are either 50% (a conservative value presented for comparative purposes) or 64% (our best estimate reported in the OLRAC Report) of the price of rock lobsters per year.
2. For West Coast rock lobster, we present two harvesting cost options, viz. for the Actual situation with overcatches it is assumed that harvesting costs are either 15% (a low figure) or 25% (a high figure) of the price of rock lobsters per year.
3. We note that for South Coast rock lobster we also include a number of estimates based on two different population models, being the effort saturation and low recruitment versions of the base case model. The effort saturation hypothesis is discussed earlier in our report, and the low recruitment version of the population model is yet another of the sensitivity tests that are routinely run by the Rock Lobster Working Group each year in the determination of TAC recommendations for the resource. These results are presented to give an indication of how the results differ in the event that different variants of the population model is used.
4. For West Coast rock lobster results are presented for the RC1 and RC2 stock assessment options described in documents submitted to the defense.
5. For West Coast rock lobster we have also explored the implications of running a variant of the stock assessment model which makes special allowance for natural walkouts via a procedure recommended as a sensitivity test by the Rock Lobster Working Group. This is sensitivity test W1 discussed in the document OLRAC (2003).

4. Results

The damage estimate results are presented in Table 8 – 12. Tables 8 and 9 cover the South Coast rock lobster resource, while Tables 10-12 cover the West Coast rock lobster resource. The amounts are smaller than in the OLRAC Report of 22 July primarily because of the use of lower prices. Although the information we gathered about harvesting costs indicated that 64% of the value of South Coast rock lobster in 2004 was due to effort related costs, we have considered a range of 50% - 64% for harvesting costs in the fishery since 1987, as a percentage of the final price of product under the Actual model. The results are difficult to summarise because of the use of different overcatch options, and the use of different harvest proportions. Basically, our damage estimates are:

1. South Coast rock lobster damage estimate, 1987 – 2000 overcatches, Base Case model, **Method I**, 64% harvesting cost option = US$ 45 027 000-00.
2. South Coast rock lobster damage estimate, 1987 – 2000 overcatches, **Method II** = US$ 32 436 000-00.
3. South Coast rock lobster damage estimate, 1987 – 2000 overcatches, Base Case model, **Method III**, 64% harvesting cost option = US$ 41 310 000-00.
4. For West Coast rock lobster, assuming an overcatch of 598 MT in 1999/2000 and 200 MT in each of the years 1987/88 – 1998/99, averaging the RC1 and RC2 model results, 15% harvest cost option, Method I = US$ 40 477 500-00.
5. For West Coast rock lobster, assuming an overcatch of 598 MT in 1999/2000 and 200 MT in each of the years 1987/88 – 1998/99, Method II = US$ 40 169 500-00.
6. For West Coast rock lobster, assuming an overcatch of 598 MT in 1999/2000 and 200 MT in each of the years 1987/88 – 1998/99, averaging the RC1 and RC2 model results, 15% harvest cost option, Method III = US$ 13 949 950-00.

However, there are a large number of options relating to the use of different methods, different overcatch amounts, different harvesting cost options and different models presented in Tables 8-12.

5. References

Charge sheet in the regional division of the Cape held in the regional court Wynberg. The state versus Hout Bay Fishing Industries (Pty) Ltd and Collin Ernst Hendrik van Schalkwyk.

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OLRAC. 2003. Feedback on West Coast rock lobster OMP development and testing options. WG/04/03/WCRL10.

OLRAC. 2004. Calculation of damages suffered as a result of catches exceeding legal limits in the South Coast and West Coast rock lobster resources in South Africa. 22 July 2004, 24 pages.

Table 1. Estimates of commercial catch rate, standardized for systematic effects using a GLM procedure, for the period 1986/87 – 2002/2003.

Season	CPUE (kg/trap)
77/78	0.2213
78/79	0.2074
79/80	0.1613
80/81	0.2060
81/82	0.1952
82/83	0.1671
83/84	0.1986
84/85	0.1664
85/86	0.1626
86/87	0.2111
87/88	0.1877
88/89	0.2263
89/90	0.2075
90/91	0.1759
91/92	0.1452
92/93	0.1417
93/94	0.1296
94/95	0.1190
95/96	0.1101
96/97	0.0925
97/98	0.0839
98/99	0.0799
99/00	0.0817
00/01	0.0917
01/02	0.1026
02/03	0.1129

Table 2. A worked example of the calculation of additional harvesting costs incurred in the South Coast rock lobster fishery, given exploitable biomass estimates for the case with and without overcatches, and given the actual cost of effort per kg tails for a reference year (2003/2004 in this case). The table contains the exploitable biomasses which are estimated by the base case stock assessment 'Actual' model for the South Coast rock lobster resource, including all the historic overcatch amounts that have been agreed to by the Rock Lobster Working Group. However, for this example, we only consider the overcatches for 1999/2000 and 2000/2001 to be included in the damage calculation, i.e. only these catches are excluded from the Hypothetical model run. The spawning biomass for the 'Actual' model has been grown back to the level that it would have been in the absence of overcatches, by forfeiting catches in 2004 and 2005 – note that the {Legal TAC-Catch forfeit} differs from the Legal TAC in 2004 and 2005. Note that this is a difference to the OLRAC Report (22 July 2004) where we used a one year grow back procedure, since in some cases one year is not sufficient to grow the resource back to the level that it would have otherwise reached in the absence of overcatches. Hence our use of two years over which the Catch forfeit amount is calculated. Therefore the exploitable biomass in the 'Hypothetical' and 'Actual' models are quite close in 2006. Also note that the unit harvesting costs are ZAR 178 in the 'Actual' model in 2003. All the remaining unit harvesting costs in other years are simply 178 multiplied by the exploitable biomass in the 'Actual' model in the 2003/2004 fishing season, divided by the exploitable biomass for the year, whether 'Actual' or 'Hypothetical'. The additional harvesting costs are then the difference between the unit harvesting costs multiplied by the {Legal TAC-Catch forfeit} amounts. Note that this leaves unstated the matter of the difference between the harvesting costs for the {Catch forfeit} amount, and the harvesting costs for the same amount of catch in the same years for the 'Hypothetical' model. From the point of view of the damage calculations and the valuation of this {Catch forfeit} amount, these harvesting costs should be regarded as equal to the 'Hypothetical' model's predictions, hence there is no difference to report in this regard in respect to harvesting costs. This example is illustrative. A TAC has already been set for the 2004/2005 fishing season, of 382 tons, hence the grow back/catch forfeit can only be treated as starting in the 2005/2006 fishing season. Also, this method is easily adapted to a situation where different unit harvesting costs are inputted for each year of the 'Actual' model, and then the 'Hypothetical' unit harvesting costs are given by the 'Actual' unit harvesting costs multiplied by the ratio of Actual to Hypothetical exploitable biomass estimates.

Season	**Exploitable Biomass Hypothetical**	**Exploitable Biomass Actual**	**Unit harvesting Cost Hypothetical**	**Unit harvesting Cost Actual**	**Legal TAC Hypothetical**	**Legal TAC – Catch forfeit**	**Additional harvesting costs ('000 ZAR)**
1997	2664.6	2664.6	150.3	150.3	402	402.0	0.0
1998	2600.3	2600.3	154.1	154.1	402	402.0	0.0
1999	2556.9	2492.6	156.7	160.7	377	377.0	1521.8
2000	2549.0	2397.6	157.2	167.1	365	365.0	3622.3
2001	2535.5	2357.8	158.0	169.9	288	288.0	3429.1
2002	2495.6	2320.4	160.5	172.6	340	340.0	4121.0
2003	2420.0	2250.5	165.5	178.0	350	350.0	4363.6
2004	2339.4	2214.9	171.2	180.9	382	302.8	2915.2
2005	2275.1	2230.2	176.1	179.6	382	302.8	1073.6
2006	**2257.2**	**2254.5**	177.5	177.7	350	350.0	74.1
						Total (ZAR)	**21120.6**

Table 3. Table of the legal TAC, the legal allocation to HBF, and the latter as a percentage of the former.

Fishing Season	Legal TAC	HBF Allocation	HBF Percentage
1987/88	452	112.8	24.9%
1988/89	452	112.8	24.9%
1989/90	452	112.8	24.9%
1990/91	477	119.0	24.9%
1991/92	477	119.0	24.9%
1992/93	477	119.0	24.9%
1993/94	477	119.0	24.9%
1994/95	452	111.9	24.8%
1995/96	427	111.1	26.0%
1996/97	415	102.5	24.7%
1997/98	402	99.3	24.7%
1998/99	402	80.1	19.9%
1999/00	377	71.2	18.9%
2000/01	365	69.9	19.1%
2001/02	340	0	0%
2002/03	340	0	0%
2003/04	350	0	0%
2004/05	382	0	0%

Table 4. A table of seadays recorded by MCM for the period 1987 – 2000 for HBF fishing vessels. From the known legal plus admitted illegal catches made in 1999/2000 and 2000/2001, it is possible to calculate the typical catch rate for HBF vessel in those seasons as 199 kg tails/seaday. This was at a time that the scientific catch rate was 0.87 kg tails /trap. The seaday catch rate for HBF vessels in 1987 – 1998 is calculated as 199 kg tails/seaday multiplied by the scientific catch rate divided by 0.87 kg tails/trap. Knowing the seadays for 1987 – 1998 leads to estimates of the likely catch by HBF vessels in earlier years. These are then compared in the table to those from the Groeneveld (2003) Method (a), and are larger. The Groeneveld (2003) Method (a) estimates can then be regarded as conservative estimates of overcatch.

	HBF # of Seadays: seadys	**Overcatch Admitted MT**	**GLM CPUE kg/trap**	**HBF CPUE MT/seady**	**Estimated HBF catch MT**	**HBF Quota MT**	**HBF Overcatch MT**	**Method (a) Overcatch MT**
1987	562		0.188	0.430	241.7	112.8	**128.9**	**56.3**
1988	613		0.226	0.518	317.8	112.8	**205.1**	**56.3**
1989	629		0.208	0.475	299.0	112.8	**186.3**	**56.3**
1990	609		0.176	0.403	245.4	119.0	**126.4**	**56.3**
1991	602		0.145	0.333	200.3	119.0	**81.3**	**47.5**
1992	595		0.142	0.325	193.2	119.0	**74.2**	**53.0**
1993	635		0.130	0.297	188.5	119.0	**69.5**	**47.3**
1994	648		0.119	0.273	176.7	111.9	**64.8**	**55.9**
1995	671		0.110	0.252	169.3	111.1	**58.2**	**77.9**
1996	669		0.093	0.212	141.8	102.5	**39.2**	**27.7**
1997	704		0.084	0.192	135.3	99.3	**36.0**	**14.4**
1998	953		0.080	0.183	174.5	80.1	**94.3**	**114.0**
1999	981	135.16	0.082	0.199	206.4	71.2	**135.2**	**135.2**
2000	704	58.4	0.092	0.199	128.3	69.9	**58.4**	**58.4**

Table 5. Table of the legal TAC, overcatch calculated via method (a) of Groeneveld (2003), the total catch (legal TAC + overcatch), and the standardized CPUE index calculated circa 2004 by Glazer.

Fishing Season	Legal TAC	Overcatch	Total Catch	Standardised CPUE
1991/92	477	47.54	524.54	0.1452
1992/93	477	52.96	529.96	0.1417
1993/94	477	47.27	524.27	0.1296
1994/95	452	55.89	507.89	0.1190
1995/96	427	77.89	504.89	0.1101
1996/97	415	27.69	442.69	0.0925
1997/98	402	14.39	416.39	0.0839
1998/99	402	114.03	516.03	0.0799
1999/00	377	135.16	512.16	0.0817
2000/01	365	58.4	423.40	0.0917
2001/02	288	0	288	0.1026
2002/03	340	0	340	0.1129
2003/04	350	0	350	Data not available
2004/05	382	0	382	Data not yet available

Table 6. Overcatch values used to produce damage estimates in the South Coast rock lobster resource.

South Coast Rock Lobster Overcatch Options (MT tails)	
Fishing Season	**Overcatch estimates: Option 1.**
1987/1988	56.3
1988/1989	56.3
1989/1990	56.3
1990/1991	56.3
1991/1992	47.54
1992/1993	52.96
1993/1994	47.27
1994/1995	55.89
1995/1996	77.89
1996/1997	27.7
1997/1998	14.3
1998/1999	114.0
1999/2000	135.16
2000/2001	58.4

Table 7. Overcatch values used to produce damage estimates in the West Coast rock lobster resource.

West Coast Rock Lobster Overcatch Options (MT whole)			
Fishing Season	**Option 1**	**Option 2**	**Option 3**
1987/1988	200	100	0
1988/1989	200	100	0
1989/1990	200	100	0
1990/1991	200	100	0
1991/1992	200	100	0
1992/1993	200	100	0
1993/1994	200	100	0
1994/1995	200	100	0
1995/1996	200	100	0
1996/1997	200	100	0
1997/1998	200	100	0
1998/1999	200	100	0
1999/2000	598	598	598

Table 8a. Damage estimates for the South Coast rock lobster resource using the Base Case model in conjunction with Method I. Financial units are '000 US$. These results compare the effect of assuming that the cost of harvesting (i.e. cost of fishing effort) is either 50% or 64% of the price of lobsters under the Actual situation. The values in parentheses are the coefficients of variation of the damage amounts, calculated using the 'SD Report' facility of the computer software, AD Model Builder.

South Coast Rock Lobster Damage Estimates					
Method I, Base Case Model, 64% Harvesting Costs Option					
Overcatches are zero or as referenced				**Damage Amount**	
1987/88 – 1990/91	**1991/92 – 1995/96**	**1996/97 – 1998/99**	**1999/00 - 2000/01**	**Catch forfeit (C.V.)**	**Additional harvesting costs (C.V.)**
0	0	0	Admitted	6750.4 (0.10)	4233.7 (0.17)
0	0	Option 1	Admitted	11615.0 (0.11)	7833.6 (0.16)
0	Option 1	Option 1	Admitted	18531.0 (0.13)	15817.0 (0.15)
Option 1	Option 1	Option 1	Admitted	22651.0 (0.15)	22376.0 (0.15)
Method I, Base Case Model, 50% Harvesting Costs Option					
Overcatches are zero or as referenced				**Damage Amount**	
1987/88 – 1990/91	**1991/92 – 1995/96**	**1996/97 – 1998/99**	**1999/00 - 2000/01**	**Catch forfeit (C.V.)**	**Additional harvesting costs (C.V.)**
0	0	0	Admitted	6750.4 (0.10)	3307.6 (0.17)
0	0	Option 1	Admitted	11615.0 (0.11)	6120.0 (0.16)
0	Option 1	Option 1	Admitted	18531.0 (0.13)	12357.0 (0.15)
Option 1	Option 1	Option 1	Admitted	22651.0 (0.15)	17481.0 (0.15)

Table 8b. Damage estimates for the South Coast rock lobster resource using the Base Case model, Method II. Financial units are '000 US$. These results are model independent.

South Coast Rock Lobster Damage Estimates – Method II				
Overcatches are zero or as referenced				**Damage Amount**
1987/88 – 1990/91	**1991/92 – 1995/96**	**1996/97 – 1998/99**	**1999/00 - 2000/01**	**'000 US$**
0	0	0	Admitted	8284.56
0	0	Option 1	Admitted	14608.32
0	Option 1	Option 1	Admitted	24635.63
Option 1	Option 1	Option 1	Admitted	32436.83

Table 8c. Damage estimates for the South Coast rock lobster resource using the base case model, Method III. Financial units are '000 US$. These results compare the effect of assuming that the cost of harvesting (i.e. cost of fishing effort) is either 64% or 50% of the price of lobsters under the Actual situation. The values in parentheses are the coefficients of variation of the damage amounts, calculated using the 'SD Report' facility of the computer software, AD Model Builder. For Method III, no damage due to increased harvesting costs beyond 2015 are accounted for since the standard errors on the estimates begin to exceed the mean estimates of the year specific additional harvesting costs and they can therefore not be relied on from a statistical standpoint.

South Coast Rock Lobster Damage Estimates				
Method III, Base Case Model, 64% Harvesting Costs				
Overcatches are zero or as referenced				**Damage Amount (C.V.)**
1987/88 – 1990/91	**1991/92 – 1995/96**	**1996/97 – 1998/99**	**1999/00 - 2000/01**	**'000 US$.**
0	0	0	Admitted	10396.0 (0.30)
0	0	Option 1	Admitted	18262.0 (0.28)
0	Option 1	Option 1	Admitted	32055.0 (0.26)
Option 1	Option 1	Option 1	Admitted	41310.0 (0.25)
Method III, Base Case Model, 50% Harvesting Costs				
Overcatches are zero or as referenced				**Damage Amount (C.V.)**
1987/88 – 1990/91	**1991/92 – 1995/96**	**1996/97 – 1998/99**	**1999/00 - 2000/01**	**'000 US$.**
0	0	0	Admitted	8121.7 (0.30)
0	0	Option 1	Admitted	14268.0 (0.28)
0	Option 1	Option 1	Admitted	25043.0 (0.26)
Option 1	Option 1	Option 1	Admitted	32273.0 (0.25)

Table 9a. Damage estimates for the South Coast rock lobster resource Method I. Financial units are '000 US$. These results show what happens to the damage estimate when one uses two of the sensitivity test that the Rock Lobster Working Group runs on an annual basis in addition to the Base Case model, viz. the effort saturation and low recruitment sensitivity tests. The values in parentheses are the coefficients of variation of the damage amounts, calculated using the 'SD Report' facility of the computer software, AD Model Builder.

South Coast Rock Lobster Damage Estimates					
Method I, Effort Saturation Model Sensitivity Test, 64% Harvesting Cost Option					
Overcatches are zero or as referenced				**Damage Amount**	
1987/88 – 1990/91	**1991/92 – 1995/96**	**1996/97 – 1998/99**	**1999/00 - 2000/01**	**Catch forfeit (C.V.)**	**Additional harvesting costs (C.V.)**
0	0	0	Admitted	5870.2 (0.10)	3506.6 (0.18)
0	0	Option 1	Admitted	9939.0 (0.11)	6501.5 (0.17)
0	Option 1	Option 1	Admitted	15082.0 (0.14)	13006.0 (0.17)
Option 1	Option 1	Option 1	Admitted	17800.0 (0.16)	18580.0 (0.18)
Method I, Low Recruitment Model Sensitivity Test, 64% Harvesting Cost Option					
Overcatches are zero or as referenced				**Damage Amount**	
1987/88 – 1990/91	**1991/92 – 1995/96**	**1996/97 – 1998/99**	**1999/00 - 2000/01**	**Catch forfeit (C.V.)**	**Additional harvesting costs (C.V.)**
0	0	0	Admitted	6707.4 (0.10)	4238.8 (0.17)
0	0	Option 1	Admitted	11530.0 (0.11)	7832.4 (0.16)
0	Option 1	Option 1	Admitted	18305.0 (0.13)	15770.0 (0.15)
Option 1	Option 1	Option 1	Admitted	22320.0 (0.15)	22282.0 (0.15)

Table 9b. Damage estimates for the South Coast rock lobster resource using the base case model, Method III. Financial units are '000 US$. These results show what happens to the damage estimate when one uses two of the sensitivity test that the Rock Lobster Working Group runs on an annual basis in addition to the Base Case model, viz. the effort saturation and low recruitment sensitivity tests. The values in parentheses are the coefficients of variation of the damage amounts, calculated using the 'SD Report' facility of the computer software, AD Model Builder. For Method III, no damage due to increased harvesting costs beyond 2015 are accounted for since the standard errors on the estimates begin to exceed the mean estimates of the year specific additional harvesting costs and they can therefore not be relied on from a statistical standpoint.

South Coast Rock Lobster Damage Estimates				
Method III, Effort Saturation Model Sensitivity Test, 64% Harvesting Cost Option				
Overcatches are zero or as referenced				**Damage Amount (C.V.)**
1987/88 – 1990/91	**1991/92 – 1995/96**	**1996/97 – 1998/99**	**1999/00 - 2000/01**	**'000 US$**
0	0	0	Admitted	7583.3 (0.29)
0	0	Option 1	Admitted	13362.0 (0.28)
0	Option 1	Option 1	Admitted	23341.0 (0.27)
Option 1	Option 1	Option 1	Admitted	30632.0 (0.26)
Method III, Low Recruitment Model Sensitivity Test, 64% Harvesting Cost Option				
Overcatches are zero or as referenced				**Damage Amount (C.V.)**
1987/88 – 1990/91	**'000 US$**	**1996/97 – 1998/99**	**1999/00 - 2000/01**	**'000 US$**
0	0	0	Admitted	11083.0 (0.30)
0	0	Option 1	Admitted	19329.0 (0.29)
0	Option 1	Option 1	Admitted	33450.0 (0.26)
Option 1	Option 1	Option 1	Admitted	42774.0 (0.25)

Table 10a. Damage estimates for the West Coast rock lobster resource. Method I, and the 15% harvesting costs option. Units are '000 US$. RC1 and RC2 are two alternative assessment models that the Rock Lobster Working Group runs in order to test the performance of different management procedures. The values in parentheses represent the results that were obtained when we ran a variant of RC1 which makes special allowance for the natural walk-outs that are alluded to in the Baird Report. This is done via the sensitivity test W1 (OLRAC, 2003). These results do not appear to be particularly sensitive to whether the RC1 model is used, or whether the particular variant, W1, is used.

West Coast Rock Lobster Damage Estimates		
Method I, RC1 Model, 15% Harvesting Cost Option		
Overcatch values used	**Damage Amount**	
	Catch forfeit	**Additional harvesting costs**
598 MT in 1999/2000 and 200 MT between 1987/88 and 1998/99	32602.5 (33102.8)	4617.0 (4414.7)
598 MT in 1999/2000 and 100 MT between 1987/88 and 1998/99	20286.0	2585.8
598 MT in 1999/2000 and 0 MT between 1987/88 and 1998/99	8055.8	470.2
Method I, RC2 Model, 15% Harvesting Cost Option		
598 MT in 1999/2000 and 200 MT between 1987/88 and 1998/99	39295.5	4440.0
598 MT in 1999/2000 and 100 MT between 1987/88 and 1998/99	24391.5	2542.5
598 MT in 1999/2000 and 0 MT between 1987/88 and 1998/99	9642.8	554.4

Table 10b. Damage estimates for the West Coast rock lobster resource. Method I, and the 25% harvesting costs option. Units are '000 US$. RC1 and RC2 are two alternative assessment models that the Rock Lobster Working Group runs in order to test the performance of different management procedures.

West Coast Rock Lobster Damage Estimates		
Method I, RC1 Model, 25% Harvesting Cost Option		
Overcatch values used	**Damage Amount**	
	Catch forfeit	**Additional harvesting costs**
598 MT in 1999/2000 and 200 MT between 1987/88 and 1998/99	32602.5	7695.0
598 MT in 1999/2000 and 100 MT between 1987/88 and 1998/99	20286.0	4309.7
598 MT in 1999/2000 and 0 MT between 1987/88 and 1998/99	8055.8	783.6
Method I, RC2 Model, 25% Harvesting Cost Option		
Overcatch values used	**Damage Amount**	
	Catch forfeit	**Additional harvesting costs**
598 MT in 1999/2000 and 200 MT between 1987/88 and 1998/99	39295.5	7400.0
598 MT in 1999/2000 and 100 MT between 1987/88 and 1998/99	24391.5	4237.5
598 MT in 1999/2000 and 0 MT between 1987/88 and 1998/99	9642.8	924.0

Table 11. Damage estimates for the West Coast rock lobster resource. Method II. Units are '000 US$.

West Coast Rock Lobster Damage Estimates – Method II	
Overcatch values used	**Damage Amount US$**
Results are model independent	
Overcatch values used	**Damage Amount US$**
598 MT in 1999/2000 and 200 MT between 1987/88 and 1998/99	40169.5
598 MT in 1999/2000 and 100 MT between 1987/88 and 1998/99	24638.8
598 MT in 1999/2000 and 0 MT between 1987/88 and 1998/99	9108.0

Table 12a. Damage estimates for the West Coast rock lobster resource. Method III. 15%. Units are '000 US$. RC1 and RC2 are two alternative assessment models that the Rock Lobster Working Group runs in order to test the performance of different management procedures.

West Coast Rock Lobster Damage Estimates – Method III	
Method III, RC1 Model, 15% Harvesting Cost Option	
Overcatch values used	**Damage Amount '000 US$**
598 MT in 1999/2000 and 200 MT between 1987/88 and 1998/99	8256.7
598 MT in 1999/2000 and 100 MT between 1987/88 and 1998/99	4793.1
598 MT in 1999/2000 and 0 MT between 1987/88 and 1998/99	1329.5
Method III, RC2 Model, 15% Harvesting Cost Option	
Overcatch values used	**Damage Amount '000 US$**
598 MT in 1999/2000 and 200 MT between 1987/88 and 1998/99	8483.3
598 MT in 1999/2000 and 100 MT between 1987/88 and 1998/99	4997.4
598 MT in 1999/2000 and 0 MT between 1987/88 and 1998/99	1544.0

Table 12b. Damage estimates for the West Coast rock lobster resource. Method III. 15%. Units are '000 US$. RC1 and RC2 are two alternative assessment models that the Rock Lobster Working Group runs in order to test the performance of different management procedures.

West Coast Rock Lobster Damage Estimates – Method III	
Method III, RC1 Model, 15% Harvesting Cost Option	
Overcatch values used	**Damage Amount '000 US$**
598 MT in 1999/2000 and 200 MT between 1987/88 and 1998/99	13761.1
598 MT in 1999/2000 and 100 MT between 1987/88 and 1998/99	7988.4
598 MT in 1999/2000 and 0 MT between 1987/88 and 1998/99	2215.8
Method III, RC2 Model, 15% Harvesting Cost Option	
Overcatch values used	**Damage Amount '000 US$**
598 MT in 1999/2000 and 200 MT between 1987/88 and 1998/99	14138.8
598 MT in 1999/2000 and 100 MT between 1987/88 and 1998/99	8328.9
598 MT in 1999/2000 and 0 MT between 1987/88 and 1998/99	2573.3

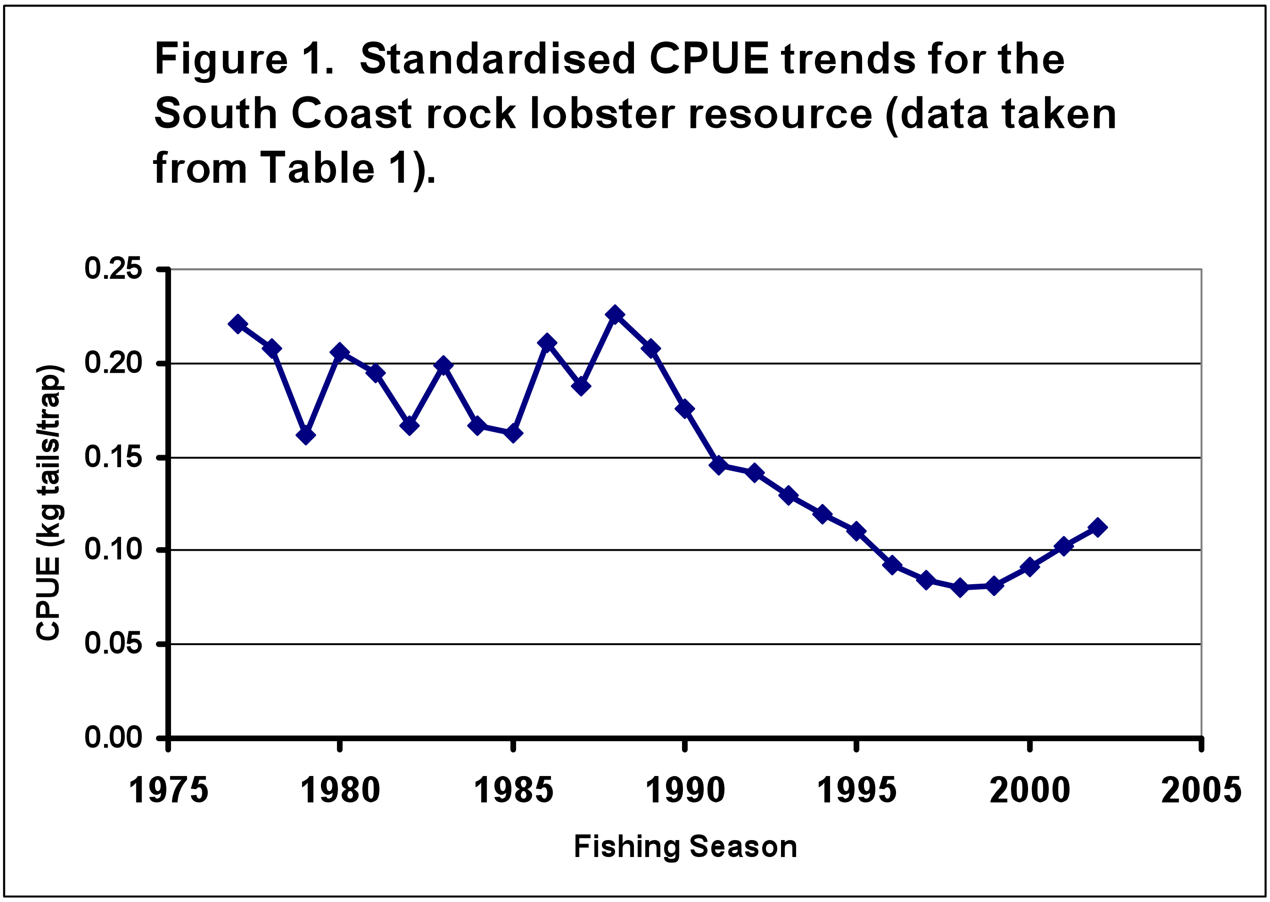

Figure 1. Standardised CPUE trends for the South Coast rock lobster resource (data taken from Table 1).
CPUE (kg tails/trap)
0.25
0.20
0.15
0.10
0.05
0.00
1975
1980
1985
1990
1995
2000
2005
Fishing Season

Appendix A. A list of documents which are relevant to the methods that have been followed to address interanual changes in somatic growth rates in the mathematical models used to produce scientific recommendations for the management of the South African West Coast Rock Lobster resource.

1. Johnston, S. J. and D. S. Butterworth. 2000. Specifications and assumptions of the size-structured model for the South African West Coast rock lobster which is to be used in developing an updated OMP for the resource, as at March 2000. MCM document, WG/03/00/WCL13. 2000
2. West Coast Rock Lobster 2003 assessment model update: reference case and other model variants results. S.J. Johnston and D.S. Butterworth. MARAM. WG/03/03/WCRL1. 2003
3. Issues relating to West Coast rock lobster OMP development and testing. S.J. Johnston and D.S. Butterworth. MARAM. WG/03/03/WCL2. 2003
4. The use of mixed linear ("random effects") models to standardize the male west coast rock lobster somatic growth trend with time in a manner that allows for differences in magnitude and fluctuations in trend between locations: reference case model and other variants. Anabela Brandão, D.S. Butterworth, J. Glazer and S.J. Johnston. WG/03/03/WCL4. 2003
5. Further modifications to growth rate estimates for male West Coast rock lobsters. OLRAC. Feb 2003. WG/03/03/WCL5. 2003
6. Spatially aggregated assessments for West Coast rock lobster obtained using automatic differentiation model fitting techniques. OLRAC. March 2003. WG/03/03/WCRL6. 2003
7. Results of two alternate stock assessment models for the West Coast rock lobster resource. S.J. Johnston and D.S. Butterworth. MARAM. WG/04/03/WCRL8 2003
8. Feedback on West Coast rock lobster OMP development and testing options. OLRAC. 23 April 2003. WG/04/03/WCRL10. 2003
9. Notes on the occurrence of low oxygen water in ST Helena Bay. L Hutchings. 24-04-2003. WG/04/03/WCRL12. 2003
10. West Coast rock lobster 2003 Robustness test rankings. S.J. Johnston and D.S. Butterworth. WG/04/03/WCL13. 2003
11. Final Operating models and other issues relating to the West Coast Rock Lobster 2003 OMP development. S.J. Johnston and D.S. Butterworth. WG/06/03/WCRL14. 2003
12. Initial results of some new OMPs for the West Coast rock lobster resource. S.J. Johnston and D.S. Butterworth. MARAM. WG/07/03/WCRL16. 2003
13. Standardized male west coast rock lobster somatic growth trend using a mixed linear ("random effects") model including data from the 2002/03 season. A. Brandão and D.S. Butterworth. WG/07/03/WCRL19. 2003
14. Further results of alternate OMPs for the management of the West Coast Rock Lobster resource. S.J. Johnston and D.S. Butterworth. MARAM. WG/07/03/WCRL22. 2003
15. OLRAC: Update of West Coast rock lobster male growth rate estimates with the addition of 2002/2003 data. 28 Jul 2003. WG/07/03/WCRL23. 2003
16. Final results of alternate OMPs for the management of the West Coast Rock Lobster resource. S.J. Johnston and D.S. Butterworth. MARAM. WG/08/03/WCRL25. 2003
17. West Coast Rock Lobster TAC for the 2003 season as calculated using the updated OMP. S.J. Johnston, J. Glazer and A. Brandão. WG/10/03/WCRL26. 2003
18. Summary of area-by-area data for west coast rock lobster. S.J. Johnston. WG/01/04/WCRL2. 2004
19. Some considerations regarding the moult windows for West Coast rock lobster. J.D. Gaylard and M.O. Bergh. OLRAC. Feb 2004. WG/03/04/WCL5. 2004
20. Treatment of year by year interactions as random effects within the context of a moult probability analysis of growth rate for male West Coast rock lobster. J.D. Gaylard and M.O. Bergh. OLRAC. Feb 2004. WG/03/04/WCL6. 2004
21. Appendix A. Methodology for the growth rate moult probability analysis, allowing for the treatment of area*season interactions as random effects. Addendum to WG/03/04/WCRL6. 2004
22. Considerations regarding the role of the *pre-moult length* as a covariate in the growth rate model for male West Coast rock lobster. J.D. Gaylard and M.O. Bergh. OLRAC. March 2004. WG/03/04/WCL7. 2004
23. A compilation of data to be used for spatial disaggregated assessments of the West Coast Rock Lobster resource. S.J. Johnston, J. Glazer and D.L. van Zyl. WG/04/04/WCRL8. 2004

24. General linear mixed model analyses of male west coast rock lobster somatic growth for each of three super-areas where mark-recapture programmes takes place. A. Brandão and D.S. Butterworth. WG/04/04/WCRL12. 2004
25. Regional growth rate considerations for male West Coast rock lobsters. OLRAC. May 2004. WG/04/05/WCL13. 2004
26. On the impact on estimation of west coast rock lobster somatic growth trends of reducing the size of the data set used. A. Brandão and D.S. Butterworth. May 2004. WG/04/05/WCRL14. 2004
27. Revised Growth Rate Estimates for Male West Coast Rock Lobsters. OLRAC. Jun 2004. WG/07/04/WCRL18. 2004
28. Updated standardized male west coast rock lobster somatic growth trend using the "less data" selection. A. Brandão and D.S. Butterworth. July 2004. WG/07/04/WCRL20. 2004
29. West Coast Rock Lobster TAC for the 2004 season as calculated using the current OMP. S.J. Johnston, J. Glazer and A. Brandão. WG/07/04/WCRL21. 2004
30. A final compilation of data to be used for spatial disaggregated assessments of the West Coast Rock Lobster resource. S.J. Johnston, J. Glazer and D. van Zyl. WG/07/04/WCRL22. 2004

Appendix B. A list of documents which are relevant to the methods that have been followed to address mass walk-outs of rock lobsters in the mathematical models used to produce scientific recommendations for the management of the South African West Coast Rock Lobster resource.

1. West Coast Rock Lobster 2003 assessment model update: reference case and other model variants results. S.J. Johnston and D.S. Butterworth. MARAM. WG/03/03/WCRL1. 2003
2. Issues relating to West Coast rock lobster OMP development and testing. S.J. Johnston and D.S. Butterworth. MARAM. WG/03/03/WCL2. 2003
3. Feedback on West Coast rock lobster OMP development and testing options. OLRAC. 23 April 2003. WG/04/03/WCRL10. 2003
4. Notes on the occurrence of low oxygen water in ST Helena Bay. L Hutchings. 24-04-2003. WG/04/03/WCRL12. 2003
5. West Coast rock lobster 2003 Robustness test rankings. S.J. Johnston and D.S. Butterworth. WG/04/03/WCL13. 2003
6. Final Operating models and other issues relating to the West Coast Rock Lobster 2003 OMP development. S.J. Johnston and D.S. Butterworth. WG/06/03/WCRL14. 2003
7. Final results of alternate OMPs for the management of the West Coast Rock Lobster resource. S.J. Johnston and D.S. Butterworth. MARAM. WG/08/03/WCRL25. 2003

Appendix C. Lobster price information.

Based on information supplied by sources in the fishing industry, we have obtained the following price information in US$ (including freight costs):

	tails USA per kg	whole cooked per kg	tails Japan per kg	Live per kg
1986	23.1			
1987	28.2	12.7	33.0	
1988		13.9	30.1	
1989	29.5	13.3	27.5	
1990			41.8	
1991	47.3	19.0	41.3	
1992	35.2		35.5	
1993	33.0	17.0		
1994		20.4		
1995 - 2000	No data	No data	No data	No data
2001	45.8			
2002	47.2			
2003	48.6			
2004	45.0			19.0

The average price for tails into the USA market is US$38.3, and for the Japanese market the average is US$ 34.8. However, the information indicates a larger price in recent times. We therefore used the average price for 1987 to 1993 of US$ 34.6 for those years, and a value of US$45 for 2001 – 2015. We linearly interpolated to obtain prices for 1994 to 2000, and the values are as given in the table below:

South Coast rock lobster prices used			
Year	US$/kg tail	**Year**	US$/kg tail
1987	34.6	**2001**	45.0
1988	34.6	**2002**	45.0
1989	34.6	**2003**	45.0
1990	34.6	**2004**	45.0
1991	34.6	**2005**	45.0
1992	34.6	**2006**	45.0
1993	34.6	**2007**	45.0
1994	35.9	**2008**	45.0
1995	37.2	**2009**	45.0
1996	38.5	**2010**	45.0
1997	39.8	**2011**	45.0
1998	41.1	**2012**	45.0
1999	42.4	**2013**	45.0
2000	43.7	**2014**	45.0
		2015	45.0

The situation is different for West Coast rock lobster where over the last 10-14 years there has been a concerted effort to increase the tonnage sold at much higher prices in the live form, to the extent that the proportion of product sold live is currently in the region of 75%. We have therefore assumed an average price per kg whole of US$12 for West Coast rock lobster, but increasing that amount linearly to a 2004 price of US$17.25/kg whole weight, which is the average of the whole cooked and frozen price of US$12.00/kg whole weight and the live price of US$ 19/kg whole weight, but weighted 25:75. For the future we assumed the prevailing price of US$17.25/kg whole weight. The year specific prices are therefore:

West Coast rock lobster prices used			
Year	US$/kg whole	**Year**	US$/kg whole
1987	12.0	**2001**	16.0
1988	12.0	**2002**	16.4
1989	12.0	**2003**	16.8
1990	12.0	**2004**	17.25
1991	12.0	**2005**	17.25
1992	12.4	**2006**	17.25
1993	12.8	**2007**	17.25
1994	13.2	**2008**	17.25
1995	13.6	**2009**	17.25
1996	14.0	**2010**	17.25
1997	14.4	**2011**	17.25
1998	14.8	**2012**	17.25
1999	15.2	**2013**	17.25
2000	15.6	**2014**	17.25
		2015	17.25