

# Re-analysis of the Fisheries Independent Monitoring Survey of the Rock Lobster resource of South Africa

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## Introduction

Data from the FIMS surveys carried over the period 1992/93 to 2008/09 have been re-analysed here. This re-analysis was necessary because verification of the data resulted in several corrections. These corrections mainly involved differentiation of records that had a zero catch associated with them when in fact the trap had been lost or open or not set. The total area of each Zone as well as the area for each transect surveyed was also re-calculated (see van Zyl *et al.*, 2009). The allocation of stations to Hotspot areas changed in some cases from that in previous analyses. The methodology for calculating abundance indices has also been changed slightly.

## Data

The FIMS data analysed covers the period 1992/93 to 2008/09. A data validation exercise resulted in several corrections made to the FIMS database. These changes were:

- differentiation between a true zero catch and a zero record which denoted a lost trap or a trap not set, or an open bag;
- zero catches recorded but lobsters had been measured; these records were replaced with estimates calculated from the mass of the catch;
- incorrect assignment of survey leg to records;
- correction of a few incorrect entries in the number of lobsters caught;
- reassignment of stations to Hotspots, and new area calculations for each surveyed transect and area surveyed as reported in van Zyl *et al.* (2009).

## Methodology

### Relative Abundance Indices by Zone

For each Zone (Dassen Island, Lambert's Bay, Saldanha Bay and Cape Point) and each leg of the FIMS survey, the computations used to calculate the weighted average CPUE (and its standard error) for each stratum (where stratum here depicts whether a station in a particular Zone is within the 100 m contour (shallow), within the 100 to 200 m contour (deep, applicable to the Cape Point only) or if it lies within a Hotspot) are given below. The various weights applied in these computations are given in van Zyl *et al.* (2009).

The weighted mean Catch Per Unit Effort (CPUE) for each stratum and each leg in a particular Zone is given by:

$$CPUE_{y,z}^{\ell} = \frac{\sum_{i=1}^{z_s} a_i^z C_{y,i}^{\ell,z}}{\sum_{i=1}^{z_s} a_i^z},$$

where

$CPUE_{y,z}^{\ell}$  is the weighted mean CPUE in year  $y$  for stratum  $z$  and leg  $\ell$ ,

$C_{y,i}^{\ell,z}$  is the average number of lobsters caught per trap set at station  $i$  in stratum  $z$  and year  $y$  and leg  $\ell$ ,

$a_i^z$  is the area of the transect section within which station  $i$  is positioned in stratum  $z$ , and

$z_s$  is the number of stations in stratum  $z$ .

The sampling standard error of the weighted CPUE for each stratum and each leg in year  $y$  is then given by:

$$SE(CPUE_{y,z}^{\ell}) = \sqrt{\frac{\sigma_{y,z,\ell}^2 \sum_{i=1}^{z_s} (a_i^z)^2}{\left(\sum_{i=1}^{z_s} a_i^z\right)^2}},$$

where

$\sigma_{y,z,\ell}^2$  is the variance of the average number of lobsters caught per trap set at station  $i$  in stratum  $z$  and year  $y$  and leg  $\ell$  ( $C_{y,i}^{\ell,z}$ ), for which the estimate is given by:

$$s_{y,z,\ell}^2 = \frac{\sum_{i=1}^{z_s} (C_{y,i}^{\ell,z} - \bar{C}_y^{\ell,z})^2}{(z_s - 1)},$$

where  $\bar{C}_y^{\ell,z}$  is the unweighted average of the number of lobsters caught per trap set in stratum  $z$  and year  $y$  and leg  $\ell$ .

The weighted mean CPUE for each stratum in a particular Zone  $CPUE_{y,z}$  is the average of the weighted mean CPUE for each leg. The overall CPUE index for each Zone for all the strata combined is then given by:

$$CPUE_y = \sum_{z=1}^s p_z^A CPUE_{y,z},$$

where the summation is over the  $s$  strata sampled and

$p_z^A$  is the proportion that the area surveyed in stratum  $z$  comprises of the total area sampled, i.e.  $p_z^A = \frac{A_z}{\sum_{z=1}^s A_z}$ , where  $A_z$  is the total area sampled in stratum  $z$ .

The sampling standard error of the overall CPUE index for sampled strata combined is then given by:

$$SE(CPUE_y) = \sqrt{\sum_{z=1}^s (p_z^A)^2 SE(CPUE_{y,z})^2},$$

where  $SE(CPUE_{y,z})$  is the standard error of the average of the weighted mean CPUE for each leg. It should be noted that the calculation of the standard errors in this paper has not taken account of any correlation between strata nor of any changes in catchability between the two legs of the survey in a stratum which would invalidate the assumption of independence of samples from leg to leg..

For each Zone, except for Lambert's Bay, CPUE indices were calculated considering each individual Hotspot as a stratum in that Zone. For Lambert's Bay this posed a problem when calculating standard errors of CPUE estimates as most Hotspot strata in this Zone only have one station surveyed in a particular leg and thus no standard deviation can be calculated. Therefore, for Lambert's Bay, it was decided to consider all Hotspot strata as one combined stratum.

In the Cape Point Zone, for the 1997/98 and the 2005/06 season, there was only one station in one of the legs and in one of the Hotspot strata. The standard deviation ( $\sigma_{y,z,\ell}$ ) for these two records were estimated as the average of the observed (and computable) standard deviations or CVs for that stratum. The choice between using the average of standard deviations or the average of the CVs was based on which measure was more constant over the years.

The 1999/00 FIMS data point (for Cape Point) is based on only a single leg (leg 2) as the first leg was not conducted.

### Comparison with previous FIMS indices

Given the changes in the data and the methodology in obtaining the FIMS indices reported in this

paper, a comparison to the previous FIMS indices has been conducted. A comparison between the trends of the new indices to the previous ones is of particular interest as this is the primary information that informs the OMP output. To do this, an exponential curve has been fitted to the FIMS indices over a common period (i.e. 1992/93 to 2006/07). For each Zone the following model has been fitted:

$$\ln(CPUE_y) = \mu + \alpha(year),$$

where *year* represents the season in which the survey took place,  $\mu$  is the intercept and  $\alpha$  is the slope.

## Results

Table 1 reports the FIMS CPUE indices for each individual Zone for rock lobsters measuring more than 60 cm together with their sampling standard errors. Figure 1 compares the values reported in Table 1 to those obtained previously, as well as a comparison of an exponential curve fitted to each of the series (over the common period of 1992/93 to 2006/07). The trend fits to the old and the new FIMS indices are very similar for all Zones with the exception of Cape Point which shows a more downward trend for the new FIMS indices. Table 2 shows the estimate of the slope (and its standard error) for each trend curve fitted, where this slope is effectively the annual proportional change in the index. The more negative trend in the new FIMS series for the Cape Point is the only difference of note (given the precision of the estimates), though the difference is less when the values for the next two years are included.

## Reference

van Zyl, D., Auerswald, L. and Merkle, D. 2009. FIMS area calculations, station numbers, category, repeats and position. Marine and Coastal Management Document: MCM/2009/JUL/SWG/WCRL/04.

**Table 1.** FIMS CPUE series for each individual Zone and their corresponding sampling standard errors.

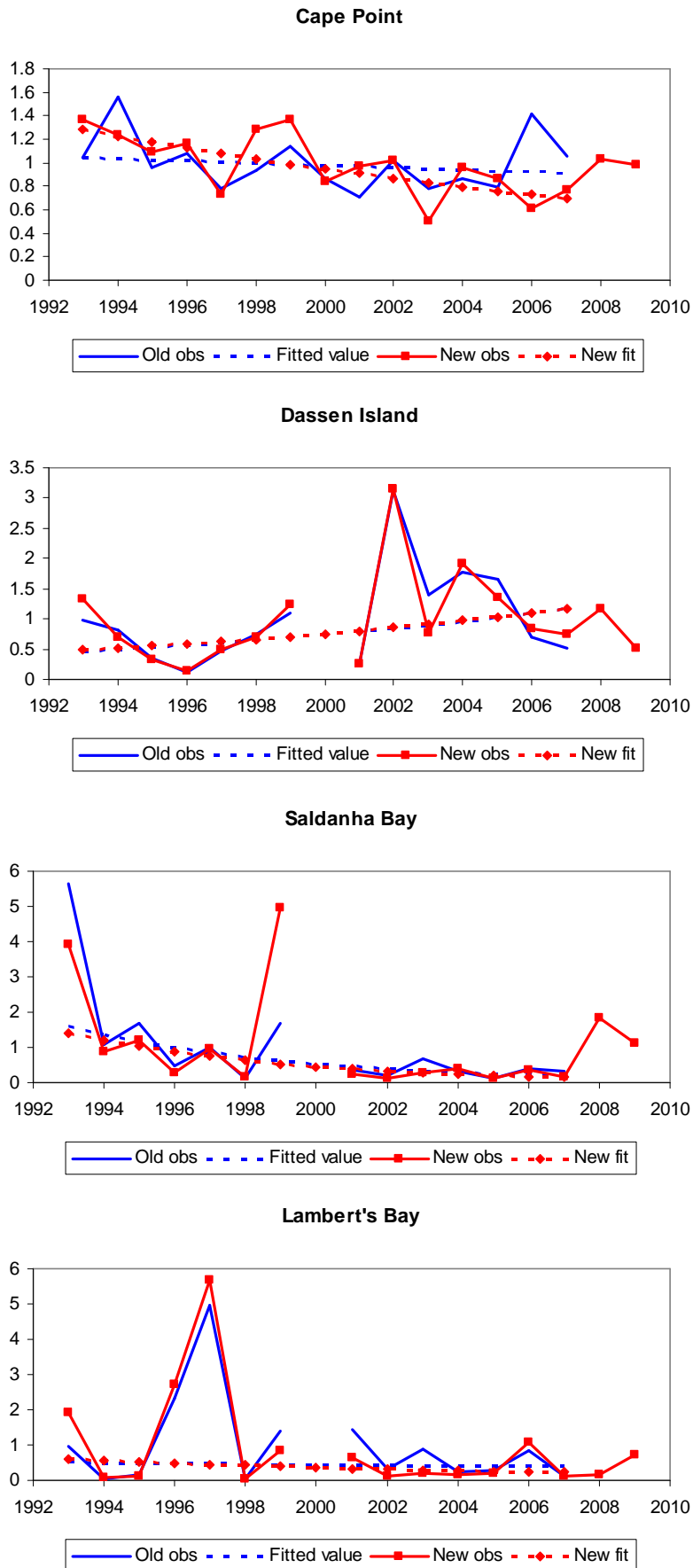
Year	Zone			
	Cape Point	Dassen Island	Saldanha Bay	Lambert's Bay
<b>1992/93</b>	140.75 (17.30)	24.89 (4.370)	2.720 (0.871)	3.228 (1.233)
<b>1993/94</b>	128.18 (13.47)	13.16 (3.435)	0.615 (0.673)	0.137 (0.061)
<b>1994/95</b>	112.43 (20.97)	6.057 (1.730)	0.821 (0.443)	0.204 (0.067)
<b>1995/96</b>	120.07 (17.61)	2.543 (1.196)	0.185 (0.058)	4.341 (1.042)
<b>1996/97</b>	75.50 (9.572)	9.295 (2.733)	0.647 (0.471)	9.855 (2.205)
<b>1997/98</b>	132.26 (19.17) <sup>†</sup>	12.84 (3.382)	0.106 (0.047)	0.068 (0.046)
<b>1998/99</b>	141.64 (16.32)	22.97 (4.019)	3.403 (0.997)	1.495 (0.571)
<b>1999/00</b>	86.60 (20.02) <sup>*</sup>			
<b>2000/01</b>	100.71 (16.60)	4.809 (1.119)	0.176 (0.100)	1.344 (0.193)
<b>2001/02</b>	105.01 (18.17)	58.66 (7.127)	0.075 (0.058)	0.214 (0.097)
<b>2002/03</b>	52.02 (10.43)	14.49 (2.623)	0.192 (0.174)	0.473 (0.236)
<b>2003/04</b>	98.67 (14.48)	35.78 (6.696)	0.276 (0.386)	0.420 (0.223)
<b>2004/05</b>	89.05 (12.35)	25.36 (3.935)	0.071 (0.030)	0.375 (0.243)
<b>2005/06</b>	62.71 (35.89) <sup>†</sup>	15.79 (3.969)	0.241 (0.063)	1.725 (0.722)
<b>2006/07</b>	79.18 (21.90)	13.96 (3.393)	0.119 (0.144)	0.238 (0.098)
<b>2007/08</b>	106.65 (29.10)	21.88 (4.212)	1.267 (1.343)	0.277 (0.193)
<b>2008/09</b>	101.43 (33.20)	9.665( 1.974)	0.756 (0.310)	1.207 (0.536)

\* Based on only one leg of the survey.

† Standard error based on an estimate because only one station was sampled in a leg for a particular Hotspot.

**TABLE 2.** Trend values (effectively proportional changes per annum) from old and the new FIMS series together with their standard errors.

	<b>Old trend (s.e.) (1992/93 to 2006/07)</b>	<b>New trend (s.e.) (1992/93 to 2006/07)</b>	<b>New trend (s.e.) (1992/93 to 2008/09)</b>
<b>Cape Point</b>	-0.010 (0.014)	-0.044 (0.014)	-0.028 (0.013)
<b>Dassen Island</b>	0.065 (0.051)	0.063 (0.048)	0.044 (0.038)
<b>Saldanha Bay</b>	-0.156 (0.052)	-0.162 (0.060)	-0.071 (0.059)
<b>Lambert's Bay</b>	-0.019 (0.092)	-0.073 (0.089)	-0.050 (0.070)



**Figure 1.** Comparison of old and new FIMS CPUE series (normalised to the mean over the 1993–2007 period) as well as the comparison of an exponential trend fitted to each curve. In this plot the period 1993 corresponds to the season 1992/93, and so on.