Preliminary re-analysis of the Fisheries Independent Monitoring Survey of the Rock Lobster resource of South Africa

A. Brandão and D.S. Butterworth

Marine Resource Assessment & Management Group (MARAM)
Department of Mathematics and Applied Mathematics
University of Cape Town
Rondebosch 7701, Cape Town

July 2009

Introduction

Data from the FIMS surveys carried over the period 1993 to 2009 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. Changes in methodology in calculating abundance indices has also been changed slightly.

It should be noted that the results presented here are still preliminary.

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 ℓ,

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

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:

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

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 ℓ ($C_{y,i}^{\ell,z}$), for which the estimate is given by:

$$s_{y,z,\ell}^2 = \left. \sum_{i=1}^{z_s}\left(C_{y,i}^{\ell,z} - \overline{C}_y^{\ell,z}\right)^2 \middle/ \left(z_s - 1\right) \right. ,$$

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

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. $p_z^A = \left. A_z \middle/ \sum_{z=1}^{s} A_z \right.$, 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:

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

where $SE\left(CPUE_{y,z}\right)$ is the standard error of the average of the weighted mean CPUE for each leg.

Composite Relative Abundance Indices

The General Linear Model (GLM) analysis described in Glazer (2007) has been applied to the individual FIMS series for the four Zones to obtain a composite FIMS series. In that paper, and also here, the 2000 FIMS data point is based on 0nly a single leg (leg 2) as the first leg was not conducted. The calculation of the areas of the Zones has been updated (van Zyl *et al.*, 2009) and therefore the new areas as well as those used by Glazer (2007) have been used as weights for the FIMS of Dassen Island, Lambert's Bay and Saldanha Bay. The same adjustment as used by Glazer (2007) has been applied to the Cape Point FIMS indices for the initial period (1993 to 1995) to reflect the fact that the area covered by the survey in this Zone was increasing. The values of these adjustments (the proportion of the surveyed area in that for year to the total area of the Cape plus the area East of Hangklip) have not been updated to incorporate the new area calculations. These areas are thus given by:

$$Area_{1993} = 3462$$
$$Area_{1994} = 3603$$
$$Area_{1995} = 3743$$
$$Area_{Cape+EOH} = 3883$$

References

Glazer, J. 2007. GLM analysis applied to the FIMS data. Marine and Coastal Management Document: WG/08/07/WCRL?.

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 Area.

Year	Area			
	Cape Point	**Dassen Island**	**Lambert's Bay**	**Saldanha Bay**
1993	140.75	24.89	3.013	2.720
1994	128.18	13.16	0.152	0.615
1995	112.43	6.057	0.190	0.821
1996	120.07	2.543	4.180	0.185
1997	75.50	9.295	9.012	0.647
1998	132.26	12.84	0.087	0.106
1999	141.64	22.97	1.554	3.403
2000	86.60*			
2001	100.71	4.809	1.149	0.176
2002	105.01	58.66	0.176	0.075
2003	52.02	14.49	0.374	0.192
2004	98.67	35.78	0.332	0.276
2005	89.05	25.36	0.340	0.071
2006	62.71	15.79	1.686	0.241
2007	79.18	13.96	0.234	0.119
2008	106.65	21.88	0.264	1.267
2009	101.43	9.665	1.424	0.756

* Based on only one leg of the survey.

Table 2. Total area (km^2) for each Area used to weight the individual CPUE series to obtain a composite CPUE series.

Area	New area calculations	Old area calculations†
Dassen Island	858.6	2855
Lambert's Bay	1622	2092
Saldanha Bay	2363	2035

† Note that these areas are different from those given in WG/03/06/WCRL18 by S. Bouwer and reproduced in van Zyl *et al.* (2009).

Table 3. FIMS CPUE series used in the GLM analysis (where Dassen Island, Lambert's Bay and Saldanha Bay have been area-weighted), and adjustments have been made (where applicable) to incorporate the area East of Hangklip as part of the area covered by the Cape Point.

Year	FIMS CPUE for Cape Point	Combined FIMS CPUE for Dassen Island, Lambert's Bay and Saldanha Bay (new area calculations)	Combined FIMS CPUE for Dassen Island, Lambert's Bay and Saldanha Bay (old area calculations)
1993	125.5φ	6.748	11.87
1994	118.9φ	2.684	5.606
1995	108.4φ	1.537	2.773
1996	120.1	1.941	2.346
1997	75.50	4.981	6.689
1998	132.3	2.357	5.308
1999	141.6	6.252	10.85
2000	86.60*		
2001	100.7	1.323	2.362
2002	105.0	10.49	24.06
2003	52.02	2.787	6.093
2004	98.67	6.587	14.81
2005	89.05	4.644	10.49
2006	62.71	3.481	7.033
2007	79.18	2.610	5.811
2008	106.6	4.585	9.395
2009	101.4	2.559	4.599

φ FIMS CPUE adjusted to include the increasing portions of the area East of Hangklip.

* Value has not been adjusted to reflect that this value is based on only one leg of the survey.

TABLE 4. The exponent of the year factors (normalised to the mean over the 1993–2007 period) obtained from the GLM applied to the FIMS CPUE series. For comparison the values previously obtained by Glazer (2007) are also shown.

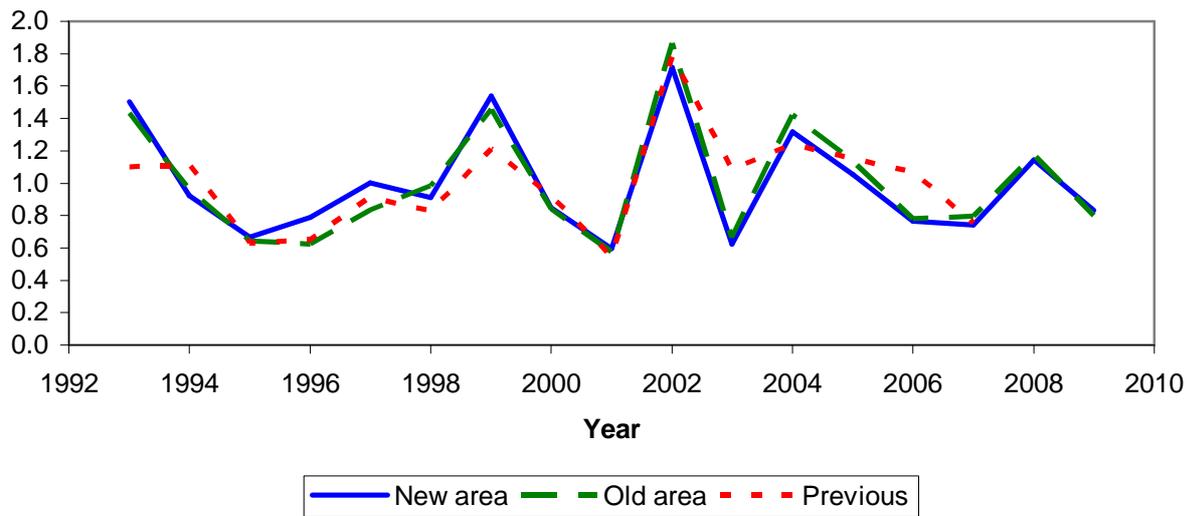| Year	e^{year} (new area calculations)	e^{year} (old area calculations)	e^{year} (from Glazer, 2009)
1993	1.505	1.433	1.100
1994	0.924	0.959	1.113
1995	0.667	0.643	0.632
1996	0.789	0.623	0.649
1997	1.003	0.834	0.913
1998	0.913	0.984	0.829
1999	1.538	1.455	1.213
2000	0.847	0.840	0.924
2001	0.597	0.573	0.543
2002	1.717	1.866	1.783
2003	0.623	0.661	1.084
2004	1.319	1.419	1.239
2005	1.052	1.135	1.151
2006	0.764	0.779	1.071
2007	0.743	0.796	0.755
2008	1.143	1.176	
2009	0.833	0.802	

Figure 1. Composite FIMS CPUE series (normalised to the mean over the 1993–2007 period) for rock lobster measuring more than 60 cm. Results are shown for area-weighting of the Dassen Island, Lambert's Bay and Saldanha Bay CPUEs using the new area calculations as well as the old area calculations. For comparison the previous FIMS CPUE series is also shown.