Summary of the most recent GLMM standardised male west coast rock lobster somatic growth trend based upon the "Less data" approach

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Summary

Updated random effects model estimates of annual standardised somatic growth for male rock lobsters to include data from the 2004/05 season are reported in Table 1 and Figure 1. These reflect the "Less data" selection, as used for input to the current ("2003") OMP.

Introduction

A General Linear Mixed Model (GLMM) has been used to describe seasonal and spatial variation in somatic growth of the west coast rock lobster, with the year-location interaction treated as a random effect (Brandão *et al.* 2004). In this paper the analyses of Brandão and Butterworth (2004) are updated to include data from the 2003/04 season. This constitutes the approach adopted both for testing and for applying the present ("2003") west coast rock lobster OMP.

The data

The inclusion of the time between tagging and recapture ("time-at-large" effect) in the GLM analysis to obtain growth rate estimates for rock lobsters led to a statistically significant positive correlation with the growth increment (Butterworth and Glazer 2002). This might be a consequence of the analysis incorrectly including lobsters that have not moulted between the time of tagging and recapture. By means of a stepwise procedure, the biological moult period (in general one and a half to two months) was extended on either side until a non-significant time-at-large effect was obtained (Glazer and Butterworth 2002a, 2002b). Brandão *et al.* (2003) investigated the use of a GLMM model for various variants of a moult period proposed by Glazer and Butterworth (2002a, 2002b). On the basis of results obtained, the "Less data" selection (an expansion of 8 weeks on either side of the original moult cycle for the LM, DI, CP and KN

locations, and Port Nolloth, for which the pattern of growth over time is quite different, excluded from the analysis) was chosen to be the most appropriate selection for future analyses. This selection produces a reduction (compared to the original moult window) in the sample size available for analyses by 47%. This report presents results for the "Less data" selection which contains 7 140 records.

The General Linear Mixed Model

The approach to standardise male west coast rock lobster somatic growth is that proposed by Brandão *et al.* (2004) in which the interaction between the year and the location factors is treated as a random effect in the GLMM.

The GLMM applied to the growth data is of the form:

$$Incr = \mathbf{X}\alpha + \mathbf{Z}\beta + \varepsilon\,, \qquad (1)$$

where :

- $Incr$ is the annual growth increment (mm),
- α is the unknown vector of fixed effects parameters (this vector includes all the parameters for the intercept, the year effect, the location effect and the coefficient for the initial length variate),
- $\mathbf{X}$ is the design matrix for the fixed effects,
- β is the unknown vector of random effects parameters (here the year-location interactions with standard deviation σ_M),
- $\mathbf{Z}$ is the design matrix for the random effects,
- ε is an error term assumed to be normally distributed and independent of the random effects with standard deviation σ_G.

Further assumptions underlying the GLMM are detailed in Brandão *et al.* (2003) and Brandão *et al.* (2004).

Results

The parameter estimates and 95% confidence intervals for the year effects when a GLMM is fitted to the "Less data" selection are shown in Figure 1. Table 1 reports the annual estimates of the mean moult increment of a 70mm male lobster from the GLMM analysis described above. The results obtained in the previous analysis (records available up to and including the 2003/04 season – reflected in tables as the 2003 "year") are also shown for comparison. Figure 2 illustrates the values reported in Table 1.

References

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Table 1. Mean moult increment (in mm) of a 70 mm male lobster at Dassen Island when a GLMM (equation (1)) is fitted to the "Less data" variant for data selection. For years for which data are not available, the average of adjacent years has been taken (shown in italics). The slope parameter is the coefficient of the length covariate in the GLMM. The sample size in each season is also given.

Year	Current	Sample size
1968	5.40	99
1969	6.71	296
1970	*7.34*	
1971	7.97	2
1972	*8.26*	
1973	8.56	6
1974	7.21	1
1975	6.23	96
1976	5.70	42
1977	5.83	4
1978	6.83	65
1979	6.35	109
1980	4.50	21
1981	6.66	375
1982	5.53	56
1983	4.70	21
1984	6.43	99
1985	5.81	62
1986	*5.78*	
1987	5.76	184
1988	5.32	268
1989	4.53	179
1990	3.87	87
1991	4.51	146
1992	4.01	833
1993	4.13	243
1994	4.01	414
1995	4.44	688
1996	4.77	473
1997	3.95	752
1998	3.61	489
1999	3.54	478
2000	4.50	36
2001	3.95	137
2002	4.40	159
2003	4.32	143
2004	3.57	77
Ave 68-end	5.43	
Slope parameter	-0.08231	

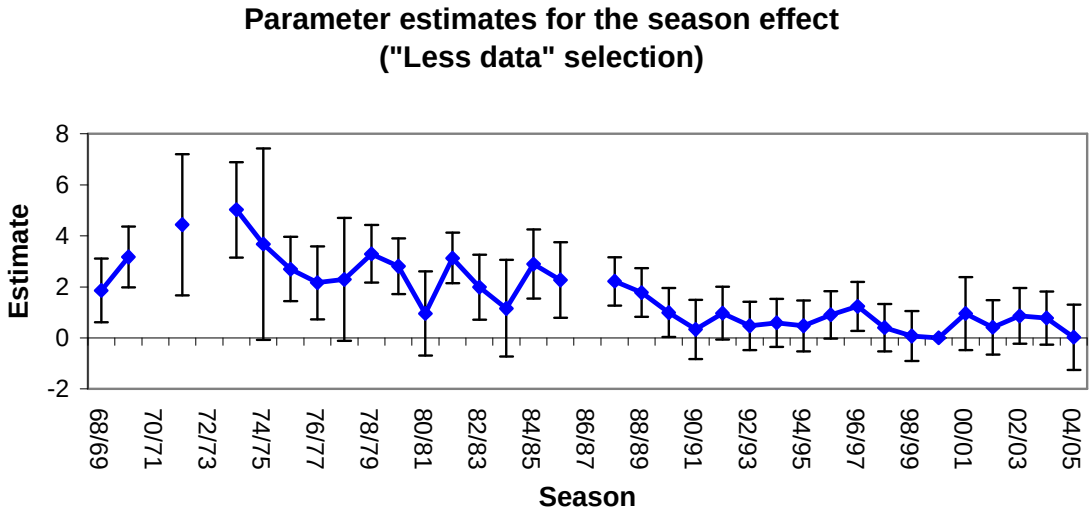

Figure 1. Parameter estimates (with 95% confidence intervals) for the year effect relative to the 1999/00 estimate when a GLMM is fitted to the "Less data" selection.

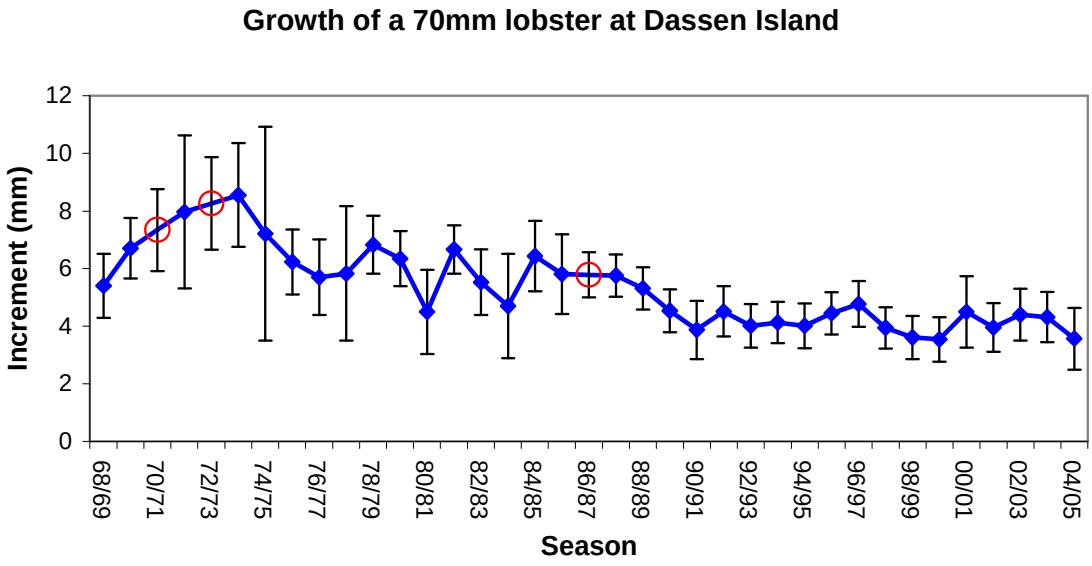

Figure 2. Mean moult increment values of 70mm male lobsters (with 95% confidence intervals) for the "Less data" selection. For seasons without data, averages of adjacent seasons' estimates are shown (denoted as large open circles). Confidence intervals are omitted for these seasons.