UPDATED (AND RESCALED) TRISTAN GLM-STANDARDISED LOBSTER CPUE TO TAKE ACCOUNT OF DATA FOR THE 2016 SEASON

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ABSTRACT

The Powerboat CPUE series for Tristan was last updated in 2016 (MARAM/Tristan/2016/MAY/08) and took data for the 1994-2014[1] seasons into account. This GLM incorporated a method whereby the full GLM for Tristan can be rescaled to take into account the overall fishing efficiency changes informed by the data on fishermen's names (available for only 2005-2007 and 2013-2016 seasons). This document updates this GLM analysis by incorporating data from the most recent 2016 season. A continued improvement in the 2016 CPUE is evident.

INTRODUCTION

The commercial CPUE series for a resource is often used as an index of population density and consequently to inform on population abundance when modelling the dynamics of the underlying population. It is known, however, that a number of factors besides density may influence the recorded values for CPUE. Where sufficient data exist, General Linear Model (GLM) standardisation is able to take some of these further effects into account, thereby producing a more reliable index of abundance. This document reports the application of a number of GLM standardisations to the *Jasus tristiani* lobster catch per unit effort data from the Tristan powerboat fishery for the period 1997-2016.

METHODOLOGY

The standard powerboat CPUE database for Tristan contains information at a trip level for all seasons for the following:

Year
Month
Number of traps
Number of hoops
Hours fished
Total catch (in kgs)

[1] The convention used here for split season is to use the first year, i.e. 2014 refers to the 2014/2015 season.

Note that for Tristan the "season" is assumed to start in July each year. In Johnston *et al.* (2010) a GLM was developed for which the CPUE is taken to be equal to:

$$CPUE = \frac{catch}{(number\ of\ gear)(hours\ fished)} \text{ kg/hour/gear} \quad (1)$$

where the number of gear is:

$$number\ of\ gear = traps + 0.5 * hoopnets$$

(as suggesetd by James Glass pers. comm.) to allow for the different relative efficiency of the two types of gear. [Note that previous GLM analyses showed little sensitivity to alternate hoopnet calibration factors to this 0.5 value.]

Table 1 summarises the variables currently available for the Tristan CPUE GLM analysis. Note that data on *area* fished are now available from 2005, and data on the fishermen's *names* (two for each trip) are available for seven seasons (2005-2007, 2013-2016). It is assumed here that both fishermen in a pair contribute fully to the catch and effort recorded for that trip (the data do not provide details at the individual level, only at the pair-level).

GLM1

The form of GLM model used in the past, and termed GLM1 here, is given by:

$$\ln(CPUE + \delta) = \mu + \alpha_{year} + \beta_{month} \quad (2)$$

where:

C	is the catch in kg,
E	is the effort in hours fished,
μ	is the intercept,
year	is a factor with 24 levels associated with the years (i.e. the Season-Years: 1994-2016),
month	is a factor with levels associated with the fishing month (1-12), and
δ	is taken to be 0.95 (used to prevent taking logs of zero).

The standardised CPUE series is obtained from:

$$CPUE_{year} = \exp\left(\mu + \alpha_{year} + \beta_{September}\right) - \delta \quad (3)$$

GLM3

GLM3 is an extension of GLM1 (as described in MARAM/TRISTAN/2016/MAR/05) that takes the fishermen's names into account in the standardisation:

$$\ln(CPUE + \delta) = \mu + \alpha_{year} + \beta_{month} + \gamma_{area} + \phi_{Name} \quad (4)$$

where:

ϕ_{Name}	is the factor associated with a fisherman's name.

The standardised CPUE series (GLM3) is obtained from:

$$CPUE_{year} = \exp\left(\mu + \alpha_{year} + \beta_{September} + \gamma_{D4} + \phi_{Name12}\right) - \delta \quad (5)$$

Note that GLM3 can be run only for those years for which the fishermen's names are available, i.e. for 2005-2007 and 2013-2016.

Note the intercept in the GLMs includes 2005, September, Area D4, and fisherman number 12 (who is a fisherman who operated over each of the seven years with data on names).

Rescaling of GLM1

The approach taken here is that GLM1 continues to be the most appropriate GLM to be used as the reference case GLM for the Tristan powerboat CPUE as it takes data for the full 1994-2016 period into account. GLM3 however has the advantage that it takes both the area fished and the fishermen's names (and hence their different efficiencies) into account; however this information is available for only seven years, 2005-2007, 2013-2016. GLM3 thus has the important ability to inform on changes in the overall fishing efficiency over this period.

A reasonable way to incorporate this useful information on fishing efficiency changes, is to use GLM1 as the underlying GLM for Tristan, but to rescale the CPUE decline observed from the 2005-2016 period in line with what is estimated by GLM3 (which is able to take any fishing efficiency changes into account).

GLM1 results in a ratio $\frac{CPUE_{13-16}}{CPUE_{05-07}}$=**0.38**, where $CPUE_{05-07}$ is the average CPUE over the 2005-2007 period and $CPUE_{13-16}$ is the average CPUE over the 2013-2016 period.

GLM3 results in a ratio $\frac{CPUE_{13-16}}{CPUE_{05-07}}$=**0.43**, indicating a somewhat lesser decline in CPUE over the 2005-2016 period than GLM1 does because of a decline in the overall average of the fishermen's efficiency.

The GLM1 values are **rescaled** from 2005 to 2016 using a linear function of year as a multiplier which does not change the value for 2005 but achieves a $\frac{CPUE_{13-16}}{CPUE_{05-07}}$ ratio that equals 0.43.

RESULTS

Table 2 reports both the (unscaled) GLM1 standardised CPUE series, as well as the rescaled GLM1 series.

Figure 1 plots the standardised CPUE for GLM1 and GLM3 (where the GLM3 values are renormalized so that the average CPUE for the 2005-2007 period are identical to that for GLM1). Figure 2 plots the standardised CPUE for GLM1 and for the rescaled GLM1a. Figure 3 shows the scaling vector applied to the GLM1 standardised CPUE values to produce the rescaled GLM1 values.

Figure 4a shows the month effects estimated for GLM1 and GLM3; month effects are generally higher for August to December. Figure 4b shows the area effects estimated by GLM3 – this shows that area effects are minimal. Figure 4c shows the "Name" effects for GLM3.

DISCUSSION

We continue to recommend that the re-scaled GLM1 series remains the more reliable CPUE series as both the full time series of data is taken into account and the new data on areas and fishing names are also incorporated. The rescaled GLM1 thus takes the fishing efficiency changes informed by these new data into account. The inclusion of the fishing efficiency changes results in a slightly less pessimistic CPUE trend over recent seasons. It is planned to use the rescaled GLM1 CPUE series presented here as input into the new OMP 2016 to recommend the TAC for the 2017/18 season. Figure 2 shows that the most recent data for the 2016/17 season show an improvement (as was the case the previous season).

Table 1: Table showing for which seasons different variables are available for CPUE GLM standardisation analysis.

	Season	Month	Area	Name	Nominal CPUE
1997					
1998					
1999					
2000					
2001					
2002					
2003					
2004					
2005					
2006					
2007					
2008					
2009					
2010					
2011					
2012					
2013					
2014					
2015					
2016					

Table 2: Standardised powerboat CPUE series for **Tristan** Island using the original GLM1a model as well as the rescaled GLM1a which takes fisherman efficiency into account. The number of data records for each Season-Year (*N*) is listed, along with nominal CPUE series for comparison.

Season-Year	*N*	**Nominal CPUE (kg/hour/gear)**	**GLM1 Standardised CPUE (kg/hour/gear)**	**Rescaled GLM1 Standardised CPUE (kg/hour/gear)**
1994	1138	0.269	0.328	0.328
1995	1139	0.264	0.291	0.291
1996	1241	0.280	0.327	0.327
1997	696	0.489	0.498	0.498
1998	446	0.712	0.602	0.602
1999	338	0.961	0.778	0.778
2000	324	1.019	0.969	0.969
2001	334	1.107	0.992	0.992
2002	335	1.397	1.358	1.358
2003	382	1.684	1.555	1.555
2004	385	1.726	1.732	1.732
2005	339	2.155	2.246	2.246
2006	284	2.840	2.589	2.621
2007	310	2.365	2.119	2.173
2008	486	1.453	1.273	1.322
2009	305	1.835	1.785	1.877
2010	484	1.317	1.271	1.353
2011	376	1.321	1.225	1.321
2012	344	1.104	1.059	1.156
2013	476	0.990	0.975	1.078
2014	366	0.704	0.703	0.787
2015	343	0.833	0.851	0.965
2016	376	1.028	1.017	1.168

Figure 1: Comparative plot of the GLM1 and GLM3 standardised powerboat CPUE series for **Tristan** Island. GLM3 covers the years 2005-2007 and 2013-2016 only, and takes account of fishermen efficiency. It is renormalised to the GLM1 mean for the 2005-07 period for easier comparison of trends.

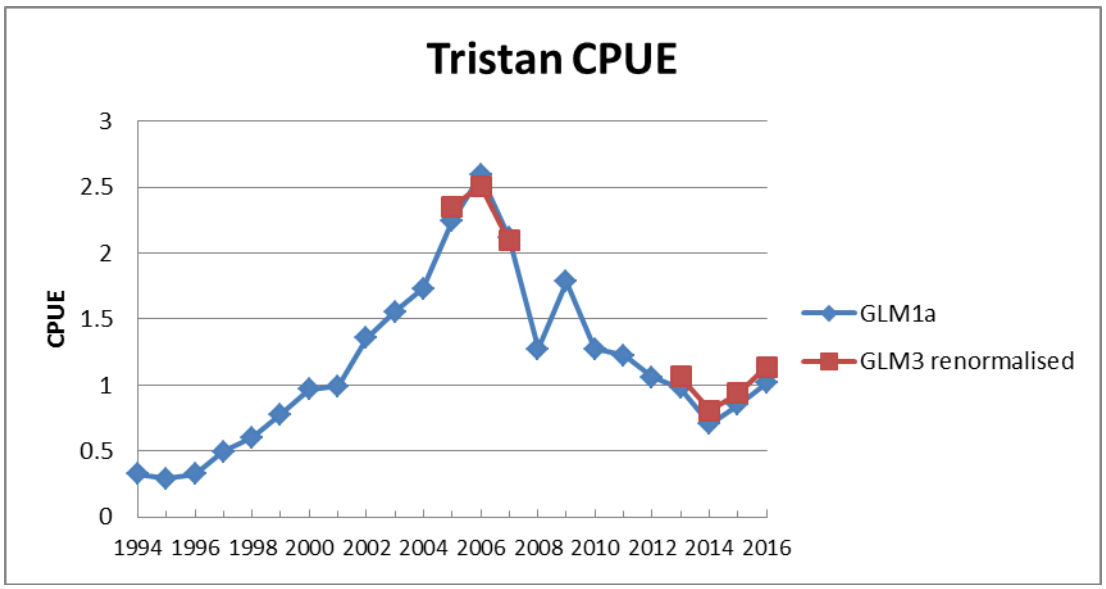

Figure 2: Comparative plot of the GLM1 and rescaled GLM1 powerboat CPUE series for **Tristan** Island. The latter includes an adjustment for changing average fisherman efficiency over time.

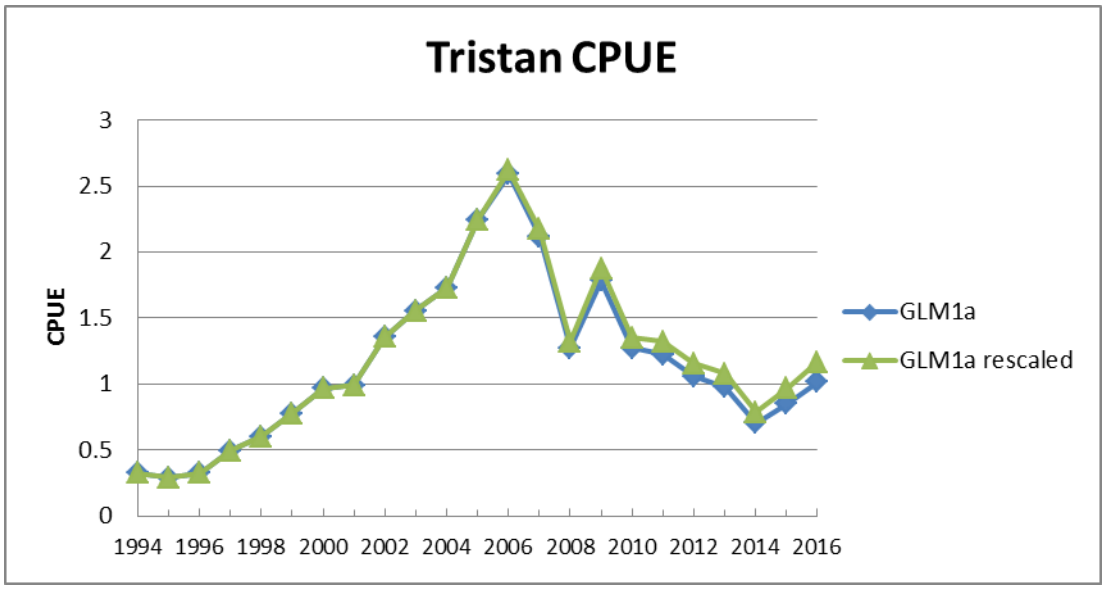

Figure 3: The scaling vector which is applied to the GLM1 standardised CPUE values to produce the rescaled GLM1 values

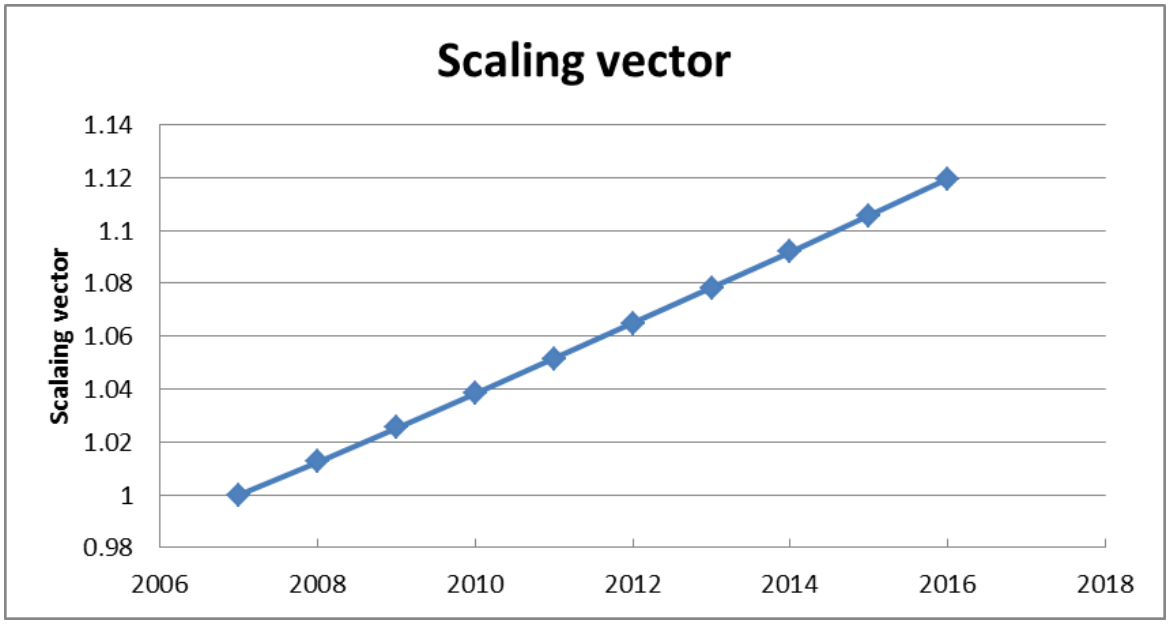

Figure 4a: GLM month effects for the **Tristan** Island for both GLM1 and GLM3.

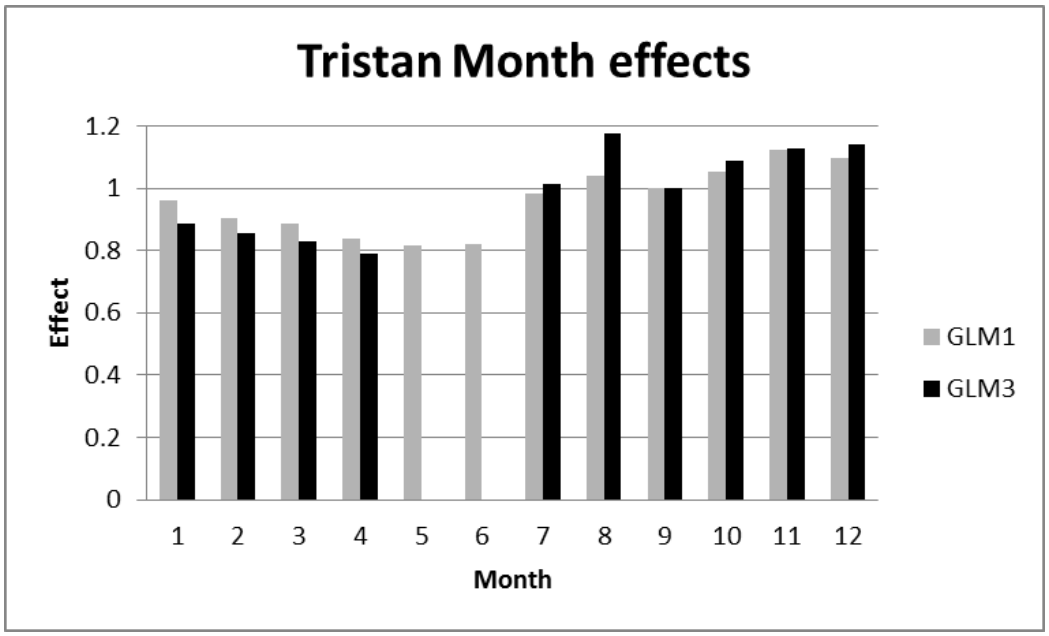

Figure 4b: GLM3 area effects for the **Tristan** Island.

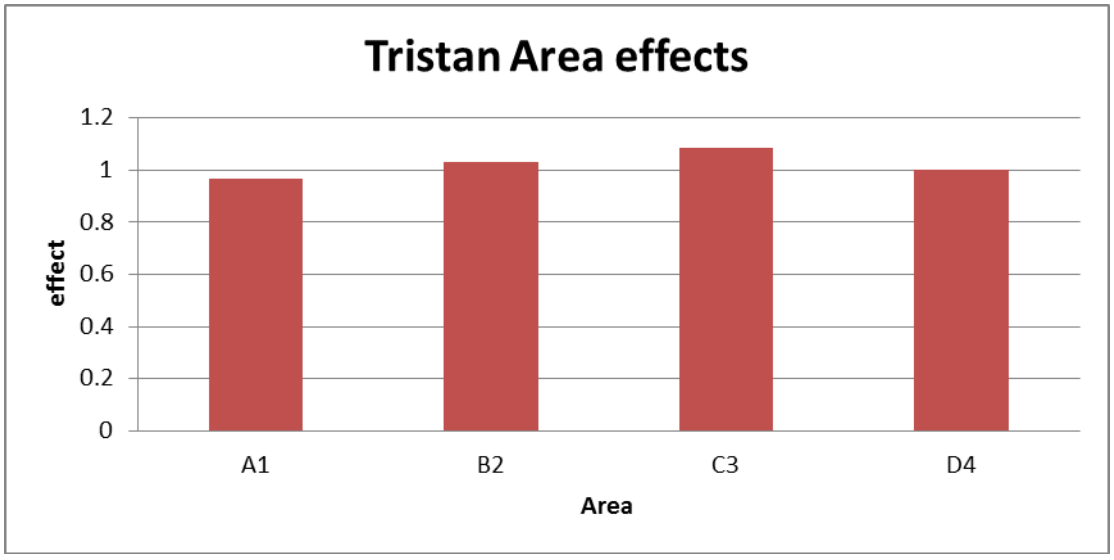

Figure 4c: GLM3 name (i.e. fisherman efficiency) effects for the **Tristan** Island. Names have been replaced by numerics for reasons of confidentiality.