

**UPDATED (AND RESCALED) TRISTAN GLM-STANDARDISED LOBSTER
CPUE TO TAKE ACCOUNT OF DATA FOR THE 2015 SEASON**

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ABSTRACT

The Powerboat CPUE series for Tristan was last updated in 2016 (MARAM/Tristan/2016/MAR/05) and took data for the 1994-2014¹ 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 more recent seasons). This document updates this GLM analysis incorporating data from the most recent 2015 season. An improvement in the 2015 CPUE is noted.

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 tristani* lobster catch per unit effort data from the Tristan powerboat fishery for the period 1997-2015.

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 estimated 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 scaling 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 five seasons (2005-2007, 2013-2015). It is assumed here that both fishermen in a pair contribute fully to the catch and effort recorded for that trip (data do not provide details at the individual level, only at the pairs-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 22 levels associated with the years (i.e. the Season-Years: 1994-2014),
$month$	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:

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

GLM3

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

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

where:

$Name$	is the factor associated with the fishermen’s names.
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The standardised CPUE series (GLM3) is obtained from:

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

Note that GLM3 can be run only for those years for which the fishermen's names are available, i.e. for 2005-2007, 2013-2015.

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

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 1994-2015 period into account. GLM3 however has the advantage that it takes both the area fished and the fishermen's names into account; however is available for only five years, 2005-2007, 2013-2015. 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 2005-2015 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 $\frac{CPUE_{13-15}}{CPUE_{05-07}} = \mathbf{0.35}$, where $CPUE_{05-07}$ is the average CPUE over the 2005-2007 period and $CPUE_{13-15}$ is the average CPUE over the 2013-2015 period.

GLM3 results in a ratio $\frac{CPUE_{13-15}}{CPUE_{05-07}} = \mathbf{0.40}$, indicating a somewhat lesser decline in CPUE over the 2005-2015 period than does GLM1 because of a decline in the overall average of the fishermen's efficiency.

The GLM1 values are **rescaled** from 2005 to 2015 using a linear function in the year as a multiplier which does not change the value for 2005 but achieves a $\frac{CPUE_{13-15}}{CPUE_{05-07}}$ ratio that equals 0.40.

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

It is recommended 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. The rescaled GLM1 CPUE series presented here will be used as input into the new OMP 2016 to recommend the TAC for the 2016/17 season. It is noted that the most recent data from the 2015/16 season show an improvement.

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					

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	0.274	0.274
1995	1139	0.264	0.239	0.239
1996	1241	0.280	0.276	0.276
1997	696	0.489	0.446	0.446
1998	446	0.712	0.552	0.552
1999	338	0.961	0.727	0.727
2000	324	1.019	0.917	0.917
2001	334	1.107	0.940	0.940
2002	335	1.397	1.304	1.304
2003	382	1.684	1.502	1.502
2004	385	1.726	1.677	1.677
2005	339	2.155	2.192	2.192
2006	284	2.840	2.540	2.540
2007	310	2.365	2.066	2.066
2008	486	1.453	1.222	1.246
2009	305	1.835	1.732	1.801
2010	484	1.317	1.219	1.292
2011	376	1.321	1.173	1.268
2012	344	1.104	1.006	1.110
2013	476	0.990	0.920	1.034
2014	366	0.704	0.651	0.746
2015	343	0.833	0.795	0.930

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

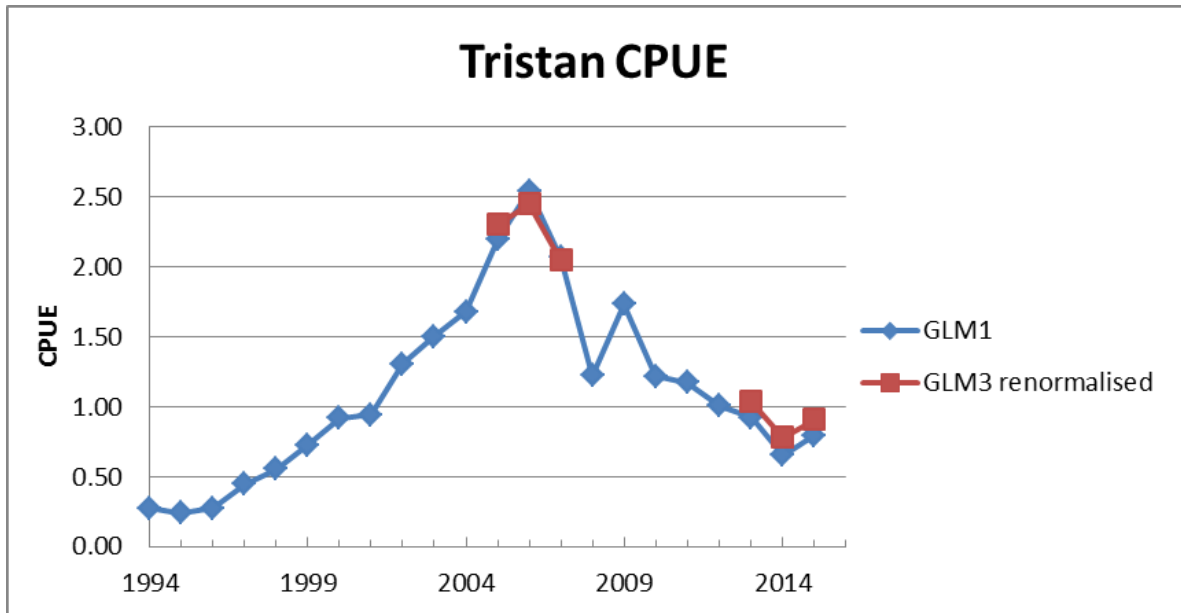


Figure 2: Comparative plot of the GLM1 and rescaled GLM1 powerboat CPUE series for **Tristan** Island.

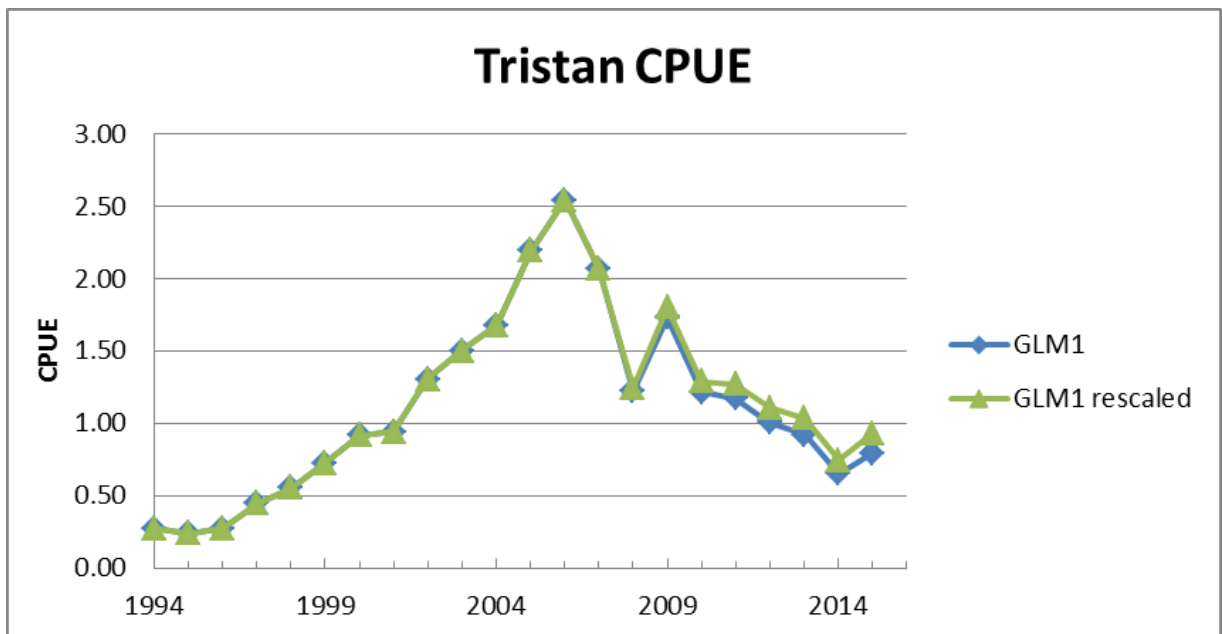


Figure 3: The scaling vector required to be applied to the GLM1 standardised CPUE values to produce the rescaled GLM1 values

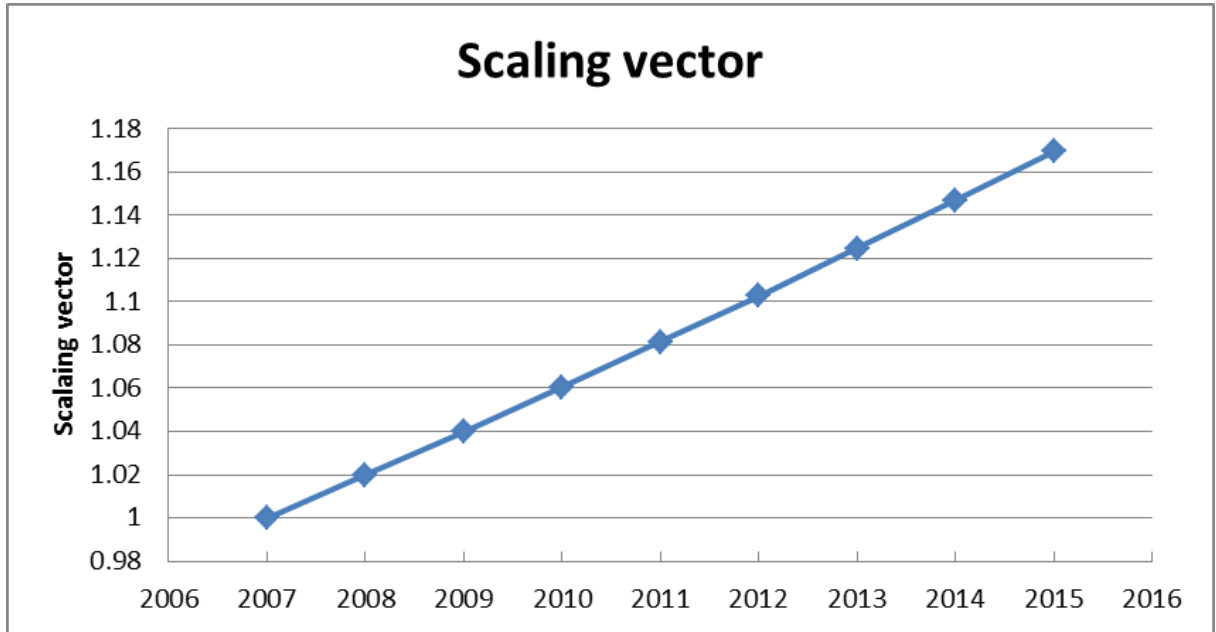


Figure 4a: GLM month effects for the **Tristan** Island for both GLM1 and GLM3.

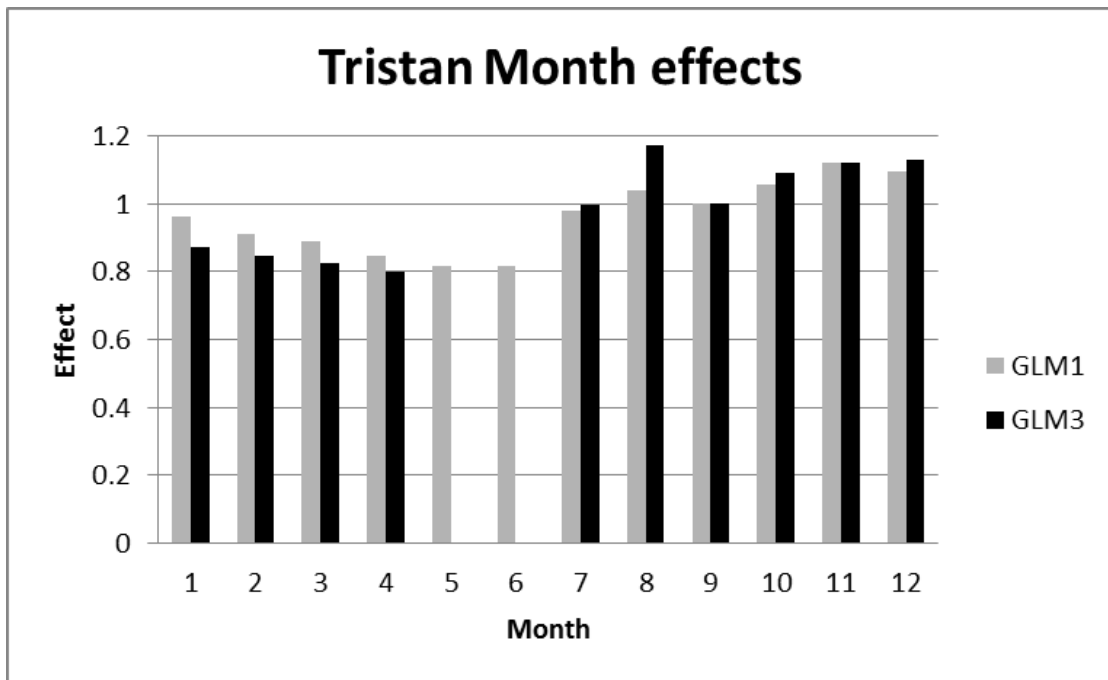


Figure 4b: GLM3 area effects for the **Tristan** Island.

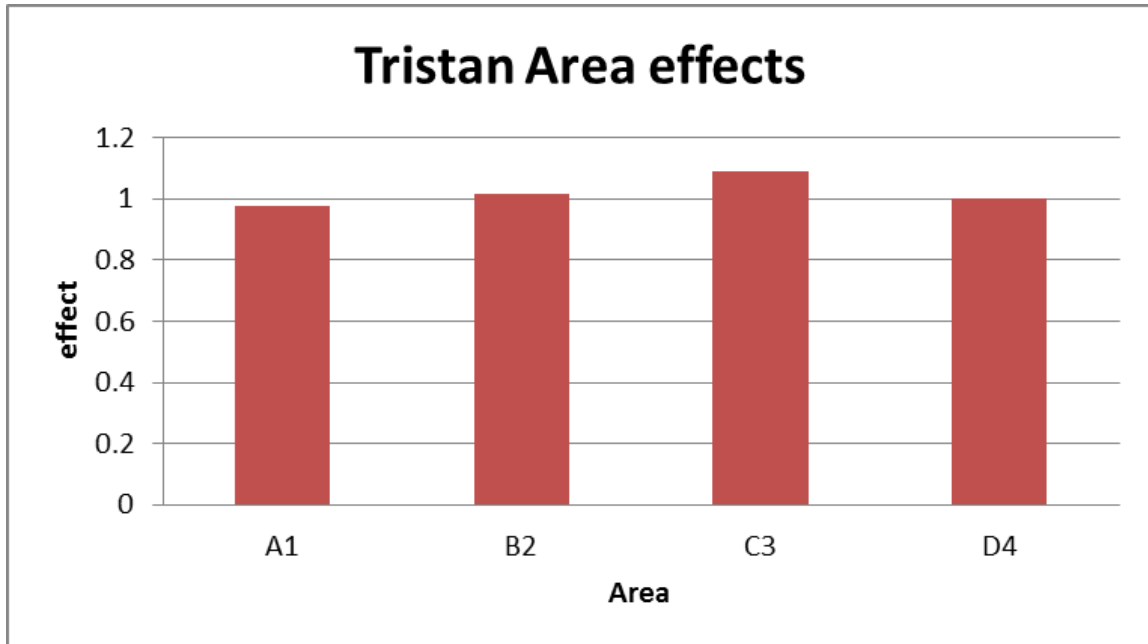


Figure 4c: GLM3 name (i.e. fisherman efficiency) effects for the **Tristan** Island. Names have been replaced by numerics for reasons of confidentiality.

