Tristan Group Biomass Survey (Leg 1) results including data from the 2017 season

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Summary

This paper reports the updated biomass indices (to include the 2017 season) obtained from the annual (Leg 1) biomass survey at each island. The index continues to show steady improvement for Inaccessible and Tristan over recent years, and a fairly constant trend for Gough. The Nightingale biomass index remains high following a sharp increase subsequent to the 2011 OLIVA event. There have been some changes over time in the size distribution, the most marked of which have been a steady increase at Inaccessible, with a steady decrease in the mean length at Tristan which having reversed over the last three seasons. The percentage of females in the catch at Gough is about double that at the other islands but has shown a decline in the most recent 2017 season.

Introduction

A now fairly large number (18) of biomass surveys has been completed thus far at each of the four islands of the Tristan da Cunha group. Table 1 lists the months during which each of these surveys were undertaken at each of the four islands. For each season there has traditionally been a Leg1 survey carried out around Aug/Sept and then a further Leg 2 survey conducted around Feb/Mar. This document provides a brief summary of the biomass index and catch-at-length (CAL) data collected thus far for the Leg 1 surveys, including the most recent 2017[1] data. For stock assessment purposes, a decision was made earlier that the operating models will be fit to the Leg 1 biomass survey index and catch-at-length data only; and that the Leg2 surveys will be discontinued. The rationale for the latter decision was that whilst the Leg 1 surveys were consistently undertaken at the start of each season, the timing of the Leg 2 surveys tended to vary somewhat, particularly with respect to the amount of catch that had been taken at the time of the

[1] The split season is denoted by the first year, i.e. 2013 refers to the 2013/14 season.

Leg 2 survey. It was consequently considered that the Leg 2 surveys would not be readily comparable from season to season.

Methods

Biomass index

At each island a number of transects is set (e.g. Tristan has eight transects) – Table 1 lists the number of transects for each island. On each transect, 9 traps are set – 3 inshore, 3 towards the middle of each transect and 3 offshore. The total number of lobsters and the biomass caught from each of the nine traps has been recorded by James Glass (pers. commn). Thus for each survey at Tristan, there are 8 transects x 9 traps = 72 values of a biomass index in terms of numbers caught per trap.

For each transect (*s*) the average of the reported biomass indices for the 9 traps is obtained ($\overline{B}_s$). (This analysis treats transects rather than traps as the sampling unit, both because of possible spatial correlation (non-independence) along a transect, and because lobster density may vary with depth so that the survey design is such as allows this variation to be integrated out.)

The following are then calculated where *n* is the pertinent number of transects:

Biomass index $\overline{B}_s = \frac{\sum_s \overline{B}_s}{n}$

Standard deviation $sd = \sqrt{\frac{n\sum \overline{B}_s^2 - (\sum \overline{B}_s)^2}{n(n-1)}}$

Standard error $se_m = \frac{sd}{\sqrt{n}}$

The value and 95% confidence intervals for the biomass index calculated for each Leg1 survey are plotted in Figures 1a-d. To avoid confidence intervals overlapping zero, the assumption of distribution lognormality with $CV = \frac{se_m}{\bar{B}_s}$ has been made.

Catch-at-length proportions

Catch-at-length (CAL) data are recorded initially at a 1mm carapace interval, then put into 5mm carapace length classes; as an example, the size class 60mm refers to lobsters sized 60-64mm CL. Plus- and minus-groups are created where necessary to avoid size-classes with extremely small frequencies. Males and females are reported separately.

% Females

The percentage females (by number) caught in these surveys is also reported.

Mean size of catch

Another useful statistic that is reported is the mean size of the catch (where males and females are combined).

Results and Discussion

Biomass index

Table 2 reports the biomass survey index values with their associated CVs. The mean and 95% confidence intervals for the biomass index calculated for each Leg1 survey are plotted in Figures 1a-d.

Figures 1b shows a continued increase in the latest 2016 and 2017 biomass survey index at Inaccessible – the highest 2016 value since the surveys were initiated. Figure 1b shows a slight increase to the previous season for Nightingale, and the index for Nightingale remains high relative to earlier values and high since the 2011 OLIVA event. The Tristan biomass index has shown a continued increase since 2015 with the 2017 value being the highest since 2012 (Figure 1a). The Gough (Figure 1d) 2017 value is very similar to the previous three years' values (2014, 2015 and 2016).

Catch-at-length proportions

Biomass survey catch-at-length proportions (with males and females together summing to 1.0) are used as input data to the updated assessment of each island. Here, these data, including now the 2017 data, are shown in Figures 2a-d (for each island), where the proportions have been modified to sum to 1.0 separately for males and females (so as not to be confounded with the relative female to male ratio information). Note that for these plots (and for the input data into the assessments) plus- and minus-groups have been selected in a manner that avoids extremely small proportions.

Some interesting patterns in the biomass survey CAL data are evident. It is also useful to compare the biomass survey CAL data with the CAL data collected by observers from the fishery itself (see Johnston and Butterworth 2015; Johnston 2016). One of the most noticeable trends is that the Nightingale CAL (males) has seen a fairly marked shift to larger lobsters over the 2010, 2011 and 2012 seasons. This shift is also evident in the CAL data collected from the fishery. What is notable is that the 2013 and 2014 Nightingale male CAL data appear to have reverted to a pattern seen in 2006 and 2007. There was a shift again towards the large lobsters evident in the CAL data from 2015, but this again seems to have reverted somewhat more to smaller lobsters. There is a similar (though lesser) shift evident in the Gough male 2012 Leg1 data – i.e. shift towards large lobsters – but again the 2013 - 2017 data appear more "normal" (Figure

2d). The Gough 2017 female CAL data shows an unusually large shift towards large lobsters for the females, though note that there was also an unusually small sample size of females in the survey for Gough 2017 – so this might be an effect of small sample size.

The Tristan Leg 1 male data showed the opposite trend (Figure 2a), with a shift to the smaller lobsters over the 2006-2013 period until 2013. Such a trend could be caused by some combination of heavier fishing (of the larger sized lobsters) or a recruitment increase at the same stage during this period. The 2014 data show a shift back towards slightly larger lobster, with this trend continuing with 2015 and 2016 data, and with an even larger shift to large lobsters for 2017.

The Inaccessible CAL data (Figure 2b) do show a steady increase towards the larger male lobsters over the 2013-2017 period.

Mean size of survey catch

The mean length of the survey catch (considering both males and females combined) can also be calculated. The values are plotted against season in Figures 3a-d. These plots generally show the patterns that are to be expected given the features in the length distributions and their changes over time which are mentioned above. In particular, it is evident that the mean size of the survey catch declined steadily from 2006-2012 at Tristan (from around 87mm CL to 75mm CL), but increased steadily over the 2013-2017 period. The mean size of catch has however increased steadily at Inaccessible over the 2010-2016 period. For Gough and Nightingale, no clear patterns are obvious with fairly large inter-annual changes being evident. The mean size of the survey catches did increase sharply after the 2011 OLIVA event at Nightingale – but is similar to the values observed in 2006 and 2007. For Gough there does seem to have been some general reduction in mean length of catch over the 2006-2017 period (Figure 3d).

% Females

These data are plotted in Figures 4a-d. The very low % female value for Nightingale reported for 2012 is evident in Figure 4c. For the 2016 and 2017 surveys, these values are once again at the higher levels seen in the pre-OLIVA seasons.

The % females from the surveys at the other three islands have been fairly consistent since 2006. It is notable that the % females in the Gough catch is generally much higher (around 25%-35%) than at the other three islands (around 5-15%), although this value had decreased substantially for the 2017 season (Figure 4d).

References

Johnston, S.J. and Butterworth, D.S. 2015. Updated observer catch-at-length data from the commercial fisheries at the Tristan da Cunha group of islands. MARAM document, MARAM/Tristan/2015/MAY/05

Johnston, S.J. 2016. Updated observer catch-at-length data from the commercial fisheries at the main Tristan da Cunha island. MARAM document, MARAM/Tristan/2016/FEB/02/

Table 1: Months during which the surveys completed thus far for the four islands have taken place. Leg 1 surveys are shown in bold.

	Tristan	**Nightingale**	**Inaccessible**	**Gough**
Season 2006/07 Leg 1	**Sep 2006**	**Sep 2006**	**Sep 2006**	**Oct 2006**
Season 2006/07 Leg 2	Feb 2007	Feb 2007	Feb 2007	Feb 2007
Season 2007/08 Leg 1	**Sep 2007**	**Sep 2007**	**Sep 2007**	**Oct 2007**
Season 2007/08 Leg 2	Mar 2008	Mar 2008	Mar 2008	Feb 2008
Season 2008/09 Leg 1	**No surveys due to factory fire**			
Season 2008/09 Leg 2	Feb 2009	Feb 2009	Feb 2009	Feb 2009
Season 2009/10 Leg 1	**Sep 2009**	**Sep 2009**	**Sep 2009**	**Sep 2009**
Season 2009/10 Leg 2	Mar 2010	Mar 2010	Mar 2010	Apr 2010
Season 2010/11 Leg 1	**Sep 2010**	**Sep 2010**	**Sep 2010**	**Sep 2010**
Season 2010/11 Leg 2	Mar 2011	Mar 2011	Mar 2011	April 2011
Season 2011/12 Leg 1	**Aug 2011**	**Aug 2011**	**Aug 2011**	**Sep 2011**
Season 2011/12 Leg 2	Feb 2012	Feb 2012	Feb 2012	Feb 2012
Season 2012/13 Leg 1	**Sep 2012**	**Aug 2012**	**Sep 2012**	**Sep 2012**
Season 2012/13 Leg 2	Mar 2013	Feb 2013	Feb 2013	Jan 2013
Season 2013/14 Leg 1	**Sep 2013**	**Aug 2013**	**Aug 2013**	**Sep 2013**
Season 2014/15 Leg 1	**Sep 2014**	**Sep 2014**	**Sep 2014**	**Sep 2014**
Season 2015/16 Leg 1	**Aug 2015**	**Aug 2015**	**Aug 2015**	**Sep 2015**
Season 2016/17 Leg 1	**Sep 2016**	**Sep 2016**	**Sep 2016**	**Sep 2016**
Season 2017/18 Leg 1	**Sep 2016**	**Sep 2016**	**Sep 2016**	**Oct 2016**
# Leg1 transects *n*	8	4	5	8

Table 2: Leg1 biomass survey index values, with associated CVs in parentheses.

	Tristan	**Inaccessible**	**Nightingale**	**Gough**
2006	31.60 (0.21)	17.80 (0.23)	13.86 (0.15)	8.03 (0.31)
2007	40.23 (0.13)	16.33 (0.21)	20.31 (0.19)	11.15 (0.28)
2008	-	-	-	-
2009	26.64 (0.13)	14.98 (0.36)	16.31 (0.05)	26.47 (0.26)
2010	25.49 (0.14)	10.98 (0.55)	14.00 (0.26)	11.15 (0.32)
2011	28.36 (0.14)	16.60 (0.19)	4.63 (0.51)	16.39 (0.26)
2012	17.96 (0.14)	9.51 (0.22)	18.10 (0.19)	9.11 (0.27)
2013	17.14 (0.13)	12.64 (0.30)	23.50 (0.19)	13.07 (0.30)
2014	18.82 (0.17)	12.22 (0.22)	30.92 (0.11)	8.50 (0.28)
2015	15.63 (0.18)	9.27 (0.36)	23.61 (0.21)	8.31 (0.33)
2016	18.99 (0.13)	18.60 (0.19)	23.58 (0.10)	9.46 (0.30)
2017	23.94 (0.15)	16.51 (0.17)	24.25 (0.10)	8.13 (0.31)

Figure 1a: Biomass indices (in terms on the average mass caught per trap) for the Leg 1 surveys for **Tristan**. The means and (and assumed log normal) 95% confidence intervals are shown. The arrow shows the timing of the OLIVA incident.

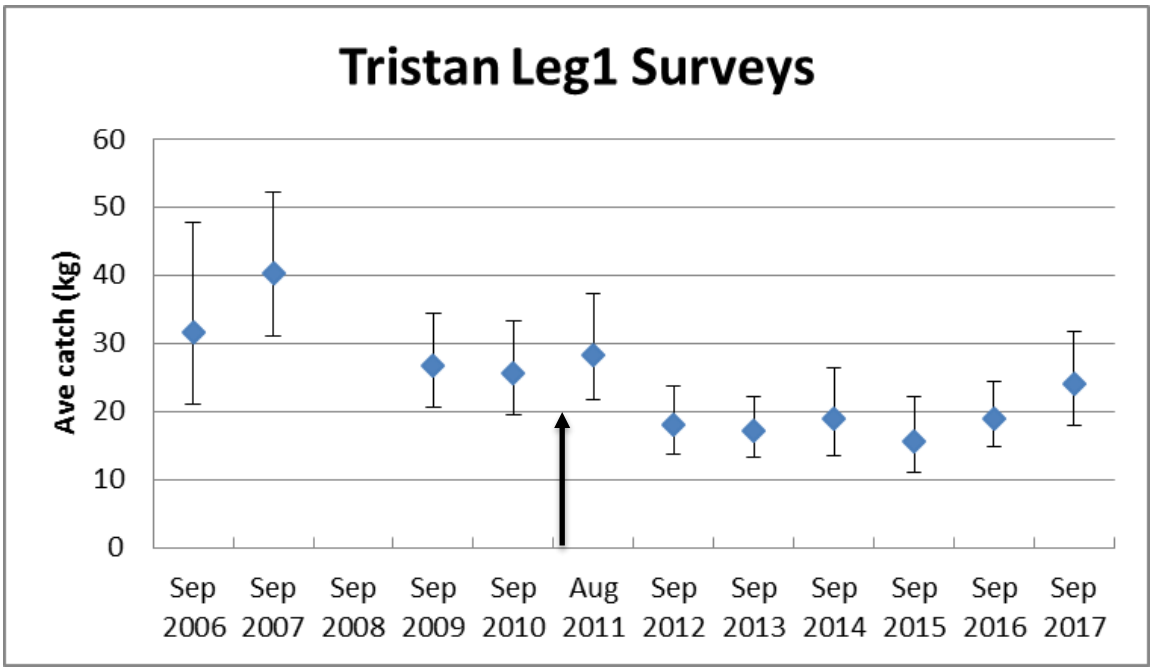


Figure 1b: Biomass indices (in terms on the average mass caught per trap) for the Leg1 surveys for **Inaccessible**. The means and (and assumed log normal) 95% confidence intervals are shown. The arrow shows the timing of the OLIVA incident.

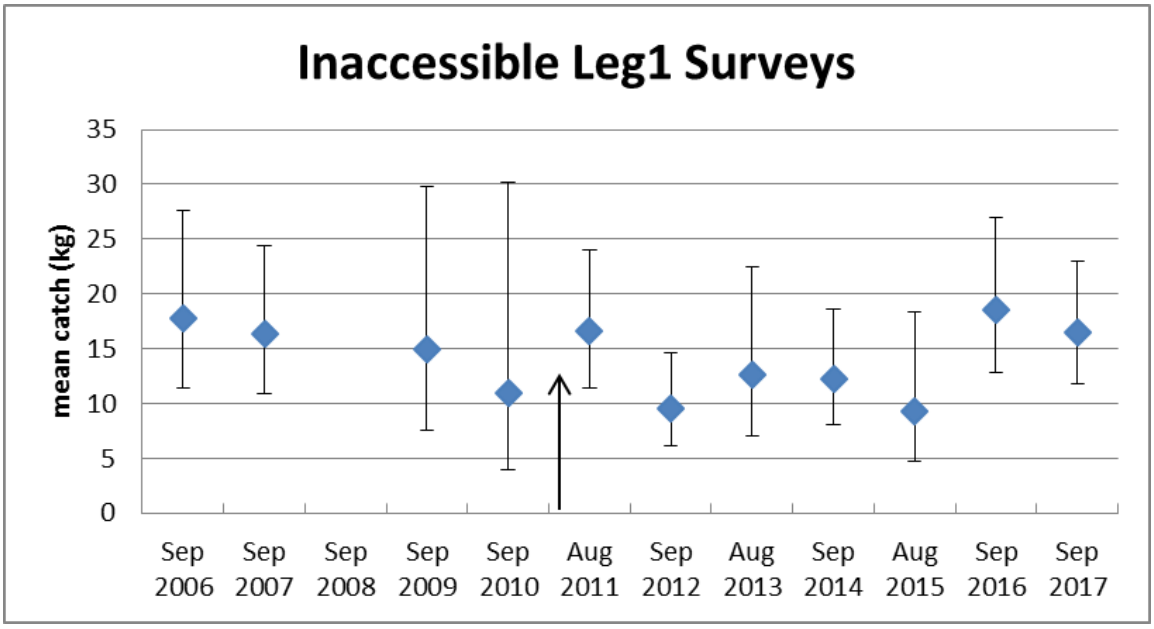


Figure 1c: Biomass indices (in terms on the average mass caught per trap) for the Leg 1 surveys for **Nightingale**. The means and (and assumed log normal) 95% confidence intervals are shown. The arrow shows the timing of the OLIVA incident.

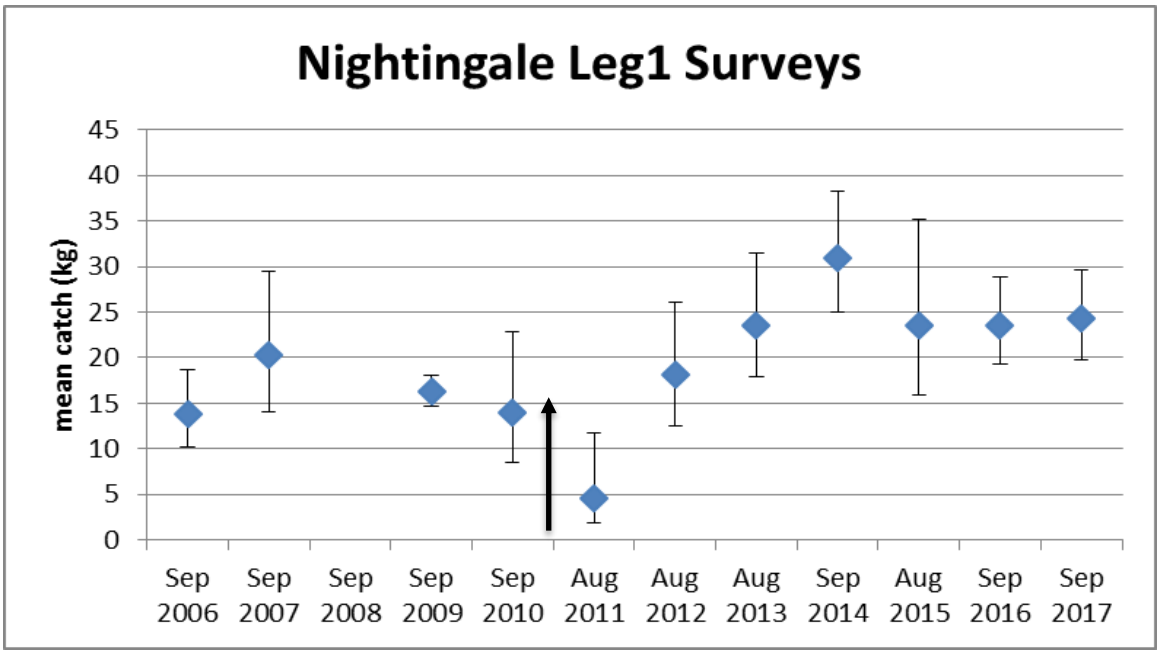


Figure 1d: Biomass indices (in terms on the average mass caught per trap) for the Leg 1 surveys for **Gough**. The means and (and assumed log normal) 95% confidence intervals are shown. The arrow shows the timing of the OLIVA incident.

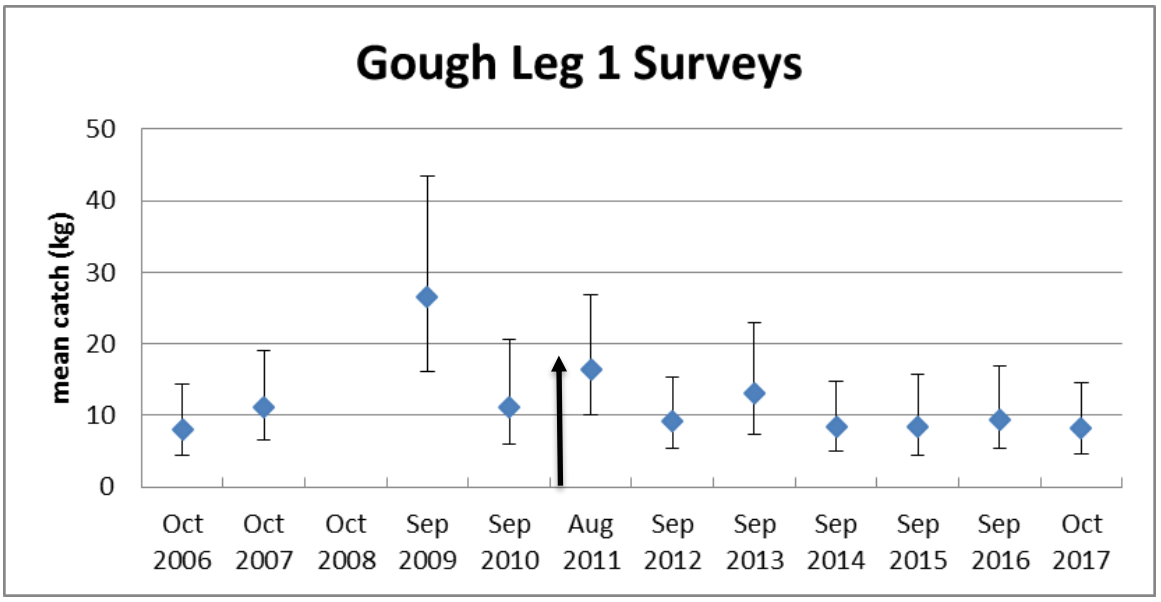
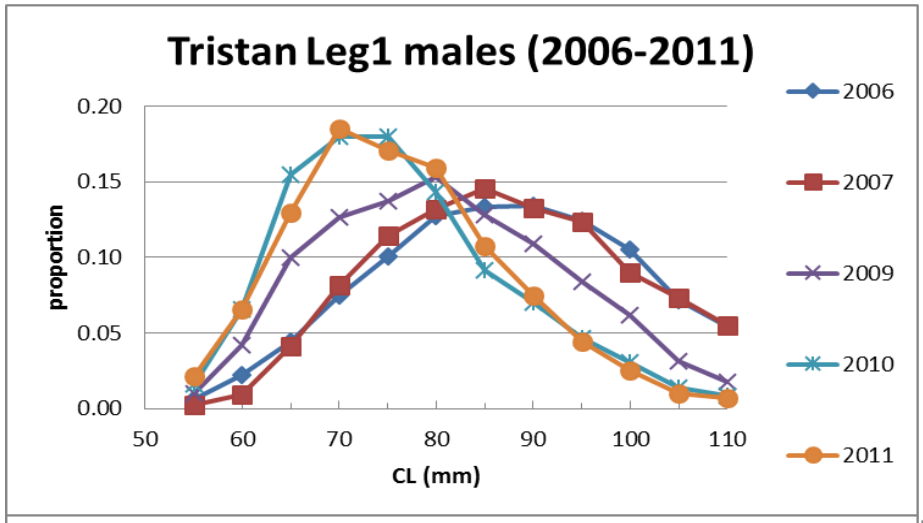
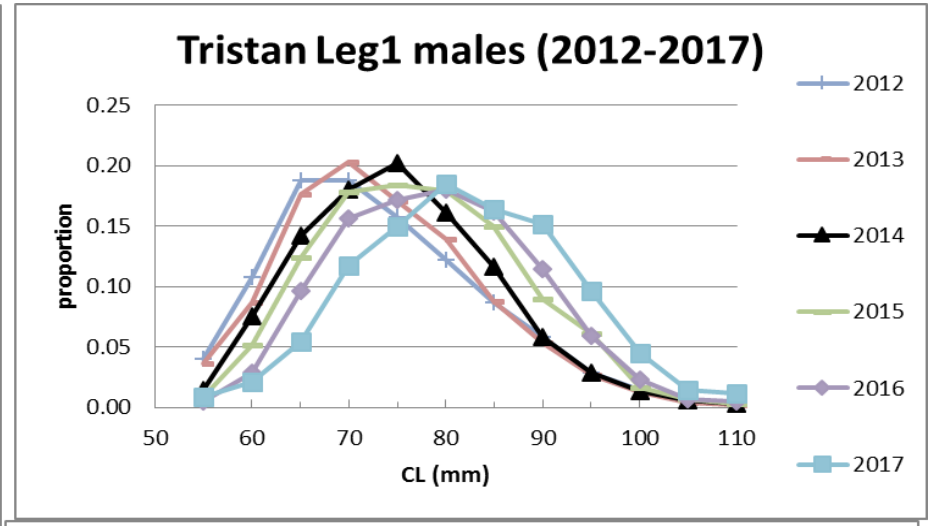
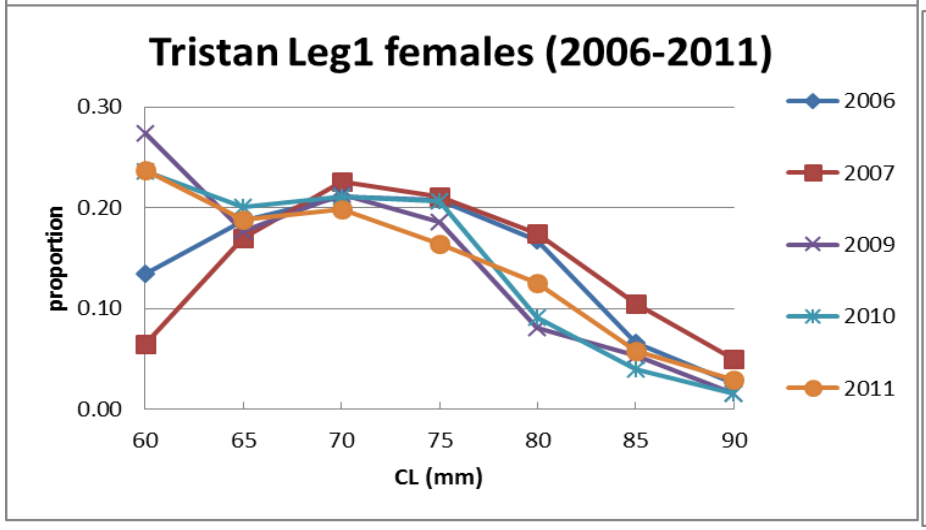


Figure 2a: **Tristan** catch-at-length proportions for males (top) and females (bottom) for the Leg 1 surveys. Proportions here sum to 1.0 separately for each sex. The smallest and largest size categories are minus- and plus-groups respectively.







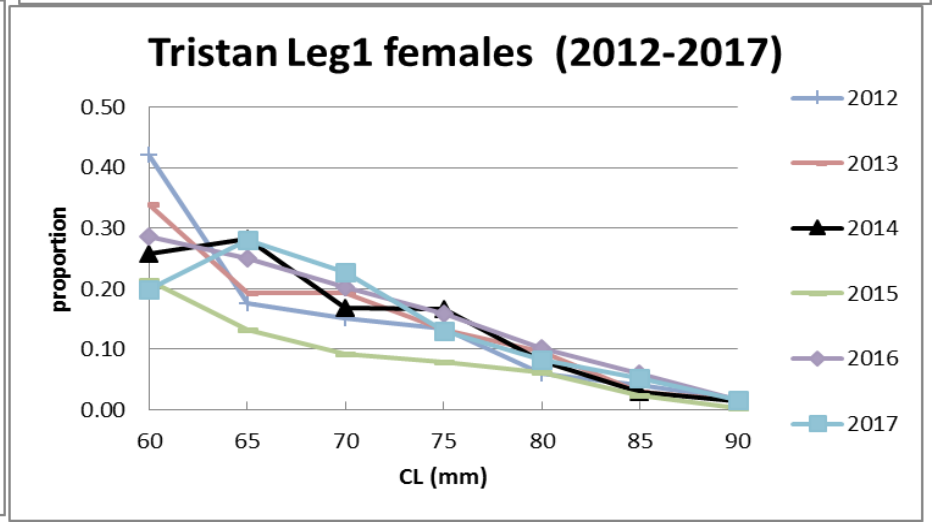


Figure 2b: **Inaccessible** catch-at-length proportions for males (top) and females (bottom) for the Leg 1 surveys. Proportions here sum to 1.0 separately for each sex. The smallest and largest size categories are minus- and plus-groups respectively.

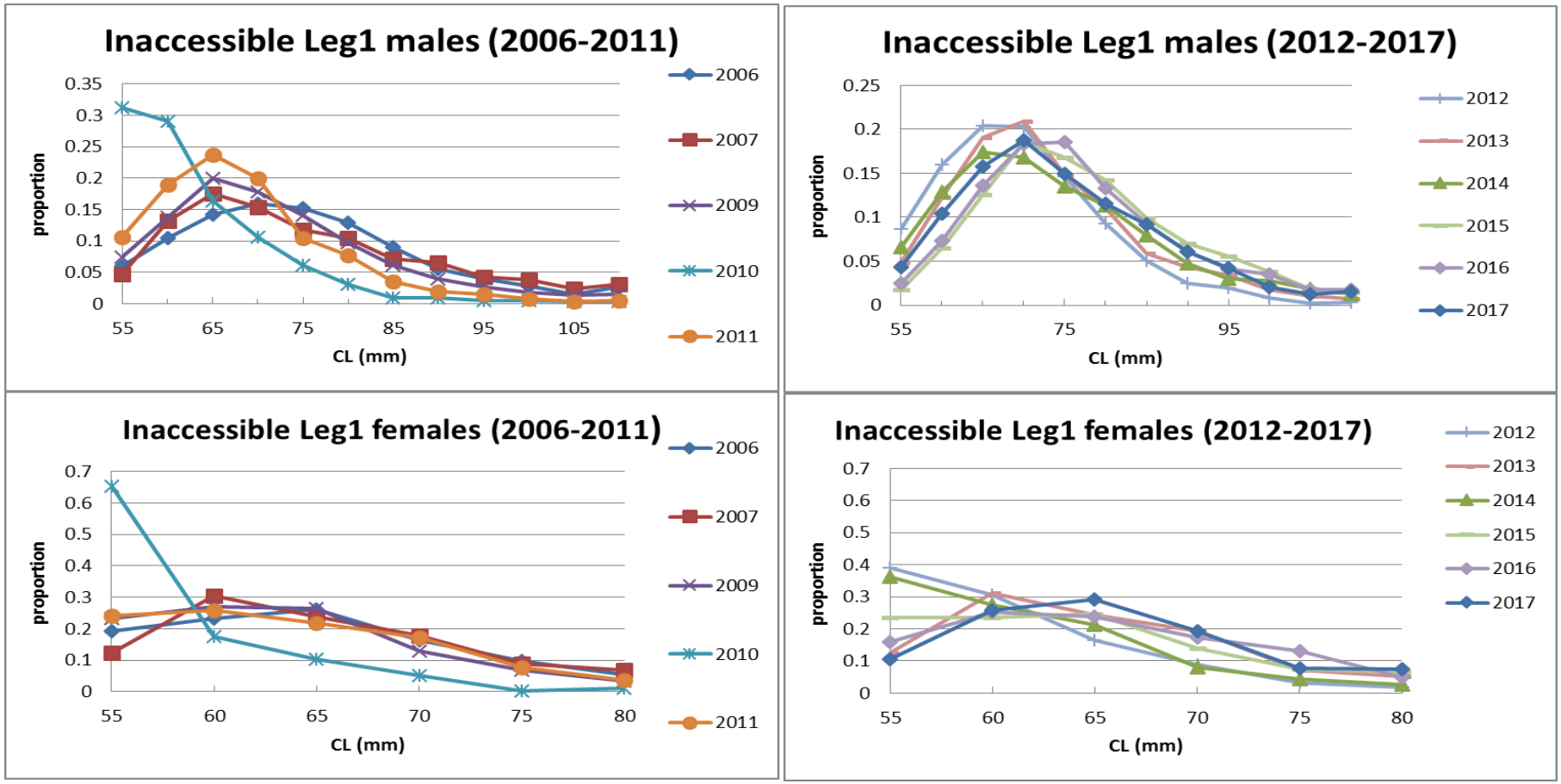
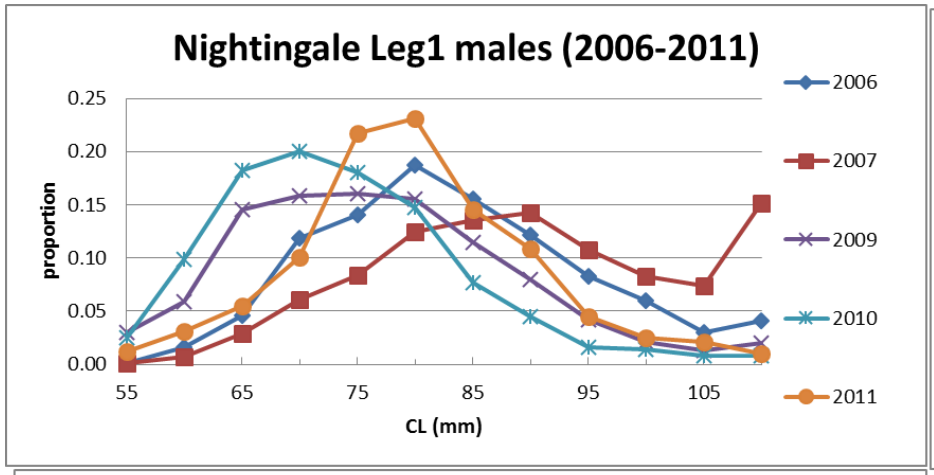
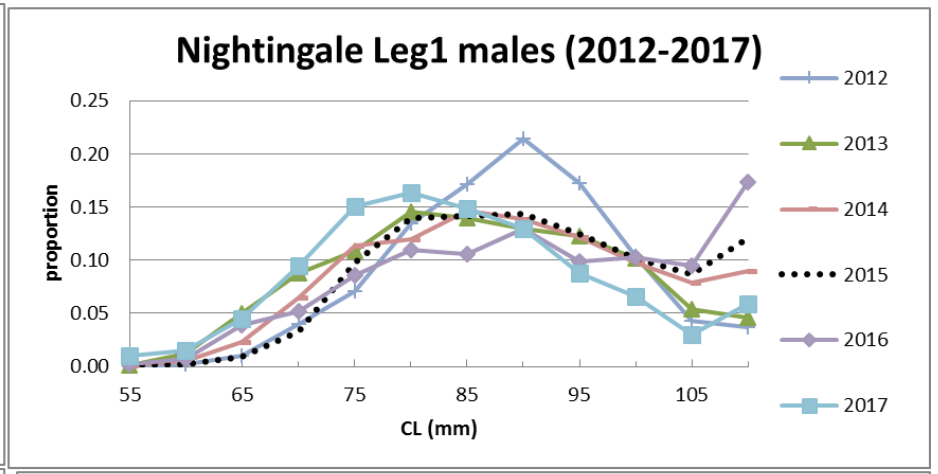
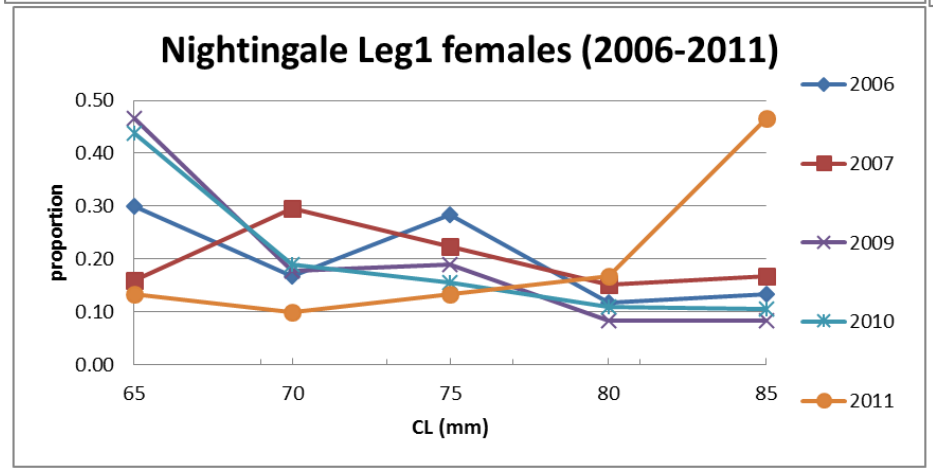


Figure 2c: **Nightingale** catch-at-length proportions for males (left) and females (right) for the Leg 1 surveys. Proportions here sum to 1.0 separately for each sex. The smallest and largest size categories are minus- and plus-groups respectively.







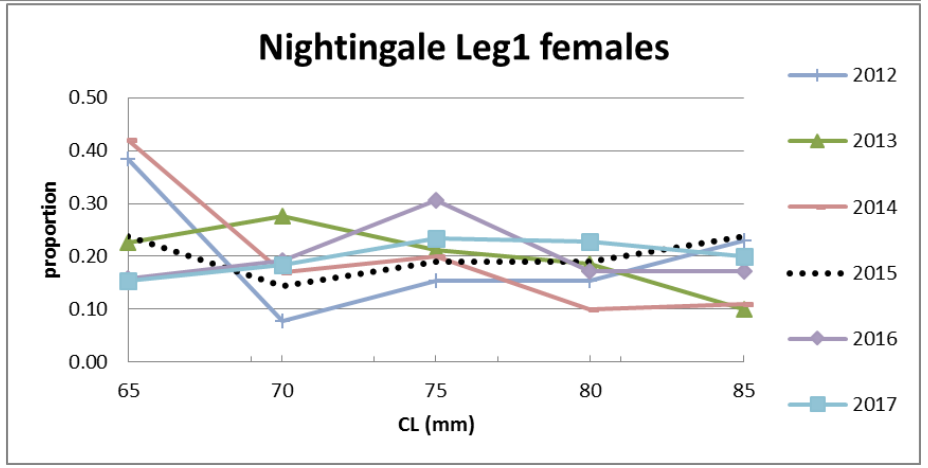


Figure 2d: **Gough** catch-at-length proportions for males (top) and females (bottom) for the Leg 1 surveys. Proportions here sum to 1.0 separately for each sex. The smallest and largest size categories are minus- and plus-groups respectively.

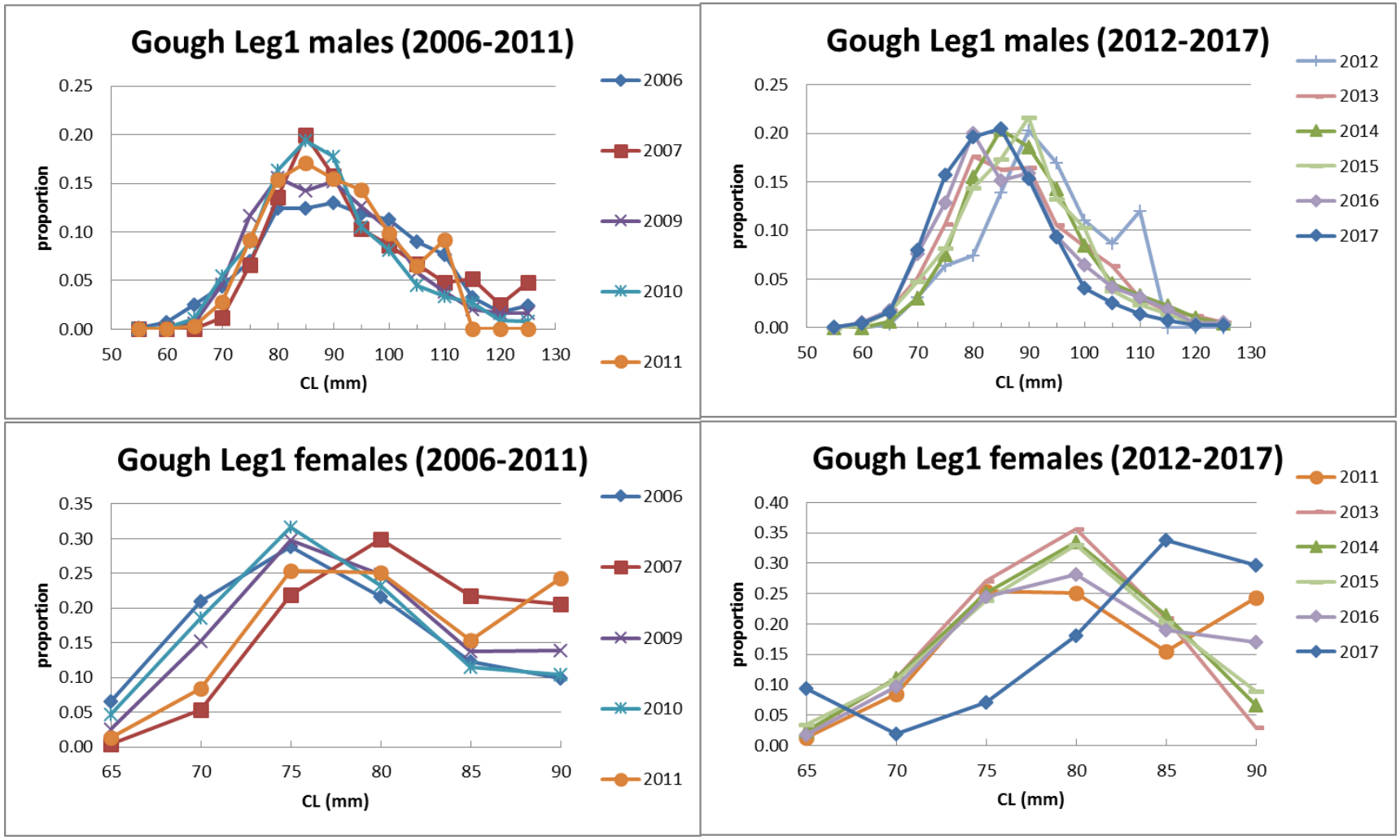


Figure 3a: Mean length of survey catch at **Tristan**.

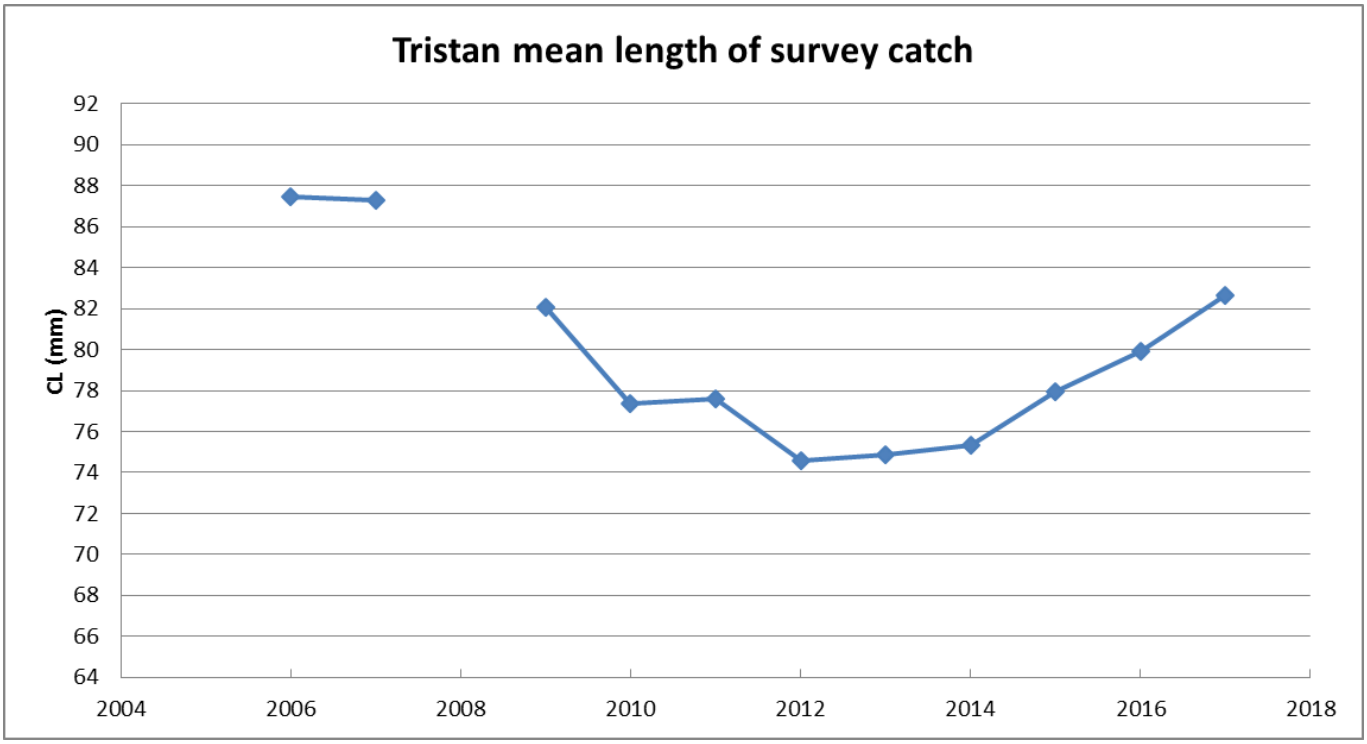


Figure 3b: Mean length of survey catch at **Inaccessible.**

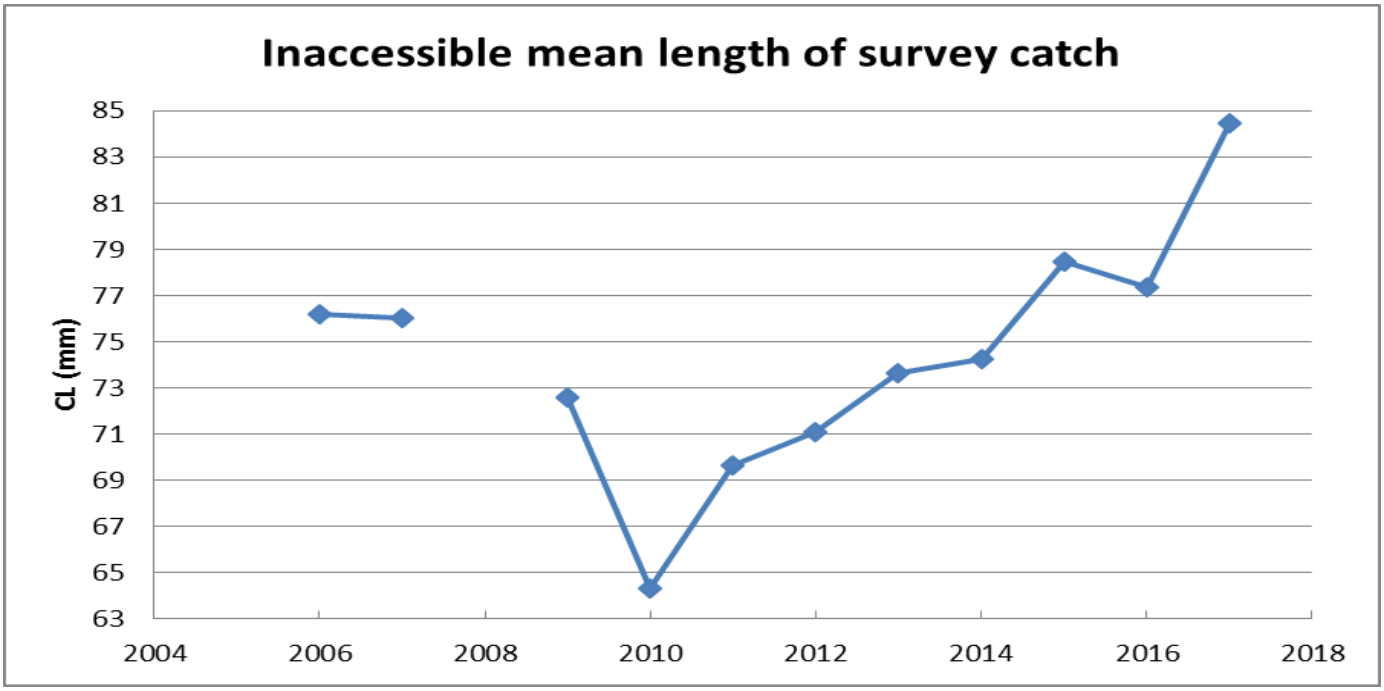


Figure 3c: Mean length of survey catch at **Nightingale**.

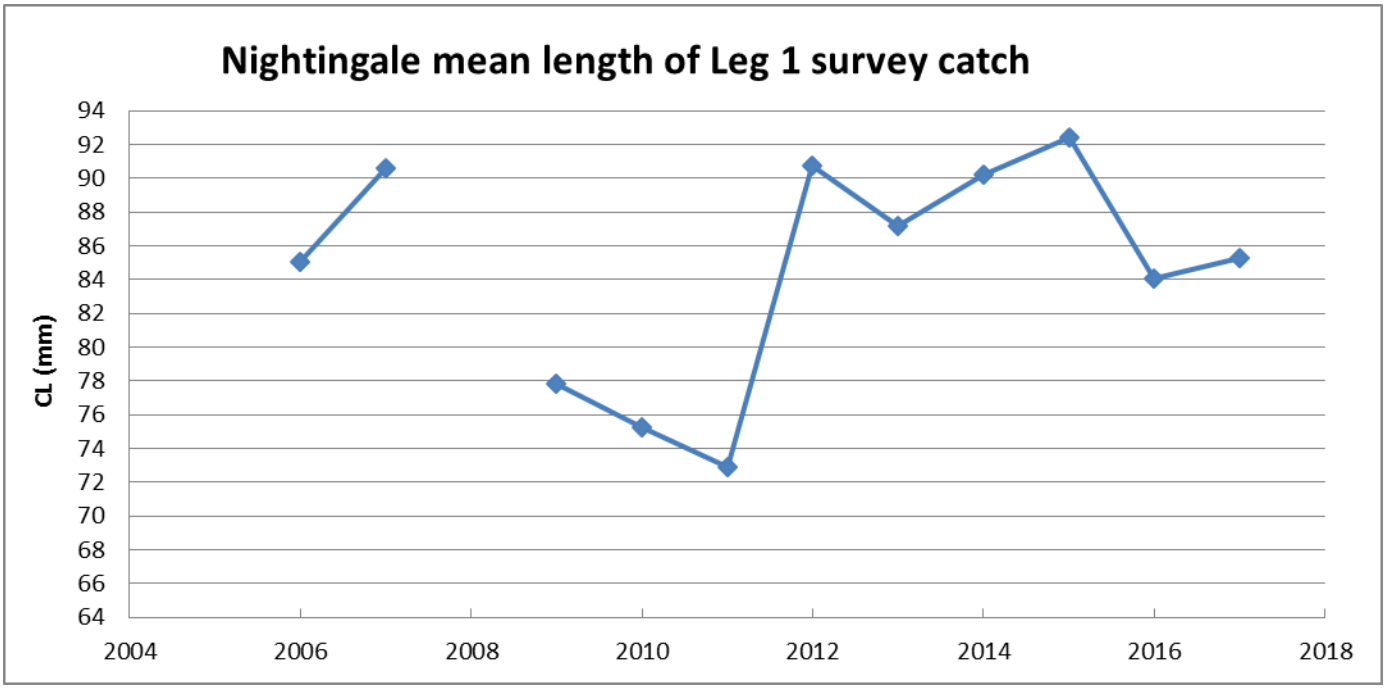


Figure 3d: Mean length of survey catch at **Gough**.

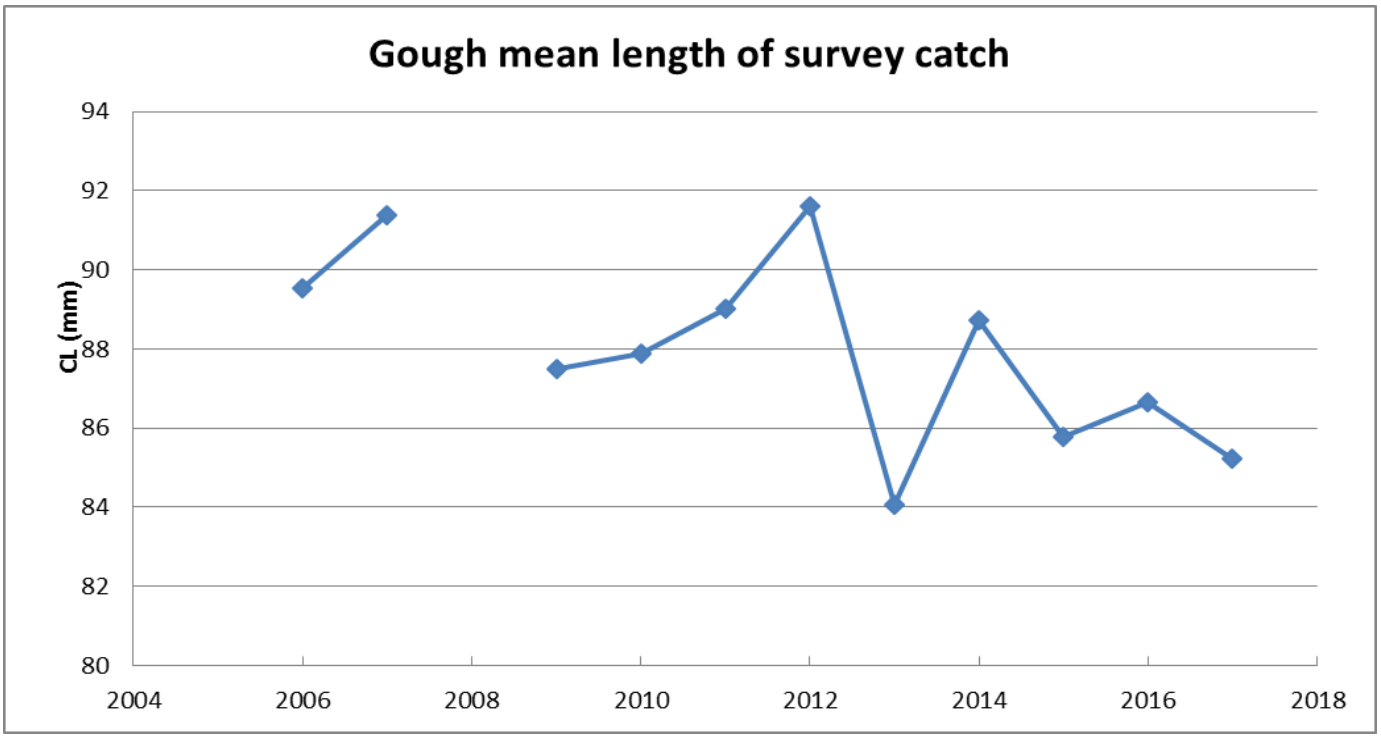


Figure 4a: Percentage females in the Leg 1 Tristan surveys.

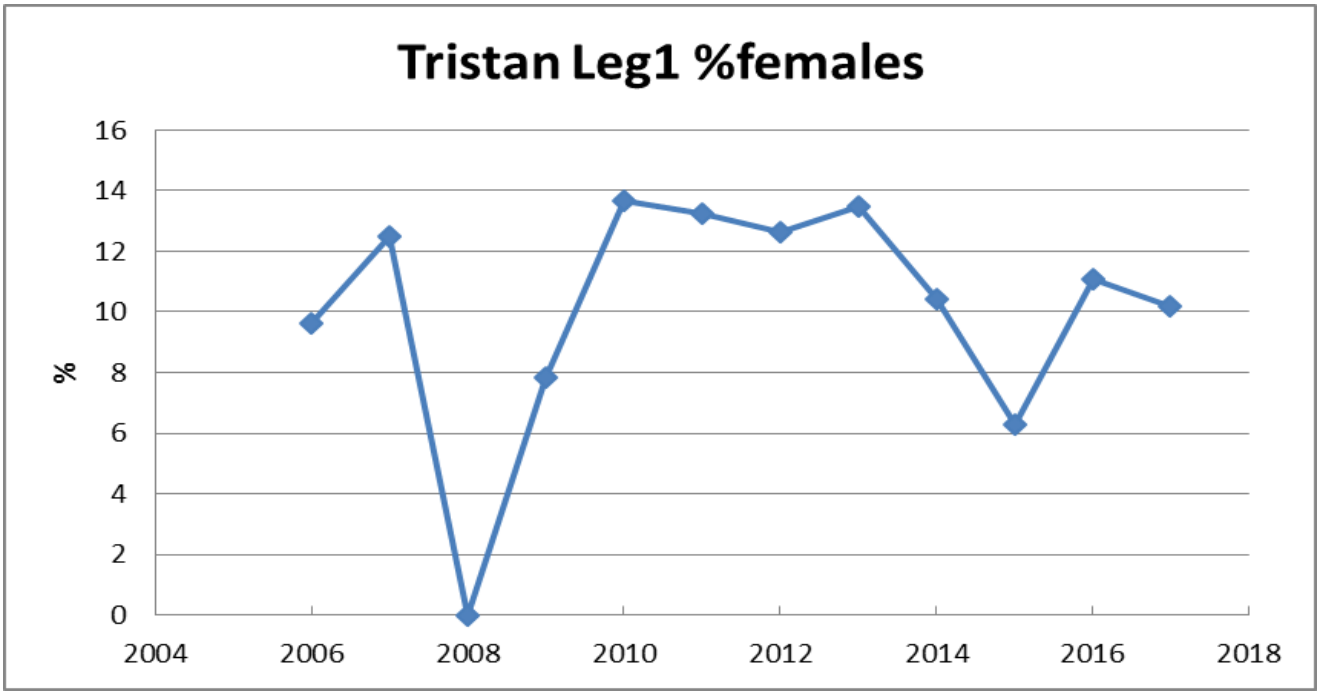


Figure 4b: Percentage females in the Leg 1 Inaccessible surveys.

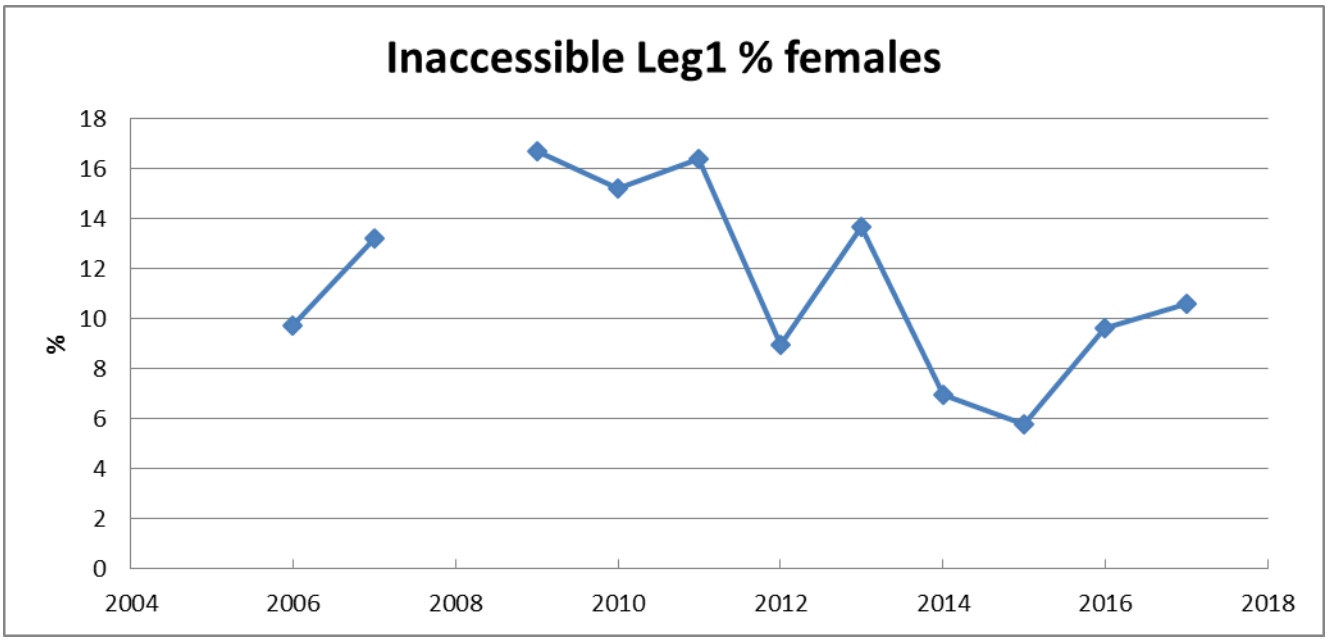


Figure 4c: Percentage females in the Leg 1 Nightingale surveys.

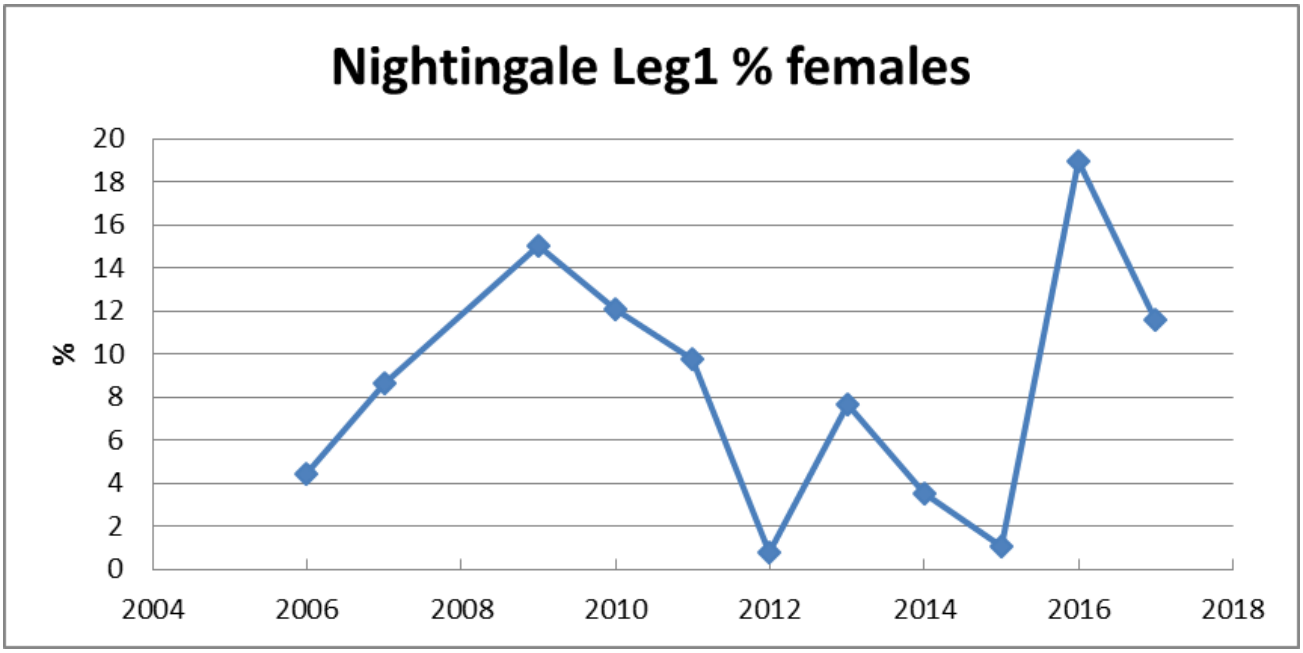


Figure 4d: Percentage females in the Leg 1 Gough surveys.