Tristan Group Biomass Survey (Leg 1) results including data from the 2019 season

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Summary

This paper reports the updated biomass indices (to include the 2019[1] season) obtained from the annual (Leg 1) biomass survey at each island. The index values have declined notably since the 2018 season at the outer islands of Inaccessible, Nightingale and Gough but increased marginally at Tristan. There have been some changes over time in the size distributions, the most marked of which have been steady increases at Inaccessible and Tristan in the mean length of the survey catch. However, the mean length of the catch from Gough continues to decline. The percentage of females in the catch at Gough (around 25-35%) is much higher that at the other three islands (around 5-15%).

Introduction

A now fairly large number (20) of biomass surveys has been completed 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 Leg 1 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 2019 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 Leg 2 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 by the time of the Leg 2 survey. It was consequently considered that the Leg 2 surveys would not be readily comparable from season to season.

[1] The split season is denoted by the first year, i.e. 2019 refers to the 2019/2020 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 ($\bar{B}_s$). (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 $\bar{B} = \frac{\sum_s \bar{B}_s}{n}$

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

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 aggregated 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 length of catch

Another informative statistic reported is the mean length of the catch (for which 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 Leg 1 survey are plotted in Figures 1a-d.

The Tristan biomass index has shown a slight increase since the previous season and remains higher than the 2012-2016 values (Figure 1a). Figure 1b shows that the biomass survey index at Inaccessible has now decreased over the last three seasons – this index is now similar to the 2012-2015 levels. Figure 1c shows some decrease to the previous season for Nightingale - this index for is now at its lowest level since 2012. The Gough (Figure 1d) 2019 index has shown some downturn since 2018, but remains above the 2014-2017 values.

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, now including the 2019 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 defined in a manner that avoids extremely small proportions.

Some interesting patterns in the biomass survey CAL data are evident. The Tristan male data (Figure 2a) show a clear shift to larger lobsters over the 2012-2019 period. This trend is also evident in the commercial catch. This trend might be caused by a strong pulse of recruitment moving though the fishery – a subsequent updated assessment will throw more light on this.

The Inaccessible CAL data (Figure 2b) also show a steady increase towards larger male lobsters over the 2013-2019 period.

Mean length of survey catch

The mean length of the survey catch (considering both males and females combined) has also been 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 length of the survey catch declined steadily from 2006-2012 at Tristan (from around 87mm CL to 75mm CL), but has increased steadily over the 2013-2018 period. The mean length of catch has increased steadily at Inaccessible over the 2010-2019 period. For Nightingale, no clear pattern is obvious since 2012, with fairly large inter-annual changes being evident. The mean length of the survey catches did increase sharply after the 2011 OLIVA event at Nightingale – but remains similar to the values observed in 2006 and 2007. For Gough there has been some general reduction in mean length of the catch over the 2011-2019 period (Figure 3d).

% Females

These data are plotted in Figures 4a-d. The very low % female value for Nightingale reported for 2012 and 2015 is evident in Figure 4c. A sharp increase is shown for 2016, but this value has declined again for the following three seasons.

The % females from the surveys at Tristan has shown a slight decline, with the % females at Inaccessible showing a slight increase. However, the % females for 2019 for Gough has shown continuation of the increase the previous year. 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%).

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 2017**	**Sep 2017**	**Sep 2017**	**Oct 2017**
Season 2018/19 Leg 1	**Sep 2018**	**Aug 2018**	**Aug 2018**	**Sep 2018**
Season 2019/20 Leg 1	**Aug/Sep 2019**	**Aug 2019**	**Aug 2019**	**Sep 2019**
# 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)
2018	20.76 (0.14)	13.44 (0.36)	25.08 (0.16)	14.81 (0.27)
2019	21.26 (0.15)	10.16 (0.48)	18.00 (0.23)	10.96 (0.24)

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 time of the OLIVA incident.

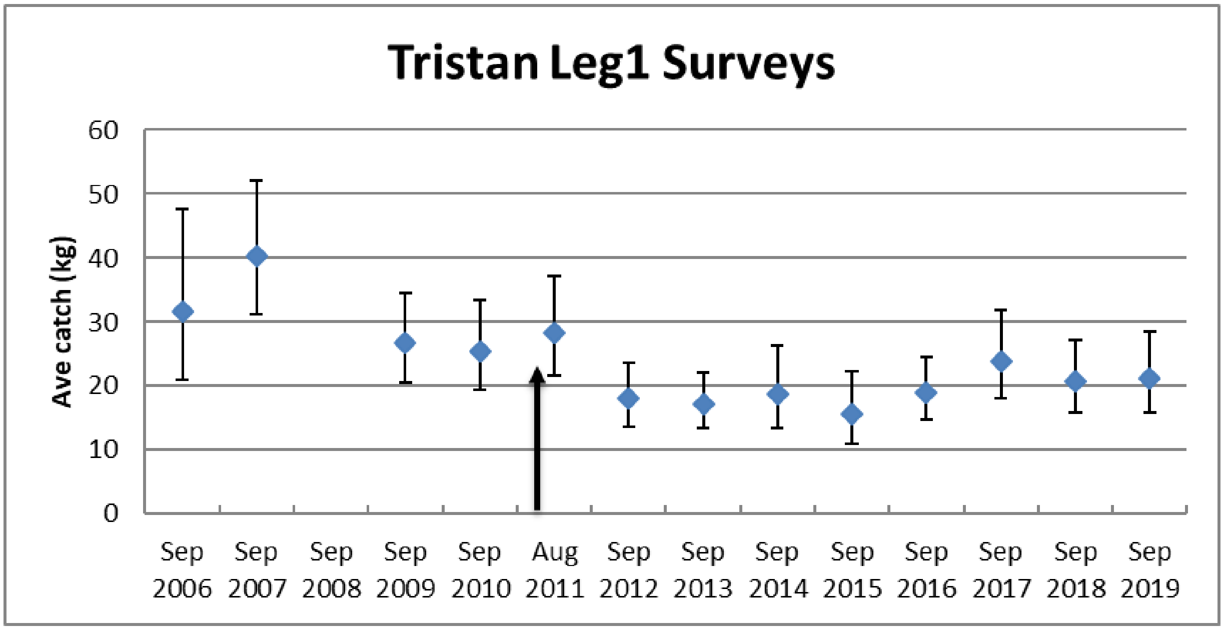

Figure 1b: Biomass indices (in terms on the average mass caught per trap) for the Leg1 surveys for **Inaccessible**. The means and (and assumed log normal) 95% confidence intervals are shown. The arrow shows the time of the OLIVA incident.

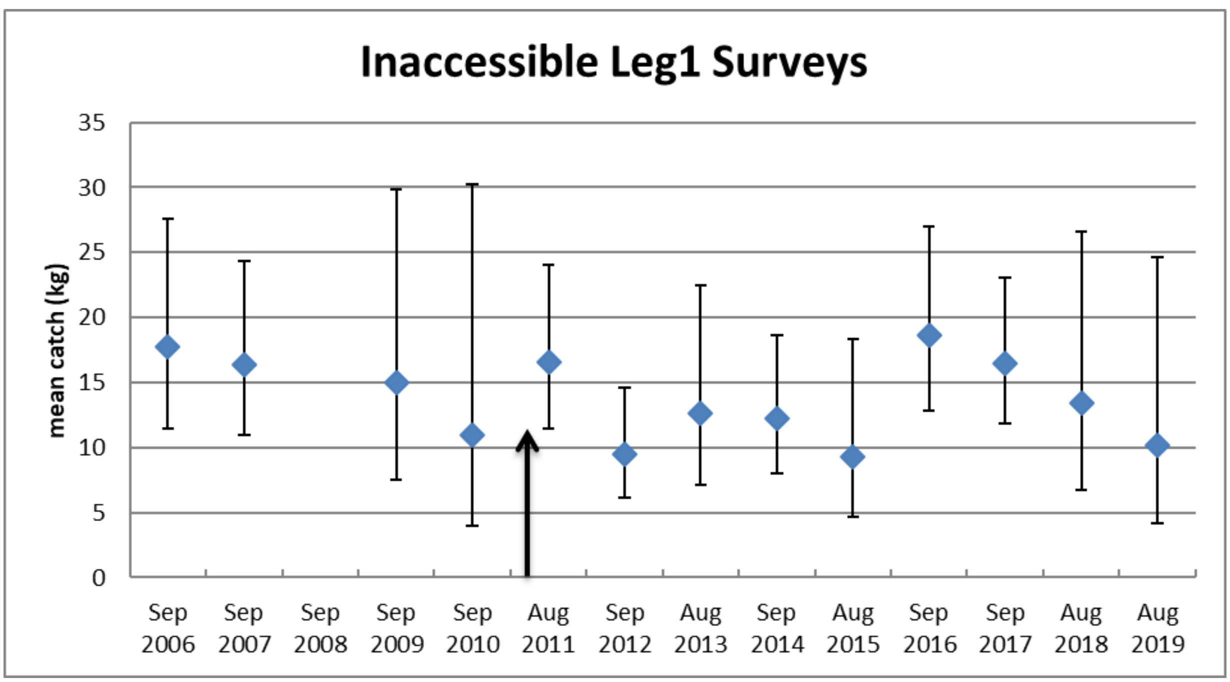

Figure 1c: Biomass indices (in terms on the average mass caught per trap) for the Leg 1 surveys for **Nightingale**. The means and (and assumed log normal) 95% confidence intervals are shown. The arrow shows the time of the OLIVA incident.

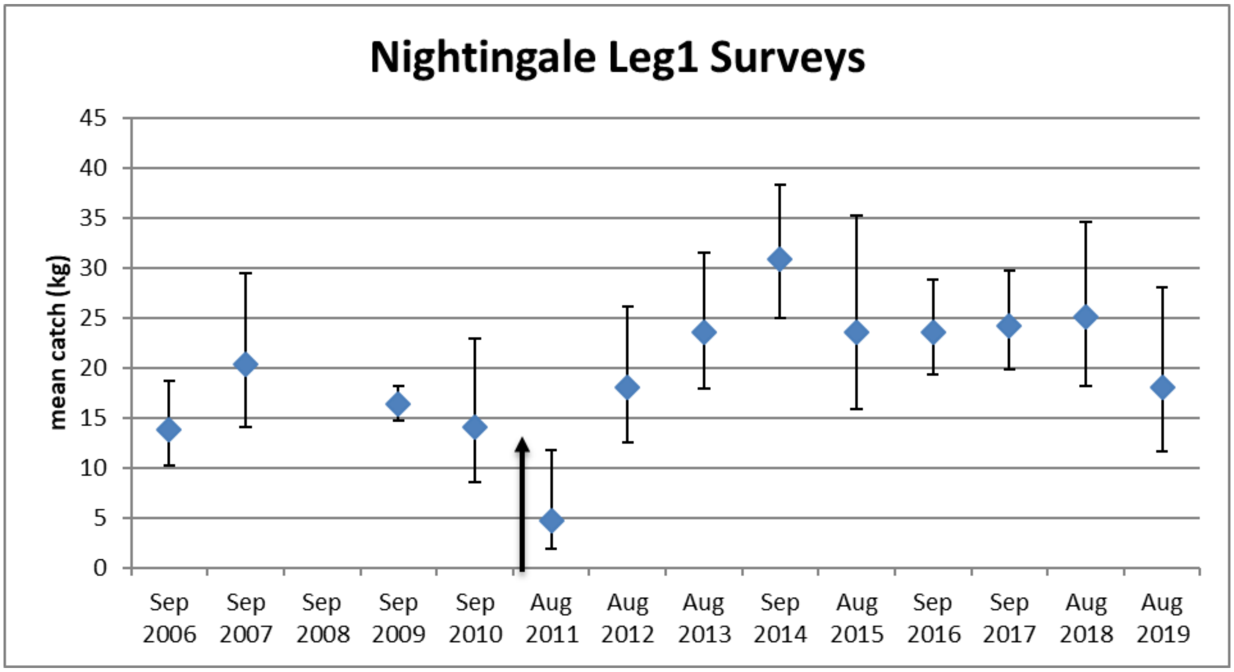

Figure 1d: Biomass indices (in terms on the average mass caught per trap) for the Leg 1 surveys for **Gough**. The means and (and assumed log normal) 95% confidence intervals are shown. The arrow shows the time of the OLIVA incident.

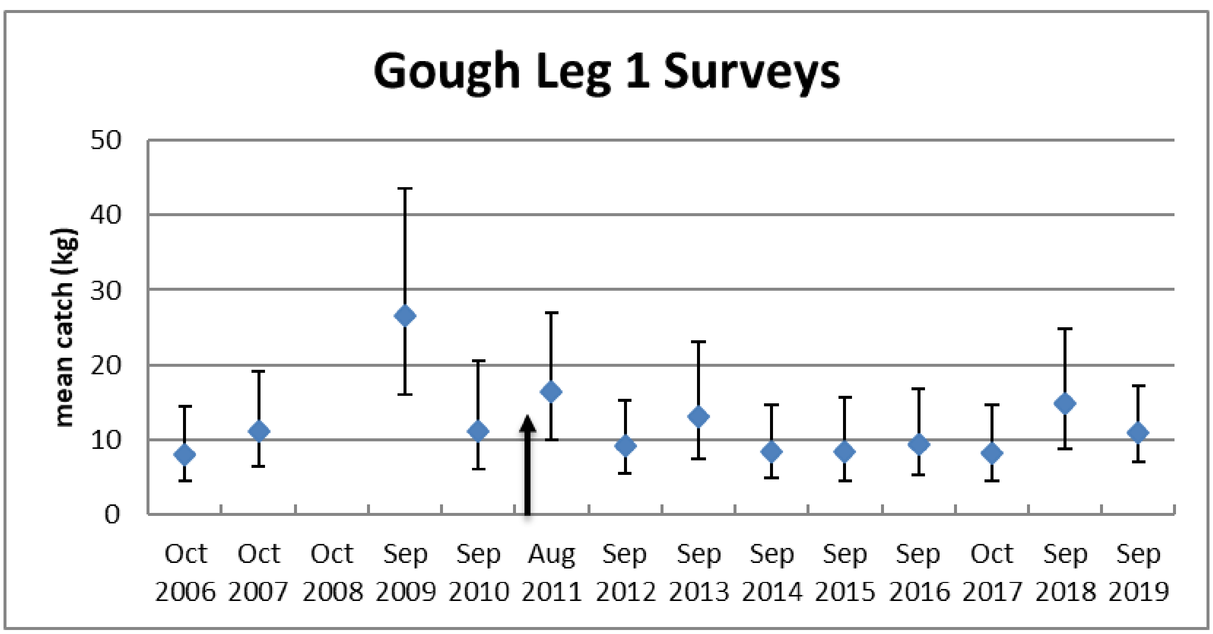

Figure 2a: **Tristan** catch-at-length proportions for males (top) and females (bottom) for the Leg 1 surveys. Proportions here sum to 1.0 separately for each sex. The smallest and largest size categories are minus- and plus-groups respectively.

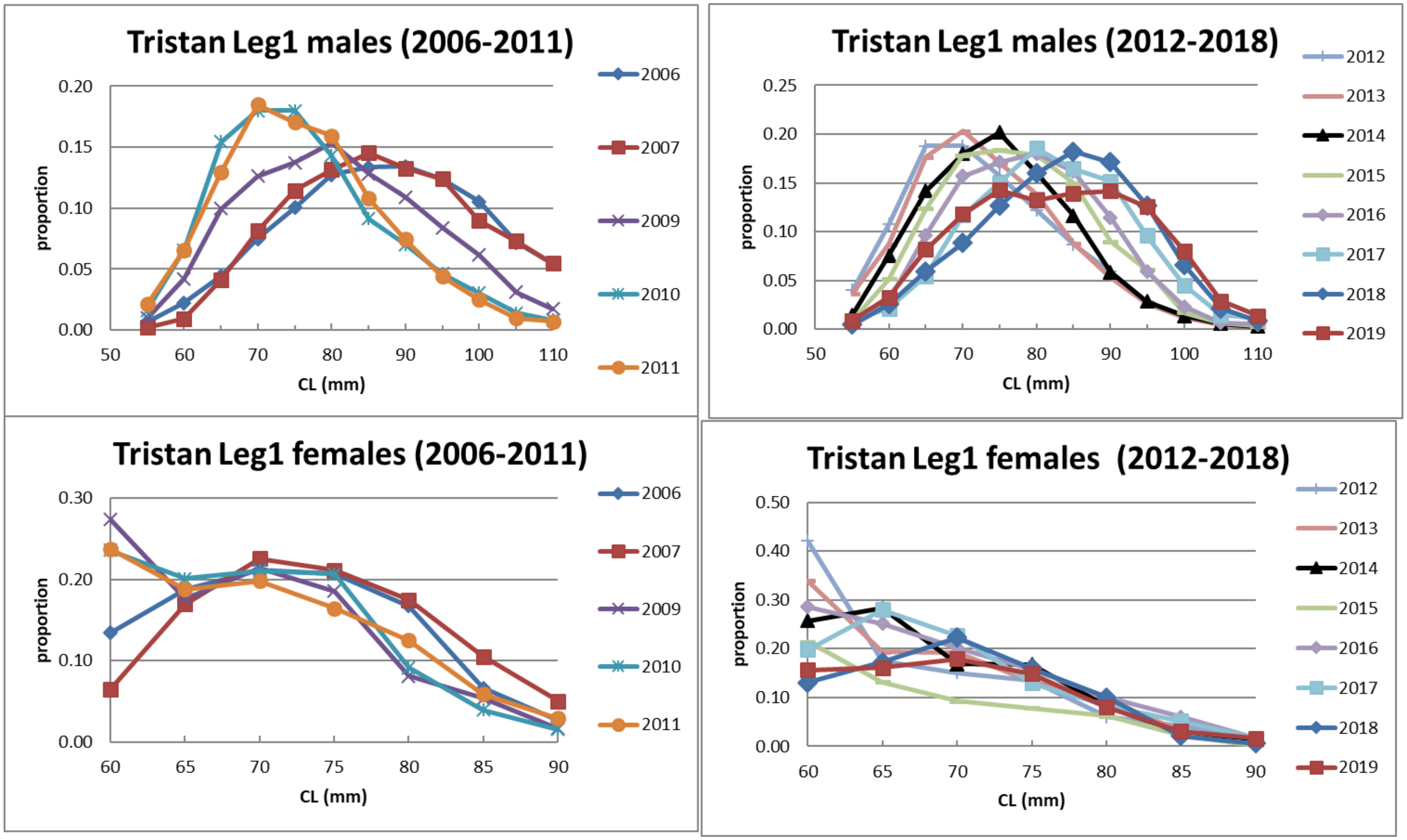

Figure 2b: **Inaccessible** catch-at-length proportions for males (top) and females (bottom) for the Leg 1 surveys. Proportions here sum to 1.0 separately for each sex. The smallest and largest size categories are minus- and plus-groups respectively.

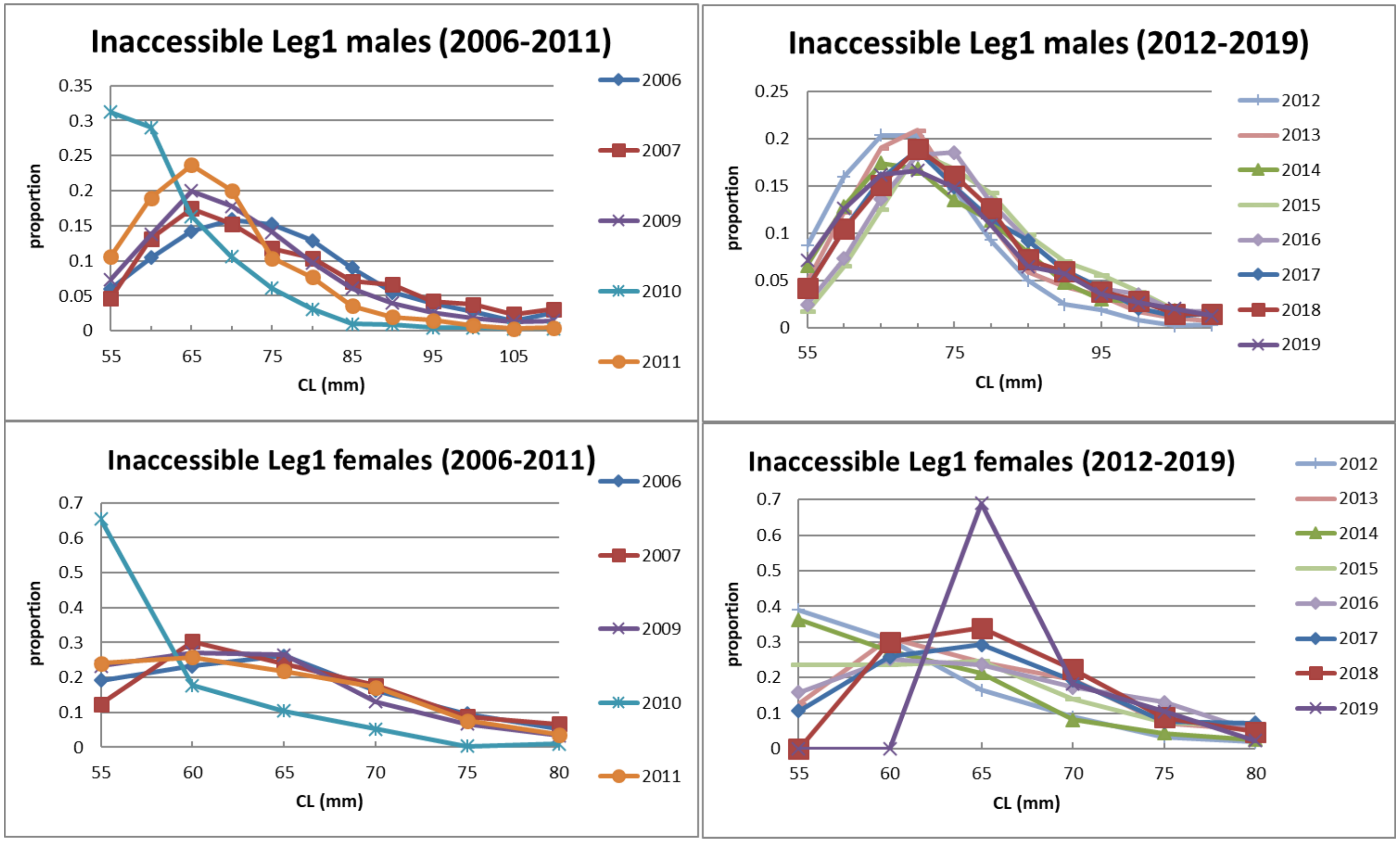

Figure 2c: **Nightingale** catch-at-length proportions for males (left) and females (right) for the Leg 1 surveys. Proportions here sum to 1.0 separately for each sex. The smallest and largest size categories are minus- and plus-groups respectively.

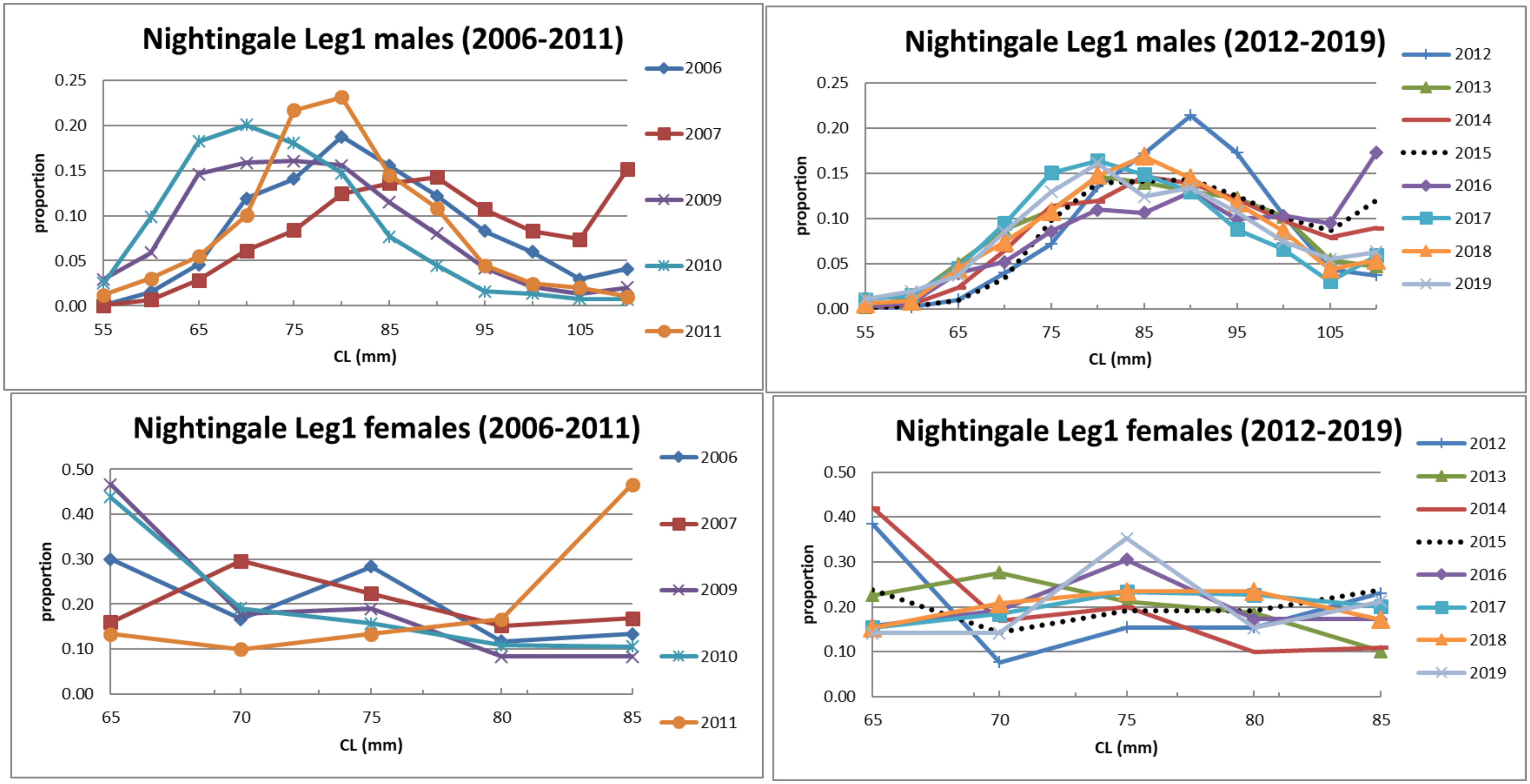

Figure 2d: **Gough** catch-at-length proportions for males (top) and females (bottom) for the Leg 1 surveys. Proportions here sum to 1.0 separately for each sex. The smallest and largest size categories are minus- and plus-groups respectively.

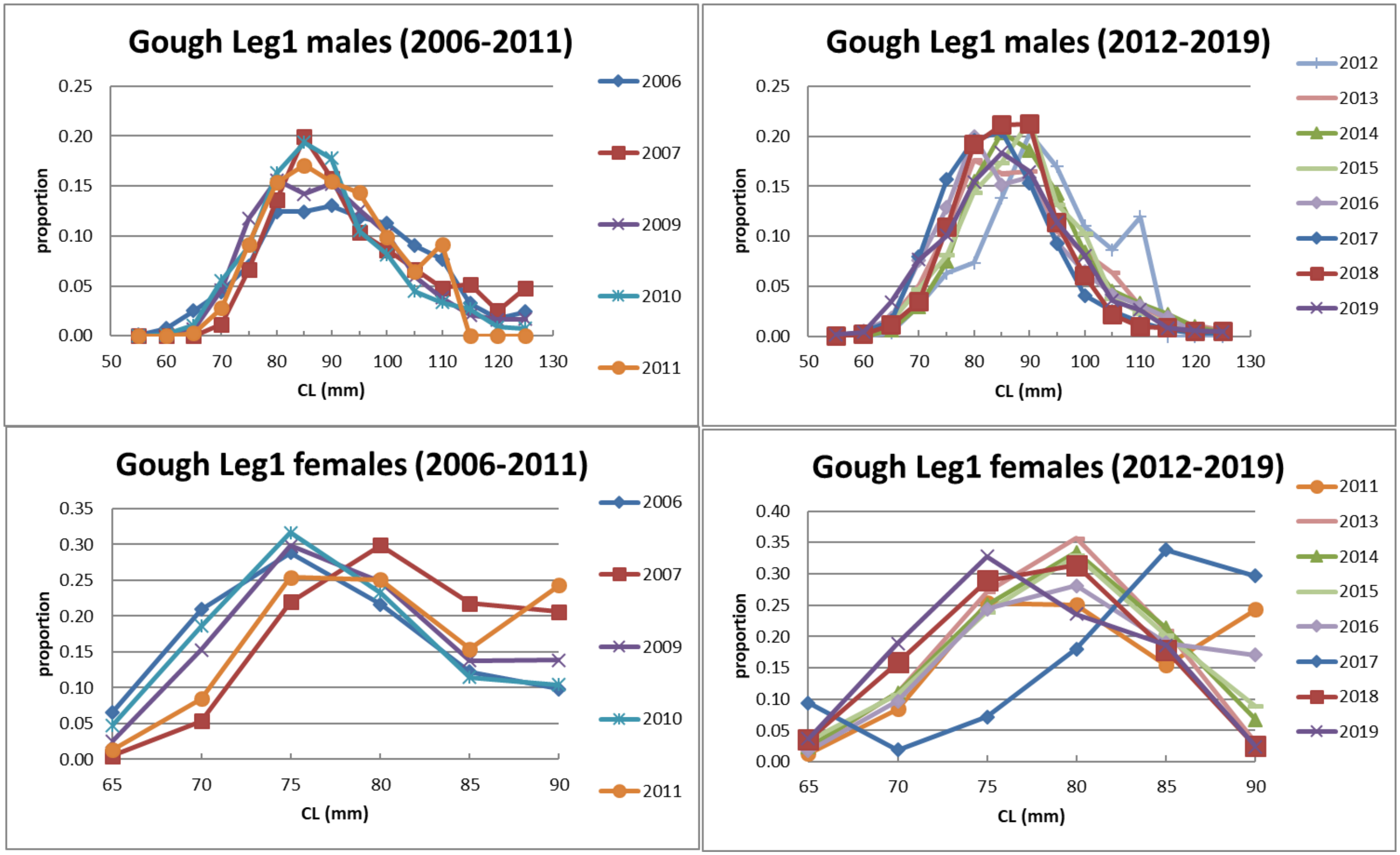

Figure 3a: Mean length of survey catch at **Tristan** (for both sexes combined).

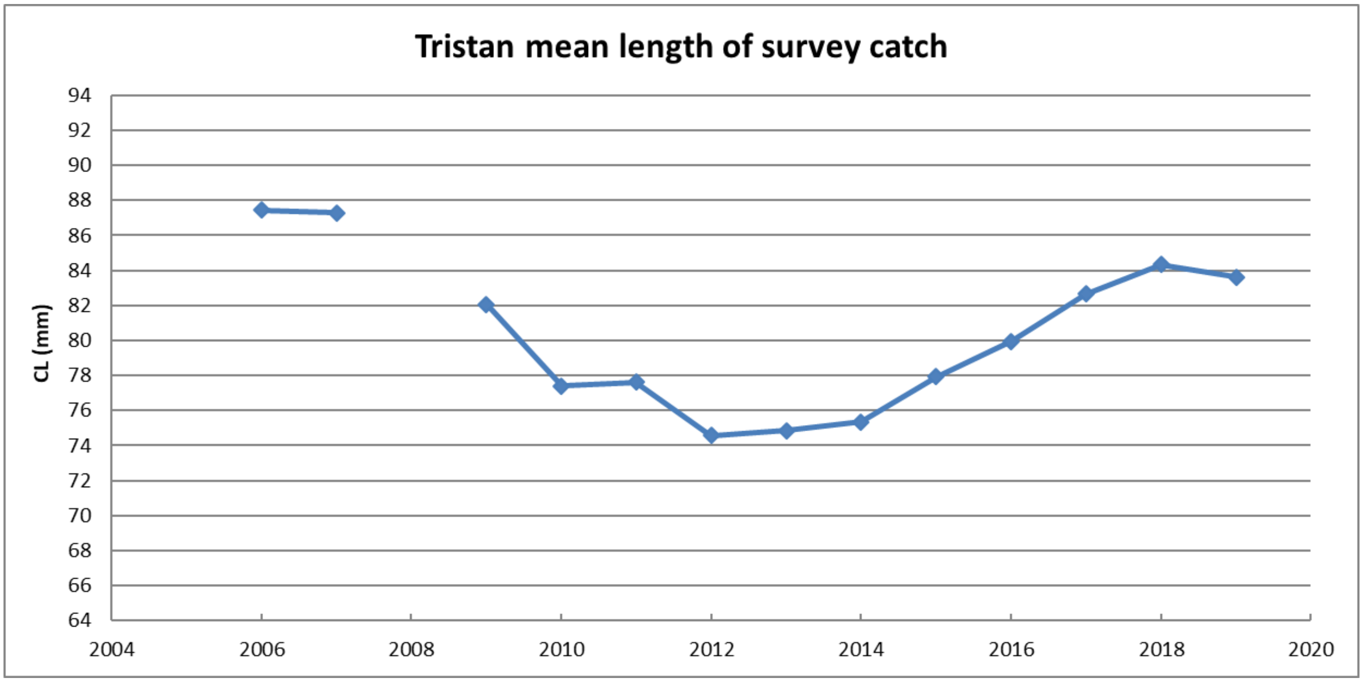

Figure 3b: Mean length of survey catch at **Inaccessible** (for both sexes combined).

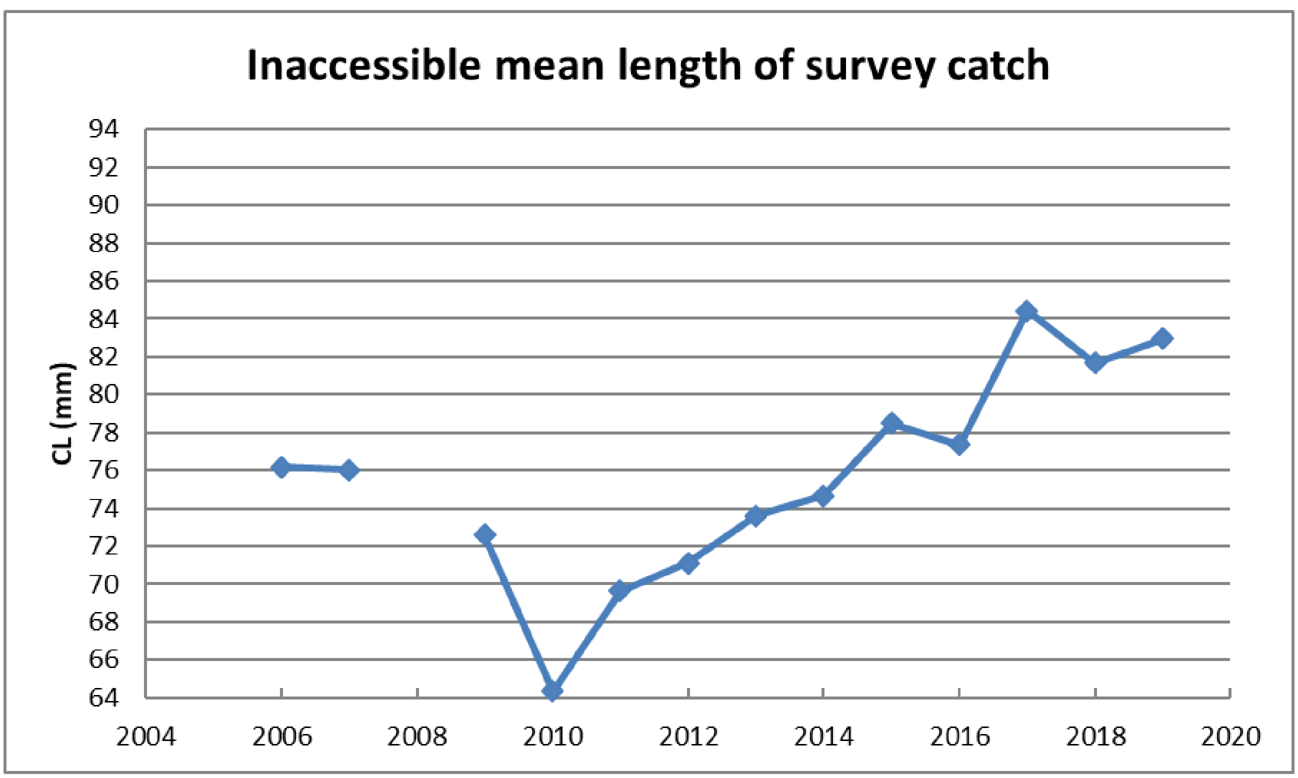

Figure 3c: Mean length of survey catch at **Nightingale** (for both sexes combined).

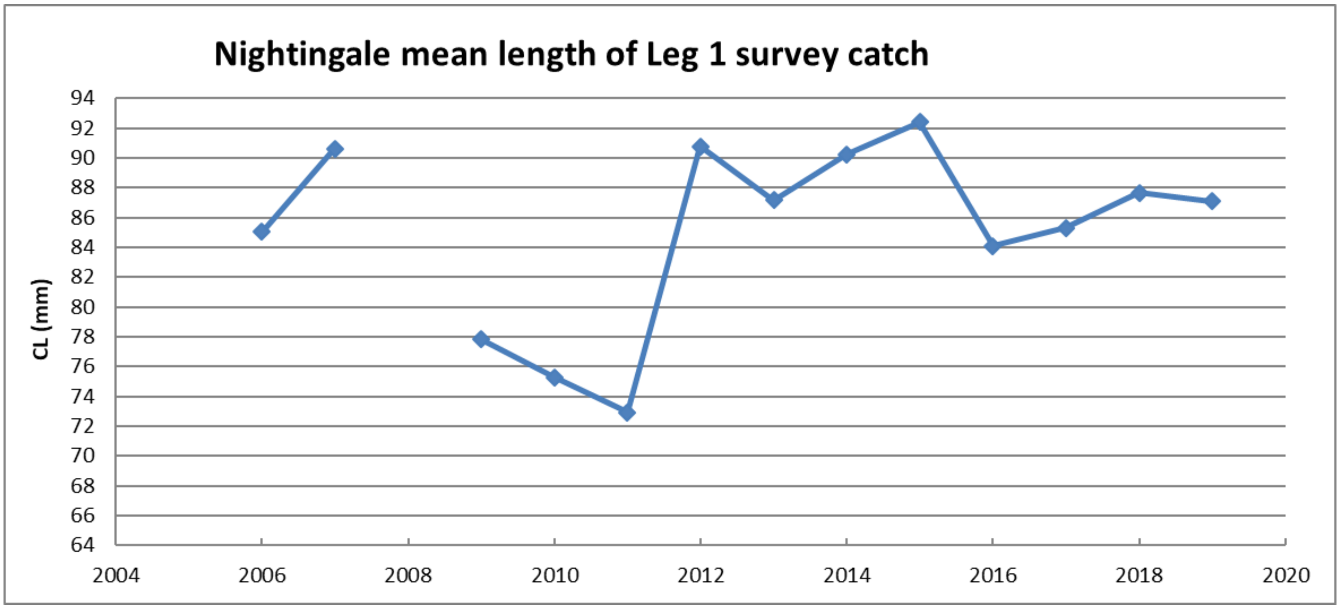

Figure 3d: Mean length of survey catch at **Gough** (for both sexes combined).

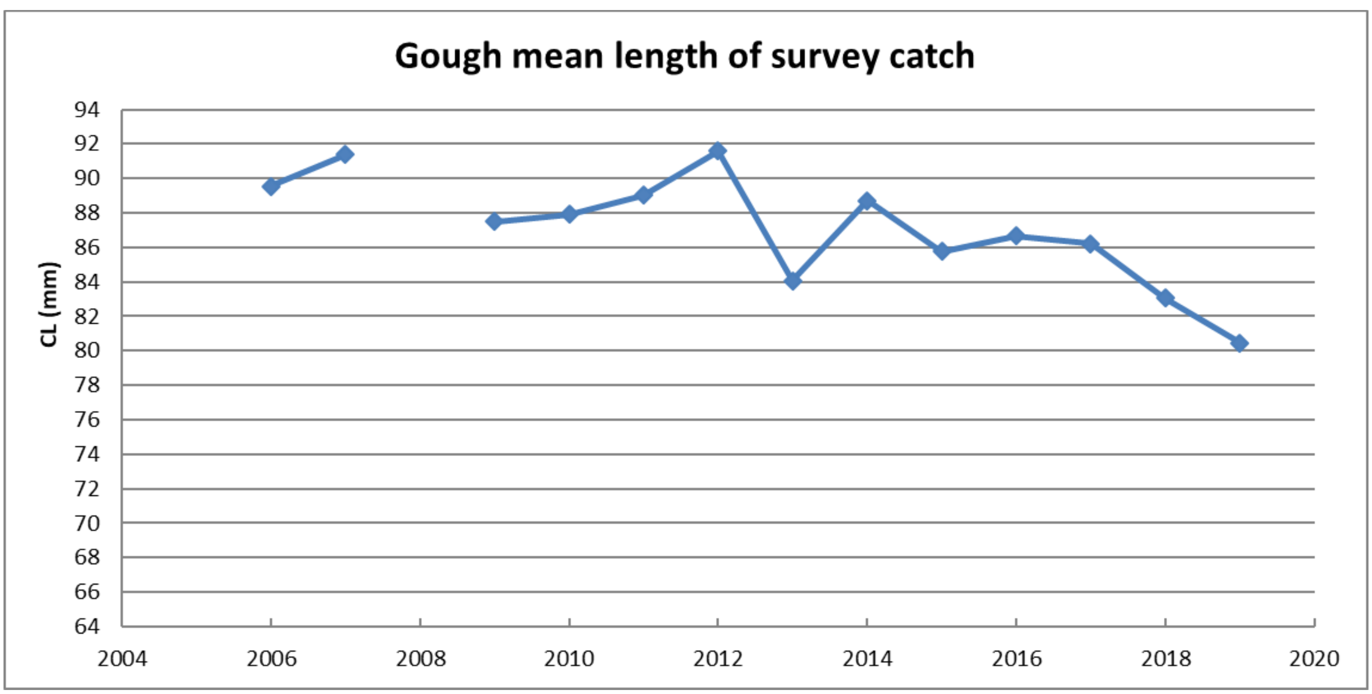

Figure 4a: Percentage females in the Leg 1 Tristan surveys.

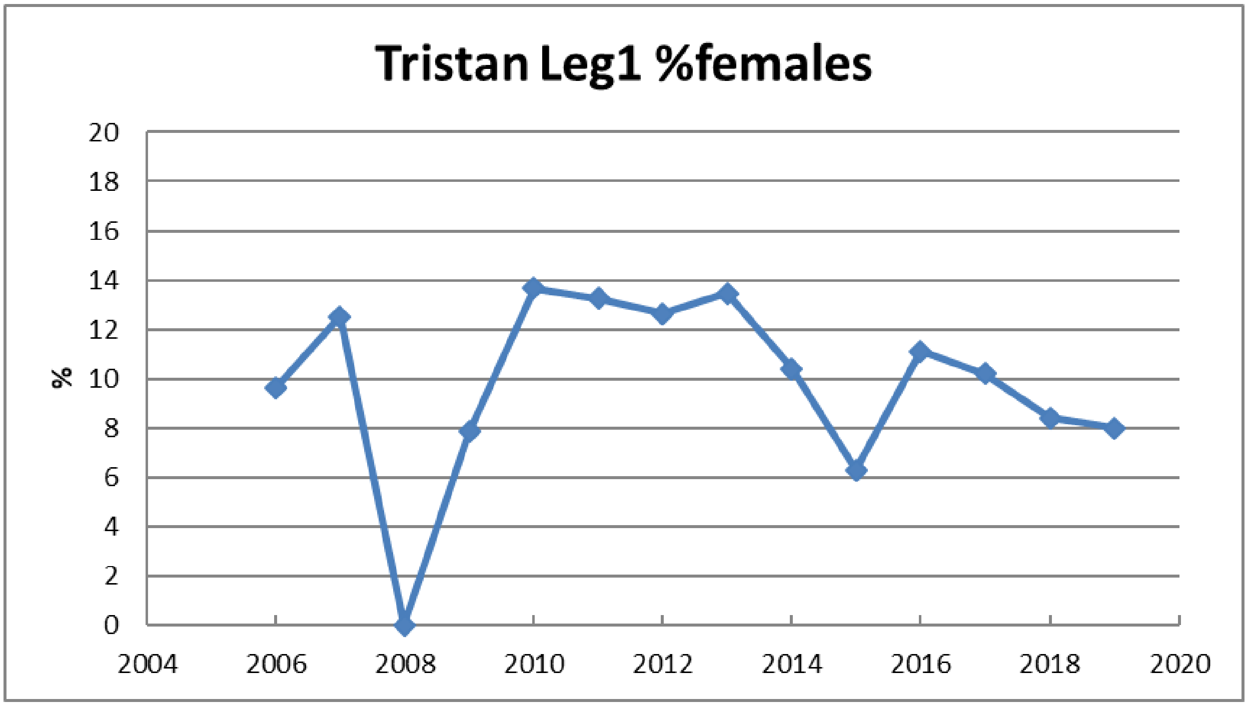

Figure 4b: Percentage females in the Leg 1 Inaccessible surveys.

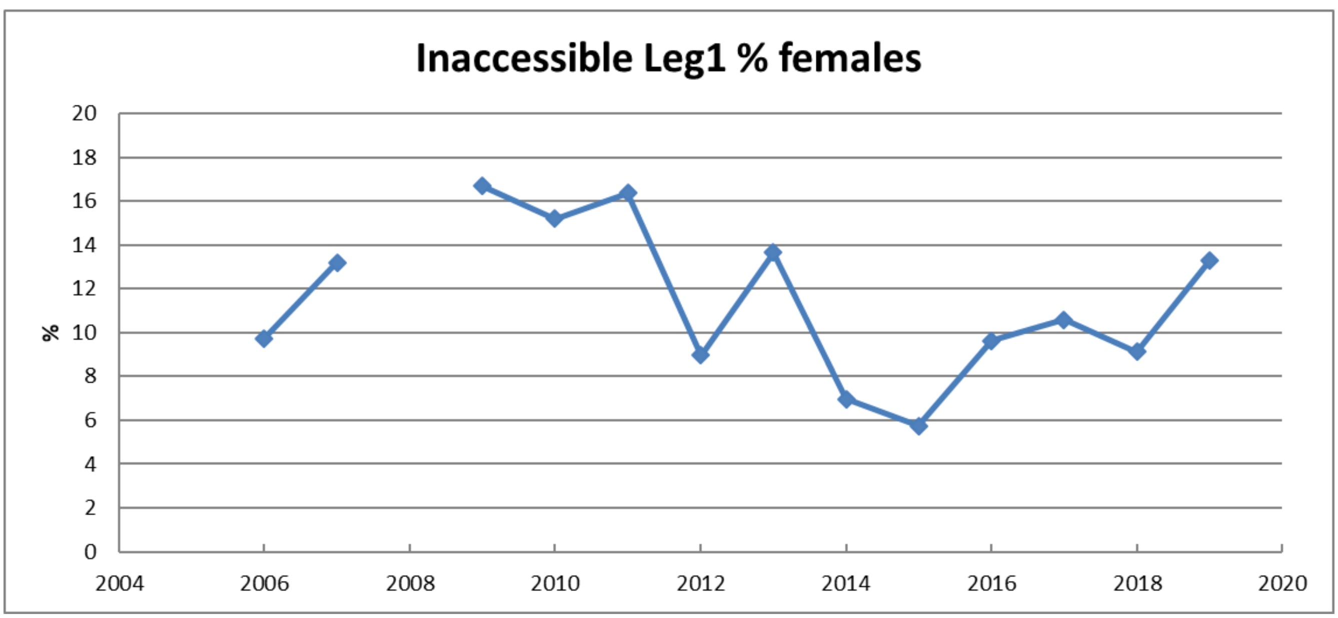

Figure 4c: Percentage females in the Leg 1 Nightingale surveys.

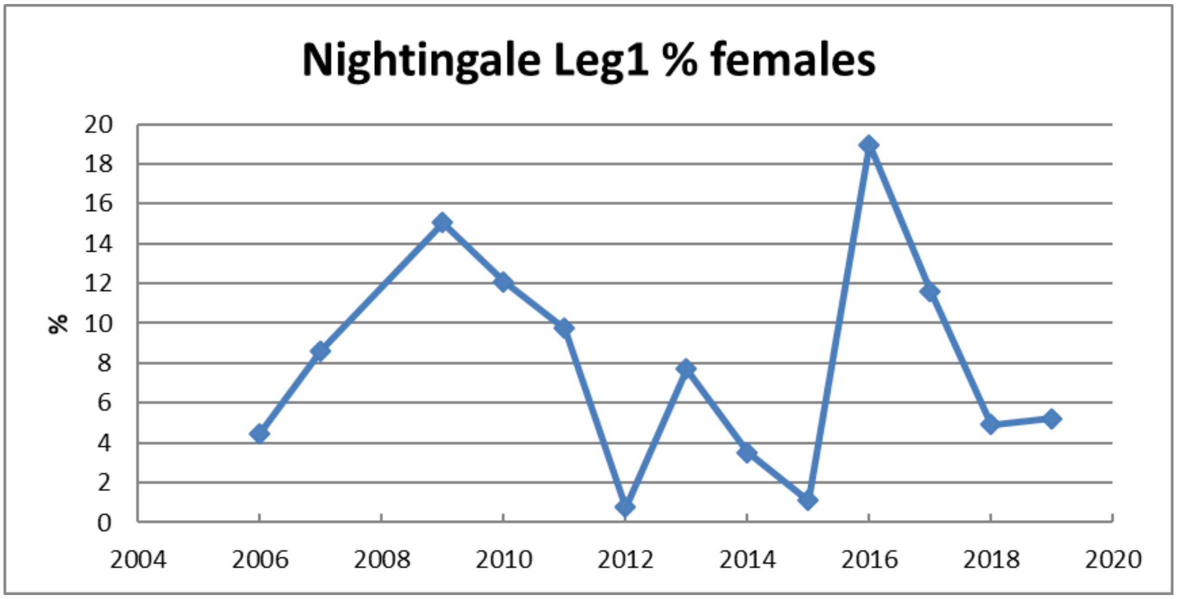

Figure 4d: Percentage females in the Leg 1 Gough surveys.