# 23rd MEETING OF THE PZJA TORRES STRAIT TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG 23)

**Tuesday 15 May 2018 - 8:00 AM - 4:00 PM**

**Cairns - Northern Fisheries Centre, 38-40 Tingira Street, Portsmith**

# DRAFT AGENDA

1. Preliminaries
   1.1. Welcome and apologies (Chair)
   1.2. Adoption of agenda (Chair)
   1.3. Declaration of interests (Chair)
   1.4. Action items from previous meetings (AFMA)

2. Updates from members
   2.1. Industry and scientific members
   2.2. Government agencies (AFMA, TSRA, QDAF)
   2.3. PNG National Fisheries Authority (if PNG NFA is in attendance)
   2.4. Native Title (if Malu Lamar Chairperson is in attendance)

3. 2017/18 TRL CPUE and length frequency trends (AFMA, CSIRO)

4. 2017/18 trends in 2+ lobster abundance (AFMA, CSIRO)

5. Evaluation of additional survey options to support future stock assessments (AFMA, CSIRO)

6. Other Business

7. Date and venue for next meeting

**The Chair must approve the attendance of all observers at the meeting. Individuals wishing to attend the meeting as an observer must contact the Executive Officer – Natalie Couchman (natalie.couchman@afma.gov.au)**

| TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) | MEETING 23<br>15 May 2018 |
|---|---|
| **PRELIMINARIES**<br>**Welcome and apologies** | **Agenda Item 1.1**<br>**For Noting** |

## RECOMMENDATIONS

1. That the RAG **NOTE**:
   a. an opening prayer;
   b. an acknowledgement of Traditional Owners;
   c. the Chair's welcome address; and
   d. apologies received from members unable to attend.

## BACKGROUND

2. Apologies have been received from Charlie Kaddy (TSRA Member).
3. Mark David (Industry Member) and Maluwap Nona (Chair, Malu Lamar (Torres Strait Islander) Corporation RNTBC) were invited but did not confirm attendance.

| TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) | MEETING 23<br>15 May 2018 |
| --- | --- |
| **PRELIMINARIES**<br>**Adoption of agenda** | **Agenda Item 1.2**<br>**For Decision** |

**RECOMMENDATIONS**

1. That the Working Group consider and **ADOPT** the agenda.

**BACKGROUND**

2. A draft agenda was circulated to members and other participants on 23 April 2018 along with preliminary papers for consideration at this meeting (**Attachment 1.2a**). These papers have since been updated, but are provided here for reference.
3. The Torres Strait Tropical Rock Lobster (TRL) Fishery 2017/18 fishing season is being managed in line with a historically low recommended biological catch (RBC). This has required changes to management arrangements which may in turn have impacts on fishery-dependent catch per unit effort (CPUE) and length frequency data indicators available for future stock assessments. Additionally, whilst some in industry consider the Fishery to be overfished, AFMA has continued to receive feedback from others who advise based on catch rates that lobsters are more abundant than what might have been expected under such a low RBC. For these reasons they believe the stock assessment may be misaligned with actual abundance this year.
4. The broad purpose of this RAG meeting is to consider the Fishery's data needs in light of management and potential catch and effort changes this season and also to continue to review data from the current season against the results of the November 2017 pre-season survey.
5. Specifically the RAG will:
    - consider a further update on CPUE and length frequency data to date for the fishing season;
    - assess likelihood and quantum of anomalous residual 2+ lobsters remaining in the Fishery and if relevant, whether there are implications for future RBC calculations; and
    - evaluate merits of additional survey options to support future stock assessment. Whilst the requirement for a mid-year survey under the draft revised harvest strategy has not been triggered, management changes have been applied and the Fishery may still close early.

# Catch Summary for TRSL Fishery - April 2018

## 1. Catch by Season and Month

Note: 2018 data from Catch Disposal Form (incomplete, especially for April)
TIB data 2014-2017 based on Docket-Book data
TVH data 2014-2017 based on TRL04 Logbook data

(a) TIB

| SEASON | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | | 15,542 | 24,309 | 35,574 | 17,737 | 30,356 | 28,516 | 26,449 | 18,976 | 12,873 | 24 | 25 | 210,381 |
| 2005 | 21,648 | 15,098 | 50,625 | 58,221 | 47,575 | 56,758 | 43,061 | 34,474 | 23,682 | 16,088 | 314 | 71 | 367,615 |
| 2006 | 12,507 | 9,447 | 24,018 | 26,814 | 19,091 | 18,380 | 9,814 | 9,910 | 7,672 | 2,747 | 0 | 51 | 140,451 |
| 2007 | 19,002 | 24,941 | 24,716 | 62,040 | 29,185 | 33,759 | 29,025 | 23,193 | 13,907 | 8,920 | 0 | 0 | 268,688 |
| 2008 | 10,435 | 13,461 | 31,237 | 36,127 | 24,110 | 16,711 | 14,805 | 23,516 | 9,277 | 5,969 | 18 | 0 | 185,666 |
| 2009 | 9,716 | 13,273 | 20,547 | 23,103 | 23,733 | 15,647 | 13,242 | 15,393 | 7,811 | 4,819 | 529 | 0 | 147,813 |
| 2010 | 5,764 | 6,198 | 21,259 | 15,829 | 14,995 | 12,180 | 16,348 | 19,073 | 17,001 | 9,782 | 1,610 | 0 | 140,039 |
| 2011 | 6,929 | 18,215 | 30,141 | 49,767 | 20,400 | 23,990 | 18,686 | 18,856 | 8,858 | 3,218 | 0 | 0 | 199,060 |
| 2012 | 9,036 | 13,403 | 19,028 | 24,718 | 19,606 | 9,689 | 22,874 | 11,194 | 10,836 | 1,996 | 0 | 0 | 142,380 |
| 2013 | 3,080 | 851 | 9,896 | 8,332 | 12,899 | 11,551 | 10,134 | 11,582 | 8,955 | 9,832 | 0 | 0 | 87,112 |
| 2014 | 6,688 | 8,992 | 12,390 | 26,237 | 19,135 | 17,160 | 11,398 | 11,767 | 11,722 | 6,498 | 126 | 0 | 132,113 |
| 2015 | 12,480 | 5,775 | 19,350 | 13,182 | 16,700 | 10,469 | 27,784 | 8,031 | 7,189 | 4,569 | 172 | 0 | 125,701 |
| 2016 | 6,177 | 6,962 | 23,572 | 16,243 | 10,340 | 15,255 | 15,030 | 11,165 | 10,011 | 4,828 | 98 | 75 | 119,756 |
| 2017 | 5,147 | 8,290 | 23,339 | 15,831 | 11,697 | 14,959 | 7,476 | 9,730 | 10,803 | 4,075 | 155 | 0 | 111,502 |
| 2018 | 12,153 | 12,941 | 19,836 | 14,863 | 7,256 | | | | | | | | 67,049 |

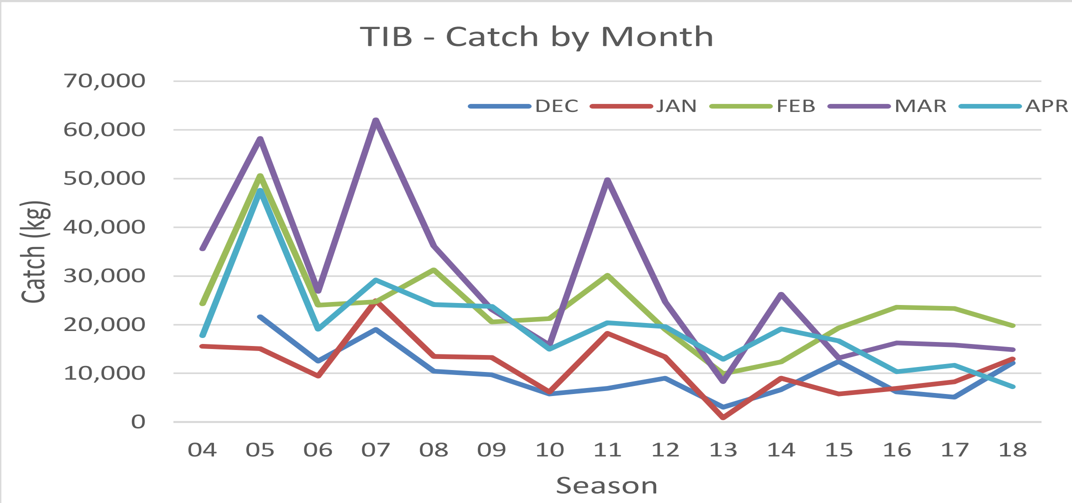
(b) TVH

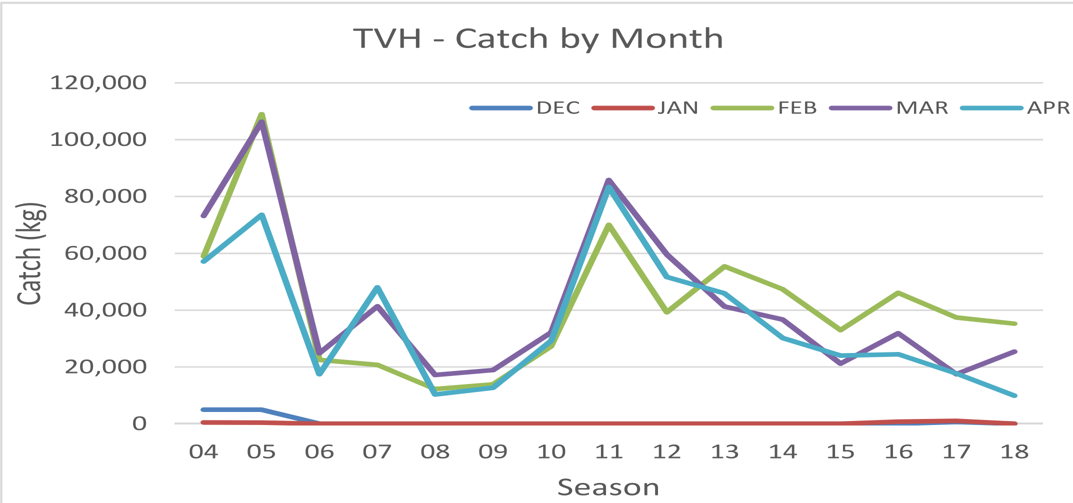
| SEASON | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 4,949 | 452 | 58,965 | 73,180 | 57,142 | 70,551 | 79,438 | 65,766 | 48,014 | 22,625 | 0 | 0 | 481,082 |
| 2005 | 4,984 | 398 | 108,962 | 106,276 | 73,510 | 59,475 | 53,618 | 60,103 | 51,795 | 30,814 | 0 | 0 | 549,935 |
| 2006 | 25 | 0 | 22,512 | 24,860 | 17,491 | 14,798 | 11,490 | 21,952 | 16,756 | 5,589 | 0 | 0 | 135,473 |
| 2007 | 0 | 0 | 20,768 | 41,389 | 47,980 | 62,933 | 48,836 | 26,689 | 13,633 | 6,368 | 0 | 0 | 268,596 |
| 2008 | 0 | 0 | 12,285 | 17,166 | 10,334 | 10,809 | 7,997 | 15,482 | 16,819 | 9,545 | 0 | 0 | 100,437 |
| 2009 | 0 | 0 | 13,905 | 18,881 | 12,748 | 10,479 | 13,408 | 7,824 | 10,345 | 3,470 | 0 | 0 | 91,060 |
| 2010 | 0 | 0 | 27,311 | 32,164 | 29,202 | 29,192 | 30,315 | 44,734 | 52,026 | 37,670 | 0 | 0 | 282,614 |
| 2011 | 0 | 0 | 69,994 | 85,730 | 83,334 | 65,515 | 62,084 | 61,867 | 45,097 | 29,913 | 0 | 0 | 503,534 |
| 2012 | 0 | 0 | 39,228 | 59,636 | 51,696 | 35,159 | 39,807 | 69,718 | 48,959 | 26,280 | 0 | 0 | 370,483 |
| 2013 | 0 | 0 | 55,428 | 41,275 | 45,929 | 45,030 | 41,502 | 56,818 | 47,621 | 28,058 | 0 | 0 | 361,661 |
| 2014 | 0 | 0 | 47,338 | 36,706 | 30,230 | 42,088 | 38,160 | 39,061 | 23,418 | 16,185 | 0 | 0 | 273,186 |
| 2015 | 0 | 0 | 32,992 | 21,166 | 24,051 | 17,623 | 16,745 | 14,460 | 19,782 | 5,891 | 0 | 0 | 152,710 |
| 2016 | 0 | 750 | 46,101 | 31,830 | 24,474 | 40,200 | 42,871 | 28,854 | 18,851 | 9,079 | 0 | 0 | 243,010 |
| 2017 | 690 | 1,051 | 37,432 | 17,478 | 17,701 | 23,982 | 19,559 | 16,105 | 12,939 | 2,801 | 0 | 0 | 149,738 |
| 2018 | 34 | 0 | 35,214 | 25,427 | 9,923 | | | | | | | | 70,597 |
| TRL04 | | 565 | 45,187 | 24,123 | 11,721 | | | | | | | | |

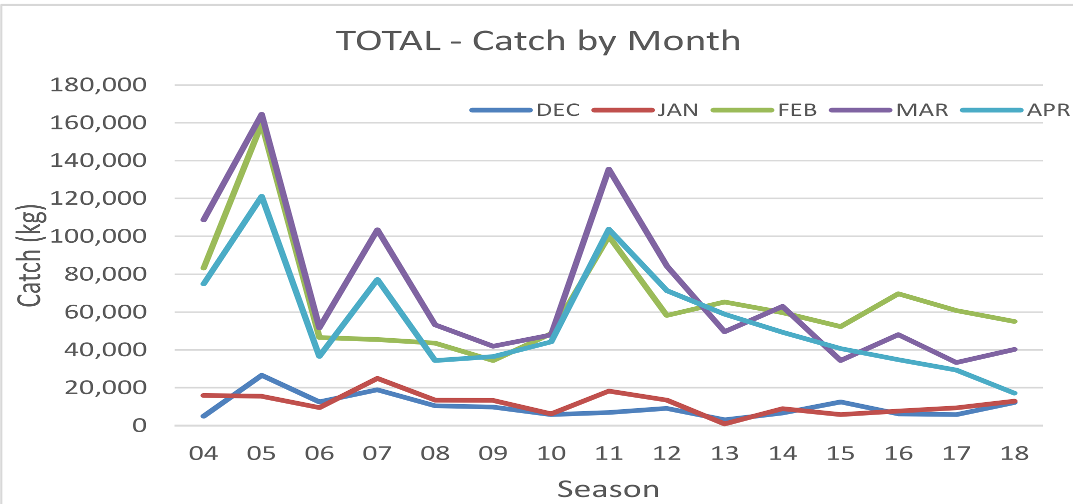
(c) TOTAL

| SEASON | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 4,949 | 15,994 | 83,274 | 108,754 | 74,879 | 100,907 | 107,954 | 92,215 | 66,990 | 35,498 | 24 | 25 | 691,463 |
| 2005 | 26,632 | 15,496 | 159,587 | 164,497 | 121,085 | 116,233 | 96,679 | 94,577 | 75,477 | 46,902 | 314 | 71 | 917,550 |
| 2006 | 12,532 | 9,447 | 46,530 | 51,674 | 36,582 | 33,178 | 21,304 | 31,862 | 24,428 | 8,336 | 0 | 51 | 275,924 |
| 2007 | 19,002 | 24,941 | 45,484 | 103,429 | 77,165 | 96,692 | 77,861 | 49,882 | 27,540 | 15,288 | 0 | 0 | 537,284 |
| 2008 | 10,435 | 13,461 | 43,522 | 53,293 | 34,444 | 27,520 | 22,802 | 38,998 | 26,096 | 15,514 | 18 | 0 | 286,103 |
| 2009 | 9,716 | 13,273 | 34,452 | 41,984 | 36,481 | 26,126 | 26,650 | 23,217 | 18,156 | 8,289 | 529 | 0 | 238,873 |
| 2010 | 5,764 | 6,198 | 48,570 | 47,993 | 44,197 | 41,372 | 46,663 | 63,807 | 69,027 | 47,452 | 1,610 | 0 | 422,653 |
| 2011 | 6,929 | 18,215 | 100,135 | 135,497 | 103,734 | 89,505 | 80,770 | 80,723 | 53,955 | 33,131 | 0 | 0 | 702,594 |
| 2012 | 9,036 | 13,403 | 58,256 | 84,354 | 71,302 | 44,848 | 62,681 | 80,912 | 59,795 | 28,276 | 0 | 0 | 512,863 |
| 2013 | 3,080 | 851 | 65,324 | 49,607 | 58,828 | 56,581 | 51,636 | 68,400 | 56,576 | 37,890 | 0 | 0 | 448,773 |
| 2014 | 6,688 | 8,992 | 59,728 | 62,943 | 49,365 | 59,248 | 49,558 | 50,828 | 35,140 | 22,683 | 126 | 0 | 405,299 |
| 2015 | 12,480 | 5,775 | 52,342 | 34,348 | 40,751 | 28,092 | 44,529 | 22,491 | 26,971 | 10,460 | 172 | 0 | 278,411 |
| 2016 | 6,177 | 7,712 | 69,673 | 48,073 | 34,814 | 55,455 | 57,901 | 40,019 | 28,862 | 13,907 | 98 | 75 | 362,766 |
| 2017 | 5,837 | 9,341 | 60,771 | 33,309 | 29,398 | 38,941 | 27,035 | 25,835 | 23,742 | 6,876 | 155 | 0 | 261,240 |
| 2018 | 12,187 | 12,941 | 55,050 | 40,289 | 17,179 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 137,646 |

2. Catch by Season for December-to-April



# Updated length frequency analysis for TRL, April 2018

**Éva Plagányi, Michael Haywood, Mark Tonks, Rob Campbell, Roy Deng, Nicole Murphy, Kinam Salee, Trevor Hutton**

CSIRO Oceans and Atmosphere, Queensland BioSciences Precinct (QBP), St Lucia, Brisbane,

Queensland, and Aspendale, Victoria, 3195

19 April 2018 – out of session document to support management of Torres Strait TRL

**SUMMARY CONCLUSION**: This document provides an update using data available up until end of March 2018 on length frequencies of catch samples for Torres Strait (TS) tropical lobster (TRL). We maintain our earlier conclusion that it is too early for fishers to make a call as to the entire season for Torres Strait (TS) tropical lobster (TRL) over the full area and considering all sectors of the fishery. There is currently no firm basis to support an alternative to the survey prediction of a below average recruiting age class when averaged over the entire TS region. The data from the Torres Strait Australian catch sectors are consistent with expectations of some recruiting animals becoming available to fishers, but don't reveal anything particularly noteworthy. Ongoing analyses will investigate this aspect further. Data were also provided from the PNG sector and these data are very helpful in understanding the current status in the PNG stratum given this stratum wasn't included in the November preseason survey. The PNG data show some indications of a slightly stronger than expected incoming recruitment in the PNG stratum but further information and analyses are necessary to fully interpret these data. Ongoing analyses will continue to review information as it becomes available, but we maintain that all indications from available data and the stock assessment suggest that the spawning biomass is currently below average and a precautionary approach is needed to ensure the longer-term sustainability of the stock. Finally, this document provides a brief summary of length frequency data from the QLD East Coast fishery which provides a useful comparison and shows potential in supporting broader understanding of the TRL stock dynamics given it is a shared stock.

## Background - Length Frequency Analyses

- The length frequency data from the November 2017 survey were plotted as shown below (Fig 1.). The von Bertalanffy growth curve was then applied to this distribution to illustrate the expected size distribution of this cohort in January 2018. This distribution was then compared with the actual observed size distribution of lobsters caught in January 2018 (data kindly provided by Kailis) to assess whether the November 1+ cohort were already being refelected in the commercial catches. As per Figure 2 below, this highlights that the January catches do not represent the 1+ cohort surveyed in November 2017, but are comprised mostly of animals (males in particular) from an older cohort, i.e. non-migrants from the previous year's 2+ cohort.

- Our length frequency (90-140 mm CL) and sex ratio analysis (mostly male) show these animals represent the 2+ cohort from the previous year so are not an index of abundance of the new 1+ cohort which is usually only accessible (due to size) to fishers from about March.
- The sex-disaggregated length frequency plot for January (Fig. 2) clearly highlights that in 2018, as in previous years, almost all the large lobsters caught are male. This further confirms that these animals are non-migrant survivors from the previous year because most of the females migrate out of the region to spawn. Comparison of changes in the length frequency and sex ratio of the catch during the year shows the progression of the fishery each year from a focus on “left-over” 2+ animals to fishing the new cohort, which constitutes the bulk of the annual catch. Full details were provided in a report submitted to the TRLRAG meeting in March.
- A summary of the mean expected relationship between age and length for TRL is provided in Appendix 1, noting that these are mean estimates only and as per the length frequency plots shown here, there is a spread about these mean values. Additional length frequency plots are also provide din Appendix 2.

**Updated Length Frequency Analyses**

- **Torres Strait**: The sex-disaggregated length frequency plots for February and March TRL Torres Strait samples (Figs 3-4) are much as expected and don’t suggest anything notable. There continue to be a substantial proportion of large males being caught, and the slight leftward shift in the distribution from January through February to March (Fig. 5) shows some 1+ recruitment from last year growing into the fished size class, but doesn’t suggest a particularly large influx of new recruits, noting that as per earlier comments, it is still early in the season to make a call on the strength of the new recruitment. We note also that the sex ratio of the smaller-sized animals shows a shift to a more equal representation of females, which is also as expected. The fact that most of the large animals caught are male is helpful in negating the hypothesis that a disruption to the usual migration pattern occurred due to the environmental anomalies – rather the residual population is similar in terms of sex ratio and length distribution to that in previous years, although additional data are required to assess whether the abundance of the residual population is greater than expected. The latter scenario is plausible given recent anomalous environmental conditions which caused changes in suitable habitat for lobster settling and feeding, and it’s possible that lobsters that were away from the regular fishing areas have now moved back to suitable feeding grounds that have opened up (in response to sand shifting) and are hence more accessible to fishers. However there are currently insufficient data to separate this hypothesis from the alternative hypothesis that the recent catches and catch rates are higher than would be expected in a poor recruitment year because of increased fishing effort, fishing efficiency and competitive fishing that is a characteristic of fisheries under situations where quota is limited. Ongoing analyses may shed light on the latter. We reiterate though that the available data to date are not inconsistent with the survey prediction of a poor recruiting age class, and further data and analyses are necessary to quantify this aspect with any certainty.

- **PNG**: The PNG length frequency data (Fig. 6) is different to that provided by the Australian sectors, and highlights the valuable information content of data from PNG. As with the Australian catch samples, the large animals are almost all male suggesting they are non-migratory males from the previous season. However the sex ratio and distribution for the smaller size classes suggests that there may be stronger incoming recruitment in the PNG stratum. The latter was not included in the Preseason survey. It would be instructive to analyse additional data from the PNG catch sector, and in particular to obtain information as to the spatial locations of the catches. For example, it would be helpful to get confirmation whether some of the larger females represented in the PNG catch samples (eg January length frequency – females ca. 116cm CL – Fig. 6) are from mature populations further to the east travelling along the lobster migration route.
- **East Coast**: Data from East Coast samples have been analysed for the first time and show some similar features to the TRL data such as most large animals being male and a more even sex ratio of females in smaller length classes (Fig. 7). However as expected given the greater longevity of TRL on the east Coast, the size distribution reflects many much larger individuals. The length frequency plots for 2016 and 2017 (Figs 8-9) are potentially helpful too to inform on recruitment pulses – for example, there are some indications that the new 1+ cohort predominantly enters the fishery in March-April consistent with what is observed in Torres Strait. However the East Coast data are highly variable and analyses of these data is likely confounded by variability in the spatial location of the catch samples given the fishery operates over a large area. It is therefore recommended that if possible, future catch samples for the East Coast should be separated by spatial zone and this will likely mean an increased number of samples per zone is needed to ensure the data are as informative as possible.

**Future work**: The CDR catch data were provided to CSIRO on 18/4/18 and we are waiting for updated logbook data. We will thus in the near future again do an updated analysis of catch and catch rate information for the current fishing season to assist in understanding the current season's stock abundance.

**Acknowledgements**

We are grateful to Darren Dennis for kindly sharing insights into the history of the fishery based on his long history of involvement. Many thanks to the many stakeholders who have contributed information and perspectives on the current status of the fishery. Thanks also to M.G. Kailis for providing length sample measurements and in particular to also providing data for PNG and the East Coast fishing sectors.

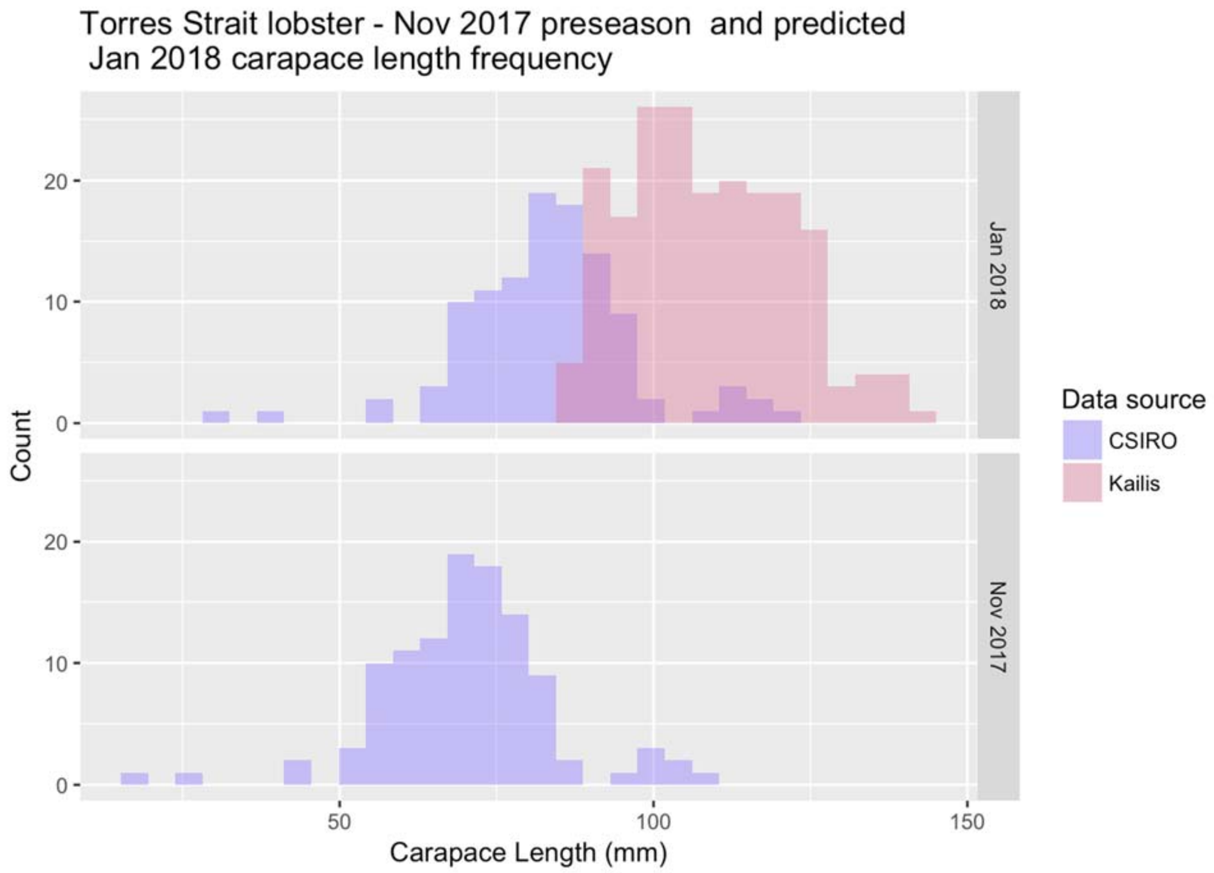



Fig. 1. Comparison between observed length frequency sample from January 2018 commercial catches, and predicted length frequency of 1+ cohort recruiting to fishery in 2018, with the latter predicted based on applying the expected average growth rates to the November 2017 survey-observed frequencies.

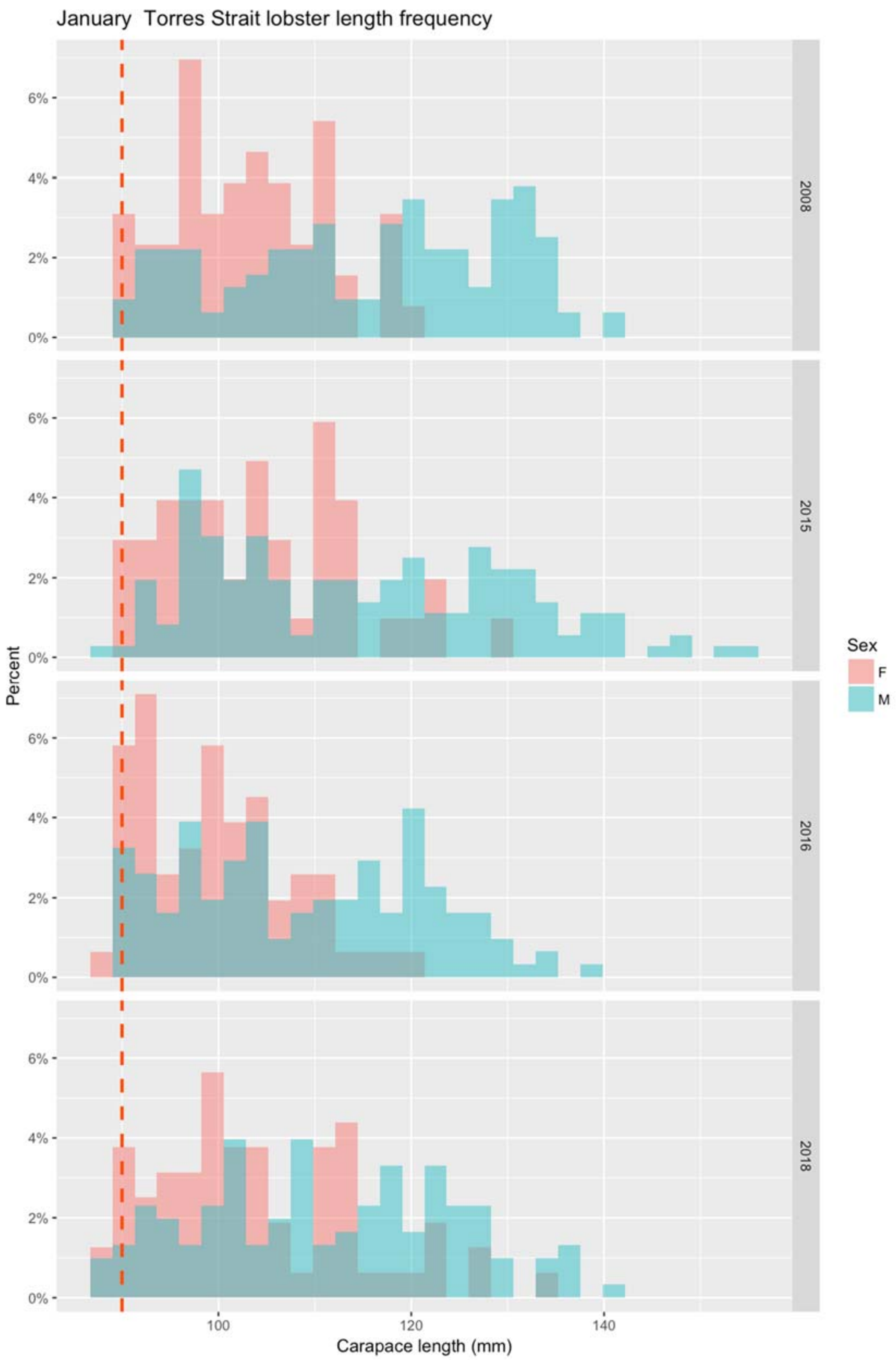



Fig. 2. Sex-disaggregated length frequency (percentage of sample having a carapace length (mm) as shown) from commercial catch samples shown for January from each of the years as indicated, and with pink shading representing females and blue shading males. The dashed vertical line represents the legal size limit. Note that no data was collected during January 2017.

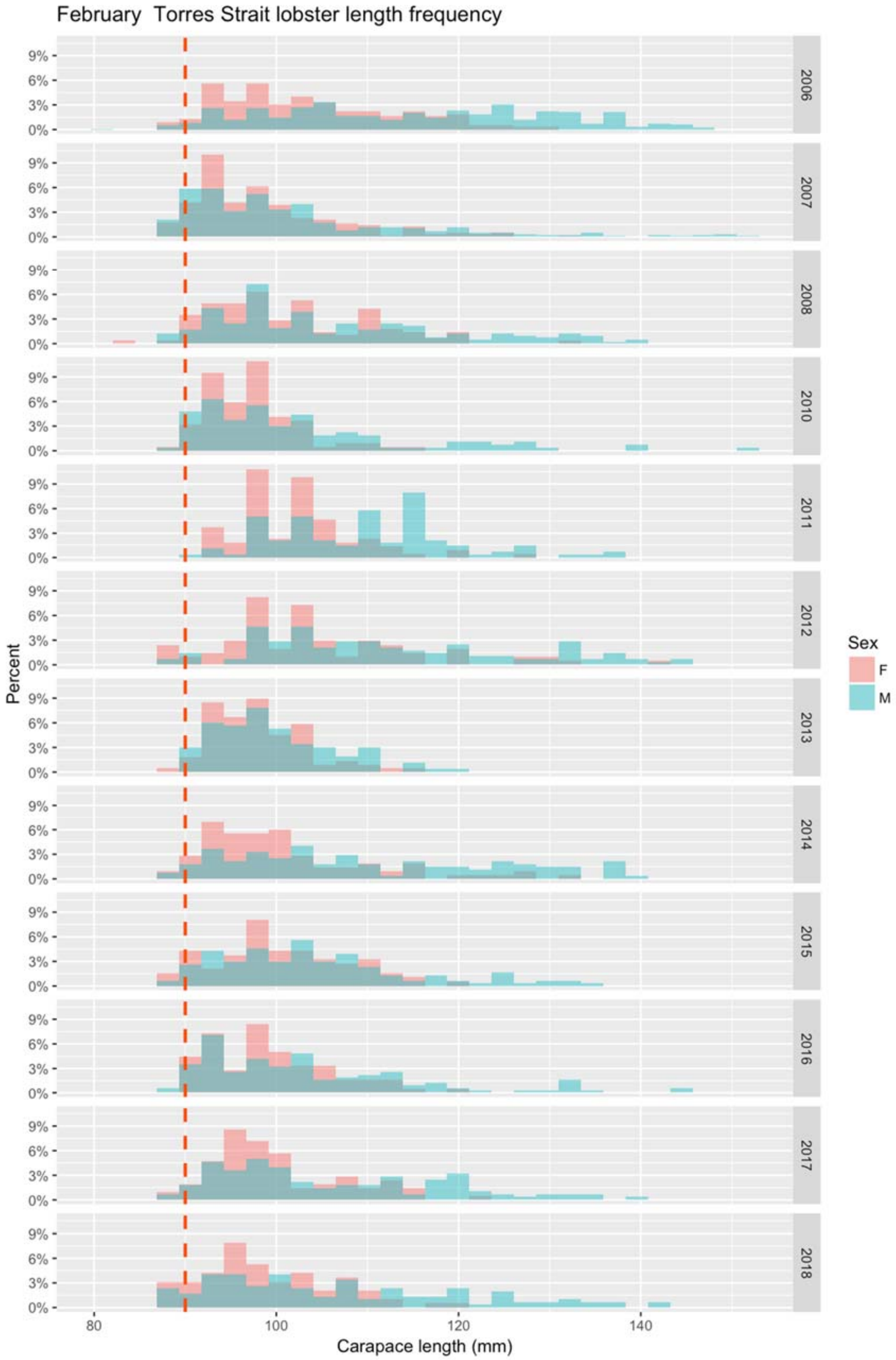



Fig. 3 Sex-disaggregated length frequency (percentage of sample having a carapace length (mm) as shown) from commercial catch samples shown for February from each of the years as indicated, and with pink shading representing females and blue shading males. The dashed vertical line represents the legal size limit.

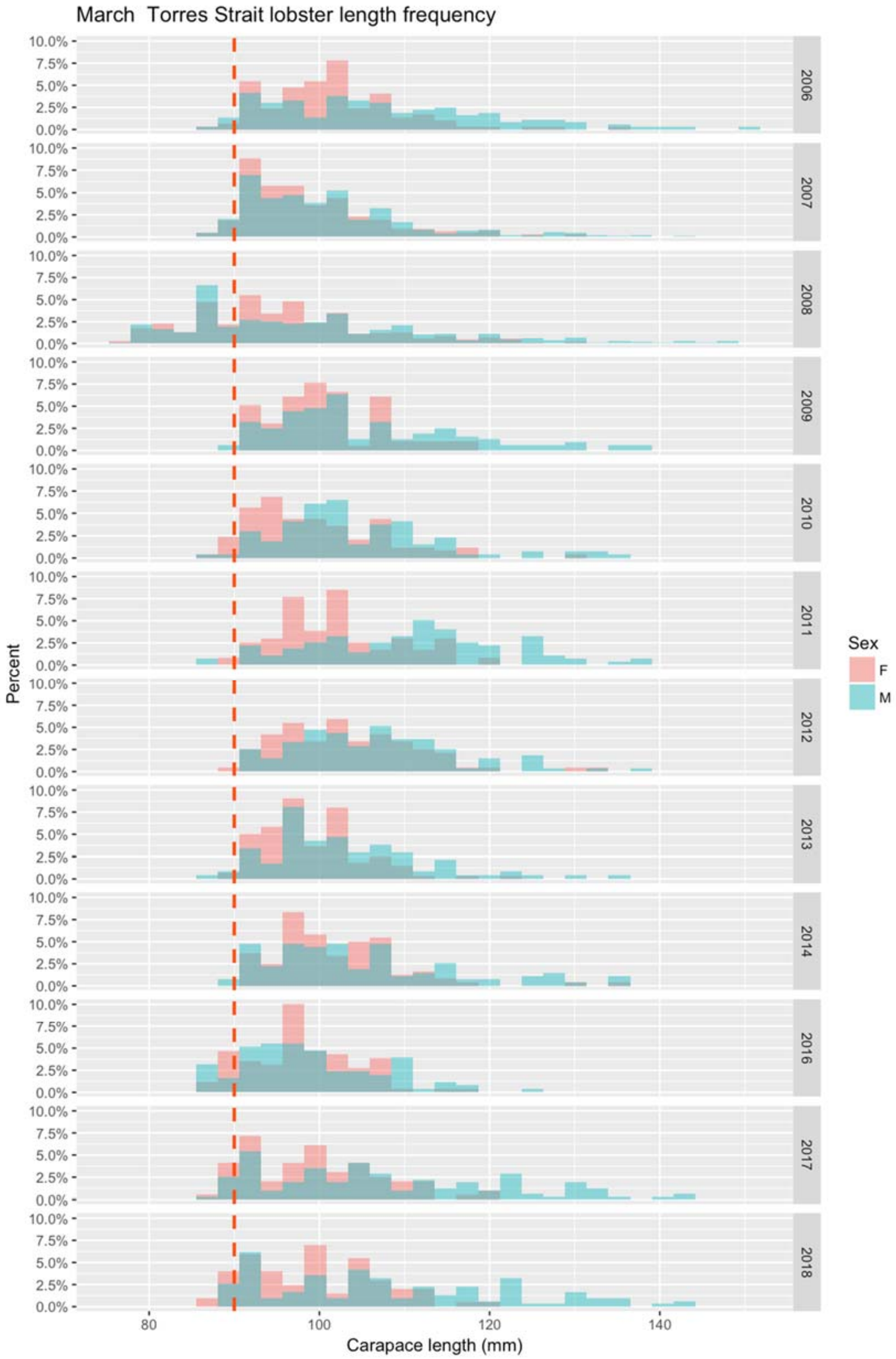



Fig. 4. Sex-disaggregated length frequency (percentage of sample having a carapace length (mm) as shown) from commercial catch samples shown for January from each of the years as indicated, and with pink shading representing females and blue shading males. The dashed vertical line represents the legal size limit.

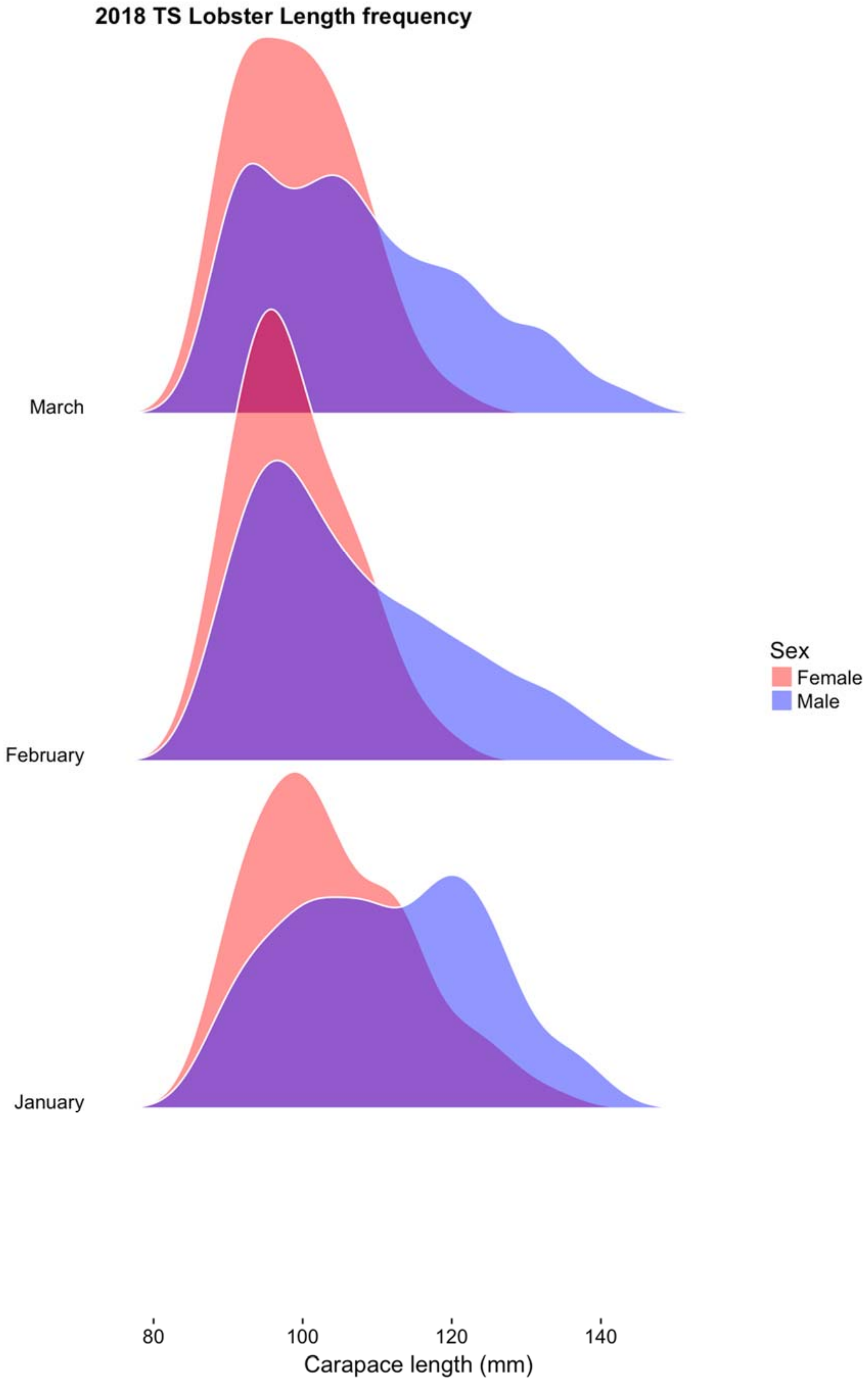



Fig. 5. Smoothed plots using ridge lines package, to show changes in length frequency from commercial catch samples of Torres Strait TRL over the period January to March 2018.

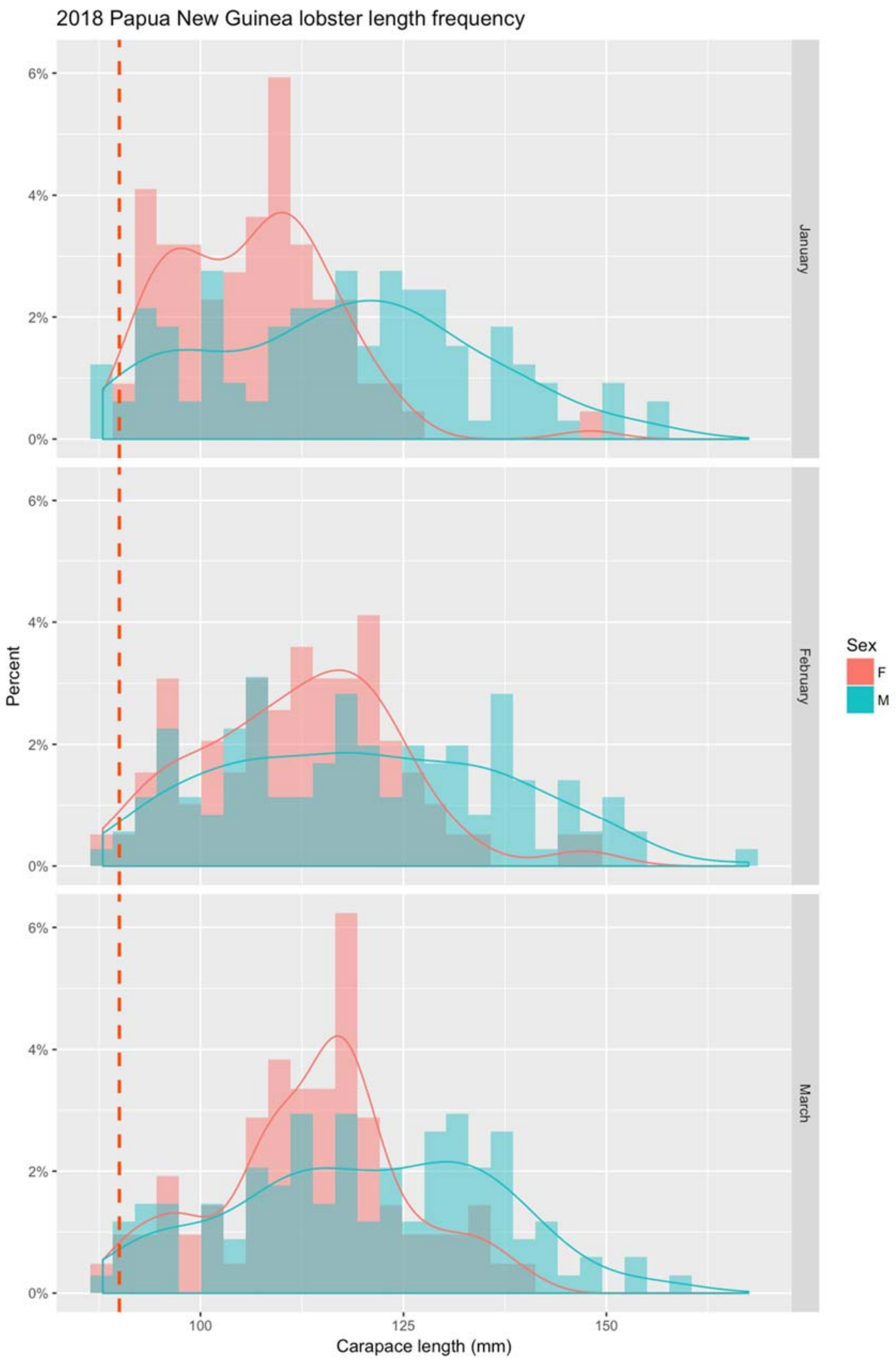



Fig. 6. Sex-disaggregated length frequency (percentage of sample having a carapace length (mm) as shown) from PNG commercial catch samples shown for January to March 2018, and with pink shading representing females and blue shading males. The dashed vertical line represents the legal size limit.

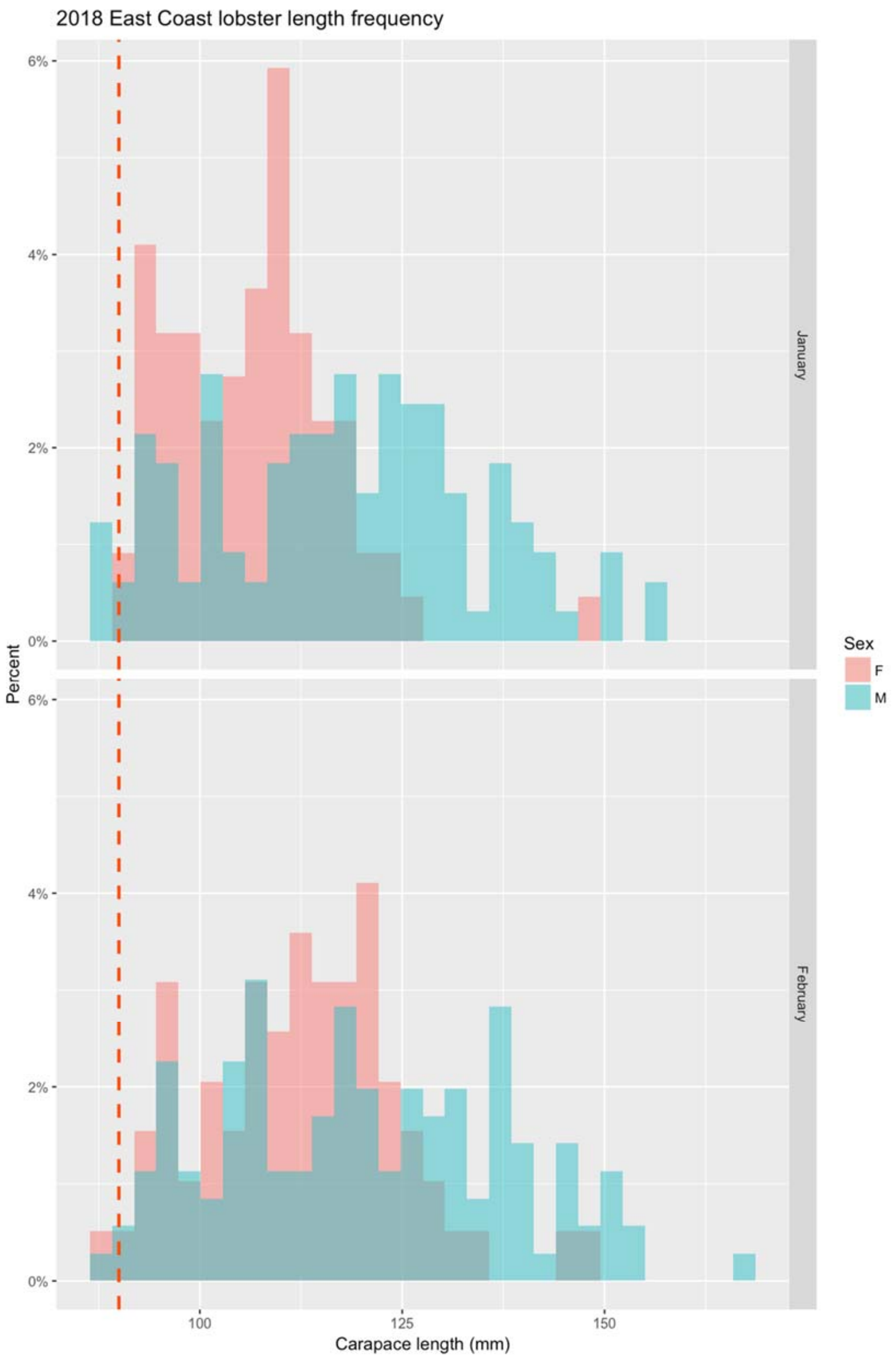



Fig. 7. Sex-disaggregated length frequency (percentage of sample having a carapace length (mm) as shown) from East Coast commercial catch samples shown for January and February 2018, and with pink shading representing females and blue shading males. The dashed vertical line represents the legal size limit.

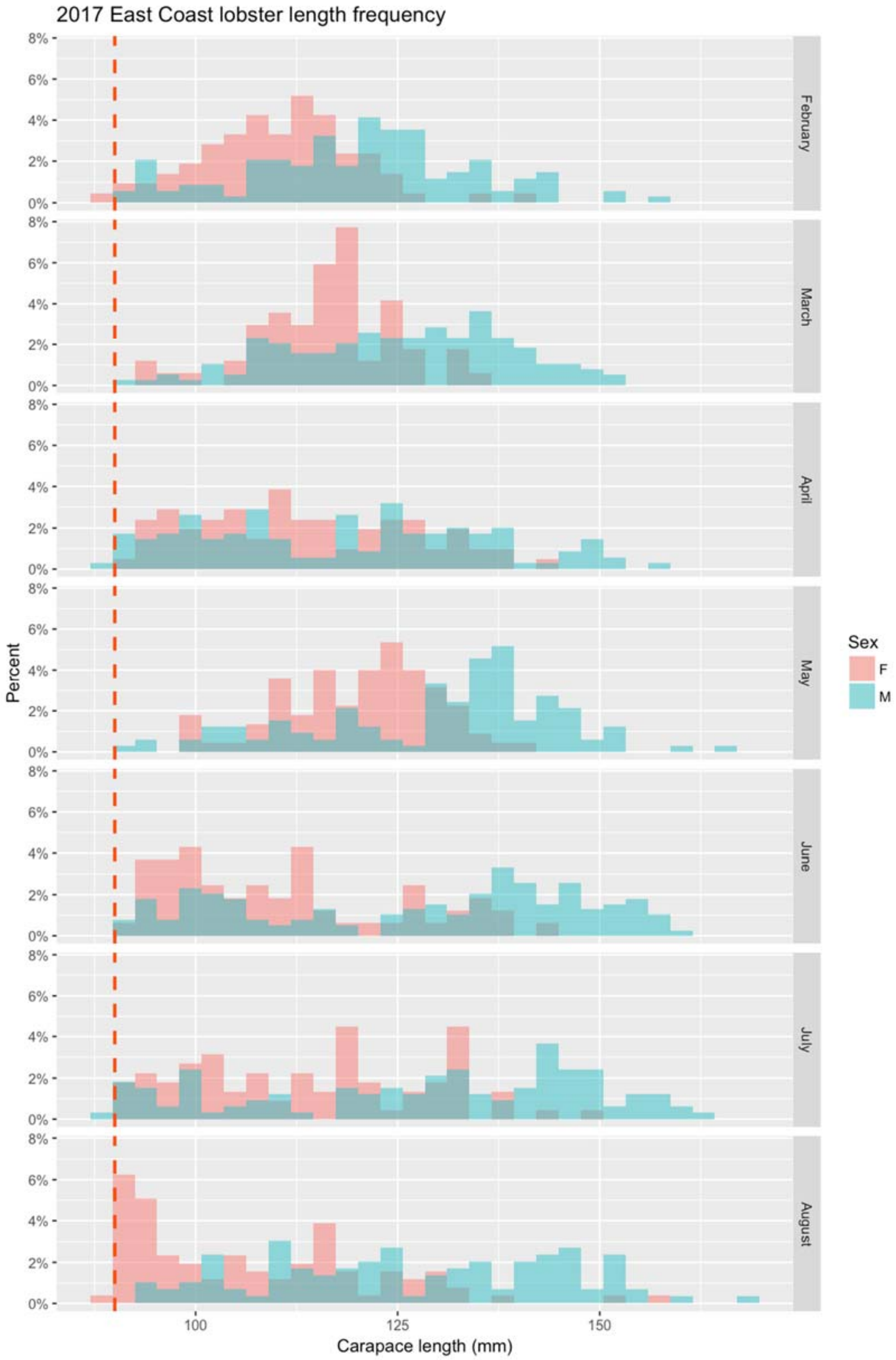



Fig. 8. Sex-disaggregated length frequency (percentage of sample having a carapace length (mm) as shown) from East Coast commercial catch samples for months as shown in 2017, and with pink shading representing females and blue shading males. The dashed vertical line represents the legal size limit.

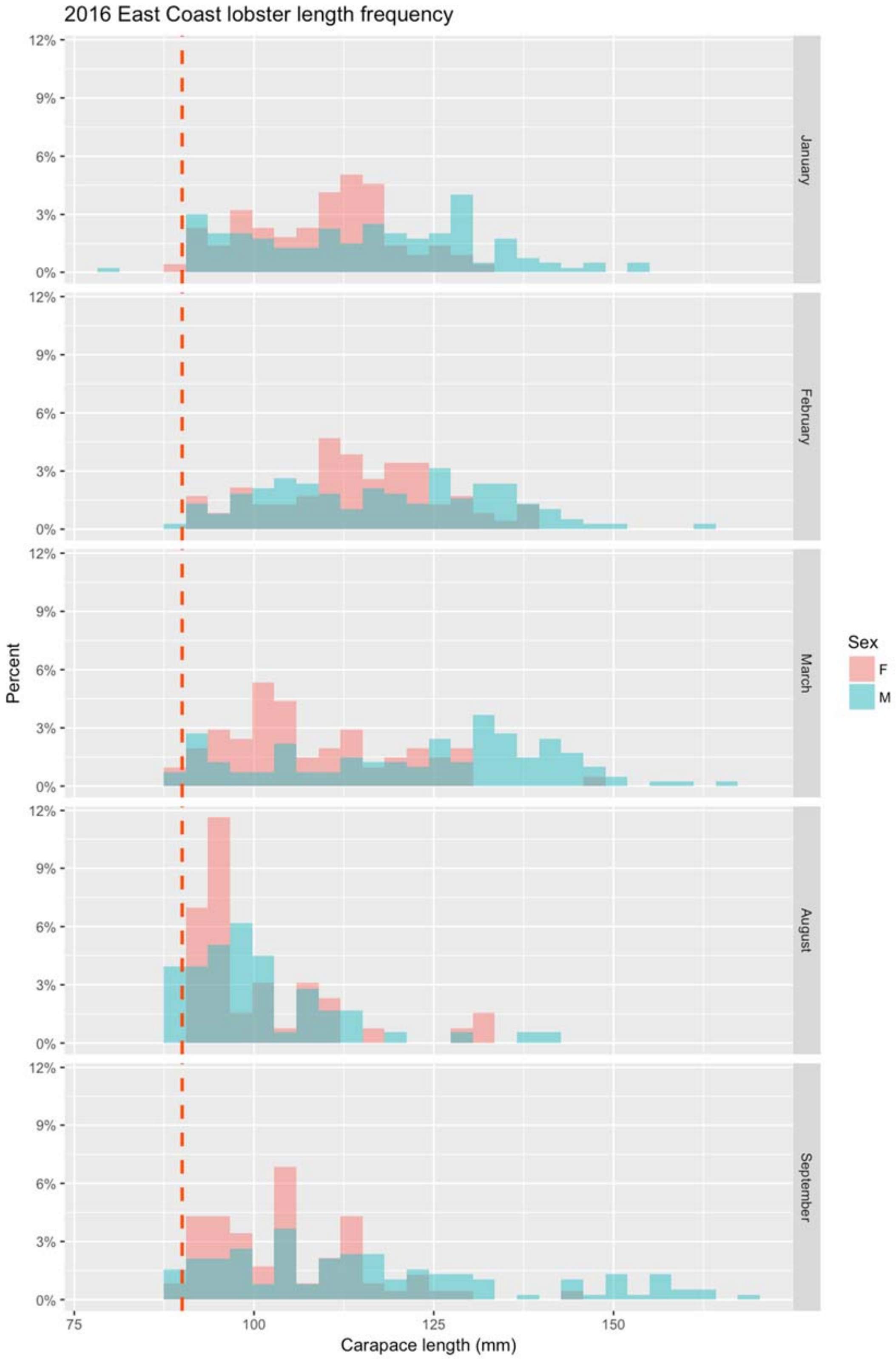



Fig. 8. Sex-disaggregated length frequency (percentage of sample having a carapace length (mm) as shown) from East Coast commercial catch samples for months as shown in 2016, and with pink shading representing females and blue shading males. The dashed vertical line represents the legal size limit.

**Appendix 1** – Age-length relationship for TRL based on von Bertalanffy growth curve

| | Age (months) | length carapace (mm) | Tail width (mm) | Mass (kg) |
|---|---|---|---|---|
| 0+ Nov | 6 | 32.240 | 21.738 | 0.038 |
| | 7 | 36.968 | 25.038 | 0.055 |
| | 8 | 41.529 | 28.220 | 0.076 |
| | 9 | 45.929 | 31.291 | 0.100 |
| | 10 | 50.173 | 34.252 | 0.127 |
| | 11 | 54.267 | 37.109 | 0.158 |
| | 12 | 58.216 | 39.865 | 0.192 |
| | 13 | 62.026 | 42.524 | 0.229 |
| | 14 | 65.701 | 45.089 | 0.268 |
| | 15 | 69.246 | 47.562 | 0.310 |
| | 16 | 72.666 | 49.949 | 0.354 |
| | 17 | 75.964 | 52.251 | 0.400 |
| 1+ NOV | 18 | 79.146 | 54.471 | 0.448 |
| Dec | 19 | 82.216 | 56.613 | 0.498 |
| Jan | 20 | 85.177 | 58.680 | 0.549 |
| Feb | 21 | 88.033 | 60.673 | 0.601 |
| March - LEGAL | 22 | 90.789 | 62.596 | 0.655 |
| April | 23 | 93.447 | 64.451 | 0.709 |
| May | 24 | 96.011 | 66.240 | 0.764 |
| June | 25 | 98.484 | 67.966 | 0.820 |
| July | 26 | 100.870 | 69.631 | 0.876 |
| Aug | 27 | 103.171 | 71.237 | 0.932 |
| SEPT | 28 | 105.391 | 72.786 | 0.988 |
| Oct | 29 | 107.533 | 74.281 | 1.045 |
| 2+ NOV | 30 | 109.599 | 75.722 | 1.101 |
| | 31 | 111.592 | 77.113 | 1.157 |
| | 32 | 113.514 | 78.454 | 1.213 |
| | 33 | 115.368 | 79.748 | 1.268 |
| | 34 | 117.157 | 80.997 | 1.323 |
| | 35 | 118.883 | 82.201 | 1.378 |
| | 36 | 120.547 | 83.362 | 1.432 |

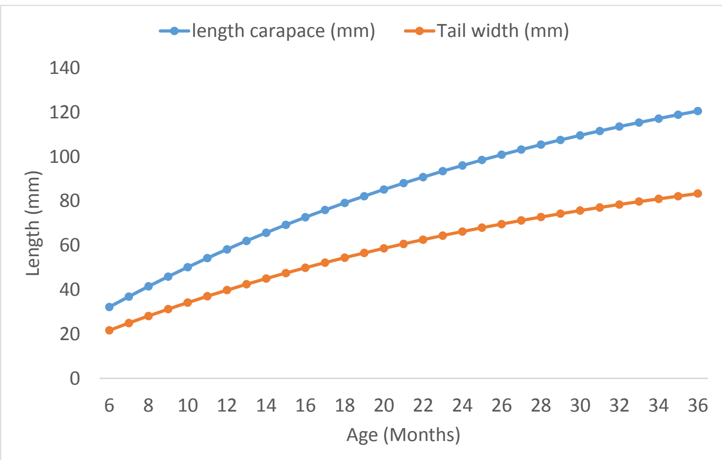
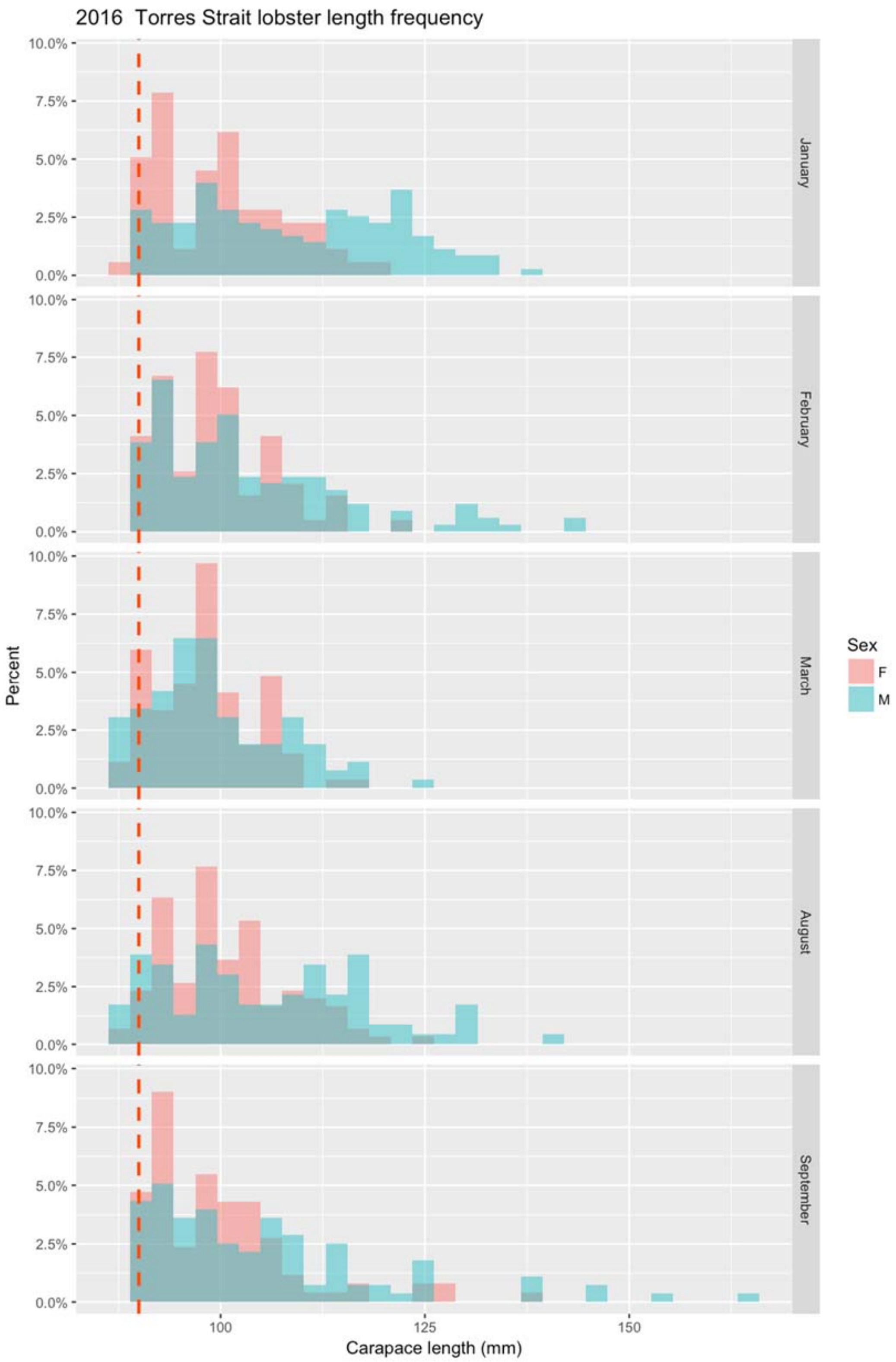
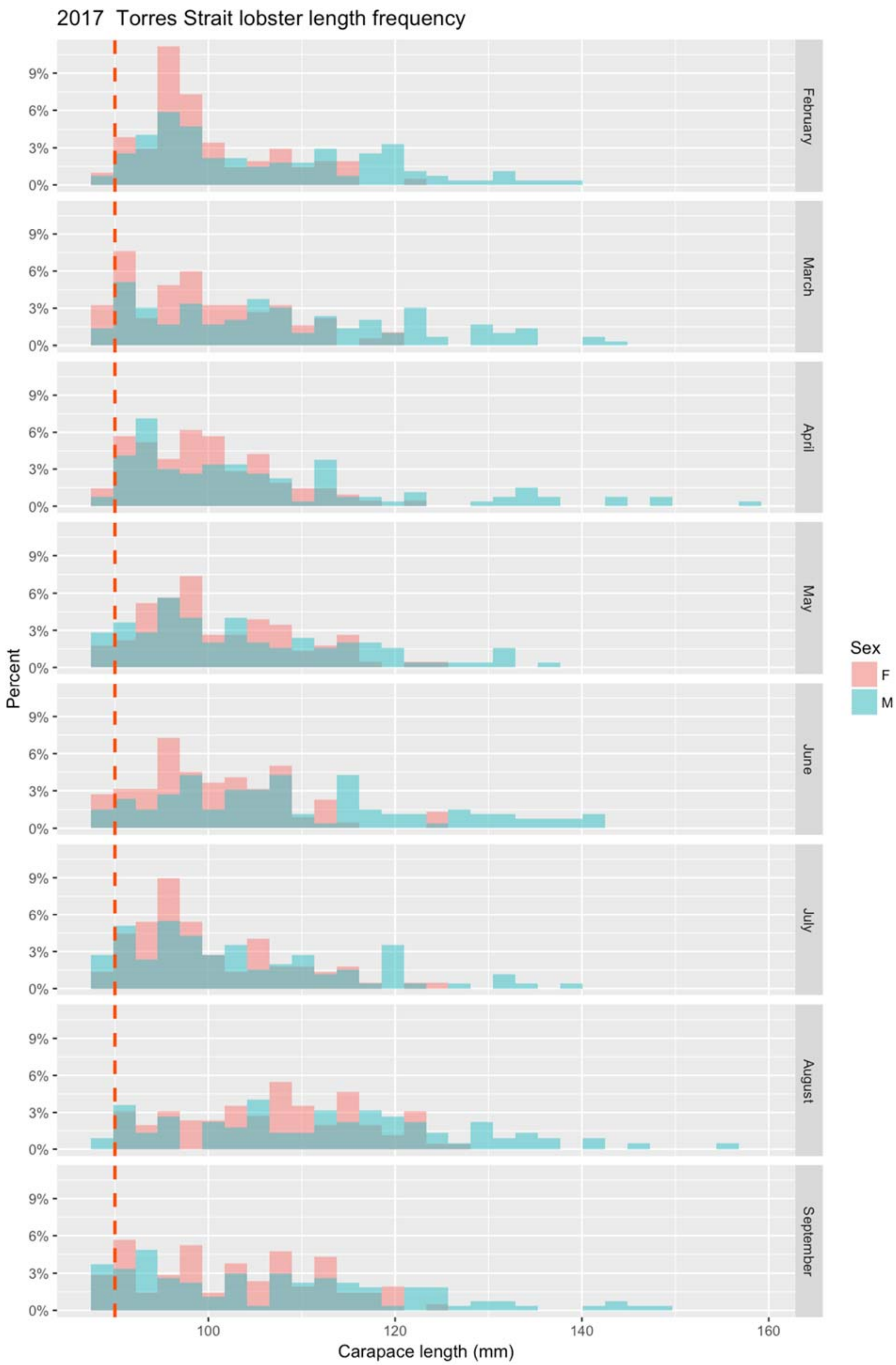
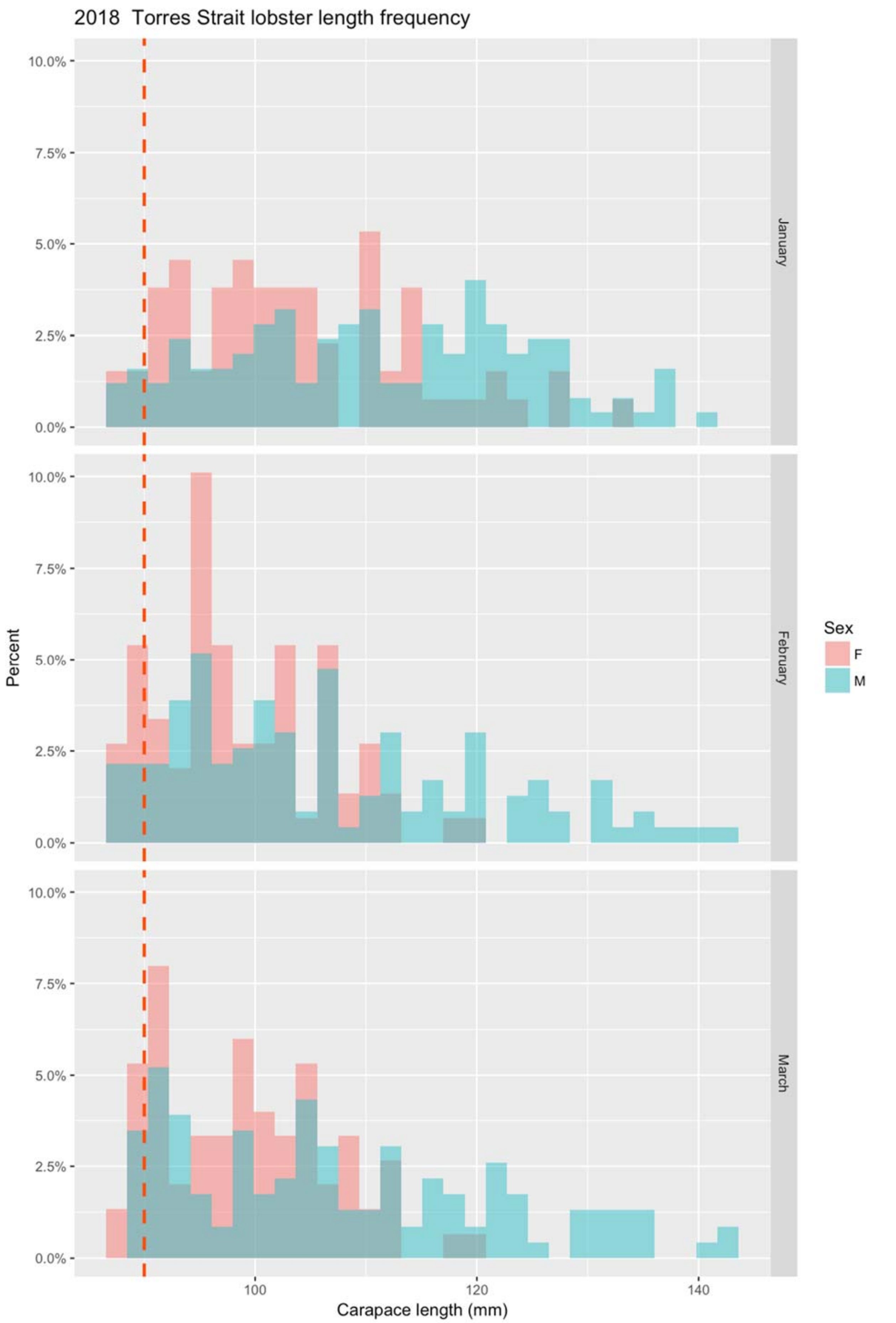



Fig. A.1. Plot of TRL length (shown both as carapace length (mm) and tail width (mm) as a function of age in months.

**Appendix 2** – Additional Length Frequency Plots for Reference Purposes




2017 Torres Strait lobster length frequency
February
March
April
May
June
July
August
September
9%
6%
3%
0%
Percent
100
120
140
160
Carapace length (mm)
Sex
F
M


2018 Torres Strait lobster length frequency
10.0%
7.5%
5.0%
2.5%
0.0%
January
February
March
Percent
Sex
F
M
100
120
140
Carapace length (mm)

**Summary of additional survey options for TRL for 2018**

**Éva Plagányi, Mark Tonks, Michael Haywood, Nicole Murphy, Rob Campbell, Roy Deng, Kinam Salee**

CSIRO Oceans and Atmosphere, Queensland BioSciences Precinct (QBP), St Lucia, Brisbane,

**SUMMARY**: Based on recent data analyses, CSIRO found no firm basis to support an alternative to the survey prediction of a below average recruiting age class when averaged over the entire TS region. All indications from available data and the stock assessment suggest that the spawning biomass is currently below average and a precautionary approach is needed to ensure the longer-term sustainability of the stock. However there are ongoing anecdotal reports that stock abundance has been underestimated, and an assessment of stock status this year is confounded by a number of factors including: (1) if the fishing season closes early then data may not be available over the full fishing season to end of September as has been the case in the past; and (2) there are a number of factors (including eg the low TAC with no formal sectoral allocations) that have influenced fishing effort this year. Fishery-independent surveys are one method for independently and objectively quantifying stock status as well as potentially assisting with standardisation of CPUE data during periods when fishing practices change. The TRLRAG thus briefly discussed the pros and cons of conducting a (A) Midyear survey and/or (B) extending the Preseason survey. Given reports that the habitat may have changed, another option (albeit expensive) would be to conduct another benchmark survey. The last benchmark survey was conducted in 2002 surveying 375 sites and for reference purposes, a costing is provided of a (C) slightly reduced benchmark survey. The pros and cons of Options A-C are listed below.

## Option A - Mid-year survey

Cost: $174k (CSIRO contribution 69k; External 104k)

Description: Timing would be July – would be comparable to previous midyear surveys

***Pros***

- On the ground assessment of 1+ and 2+ abundance and size before migration will provide a solid scientific basis for cross-checking and validating the Preseason survey results, or alternatively highlighting that changes in the fishery are occurring which may necessitate a revision of survey and assessment protocols.
- In addition this provides an index of the 2+ abundance to more accurately inform on stock status and for comparison with CPUE data, which will be useful in again cross-checking how well the CPUE data reflect 2+ abundance given recent changes in some fishing practices.
- If the fishing season closes early in 2018, then the survey would provide information on the stock that will otherwise not be available.
- Compare 2018 June survey to previous mid-year surveys (75 sites). We propose that about 40 sites are critical.

***Cons***

- Large cost which would likely not change current TAC, but would contribute to understanding of stock status and informing on standardization of CPUE for future analyses
- Surveying sites that may have already been fished – not that different to previous surveys. However if the fishery is closed early, then the survey would survey sites that may not have been fished for 1-2 months, which may bias the survey relative to previous surveys which have always been during the active fishing season. This is particularly because fishing tends to remove aggregations and in the absence of fishing, the survey may detect more aggregations than in past ears and this may need to be accounted for in the analysis as a bias correction factor

## Option B – Extension to Pre-season survey

Cost: $55k (CSIRO contribution 22k; External 33k)

Description: This would involve adding approximately 5 days to the existing November preseason survey, with additional sites chosen as per preliminary discussions at the last TRLRAG, i.e. to ensure consistency with previous surveys and usefulness for the survey standardized index, but also to improve precision, particularly for a couple of areas where changes in stock distribution may have influenced the precision of estimates for a zone.

***Pros***

- This would allow reintroducing some sites that have been less well represented than ideal (due to costing constraints) and thereby improve the precision of the survey index. Previous analyses suggested that the reduced Preseason survey is less precise but has similar accuracy to the more extensive Preseason survey, and these data could assist in again checking the effect on survey accuracy and precision of reducing the number of sites.
- This is a relatively low cost option as simply adds to the existing planned survey.
- This would assist in providing more confidence to the prediction for 2019, given the RBC (whether based on the stock assessment model or Harvest Control Rule) is primarily determined by the Preseason 1+ index.

***Cons***

- This wouldn't assist in validating or helping understand whether the TAC for 2018 was set too low as the large lobsters will have migrated out the area by the time of the survey.
- This doesn't provide an index of the 2+ abundance and wouldn't fill in any data gaps if the fishing season closes early – it serves only to strengthen the following year's prediction.

## Option C – Benchmark Survey

Cost: $486k (CSIRO contribution 194k; External 291k)

Description: This would build on the previous 2 benchmark surveys conducted in 1989 and 2002, but would ideally be conducted as an extensive preseason November survey given Preseason surveys are now being used as the primary survey tool. A slightly scaled down version could be conducted, involving 40 days and surveying approximately 280 sites (that is double the usual full preseason survey number but less than the 2002 survey involving 375 sites). There would be some associated additional research to select sites and analyse the data. Timing would be similar to the current November preseason survey.

***Pros***

- This would allow a more thorough review of the current survey sampling in order to assess in particular whether substantial habitat changes have occurred which need ot be taken into account.
- This would assist in providing more confidence to the prediction for 2019 and future years, given the RBC (whether based on the stock assessment model or Harvest Control Rule) is primarily determined by the Preseason 1+ index.
- The additional habitat and other baseline information collected would be useful for other broader studies, such as providing a baseline for climate and modeling studies.

***Cons***

- This survey option is very expensive (but used to highlight the additional work and resources required to substantially review and expand the current survey)
- This wouldn't assist in validating or helping understand whether the TAC for 2018 was set too low as the large lobsters will have migrated out the area by the time of the survey.
- This doesn't provide an index of the 2+ abundance and wouldn't fill in any data gaps if the fishing season closes early – it serves only to strengthen the following year's prediction.

| TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) | MEETING 23<br>15 May 2018 |
|---|---|
| **PRELIMINARIES**<br>**Declaration of interests** | **Agenda Item 1.3**<br>**For Decision** |

## RECOMMENDATIONS

1. That RAG members:
   a. **DECLARE** all real or potential conflicts of interest in the Torres Strait Rock Lobster Fishery at the commencement of the meeting (**Attachments 1.3a** and **1.3b**);
   b. **DETERMINE** whether the member may or may not be present during discussion of or decisions made on the matter which is the subject of the conflict;
   c. **ABIDE** by decisions of the RAG regarding the management of conflicts of interest; and
   d. **NOTE** that the record of the meeting must record the fact of any disclosure, and the determination of the RAG as to whether the member may or may not be present during discussion of, or decisions made, on the matter which is the subject of the conflict.

## BACKGROUND

2. Consistent with the *Protected Zone Joint Authority (PZJA) Fisheries Management Paper No. 1* (FMP1), which guides the operation and administration of PZJA consultative forums, members are asked to declare any real or potential conflicts of interest.
3. RAG members are asked to confirm the standing list of declared interests (**Attachments 1.3a** and **1.3b**) is accurate and provide an update to be tabled if it is not.
4. FMP1 recognises that members are appointed to provide input based on their knowledge and expertise and as a consequence, may face potential or direct conflicts of interest. Where a member has a material personal interest in a matter being considered, including a direct or indirect financial or economic interest; the interest could conflict with the proper performance of the member's duties. Of greater concern is the specific conflict created where a member is in a position to derive direct benefit from a recommendation if it is implemented.
5. When a member recognises that a real or potential conflict of interest exists, the conflict must be disclosed as soon as possible. Where this relates to an issue on the agenda of a meeting this can normally wait until that meeting, but where the conflict relates to decisions already made, members must be informed immediately. Conflicts of interest should be dealt with at the start of each meeting. If members become aware of a potential conflict of interest during the meeting, they must immediately disclose the conflict of interest.
6. Where it is determined that a direct conflict of interest exists, the forum may allow the member to continue to participate in the discussions relating to the matter but not in any decision making process. They may also determine that, having made their contribution to the discussions, the member should retire from the meeting for the remainder of discussions on that issue. Declarations of interest, and subsequent decisions by the forum, must be recorded accurately in the meeting minutes.

**TRLRAG Declarations of Interest as at meeting 22 held on 27-28 March 2018**

| Name | Position | Declaration of interest |
|---|---|---|
| **Members** | | |
| Dr Ian Knuckey | Chair | Chair/Director of Fishwell Consulting Pty Ltd and Olrac Australia (electronic logbooks). Chair/member of other RAGs and MACs. Conducts various AFMA and FRDC funded research projects including FRDC Indigenous Capacity Building project. No research projects in the Torres Strait.<br>Full declaration of interests provided at **Attachment 1.3b**. |
| Natalie Couchman | Executive Officer | Nil |
| Selina Stoute | AFMA Member | Nil |
| Allison Runck | TSRA Member | Nil. TSRA holds multiple TVH TRL fishing licences on behalf of Torres Strait Communities but does not benefit from them. |
| John Dexter (attending on behalf of Tom Roberts) | QDAF Member | Nil |
| Dr Eva Plaganyi | Scientific Member | Project staff for PZJA funded TRL research projects. |
| Dr Andrew Penney | Independent Scientific Member | Research consultant (Pisces Australis), member of other RAGs. No research projects in the Torres Strait. |
| Aaron Tom | Industry Member | Industry representative, TRLWG Industry member, does not hold a TIB licence. |
| Mark David | Industry Member | Industry representative, TRLWG Industry member, Traditional Owner and TIB licence holder. |
| Terrence Whap | Industry Member | Industry representative, TRLWG Industry member, Traditional Owner, does not hold a TIB licence. |
| Les Pitt | Industry Member | Industry representative, TRLWG Industry member and TIB licence holder. |
| Phillip Ketchell | Industry Member | Industry representative, TRLWG Industry member, Traditional Owner and TIB licence holder. |

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|---|---|---|
| Daniel Takai | Industry Member | Pearl Island Seafoods, Tanala Seafoods and TIB licence holder. |
| Dr Ray Moore | Industry Member | Industry representative and Master Fisherman licence holder. |
| Brett Arlidge | Industry Member | General Manager MG Kailis Pty Ltd. MG Kailis Pty Ltd is a holder of TVH licences. |
| **Observers** | | |
| Robert Campbell | CSIRO | Project staff for PZJA funded TRL research projects. |
| Jerry Stephen | TSRA Deputy Chair, TSRA Member for Ugar and TSRA Portfolio Member for Fisheries | TIB licence holder and Traditional Owner. |
| Kenny Bedford | Observer | To be declared at meeting. |
| Trent Butcher | Observer | TVH fisher. |

**Declaration of interests**
**Dr Ian Knuckey – April 2018**

**Positions:**

- Director – Fishwell Consulting Pty Ltd
- Director – Olrac Australia (Electronic logbooks)
- Chair / Director – Australian Seafood Co-products (seafood waste utilisation)
- Chair / Director – ASCo Fertilisers (seafood waste utilization)
- Chair – Northern Prawn Fishery Resource Assessment Group
- Chair – Tropical Rock Lobster Resource Assessment Group
- Chair – Victorian Rock Lobster and Giant Crab Assessment Group
- Scientific Member – Northern Prawn Management Advisory Committee
- Scientific Member – SESSF Shark Resource Assessment Group
- Scientific Member – Great Australian Bight Resource Assessment Group
- Invited scientific participant – SEMAC, SERAG

**Current / Recent Projects and funding:**

- Principal Investigator – FRDC Project 2017-069 Indigenous Capacity Building
- Principal Investigator – VFA Project 17-646976 – Ocean Scallop Biomass Survey – 2018
- Principal Investigator – FRDC Project 2017/122 - Review of fishery resource access and allocation arrangements across Australian jurisdictions
- Principal Investigator – FRDC Project 2016/116 - 5-year RD&E Plan for Northern Territory fisheries and aquaculture
- Principal Investigator – AFMA Project 2017/0803 - Analysis of Shark Fishery Electronic Monitoring data
- Principal Investigator – AFMA Project 2017/0807 - Resource Survey of the Great Australian Bight Trawl Sector – 2018
- Principal Investigator – AFMA Project 2016/0809 – Improved targeting of arrow squid
- Principal Investigator – AFMA Project 2018/08xx – Bass Strait and Central Zone Scallop Fishery – 2018 and 2019 Survey
- Principal Investigator – DPIPWE Project – Review of abalone dive rates
- Principal Investigator – FRDC Project 2015/204 – Realising economic returns of reducing waste through utilization of bycatch in the GAB Trawl Sector of the SESSF
- Principal Investigator – FRDC Project 2014/203 – Review of Monitoring and Assessment in the SESSF
- Principal Investigator – AFMA Project 2014/0809 – Fishery Independent Survey of shelf resources in the Great Australian Bight Trawl Fishery 2017
- Principal Investigator – Survey for Black teatfish in the Queensland Sea Cucumber Fishery.
- Principal Investigator – CRC Project 2013/748.40 – Improved understanding of economics in fisheries harvest strategies.
- Principal Investigator – FRDC Project 2014/207 – The social drivers and implications of conducting an ecological risk assessment of both recreational and commercial fishing - a case study from Port Phillip Bay
- Co-Investigator – Optimising processes and policy to minimise business and operational impacts of seismic surveys on the fishing industry and oil and gas industry.
- Co-Investigator – FRDC Project 2017/014 – SA Marine Scalefish Review

- Co-investigator – AFMA Project - SESSF 2018 Fishery Independent Survey
- Co-investigator – Bird mitigation in the SESSF trawl sector
- Researcher – Various fishing industry liaison projects for oil and gas industry
- Scientific Advisor – Atlantis, GABIA, Gulf St Vincent Prawn Fishery, Seafish JV, SETFIA, SSIA
- MSC Auditor – Falklands Is 2016 Surveillance Audit (Acoura), Macquarie Is Toothfish (SCS)
- Facilitator – WWF shark traceability workshop
- Facilitator – SPC Tuna Data Collection Committee
- Facilitator – Indonesian fishery training and development

**Current / Recent Clients (>$5000):**

- ABARES
- Acoura
- Atlantis Fisheries Consulting Group
- Australian Fisheries Management Authority (AFMA)
- CRC – Seafoods
- Department of Agriculture and Water Resources
- Department of Primary Industry - Victoria
- Dept. Primary Industry, Parks Water and Environment (DPIPWE) Tasmania
- Fisheries Research and Development Corporation (FRDC)
- Great Australian Bight Fishing Industry Association (GABIA)
- Gulf of St Vincent Prawn Boat Owners Association
- Monash University
- NT Fisheries
- Richey Fishing
- South Australian Rock Lobster Advisory Council (SARLAC)
- SARDI Aquatic Sciences
- SCS Global Services
- Seafood Industry Victoria
- Seafish JV
- SeaFresh
- Secretariat of the Pacific Community
- South East Trawl Fishing Industry Association (SETFIA)
- Southern Shark Industry Alliance (SSIA)
- Tasmanian Seafoods
- Victorian Fisheries Authority
- Western and Central Pacific Fisheries Commission
- World Wildlife Fund – Australia (WWF)

| TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) | MEETING 23<br>15 May 2018 |
|---|---|
| **PRELIMINARIES**<br>**Action items from previous meetings** | **Agenda Item 1.4**<br>**For Noting** |

**RECOMMENDATIONS**

1. That the RAG:
   a. **NOTE** the progress against actions arising from previous meetings (**Attachment 1.4a**).
   b. **NOTE** the draft meeting record for TRLRAG 22 held on 27-28 March 2018 will be provided out of session for comment following this meeting.

**BACKGROUND**

*Actions arising*

2. Updates are provided on the status of actions arising from previous TRLRAG meetings and relevant TRLWG meetings at **Attachment 1.4a**.

*Meeting record*

3. The draft meeting record for TRLRAG 22 held on 27-28 March 2018 will be provided out of session for comment following this meeting. The record will then be finalised out of session following the closure of the comment period.

**Attachment 1.4a**

**Action items from previous TRLRAG meetings**

| # | Action Item | Agenda | Agency | Due Date | Status |
|---|---|---|---|---|---|
| 1. | AFMA to review the effectiveness of certain TIB licensing arrangements (in its 2016 licencing review) including:<br>• TIB licenses should share a common expiry date<br>• licences to last for longer than the current 12 month period. | TRLRAG14 | AFMA | 2017 | **Ongoing**<br>AFMA has begun undertaking a review of licensing of Torres Strait Fisheries, this issue will be considered as part of this review. At present however, AFMA resources are focused on progressing the proposed legislative amendments as a matter of priority. |
| 2. | AFMA and CSIRO prepare a timeline of key events that have occurred in the Torres Strait Tropical Rock Lobster Fishery (e.g. licence buy backs, weather events and regulation changes) and provide a paper to TRLRAG. | TRLRAG14 | AFMA<br>CSIRO | TRLRAG17 | **Ongoing**<br>AFMA to complete further work. This has been difficult to action ahead of other priorities for the TRL Fishery. |
| 3. | AFMA to prepare a summary of evidence that PNG trawl-caught TRL are a shared stock between Australia and PNG, including details such as the TRL biological characteristics, larvae dispersal, tag recapture data and catch and effort information. AFMA will circulate the paper to the RAG out-of-session for comment before sending to PNG NFA. | TRLRAG19 | AFMA | | **Ongoing**<br>AFMA sent a letter to PNG NFA outlining concerns of trawlers retaining TRL on 8 March 2017.<br>AFMA presented the key findings of the CSIRO larval advection model at the Fisheries Bilateral meeting held in Port Moresby on 5 February 2018. The bilateral meeting noted that the findings show the Australian and PNG TRL fisheries are based on a single stock.<br>AFMA and CSIRO (Dr Plaganyi) met with PNG NFA officials, including the NFA Managing Director, John Kasu on 7 February 2018 at the NFA offices in Port Moresby. Dr Plaganyi presented the updated stock assessment results and larval advection modelling. There was agreement that |

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|---|---|---|---|---|---|
| | | | | | the updated larval modelling together with past research provides strong evidence that TRL is a shared stock between Australia and PNG.<br>These meetings have been followed up with teleconference between the PNG NFA Managing Director and AFMA CEO which included discussions on the importance of controlling catches so they do not exceed each jurisdiction's catch share of the recommended biological catch (RBC). |
| 4. | Malu Lamar RNTBC to provide AFMA with the map of traditional boundaries and regional area and reef names for each of the Torres Strait Island nations and for CSIRO to examine possible revised naming conventions for survey sites | TRLRAG20 | Malu Lamar | | **Ongoing**<br>AFMA is awaiting advice from Malu Lamar and will assist where possible.<br>CSIRO advised that they have received some maps with information on traditional names but that this is not complete. They will work with Malu Lamar if further information is needed. |

**Relevant action items from previous TRLWG meetings***

| # | Action Item | Agenda | Agency | Due Date | Status |
|---|---|---|---|---|---|
| 1. | TRLRAG to provide advice on any findings relating to the impacts of changing the season start date to provide industry with a longer TAC notice period. | TRLWG #5 held on 5-6 April 2016 | AFMA to draft RAG paper | TRLRAG22 | **Ongoing**<br>AFMA are working with CSIRO to progress this action, noting competing priorities relating to the TRL Fishery have caused delays. |

*TRLWG actions not relevant to TRLRAG have not been included in the above.

| TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) | MEETING 23<br>15 May 2018 |
| --- | --- |
| **UPDATES FROM MEMBERS**<br>**Industry and scientific members** | **Agenda Item 2.1**<br>**For Noting** |

**RECOMMENDATIONS**

1. That the RAG:
   a. **NOTE** updates provided by industry and scientific members;
   b. **DISCUSS** strategic issues, including economic, fishing and research trends relevant to the management the Torres Strait Tropical Rock Lobster (TRL) Fishery.

**BACKGROUND**

2. Verbal reports are sought from industry and scientific members under this item.
3. It is important that the RAG develops a common understanding of any strategic issues, including economic, fishing and research trends relevant to the management the TRL Fishery. This includes within adjacent jurisdictions. This ensures that where relevant, the RAG is able to have regard for these strategic issues and trends.
4. RAG members are asked to provide any updates on trends and opportunities in markets, processing and value adding. Industry is also asked to contribute advice on economic and market trends where possible. Scientific members are asked to contribute advice on any broader strategic research projects or issues that may be of interest to the Torres Strait in future.

| TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) | MEETING 23<br>15 May 2018 |
|---|---|
| **UPDATES FROM MEMBERS**<br>**Government agencies** | **Agenda Item 2.2**<br>**For Noting** |

**RECOMMENDATIONS**

1. That the Working Group:
   a. **NOTE** the update provided by AFMA below;
   b. **NOTE** a verbal update will be provided by the QDAF and TSRA.

**AFMA UPDATE**

***Management changes in the TRL Fishery since TRLRAG 22***

2. At its meeting on 27-28 March 2018, TRLRAG (TRLRAG 22) considered the results of the updated integrated stock assessment. The RAG recommended a final recommended biological catch (RBC) of 299 tonnes for the 2017/18 fishing season (Australia and PNG inclusive).
3. At its meeting on 28-29 March 2018, TRLWG (TRLWG 7) considered management measures necessary to ensure catches do not exceed the Australian catch share of the RBC for the 2017/18 fishing season. The WG recommended:
   a. catches should not exceed the RBC noting over catching will increase the risk of the Fishery not reaching its interim harvest strategy target. Which is to maintain the stock at (on average), or return to, a target biomass point $B_{TARG}$ ($B_{TARG}$ = 0.65 $B_0$) that takes account of the fact that the resource is shared and important for the traditional way of life and livelihood of traditional inhabitants and is biologically and economically acceptable; and
   b. measures be adopted to prolong the opportunity for the Traditional Inhabitant Boat (TIB) sector to fish for the duration of the season. It was also noted that prolonging fishing would allow the collection of catch per unit effort data over a longer period which will inform the next stock assessment for the Fishery.
4. Commencing 13 April 2018, AFMA (as PZJA licencing delegate) implemented additional moon-tide hookah closures in the TRL Fishery covering all new and full moon periods for the remainder of the 2017/18 fishing season. The implementation of these closures was undertaken to give immediate effect to the TRLWG recommendations.
5. The closures reduced effort in the TRL Fishery but updated projections following the TRLRAG and TRLWG meetings estimated the Australian catch share of the RBC would be reached by late May 2018. These projections were based on:
   a. updated catch figures which included Catch Disposal Records (TDB02) received after 21 March (total 14 tonnes) and catch data that had been incorrectly reported as tailed weight not live weight (total 10 tonnes); and,
   b. average weekly catch of approximately 14 tonnes when hookah is permitted and 3.3 tonnes when hookah is not permitted.
6. On 26 April 2018, a teleconference of TRLWG members was held to seek advice on whether any additional management measures should be applied in the TRL Fishery to further prolong fishing within the season, noting the PZJA will take steps to close the fishery to ensure the Australian catch share of the RBC is not exceeded. A majority of TIB

Industry members were absent from the meeting, a quorum was not present and so did not constitute a formal meeting of the TRLWG. The meeting proceeded to enable an opportunity for those present members to provide advice.

7. Having regard for the objectives of the *Torres Strait Fisheries Act 1984* (the Act) and administrative feasibility options discussed by members of the TRLWG included:
    a. no additional measures and close the Fishery when the Australian share of the RBC is reached;
    b. further hookah closures for May-June or for the remainder of the fishing season;
    c. Fishery closure for May-June or fortnight each month;
    d. increase the minimum size limits.
8. Commencing 30 April 2018, AFMA (as PZJA licencing delegate) implemented a prohibition on the carriage and use of hookah gear in the TRL Fishery for the remainder of the 2017/18 fishing season. This decision:
    a. was made to restrict the fishing effort in the Fishery so as to ensure catches do not exceed the limit of Australian catch share of the RBC and to prolong the opportunity for fishing for the duration of the 2017/18 fishing season;
    b. pursues the objectives of the Act, including the administration of commercial fisheries so as not to prejudice traditional fishing, to manage commercial fisheries for optimum utilisation, and to share allowable catch of commercial fisheries in accordance with Australia's treaty obligations with PNG.
9. AFMA continues to closely monitor catches and will provide further updates to industry on catch landed as the season progresses. Further details on catch landed to date is provided under **Agenda Item 3**.

***Finalisation of catch sharing arrangements with PNG***

10. Under the Torres Strait Treaty, the Australian catch share of the RBC is 190.65 tonnes in Australian waters, with the option of an additional 11.2 tonnes in PNG waters if cross-endorsement arrangements are agreed.
11. AFMA has pursued the finalisation of catch sharing arrangements with PNG. The CEO of AFMA will meet with the Managing Director of the PNG National Fisheries Authority in the coming weeks to agree on final catch shares. Industry will be advised of outcomes as soon as they become available.

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| **TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG)** | **MEETING 23**<br>**15 May 2018** |
| **UPDATES FROM MEMBERS**<br>**PNG National Fisheries Authority** | **Agenda Item 2.3**<br>**For Noting** |

**RECOMMENDATIONS**

1. That the RAG **NOTE** the update to be provided by the PNG National Fisheries Authority (NFA), if in attendance.

**BACKGROUND**

2. A verbal report will be provided under this item subject to the availability of NFA officers.

| TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) | MEETING 23<br>15 May 2018 |
|---|---|
| **UPDATES FROM MEMBERS**<br>**Native Title** | **Agenda Item 2.4**<br>**For Noting** |

## RECOMMENDATIONS

1. That the RAG **NOTE** any updates on Native Title matters from members, including the Chair of Malu Lamar (Torres Strait Islanders) Corporation RNTBC (Malu Lamar), if in attendance.

## BACKGROUND

2. On 7 August 2013 the High Court of Australia confirmed coexisting Native Title rights, including commercial fishing, in the claimed area (covering most of the Torres Strait Protected Zone). This decision gives judicial authority for Traditional Owners to access and take the resources of the sea for all purposes. Native Title rights in relation to commercial fishing must be exercisable in accordance with the *Torres Strait Fisheries Act 1984*.
3. Traditional Owners and Native Title representative bodies have an important role in managing Torres Strait fisheries. It is important therefore that the Working Group keep informed on any relevant Native Title issues arising.
4. AFMA has extended an invitation to Malu Lamar to attend this meeting as an observer and is investigating longer term arrangements for representation in consultation with PZJA agencies.

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| **TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG)** | **MEETING 23**<br>**15 May 2018** |
| **2017/18 TRL CPUE AND LENGTH FREQUENCY TRENDS** | **Agenda Item 3**<br>**For Discussion and Advice** |

**RECOMMENDATIONS**

1. That the RAG:
    a. **NOTE** the reported landed catch for the Torres Strait Tropical Rock Lobster (TRL) Fishery is 156,623 kilograms for the period 1 December 2017 to 10 May 2018 (**Attachment 3a**);
    b. **NOTE**, if available, reported landed catch for the PNG TRL Fishery to date; and
    c. **DISCUSS** and **PROVIDE ADVICE** on the summary of the catch and effort (December-April 2018) and updated length frequency analysis for TRL (April 2018) (**Attachment 3b, 3c and 3d**);
    d. **PROVIDE ADVICE** on the updated catch, effort and length frequency data against the pre-season survey results.

**KEY ISSUES**

2. As reported through the new mandatory fish receiver system, implemented on 1 December 2017, the reported landed catch for the TRL Fishery from 1 December 2017 to 10 May 2018 is 156,623 kilograms. This equates to approximately 82 per cent of the 190.65 tonnes Australian catch share of the recommended biological catch (RBC) (**Table 1**). This catch data is sourced from the Torres Strait Fisheries Catch Disposal Record (TDB02) and covers the Traditional Inhabitant Boat (TIB) and Transferable Vessel Holder (TVH) sectors only. Further details are provided at **Attachment 3a**).
3. AFMA is awaiting an update from the PNG National Fisheries Authority on catches to date for the PNG TRL Fishery. At the last meeting of the TRLRAG held on 27-28 March 2018 (TRLRAG 22), an Industry member reported that catches from PNG are low, in part due to hookah gear being prohibited until 31 March 2018.
4. At the last TRLRAG meeting on 27-28 March 2018 (TRLRAG 22) some industry members expressed concerns that the catch rates and sizes experienced to date do not align with what is expected from the November 2017 pre-season survey and integrated stock assessment.
5. AFMA have continued to receive feedback from some in industry who advise that based on their own catch rates, observations of TRL on the fishing grounds and overall TRL catches to date, that TRL are more abundant than what would be expected from the integrated stock assessment and low RBC. For that reason they believe the assessment may be misaligned with actual abundance this season.
6. Additional analysis conducted by CSIRO and circulated to members on 23 April 2018 indicated that there is no firm basis to support an alternative to the survey prediction of a below average recruiting age class (1+ lobsters) when averaged over the entire region. Further, based on sex-disaggregated length frequency data from February-March 2018, there continue to be a substantial proportion of large males being caught and some 1+ recruitment from last year is growing into the fishable size class but there isn't a particularly large influx.

7. CSIRO have continued to analyse all available data. CSIRO's latest analysis is attached for RAG consideration. This will also be presented further at the meeting:

    a. *Torres Strait Rock Lobster Fishery – Summary of the Catch and Effort Data pertaining to the 2018 Fishing Season (Dec-17 to Apr-18)* (**Attachment 3b**);

    b. *Updated length frequency analysis for TRL, April 2018* (**Attachment 3c**); and

    c. *Updated summary responses to reports querying the TRL RBC for 2018* (**Attachment 3d**).

## Landed catch from Torres Strait TRL Fishery

As reported through the new mandatory fish receiver system, implemented on 1 December 2017, the reported landed catch for the TRL Fishery from 1 December 2017 to 10 May 2018 is 156,623 kilograms. This equates to approximately 82 per cent of the 190.65 tonnes Australian catch share of the recommended biological catch (RBC) (**Table 1**). This catch data is sourced from the Torres Strait Fisheries Catch Disposal Record (TDB02) and covers the Traditional Inhabitant Boat (TIB) and Transferable Vessel Holder (TVH) sectors only.

**Table 1.** Landed catch (kilograms whole weight) of tropical rock lobster for the Torres Strait Tropical Rock Lobster Fishery for the period 1 December 2017 to 10 May 2018. Source: Torres Strait Fisheries Catch Disposal Record (TDB02).

| Month | TIB | TVH | Total Reported Landed Catch (kilograms whole weight) |
|---|---|---|---|
| December 2017* | 14,753.38 | 33.72 | 14,787.11 |
| January 2018* | 13050.10 | 0 | 13,050.10 |
| February 2018 | 20,936.83 | 35,206.15 | 56,142.98 |
| March 2018 | 16,952.35 | 26,726.08 | 43,678.43 |
| April 2018** | 12,229.28 | 15,934.83 | 28,164.12 |
| May 2018** | 788.21 | 12.49 | 800.70 |
| **TOTAL** | **78,710.16** | **77,913.28** | **156,623.45** |

* Carriage and use of hookah gear prohibited in the TRL Fishery from December to January each fishing season.

**There are some outstanding Catch Disposal Records (TDB02). Therefore the landed catch reported for April 2018 and May 2018 may be under-reported.

At the last TRLRAG meeting on 27-28 March 2018 (TRLRAG 22), the reported landed catch for the TRL Fishery from 1 December 2017 to 21 March 2018 was 81,688 kilograms. In early April, updated catch figures were compiled. In doing so, an additional 24 tonnes was identified from late Catch Disposal Records (TDB02) received after 21 March 2018 (total 14 tonnes) and a correction was applied to catch data that had been incorrectly reported as tailed weight not live weight (total 10 tonnes).

Since TRLRAG 22, AFMA have issued a number of catch updates for the TRL Fishery (**Table 2**).

**Table 2.** Catch updates for the Torres Strait Tropical Rock Lobster Fishery for the period 1 December 2017 to 10 May 2018.

| Format | Date | Reported Landed Catch (kilograms whole weight) |
|---|---|---|
| TRLRAG 22 | 27-28 March 2018 | 81,688 kilograms as at 21 March 2018 |
| TRLWG 7 | 28-29 March 2018 | 81,688 kilograms as at 21 March 2018 |
| Public notice | 17 April 2018 | 139,004 kilograms as at 17 April 2018 |

| | | |
|---|---|---|
| Members of TRLWG | 26 April 2018 | 139,004 kilograms as at 17 April 2018 |
| Letter to industry and public notice | 30 April 2018 | 145,860 kilograms as at 30 April 2018 |

AFMA continues to closely monitor catches and will provide further updates to industry on landed catch for the TRL Fishery as the season progresses.

# Torres Strait Rock Lobster Fishery – Summary of the Catch and Effort Data pertaining to the 2018 Fishing Season (Dec-17 to Apr-18)

*Robert Campbell, Eva Plaganyi, Roy Deng, Mark Tonks, Mick Haywood*

CSIRO Oceans and Atmosphere

May 2018

## 1. Introduction

This paper provides a summary of the catch and effort data pertaining to the Torres Strait Rock Lobster (TSRL) fishery during the initial five month period of the 2018 fishing season. (Note, a fishing season begins on 1-December in a given year and extends through to 30-November the following year). In particular the paper provides a comparison of the annual trends in catch, effort and catch-rates in the five months of December, January, February, March and April so that the relative performance of the fishery since December 2017 can be assessed.

## 2. Data

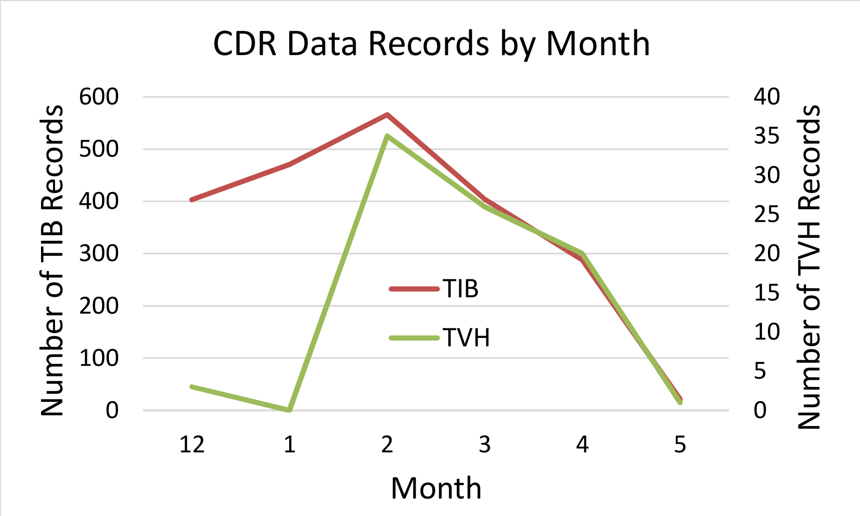
*TIB-Sector*

A new logbook, known as the Torres Strait Catch Disposal Record (TDB02), was introduced in the TSRL fishery at the start of November 2017. This logbook, which is mandatory to complete, records the catch weight of lobsters landed at the completion of all fishing trips. As well as information related to the fish receiver, the logbook also records information related to the fisher (name, boat symbol, etc), the sector of the fishery that the fisher operated (e.g. TIB or TVH) and the process state of the catch (e.g. whole, live or tailed). Additional information related to fishing effort (e.g. days fished, number of fishers) together with the area fished and methods used is currently only optional.

The TDB02 logbook replaces the Torres Strait Seafood Buyers and Processors Docket Book (TDB01) which had been used in the TIB sector to record the catch sold by fishers at the end of a fishing trip. Completion of this docket-book had only been voluntary and in several fishing seasons (2013-2016) the catch data for the TIB sector was supplemented with aggregate catch data obtained directly from several processors. The introduction of the compulsory TDB02 should rectify this past issue. Hopefully, the TDB02 logbook will also rectify previous issues which were associated with the use of the TDB01 docket-book such as the double recording of catches (see Campbell and Pease 2017). Whether or not the introduction of the compulsory TDB02 logbook will lead to an increase in the reporting levels of the TIB catch will also need to be assessed.

Data related to the TDB02 CDR logbook was obtained from AFMA on 8 May 2018 while the last batch of data related to the TDB01 docket-book was obtained from AFMA in late October 2017. For the data summaries presented in this paper for the TIB sector, all data before December 2017 is based from this latter data while all data since December 2017 is taken from the TDB02 CDR logbook. The TDB01 docket-book data is likely to be incomplete to some extent for the last few months up until November 2017, and while the degree of completeness of the TDB02 data since December 2017 remains uncertain it is likely to be reasonably

Figure 1. Number of data records per month for each sector of the TSRL fishery present in the TDB02 CDR data sent by AFMA on 8-May-18. Note, the month of each record is based on the trip-end date. The date of the last trip recorded for the TIB and TVH sectors is 7-May-18 and 5-May-18 respectively.




complete through to February-March 2018 (c.f. Figure 1). A more detailed summary of the TIB data for the period up to October 2017 is provided in Campbell et al (2017a).

*TVH-Sector*

Together with the catch landed by the TIB-sector of the TSRL fishery, the new Torres Strait Catch Disposal Record (TDB02), introduced in the TSRL fishery at the start of November 2017, also records the catch landed by the TVH-sector. However, unlike for the TIB-sector, catch and effort data related to the TVH sector also continues to be recorded in the Torres Strait Tropical Rock Lobster Fishery Daily Fishing Log (TRL04).

Data related to both the TDB02 and TRL04 logbooks was obtained from AFMA on 8 May 2018. For the data summaries presented in this paper for the TVH sector all data is based on information recorded in the TRL04 logbook. As with the TSDB01 logbook the TRL04 logbook data is also likely to be incomplete to some extent up until November 2017, while the degree of completeness of the TRL04 data (as with the TDB02 logbook) since December 2017 remains uncertain, though hopefully it is reasonably complete through to February-March 2018 (c.f. Figure 1). A more detailed summary of the TVH data for the period up to October 2017 is provided in Campbell et al (2017b).

## 3. Catch by Season

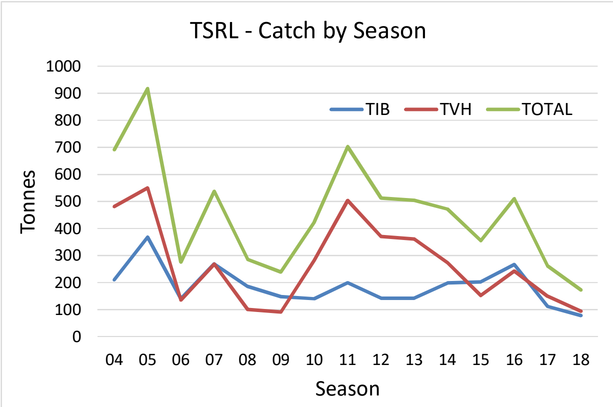
A comparison of the estimated total catch by sector for the seasons 2004 to 2017 is shown in Figure 2. The catch for the initial five months of the 2018 season is also shown, though as explained in the previous section this is an under-estimate as the data for these months is still incomplete. As the TVH catch is recorded in both the TRL04 logbook and the TDB02 logbook, two estimates for the 2018 season are provided. While the difference noted in this catch estimate is no doubt due to differences in the delays taken for AFMA to receive and process records pertained to these two logbooks any differences between these two logbooks should be checked at the end of the season when both logbooks are considered complete.

Figure 2. Time-series of total catch by fishing season (December-November) and sector since 2004. TIB data is based on TDB01 docket-book and TDB02 CDR data, while TVH data is based on TRL04 logbook data. Data for 2018 only covers the period December-April and is also not complete for this period.

.

| SEASON | TIB | TVH | TOTAL |
|---|---|---|---|
| 04 | 210.4 | 481.1 | 691.5 |
| 05 | 367.6 | 549.9 | 917.6 |
| 06 | 140.5 | 135.5 | 275.9 |
| 07 | 268.7 | 268.6 | 537.3 |
| 08 | 185.7 | 100.4 | 286.1 |
| 09 | 147.8 | 91.1 | 238.9 |
| 10 | 140.0 | 282.6 | 422.7 |
| 11 | 199.1 | 503.5 | 702.6 |
| 12 | 142.4 | 370.5 | 512.9 |
| 13 | 142.5 | 361.7 | 504.2 |
| 14 | 198.8 | 273.2 | 472.0 |
| 15 | 202.6 | 152.7 | 355.3 |
| 16 | 267.1 | 243.0 | 510.1 |
| 17 | 111.5 | 149.7 | 261.2 |
| 18 | 78.8 | 94.0 | 172.7 |

NB. TVH (2018) =77.9 based on CDR




The reported catch by month for each sector of the TSRL for the 2004-2018 fishing seasons is shown in Table 1. The catch by month for the TVH sector is based on information reported in the TRLO04 logbook, while the catches for the TIB sector are based on information reported in the TBD01 docket-book and TDB02 CDR. Furthermore, for the TIB sector the catch by month for the 2013-2016 fishing seasons is an estimate as the catch month is not known for a substantive portion *P* of the total catch in these seasons (*P*=39%, 34%, 33%, 55% respectively). These relate to the aggregate catches reported by several processors on a seasonal basis to account for missing docket-book records. For these seasons the catch within each month was estimated by raising the known catch in each month by the factor *R= 1/(1-P*). This assumes that the distribution of the catches by month in the aggregate catch data is the same as the distribution within the docket-book recorded catches.

Based on the catch-by-month estimates provided in Table 1, the time-series of catch by month for the four months January-to- April is shown in Figure 3 for each sector of the TSRL over the seasons 2004-2018.

Table 1. Catch by month for (a) the TIB sector, (b) the TVH sector and (c) the total TSRL fishery for the 2004-2018 fishing seasons. Note, the catch by month for the TVH is based on information reported in the TRLO04 logbook, while the catches for the TIB sector are based on information reported in the TBD01 docket-book and TDB02 CDR. Furthermore, for the TIB sector the catch by month for the 2013-2016 fishing seasons is an estimate as the catch month is not known for a substantive portion *P* of the total catch in these seasons (*P*=39%, 34%, 33%, 55% respectively). For these seasons the catch within each month was estimated by raising the known catch in each month by the factor *R= 1/(1-P*).

(a) TIB

| SEASON | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 0.00 | 15.54 | 24.31 | 35.57 | 17.74 | 30.36 | 28.52 | 26.45 | 18.98 | 12.87 | 0.02 | 0.03 | 210.383 |
| 2005 | 21.65 | 15.10 | 50.63 | 58.22 | 47.58 | 56.76 | 43.06 | 34.47 | 23.68 | 16.09 | 0.31 | 0.07 | 367.615 |
| 2006 | 12.51 | 9.45 | 24.02 | 26.81 | 19.09 | 18.38 | 9.81 | 9.91 | 7.67 | 2.75 | 0.00 | 0.05 | 140.451 |
| 2007 | 19.00 | 24.94 | 24.72 | 62.04 | 29.19 | 33.76 | 29.03 | 23.19 | 13.91 | 8.92 | 0.00 | 0.00 | 268.689 |
| 2008 | 10.43 | 13.46 | 31.24 | 36.13 | 24.11 | 16.71 | 14.80 | 23.52 | 9.28 | 5.97 | 0.02 | 0.00 | 185.665 |
| 2009 | 9.72 | 13.27 | 20.55 | 23.10 | 23.73 | 15.65 | 13.24 | 15.39 | 7.81 | 4.82 | 0.53 | 0.00 | 147.814 |
| 2010 | 5.76 | 6.20 | 21.26 | 15.83 | 14.99 | 12.18 | 16.35 | 19.07 | 17.00 | 9.78 | 1.61 | 0.00 | 140.039 |
| 2011 | 6.93 | 18.22 | 30.14 | 49.77 | 20.40 | 23.99 | 18.69 | 18.86 | 8.86 | 3.22 | 0.00 | 0.00 | 199.061 |
| 2012 | 9.04 | 13.40 | 19.03 | 24.72 | 19.61 | 9.69 | 22.87 | 11.19 | 10.84 | 2.00 | 0.00 | 0.00 | 142.379 |
| 2013 | 5.04 | 1.39 | 16.19 | 13.63 | 21.10 | 18.90 | 16.58 | 18.95 | 14.65 | 16.09 | 0.00 | 0.00 | 142.522 |
| 2014 | 10.06 | 13.53 | 18.64 | 39.48 | 28.79 | 25.82 | 17.15 | 17.70 | 17.64 | 9.78 | 0.19 | 0.00 | 198.776 |
| 2015 | 20.12 | 9.31 | 31.19 | 21.25 | 26.92 | 16.87 | 44.78 | 12.94 | 11.59 | 7.36 | 0.28 | 0.00 | 202.606 |
| 2016 | 13.78 | 15.53 | 52.58 | 36.23 | 23.07 | 34.03 | 33.53 | 24.91 | 22.33 | 10.77 | 0.22 | 0.17 | 267.136 |
| 2017 | 5.15 | 8.29 | 23.34 | 15.83 | 11.70 | 14.96 | 7.48 | 9.73 | 10.80 | 4.08 | 0.16 | 0.00 | 111.504 |
| 2018 | 14.77 | 13.06 | 20.95 | 16.96 | 12.23 | 0.79 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 78.762 |

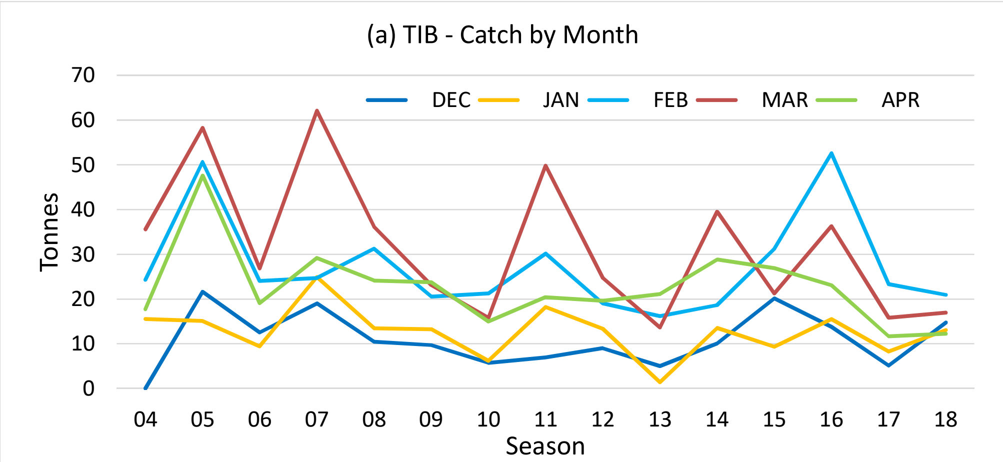
(b) TVH

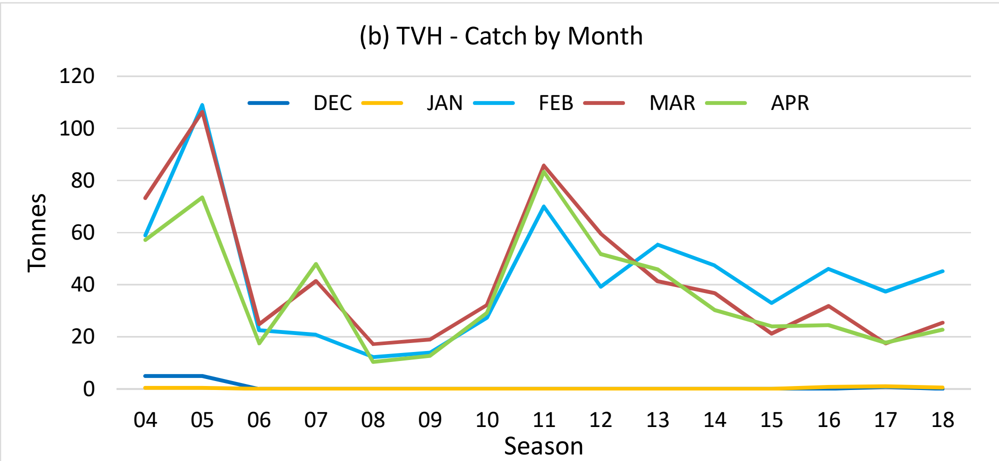
| SEASON | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 4.95 | 0.45 | 58.97 | 73.18 | 57.14 | 70.55 | 79.44 | 65.77 | 48.01 | 22.63 | 0.00 | 0.00 | 481.082 |
| 2005 | 4.98 | 0.40 | 108.96 | 106.28 | 73.51 | 59.48 | 53.62 | 60.10 | 51.80 | 30.81 | 0.00 | 0.00 | 549.935 |
| 2006 | 0.03 | 0.00 | 22.51 | 24.86 | 17.49 | 14.80 | 11.49 | 21.95 | 16.76 | 5.59 | 0.00 | 0.00 | 135.473 |
| 2007 | 0.00 | 0.00 | 20.77 | 41.39 | 47.98 | 62.93 | 48.84 | 26.69 | 13.63 | 6.37 | 0.00 | 0.00 | 268.596 |
| 2008 | 0.00 | 0.00 | 12.29 | 17.17 | 10.33 | 10.81 | 8.00 | 15.48 | 16.82 | 9.55 | 0.00 | 0.00 | 100.437 |
| 2009 | 0.00 | 0.00 | 13.91 | 18.88 | 12.75 | 10.48 | 13.41 | 7.82 | 10.35 | 3.47 | 0.00 | 0.00 | 91.060 |
| 2010 | 0.00 | 0.00 | 27.31 | 32.16 | 29.20 | 29.19 | 30.32 | 44.73 | 52.03 | 37.67 | 0.00 | 0.00 | 282.614 |
| 2011 | 0.00 | 0.00 | 69.99 | 85.73 | 83.33 | 65.52 | 62.08 | 61.87 | 45.10 | 29.91 | 0.00 | 0.00 | 503.534 |
| 2012 | 0.00 | 0.00 | 39.23 | 59.64 | 51.70 | 35.16 | 39.81 | 69.72 | 48.96 | 26.28 | 0.00 | 0.00 | 370.483 |
| 2013 | 0.00 | 0.00 | 55.43 | 41.28 | 45.93 | 45.03 | 41.50 | 56.82 | 47.62 | 28.06 | 0.00 | 0.00 | 361.661 |
| 2014 | 0.00 | 0.00 | 47.34 | 36.71 | 30.23 | 42.09 | 38.16 | 39.06 | 23.42 | 16.21 | 0.00 | 0.00 | 273.214 |
| 2015 | 0.00 | 0.00 | 32.99 | 21.17 | 24.05 | 17.62 | 16.75 | 14.46 | 19.78 | 5.89 | 0.00 | 0.00 | 152.710 |
| 2016 | 0.00 | 0.75 | 46.10 | 31.83 | 24.47 | 40.20 | 42.87 | 28.85 | 18.85 | 9.08 | 0.00 | 0.00 | 243.010 |
| 2017 | 0.69 | 1.05 | 37.43 | 17.48 | 17.70 | 23.98 | 19.56 | 16.11 | 12.94 | 2.80 | 0.00 | 0.00 | 149.738 |
| 2018 | 0.00 | 0.57 | 45.19 | 25.44 | 22.79 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 93.983 |

(c) TOTAL

| YEAR | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 4.95 | 15.99 | 83.27 | 108.75 | 74.88 | 100.91 | 107.95 | 92.22 | 66.99 | 35.50 | 0.02 | 0.03 | 691.465 |
| 2005 | 26.63 | 15.50 | 159.59 | 164.50 | 121.09 | 116.23 | 96.68 | 94.58 | 75.48 | 46.90 | 0.31 | 0.07 | 917.550 |
| 2006 | 12.53 | 9.45 | 46.53 | 51.67 | 36.58 | 33.18 | 21.30 | 31.86 | 24.43 | 8.34 | 0.00 | 0.05 | 275.924 |
| 2007 | 19.00 | 24.94 | 45.48 | 103.43 | 77.17 | 96.69 | 77.86 | 49.88 | 27.54 | 15.29 | 0.00 | 0.00 | 537.285 |
| 2008 | 10.43 | 13.46 | 43.52 | 53.29 | 34.44 | 27.52 | 22.80 | 39.00 | 26.10 | 15.51 | 0.02 | 0.00 | 286.102 |
| 2009 | 9.72 | 13.27 | 34.45 | 41.98 | 36.48 | 26.13 | 26.65 | 23.22 | 18.16 | 8.29 | 0.53 | 0.00 | 238.874 |
| 2010 | 5.76 | 6.20 | 48.57 | 47.99 | 44.20 | 41.37 | 46.66 | 63.81 | 69.03 | 47.45 | 1.61 | 0.00 | 422.653 |
| 2011 | 6.93 | 18.22 | 100.14 | 135.50 | 103.73 | 89.51 | 80.77 | 80.72 | 53.96 | 33.13 | 0.00 | 0.00 | 702.595 |
| 2012 | 9.04 | 13.40 | 58.26 | 84.35 | 71.30 | 44.85 | 62.68 | 80.91 | 59.79 | 28.28 | 0.00 | 0.00 | 512.862 |
| 2013 | 5.04 | 1.39 | 71.62 | 54.91 | 67.03 | 63.93 | 58.08 | 75.77 | 62.27 | 44.14 | 0.00 | 0.00 | 504.183 |
| 2014 | 10.06 | 13.53 | 65.98 | 76.18 | 59.02 | 67.91 | 55.31 | 56.77 | 41.05 | 25.99 | 0.19 | 0.00 | 471.990 |
| 2015 | 20.12 | 9.31 | 64.18 | 42.41 | 50.97 | 34.50 | 61.53 | 27.40 | 31.37 | 13.26 | 0.28 | 0.00 | 355.316 |
| 2016 | 13.78 | 16.28 | 98.68 | 68.06 | 47.54 | 74.23 | 76.40 | 53.76 | 41.18 | 19.85 | 0.22 | 0.17 | 510.146 |
| 2017 | 5.84 | 9.34 | 60.77 | 33.31 | 29.40 | 38.94 | 27.04 | 25.84 | 23.74 | 6.88 | 0.16 | 0.00 | 261.242 |
| 2018 | 14.77 | 13.62 | 66.14 | 42.40 | 35.03 | 0.79 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 172.745 |

Figure 3. Time-series of catch by month for the four months January-to- April for (a) the TIB sector, (b) the TVH sector and (c) the total TSRL fishery. Note, the catch by month for the TVH is based on information reported in the TRLO04 logbook, while the catches for the TIB sector are based on information reported in the TBD01 docket-book and TDB02 CDR. Furthermore, the TIB sector the catch by month for the 2013-2016 fishing seasons is an estimate as the catch month is not known for a substantive portion *P* of the total catch in these seasons (*P*=39%, 34%, 33%, 55% respectively). For these seasons the catch within each month was estimated by raising the known catch in each month by the factor *R= 1/(1-P*).



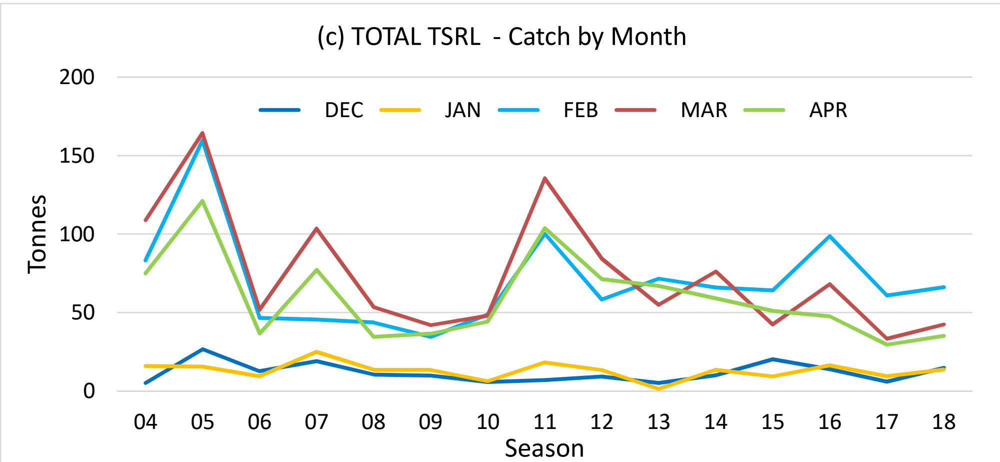



Figure 4. Map of the TIB fishing areas described in the analysis.

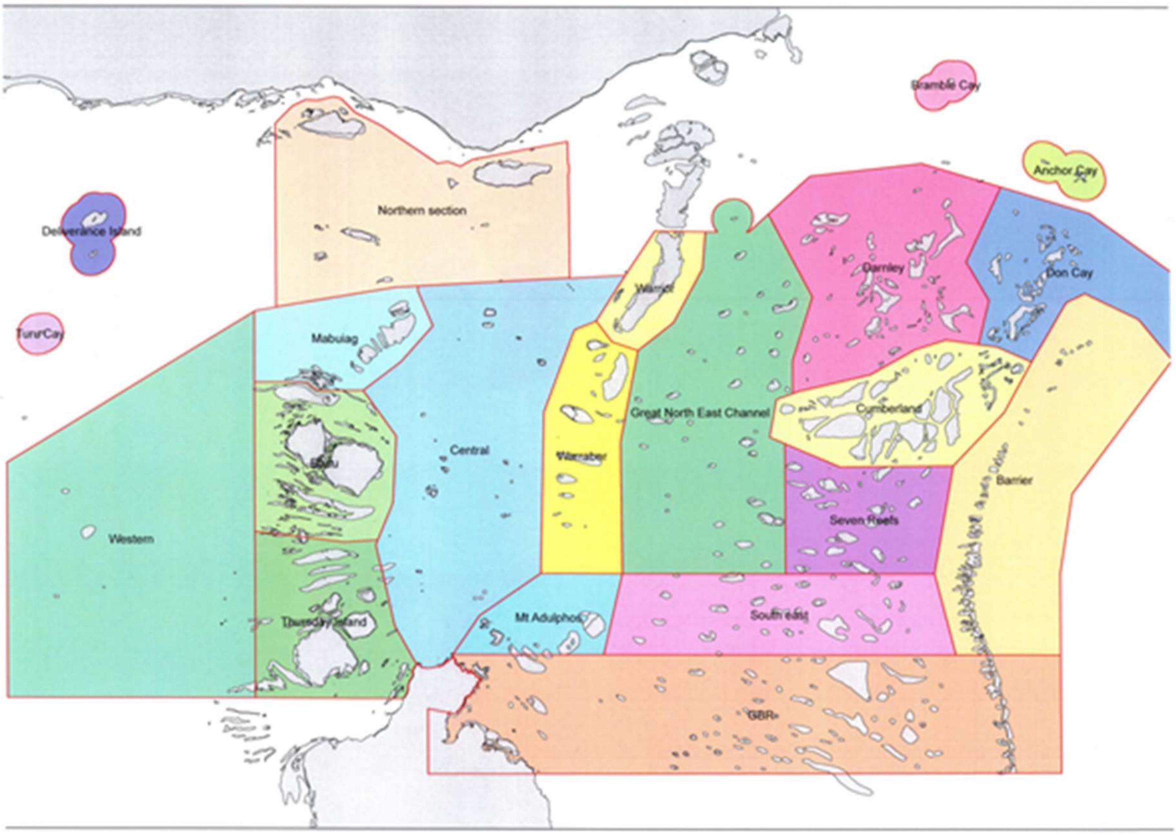



Table 2. (a) List of the area codes and names used in the TIB fishery together with the total number of data records associated with each area. A revised listing of area codes and names based on aggregating areas with few data records is shown in (b).

(a) List of TIB Areas and number of GLM-Data records

| TIB Area Name | Area | Area-Rev | N-Records |
|---|---|---|---|
| Turu Cay | 1 | 6 | 47 |
| Deliverance Island | 2 | 6 | 15 |
| Northern Section | 3 | 6 | 142 |
| Bramble Cay | 4 | 16 | 10 |
| Anchor Cay | 5 | 16 | 8 |
| Western | 6 | 6 | 6 |
| Mabuiag | 7 | 7 | 2920 |
| Badu | 8 | 8 | 3118 |
| Thursday Island | 9 | 9 | 10652 |
| Central | 10 | 10 | 451 |
| Warrior | 11 | 11 | 1575 |
| Warraber | 12 | 12 | 1796 |
| Mt Adolphus | 13 | 13 | 295 |
| Great NE Channel | 14 | 14 | 740 |
| South East | 15 | 15 | 39 |
| Darnley | 16 | 16 | 555 |
| Cumberland | 17 | 17 | 355 |
| Seven Reefs | 18 | 15 | 6 |
| Don Cay | 19 | 16 | 4 |
| GBR | 21 | 15 | 90 |
| | | | 22824 |

(b) Revised list of TIB Areas

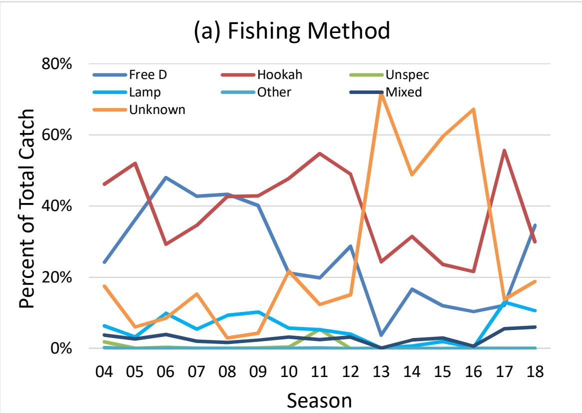
| TIB Area Name | Area-Rev | N-Records |
|---|---|---|
| Northern Section | 6 | 210 |
| Mabuiag | 7 | 2920 |
| Badu | 8 | 3118 |
| Thursday Island | 9 | 10652 |
| Central | 10 | 451 |
| Warrior | 11 | 1575 |
| Warraber | 12 | 1796 |
| Mt Adolphus | 13 | 295 |
| Great NE Channel | 14 | 740 |
| GBR | 15 | 135 |
| Darnley | 16 | 577 |
| Cumberland | 17 | 355 |
| | | 22824 |

## 4. TIB Sector Summary

The 21 areas used to record the spatial location of catch taken in the TIB sector are shown in Figure 4 and listed in Table 2(a). The total number of data records associated with each area is also shown. For the purpose of the following analyses, several areas where the data coverage was low were combined. A revised listing of area codes and names based on aggregating some areas is shown in Table 2(b). These are the areas and names referred to in the following Figures.

A comparison of the percent of the total TIB catch within each fishing season by (a) fishing method and (b) processed form is shown in Figure 5 while a comparison by area fished is shown in Figure 6. Note these results are based on all data available for each season, i.e. they are not limited to the temporal period (December-April) covered by the data for the 2018 season.

Figure 5. Time-series of percent of the total TIB catch within each fishing season by (a) fishing method and (b) processed form.



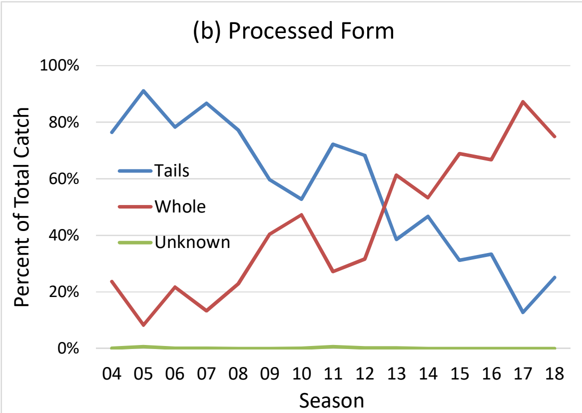




Figure 6. Time-series of percent of the total TIB catch within each fishing season taken in each area fished.

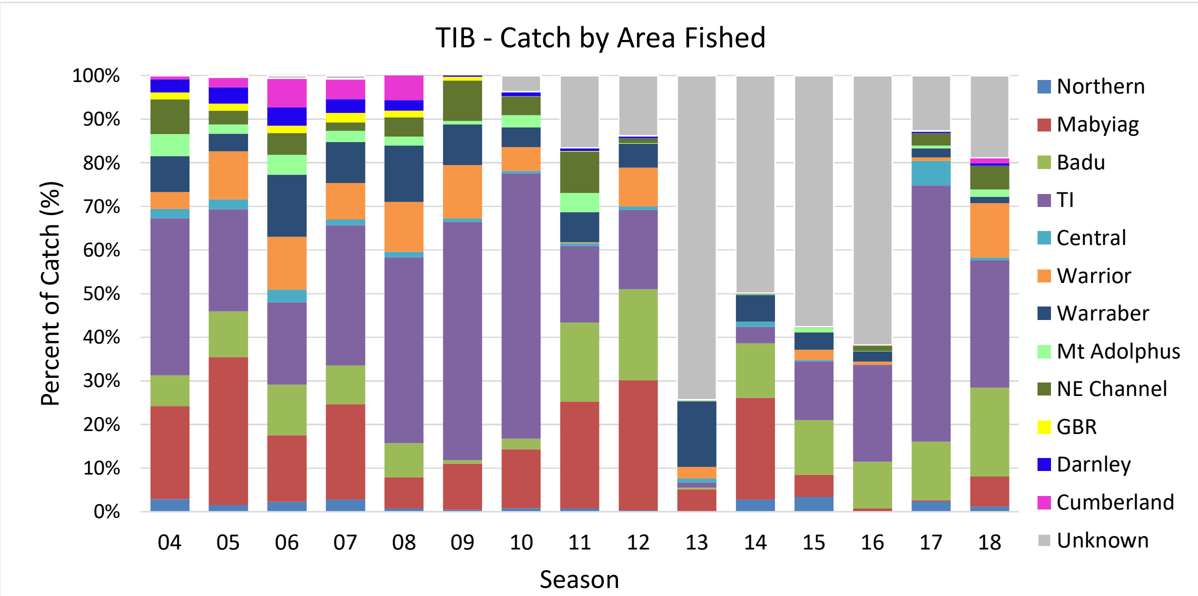


Figure 7. Comparison of percent of the TIB total annual catch stratified by the number of days fished per trip based on (a) all records including those where the days fished is unknown, and (b) those records where the unknown days fished are excluded.

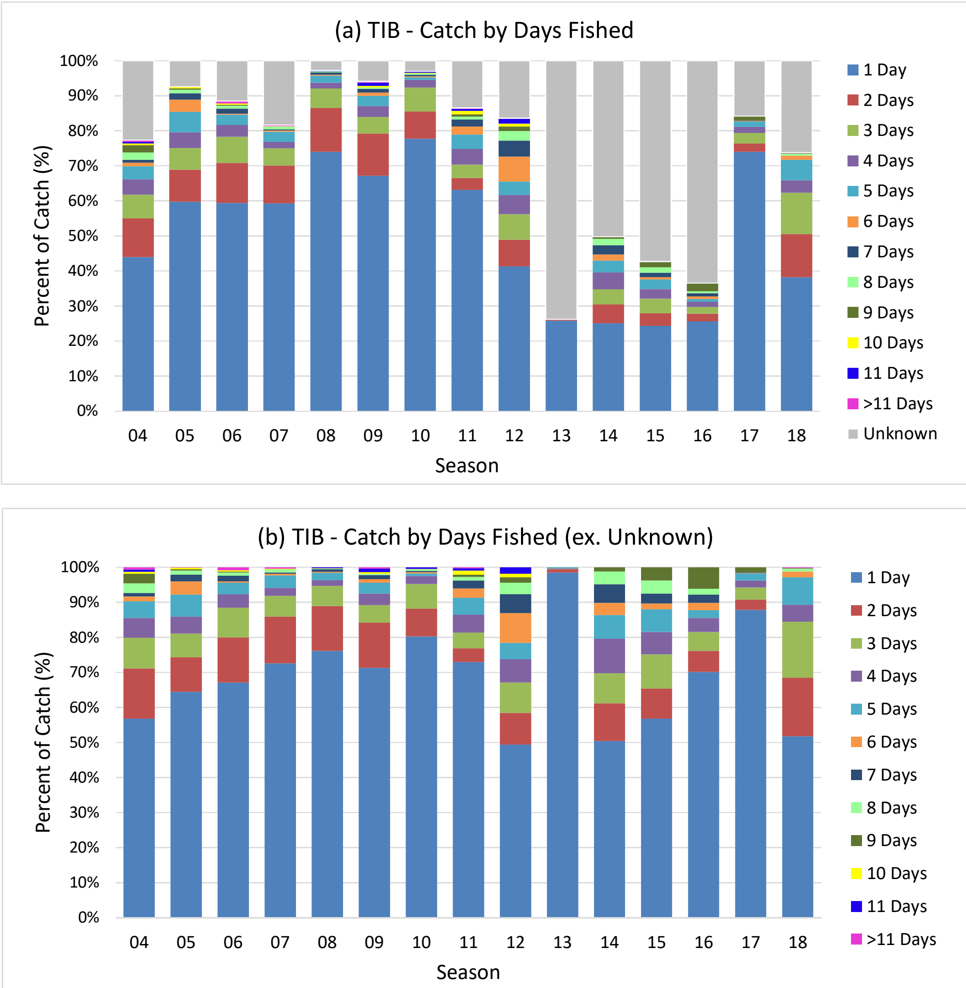
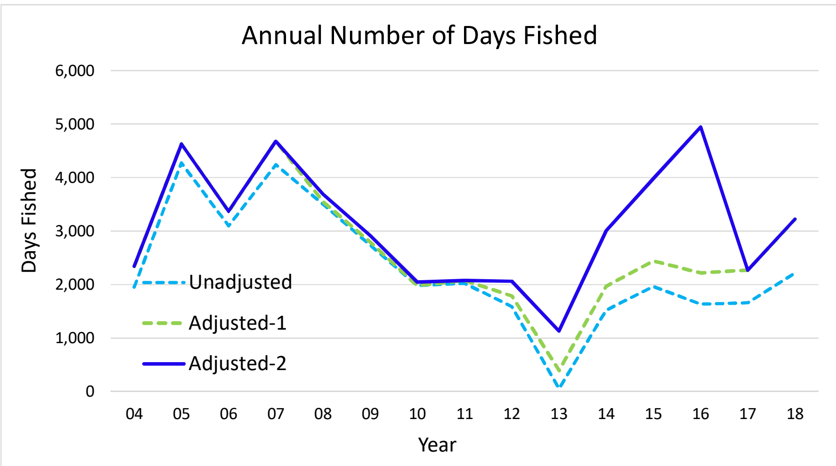



Figure 8. Seasonal comparison of estimated effort in the TIB fishery during the five month period December-April. Analysis based on the method outlined in Campbell (2017).



A comparison of percent of the TIB total annual catch stratified by the number of days fished per trip is shown in Figure 7. As the number of days fished was not recorded for all docket-book records, and was also not available for the TIB catch provided in aggregate form by several processes, the proportion of the catch where the days fished is unknown is included in the result shown in Figure 7a. If one assumes that the distribution of days fished associated with the catch for which the effort information remains unknown is the same as that associated with the catch for which the effort information is known, then one can ascertain an estimate of the effort distribution across the entire catch by just excluding that portion of the catch where the effort information remain unknown. This result is shown in Figure 7b and indicates an increase in the proportion of the catch associated with trips of length greater than 1 day during the 2018 season. Finally, a seasonal comparison of estimated effort in the TIB fishery during the five month period December-April is shown in Figure 8 This estimate is based on the method outlined in Campbell (2017) and uses as the total catch during these five months those estimates shown in Table 1.

As noted above, not all the data fields on either the TBD01 docket-book or TDB02 logbook are complete due to the voluntary nature of the provision of this information on both books. The incompleteness of these data fields creates problems in providing a complete analysis of the information for the TIB sector (i.e. as noted above). An indication of availability of information is shown in Figure 9, which provides the annual percentage of the total TIB catch associated with records where various data fields are non-null. The data fields are, (i) Trip operation-date, (ii) Number of days fished, (iii) Area fished, (iv) Vessel-symbol and (v) Seller-name.

Another issue noted in previous analyses of the data for the TIB-sector is the observation that while the structure of the Docket-Book would seem to indicate that there should be a unique Record- Number associated with each vessel, date and seller-name, investigation of the data indicates that there are often multiple Record-Nos associated for a given vessel, date and seller-name. While the reason for these multiple records remains uncertain (they could be recording errors), in order to identity an appropriate data structure for analysis the following procedure has been adopted to filter the data:

1. The TIB data was aggregated over vessel-symbol, date and seller-name. Where the vessel-symbol or seller-name was null these fields were set to 'Unknown'. These data are henceforth known as GLM records;
2. Only those records where the first fishing method was either 'Hookah diving' or 'Free diving' or 'Lamp fishing' were selected;
3. Only those GLM records having a unique Record-No were selected for analysis. It was assumed that where the vessel or seller were unknown, that selection of only those GLM records having a unique Record-No limited the GLM records chosen to those associated with a single vessel and a single seller;
4. An additional check was made to ensure that the number of days fished, the number of crew on the boat, the fishing method and the area fished was unique for each Record-No. This was done to help eliminate data errors;
5. GLM records were also deleted where either the number of days fished was not recorded, the area fished was not recorded, the record pertained to the TVH logbook data as the structure of the data for these records was different, or the weight of the catch was zero or greater than 1000 kg.

Figure 9. Time-series of the percent of the total seasonal TIB catch associated with data records where various data fields are non-null. (a) Trip operation-date, number of days fished, area fished and all thee together, and (b) vessel-symbol and seller-name.

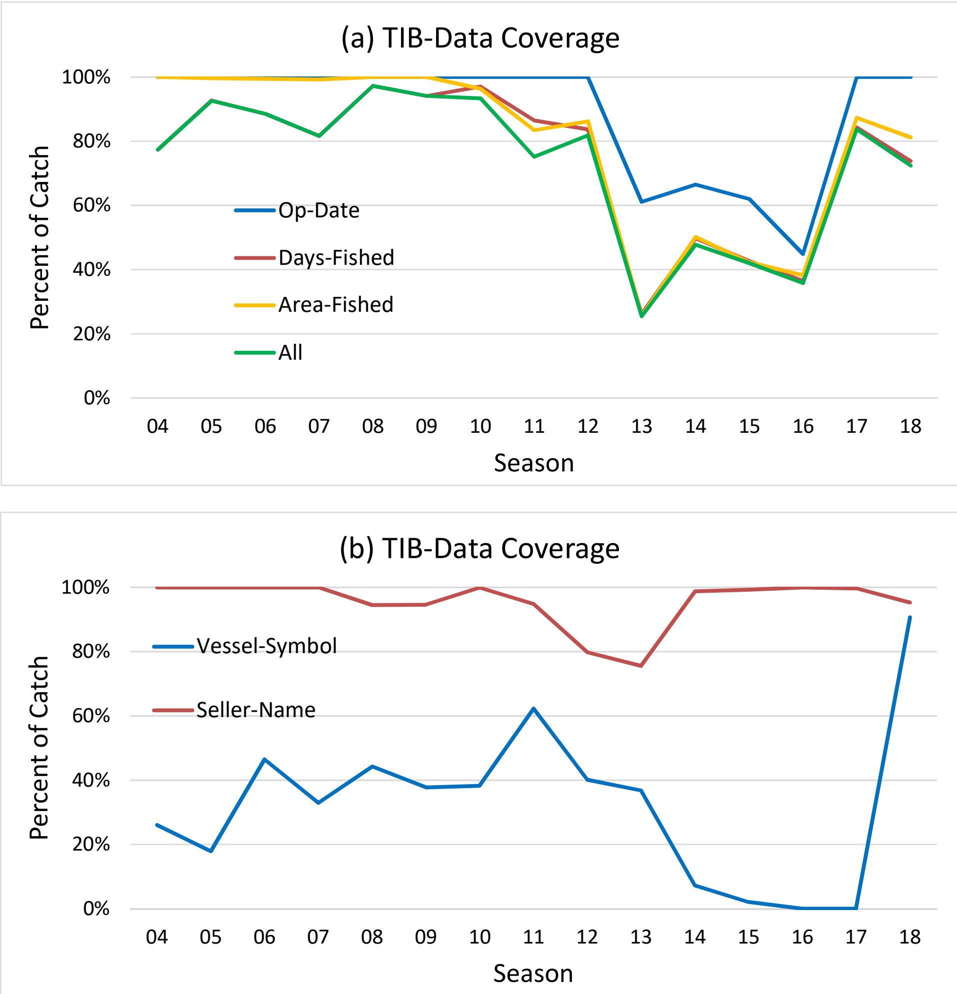
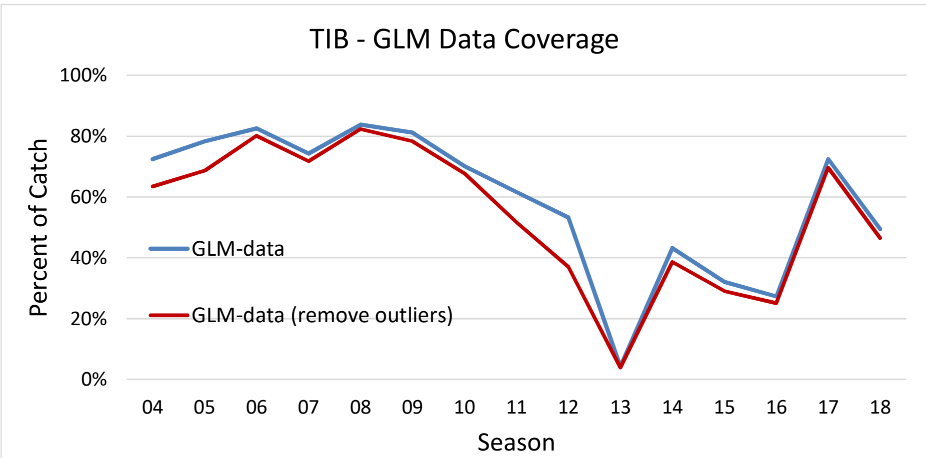


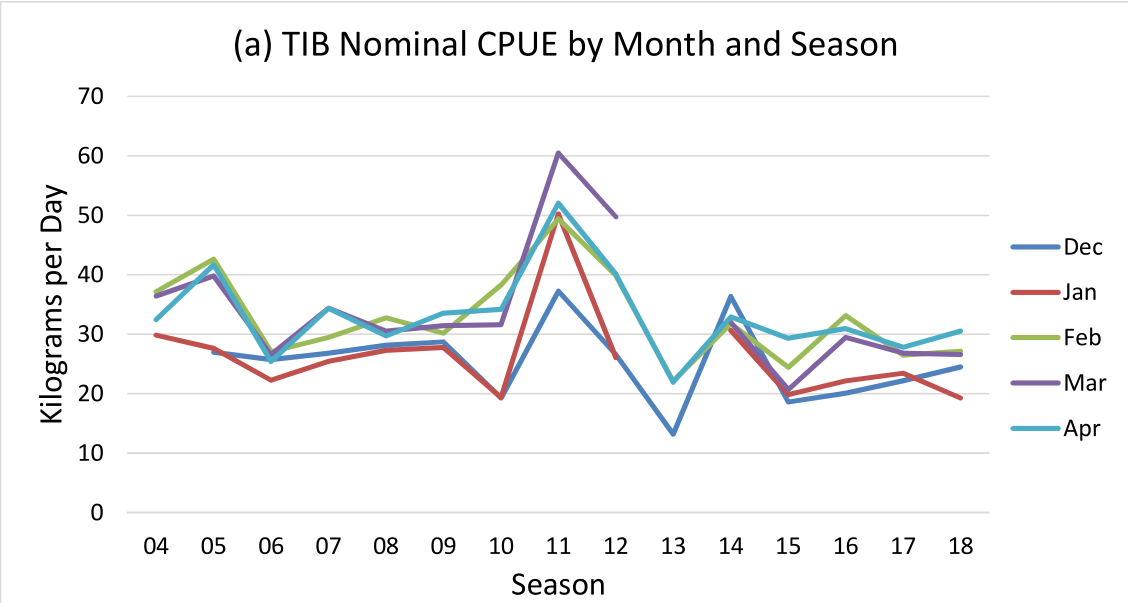

Figure 10. Time-series of the percent of the total seasonal TIB catch associated with data records included in (a) the GLM data set and (b) the GLM data set with selected data outliers removed.



The number of records remaining for analysis after these five steps was 38,639. Henceforth these are known as the GLM-data records. Finally, a number or additional records were eliminated from the GLM-data to remove possible outliers associated with (i) days-fished>9 (71), (ii) weight<1kg (11), and (iii) weight>300kg (323). This left 38,254 records. The coverage of the total catch by each data set is shown in Figure 10.

Using these two data sets, a series of analyses were undertaken to compare the nominal catch-rates (CPUE) according to various data stratifications. These results are shown on Figures 11 and 12. A comparison of the nominal CPUE within each area fished based on both data sets is shown in Figure 13.

Figure 11. Annual time-series of nominal CPUE for the TIB fleet within (a) month and (b) by fishing method during the five month period December-April. Based on the GLM-data set with selected outliers removed.



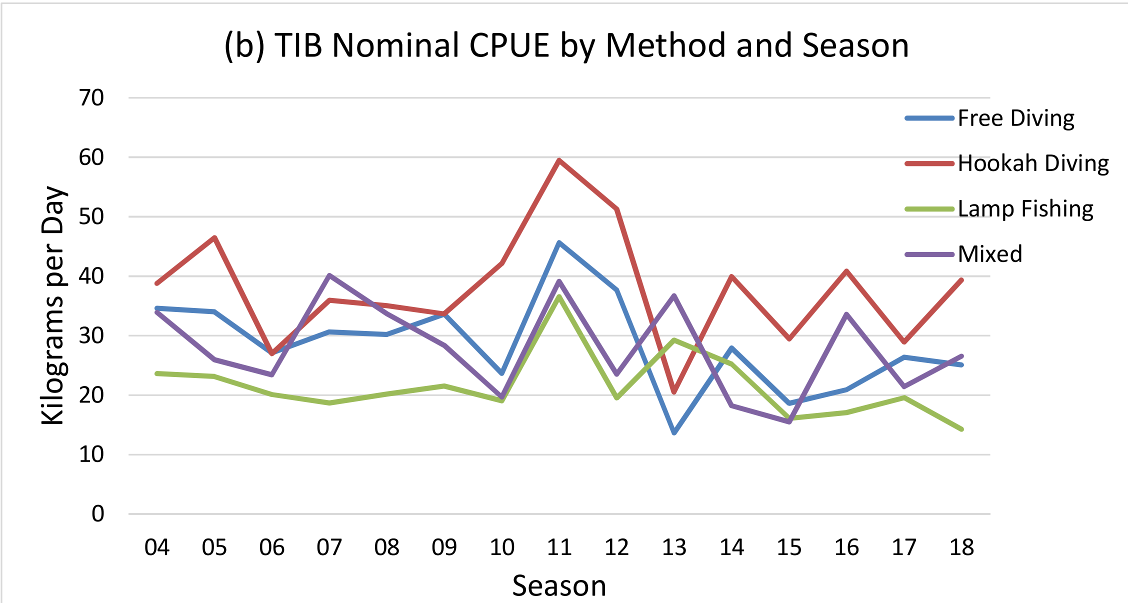
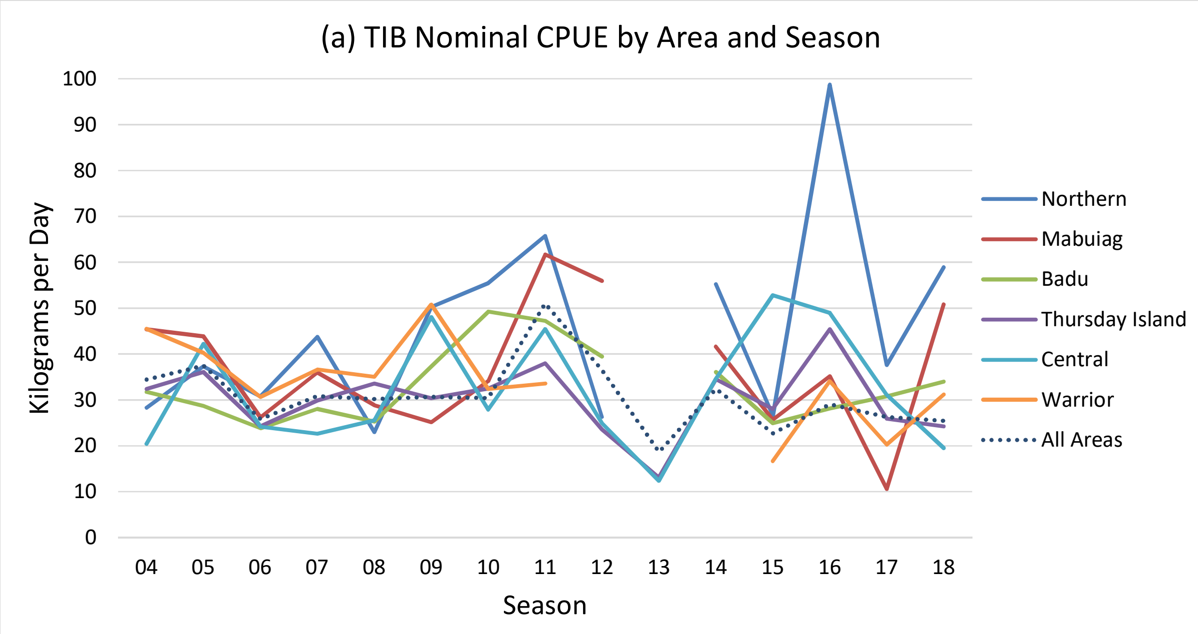



Figure 12. Annual time-series of nominal CPUE for the TIB fleet within each area fished during the five month period December-April. For comparison, the mean nominal CPUE across all areas is also shown. Based on the GLM-data set with selected outliers removed.



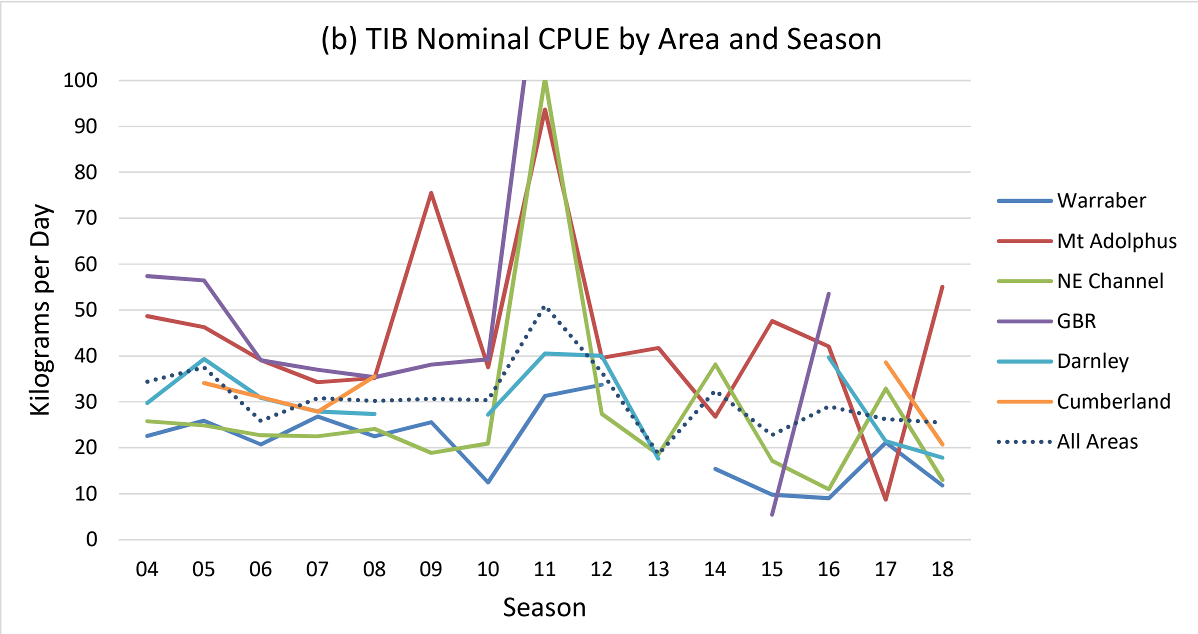
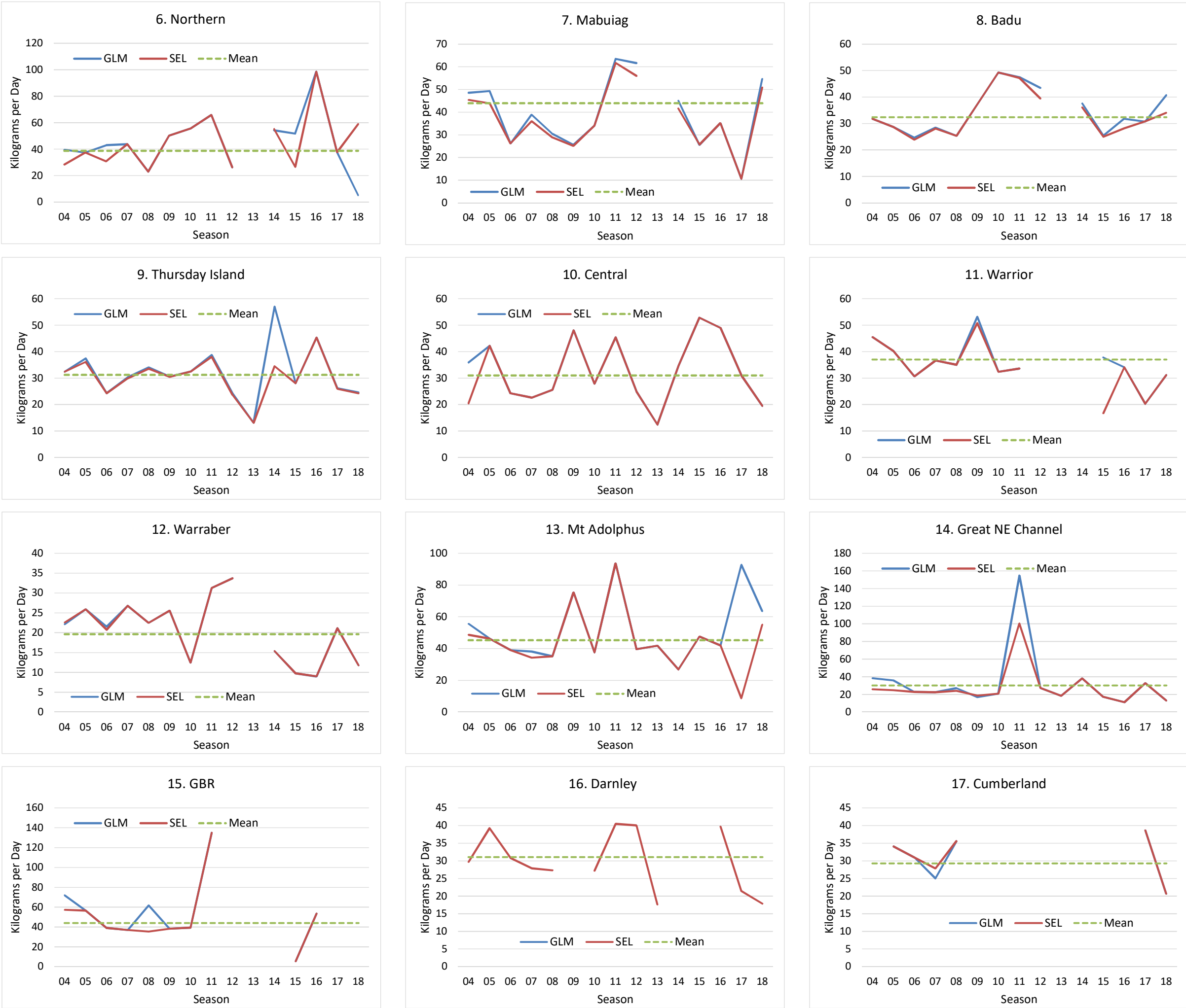



Figure 13. Comparison of the nominal TIB CPUE within each area fished (shown in Figure 12) based on the GLM-data set and the GLM-data with selected outliers removed (SEL). For each area the mean CPUE across all seasons is also shown.




## 5. TVH Sector Summary

As for the TIB-sector, a series of analyses were undertaken of the catch and effort data for the TVH-sector to provide a comparison of fishery indicators for the 2018 season and previous seasons. As the TVH data is not plagued by the same level of non-reporting of information associated with many of the data fields note in the TIB-data (e.g. the fishing date is known in the TVH data for all catches) the analyses were able to be more focused on the three-month period between February and April each year. The results of these analyses are shown in Figures 14-22. The captions above each Figure should hopefully provide sufficient information to help the reader adequately interpret each result.

Figure 14. Annual time-series of the percent of the total TVH catch during the three month period February-April stratified by (a) fishing method and (b) process form.

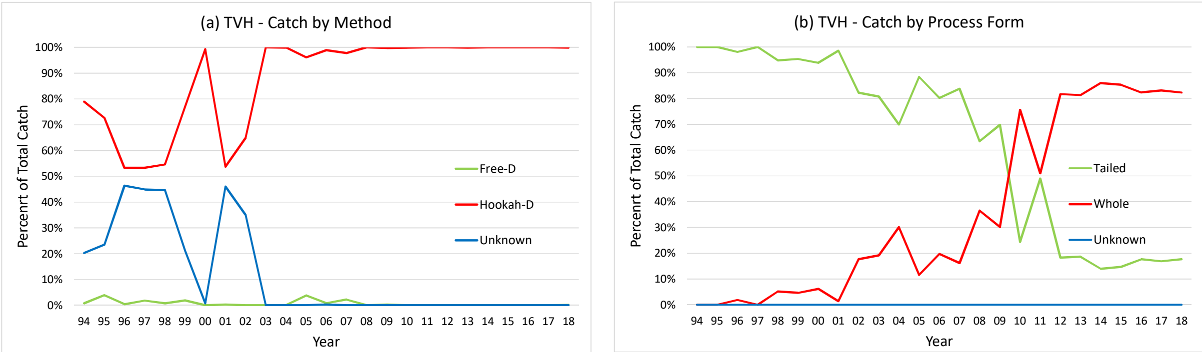



Figure 15. Annual time-series of percent of the total TVH effort (total hours fished by tenders) during the three month period February-April within each area fished. Note, this result is based only on those logbook data where effort has been recorded. The percent of the total TVH catch each year for which effort is not recorded is shown in the bottom figure.

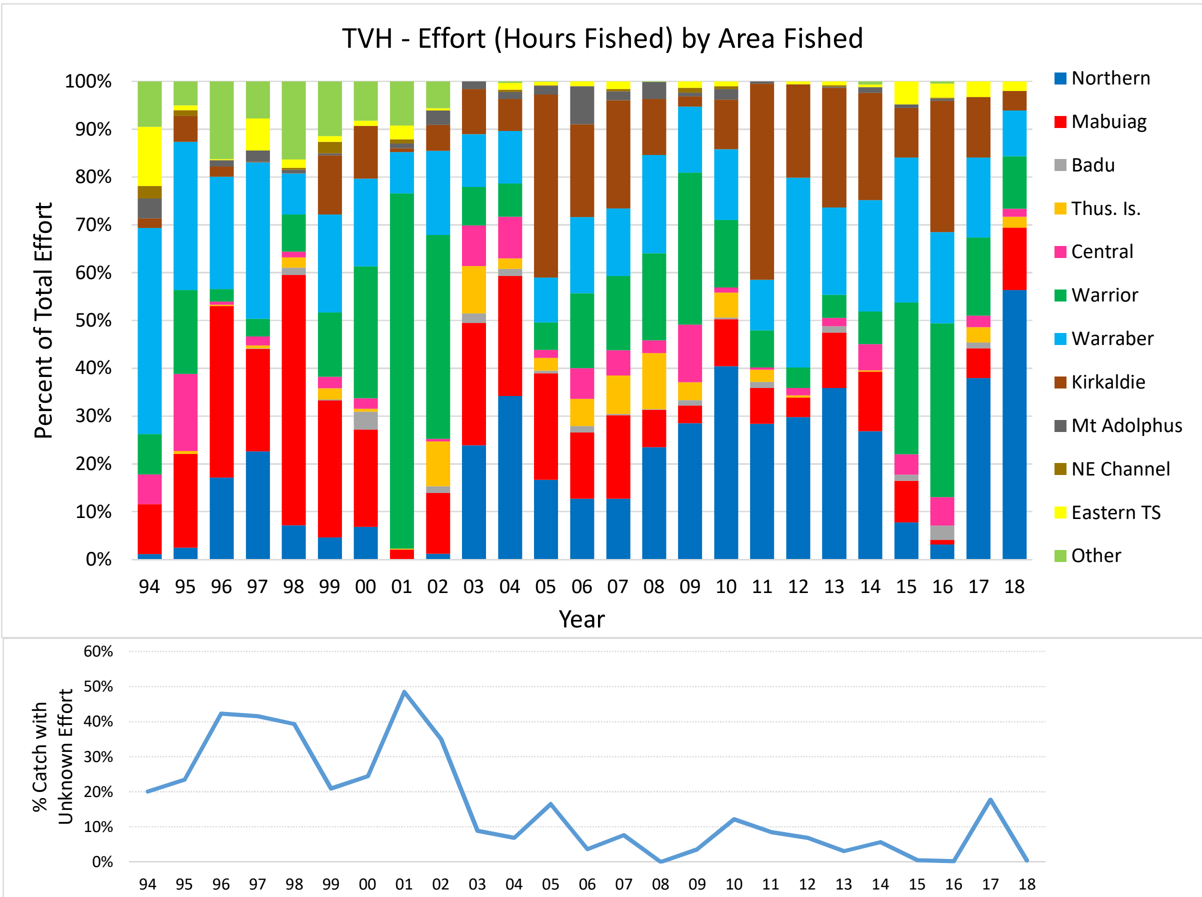


Figure 16. Map of the TVH fishing areas described in the analysis.

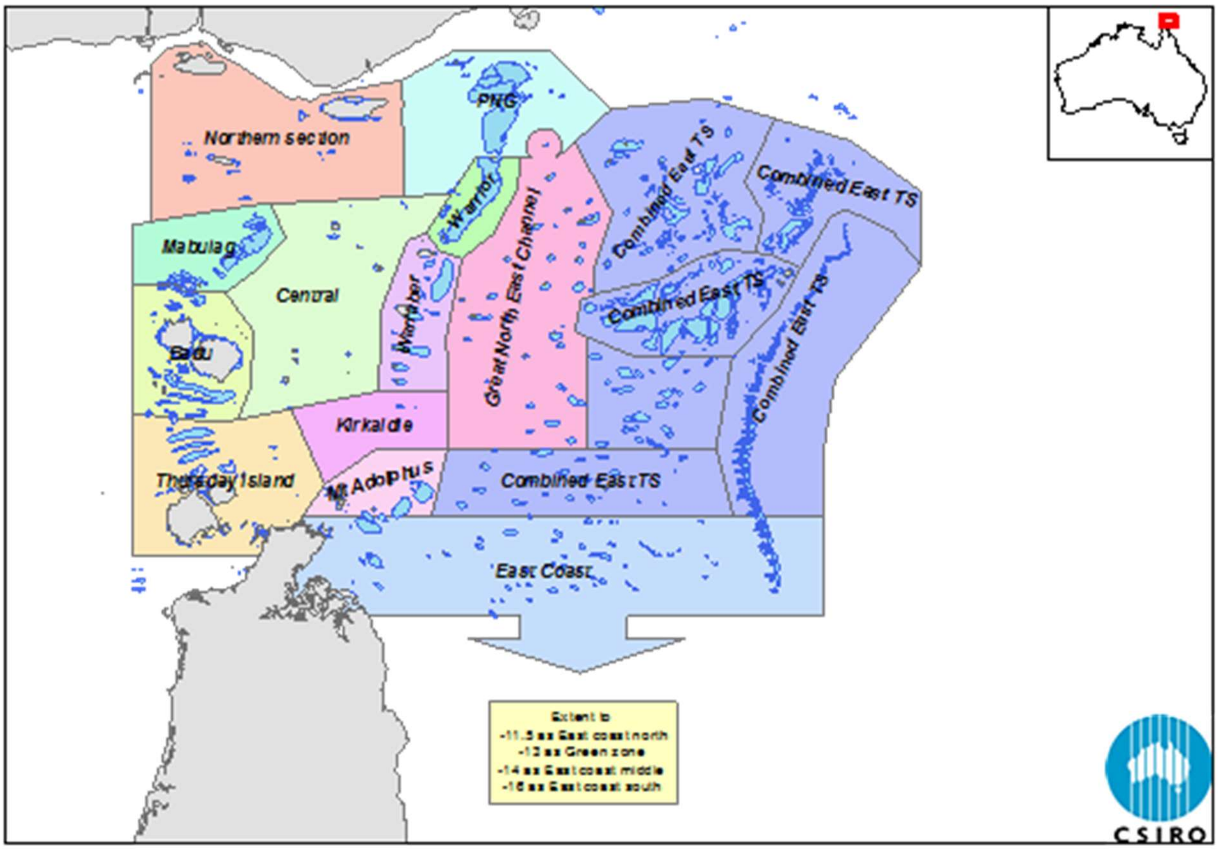



Figure 17. Annual time-series of percent of the total TVH catch during the three month period February-April taken within each area fished. Refer to Figure 16 for location of TVH areas.

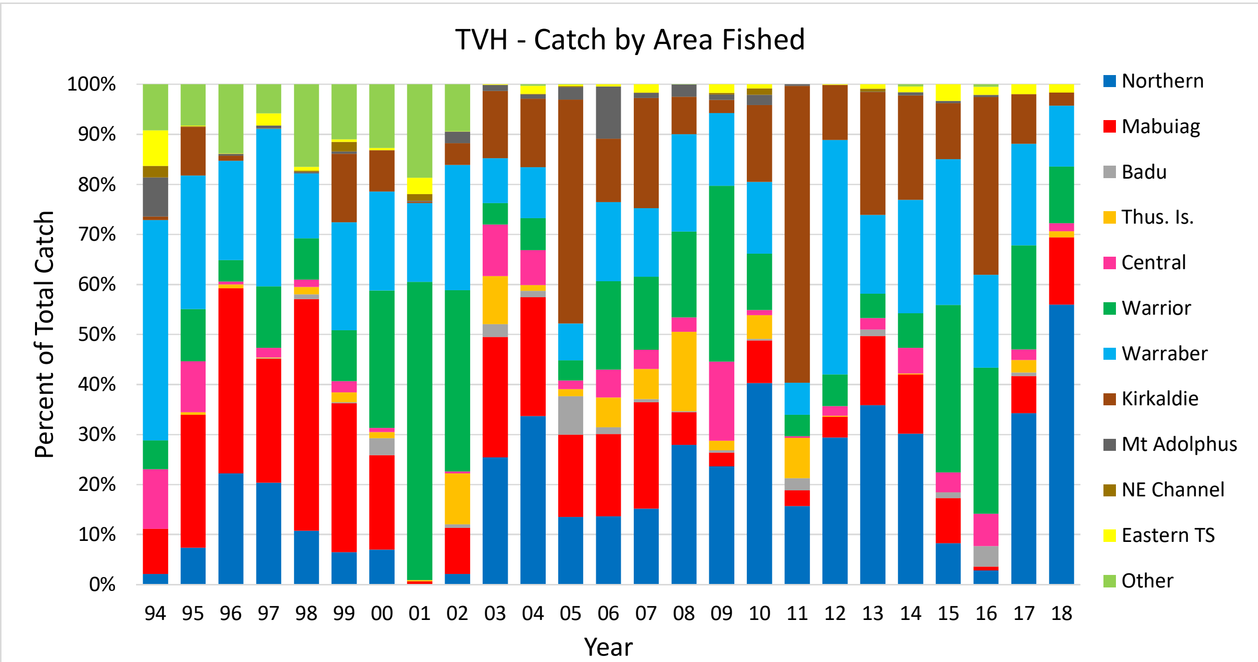
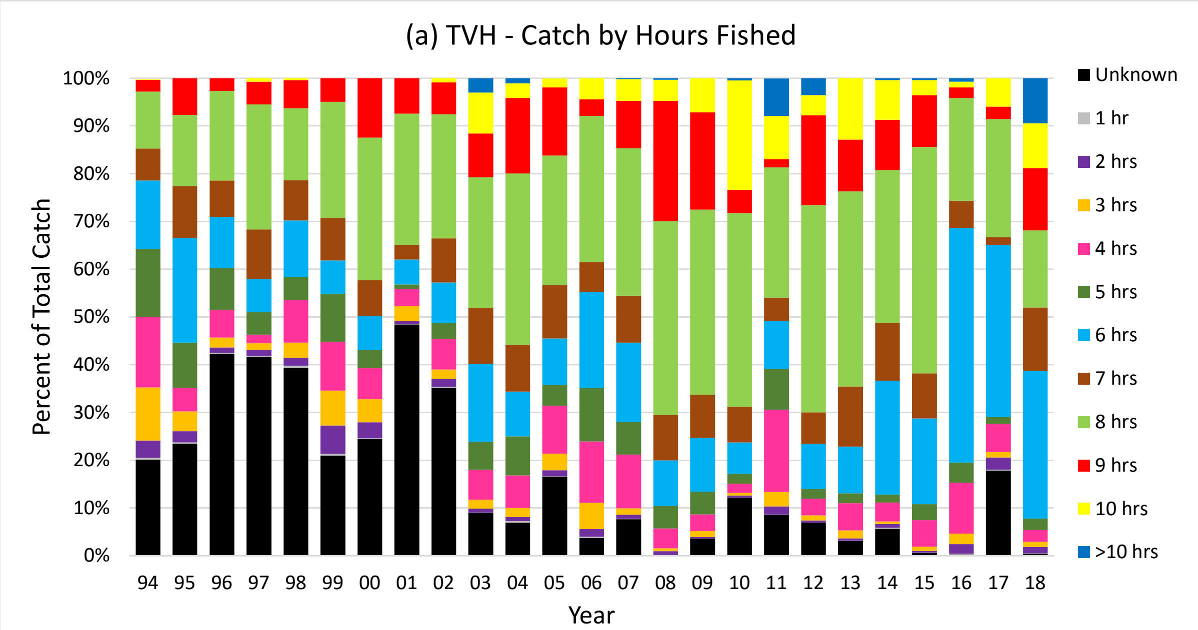


Figure 18. Comparison of percent of the TIB total catch in the three month period February-April stratified by the number of hours fished per tender-day based on (a) all records including those where the hours fished is unknown, and (b) those records where the unknown days fished are excluded and the number of hours fished is limited to 1-9.



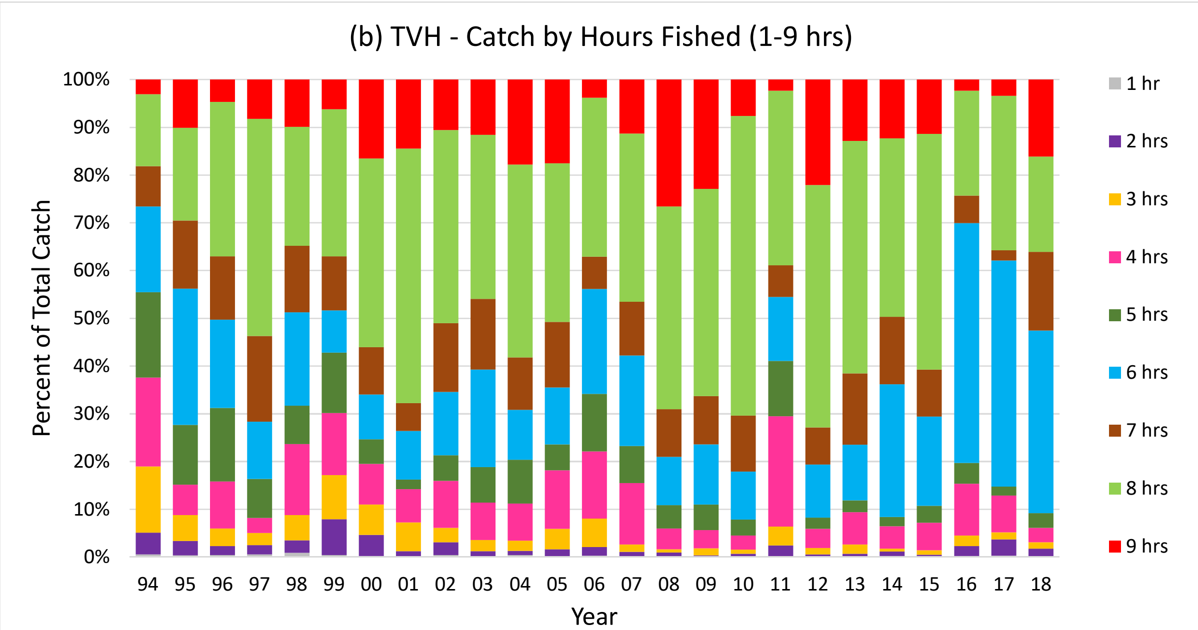
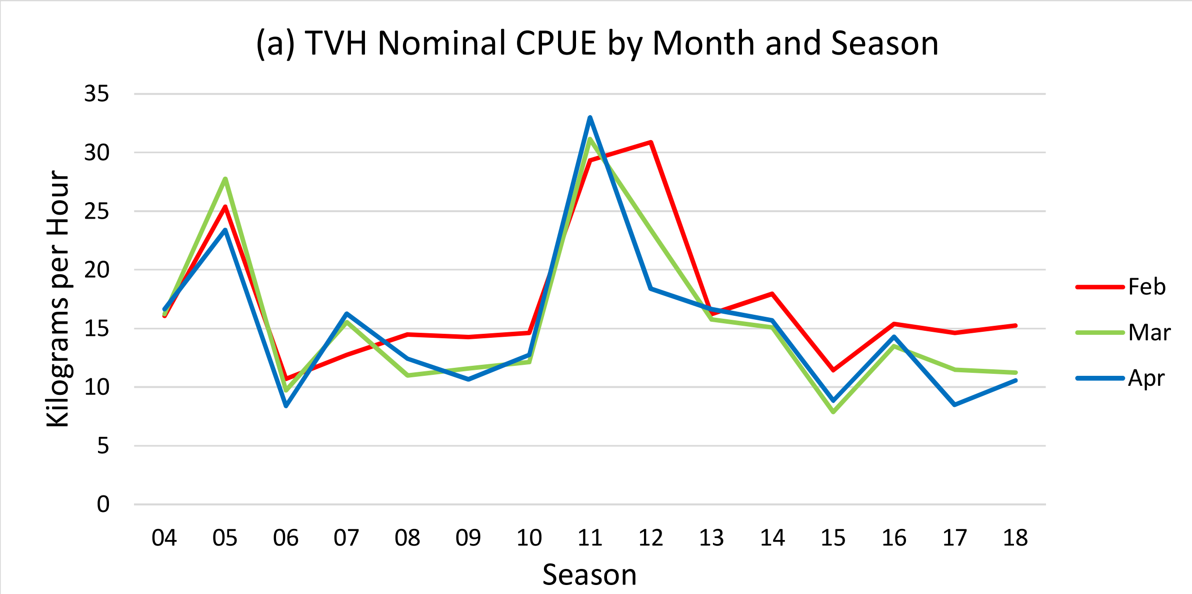



Figure 19. Annual time-series of nominal CPUE (kilograms per hour) for the TVH fleet within (a) month and (b) by fishing method during the three month period February-April.



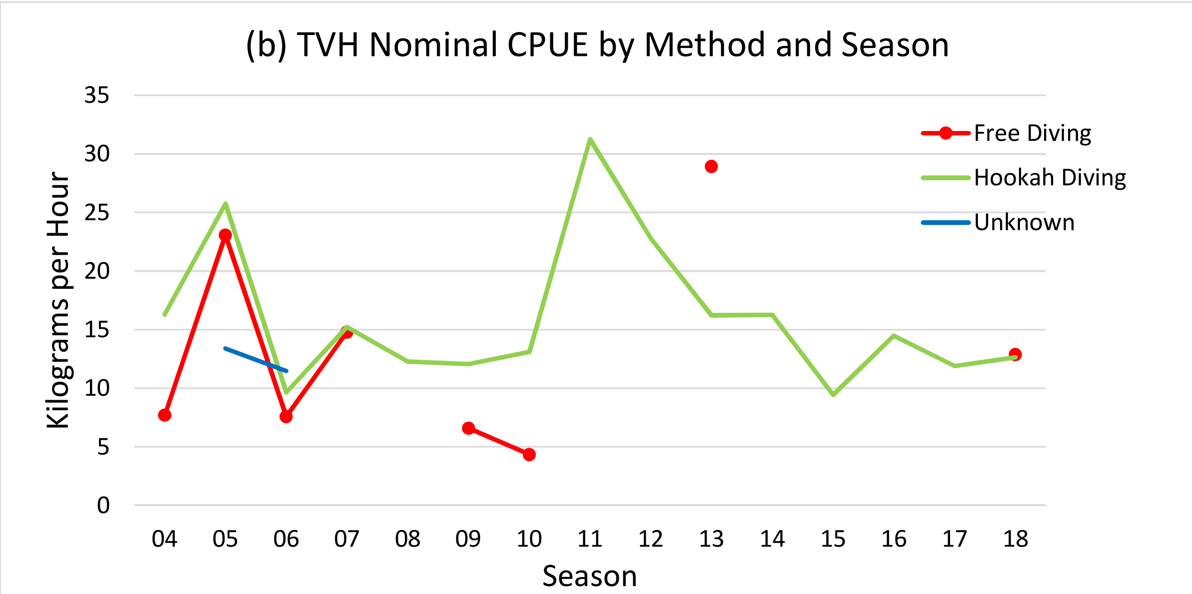
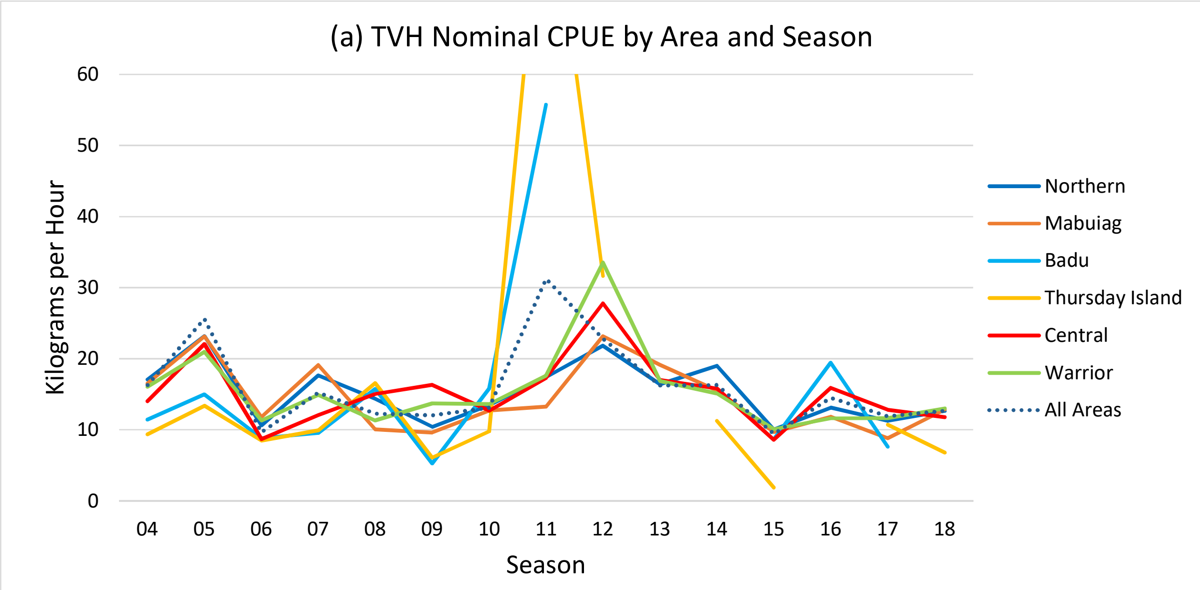



Figure 20. Annual time-series of nominal CPUE (kilograms per hour) for the TVH fleet within each area fished during the three month period February-April. For comparison, the mean nominal CPUE across all areas is also shown.



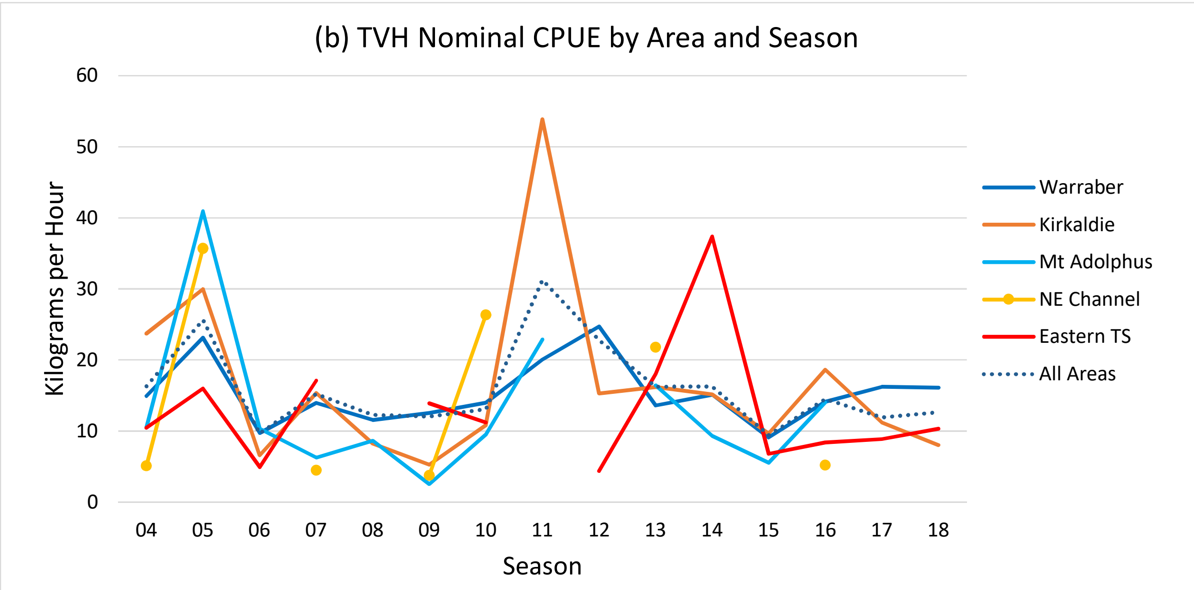



Figure 21. Annual comparison of effort in the TVH fishery during the three month period February-April. Analysis based on the method outlined in Campbell (2017)

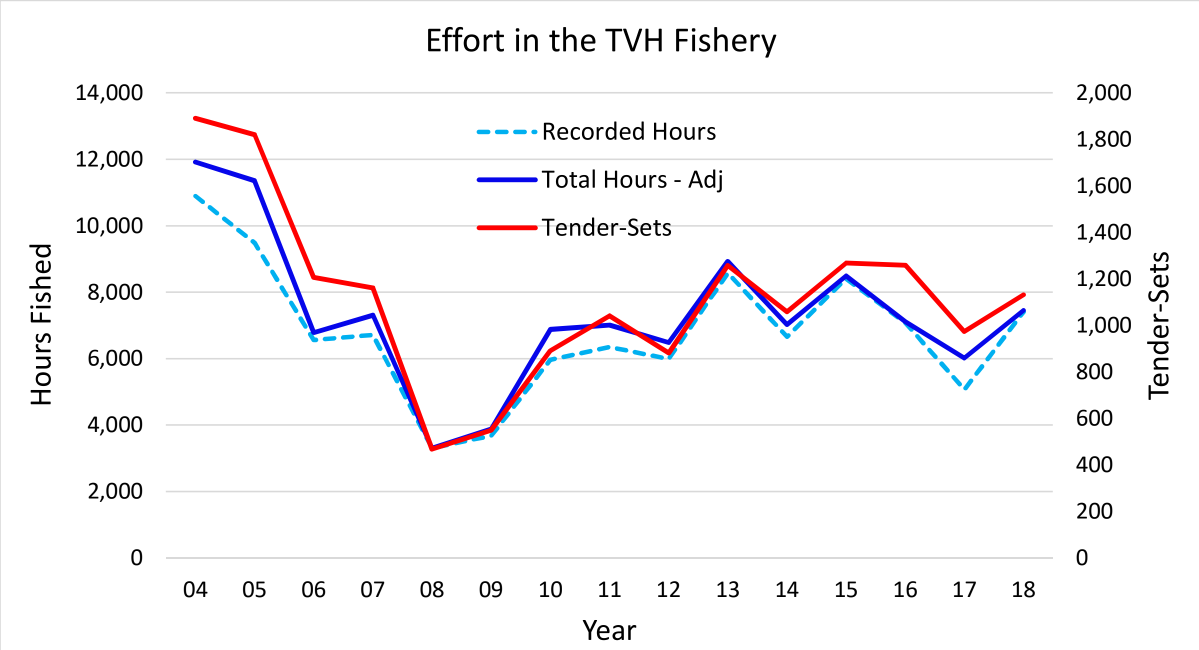
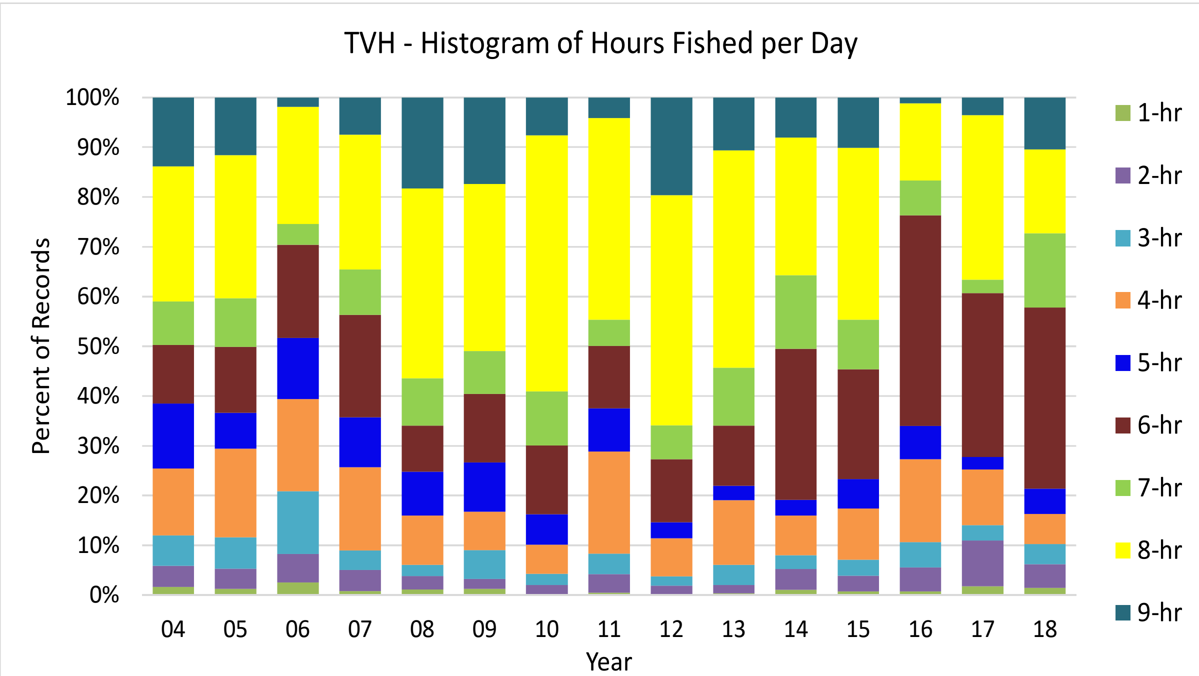



Figure 22. Annual comparison of the histogram of the number of hours fished per tender-day for the entire TVH fleet during the three month period February-April. Note, data where the hours fished was not reported or greater than 9 hours have been excluded.



**References.**

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Campbell, R.A., Pease, D. 2017. Separating TIB, TVH and Processor catch records from Docket-Book Data. Report to AFMA – 2017 Update. Information paper presented to the 21st meeting of the Torres Strait Rock Lobster Resource Assessment Group, held 12- 13 December 2017, Cairns.

Campbell, R.A. Plaganyi, E, Deng, R., 2017a. Use of TIB Docket-Book Data to construct an Annual Abundance Index for Torres Strait Rock Lobster – 2017 update. Information paper presented to the 21st meeting of the Torres Strait Rock Lobster Resource Assessment Group, held 12-13 December 2017, Cairns.

Campbell, R.A, Plaganyi, E., Deng, R., 2017b. Use of TVH Logbook Data to construct an Annual Abundance Index for Torres Strait Rock Lobster – 2017 Update. Information paper presented to the 21st meeting of the Torres Strait Rock Lobster Resource Assessment Group, held 12-13 December 2017, Cairns.

# Updated length frequency analysis for TRL, April 2018

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19 April 2018 – out of session document to support management of Torres Strait TRL

**SUMMARY CONCLUSION**: This document provides an update using data available up until end of March 2018 on length frequencies of catch samples for Torres Strait (TS) tropical lobster (TRL). We maintain our earlier conclusion that it is too early for fishers to make a call as to the entire season for Torres Strait (TS) tropical lobster (TRL) over the full area and considering all sectors of the fishery. There is currently no firm basis to support an alternative to the survey prediction of a below average recruiting age class when averaged over the entire TS region. The data from the Torres Strait Australian catch sectors are consistent with expectations of some recruiting animals becoming available to fishers, but don't reveal anything particularly noteworthy. Ongoing analyses will investigate this aspect further. Data were also provided from the PNG sector and these data are very helpful in understanding the current status in the PNG stratum given this stratum wasn't included in the November preseason survey. The PNG data show some indications of a slightly stronger than expected incoming recruitment in the PNG stratum but further information and analyses are necessary to fully interpret these data. Ongoing analyses will continue to review information as it becomes available, but we maintain that all indications from available data and the stock assessment suggest that the spawning biomass is currently below average and a precautionary approach is needed to ensure the longer-term sustainability of the stock. Finally, this document provides a brief summary of length frequency data from the QLD East Coast fishery which provides a useful comparison and shows potential in supporting broader understanding of the TRL stock dynamics given it is a shared stock.

## Background - Length Frequency Analyses

- The length frequency data from the November 2017 survey were plotted as shown below (Fig 1.). The von Bertalanffy growth curve was then applied to this distribution to illustrate the expected size distribution of this cohort in January 2018. This distribution was then compared with the actual observed size distribution of lobsters caught in January 2018 (data kindly provided by Kailis) to assess whether the November 1+ cohort were already being refelected in the commercial catches. As per Figure 2 below, this highlights that the January catches do not represent the 1+ cohort surveyed in November 2017, but are comprised mostly of animals (males in particular) from an older cohort, i.e. non-migrants from the previous year's 2+ cohort.

- Our length frequency (90-140 mm CL) and sex ratio analysis (mostly male) show these animals represent the 2+ cohort from the previous year so are not an index of abundance of the new 1+ cohort which is usually only accessible (due to size) to fishers from about March.
- The sex-disaggregated length frequency plot for January (Fig. 2) clearly highlights that in 2018, as in previous years, almost all the large lobsters caught are male. This further confirms that these animals are non-migrant survivors from the previous year because most of the females migrate out of the region to spawn. Comparison of changes in the length frequency and sex ratio of the catch during the year shows the progression of the fishery each year from a focus on "left-over" 2+ animals to fishing the new cohort, which constitutes the bulk of the annual catch. Full details were provided in a report submitted to the TRLRAG meeting in March.
- A summary of the mean expected relationship between age and length for TRL is provided in Appendix 1, noting that these are mean estimates only and as per the length frequency plots shown here, there is a spread about these mean values. Additional length frequency plots are also provide din Appendix 2.

**Updated Length Frequency Analyses**

- **Torres Strait**: The sex-disaggregated length frequency plots for February and March TRL Torres Strait samples (Figs 3-4) are much as expected and don't suggest anything notable. There continue to be a substantial proportion of large males being caught, and the slight leftward shift in the distribution from January through February to March (Fig. 5) shows some 1+ recruitment from last year growing into the fished size class, but doesn't suggest a particularly large influx of new recruits, noting that as per earlier comments, it is still early in the season to make a call on the strength of the new recruitment. We note also that the sex ratio of the smaller-sized animals shows a shift to a more equal representation of females, which is also as expected. The fact that most of the large animals caught are male is helpful in negating the hypothesis that a disruption to the usual migration pattern occurred due to the environmental anomalies – rather the residual population is similar in terms of sex ratio and length distribution to that in previous years, although additional data are required to assess whether the abundance of the residual population is greater than expected. The latter scenario is plausible given recent anomalous environmental conditions which caused changes in suitable habitat for lobster settling and feeding, and it's possible that lobsters that were away from the regular fishing areas have now moved back to suitable feeding grounds that have opened up (in response to sand shifting) and are hence more accessible to fishers. However there are currently insufficient data to separate this hypothesis from the alternative hypothesis that the recent catches and catch rates are higher than would be expected in a poor recruitment year because of increased fishing effort, fishing efficiency and competitive fishing that is a characteristic of fisheries under situations where quota is limited. Ongoing analyses may shed light on the latter. We reiterate though that the available data to date are not inconsistent with the survey prediction of a poor recruiting age class, and further data and analyses are necessary to quantify this aspect with any certainty.

- **PNG**: The PNG length frequency data (Fig. 6) is different to that provided by the Australian sectors, and highlights the valuable information content of data from PNG. As with the Australian catch samples, the large animals are almost all male suggesting they are non-migratory males from the previous season. However the sex ratio and distribution for the smaller size classes suggests that there may be stronger incoming recruitment in the PNG stratum. The latter was not included in the Preseason survey. It would be instructive to analyse additional data from the PNG catch sector, and in particular to obtain information as to the spatial locations of the catches. For example, it would be helpful to get confirmation whether some of the larger females represented in the PNG catch samples (eg January length frequency – females ca. 116cm CL – Fig. 6) are from mature populations further to the east travelling along the lobster migration route.
- **East Coast**: Data from East Coast samples have been analysed for the first time and show some similar features to the TRL data such as most large animals being male and a more even sex ratio of females in smaller length classes (Fig. 7). However as expected given the greater longevity of TRL on the east Coast, the size distribution reflects many much larger individuals. The length frequency plots for 2016 and 2017 (Figs 8-9) are potentially helpful too to inform on recruitment pulses – for example, there are some indications that the new 1+ cohort predominantly enters the fishery in March-April consistent with what is observed in Torres Strait. However the East Coast data are highly variable and analyses of these data is likely confounded by variability in the spatial location of the catch samples given the fishery operates over a large area. It is therefore recommended that if possible, future catch samples for the East Coast should be separated by spatial zone and this will likely mean an increased number of samples per zone is needed to ensure the data are as informative as possible.

**Future work**: The CDR catch data were provided to CSIRO on 18/4/18 and we are waiting for updated logbook data. We will thus in the near future again do an updated analysis of catch and catch rate information for the current fishing season to assist in understanding the current season's stock abundance.

**Acknowledgements**

We are grateful to Darren Dennis for kindly sharing insights into the history of the fishery based on his long history of involvement. Many thanks to the many stakeholders who have contributed information and perspectives on the current status of the fishery. Thanks also to M.G. Kailis for providing length sample measurements and in particular to also providing data for PNG and the East Coast fishing sectors.

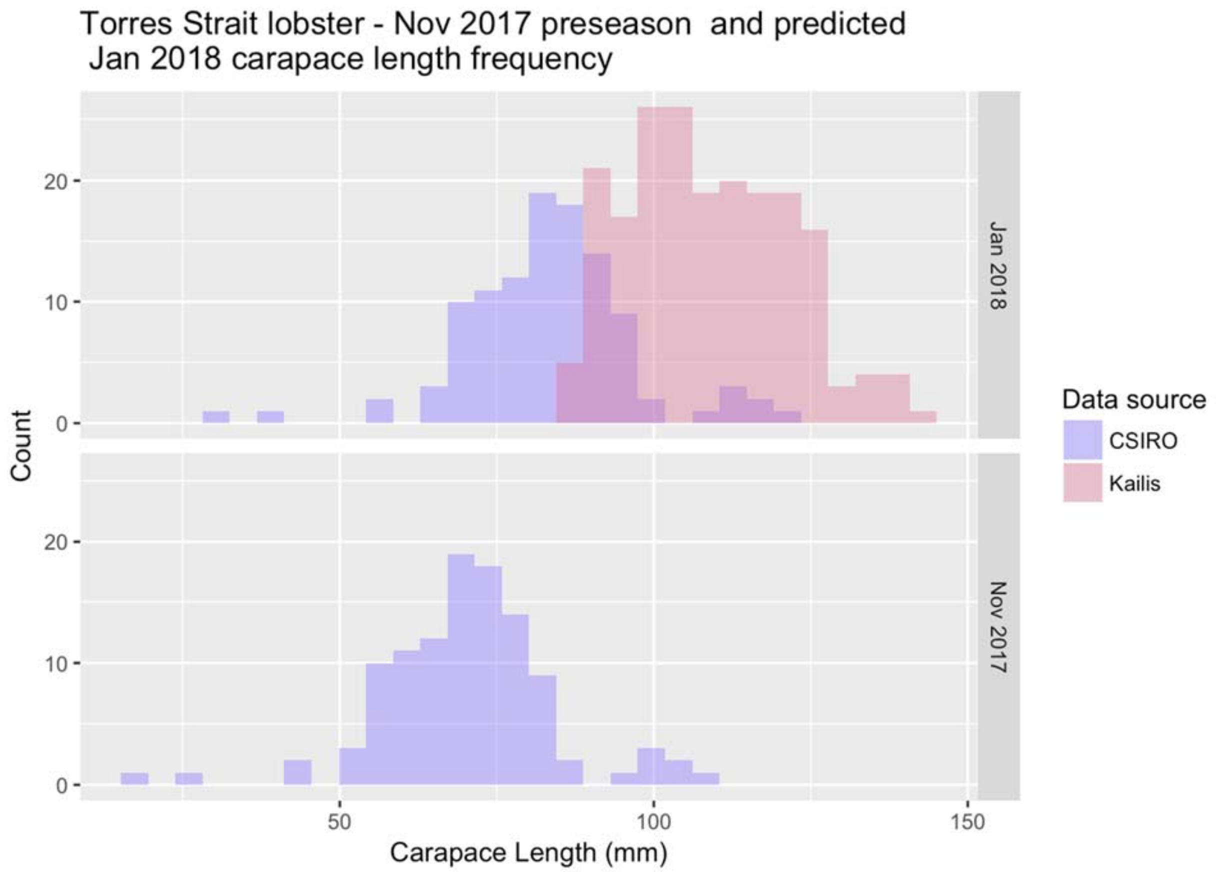



Fig. 1. Comparison between observed length frequency sample from January 2018 commercial catches, and predicted length frequency of 1+ cohort recruiting to fishery in 2018, with the latter predicted based on applying the expected average growth rates to the November 2017 survey-observed frequencies.

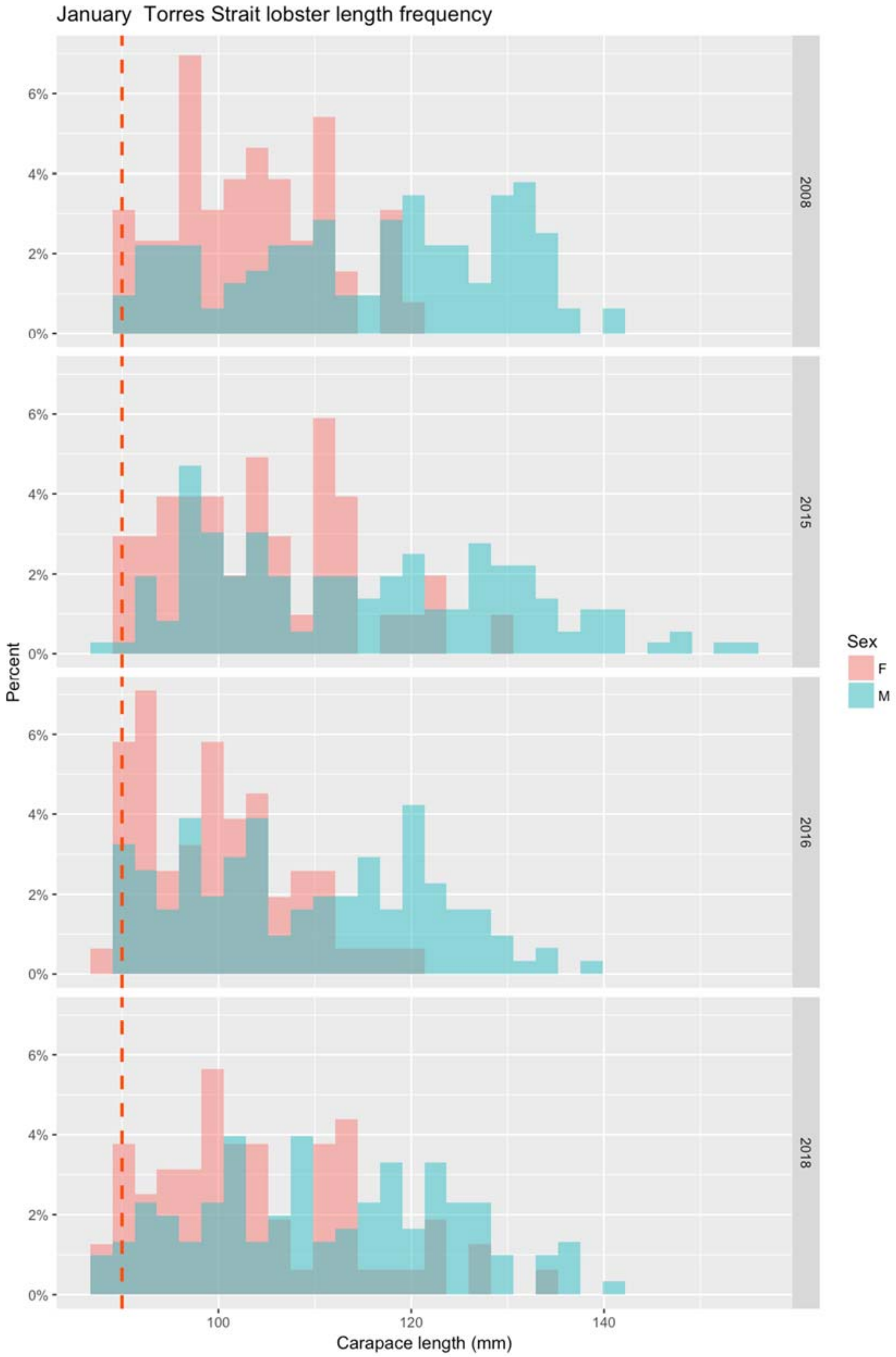



Fig. 2. Sex-disaggregated length frequency (percentage of sample having a carapace length (mm) as shown) from commercial catch samples shown for January from each of the years as indicated, and with pink shading representing females and blue shading males. The dashed vertical line represents the legal size limit. Note that no data was collected during January 2017.

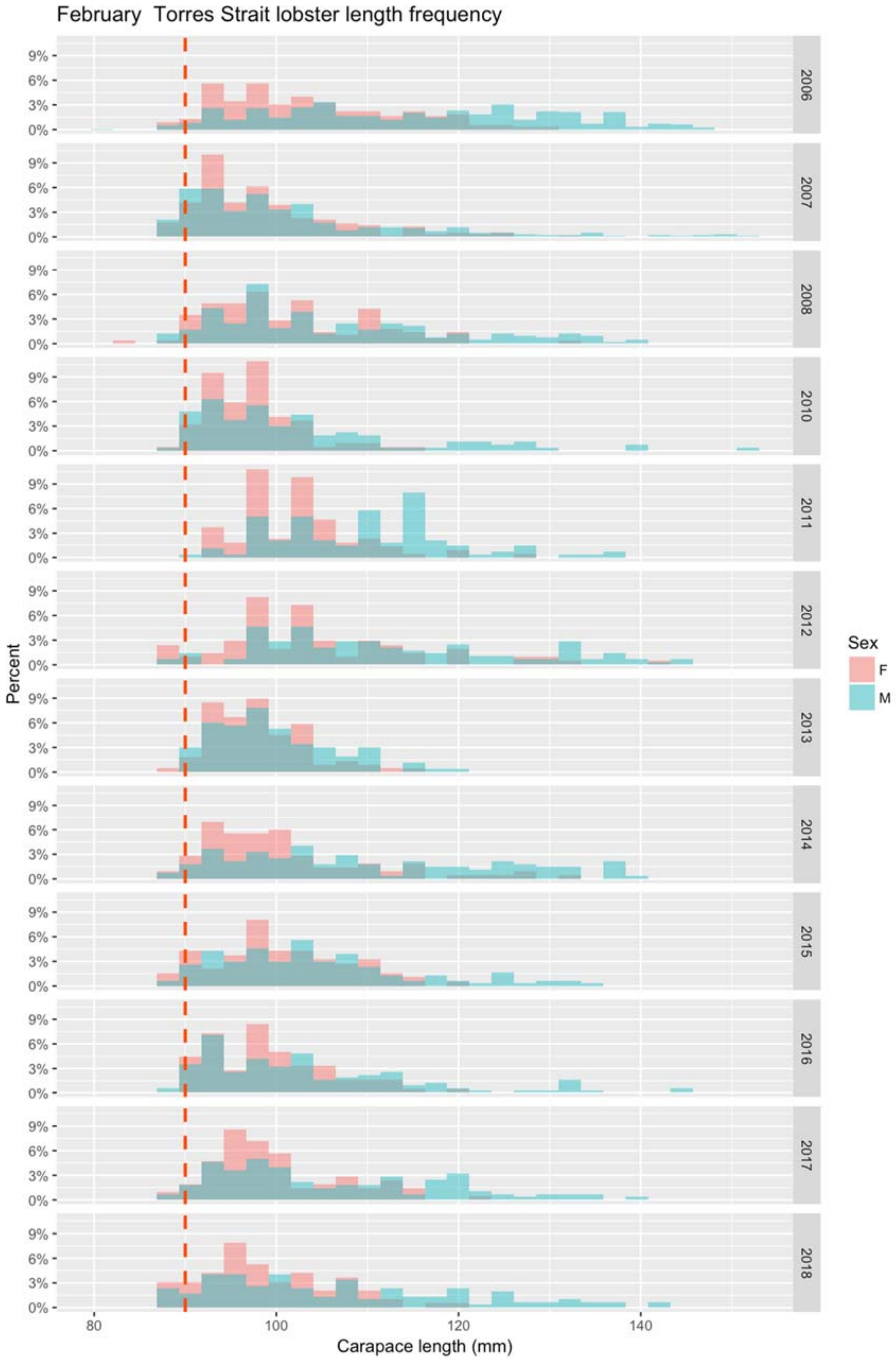



Fig. 3 Sex-disaggregated length frequency (percentage of sample having a carapace length (mm) as shown) from commercial catch samples shown for February from each of the years as indicated, and with pink shading representing females and blue shading males. The dashed vertical line represents the legal size limit.

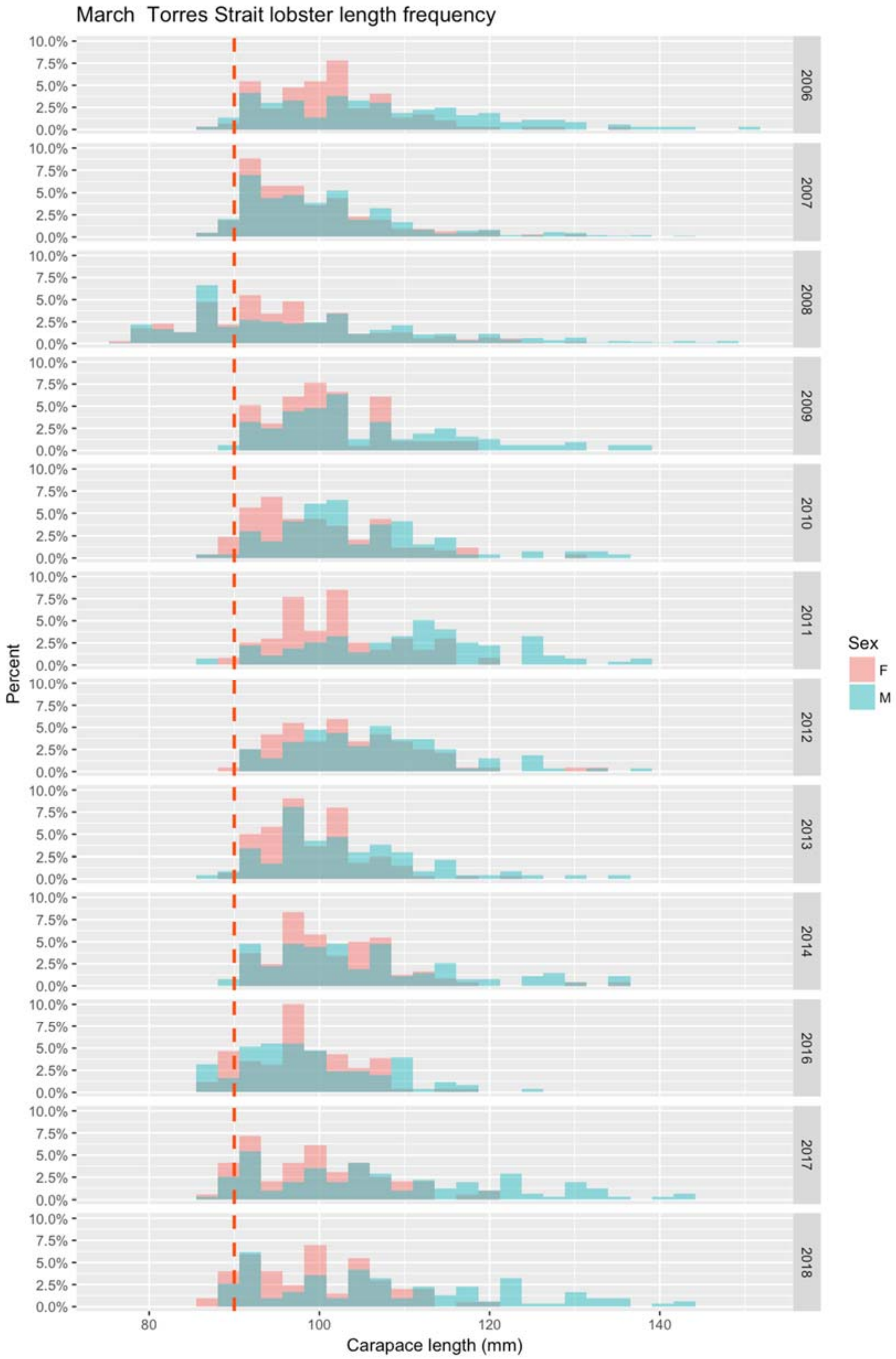



Fig. 4. Sex-disaggregated length frequency (percentage of sample having a carapace length (mm) as shown) from commercial catch samples shown for January from each of the years as indicated, and with pink shading representing females and blue shading males. The dashed vertical line represents the legal size limit.

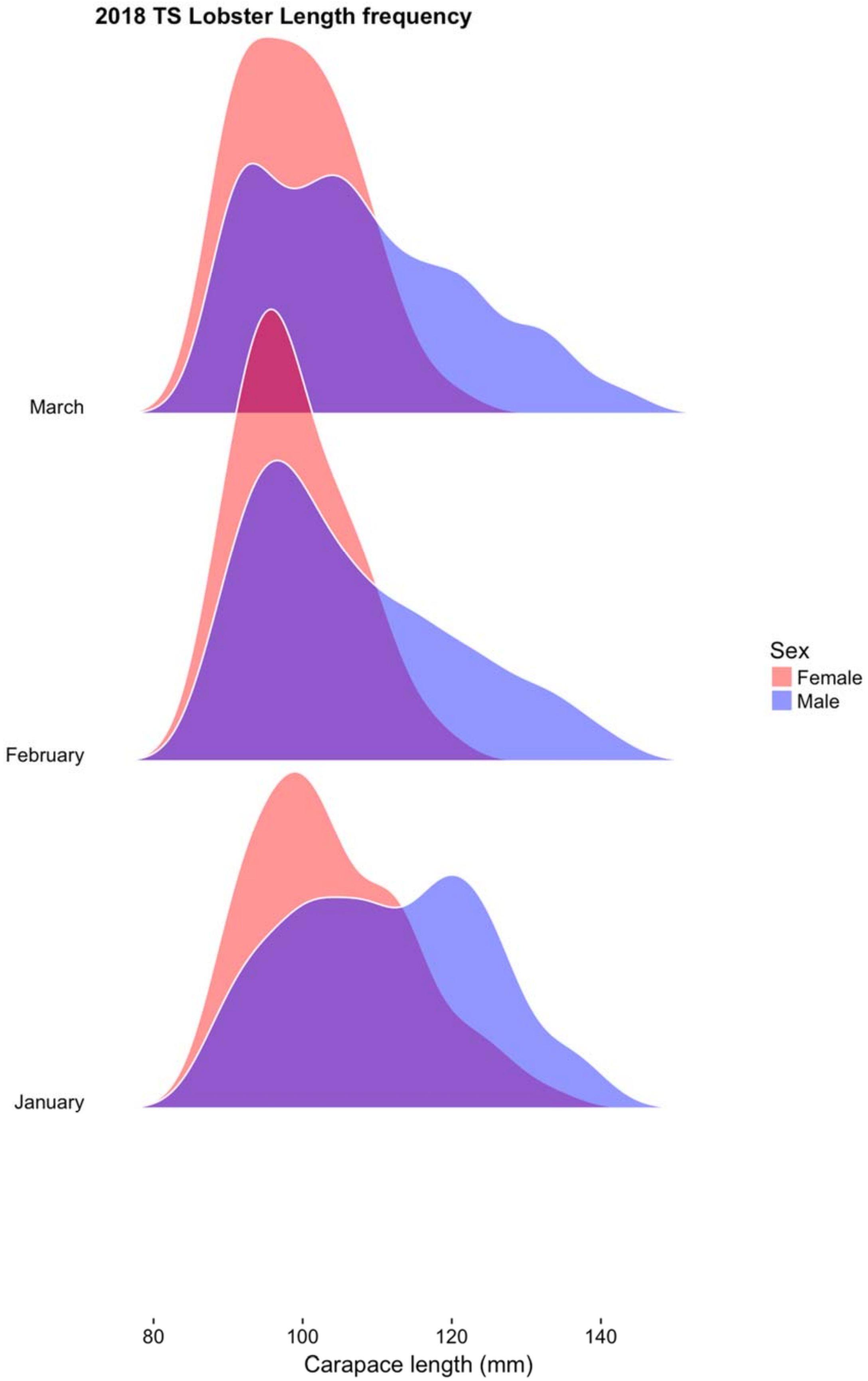



Fig. 5. Smoothed plots using ridge lines package, to show changes in length frequency from commercial catch samples of Torres Strait TRL over the period January to March 2018.

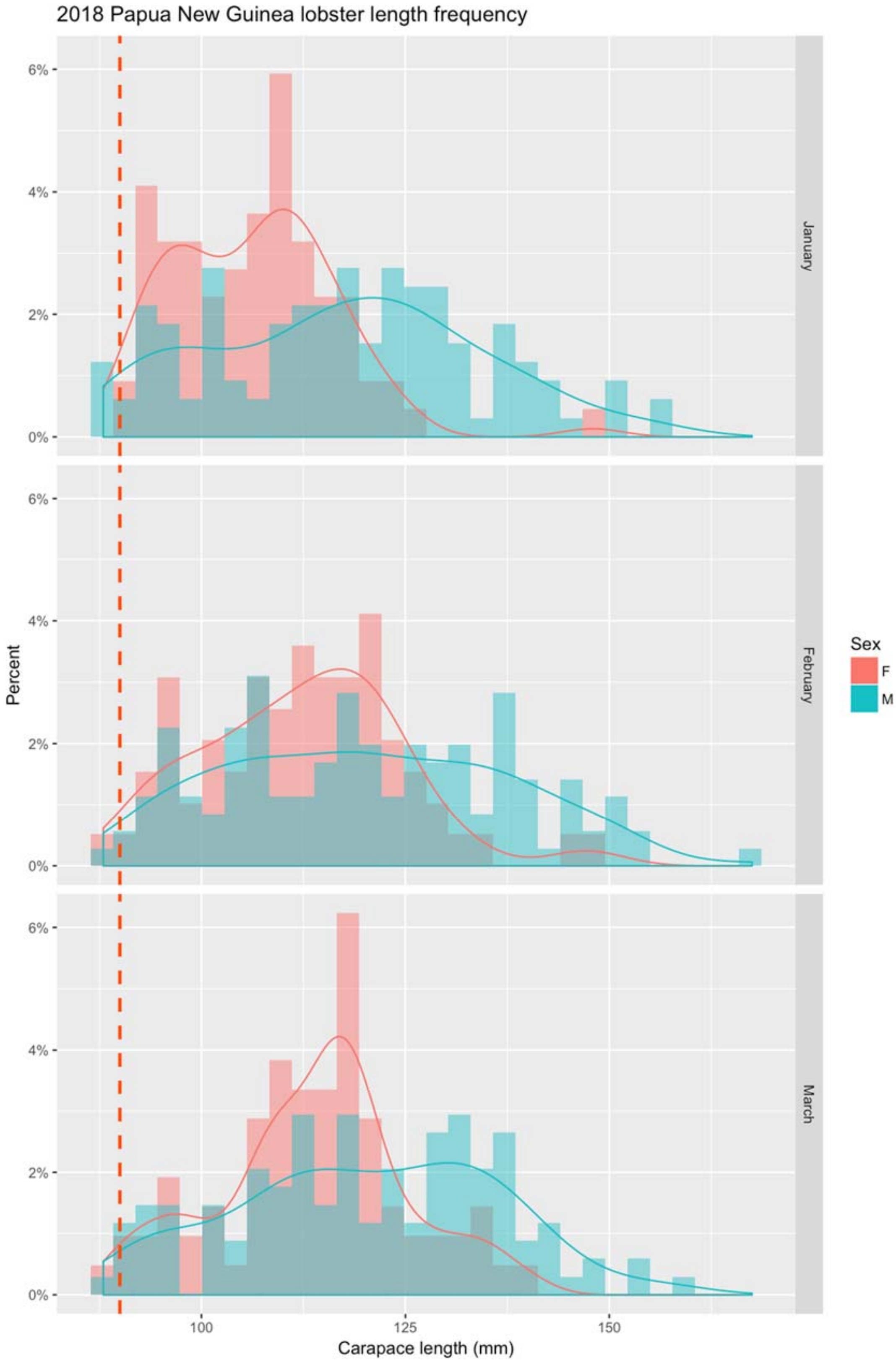



Fig. 6. Sex-disaggregated length frequency (percentage of sample having a carapace length (mm) as shown) from PNG commercial catch samples shown for January to March 2018, and with pink shading representing females and blue shading males. The dashed vertical line represents the legal size limit.

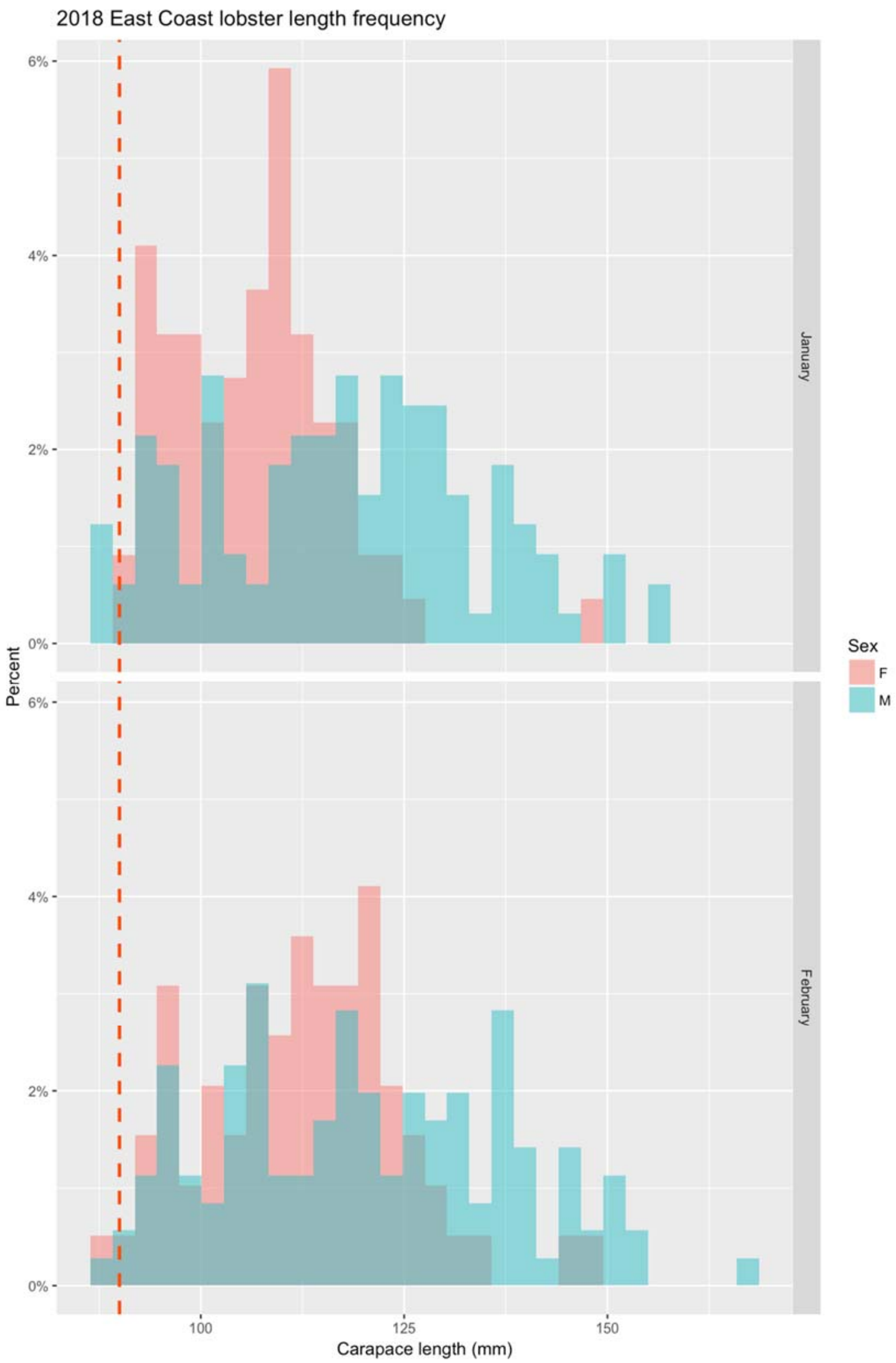



Fig. 7. Sex-disaggregated length frequency (percentage of sample having a carapace length (mm) as shown) from East Coast commercial catch samples shown for January and February 2018, and with pink shading representing females and blue shading males. The dashed vertical line represents the legal size limit.

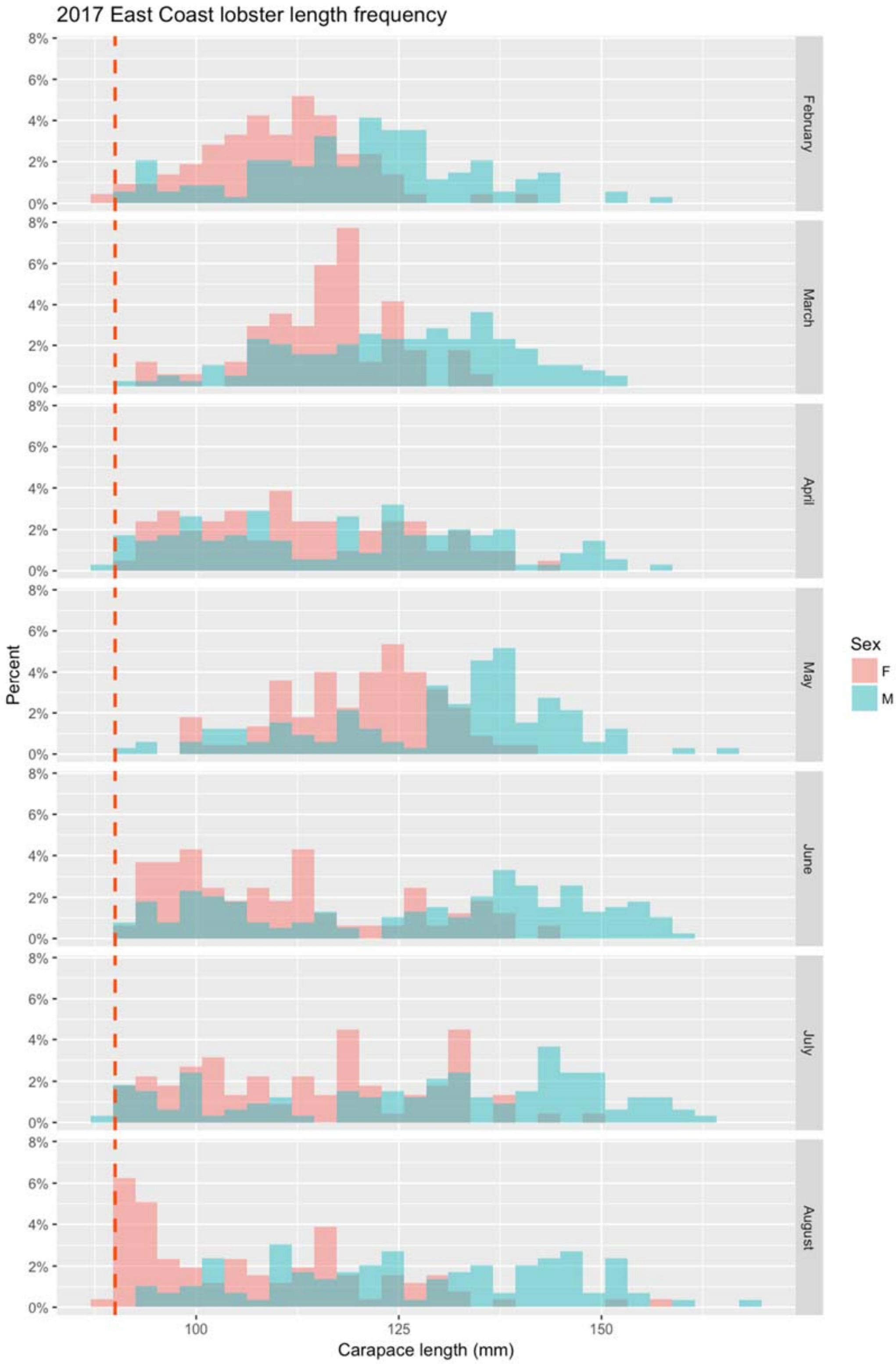



Fig. 8. Sex-disaggregated length frequency (percentage of sample having a carapace length (mm) as shown) from East Coast commercial catch samples for months as shown in 2017, and with pink shading representing females and blue shading males. The dashed vertical line represents the legal size limit.

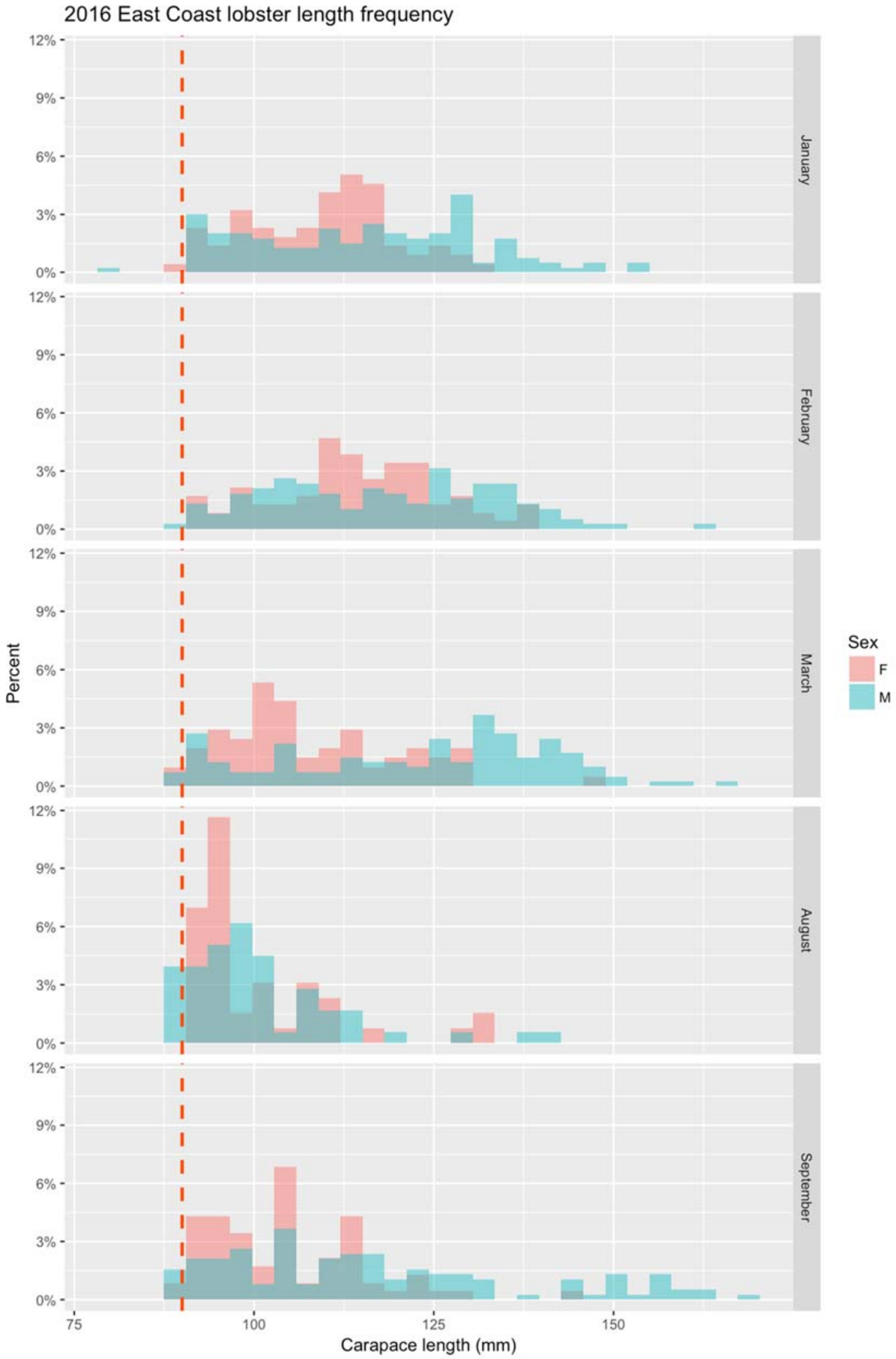



Fig. 8. Sex-disaggregated length frequency (percentage of sample having a carapace length (mm) as shown) from East Coast commercial catch samples for months as shown in 2016, and with pink shading representing females and blue shading males. The dashed vertical line represents the legal size limit.

**Appendix 1** – Age-length relationship for TRL based on von Bertalanffy growth curve

| | Age (months) | length carapace (mm) | Tail width (mm) | Mass (kg) |
|---|---|---|---|---|
| 0+ Nov | 6 | 32.240 | 21.738 | 0.038 |
| | 7 | 36.968 | 25.038 | 0.055 |
| | 8 | 41.529 | 28.220 | 0.076 |
| | 9 | 45.929 | 31.291 | 0.100 |
| | 10 | 50.173 | 34.252 | 0.127 |
| | 11 | 54.267 | 37.109 | 0.158 |
| | 12 | 58.216 | 39.865 | 0.192 |
| | 13 | 62.026 | 42.524 | 0.229 |
| | 14 | 65.701 | 45.089 | 0.268 |
| | 15 | 69.246 | 47.562 | 0.310 |
| | 16 | 72.666 | 49.949 | 0.354 |
| | 17 | 75.964 | 52.251 | 0.400 |
| 1+ NOV | 18 | 79.146 | 54.471 | 0.448 |
| Dec | 19 | 82.216 | 56.613 | 0.498 |
| Jan | 20 | 85.177 | 58.680 | 0.549 |
| Feb | 21 | 88.033 | 60.673 | 0.601 |
| March - LEGAL | 22 | 90.789 | 62.596 | 0.655 |
| April | 23 | 93.447 | 64.451 | 0.709 |
| May | 24 | 96.011 | 66.240 | 0.764 |
| June | 25 | 98.484 | 67.966 | 0.820 |
| July | 26 | 100.870 | 69.631 | 0.876 |
| Aug | 27 | 103.171 | 71.237 | 0.932 |
| SEPT | 28 | 105.391 | 72.786 | 0.988 |
| Oct | 29 | 107.533 | 74.281 | 1.045 |
| 2+ NOV | 30 | 109.599 | 75.722 | 1.101 |
| | 31 | 111.592 | 77.113 | 1.157 |
| | 32 | 113.514 | 78.454 | 1.213 |
| | 33 | 115.368 | 79.748 | 1.268 |
| | 34 | 117.157 | 80.997 | 1.323 |
| | 35 | 118.883 | 82.201 | 1.378 |
| | 36 | 120.547 | 83.362 | 1.432 |

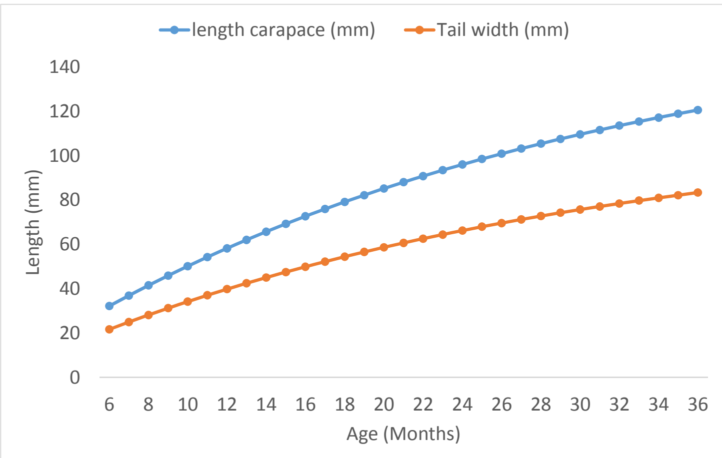
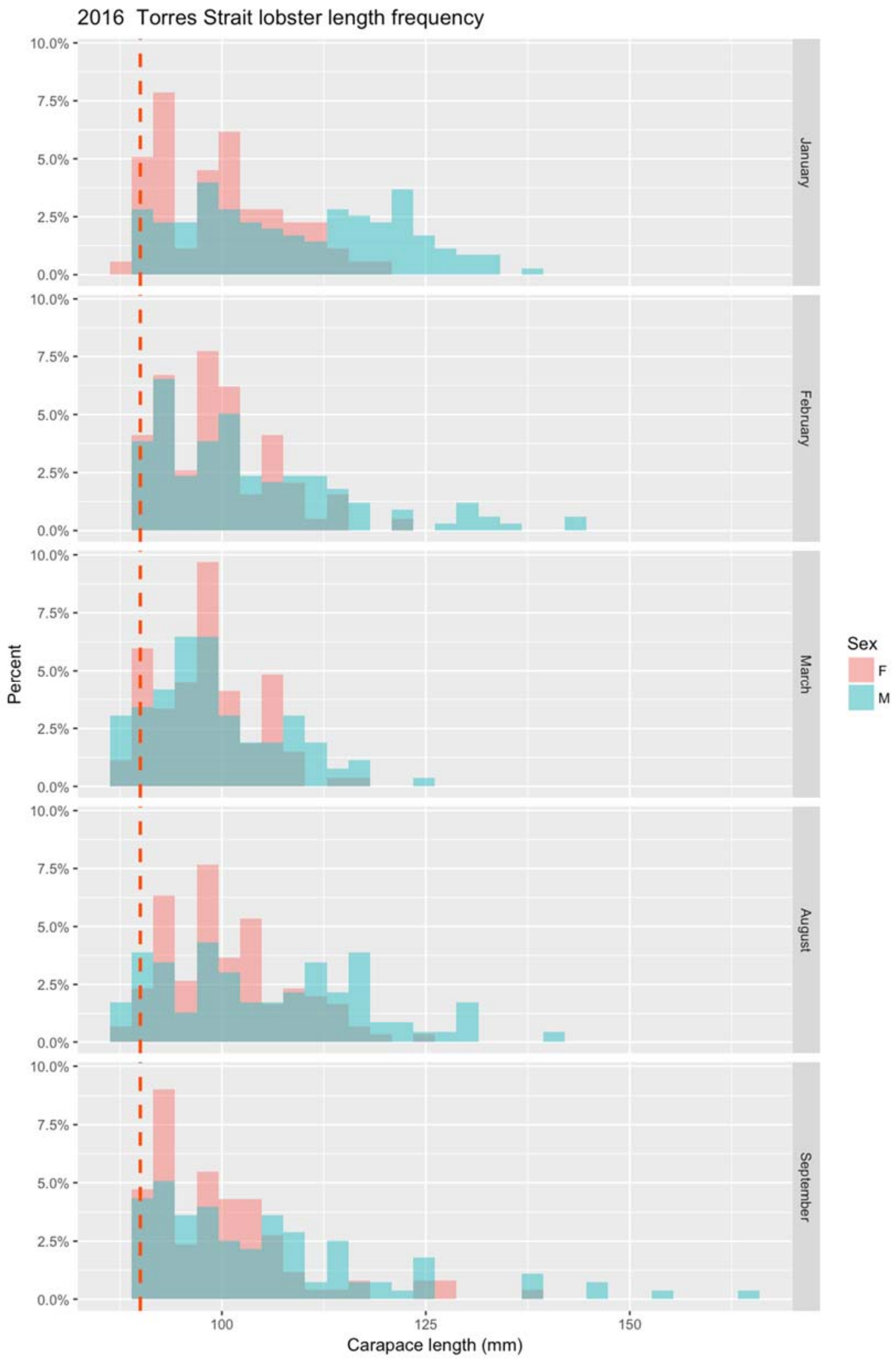
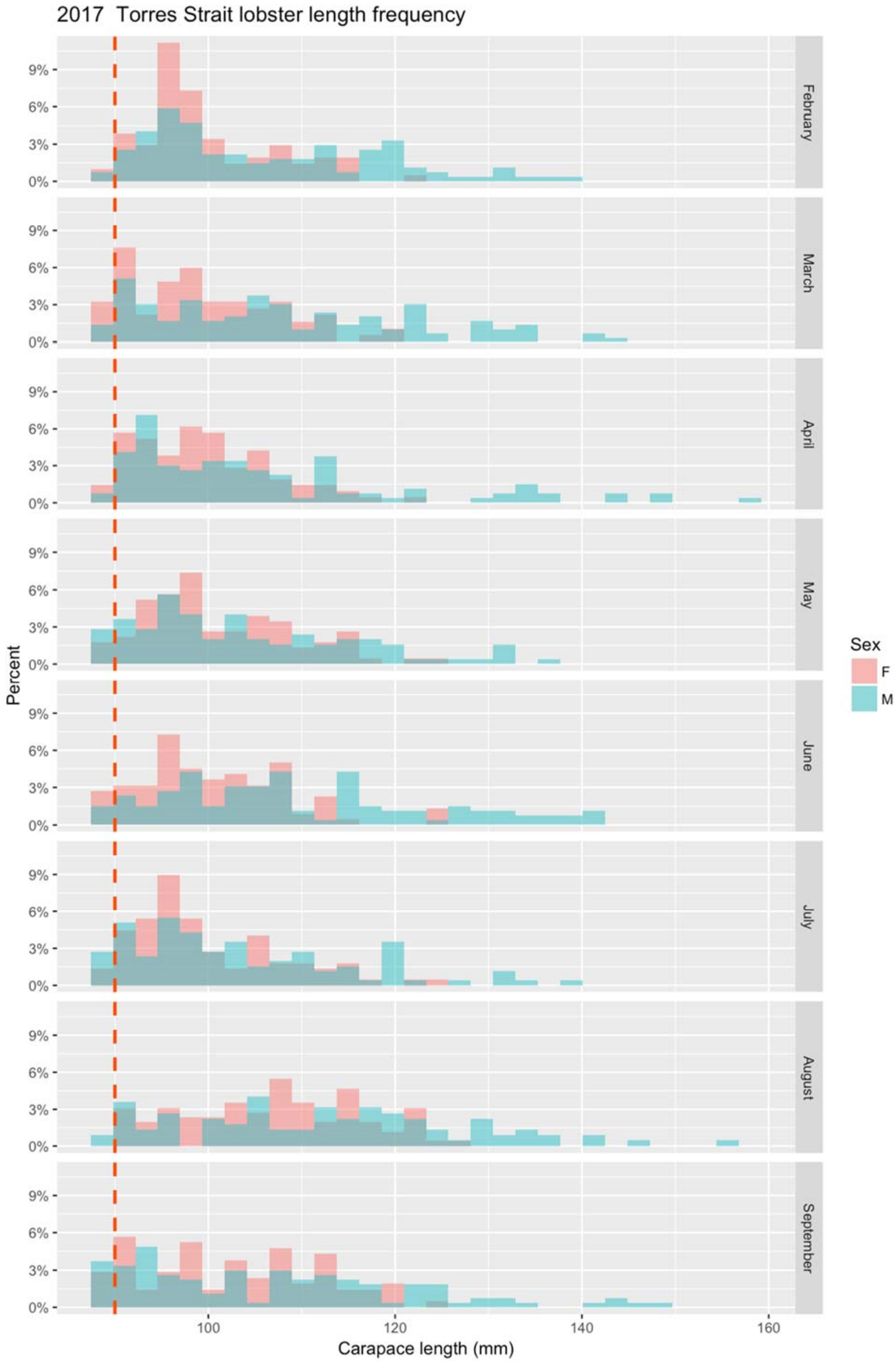


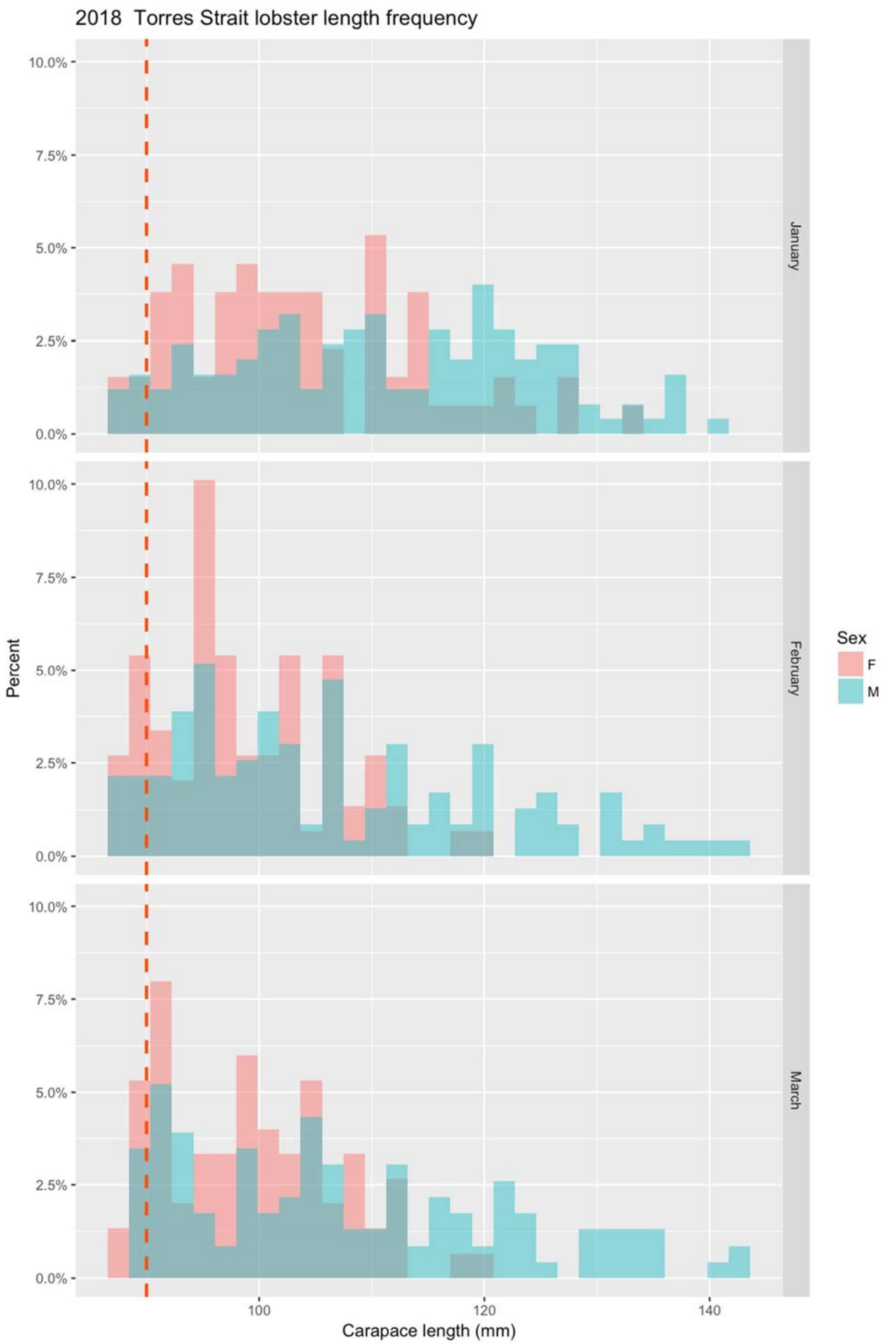

Fig. A.1. Plot of TRL length (shown both as carapace length (mm) and tail width (mm) as a function of age in months.

**Appendix 2** – Additional Length Frequency Plots for Reference Purposes





2017 Torres Strait lobster length frequency
Percent
9%
6%
3%
0%
February
March
April
May
June
July
August
September
100
120
140
160
Carapace length (mm)
Sex
F
M


2018 Torres Strait lobster length frequency
10.0%
7.5%
5.0%
2.5%
0.0%
January
February
March
Percent
Sex
F
M
100
120
140
Carapace length (mm)

**Updated summary responses to reports querying the TRL RBC for 2018**

**Éva Plagányi, Rob Campbell, Michael Haywood, Mark Tonks, Roy Deng, Nicole Murphy, Kinam Salee**

CSIRO Oceans and Atmosphere, Queensland BioSciences Precinct (QBP), St Lucia, Brisbane,

Queensland, and Aspendale, Victoria, 3195

Report for TRLRAG, May 2018

**SUMMARY CONCLUSION**: Based on the available scientific information and analyses to date, there is no firm basis for altering the current scientific advice provided to management.

**Preseason Survey:**

- There is currently no firm basis to dispute the survey prediction of generally low recruitment in 2018 across the Australian strata of Torres Strait
- The PNG stratum has not been surveyed since 2007. It is possible that there is higher recruitment in that stratum relative to the survey average, with some weak support provided by the PNG length frequency data from commercial catch samples
- The Preseason survey is considered representative but its extent has been reduced to reduce costs such that it is not as extensive as surveys prior to 2015. In particular it may have under-represented an anomalously high local hotspot of abundance in the north-western region (which has not shown overly high abundance in recent years) but this would only result in a slight bias to the overall average prediction
- The spatial variability in lobster abundance and localised hotspots of abundance as reported in 2018 are as expected and previously documented for this fishery. Given recent anomalous environmental conditions, it is plausible that this is exaggerated in some hotspots where good habitat has become available for lobsters resulting in enhanced growth, survival and small-scale movement into an area resulting in a concentrated aggregation of lobsters over a few months, but there is no scientific basis to assume that this will persist in the longer term, and this isn't an indication of the current season's spawning biomass

**Catch and CPUE data:**

- There are no indications from the latest available data that this is an average or good year, although it could be argued that it's a low-average year rather than a low year, but it is still too early to objectively evaluate the exact stock status

- The combined TIB and TVH catch over the period December to March 2018 is 87% of the average (TIB+TVH) catch in the preceding period 2005-2017, and 37% of the maximum catch over this period.
- A detailed analysis of catch and CPUE data is provided in Campbell et al. 2018, but in general although there is evidence of localised hotspots, on average both the TIB and TVH CPUE estimates for 2018 are low to average relative to historical averages
- There is some evidence from the information available in the data that fishing effort may have increased this year. There are also several anecdotal reports from the TIB sector of increases in fishing effort, but these aren't captured in the data as effort is reported per day rather than hours fished per day. There is evidence of an increase in the number of days per fishing trip for the TIB sector and more hours per day fished by the TVH sector relative to recent years. If effort or fishing efficiency (eg better use of technology) have increased, then the CPUE estimates will be positively biased (i.e. suggest the stock is in a better state than it is) and these indices will need to be standardised to take this into account if they are to be considered reliable indices for input to future assessments as well as the harvest control rule. Moreover, if fishers are focusing on a few hotspots rather than fishing more evenly across the region, this can result in a hyperstable CPUE whereby higher CPUE is maintained for longer and then falls more steeply as fishing continues, with the result that the early CPUE estimates effectively overestimate resource abundance.

**Stock sustainability and risk**

- The target and limit reference points for TRL have deliberately been set at conservative levels, and the stock assessment process is similarly conservative, in response to consultation with all stakeholders and in recognition of the need for "*… acknowledg[ing] and protect[ing] the traditional way of life and livelihood of the traditional inhabitants including their traditional fishing*"
- This means that it is to be expected that at the end of the fishing season there are still lobsters that could potentially be caught as this high abundance is needed for successful spawning (even though this is uncertain, this is to minimise risk), plus local communities should still be able to continue subsistence fishing
- This also means there is a fairly low risk of significantly depleting the spawning biomass to unacceptably low levels if fishing in one year exceeds the recommended target level of fishing. However, scientific analyses of fisheries from around the world have demonstrated unequivocally that when this cycle of overshooting the scientifically-recommended TAC continues regularly, it gradually results in a decline in stock status and leads to overfished stocks that are no longer able to produce the same large yields as in the past. This is one of the reasons it can be beneficial to not deviate from the best available scientific advice (which could include advice that conditions are anomalous), and is also part of the motivation why many fisheries have moved to adopting harvest control rules with clearly specified and pre-agreed rules for making decisions.
- To demonstrate this, Fig. 1 compares what happens if the target fishing mortality for TRL is increased from its current conservative level. Although these analyses are always

uncertain for highly variable stocks because of the role of environmental variability, the plot illustrates how the current low RBC is calculated in such a way that it will support the fishery bouncing back to a higher average level so that good and very good catches can be maintained in the longer-term. In contrast, if there is support for increasing the target fishing level, as evident from the plot, there may still be a sustainable future fishery but it is expected that it will fluctuate about a lower average level so that high future catches become less likely and there is an increased risk of the spawning biomass falling to unacceptable low levels in poor years (i.e. when compounded by the effects of environmental variability). Highly variable marine stocks can undergo high-amplitude fluctuations even in the absence of fishing but the science has shown that this can be amplified by fishing when productivity drops rapidly and management fails to respond (Mark Dickey-Collas et al., 2010; Essington et al., 2015). The TRLRAG has over the past couple of years had in-depth discussions around the potential negative impacts on the stock of recent anomalous environmental conditions, again supporting a conservative approach to fishing.

- An example of stocks that have declined substantially due to fishing pressure exaggerated by socio-economic needs is provided in Fig. 2: these stocks are currently managed sustainably with low risk of further depletion (and some have recovered or declined further since the time of the analysis shown) but they are at relatively low levels relative to historical levels and this has other associated risks and costs such as loss of the maximum possible future revenues.
- Another important reason why catch levels are set conservatively for TRL is because of uncertainty with regard to the total catch estimates. The move this year to compulsory catch reporting in Australia is a positive step forward, but there remain concerns around trawling catches, discards, unreported catches etc, and these are accounted for in the current management process.

## Modelled effect of increasing target fishing mortality F

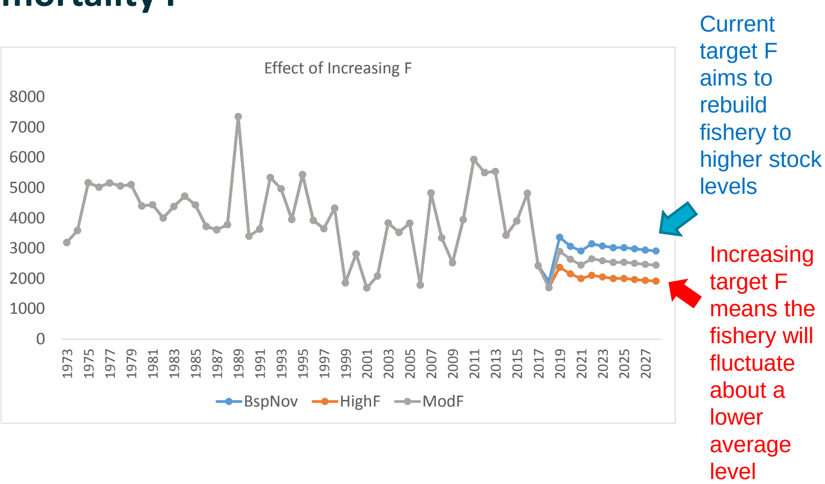



Fig. 1. Spawning biomass historical trajectory using the December 2017 Reference Case TRL stock assessment model and forward projecting using the current agreed target fishing mortality level, compared with alternative strategies with relatively higher target fishing levels.

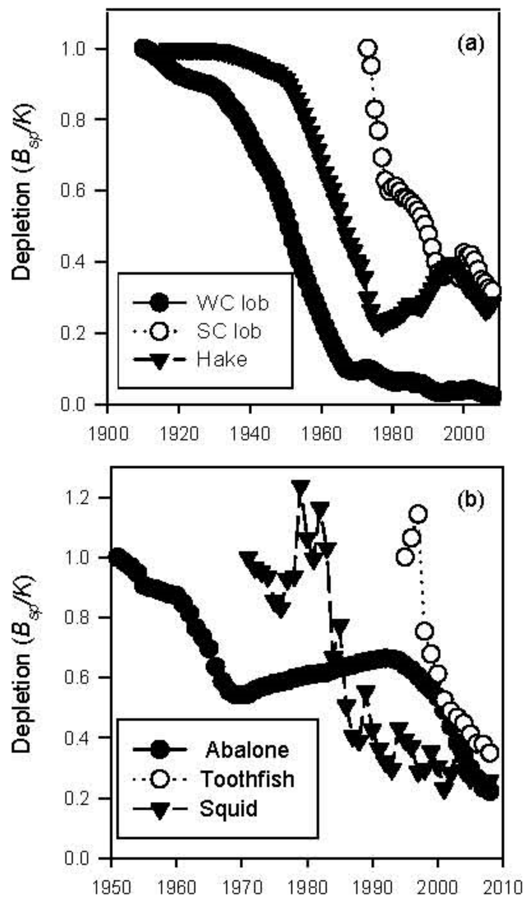



Fig. 2. Comparison of relative depletion (in terms of spawning biomass $B_{sp}$ as a proportion of average carrying capacity *K*) for several of the major South African fisheries a) hake (two-species combined) and West and South Coast rock lobsters; b) abalone, toothfish and squid (as total biomass). Trajectories shown are either "best" assessments, median trajectories or joint posterior modes. Source: Plagányi et al (2009).

**Stock Assessment Model**

- The stock assessment model is a statistical population model rather than a detailed mechanistic model. Hence whereas for example the annual contribution to the catch by residual male lobsters that remain in the area is not modelled explicitly but they are certainly included implicitly in that the model uses a long history to calibrate the expected stock productivity and satisfy the stated objectives and hence is based on an assumption of an average residual biomass. The model does explicitly quantify the predicted number of female and male 3+ lobsters combined, and the number of residual males remaining in Torres Strait and available to be fished during the following 4 months depends on the sex ratio, proportion of these lobsters that don't migrate as well as their growth and survival (all of which are likely influenced by food availability). If a constant proportion of the males chose not to migrate each year, then the inter-annual variability in the available number of residual lobsters could be expected to follow closely the pattern as shown in Fig. 3.

However, as evident from Fig. 4, there is no clear statistical relationship between the total number of 3+ lobsters predicted each year and the observed “early ” catch (eg. Total January to March) catch. Hence given indications that the proportion of residual males varies in a non-straightforward manner, it is difficult to accurately represent the residual male biomass in a model without further information. The commercial length frequency data also provide an index of the relative abundance of the residual male population, and this could be explored further. However before investing additional resources into trying to quantify this aspect, it is worth noting as per Fig. 5 that there is likely to be a small benefit (or penalty) at most to the annual RBC if the residual male biomass is explicitly analysed.

- There is some small inter-annual variability in Dec-Mar proportion of total catch (average 0.37; range 0.26-0.44) (Fig. 5). Given the observed level of variability, this suggests one could use estimates of residual biomass at most to adjust RBC up or down approx. 30t per year.
- The 2018 Dec_Mar catch is below average (even with 2005 excluded) (120t vs average of 139t or 157t (incl 2005)). Simplistically using proportions 0.44 & 0.37 suggests 2018 totals of 276t & 330t, slightly above the RBC estimate. If the RBC value of 199t for TIB and TVH combined is assumed equivalently reliable to previous assessments, this suggest the 2018 early catch is 60% the annual total, and hence the early catch proportion is higher than past observations since 2005 and may indicate a slight anomaly.

## Dec 2017 Ref Case Stock Assessment Model predicted numbers of 3+ lobsters

**residual males would be some (possibly variable) proportion of these**

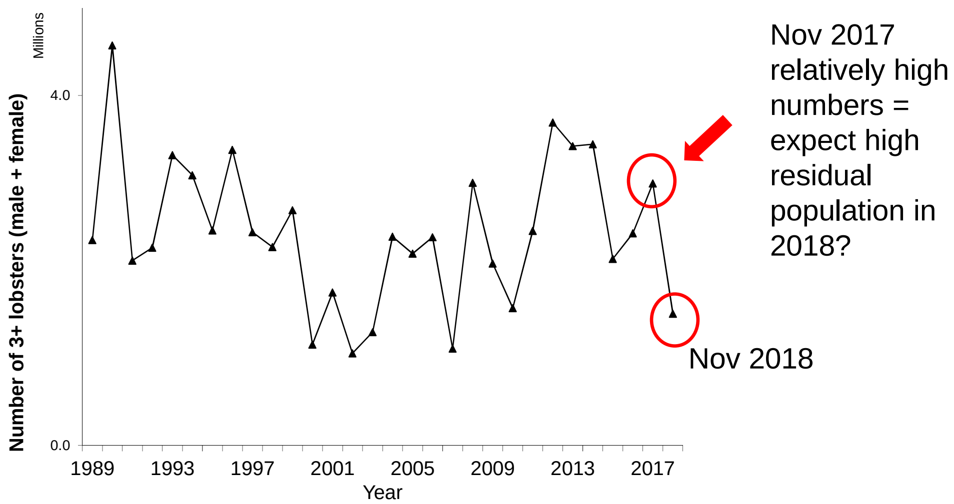



Fig. 3. December 2017 Reference Case TRL stock assessment model estimates of the total number (males and females combined) of 3+ lobsters present in November of each year.

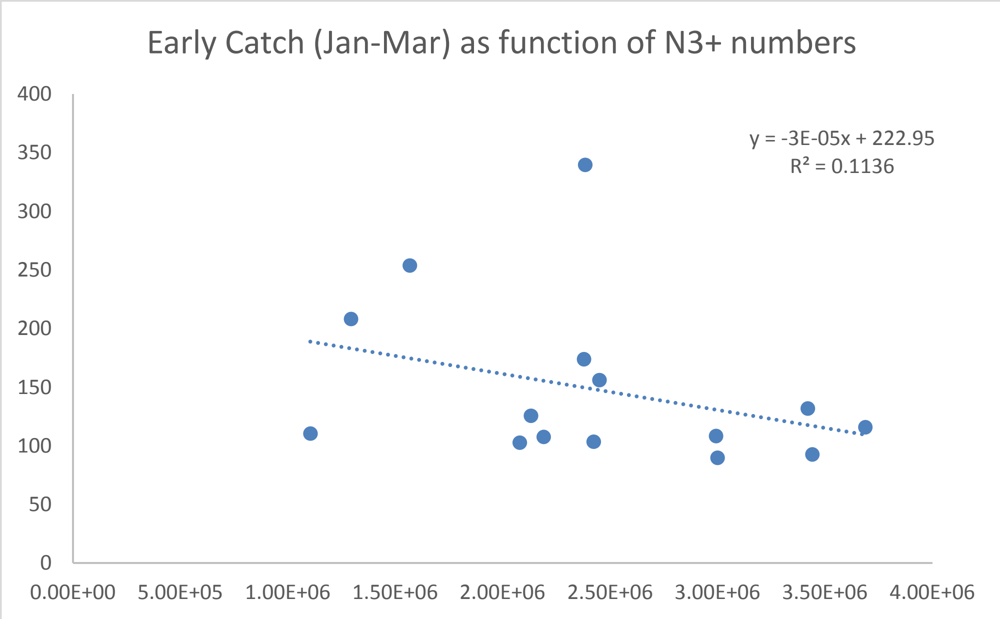



Fig. 4. Relationship between the Model-predicted relative numbers of 3+ lobsters in November and the catch taken the following January-March. A positive relationship would be expected under the hypothesis that each year a constant proportion of males don't migrate and become available to the fishery as residual males.

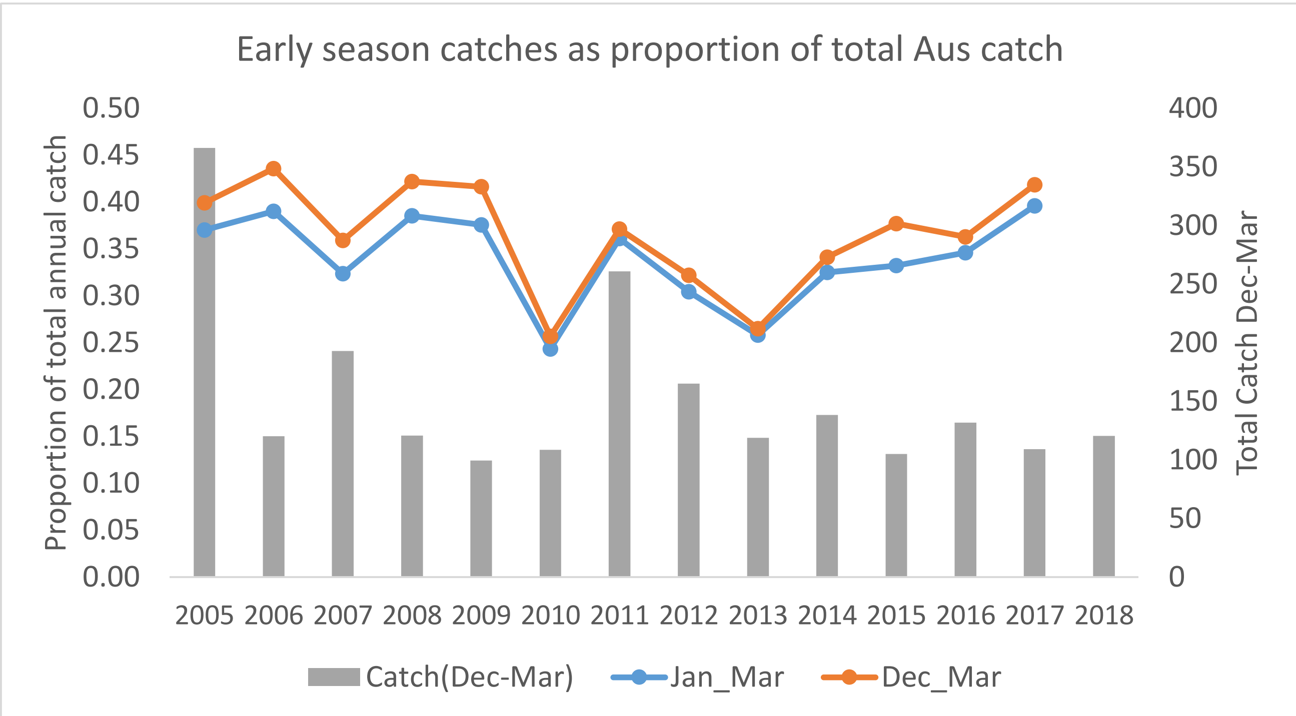



Fig. 5. Plot of the total "early" TRL (TIB+TVH) catch (December to March) and the early catch (computed either as Jan-Mar total or Dec-Mar total) as a proportion of the total annual catch.

**Uncertainties**

- As with most fisheries globally, there are a number of uncertainties associated with the data, surveys, assessment and analyses. For TRL, some of the major uncertainties relate to the accuracy and completeness of the data, and there are a number of processes that are being pursued to improve this aspect. It is also important to acknowledge that as with almost all highly variable fisheries, it is challenging to make predictions about future stock size – for example, despite considerable investment in science to understand the drivers of recruitment, there are almost no fisheries in the world that can demonstrate success in terms of explaining recruitment variability on the basis of environmental drivers. For this reason, TRL uses a Preseason survey as close as possible to the start of the fishing season to make as accurate a prediction as possible with available resources. Some larger fisheries use mid-season adjustments to optimise the economic gains from the fishery, and there is an associated trade-off with the cost and complexity of implementing such a system.
- In terms of the scientific assessments, it is possible to reduce uncertainty but there are associated costs. In light of efforts to reduce costs associated with the TRL fishery (eg reducing the frequency and scale of the survey, only funding a stock assessment every 3rd year), the current methods have been demonstrated to be adequate and have a reasonably long history of performing reasonably well (noting that considerable additional research is needed to forecast anomalous events).
- If these uncertainties can be reduced, then it is possible to set a less conservative RBC for the fishery, and hence for example, in a low year it is possible to recommend a higher catch for the same level of risk compared with a more uncertain assessment.

**Length Frequency Data**

- A recent updated analysis of the commercial length frequency information, including from data available for PNG and the East Coast, has been provided separately (Plaganyi et al. 2018)

**Midyear Survey Proposal**

- The TRLRAG have briefly discussed the pros and cons of conducting a Midyear survey in 2018 and a proposal and costing to inform decision making in this regard has been provided separately, noting the following objectives.
    - Conduct a Mid-year survey in July 2018 to determine the relative abundance of recruiting (1+) and fished (2+) lobsters, as well as the size-frequency of the TRL population in 2018, and habitat sampling
    - Analyse survey data to support answering key questions for management:
    - How should the CPUE data be standardised to ensure they represent a reasonably reliable index of spawning stock abundance?
    - Is there an anomalously large residual lobster population in Torres Straits in 2018?
    - Is the TRL spawning biomass close to target levels or are there concerns about the status of the 2018 spawning biomass?

- What do the population length frequencies, sex ratios and spatial distribution tell us about the current status or changes in the fishery?
- Did the 2017 November Preseason survey underestimate abundance?
- Is there evidence of any environmental anomalies, as evident for example from habitat sampling?
- How consistent is the 2018 1+ abundance with the predictions from the November 2017 0+ estimate, given concerns at the time that this index may not have been reliably estimated and the model was unable to satisfactorily fit the index?
- Provide a preliminary prediction of the expected 1+ recruitment for 2019 to provide a heads up on the likelihood of another poor year. The 1+ recruitment estimate will be compared with the November 2018 Preseason survey estimate, and will be incorporated into the stock assessment model.

- The attached Appendix summarises some preliminary suggestions for analysing the survey data to answer questions for management.

**References**

Campbell, R. et al. 2018 Torres Strait rock lobster fishery – summary of catch and effort data pertaining to the 2018 fishing season (Dec-17 to Apr-18). TRLRAG document, May 2018.

Dickey-Collas, Mark, Nash, R. D. M., Brunel, T., Damme, V., G, C. J., Marshall, C. T., … Simmonds, E. J. (2010). Lessons learned from stock collapse and recovery of North Sea herring: a review. *ICES Journal of Marine Science*, *67*(9), 1875–1886. https://doi.org/10.1093/icesjms/fsq033

Essington, T. E., Moriarty, P. E., Froehlich, H. E., Hodgson, E. E., Koehn, L. E., Oken, K. L., … Stawitz, C. C. (2015). Fishing amplifies forage fish population collapses. *Proceedings of the National Academy of Sciences*, *112*(21), 6648–6652. https://doi.org/10.1073/pnas.1422020112

Plagányi, É.E., Brandao, A., Butterworth, D.S., de Moor, C.L., Glazer, J., Johnston, S.J. and R.A. Rademeyer. 2009. Stock assessment in South Africa – building on a consistent yet flexible approach. Proceedings of the Fifth World Fisheries Congress. 2pp

Plagányi, É.E., Haywood, M., Tonks, M., Campbell, R., Deng, R., Murphy, N., Salee, K. & T. Hutton (2018) Updated length frequency analysis for TRL, April 2018. 19 April 2018 – out of session document to support management of Torres Strait TRL.

**Appendix 1 - Midyear Survey Potential Analyses**

**(A) Is the stock abundance significantly different to that predicted by the November 2017 survey and hence stock assessment?**

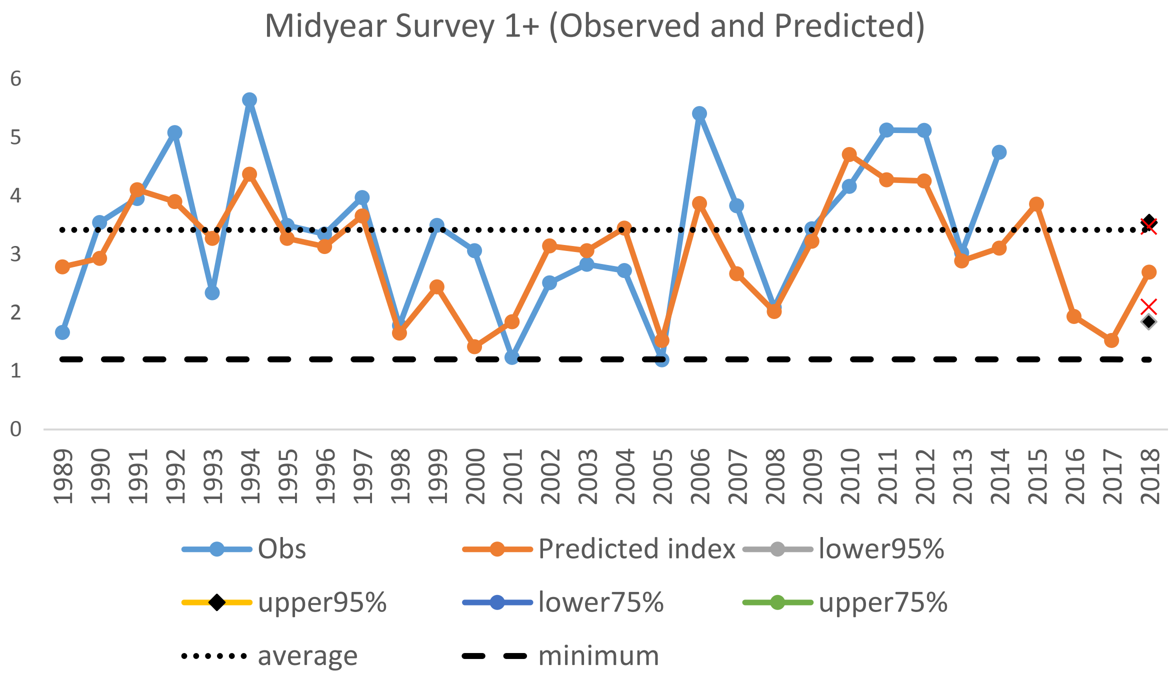
A Midyear survey conducted in an analogous fashion to previous surveys conducted every year over the period 1989-2014 would serve as an independent evaluation of stock abundance through comparison of the total stock abundance, as well as 1+ and 2+ relative numbers separately. The Dec 2017 stock assessment model has been forward projected to predict the expected survey indices (after applying the model estimated survey “catchability” estimates) and these could be compared with the actual observed July 2018 survey numbers. Accounting for survey observation error, one could then select a confidence level (eg 95% C.I.) and assess whether or not the observed survey prediction is significantly different to the model-predicted value. If the survey observation falls outside the expected confidence interval, then it would suggest the survey result is anomalous.

The last 6 midyear surveys used a similar number of sites, ranging from 73 to 77, and the average coefficient of variation (CV) (standard deviation divided by the mean) associated with 1+ and 2+ survey observations was 0.17 and 0.26 respectively. These CVs have therefore been used in calculating confidence limits for the 2018 midyear survey prediction (Fig. 1, Table 1) as a basis for comparison with actual observations. The 75% CI is also shown for comparison. Note that the 2+ estimate is particularly of interest as this gives an indication of the current year’s fishable biomass, for comparison with the 1+ recruitment prediction from the Preseason survey, as well as the future spawning biomass. The average 2+ index is 1.4 which is approximately double the “expected” value for 2018 of 0.69 (Table 1). Hence if the 2018 observed 2+ index is less than the upper 95% confidence limit of 1.04, this implies the stock is well below the average level. Note that the minimum observed 2+ survey index was 0.236 (in 2001), and hence the 2018 level is predicted to be below average but substantially greater than the lowest recorded level.

In contrast, the Midyear 1+ prediction is based on the November 0+ index which was considered much less reliable and the model over-estimated the 0+ abundance relative to the survey observation, so the prediction below may be positively biased for the 1+. However a 2018 Midyear survey 1+ observation could usefully be compared with the 2018 preseason survey index.

Table 1. Stock assessment model (Dec 2017 Reference Case version) prediction of 2018 Midyear survey expected relative numbers (i.e. equivalent to survey index) of 1+ and 2+, shown with lower and upper 75% and 95% confidence limits.

| | Value | lower95% | upper95% | lower75% | upper75% |
|---|---|---|---|---|---|
| 1+ | 2.69 | 1.84 | 3.54 | 2.10 | 3.47 |
| 2+ | 0.69 | 0.34 | 1.04 | 0.44 | 0.93 |



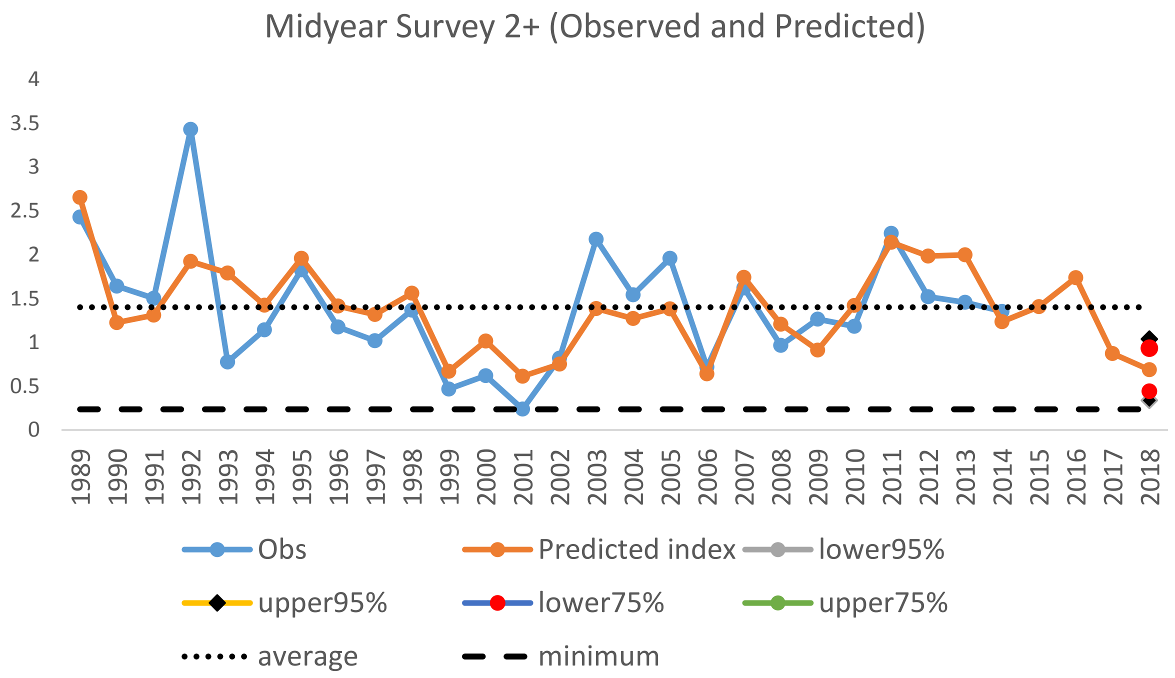




Fig. 1. Observed Midyear survey 1+ and 2+ relative abundance shown together with the corresponding model-predicted values over the period 1989-2014. The plots also show the model-predicted survey relative abundance for June/July 2018 together with confidence bounds based on the observed survey variance.

### (B) Is there an anomalously large 2+ residual biomass in 2018?

This can't be answered simply for a number of reasons including the high natural variability of the stock and also the stock assessment model is age-structured rather than size structured (in the interests of simplicity and cost, given that the size distribution of the stock has remained approximately constant over time and there are essentially only 3-4 cohorts). Moreover, answering this question relies on an indication of stock abundance as well as the sex-disaggregated size frequency. All of the following will thus be used to address this question:

(1) The 2018 midyear survey index of abundance (absolute abundance) and relative proportion of 1+ and 2+
(2) The CPUE data through the fishing season
(3) (?) The extent to which the midyear spatial distribution of the recruiting cohort matches the Preseason survey spatial predictions
(4) The commercial and survey sex-disaggregated length frequencies
(5) Comparison of the midyear survey length frequency with the expected pattern based on the von Bertalanffy growth curve
(6) (?) Possibly, comparisons with model-predicted sex-disaggregated length frequencies under a range of alternative hypotheses (eg similar to previous years versus many more residual animals)

There are a number of ways to statistically compare the average expected size distribution (Fig. 2) with a 2018 sample (e.g. model likelihood methods, Kolgomorov-Smirnov test + Wilcoxon text to compare medians of the distribution, additional simpler diagnostics comparing the properties of the distributions eg modal cohort size etc) and these will be applied as appropriate. Further analyses are required to first determine to what extent the historical data suggest a reference distribution for comparison, given there is a fairly high level of inter-annual variability. If necessary, a model could be used to make predictions based on past observations and current catches.

### (C) Can the midyear survey inform on standardisation of CPUE?

As per previous analyses (up until 2014), the midyear survey provides an objective indicator of the abundance of the 2+ animals, and hence can be compared with the TVH and TIB CPUE indices to assess to what extent these indices are reliable indicators of stock abundance. This can in turn inform on modifications needed to standardise the CPUE data to account for influences such as changes in fishing practices or efficiency, as well as potential hyperstability. This can therefore inform future standardisations of these data, particularly during phases when transitions in management are occurring and data are confounded to some extent by changing fishing practices.

### (D) Can the midyear survey inform on spawning stock abundance

As the Preseason survey doesn't provide a reliable index of 2+ abundance (as most lobsters have migrated out the area), the stock assessment (and eHCR once implemented) relies on the CPUE data to provide an indication of spawning stock biomass. However, given concerns as to the reliability of CPUE data (unless adequately validated and standardised when changes in fishing behaviour occur) and the possibility that fishing may cease or be substantially reduced before the end of the fishing season, the Midyear survey will potentially provide a valuable index of spawning stock abundance. This is particularly helpful given recent concerns of anomalous environmental impacts as well as the low observed 1+ abundance during the 2017 Preseason survey, which raised concerns for the 2018 spawning biomass.

### (E) What other data are provided by the midyear survey that may be of use?

The midyear survey uses a habitat-stratified sampling design (refs) to produce standardised abundance indices for different spatial regions. The spatial distributions can therefore be used to inform on stock distribution and abundance. In the event of any anomalies, the detailed spatial information will be valuable in understanding the underlying dynamics. Although the survey design will be kept as consistent as possible with the Preseason survey, a few less-essential sites may be swapped for a few “new” sites (“new” in the sense of not having been surveyed recently but selected based on the full set of past sites surveyed) to survey current “hotspot ” areas and assess the potential contribution of these to overall estimates of stock abundance. In addition, detailed habitat information is recorded as per all previous surveys and may assist in explaining any anomalies encountered.

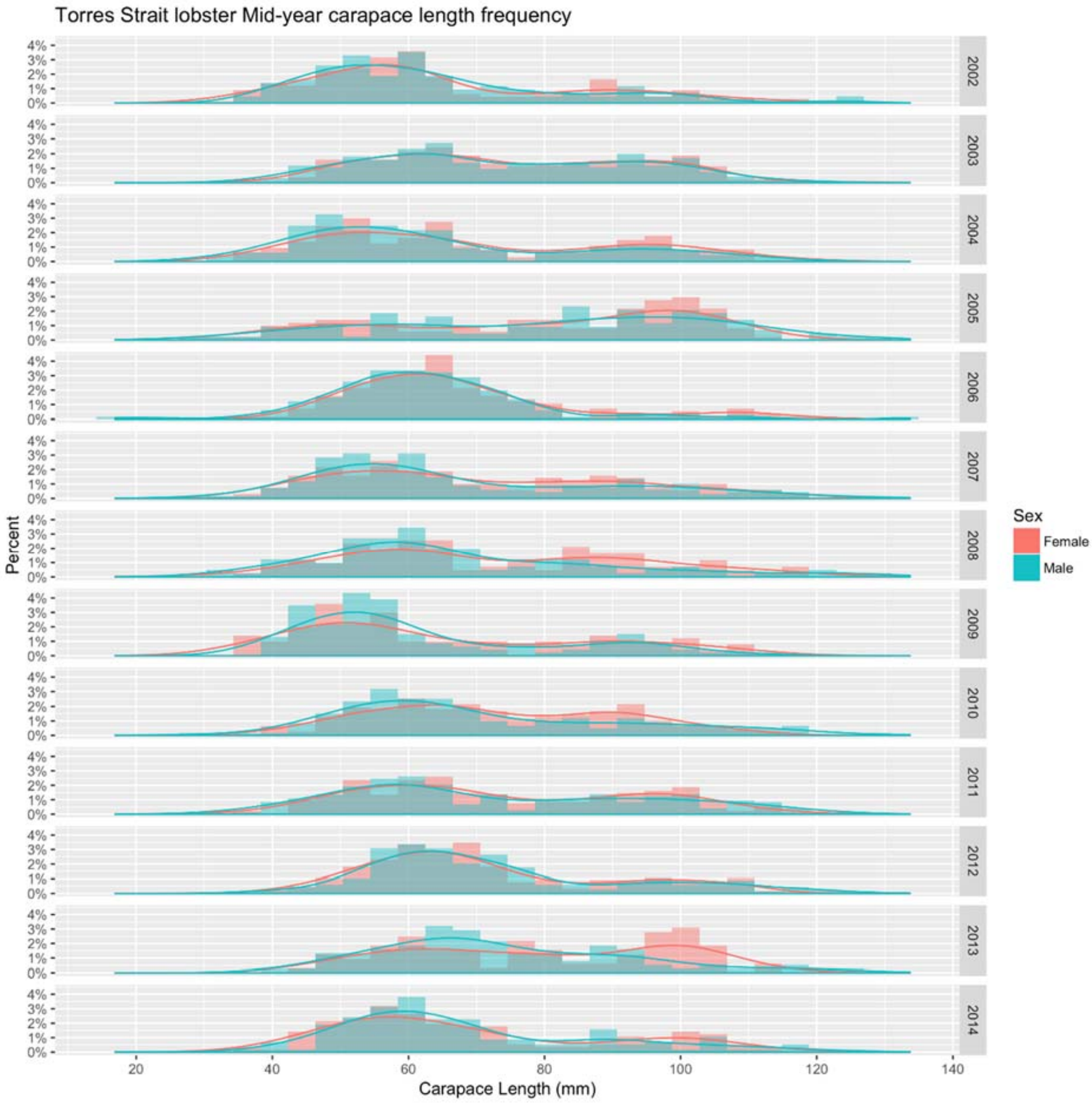
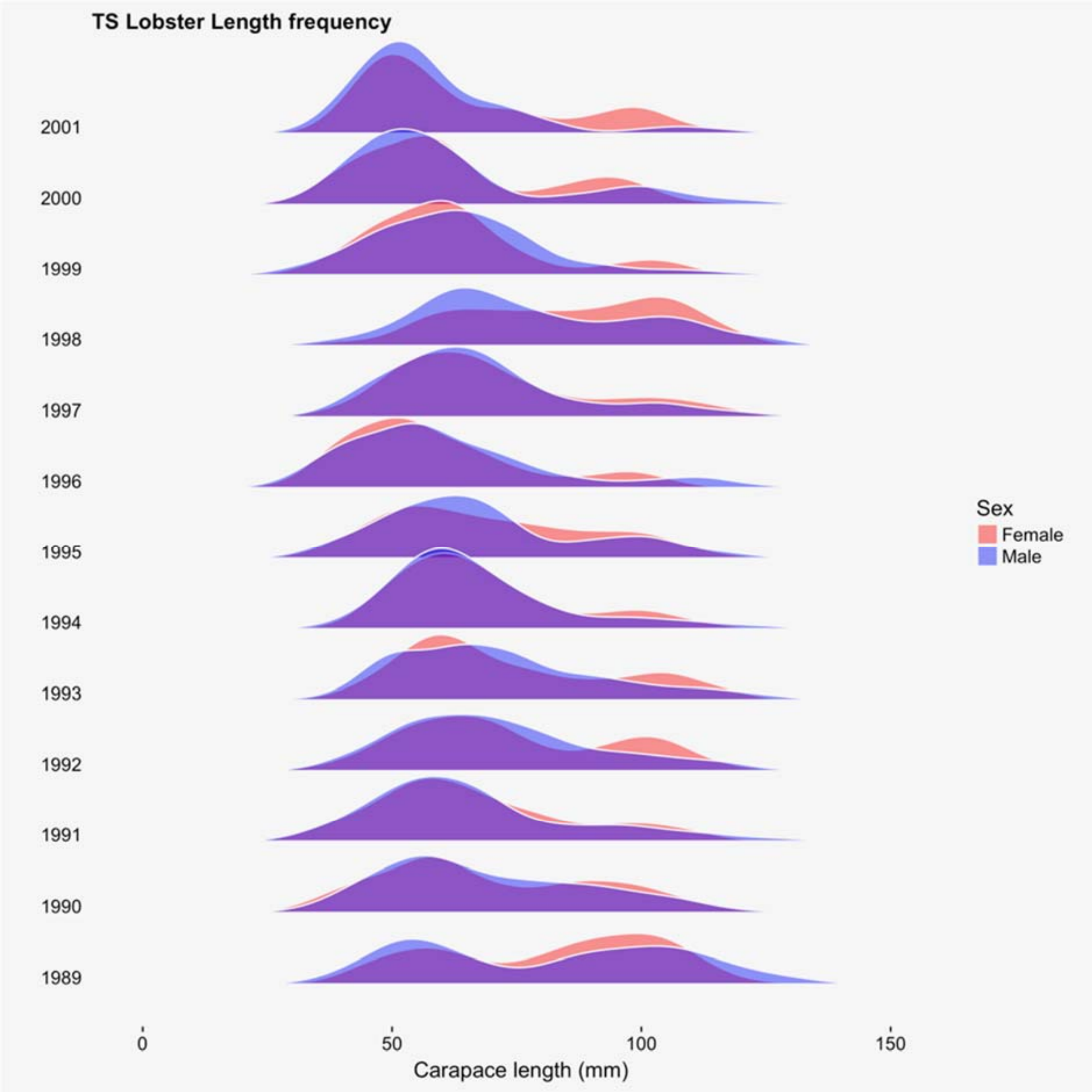



Fig. 2. Sex-disaggregated length frequency distributions from Midyear surveys during 1989 to 2004.


TS Lobster Length frequency
2001
2000
1999
1998
1997
1996
1995
1994
1993
1992
1991
1990
1989
0
50
100
150
Carapace length (mm)
Sex
Female
Male

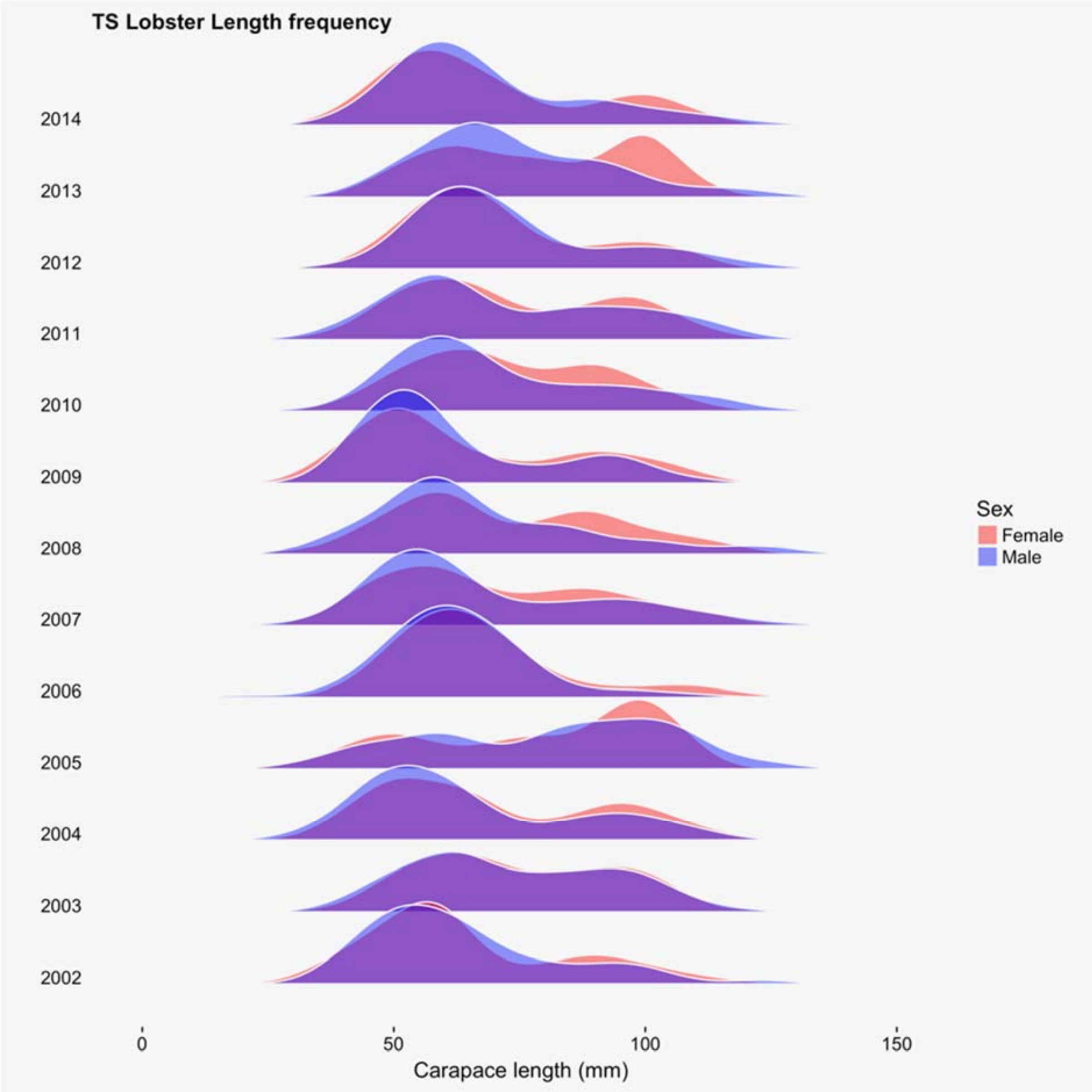



Fig. 3. Ridgeline sex-disaggregated length frequency distributions from Midyear surveys during 1989 to 2004.

| | |
|---|---|
| **TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG)** | **MEETING 23**<br>**15 May 2018** |
| **2017/18 TRENDS IN 2+ LOBSTER ABUNDANCE** | **Agenda Item 4**<br>**For Discussion and Advice** |

## RECOMMENDATIONS

1. That the RAG **DISCUSS** and **PROVIDE ADVICE** on:
   a. the likelihood of anomalous residual 2+ lobsters in the fishing grounds; and
   b. if relevant consider the implications for future stock assessments and recommended biological catch (RBC) calculations.

## KEY ISSUES

2. At the last TRLRAG meeting on 27-28 March 2018 (TRLRAG 22) the RAG noted that length frequency data available from January 2018 suggested large male 2+ lobsters left over from the previous fishing season comprised a substantial proportion of the catch. It was expected that when the 2+ lobsters are mostly caught, which they generally are during a season, there will be a drop in CPUE as they are replaced by a lower abundance of 1+ lobsters.
3. A further update from CSIRO which was provided to members on 23 April 2018 (**Attachment 1.2a**) concluded that based on sex-disaggregated length frequency data from February-March 2018, there continue to be a substantial proportion of large males being caught and some 1+ recruitment from last year is growing into the fishable size class but there isn't a particularly large influx. Additional data would be required to assess whether there is a residual abundance of non-migrant 2+ lobsters that is greater than expected. There are currently insufficient data to separate the hypothesis from the alternative hypothesis that the recent catches and catch rates are higher due to increased fishing effort and efficiency that is characteristic of fisheries in situations where quota is constrained.
4. The RAG is being asked to:
   a. consider the likelihood of anomalous residual 2+ lobsters in the fishing grounds;
      i. consider the evidence;
      ii. can the amount be estimated / quantified;
   b. if relevant, consider the implications for future stock assessments and RBC calculations.
5. Further advice from CSIRO on whether there is an anomalously large 2+ residual biomass in 2018 is provided in **Attachment 3d** (Appendix 1).

# Initial evaluation of the relative contribution of residual tropical rock lobsters *Panulirus ornatus* to early season catches in the Torres Strait

**Andrew Penney**
**Pisces Australis (Pty) Ltd**

## 1. Rationale

A relatively low recommended biological catch (RBC) of 299t was recommended for the 2018 Torres Strait tropical rock lobster (TRL, *Panulirus ornatus*) season, based on the results of the most recent dive survey and stock assessment presented by Plagányi *et al.* (2018a) at the AFMA TRL Resource Assessment Group (RAG) meeting on Thursday Island on 27-28 March 2018. This low RBC estimate was driven primarily by the November 2017 lowest pre-season survey 1+ index on record, and expectations that this low 1+ abundance would result in low availability of 2+ lobsters, upon which the bulk of the catches depend, in 2017. Fishers fishing towards the east of the Strait or around Thursday Island reported poor early season catches. In apparent contrast, those fishing towards the north-western end of the Strait reported reasonably good catches and catch rates of large lobsters during January 2018, considering these to indicate an average season.

A number of potential scenarios could have transpired at the start of the 2018 season:

- If catch rates and catches had been generally low, and industry had struggled to find legal-sized lobsters to catch, then there would probably have been greater acceptance of the low pre-season survey index and the resulting low TAC. There would still have been discussions around sectoral allocation of this TAC, but less so around the survey index, biomass estimate and TAC themselves.
- Conversely, if good catches and catch rates had been made over a wide area of smaller lobsters clearly derived from growth and recruitment of the 1+ lobsters surveyed in 2017, then there would have been strong indications that the November 2017 1+ index was under-estimated, and that the survey had somehow missed large numbers of these recruiting lobsters somewhere.

Neither of these two scenarios occurred. There were no indications of strong 1+ recruitment in early 2018 season catches, and yet good catches were made of large 2+ lobsters, at least in the western area. The apparent contradiction between predicted low availability and apparent relatively high early season abundance prompted the following questions:

- Was the November 2017 pre-season survey 1+ index under-estimated for some reason, such that 2018 early season recruited lobster abundance was higher than predicted?
- Did the industry simply fish harder in response to the lower TAC at the start of the season, resulting in higher than expected early season catches despite low abundance?
- Was there a higher than expected residual abundance of non-migrant 2+ lobsters remaining in the Torres Strait at the start of the season, resulting in good catches in the north-western area despite low abundance of new recruits?

These questions were partially addressed in Plagányi *et al.* (2018b). Regarding whether the pre-season survey 1+ index was under-estimated, length composition of January catches shows that there was little contribution of 1+ lobsters to the early 2018 season catches, providing no evidence of high abundance of new recruits. This indicates that the November 2017 survey 1+ index was probably not under-estimated.

Regarding whether industry has been fishing harder than usual in response to the low TAC, initial analysis of 2018 early season nominal CPUE was presented in Plagányi *et al.* (2018b). This showed that January 2018 nominal CPUE was a little below the average since 2004, but that February 2018 CPUE appeared to be a little higher than average, potentially supporting industry views regarding the early 2018 season being close to average. However, anecdotal reports at the March 2018 TRL RAG meeting indicated that some fishers in the eastern and southern areas had been fishing longer hours to achieve catches in these areas. Such changes in fishing power have not yet been analysed and need to be accounted for before the CPUE information can be reliably interpreted as an index of abundance. This should be a focus of work by the TRL RAG

The third question has not really been addressed: were there actually more residual, non-migrant 2+ lobsters in the Torres Strait at the start of the 2018 season than expected, and did these support the good catches and catch rates in January and February 2018? It is clear from fisher reports at the TRL RAG meeting of 27-28 March 2018, and from the analysis of length composition of January 2018 catches, that the 2018 early season catches were primarily made in a relatively limited area around Maubiag in the northwest of the Strait, and consisted primarily of large 2+ male lobsters remaining in the area from the previous season. These appear to have aggregated in an area of suitable seabed resulting from natural clearing of previous sand inundation from the area.

If there was an unexpectedly high residual abundance of large lobsters, then this was not accounted for in the stock assessment projections of exploitable biomass from which the 2018 season RBC was estimated. Evidence of additional residual, non-migrant biomass above that estimated by the stock assessment raises the question of whether some start-of-season adjustment to management arrangements may have been warranted under such circumstances.

Before such adjustments can be considered, it is necessary to consider how start-of-season residual lobster abundance might be reliably evaluated, how it might be determined whether this is higher than 'usual', and whether there is convincing evidence that there is enough additional early season lobster biomass in the Strait to justify an adjustment of management arrangements. This paper presents some initial analyses exploring:

1. What information might be used to ascertain the magnitude of residual, non-migrant lobsters in the Torres Strait at the start of the season; and
2. Whether such information might be suitable for use as an index of residual lobsters for the purposes of adjusting start-of-season management arrangements.

## 2. Methods

### 2.1 Information used

Length-frequency compositions used for the analyses presented in this report were graphically scaled from results presented at the March 2018 TRL RAG meeting by Plagányi *et al.* (2018b) (slides 43 and 44 in their presentation to the March 2018 TRL RAG meeting). These estimated length compositions are close to the length-frequency composition results presented by Plagányi *et al.* (2018b) and are adequate for the purposes of the initial analyses in this report. All analyses were conducted in MS Excel® and could easily be repeated with the actual data. Plagányi *et al.* (2018b) report that the data used to derive these early 2018 season length composition results were originally derived from two sources: the CSIRO generated length composition data for 1+ lobsters encountered during the November 2017 pre-season diving survey (survey results), and length sample measurements provided to CSIRO by M.G. Kailis for catches handled by them during January 2008, 2015, 2016 and 2018 (industry catches).

The resulting estimated carapace length composition in January 2018 is shown in Figure 1a, showing an overlay of the length composition of January 2018 catches and the predicted length composition of 1+ lobsters derived by adding growth to the 1+ lobsters measured in November 2017. Figure 1b shows the original length composition of the 1+ lobsters measured during the November 2017 preseason survey, used to derive the predicted length composition in Figure 1a by addition of growth. These figures may be compared with the source figures in Plagányi *et al.* (2018b) to verify their reasonable accuracy.

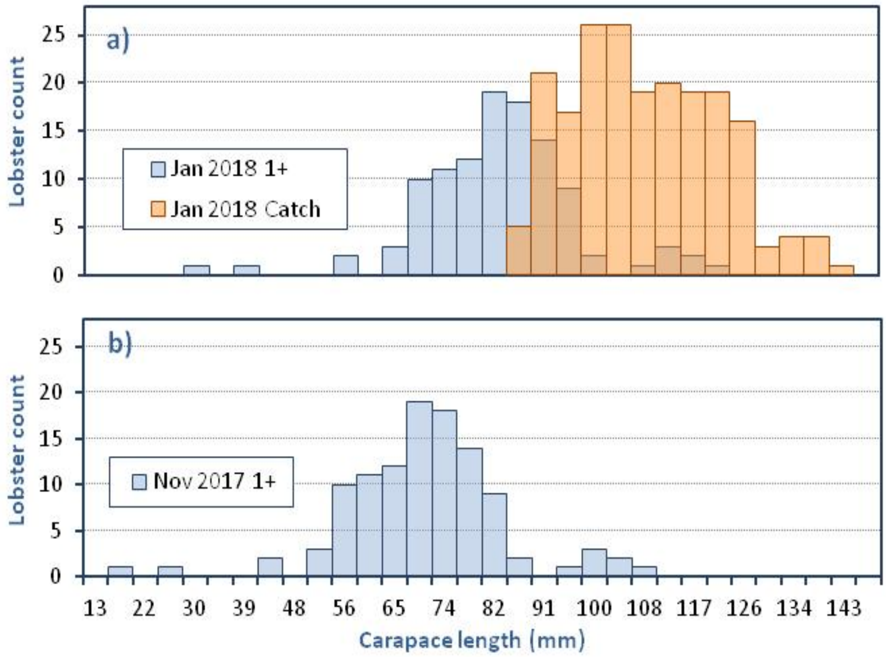



**Figure 1. Length-frequency composition of Torres Strait tropical rock lobster (numbers of lobsters per carapace length size class) during January 2018 (graphically scaled from Plagányi *et al.* 2018b) showing: a) Overlay of length composition of lobsters caught in January 2018 and the estimated length composition of 1+ lobsters derived by growth progression from the length composition observed during the November 2017 pre-season diving survey; and b) Original length composition of lobsters measured during the November 2017 pre-season survey, used to generate the 1+ length composition in a) by addition of predicted growth.**

Length compositions for lobsters in start-of-season catches are shown in Figure 2 for January 2008, 2015, 2016 and 2018, scaled from figures in Plagányi *et al.*(2018b). These figures may be compared with the source figures in Plagányi *et al.* (2018b) to verify their reasonable accuracy.

The length compositions shown in Figure 1 and Figure 2 were used in all of the analyses presented in this paper. Additionally, conversion formulae for growth rate and weight-at-length were obtained from Plagányi *et al.(*2018b), cited in turn from Phillips *et al*. (1992), for the von Bertalanffy growth relationship and length : weight relationship as follows:

$$L_m = 165.957 \times 1 - e^{((-0.0012 \times 30 \times m))}$$

$$W_m = 0.00258 \times \left({L_m}^{2.76}\right) / 1000$$

where $L_m$ is carapace length (mm) and $W_m$ is mass (kg) for an individual aged $m$ months.

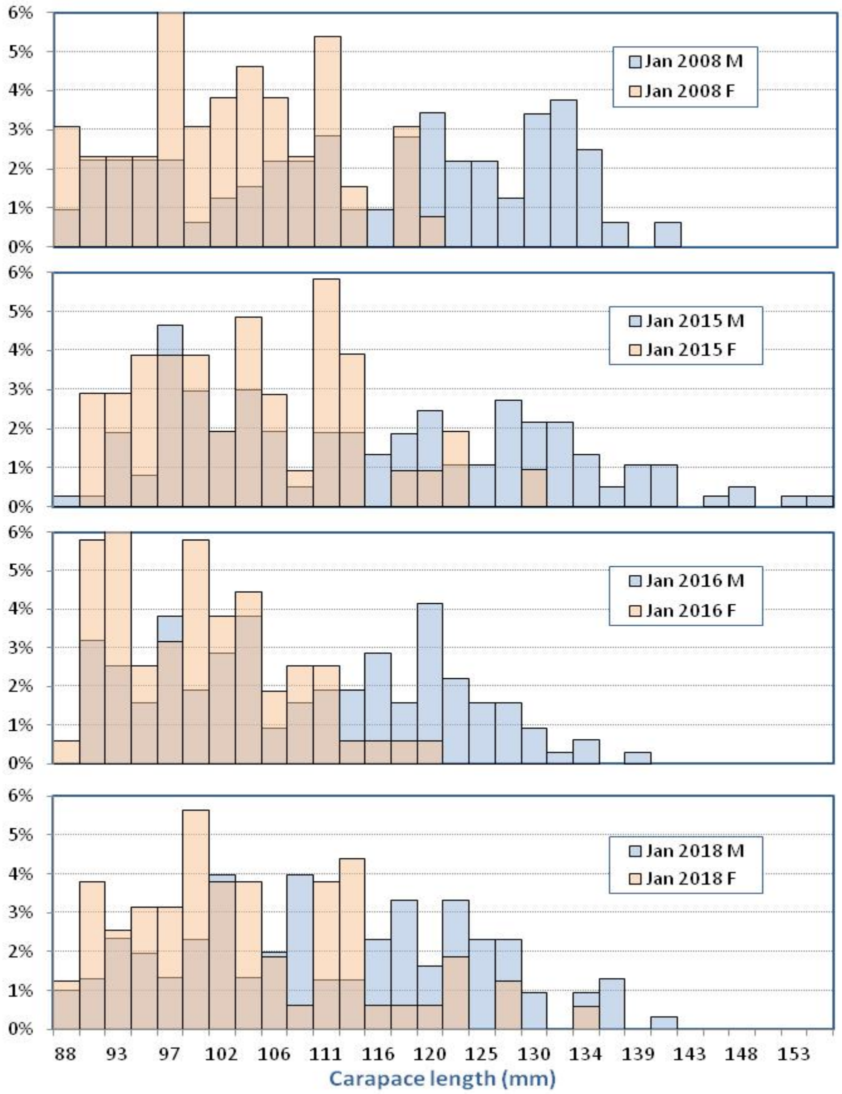



**Figure 2. Overlaid length composition of male and female tropical rock lobsters (percentage of lobsters per carapace length size class, graphically scaled from Plagányi *et al.* 2018b) of catches made in the Torres Strait during January 2008, 2015, 2016 and 2018 respectively.**

# 3. Results

## 3.1 Modal separation of 1+ and 2+ lobsters

The rapid growth of tropical rock lobsters results in good separation of length composition distributions into clear modes for 0+, 1+ and 2+ lobsters, particularly early in the season when 1+ lobsters are still below the minimum size limit. This should make it possible to identify the relative contributions of 1+ recruits and 2+ residual lobsters in length compositions. However, high growth rate is typically associated with high growth variability, which results in wide variation in size-at-age. While the respective age modes are clear, there is substantial overlap of age classes, with lobsters mid-way between the 1+ and 2+ modes being either fast-growing 1+ lobsters, or slow-growing 2+ lobsters. This needs to be dealt with in some way, to separate the modes and determine the relative contributions of 1+ and 2+ lobsters at these intermediate lengths.

This modal separation analysis should take into account the growth variability found during the ageing study for this species (Phillips *et al*. 1992), or from analysis of adequate and representative length-frequency data for each season, to inform the fitting of distributions to the respective age classes (such as done when using an age-length key). These can then be used to proportionately allocate ages to the lobsters in overlapping areas of the modal distributions, with lobsters lying between the modes being estimated to consist of inter-grading proportions of the two age classes. In the absence of adequate data on the age-composition of length compositions in each year, a simpler 'cohort-slicing' approach can be adopted. This makes the assumption that lobsters below some threshold length between the modes are all 1+, while those above that length are all 2+. For the purpose of exploratory analyses in this paper, and in the absence of information on annual variability in age-at-length, this cohort-slicing approach was adopted.

To inform the choice of an appropriate threshold length to be used to separate 1+ and 2+ lobsters, the predicted 1+ and sampled 2018 catch length composition in Figure 1 were first expressed in terms of percent contribution. Given that the November 2017 lobsters were all 1+, and assuming that the 2018 catch predominantly represented 2+ lobsters, normal distributions were then fitted to the predicted 1+ and the assumed 2+ lobster percent length compositions. The results are shown in Figure 3. Partially as a result of growth variability and partially as a result of the assumptions regarding age of caught lobsters, the fitted normal distributions are fairly wide, with 1+ lobsters having a mean carapace length of 83.2mm (90%CI 56-110mm), and assumed 2+ lobsters having a mean carapace length of 108.5mm (90%CI 83-134mm).

These modal and mean sizes of these fitted distributions correspond to predicted ages of 19 months and 29 months respectively, using the von Bertalanffy growth equation, confirming that these are appropriately spaced for 1+ and 2+ lobsters. Within the 90%CI overlap range of 83mm and 110mm, the proportion of 1+ and 2+ lobster should change steadily from predominantly 1+ to predominantly 2+. For the purpose of the exploratory analyses in this paper, the cohort-slicing assumption was made that all lobsters below the crossover point of ~97mm between the two normal distributions are 1+, while all those above that size are 2+. This crossover threshold length is indicated by the red dashed line in Figure 3.

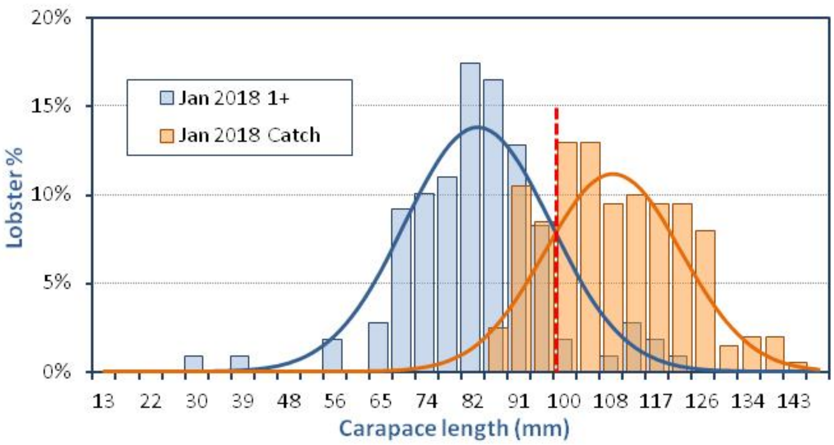



**Figure 3. Length compositions from Figure 1 expressed in terms of percent contribution by carapace length class, with fitted normal distributions to the 1+ and 2018 catch (assumed 2+) lobster length compositions. The dashed red line marks the separation point between the 1+ and 2+ distributions at ~97mm carapace length.**

Having chosen a threshold carapace length between age classes, this can be used to separate 1+ and 2+ lobsters in length compositions for catches. Relative contributions of recruiting 1+ lobsters and residual 2+ lobsters can then be compared between years, to evaluate differences in the annual contribution of 2+ lobsters to early season catches. Providing some measure of the 'expected' contribution of 2+ lobsters can be determined, years can be identified with 'above-expected' and with 'below-expected' residual 2+ lobsters in catches, potentially providing an index of residual lobsters at the start of each season.

How such an approach might be used is hypothetically illustrated in Figure 4 for the lobster size compositions in Figure 3. Under the assumption that all 2+ lobsters should have migrated out of the area, catches should then have consisted entirely of recruiting 1+ lobsters. These 1+ lobsters would constitute the 'expected' size composition. The plot of difference between 'observed' (caught) minus 'expected' (1+) lobsters in Figure 4 shows that, in this hypothetical scenario, there was an absence in catches of the expected 1+ recruits but an above-expected contribution by 2+ lobsters, which would be residual non-migrant lobsters from the previous season.

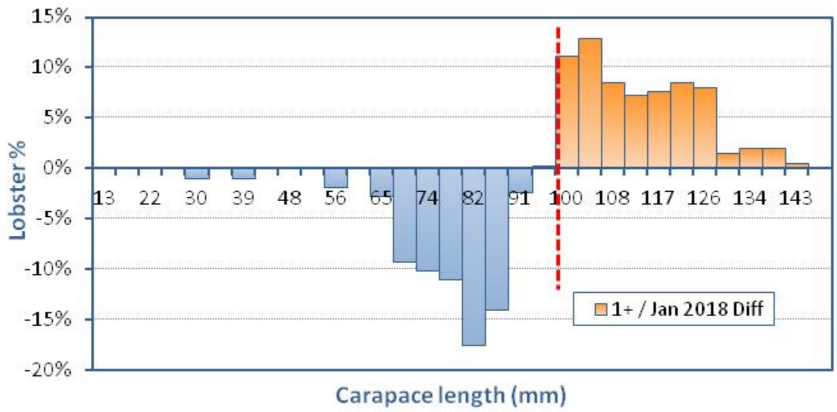



**Figure 4. Difference between 'expected' (recruiting 1+) and 'observed' (caught) length composition of lobsters in January 2018, under the assumption that all residual lobsters should have migrated out of the area and that catches should have consisted of 1+ lobsters derived from those measured in the November 2017 pre-season survey.**

## 3.2 Annual contribution by 2+ lobsters to January catches

The approach of evaluating the difference between observed and expected size composition illustrated in Figure 4 can be applied to annual size compositions to compare the relative contribution of residual 2+ lobsters to early season catches in each year. To do so, some measure of the 'expected' 2+ lobster catch is required against which to compare each year's observed size composition. One option would be to assume that all 2+ lobsters migrate out of the area each year, so that the 'expected' catches should consist entirely of recruiting 1+ lobsters derived from those measured during the preceding year's pre-season survey, such as is done in the hypothetical scenario shown in Figure 4. However, this is unrealistic, and it is clear from Figure 2 that residual 2+ lobsters contribute significantly to early season catches every year.

A more realistic approach is to determine the average contribution of residual 2+ lobsters to early season catches across years, and to then compare each individual year to this average to determine whether the contribution by residual lobsters was above or below average in each year. Size composition results are provided by Plagányi *et al.(*2018b) for January Torres Strait catches for 2008, 2015, 2016 and 2018 (Figure 2). At the start of the 2018 season, the size composition of January 2018 catches would not be known, so the average would need to be determined across the preceding years 2008, 2015 and 2016. For the following analyses, the average size composition over January 2008, 2015 and 2016 was assumed to represent the 'expected' size composition of January catches. (A longer time series of early season size composition data would be preferred to calculate an expected average, and could accrue over time.)

For each of the years 2008, 2015, 2016 and 2018, the average size composition was subtracted from the observed composition to determine the difference between these for each year. The maximum size for this analysis was restricted to the 146mm carapace length size class, this being about the maximum of the normal distribution fitted to the assumed 2+ lobsters in Figure 3. The resulting differences between observed and expected percent contribution of each carapace length size class in each of the four years are shown in **Error! Reference source not found.**. The differences per individual size class were then aggregated across the size classes 88-97mm and 100-146mm, these being the estimated size ranges of 1+ and 2+ lobsters separated at the threshold length of 97mm shown in Figure 3. The resulting aggregated differences between observed and expected contribution of 1+ and 2+ lobsters are shown for each year in the side plots in Figure 5.

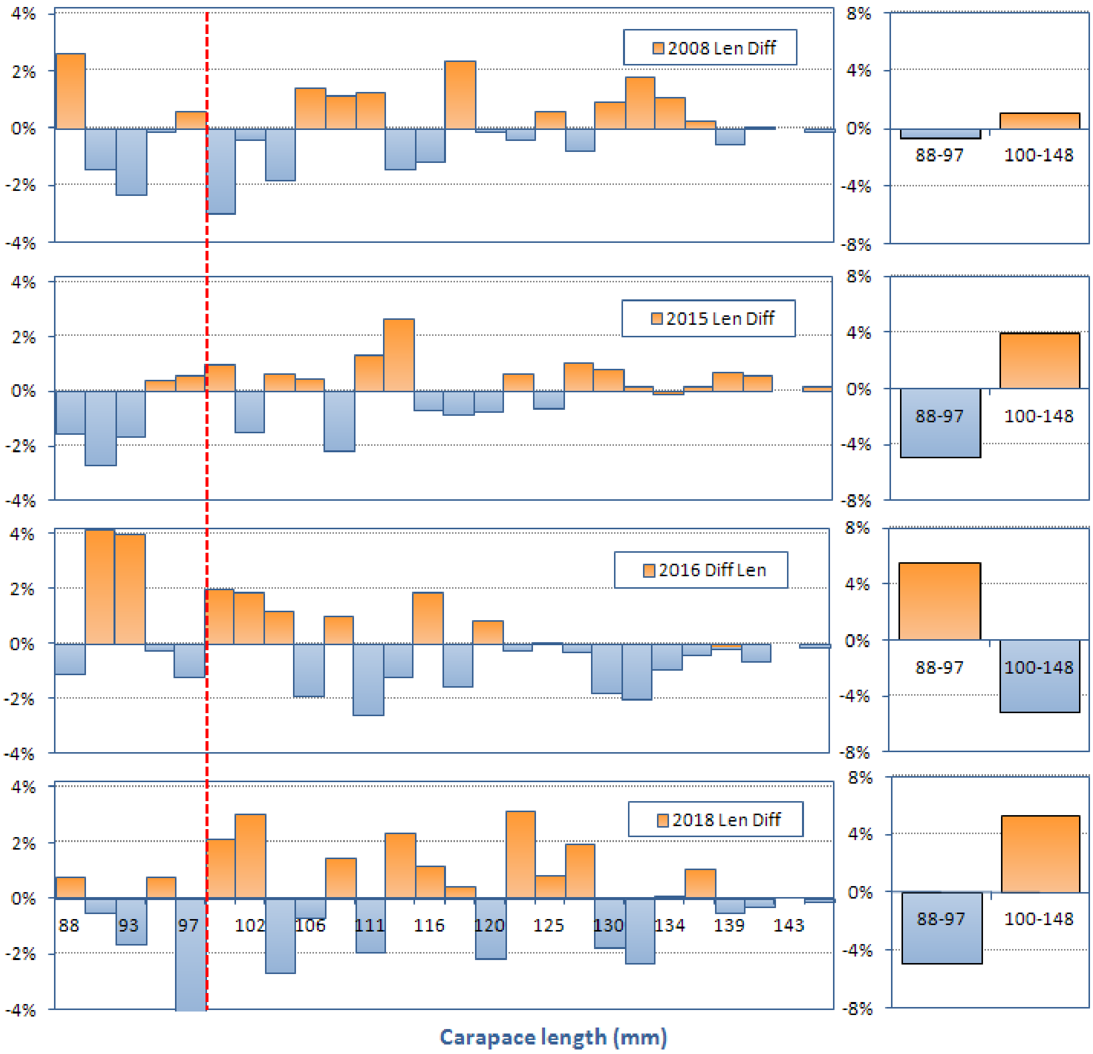



**Figure 5. Difference between the observed annual percent size composition of tropical rock lobster catches in January 2008, 2015, 2016 and 2018 minus the 'expected' (average over January 2008, 2015 and 2016) size composition. Side plots show the aggregated contribution of 1+ (88 - 97mm classes) and 2+ (100 - 138mm classes) lobsters in each year, using the 1+/2+ dividing threshold length of 97mm from Figure 3, indicated by the red dashed line.**

The aggregated differences between observed and expected contribution for the 100-146mm carapace length lobsters (the assumed 2+ cohort) potentially provide an index of relative residual 2+ lobster abundance for the years shown, indicating when this was above or below average (the righthand columns in the side plots in Figure 5). Despite there being only four years of January length composition for this analysis, there is marked contrast between years, particularly between 2016 and 2018. In January 2016 the aggregated length-class contribution of 2+ lobsters to January catches was 5.1% below the average for the three years, whereas the contribution of 2+ lobsters to January catches in 2018 was 5.3% above average.

The differences from average in Figure 5 are expressed in terms of percent contribution of numbers of lobsters by length class. To understand the contribution of residual lobsters to catches, it is more relevant to express these results in terms of catch weight. The percent contributions by length class shown in Figure 5 were converted to percent contributions by weight using the length : weight relationship (Phillips *et al*. 1992, see Methods). The differences between observed and expected weight percent contributions were then determined, as for the length compositions in Figure 5, and aggregated for the 1+ and 2+ lobster size class ranges. The aggregated percent differences between observed and expected 1+ and 2+ lobsters were then converted to catch weights by multiplying the aggregated 1+ and 2+ percent weight differences by the reported catch weight for January in each of the four years. The resulting catch weight differences for the 100-146mm (2+) lobsters are summarised for each year in Figure 6.

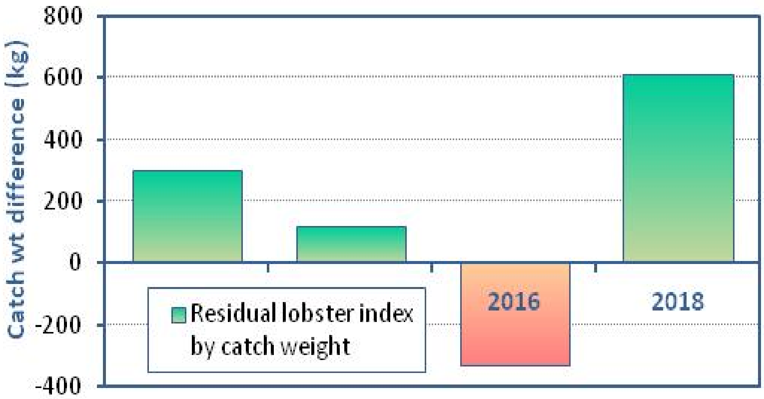



**Figure 6. Annual differences from average January catch weight of 2+ (100 - 146mm carapace length) lobsters in 2008, 2015, 2016 and 2018.**

The conversion to weight amplifies the contribution of larger lobsters, further emphasizing the inter-annual differences, particularly for 2018 (although note that the actual aggregated weight differences are fairly small, ranging from ~100kg to ~600kg).

Higher contribution of 2+ lobsters to January catches could be attributed to a higher abundance of residual, non-migrant lobsters in the fishing areas at the start of the season. However, a question arises as to why the contribution of 2+ lobsters was notably below average, and the contribution of 1+ lobsters was notably above average, in 2016. This might indicate that there was an unexpectedly high abundance of 1+ lobsters in the Strait in early 2016. In fact, the preceding year 2015 1+ survey index was the highest on record, almost 4 times the low 1+ index in the November 2017 survey (Plagányi *et al*. 2018b). This raises the question of whether it was high abundance of 1+ lobsters in November 2015 that resulted in the increased catches of 1+ lobsters in January 2016.

The relationship between the contribution of residual 2+ lobsters to January catches (from Figure 6) and the preceding year pre-season survey 1+ abundance index is shown in Figure 7. There does appear to be a relationship between these indices, complicating attempts to understand the causative mechanism for variation in contribution of residual 2+ lobsters to January catches. The relationship with the pre-season survey 1+ indices (Figure 7) suggests that the relative proportions between 1+ lobsters in early season catches might simply result from the proportional availability of 1+ recruits rather than abundance of residual 2+ lobsters – when there are lots of recruiting 1+ lobsters around, their contribution increases, and the relative contribution of larger 2+ lobster decreases, and *vice versa*. It is likely that the relative contribution of 2+ lobsters results from a combination of these two mechanisms..

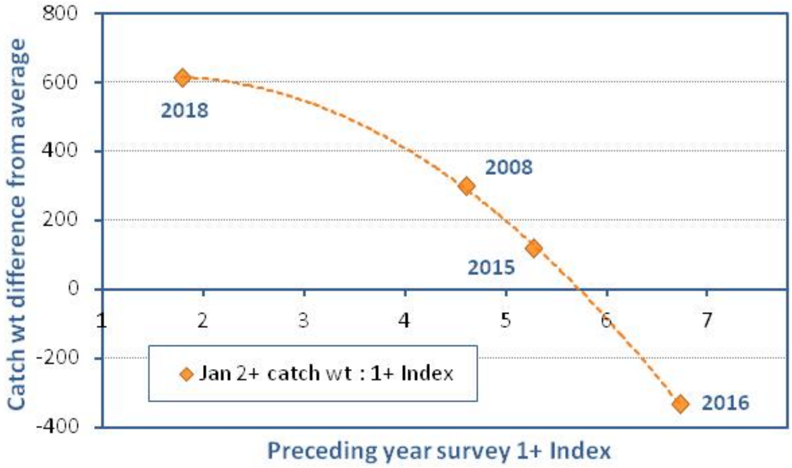



**Figure 7. Relationship between estimated contribution of residual 2+ lobsters (expressed as the difference from average) in 2008, 2015, 2016 and 2018 and pre-season survey 1+ abundance indices for the preceding years.**

## 4. Discussion

Residual, non-migrant lobsters clearly make a substantial contribution to early season catches in the Torres Strait (Figure 2, Figure 5). In the four years 2008, 2015, 2016 and 2018 for which size composition results are available for January, lobsters larger than 100mm carapace length contributed between 64% and 75% of the reported TIB and TVH sector January catches (Figure 5). Assuming similar spawning, growth and recruitment patterns each year, and applying simple cohort slicing at a carapace length of 97mm (Figure 3), these lobsters would predominantly be 2+ residual, non-migrant lobsters remaining in the area from the previous season.

There are differences between years in the relative contribution of 2+ lobsters to January catches, indicating that there may have been different abundance of residual 2+ lobsters in the area in different years (Figure 5). Estimation of the relative contribution of these larger lobsters to January catches might potentially provide the basis for an index of abundance of these residual lobsters.

The relative contribution of assumed 2+ lobsters to January catches was highest in 2018, contributing 75% of the January catch and being above the average over the years 2008, 2015 and 2016 (Figure 5, Figure 6). The high contribution of residual 2+ lobsters to January 2018 catches coincides with an above average total reported catch in January 2018 (Figure 8, from CSIRO 2018). Catches and the contribution of 2+ lobsters were therefore both above average in January 2018. This contrasts with a below average contribution of 2+ lobsters to January catches in 2016 (Figure 6), when reported catches were also below average.

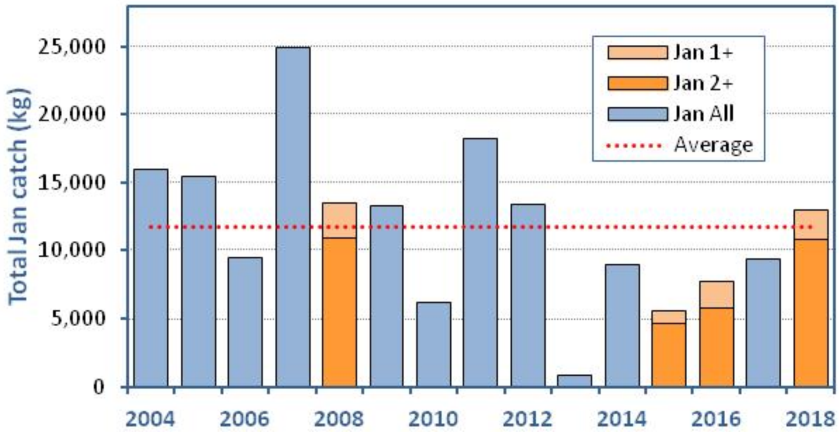



**Figure 8. Total reported TIB and TVH sector tropical rock lobster January catches from 2004 to 2018. Catches in 2008, 2015, 2016 and 2018 are divided into proportions of 88 - 97mm (assumed 1+) and 100 - 146mm carapace length (assumed 2+) lobsters, to show the relative contributions of these cohorts to January catches in these years. The red dotted line indicates the average reported January catch over 2004 - 2018.**

However, there also appears to be a relationship between the relative proportions of 1+ and 2+ lobsters in January, and the preceding year pre-season survey 1+ index (Figure 7). This suggests an additional or alternative explanation for the differential proportion of 2+ lobsters between years – when there is a high abundance of 1+ recruiting lobsters (as indicated by the pre-season survey), then there is an increased contribution of 1+ and a corresponding reduced contribution of 2+ lobsters in early season catches.

Disentangling these two possible causes of differences in proportions of 1+ and 2+ lobsters in January catches requires a better understanding of CPUE. In years of low 1+ abundance, a high catch and high proportion of 2+ lobsters (as occurred in 2018) would require harder fishing if residual 2+ lobsters were not present in increased abundance. Conversely, if fishing effort does not increase, then a good catch and high proportion of early season 2+ lobsters would indicate high abundance of residual lobsters. Understanding of CPUE therefore seems to be central to explaining the apparent contradiction between predicted low availability and apparent relatively high early season abundance in 2018.

## 5. Potential next steps

Results of the exploratory analyses in this paper indicate that the contribution of residual 2+ lobsters to early season catches in the Torres Strait can be substantial and variable. It is probably worth pursuing a better understanding of the contribution of residual lobsters to catches, and how this varies between years.

The TRL stock assessment should be able to generate estimates of the contribution of residual 2+ lobsters to early season catches each year using a more rigorous approach than the simple cohort slicing adopted in this paper. If the stock assessment can produce historical estimates of residual 2+ lobsters in early season (December, January and/or February) each year, this would provide annual estimates of residual lobster contribution to historical early season catches, which could be used to derive an average of these estimates to aid in understanding of how the contribution of residual lobsters to catches varies between years.

Stock assessment projections of exploitable lobster biomass used to set next season RBCs do not explicitly take expected residual lobster abundance into account. This contributes to the conservative approach to assessment and management of this highly variable stock. The overall contribution of

TRL RAG Discussion Paper - Contribution of residual TRL to early season Torres Strait catches residual lobsters to catches is included implicitly in assessments, in that the model uses a long history to calibrate the expected stock productivity (E. Plagányi pers comm), so the assessment itself includes an assumption of average residual biomass. RBCs could be explicitly set to include this average residual lobster abundance.

As a next step, data on size composition of early season catches (January and/or February) in the current season could then be compared with this average to determine whether residual non-migrant lobster abundance is higher than average, and whether this might justify an adjustment in management arrangements. However, this would depend on the availability of adequate an representative length-composition data across the fishery and fishing areas early in the season.

Provided such early season representative length composition data could be obtained each year, there may be merit in pursuing options for assessing the abundance of residual 2+ lobsters at the start of each season, to ascertain whether this is higher than accounted for in TAC setting. If so, consideration could be given to adjusting management arrangements to account for this. Potential options might include allocating a TAC increase to cater for the unexpected higher abundance of residual lobsters, or allowing start of season fishing to proceed without TAC decrementation under an increased size limit designed to restrict catches to the larger residual lobsters, until the 1+ lobsters grow to a size where they start recruiting to the fishery. (This latter option would potentially create a compliance risk.)

It would be appropriate to test any such proposed approaches using management strategy evaluation to ensure that the risk of stock depletion is not increased.

## 6. References

CSIRO (2018) Catch Summary for TRSL Fishery - April 2018. Inter-sessional paper to AFMA.

Phillips, B.F., Palmer, M.J., Cruz, R., Trendall J.T. (1992). Estimating growth of the spiny lobsters *Panulirus cygnus*, *P. argus* and *P. ornatus*. *Aust. J. Mar. Freshw. Res*. 43: 1177-88.

Plagányi E., R. Campbell, M. Tonks, M. Haywood, R. Deng, N. Murphy, K. Salee (2018a) Torres Strait rock lobster (TRL) 2017 fishery surveys, CPUE and stock assessment. AFMA Project 2016/0822. Draft report for TRL RAG, , Australian Fisheries Management Authority Thursday Island, March 2018. 144 pp.

Plagányi E., M. Tonks, R. Campbell, M. Haywood, R. Deng, (2018b) Final 2017 Integrated Stock Assessment and RBC(2018) for the Torres Strait rock lobster fishery. CSIRO Oceans & Atmosphere, Brisbane, March 2018 –FINAL ASSESSMENT. Presentation to the AFMA TRL RAG meeting, Thursday Island, 27-28 March 2018.

| TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) | MEETING 23<br>15 May 2018 |
|---|---|
| **EVALUATION OF ADDITIONAL SURVEY OPTIONS TO SUPPORT FUTURE STOCK ASSESSMENTS** | **Agenda Item 5**<br>**For Discussion** |

**RECOMMENDATIONS**

1. That the RAG **DISCUSS**:
   a. the effects of changes to management arrangements and fishing effort in the Torres Strait Tropical Rock Lobster (TRL) Fishery in the 2017/18 fishing season on fishery-dependent catch per unit effort (CPUE) and length composition indicators; and
   b. the costs and benefits of different options for the collection of fishery-independent data to support future stock assessments and the management of the TRL Fishery.

**KEY ISSUES**

2. The course of 2017/18 fishing season has presented a number of challenges for management and future stock assessments:
   a. a low RBC for the 2017/18 season may have influenced fishing effort across the Fishery;
   b. management changes implemented within the 2017/18 season to date will affect fishing effort and efficiency and hence fishery-dependent data (e.g. CPUE) in the Fishery. These changes include additional restrictions on the use of hookah gear and the proposed closure of the Fishery if the Australian catch share of the RBC is caught;
   c. if the Fishery is closed early then fishery-dependent data (e.g. CPUE) will not be available over the full 2017/18 fishing season as has been the case in past seasons.
3. Whilst the trigger for a mid-season survey under the draft harvest strategy has not been reached AFMA is seeking advice from the RAG on the costs and benefits of different options for the collection of fishery-independent data to support future stock assessments in light of the potential data challenges stated above.
4. Fishery-independent surveys are one method for independently and objectively quantifying stock status as well as potentially assisting with standardisation of CPUE data during periods when fishing effort and efficiency changes.
5. The CSIRO paper, titled *Summary of additional survey options for TRL for 2018*, which was provided to members on 23 April 2018 and is at **Attachment 5a**,details three options for the collection of fishery-independent data via surveys:
   a. Mid-year survey - $174k (CSIRO contribution 69k; External 104k);
   b. Extension to pre-season survey - $55k (CSIRO contribution 22k; External 33k);
   c. Benchmark survey - $486k (CSIRO contribution 194k; External 291k).
6. Each of these options would provide fishery-independent data that may improve the certainty of results from future integrated stock assessments. Each has pros and cons.

7. Further advice from CSIRO on the merits of convening a mid-year survey this year is provided in **Attachment 3d** (pages 7-8 and Appendix 1).

8. Members should note that there would need to be a significant variation between the results of the November 2017 pre-season and a 2018 mid-season survey (if undertaken) for AFMA to trigger a review of the current RBC. This is not considered likely based on indications from fishery-dependent data for the 2017/18 fishing season to date.

**Summary of additional survey options for TRL for 2018**

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**SUMMARY**: Based on recent data analyses, CSIRO found no firm basis to support an alternative to the survey prediction of a below average recruiting age class when averaged over the entire TS region. All indications from available data and the stock assessment suggest that the spawning biomass is currently below average and a precautionary approach is needed to ensure the longer-term sustainability of the stock. However there are ongoing anecdotal reports that stock abundance has been underestimated, and an assessment of stock status this year is confounded by a number of factors including: (1) if the fishing season closes early then data may not be available over the full fishing season to end of September as has been the case in the past; and (2) there are a number of factors (including eg the low TAC with no formal sectoral allocations) that have influenced fishing effort this year. Fishery-independent surveys are one method for independently and objectively quantifying stock status as well as potentially assisting with standardisation of CPUE data during periods when fishing practices change. The TRLRAG thus briefly discussed the pros and cons of conducting a (A) Midyear survey and/or (B) extending the Preseason survey. Given reports that the habitat may have changed, another option (albeit expensive) would be to conduct another benchmark survey. The last benchmark survey was conducted in 2002 surveying 375 sites and for reference purposes, a costing is provided of a (C) slightly reduced benchmark survey. The pros and cons of Options A-C are listed below.

## Option A - Mid-year survey

Cost: $174k (CSIRO contribution 69k; External 104k)

Description: Timing would be July – would be comparable to previous midyear surveys

***Pros***

- On the ground assessment of 1+ and 2+ abundance and size before migration will provide a solid scientific basis for cross-checking and validating the Preseason survey results, or alternatively highlighting that changes in the fishery are occurring which may necessitate a revision of survey and assessment protocols.
- In addition this provides an index of the 2+ abundance to more accurately inform on stock status and for comparison with CPUE data, which will be useful in again cross-checking how well the CPUE data reflect 2+ abundance given recent changes in some fishing practices.
- If the fishing season closes early in 2018, then the survey would provide information on the stock that will otherwise not be available.
- Compare 2018 June survey to previous mid-year surveys (75 sites). We propose that about 40 sites are critical.

***Cons***

- Large cost which would likely not change current TAC, but would contribute to understanding of stock status and informing on standardization of CPUE for future analyses
- Surveying sites that may have already been fished – not that different to previous surveys. However if the fishery is closed early, then the survey would survey sites that may not have been fished for 1-2 months, which may bias the survey relative to previous surveys which have always been during the active fishing season. This is particularly because fishing tends to remove aggregations and in the absence of fishing, the survey may detect more aggregations than in past ears and this may need to be accounted for in the analysis as a bias correction factor

## Option B – Extension to Pre-season survey

Cost: $55k (CSIRO contribution 22k; External 33k)

Description: This would involve adding approximately 5 days to the existing November preseason survey, with additional sites chosen as per preliminary discussions at the last TRLRAG, i.e. to ensure consistency with previous surveys and usefulness for the survey standardized index, but also to improve precision, particularly for a couple of areas where changes in stock distribution may have influenced the precision of estimates for a zone.

***Pros***

- This would allow reintroducing some sites that have been less well represented than ideal (due to costing constraints) and thereby improve the precision of the survey index. Previous analyses suggested that the reduced Preseason survey is less precise but has similar accuracy to the more extensive Preseason survey, and these data could assist in again checking the effect on survey accuracy and precision of reducing the number of sites.
- This is a relatively low cost option as simply adds to the existing planned survey.
- This would assist in providing more confidence to the prediction for 2019, given the RBC (whether based on the stock assessment model or Harvest Control Rule) is primarily determined by the Preseason 1+ index.

***Cons***

- This wouldn’t assist in validating or helping understand whether the TAC for 2018 was set too low as the large lobsters will have migrated out the area by the time of the survey.
- This doesn’t provide an index of the 2+ abundance and wouldn’t fill in any data gaps if the fishing season closes early – it serves only to strengthen the following year’s prediction.

## Option C – Benchmark Survey

Cost: $486k (CSIRO contribution 194k; External 291k)

Description: This would build on the previous 2 benchmark surveys conducted in 1989 and 2002, but would ideally be conducted as an extensive preseason November survey given Preseason surveys are now being used as the primary survey tool. A slightly scaled down version could be conducted, involving 40 days and surveying approximately 280 sites (that is double the usual full preseason survey number but less than the 2002 survey involving 375 sites). There would be some associated additional research to select sites and analyse the data. Timing would be similar to the current November preseason survey.

***Pros***

- This would allow a more thorough review of the current survey sampling in order to assess in particular whether substantial habitat changes have occurred which need ot be taken into account.
- This would assist in providing more confidence to the prediction for 2019 and future years, given the RBC (whether based on the stock assessment model or Harvest Control Rule) is primarily determined by the Preseason 1+ index.
- The additional habitat and other baseline information collected would be useful for other broader studies, such as providing a baseline for climate and modeling studies.

***Cons***

- This survey option is very expensive (but used to highlight the additional work and resources required to substantially review and expand the current survey)
- This wouldn’t assist in validating or helping understand whether the TAC for 2018 was set too low as the large lobsters will have migrated out the area by the time of the survey.
- This doesn’t provide an index of the 2+ abundance and wouldn’t fill in any data gaps if the fishing season closes early – it serves only to strengthen the following year’s prediction.

| | |
|---|---|
| **TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG)** | **MEETING 23**<br>**15 May 2018** |
| **OTHER BUSINESS** | **Agenda Item 6**<br>**For Discussion** |

**RECOMMENDATIONS**

1. That the RAG **NOMINATE** any further business for discussion.

| TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) | MEETING 23<br>15 May 2018 |
|---|---|
| **DATE AND VENUE FOR NEXT MEETING** | **Agenda Item 7**<br>**For Discussion** |

**RECOMMENDATIONS**

1. That the RAG **NOMINATE** a date and a venue for the next meeting.

**BACKGROUND**

2. The next meeting is proposed for mid-December 2018, following the pre-season survey.

# Torres Strait Rock Lobster Fishery – Summary of the Catch and Effort Data pertaining to the 2018 Fishing Season (Dec-17 to Apr-18)

*Robert Campbell, Eva Plaganyi, Roy Deng, Mark Tonks, Mick Haywood*

CSIRO Oceans and Atmosphere

May 2018

## 1. Introduction

This paper provides a summary of the catch and effort data pertaining to the Torres Strait Rock Lobster (TSRL) fishery during the initial five month period of the 2018 fishing season. (Note, a fishing season begins on 1-December in a given year and extends through to 30-November the following year). In particular the paper provides a comparison of the annual trends in catch, effort and catch-rates in the five months of December, January, February, March and April so that the relative performance of the fishery since December 2017 can be assessed.

## 2. Data

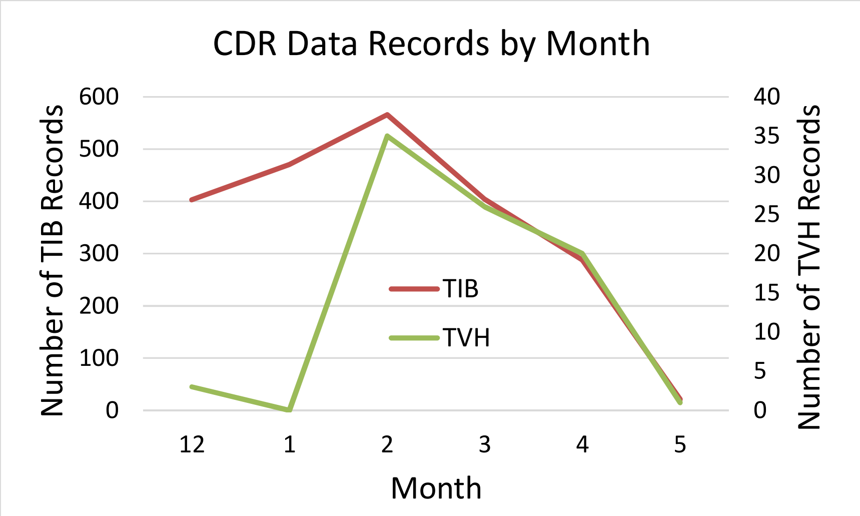
*TIB-Sector*

A new logbook, known as the Torres Strait Catch Disposal Record (TDB02), was introduced in the TSRL fishery at the start of November 2017. This logbook, which is mandatory to complete, records the catch weight of lobsters landed at the completion of all fishing trips. As well as information related to the fish receiver, the logbook also records information related to the fisher (name, boat symbol, etc), the sector of the fishery that the fisher operated (e.g. TIB or TVH) and the process state of the catch (e.g. whole, live or tailed). Additional information related to fishing effort (e.g. days fished, number of fishers) together with the area fished and methods used is currently only optional.

The TDB02 logbook replaces the Torres Strait Seafood Buyers and Processors Docket Book (TDB01) which had been used in the TIB sector to record the catch sold by fishers at the end of a fishing trip. Completion of this docket-book had only been voluntary and in several fishing seasons (2013-2016) the catch data for the TIB sector was supplemented with aggregate catch data obtained directly from several processors. The introduction of the compulsory TDB02 should rectify this past issue. Hopefully, the TDB02 logbook will also rectify previous issues which were associated with the use of the TDB01 docket-book such as the double recording of catches (see Campbell and Pease 2017). Whether or not the introduction of the compulsory TDB02 logbook will lead to an increase in the reporting levels of the TIB catch will also need to be assessed.

Data related to the TDB02 CDR logbook was obtained from AFMA on 8 May 2018 while the last batch of data related to the TDB01 docket-book was obtained from AFMA in late October 2017. For the data summaries presented in this paper for the TIB sector, all data before December 2017 is based from this latter data while all data since December 2017 is taken from the TDB02 CDR logbook. The TDB01 docket-book data is likely to be incomplete to some extent for the last few months up until November 2017, and while the degree of completeness of the TDB02 data since December 2017 remains uncertain it is likely to be reasonably

Figure 1. Number of data records per month for each sector of the TSRL fishery present in the TDB02 CDR data sent by AFMA on 8-May-18. Note, the month of each record is based on the trip-end date. The date of the last trip recorded for the TIB and TVH sectors is 7-May-18 and 5-May-18 respectively.




complete through to February-March 2018 (c.f. Figure 1). A more detailed summary of the TIB data for the period up to October 2017 is provided in Campbell et al (2017a).

*TVH-Sector*

Together with the catch landed by the TIB-sector of the TSRL fishery, the new Torres Strait Catch Disposal Record (TDB02), introduced in the TSRL fishery at the start of November 2017, also records the catch landed by the TVH-sector. However, unlike for the TIB-sector, catch and effort data related to the TVH sector also continues to be recorded in the Torres Strait Tropical Rock Lobster Fishery Daily Fishing Log (TRL04).

Data related to both the TDB02 and TRL04 logbooks was obtained from AFMA on 8 May 2018. For the data summaries presented in this paper for the TVH sector all data is based on information recorded in the TRL04 logbook. As with the TSDB01 logbook the TRL04 logbook data is also likely to be incomplete to some extent up until November 2017, while the degree of completeness of the TRL04 data (as with the TDB02 logbook) since December 2017 remains uncertain, though hopefully it is reasonably complete through to February-March 2018 (c.f. Figure 1). A more detailed summary of the TVH data for the period up to October 2017 is provided in Campbell et al (2017b).

## 3. Catch by Season

A comparison of the estimated total catch by sector for the seasons 2004 to 2017 is shown in Figure 2. The catch for the initial five months of the 2018 season is also shown, though as explained in the previous section this is an under-estimate as the data for these months is still incomplete. As the TVH catch is recorded in both the TRL04 logbook and the TDB02 logbook, two estimates for the 2018 season are provided. While the difference noted in this catch estimate is no doubt due to differences in the delays taken for AFMA to receive and process records pertained to these two logbooks any differences between these two logbooks should be checked at the end of the season when both logbooks are considered complete.

Figure 2. Time-series of total catch by fishing season (December-November) and sector since 2004. TIB data is based on TDB01 docket-book and TDB02 CDR data, while TVH data is based on TRL04 logbook data. Data for 2018 only covers the period December-April and is also not complete for this period.

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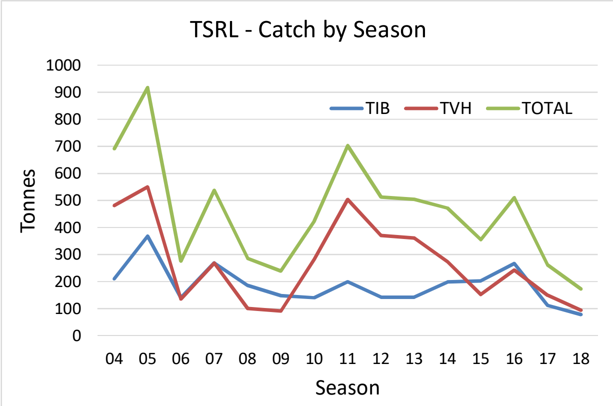
| SEASON | TIB | TVH | TOTAL |
|---|---|---|---|
| 04 | 210.4 | 481.1 | 691.5 |
| 05 | 367.6 | 549.9 | 917.6 |
| 06 | 140.5 | 135.5 | 275.9 |
| 07 | 268.7 | 268.6 | 537.3 |
| 08 | 185.7 | 100.4 | 286.1 |
| 09 | 147.8 | 91.1 | 238.9 |
| 10 | 140.0 | 282.6 | 422.7 |
| 11 | 199.1 | 503.5 | 702.6 |
| 12 | 142.4 | 370.5 | 512.9 |
| 13 | 142.5 | 361.7 | 504.2 |
| 14 | 198.8 | 273.2 | 472.0 |
| 15 | 202.6 | 152.7 | 355.3 |
| 16 | 267.1 | 243.0 | 510.1 |
| 17 | 111.5 | 149.7 | 261.2 |
| 18 | 78.8 | 94.0 | 172.7 |

NB. TVH (2018) =77.9 based on CDR




The reported catch by month for each sector of the TSRL for the 2004-2018 fishing seasons is shown in Table 1. The catch by month for the TVH sector is based on information reported in the TRLO04 logbook, while the catches for the TIB sector are based on information reported in the TBD01 docket-book and TDB02 CDR. Furthermore, for the TIB sector the catch by month for the 2013-2016 fishing seasons is an estimate as the catch month is not known for a substantive portion *P* of the total catch in these seasons (*P*=39%, 34%, 33%, 55% respectively). These relate to the aggregate catches reported by several processors on a seasonal basis to account for missing docket-book records. For these seasons the catch within each month was estimated by raising the known catch in each month by the factor $R= 1/(1-P)$. This assumes that the distribution of the catches by month in the aggregate catch data is the same as the distribution within the docket-book recorded catches.

Based on the catch-by-month estimates provided in Table 1, the time-series of catch by month for the four months January-to- April is shown in Figure 3 for each sector of the TSRL over the seasons 2004-2018.

Table 1. Catch by month for (a) the TIB sector, (b) the TVH sector and (c) the total TSRL fishery for the 2004-2018 fishing seasons. Note, the catch by month for the TVH is based on information reported in the TRLO04 logbook, while the catches for the TIB sector are based on information reported in the TBD01 docket-book and TDB02 CDR. Furthermore, for the TIB sector the catch by month for the 2013-2016 fishing seasons is an estimate as the catch month is not known for a substantive portion *P* of the total catch in these seasons (*P*=39%, 34%, 33%, 55% respectively). For these seasons the catch within each month was estimated by raising the known catch in each month by the factor *R= 1/(1-P)*.

(a) TIB

| SEASON | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 0.00 | 15.54 | 24.31 | 35.57 | 17.74 | 30.36 | 28.52 | 26.45 | 18.98 | 12.87 | 0.02 | 0.03 | 210.383 |
| 2005 | 21.65 | 15.10 | 50.63 | 58.22 | 47.58 | 56.76 | 43.06 | 34.47 | 23.68 | 16.09 | 0.31 | 0.07 | 367.615 |
| 2006 | 12.51 | 9.45 | 24.02 | 26.81 | 19.09 | 18.38 | 9.81 | 9.91 | 7.67 | 2.75 | 0.00 | 0.05 | 140.451 |
| 2007 | 19.00 | 24.94 | 24.72 | 62.04 | 29.19 | 33.76 | 29.03 | 23.19 | 13.91 | 8.92 | 0.00 | 0.00 | 268.689 |
| 2008 | 10.43 | 13.46 | 31.24 | 36.13 | 24.11 | 16.71 | 14.80 | 23.52 | 9.28 | 5.97 | 0.02 | 0.00 | 185.665 |
| 2009 | 9.72 | 13.27 | 20.55 | 23.10 | 23.73 | 15.65 | 13.24 | 15.39 | 7.81 | 4.82 | 0.53 | 0.00 | 147.814 |
| 2010 | 5.76 | 6.20 | 21.26 | 15.83 | 14.99 | 12.18 | 16.35 | 19.07 | 17.00 | 9.78 | 1.61 | 0.00 | 140.039 |
| 2011 | 6.93 | 18.22 | 30.14 | 49.77 | 20.40 | 23.99 | 18.69 | 18.86 | 8.86 | 3.22 | 0.00 | 0.00 | 199.061 |
| 2012 | 9.04 | 13.40 | 19.03 | 24.72 | 19.61 | 9.69 | 22.87 | 11.19 | 10.84 | 2.00 | 0.00 | 0.00 | 142.379 |
| 2013 | 5.04 | 1.39 | 16.19 | 13.63 | 21.10 | 18.90 | 16.58 | 18.95 | 14.65 | 16.09 | 0.00 | 0.00 | 142.522 |
| 2014 | 10.06 | 13.53 | 18.64 | 39.48 | 28.79 | 25.82 | 17.15 | 17.70 | 17.64 | 9.78 | 0.19 | 0.00 | 198.776 |
| 2015 | 20.12 | 9.31 | 31.19 | 21.25 | 26.92 | 16.87 | 44.78 | 12.94 | 11.59 | 7.36 | 0.28 | 0.00 | 202.606 |
| 2016 | 13.78 | 15.53 | 52.58 | 36.23 | 23.07 | 34.03 | 33.53 | 24.91 | 22.33 | 10.77 | 0.22 | 0.17 | 267.136 |
| 2017 | 5.15 | 8.29 | 23.34 | 15.83 | 11.70 | 14.96 | 7.48 | 9.73 | 10.80 | 4.08 | 0.16 | 0.00 | 111.504 |
| 2018 | 14.77 | 13.06 | 20.95 | 16.96 | 12.23 | 0.79 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 78.762 |

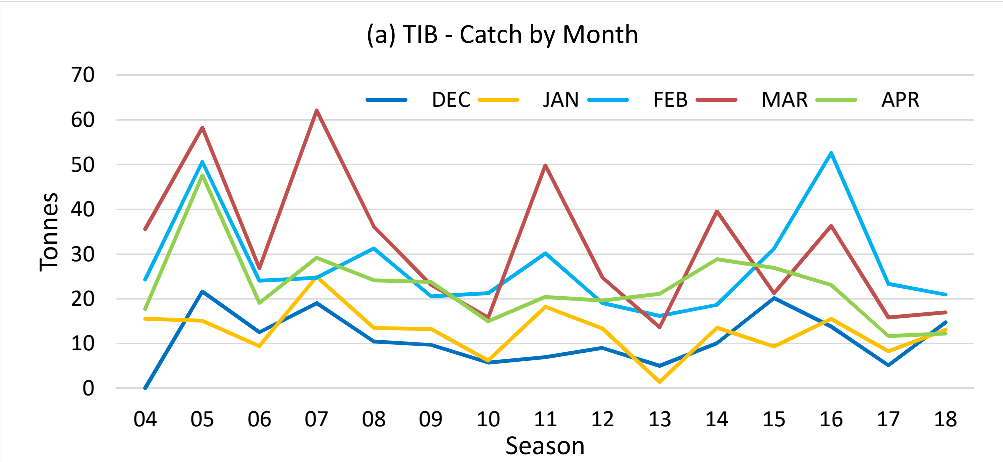
(b) TVH

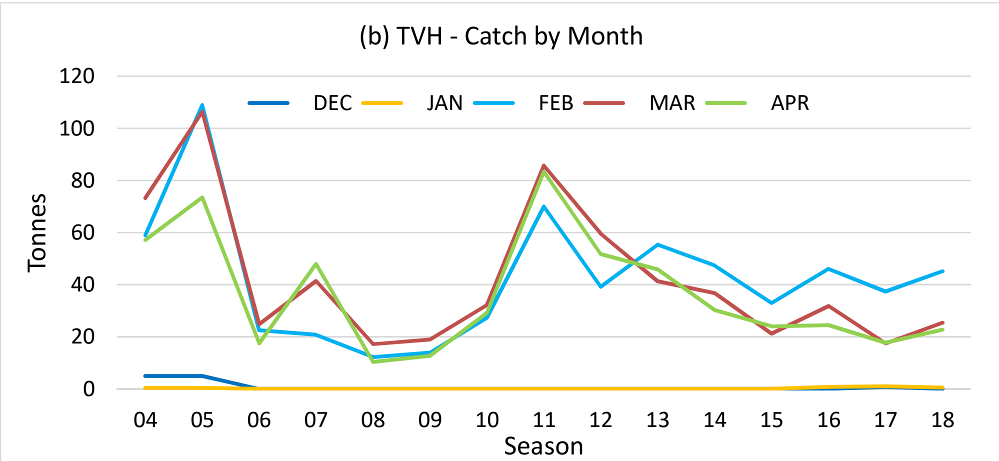
| SEASON | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 4.95 | 0.45 | 58.97 | 73.18 | 57.14 | 70.55 | 79.44 | 65.77 | 48.01 | 22.63 | 0.00 | 0.00 | 481.082 |
| 2005 | 4.98 | 0.40 | 108.96 | 106.28 | 73.51 | 59.48 | 53.62 | 60.10 | 51.80 | 30.81 | 0.00 | 0.00 | 549.935 |
| 2006 | 0.03 | 0.00 | 22.51 | 24.86 | 17.49 | 14.80 | 11.49 | 21.95 | 16.76 | 5.59 | 0.00 | 0.00 | 135.473 |
| 2007 | 0.00 | 0.00 | 20.77 | 41.39 | 47.98 | 62.93 | 48.84 | 26.69 | 13.63 | 6.37 | 0.00 | 0.00 | 268.596 |
| 2008 | 0.00 | 0.00 | 12.29 | 17.17 | 10.33 | 10.81 | 8.00 | 15.48 | 16.82 | 9.55 | 0.00 | 0.00 | 100.437 |
| 2009 | 0.00 | 0.00 | 13.91 | 18.88 | 12.75 | 10.48 | 13.41 | 7.82 | 10.35 | 3.47 | 0.00 | 0.00 | 91.060 |
| 2010 | 0.00 | 0.00 | 27.31 | 32.16 | 29.20 | 29.19 | 30.32 | 44.73 | 52.03 | 37.67 | 0.00 | 0.00 | 282.614 |
| 2011 | 0.00 | 0.00 | 69.99 | 85.73 | 83.33 | 65.52 | 62.08 | 61.87 | 45.10 | 29.91 | 0.00 | 0.00 | 503.534 |
| 2012 | 0.00 | 0.00 | 39.23 | 59.64 | 51.70 | 35.16 | 39.81 | 69.72 | 48.96 | 26.28 | 0.00 | 0.00 | 370.483 |
| 2013 | 0.00 | 0.00 | 55.43 | 41.28 | 45.93 | 45.03 | 41.50 | 56.82 | 47.62 | 28.06 | 0.00 | 0.00 | 361.661 |
| 2014 | 0.00 | 0.00 | 47.34 | 36.71 | 30.23 | 42.09 | 38.16 | 39.06 | 23.42 | 16.21 | 0.00 | 0.00 | 273.214 |
| 2015 | 0.00 | 0.00 | 32.99 | 21.17 | 24.05 | 17.62 | 16.75 | 14.46 | 19.78 | 5.89 | 0.00 | 0.00 | 152.710 |
| 2016 | 0.00 | 0.75 | 46.10 | 31.83 | 24.47 | 40.20 | 42.87 | 28.85 | 18.85 | 9.08 | 0.00 | 0.00 | 243.010 |
| 2017 | 0.69 | 1.05 | 37.43 | 17.48 | 17.70 | 23.98 | 19.56 | 16.11 | 12.94 | 2.80 | 0.00 | 0.00 | 149.738 |
| 2018 | 0.00 | 0.57 | 45.19 | 25.44 | 22.79 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 93.983 |

(c) TOTAL

| YEAR | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 4.95 | 15.99 | 83.27 | 108.75 | 74.88 | 100.91 | 107.95 | 92.22 | 66.99 | 35.50 | 0.02 | 0.03 | 691.465 |
| 2005 | 26.63 | 15.50 | 159.59 | 164.50 | 121.09 | 116.23 | 96.68 | 94.58 | 75.48 | 46.90 | 0.31 | 0.07 | 917.550 |
| 2006 | 12.53 | 9.45 | 46.53 | 51.67 | 36.58 | 33.18 | 21.30 | 31.86 | 24.43 | 8.34 | 0.00 | 0.05 | 275.924 |
| 2007 | 19.00 | 24.94 | 45.48 | 103.43 | 77.17 | 96.69 | 77.86 | 49.88 | 27.54 | 15.29 | 0.00 | 0.00 | 537.285 |
| 2008 | 10.43 | 13.46 | 43.52 | 53.29 | 34.44 | 27.52 | 22.80 | 39.00 | 26.10 | 15.51 | 0.02 | 0.00 | 286.102 |
| 2009 | 9.72 | 13.27 | 34.45 | 41.98 | 36.48 | 26.13 | 26.65 | 23.22 | 18.16 | 8.29 | 0.53 | 0.00 | 238.874 |
| 2010 | 5.76 | 6.20 | 48.57 | 47.99 | 44.20 | 41.37 | 46.66 | 63.81 | 69.03 | 47.45 | 1.61 | 0.00 | 422.653 |
| 2011 | 6.93 | 18.22 | 100.14 | 135.50 | 103.73 | 89.51 | 80.77 | 80.72 | 53.96 | 33.13 | 0.00 | 0.00 | 702.595 |
| 2012 | 9.04 | 13.40 | 58.26 | 84.35 | 71.30 | 44.85 | 62.68 | 80.91 | 59.79 | 28.28 | 0.00 | 0.00 | 512.862 |
| 2013 | 5.04 | 1.39 | 71.62 | 54.91 | 67.03 | 63.93 | 58.08 | 75.77 | 62.27 | 44.14 | 0.00 | 0.00 | 504.183 |
| 2014 | 10.06 | 13.53 | 65.98 | 76.18 | 59.02 | 67.91 | 55.31 | 56.77 | 41.05 | 25.99 | 0.19 | 0.00 | 471.990 |
| 2015 | 20.12 | 9.31 | 64.18 | 42.41 | 50.97 | 34.50 | 61.53 | 27.40 | 31.37 | 13.26 | 0.28 | 0.00 | 355.316 |
| 2016 | 13.78 | 16.28 | 98.68 | 68.06 | 47.54 | 74.23 | 76.40 | 53.76 | 41.18 | 19.85 | 0.22 | 0.17 | 510.146 |
| 2017 | 5.84 | 9.34 | 60.77 | 33.31 | 29.40 | 38.94 | 27.04 | 25.84 | 23.74 | 6.88 | 0.16 | 0.00 | 261.242 |
| 2018 | 14.77 | 13.62 | 66.14 | 42.40 | 35.03 | 0.79 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 172.745 |

Figure 3. Time-series of catch by month for the four months January-to- April for (a) the TIB sector, (b) the TVH sector and (c) the total TSRL fishery. Note, the catch by month for the TVH is based on information reported in the TRLO04 logbook, while the catches for the TIB sector are based on information reported in the TBD01 docket-book and TDB02 CDR. Furthermore, the TIB sector the catch by month for the 2013-2016 fishing seasons is an estimate as the catch month is not known for a substantive portion *P* of the total catch in these seasons (*P*=39%, 34%, 33%, 55% respectively). For these seasons the catch within each month was estimated by raising the known catch in each month by the factor *R*= *1/(1-P*).



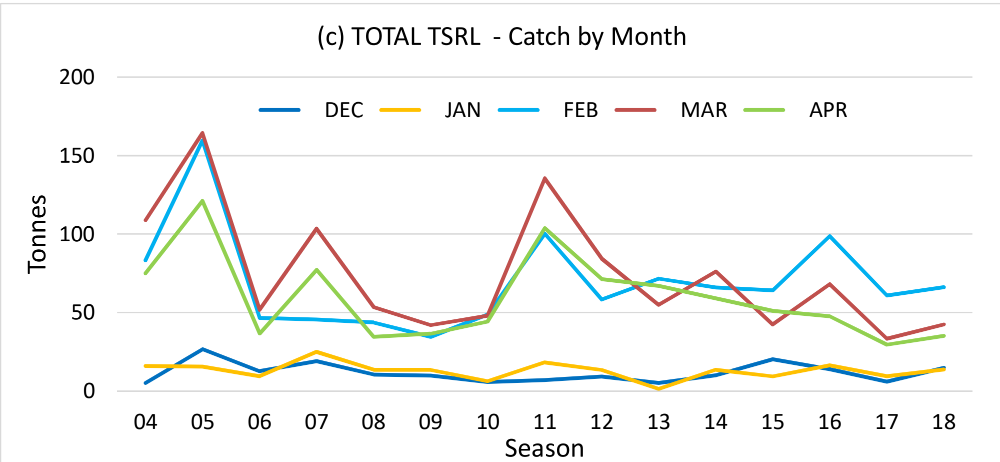



Figure 4. Map of the TIB fishing areas described in the analysis.

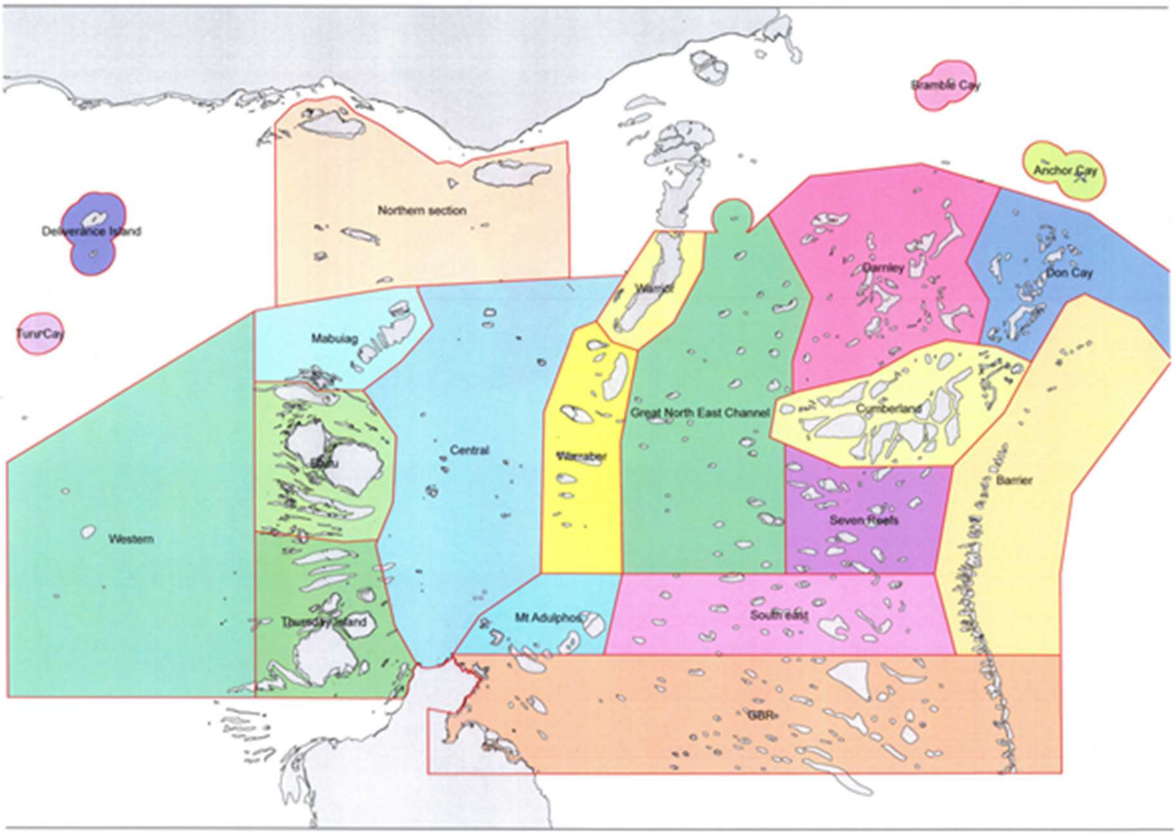



Table 2. (a) List of the area codes and names used in the TIB fishery together with the total number of data records associated with each area. A revised listing of area codes and names based on aggregating areas with few data records is shown in (b).

(a) List of TIB Areas and number of GLM-Data records

| TIB Area Name | Area | Area-Rev | N-Records |
|---|---|---|---|
| Turu Cay | 1 | 6 | 47 |
| Deliverance Island | 2 | 6 | 15 |
| Northern Section | 3 | 6 | 142 |
| Bramble Cay | 4 | 16 | 10 |
| Anchor Cay | 5 | 16 | 8 |
| Western | 6 | 6 | 6 |
| Mabuiag | 7 | 7 | 2920 |
| Badu | 8 | 8 | 3118 |
| Thursday Island | 9 | 9 | 10652 |
| Central | 10 | 10 | 451 |
| Warrior | 11 | 11 | 1575 |
| Warraber | 12 | 12 | 1796 |
| Mt Adolphus | 13 | 13 | 295 |
| Great NE Channel | 14 | 14 | 740 |
| South East | 15 | 15 | 39 |
| Darnley | 16 | 16 | 555 |
| Cumberland | 17 | 17 | 355 |
| Seven Reefs | 18 | 15 | 6 |
| Don Cay | 19 | 16 | 4 |
| GBR | 21 | 15 | 90 |
| | | | 22824 |

(b) Revised list of TIB Areas

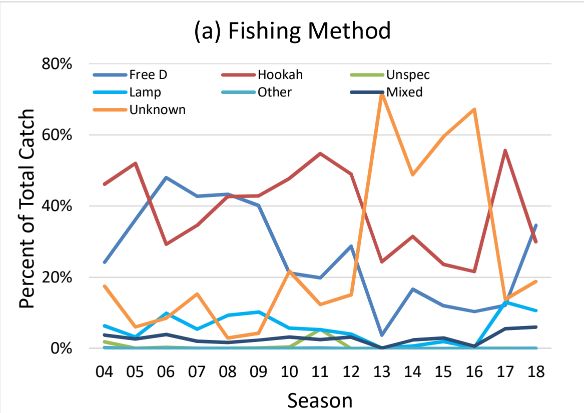
| TIB Area Name | Area-Rev | N-Records |
|---|---|---|
| Northern Section | 6 | 210 |
| Mabuiag | 7 | 2920 |
| Badu | 8 | 3118 |
| Thursday Island | 9 | 10652 |
| Central | 10 | 451 |
| Warrior | 11 | 1575 |
| Warraber | 12 | 1796 |
| Mt Adolphus | 13 | 295 |
| Great NE Channel | 14 | 740 |
| GBR | 15 | 135 |
| Darnley | 16 | 577 |
| Cumberland | 17 | 355 |
| | | 22824 |

## 4. TIB Sector Summary

The 21 areas used to record the spatial location of catch taken in the TIB sector are shown in Figure 4 and listed in Table 2(a). The total number of data records associated with each area is also shown. For the purpose of the following analyses, several areas where the data coverage was low were combined. A revised listing of area codes and names based on aggregating some areas is shown in Table 2(b). These are the areas and names referred to in the following Figures.

A comparison of the percent of the total TIB catch within each fishing season by (a) fishing method and (b) processed form is shown in Figure 5 while a comparison by area fished is shown in Figure 6. Note these results are based on all data available for each season, i.e. they are not limited to the temporal period (December-April) covered by the data for the 2018 season.

Figure 5. Time-series of percent of the total TIB catch within each fishing season by (a) fishing method and (b) processed form.



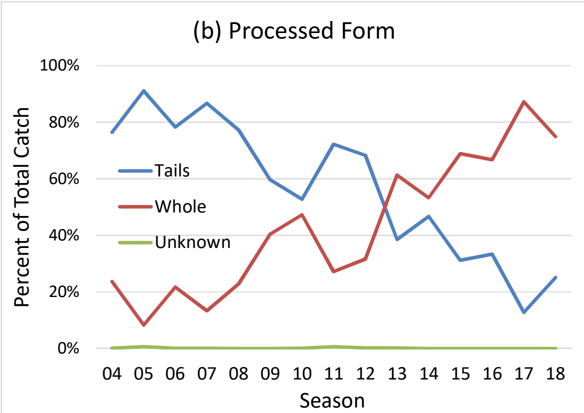




Figure 6. Time-series of percent of the total TIB catch within each fishing season taken in each area fished.

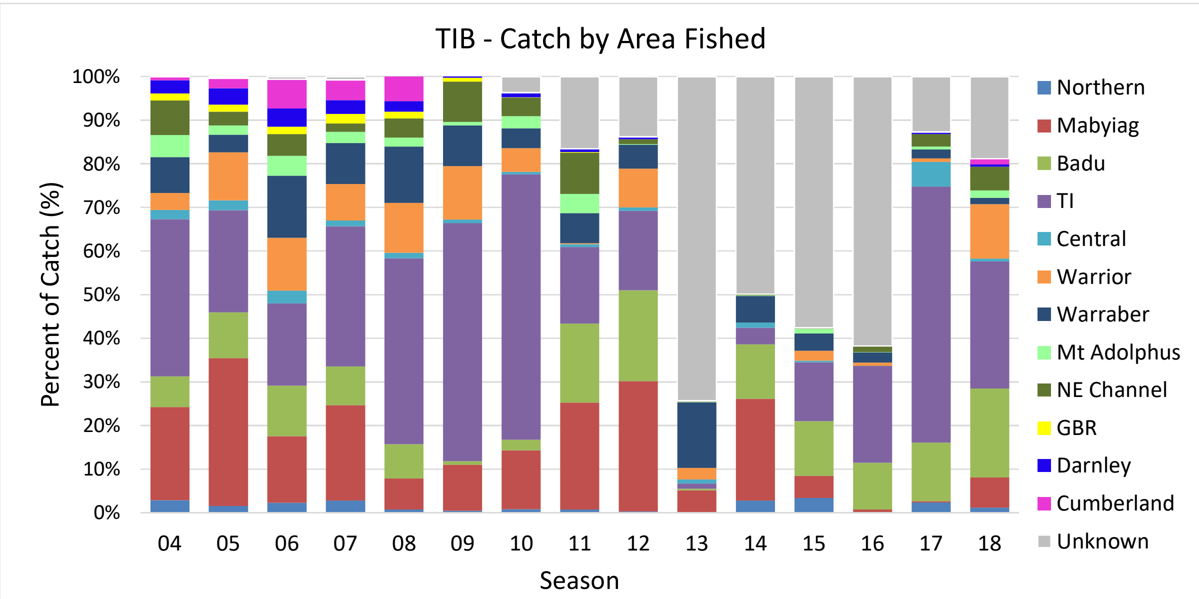


Figure 7. Comparison of percent of the TIB total annual catch stratified by the number of days fished per trip based on (a) all records including those where the days fished is unknown, and (b) those records where the unknown days fished are excluded.

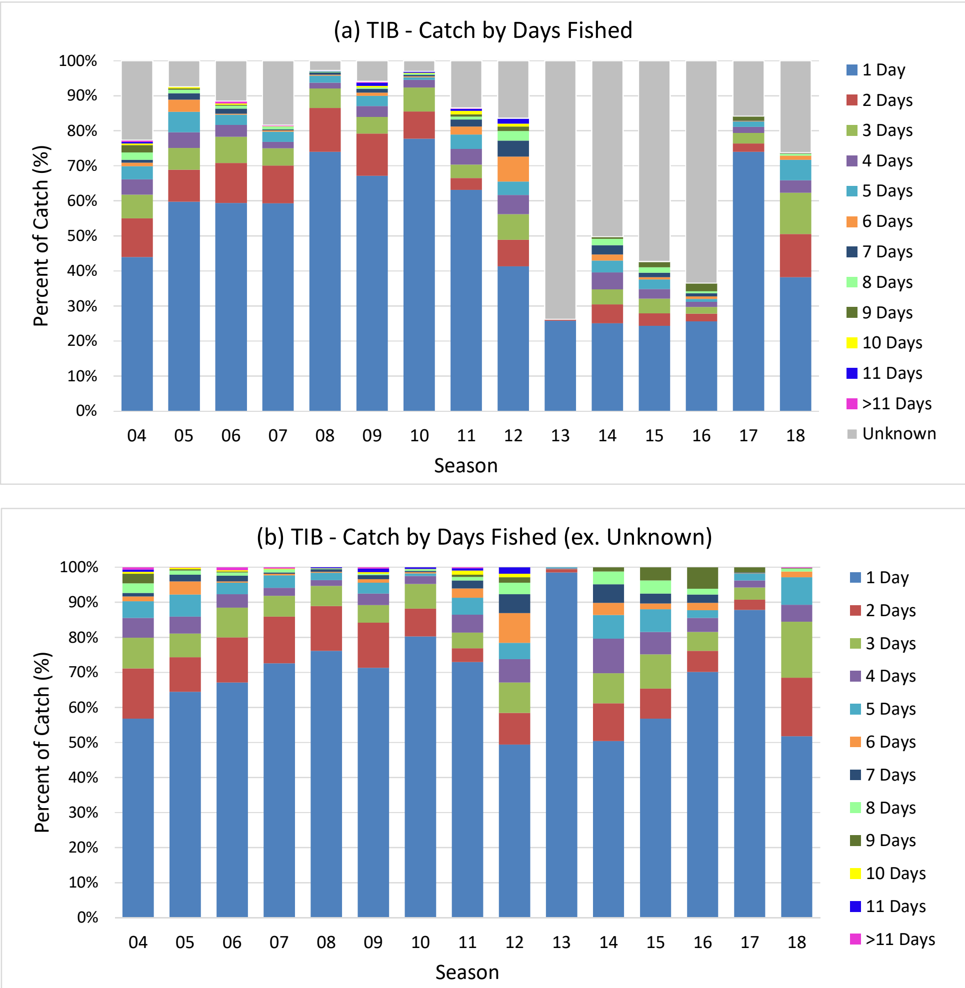
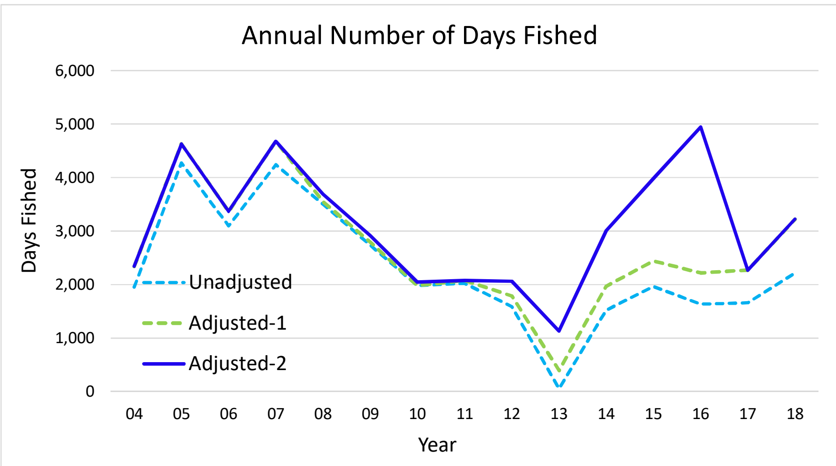



Figure 8. Seasonal comparison of estimated effort in the TIB fishery during the five month period December-April. Analysis based on the method outlined in Campbell (2017).



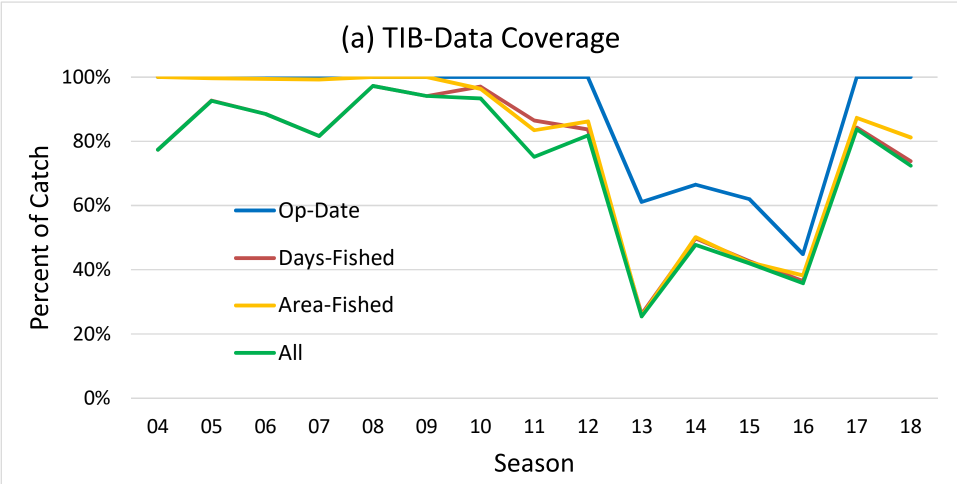
A comparison of percent of the TIB total annual catch stratified by the number of days fished per trip is shown in Figure 7. As the number of days fished was not recorded for all docket-book records, and was also not available for the TIB catch provided in aggregate form by several processes, the proportion of the catch where the days fished is unknown is included in the result shown in Figure 7a. If one assumes that the distribution of days fished associated with the catch for which the effort information remains unknown is the same as that associated with the catch for which the effort information is known, then one can ascertain an estimate of the effort distribution across the entire catch by just excluding that portion of the catch where the effort information remain unknown. This result is shown in Figure 7b and indicates an increase in the proportion of the catch associated with trips of length greater than 1 day during the 2018 season. Finally, a seasonal comparison of estimated effort in the TIB fishery during the five month period December-April is shown in Figure 8 This estimate is based on the method outlined in Campbell (2017) and uses as the total catch during these five months those estimates shown in Table 1.

As noted above, not all the data fields on either the TBD01 docket-book or TDB02 logbook are complete due to the voluntary nature of the provision of this information on both books. The incompleteness of these data fields creates problems in providing a complete analysis of the information for the TIB sector (i.e. as noted above). An indication of availability of information is shown in Figure 9, which provides the annual percentage of the total TIB catch associated with records where various data fields are non-null. The data fields are, (i) Trip operation-date, (ii) Number of days fished, (iii) Area fished, (iv) Vessel-symbol and (v) Seller-name.

Another issue noted in previous analyses of the data for the TIB-sector is the observation that while the structure of the Docket-Book would seem to indicate that there should be a unique Record- Number associated with each vessel, date and seller-name, investigation of the data indicates that there are often multiple Record-Nos associated for a given vessel, date and seller-name. While the reason for these multiple records remains uncertain (they could be recording errors), in order to identity an appropriate data structure for analysis the following procedure has been adopted to filter the data:

1. The TIB data was aggregated over vessel-symbol, date and seller-name. Where the vessel-symbol or seller-name was null these fields were set to 'Unknown'. These data are henceforth known as GLM records;
2. Only those records where the first fishing method was either 'Hookah diving' or 'Free diving' or 'Lamp fishing' were selected;
3. Only those GLM records having a unique Record-No were selected for analysis. It was assumed that where the vessel or seller were unknown, that selection of only those GLM records having a unique Record-No limited the GLM records chosen to those associated with a single vessel and a single seller;
4. An additional check was made to ensure that the number of days fished, the number of crew on the boat, the fishing method and the area fished was unique for each Record-No. This was done to help eliminate data errors;
5. GLM records were also deleted where either the number of days fished was not recorded, the area fished was not recorded, the record pertained to the TVH logbook data as the structure of the data for these records was different, or the weight of the catch was zero or greater than 1000 kg.

Figure 9. Time-series of the percent of the total seasonal TIB catch associated with data records where various data fields are non-null. (a) Trip operation-date, number of days fished, area fished and all thee together, and (b) vessel-symbol and seller-name.



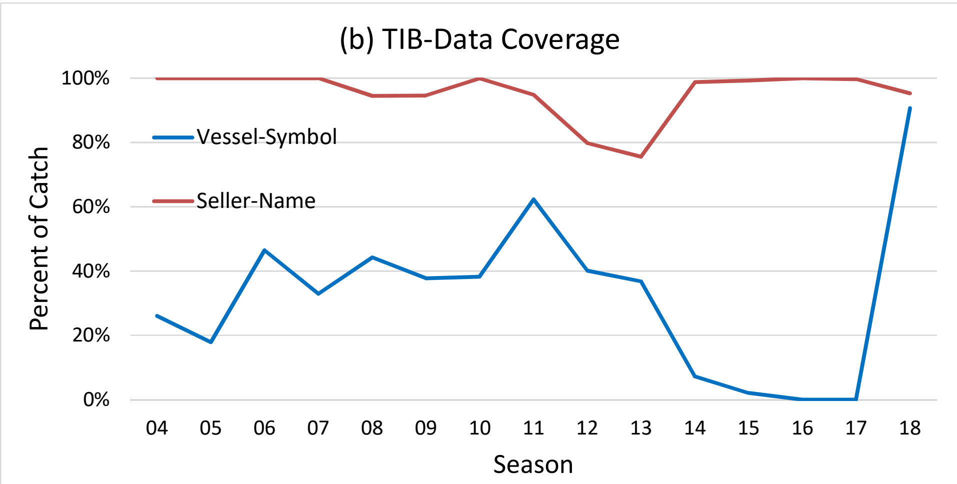
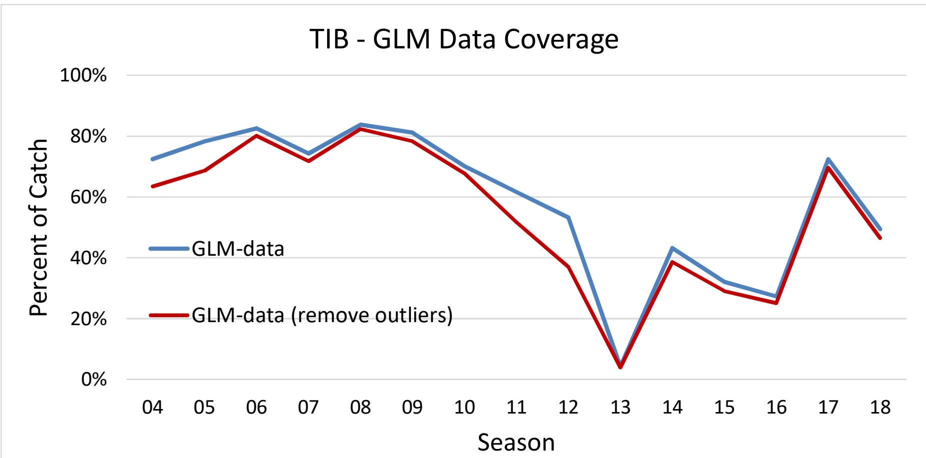



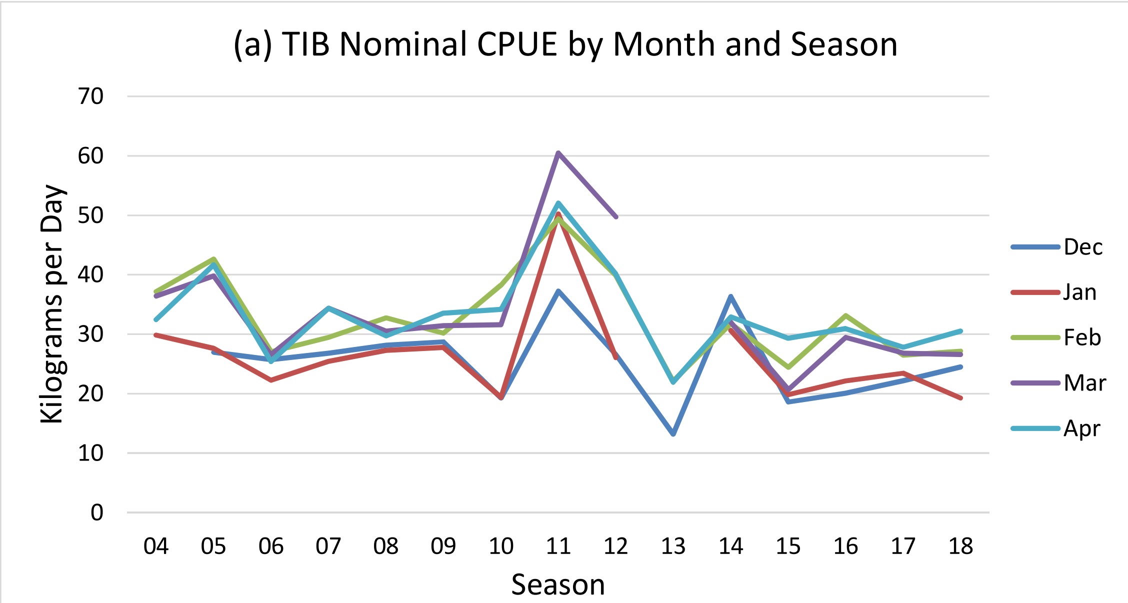

Figure 10. Time-series of the percent of the total seasonal TIB catch associated with data records included in (a) the GLM data set and (b) the GLM data set with selected data outliers removed.



The number of records remaining for analysis after these five steps was 38,639. Henceforth these are known as the GLM-data records. Finally, a number or additional records were eliminated from the GLM-data to remove possible outliers associated with (i) days-fished>9 (71), (ii) weight<1kg (11), and (iii) weight>300kg (323). This left 38,254 records. The coverage of the total catch by each data set is shown in Figure 10.

Using these two data sets, a series of analyses were undertaken to compare the nominal catch-rates (CPUE) according to various data stratifications. These results are shown on Figures 11 and 12. A comparison of the nominal CPUE within each area fished based on both data sets is shown in Figure 13.

Figure 11. Annual time-series of nominal CPUE for the TIB fleet within (a) month and (b) by fishing method during the five month period December-April. Based on the GLM-data set with selected outliers removed.



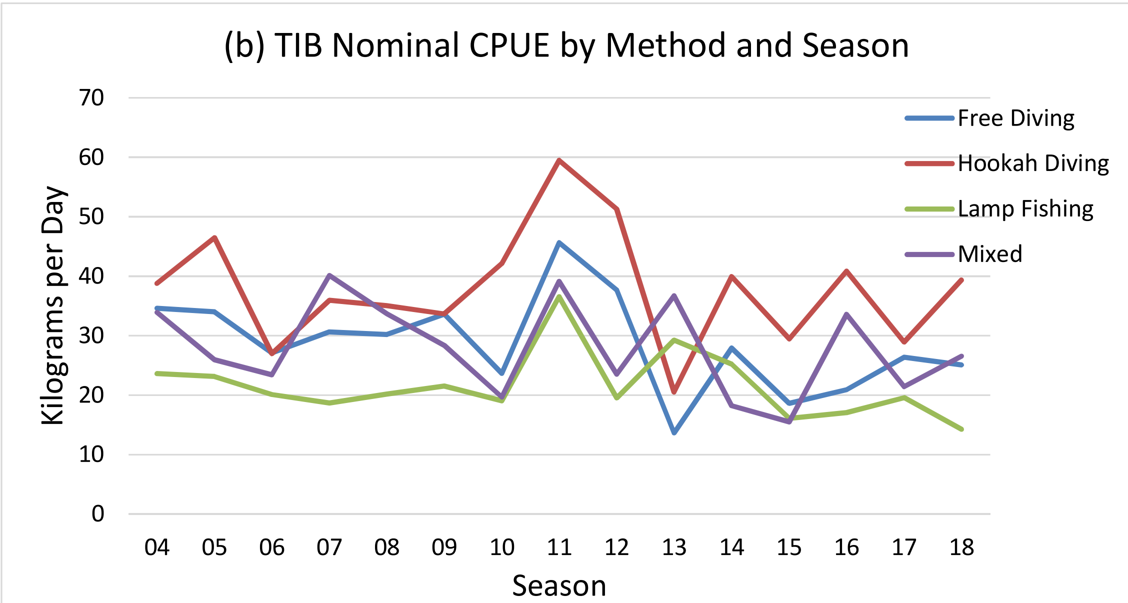
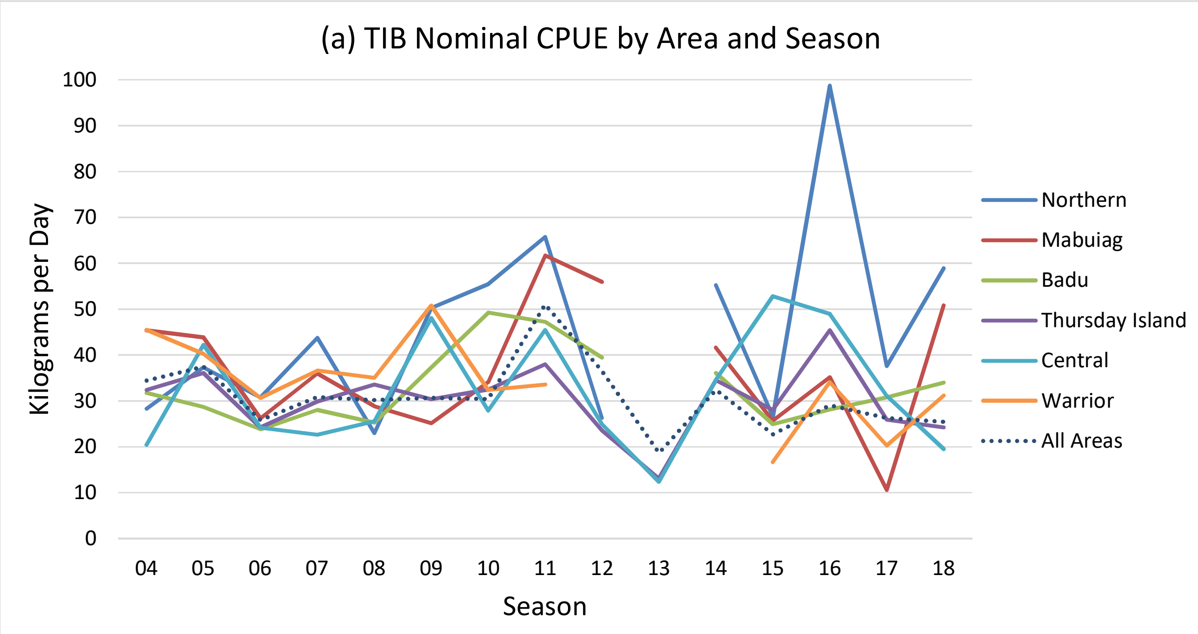



Figure 12. Annual time-series of nominal CPUE for the TIB fleet within each area fished during the five month period December-April. For comparison, the mean nominal CPUE across all areas is also shown. Based on the GLM-data set with selected outliers removed.



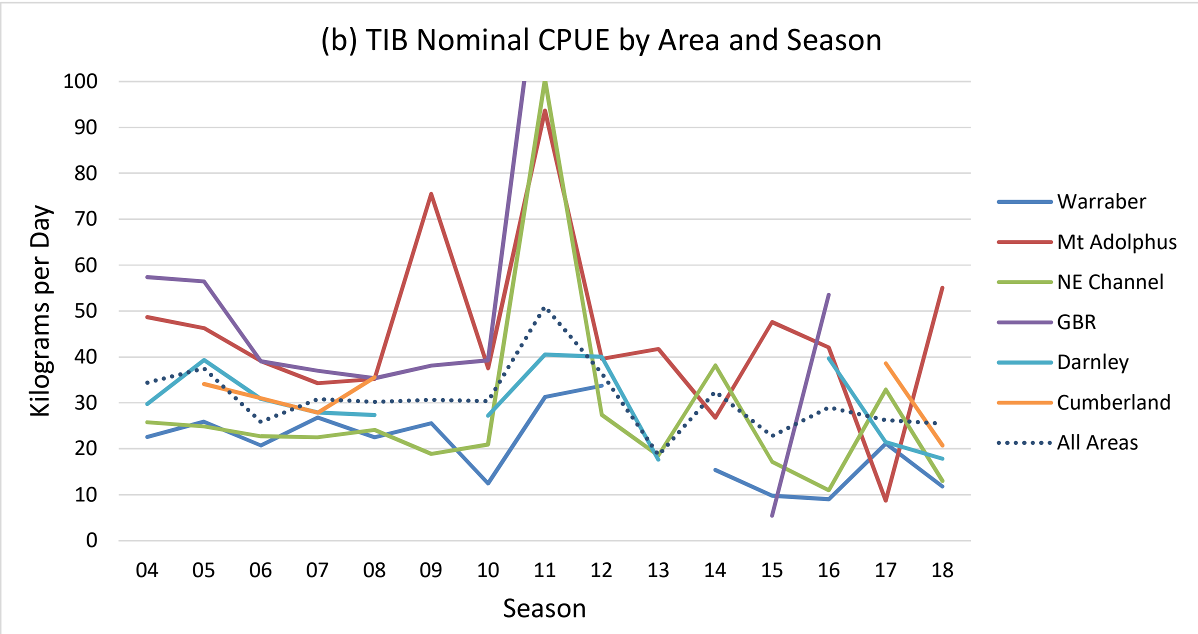
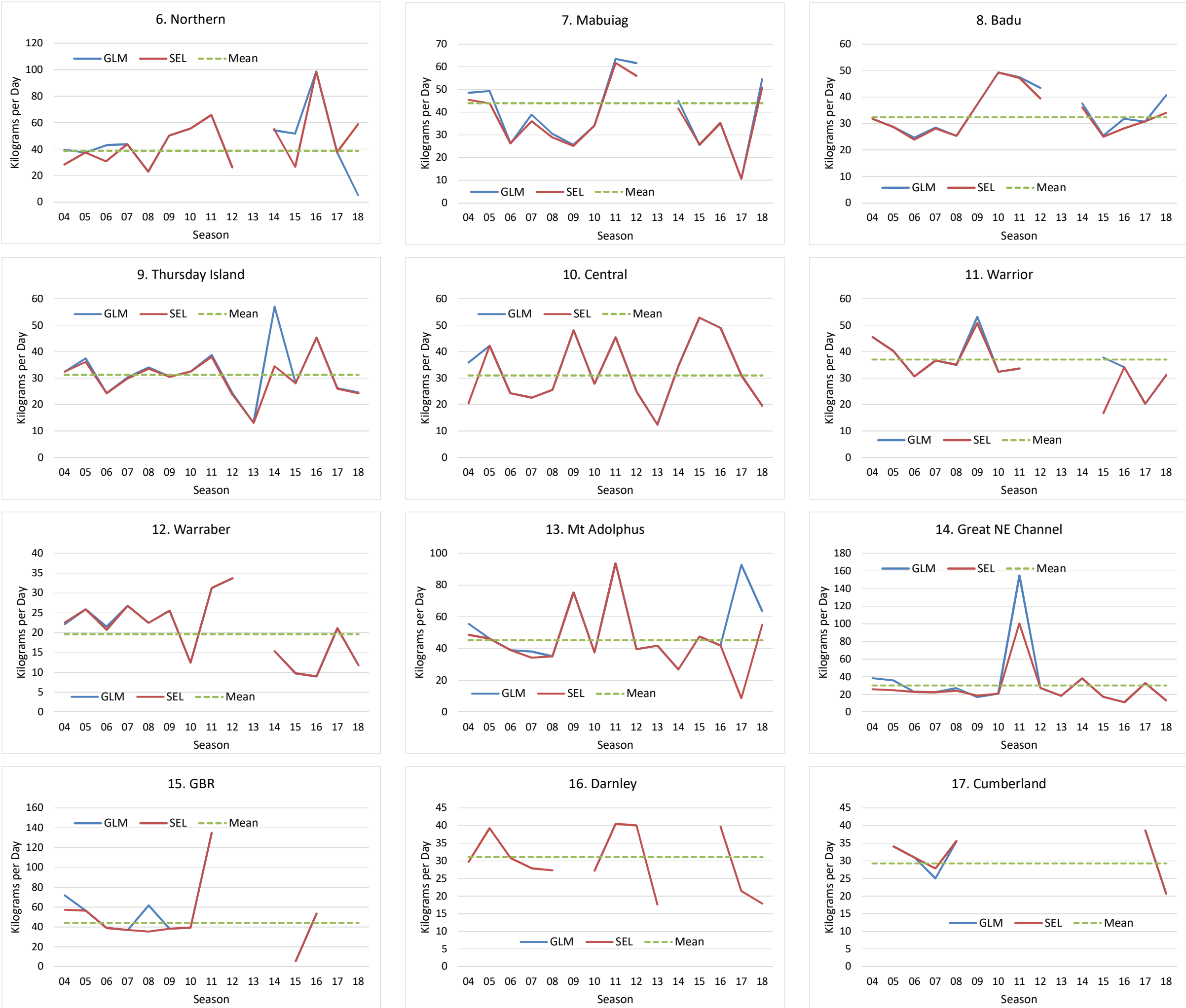



Figure 13. Comparison of the nominal TIB CPUE within each area fished (shown in Figure 12) based on the GLM-data set and the GLM-data with selected outliers removed (SEL). For each area the mean CPUE across all seasons is also shown.




## 5. TVH Sector Summary

As for the TIB-sector, a series of analyses were undertaken of the catch and effort data for the TVH-sector to provide a comparison of fishery indicators for the 2018 season and previous seasons. As the TVH data is not plagued by the same level of non-reporting of information associated with many of the data fields note in the TIB-data (e.g. the fishing date is known in the TVH data for all catches) the analyses were able to be more focused on the three-month period between February and April each year. The results of these analyses are shown in Figures 14-22. The captions above each Figure should hopefully provide sufficient information to help the reader adequately interpret each result.

Figure 14. Annual time-series of the percent of the total TVH catch during the three month period February-April stratified by (a) fishing method and (b) process form.

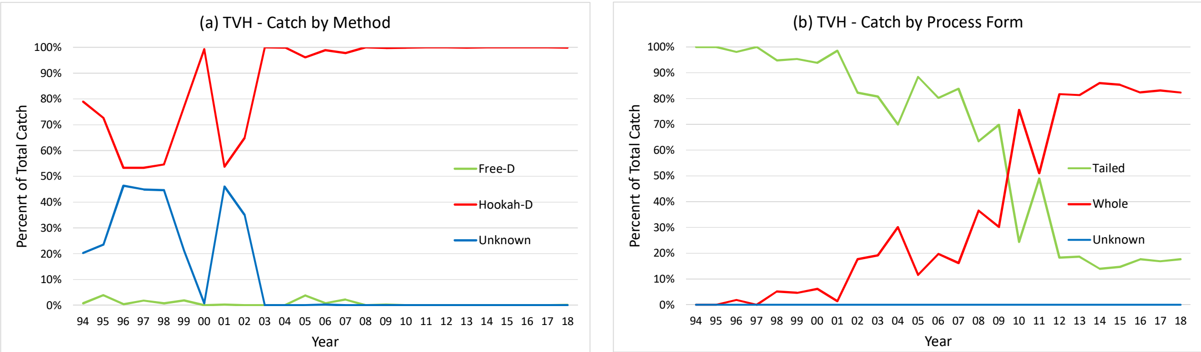



Figure 15. Annual time-series of percent of the total TVH effort (total hours fished by tenders) during the three month period February-April within each area fished. Note, this result is based only on those logbook data where effort has been recorded. The percent of the total TVH catch each year for which effort is not recorded is shown in the bottom figure.

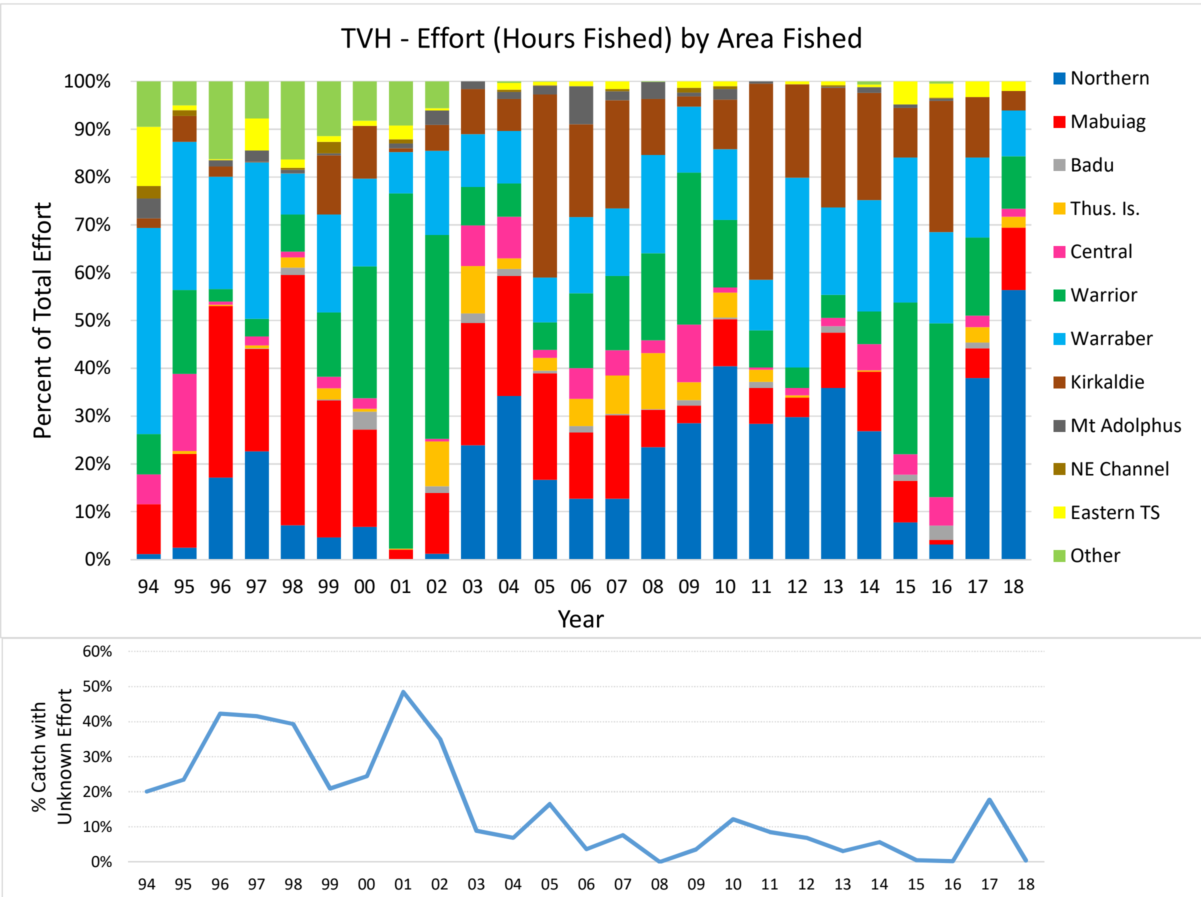


Figure 16. Map of the TVH fishing areas described in the analysis.

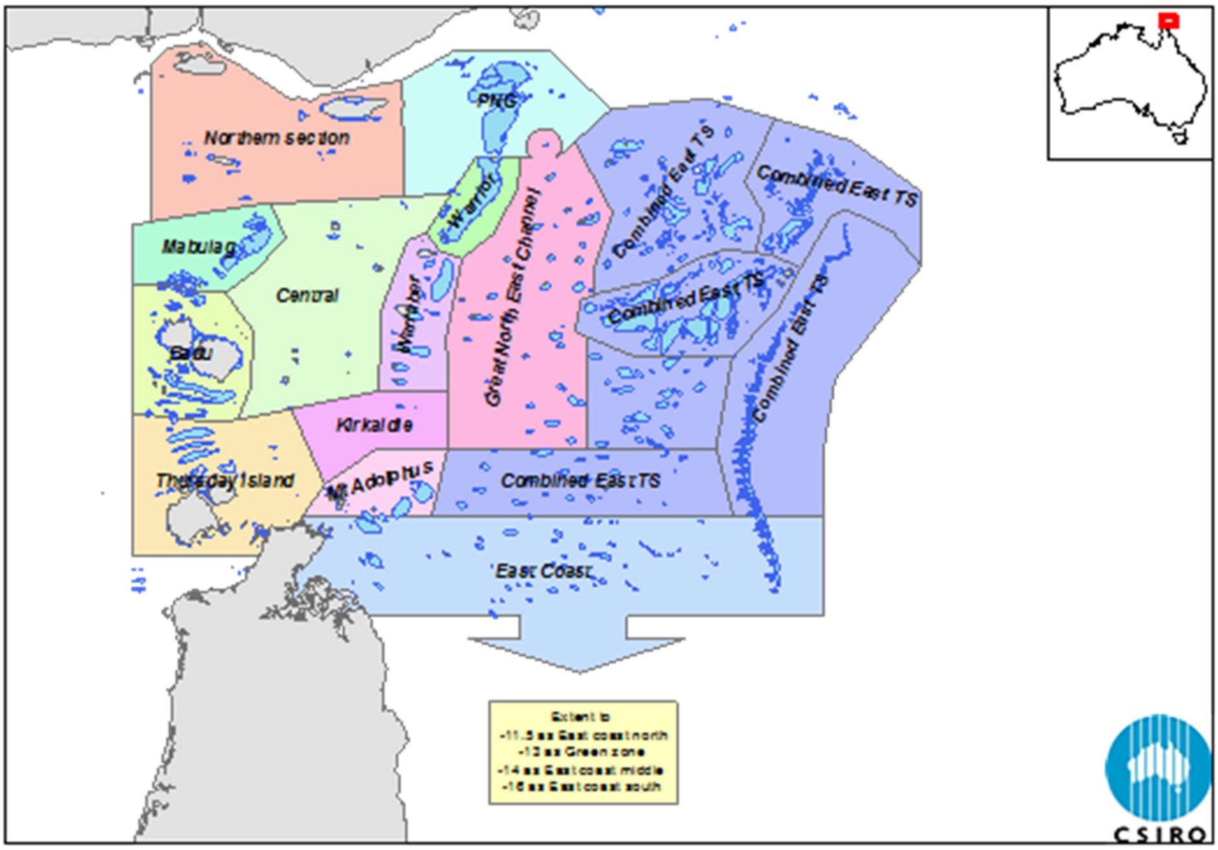



Figure 17. Annual time-series of percent of the total TVH catch during the three month period February-April taken within each area fished. Refer to Figure 16 for location of TVH areas.

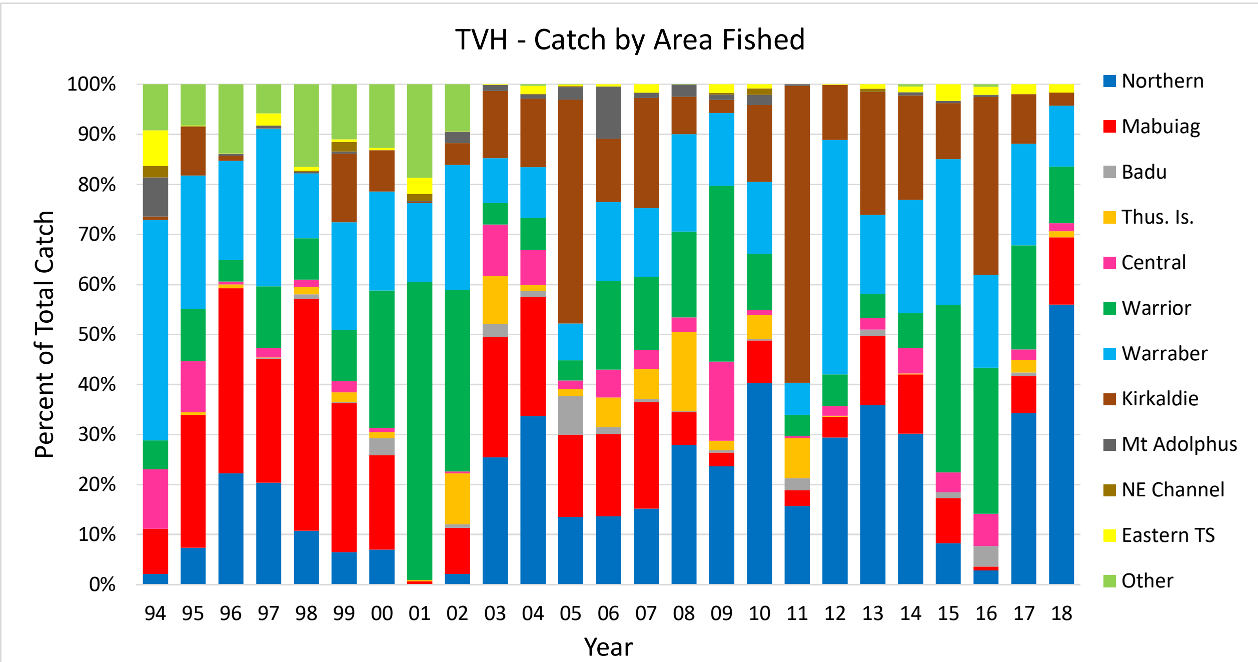
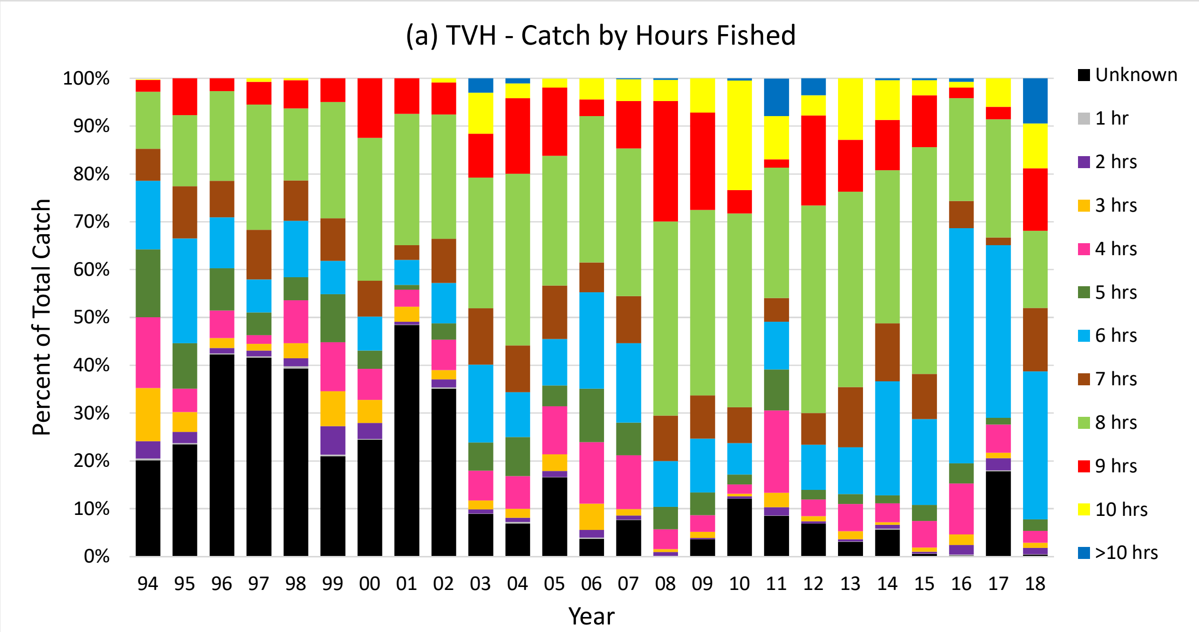


Figure 18. Comparison of percent of the TIB total catch in the three month period February-April stratified by the number of hours fished per tender-day based on (a) all records including those where the hours fished is unknown, and (b) those records where the unknown days fished are excluded and the number of hours fished is limited to 1-9.



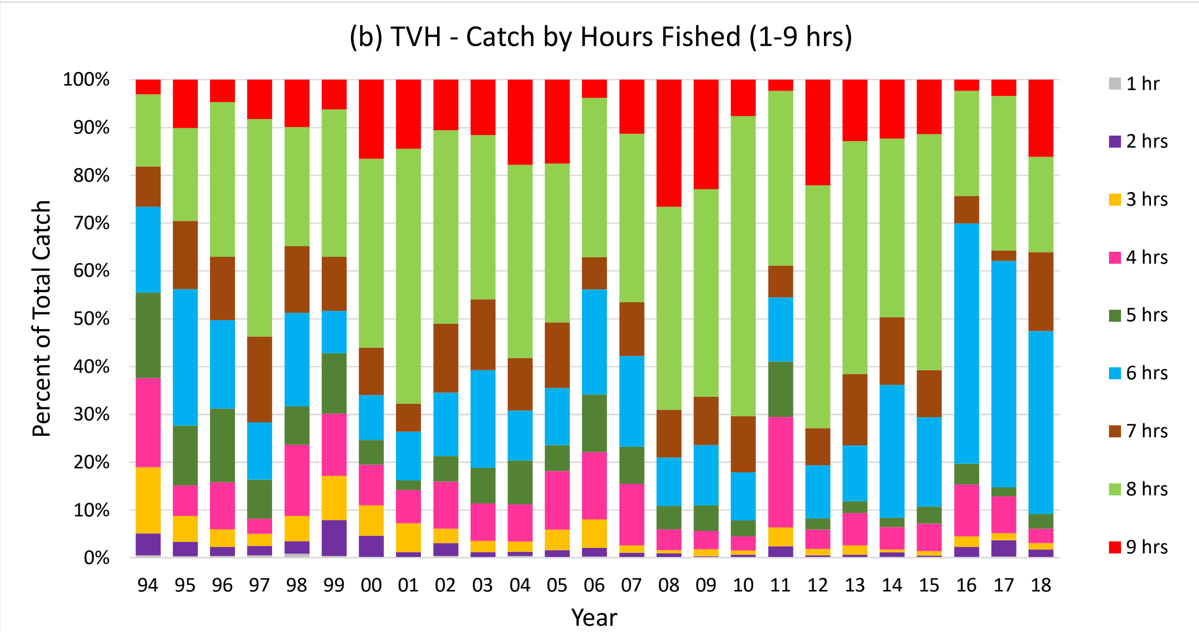
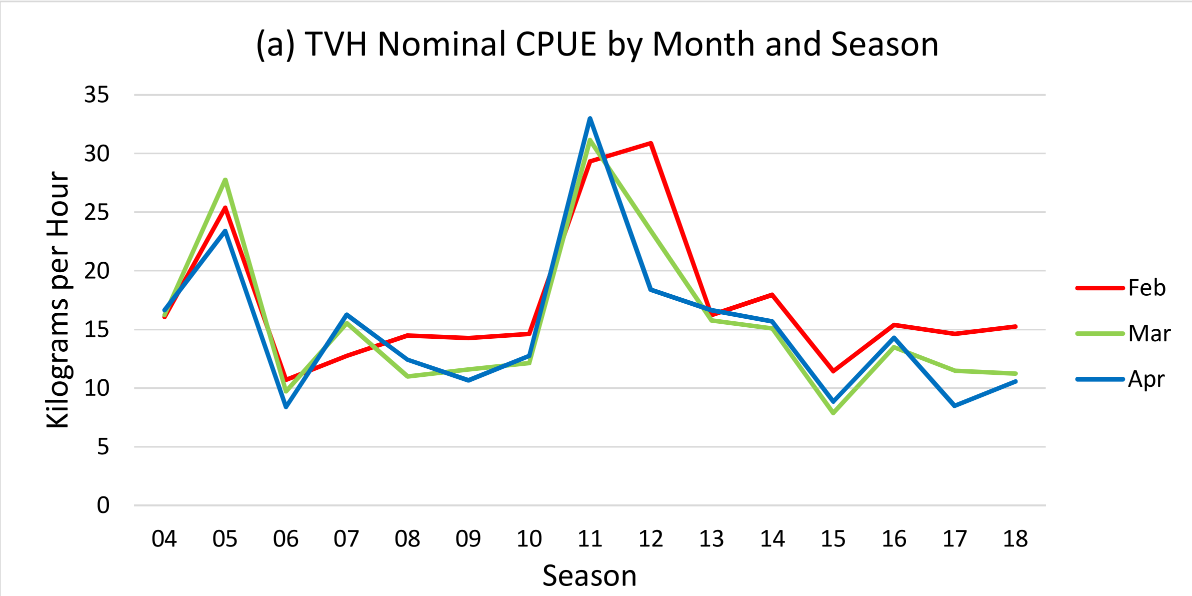



Figure 19. Annual time-series of nominal CPUE (kilograms per hour) for the TVH fleet within (a) month and (b) by fishing method during the three month period February-April.



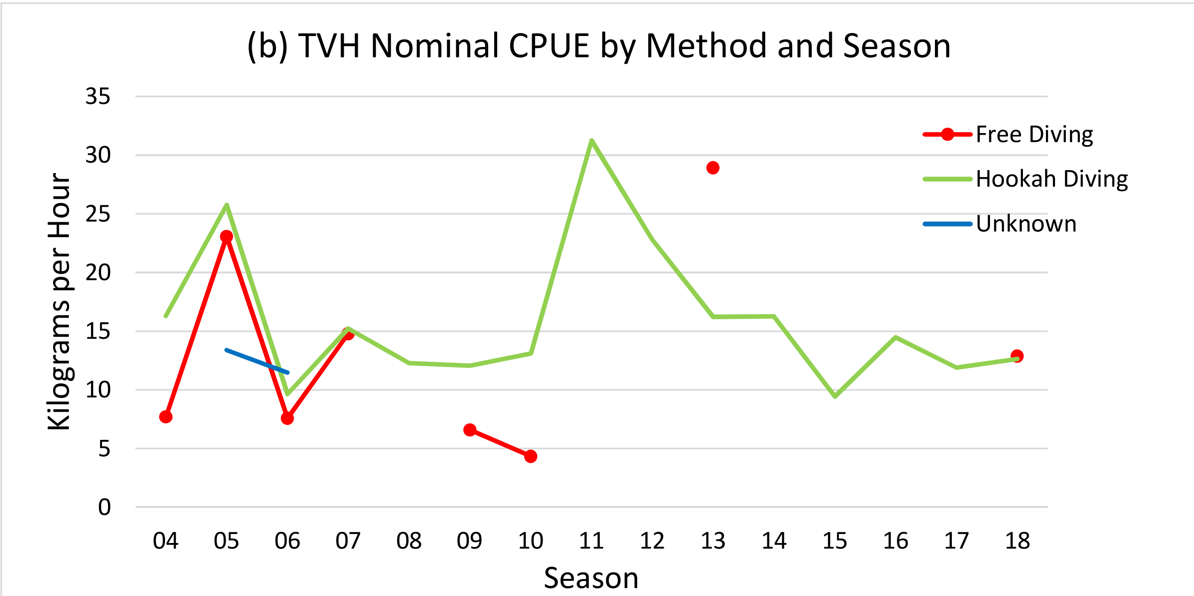
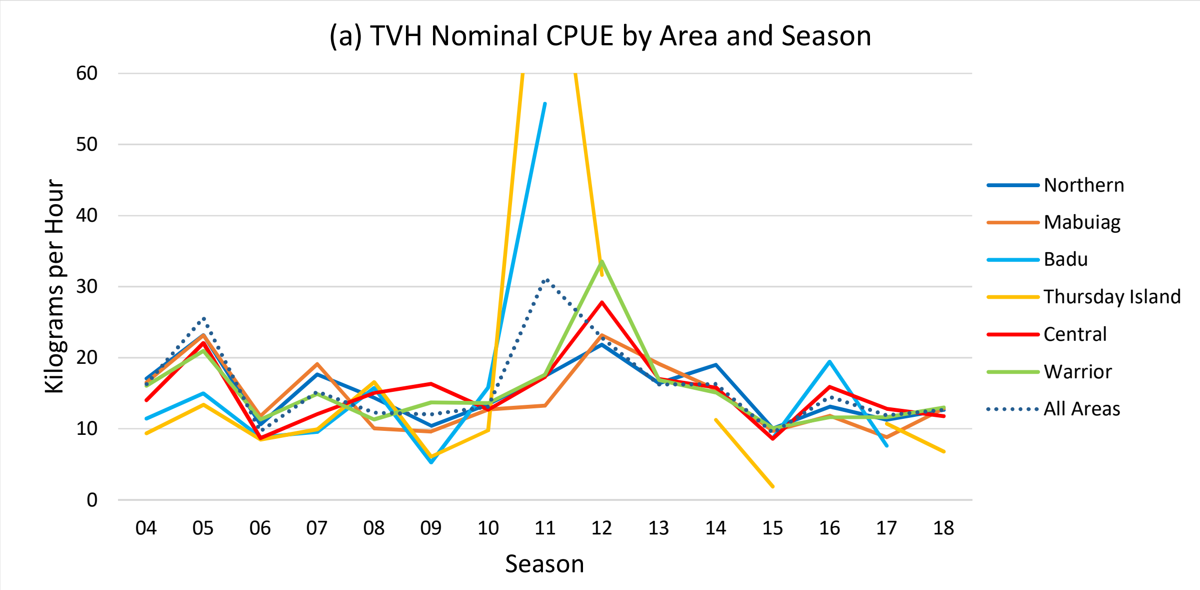



Figure 20. Annual time-series of nominal CPUE (kilograms per hour) for the TVH fleet within each area fished during the three month period February-April. For comparison, the mean nominal CPUE across all areas is also shown.



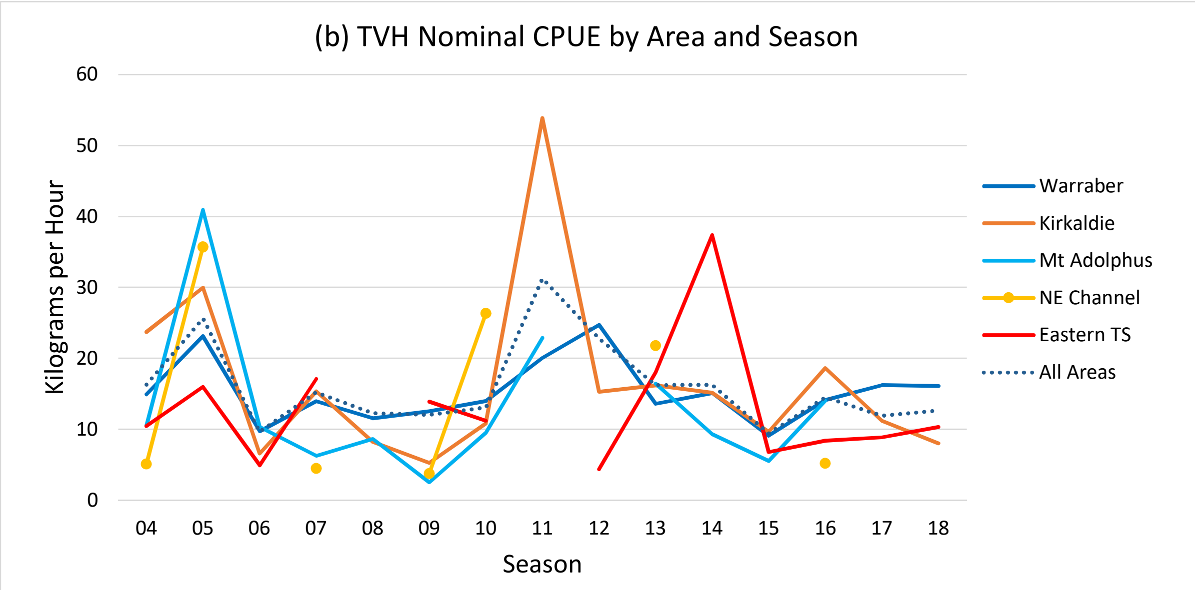



Figure 21. Annual comparison of effort in the TVH fishery during the three month period February-April. Analysis based on the method outlined in Campbell (2017)

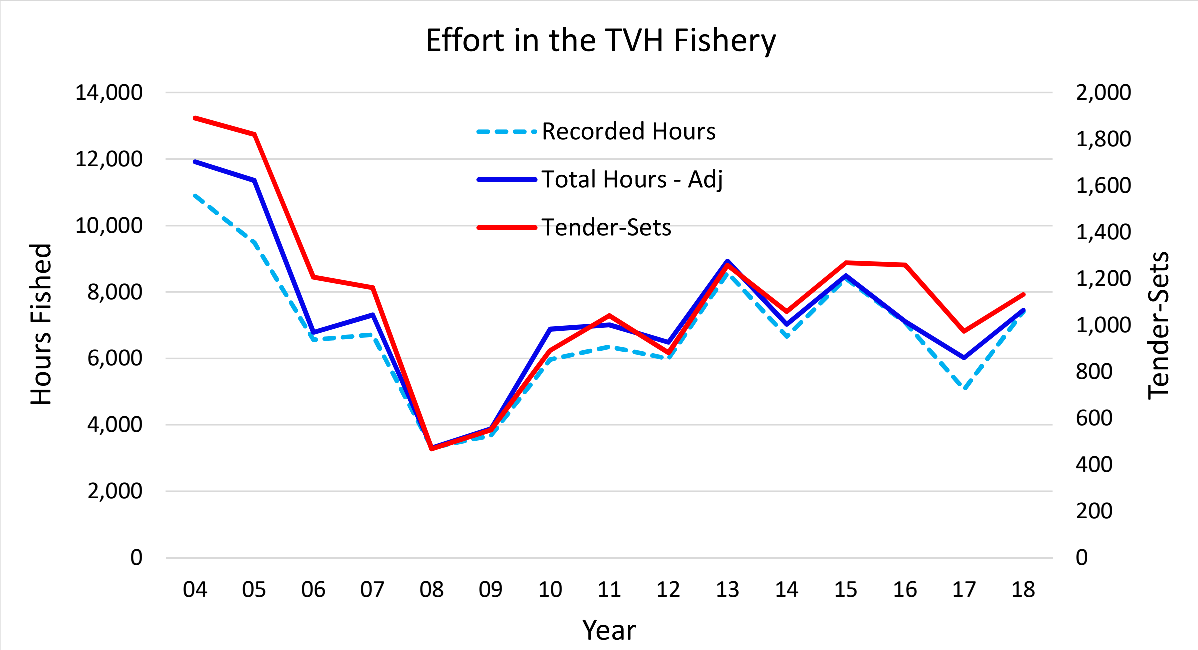
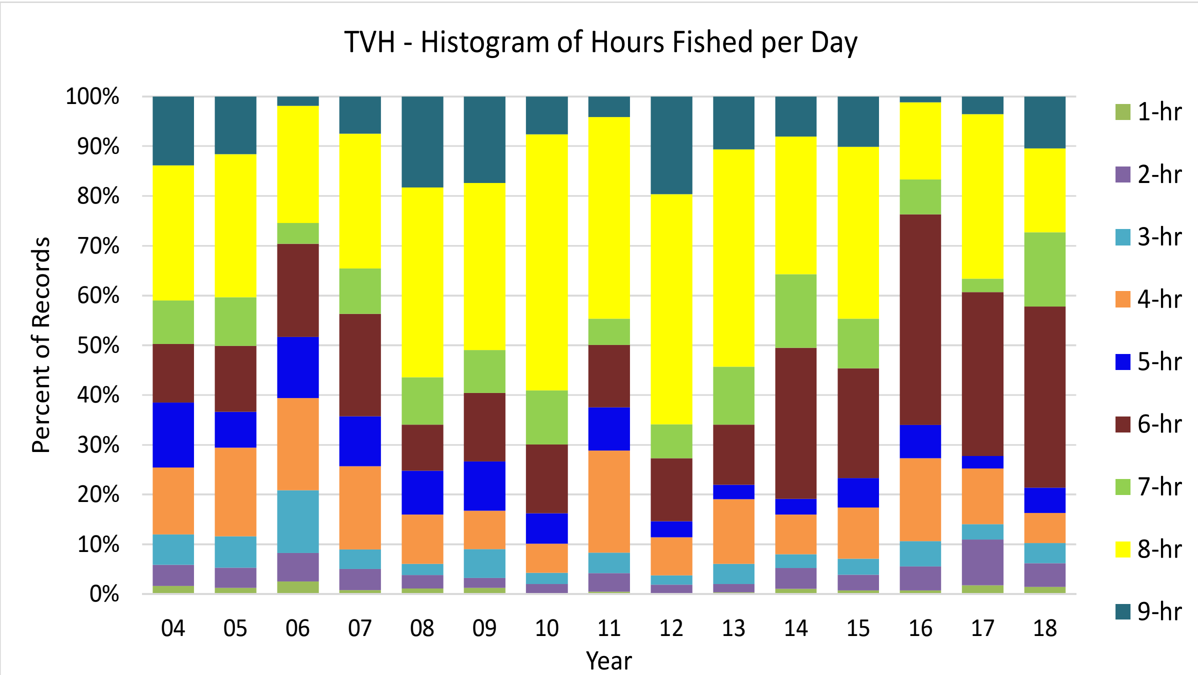



Figure 22. Annual comparison of the histogram of the number of hours fished per tender-day for the entire TVH fleet during the three month period February-April. Note, data where the hours fished was not reported or greater than 9 hours have been excluded.



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