# Response to requests made by the Arrowtooth TWG at the June 16, 2021 meeting

## 1 Revisit the Proportion female calculations and give more information on sample sizes used in weighting. Show the analysis for freezer vessels vs. wet boats.

The calculations follow the same method as in Appendix B of the 2015 Stock assessment (Grandin & Forrest, 2017).

There were two small bugs found in the code that caused several proportions shown in the presentation to be unreasonable. The bugs had the effect of only the first sample in each trip being used in the calculation instead of all of them. This was the case for both the commercial and survey calculations. In addition, for the commercial data, the quarter 3 catch was used instead of the quarter 4 catch as a divisor in the weighting of the quarter 4 weights for both male and female.

The bugs were fixed and Tables 1 and 6 are the corrected versions of those that appeared in the presentation. Tables 3 and 7 show the number of trips, samples, and weights by sex used in the weighting calculations for coastwide commercial and survey data respectively.

Tables 4 and 5 show the number of trips, samples, and weights by sex used in the weighting calculations for freezer trawlers and wet boats respectively.

Table 1: Proportions of coastwide female Arrowtooth Flounder calculated from several data sources. Note that there are no unsorted samples for 1997.

| Year | Unsorted only | Unsorted + Keepers | Unsorted + Keepers + Discards |
|------|---------------|--------------------|-------------------------------|
| 1996 | 0.85 | 0.85 | 0.85 |
| 1997 |      | 0.90 | 0.85 |
| 1998 | 0.64 | 0.79 | 0.80 |
| 1999 | 0.86 | 0.91 | 0.79 |
| 2000 | 0.86 | 0.90 | 0.78 |
| 2001 | 0.83 | 0.89 | 0.89 |
| 2002 | 0.70 | 0.88 | 0.88 |
| 2003 | 0.81 | 0.78 | 0.78 |
| 2004 | 0.82 | 0.89 | 0.89 |
| 2005 | 0.80 | 0.85 | 0.85 |
| 2006 | 0.78 | 0.86 | 0.86 |
| 2007 | 0.81 | 0.84 | 0.84 |
| 2008 | 0.92 | 0.92 | 0.92 |
| 2009 | 0.68 | 0.68 | 0.68 |
| 2010 | 0.73 | 0.73 | 0.73 |
| 2011 | 0.74 | 0.74 | 0.74 |
| 2012 | 0.83 | 0.83 | 0.83 |
| 2013 | 0.77 | 0.77 | 0.77 |
| 2014 | 0.78 | 0.78 | 0.78 |
| 2015 | 0.76 | 0.76 | 0.76 |
| 2016 | 0.76 | 0.77 | 0.77 |
| 2017 | 0.76 | 0.76 | 0.76 |
| 2018 | 0.77 | 0.77 | 0.77 |
| 2019 | 0.78 | 0.78 | 0.78 |

Table 2: Proportions of female Arrowtooth Flounder calculated for freezer trawlers only, wet boats only, and both combined. Note that freezer trawlers do not have any weight samples, so length-weight parameters calculated from the wet boats were used to calculate weights from the freezer trawler length samples.

| Year | All vessels coastwide | All vessels 3CD | All vessels 5ABCDE | Freezer trawlers coastwide | Freezer trawlers 3CD | Freezer trawlers 5ABCDE | Wet boats coastwide | Wet boats 3CD | Wet boats 5ABCDE |
|---|---|---|---|---|---|---|---|---|---|
| 1996 | 0.85 | 0.85 | | | | | 0.85 | 0.85 | |
| 1998 | 0.64 | 0.64 | | | | | 0.64 | 0.64 | |
| 1999 | 0.86 | 0.76 | 0.93 | | | | 0.86 | 0.76 | 0.93 |
| 2000 | 0.86 | 0.71 | 0.92 | | | | 0.86 | 0.71 | 0.92 |
| 2001 | 0.83 | 0.83 | 0.84 | | | | 0.83 | 0.83 | 0.84 |
| 2002 | 0.70 | 0.87 | 0.57 | | | | 0.70 | 0.87 | 0.57 |
| 2003 | 0.81 | 0.70 | 0.88 | | | | 0.81 | 0.70 | 0.88 |
| 2004 | 0.82 | 0.70 | 0.92 | | | | 0.82 | 0.70 | 0.92 |
| 2005 | 0.80 | 0.87 | 0.78 | | | | 0.80 | 0.87 | 0.78 |
| 2006 | 0.78 | 0.86 | 0.79 | 0.49 | | 0.48 | 0.90 | 0.86 | 0.90 |
| 2007 | 0.81 | 0.79 | 0.79 | 0.85 | 0.87 | 0.82 | 0.79 | 0.76 | 0.77 |
| 2008 | 0.92 | 0.92 | | 0.89 | 0.89 | | 0.95 | 0.95 | |
| 2009 | 0.68 | 0.76 | 0.61 | | | | 0.68 | 0.76 | 0.61 |
| 2010 | 0.73 | 0.60 | 0.73 | | | | 0.73 | 0.60 | 0.73 |
| 2011 | 0.74 | 0.81 | 0.71 | 0.80 | 0.80 | | 0.71 | 0.76 | 0.71 |
| 2012 | 0.83 | 0.82 | 0.85 | 0.86 | 0.87 | 0.82 | 0.75 | 0.72 | 0.87 |
| 2013 | 0.77 | 0.84 | 0.82 | 0.81 | 0.84 | 0.78 | 0.85 | 0.77 | 0.86 |
| 2014 | 0.78 | 0.65 | 0.82 | 0.79 | 0.67 | 0.84 | 0.71 | 0.64 | 0.80 |
| 2015 | 0.76 | 0.70 | 0.69 | 0.77 | 0.85 | 0.77 | 0.59 | 0.53 | 0.59 |
| 2016 | 0.76 | 0.69 | 0.83 | 0.72 | 0.69 | 0.81 | 0.86 | | 0.86 |
| 2017 | 0.76 | 0.67 | 0.79 | 0.71 | 0.80 | 0.68 | 0.82 | 0.48 | 0.88 |
| 2018 | 0.77 | 0.89 | 0.77 | 0.82 | 0.89 | 0.82 | 0.61 | | 0.61 |
| 2019 | 0.78 | 0.82 | 0.76 | 0.76 | 0.82 | 0.74 | 0.75 | 0.52 | 0.81 |

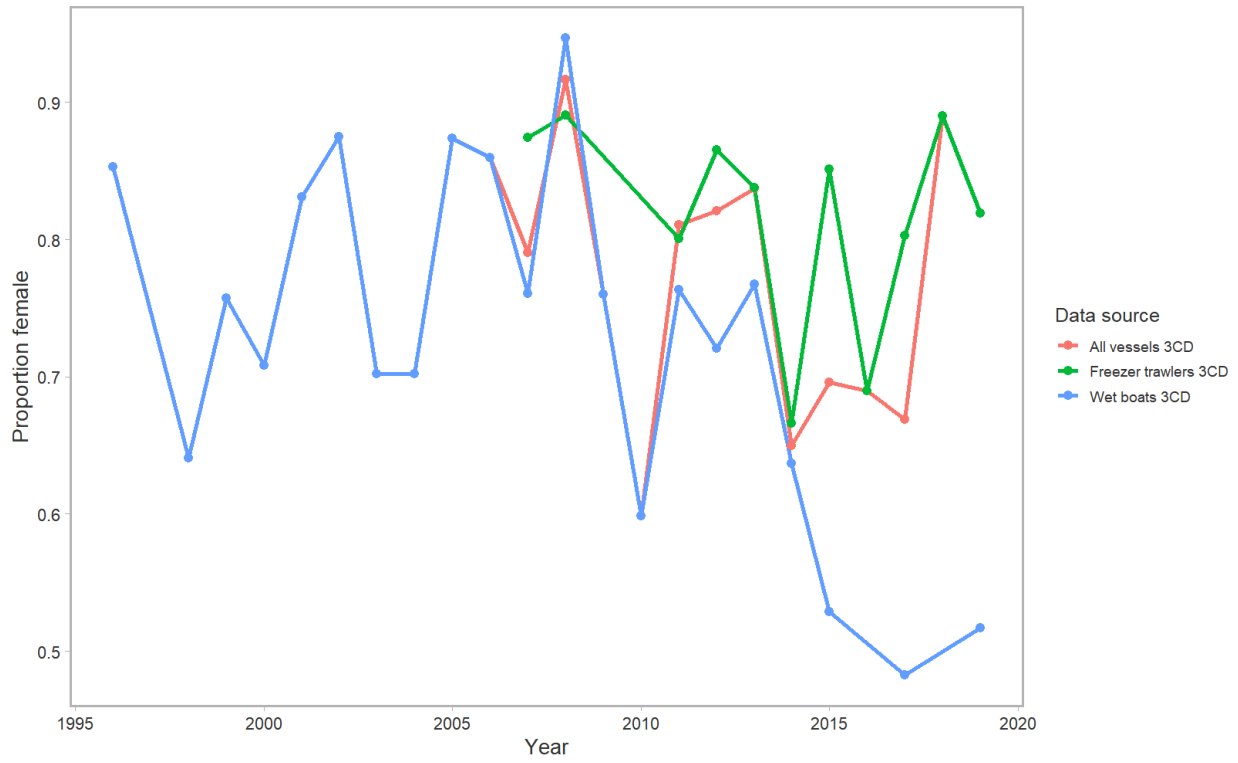Figure 1: Coastwide proportions female by fleet.



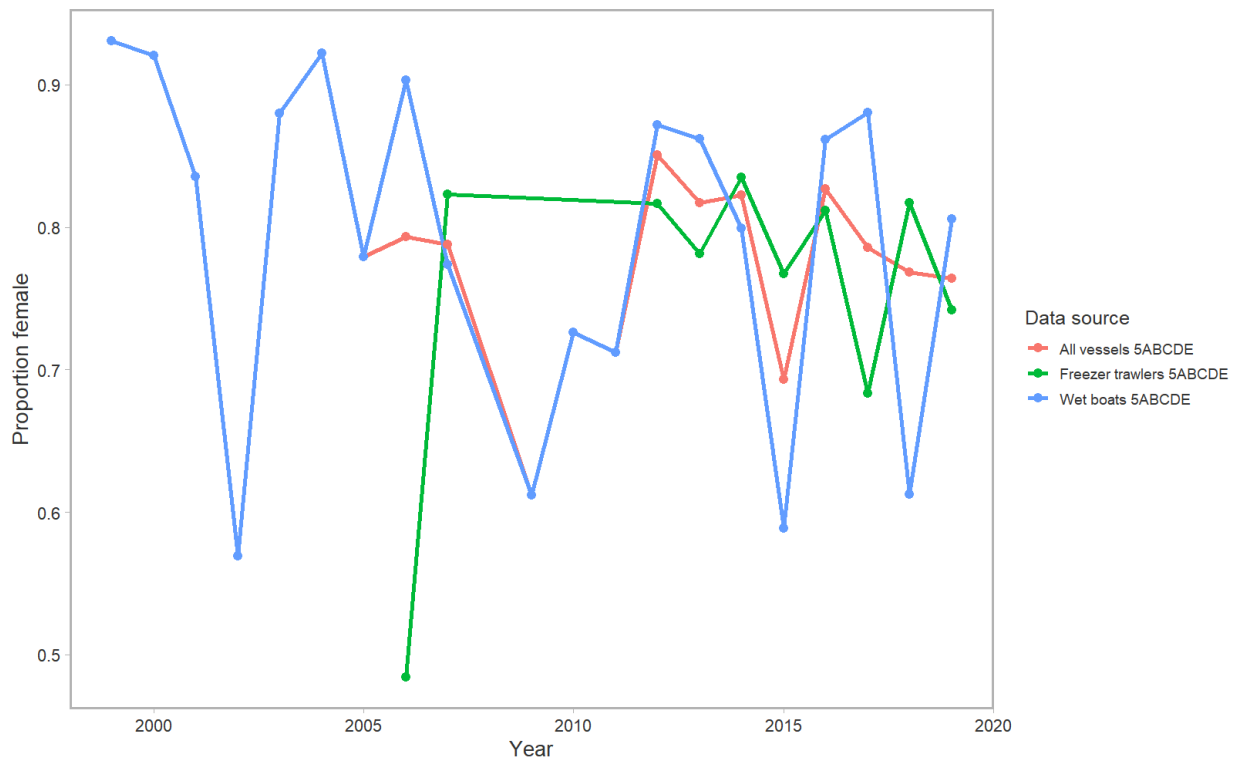Figure 2: Area 3CD proportions female by fleet.

Figure 3: Area 5ABCDE proportions female by fleet.

Table 3: Summary of the number of trips, samples, and fish weights used in the commercial coastwide proportion female calculations. Note that 1997 is missing because there are no Unsorted samples for that year.

| Year | Number of trips | Number of samples | Number of weights - Male | Number of weights - Female |
|---|---|---|---|---|
| 1996 | 1 | 6 | 195 | 479 |
| 1998 | 1 | 2 | 48 | 51 |
| 1999 | 2 | 2 | 16 | 62 |
| 2000 | 7 | 7 | 98 | 267 |
| 2001 | 22 | 23 | 379 | 808 |
| 2002 | 11 | 11 | 177 | 451 |
| 2003 | 17 | 19 | 225 | 673 |
| 2004 | 23 | 23 | 327 | 864 |
| 2005 | 40 | 43 | 676 | 1596 |
| 2006 | 24 | 25 | 312 | 980 |
| 2007 | 25 | 28 | 422 | 966 |
| 2008 | 2 | 5 | 65 | 248 |
| 2009 | 10 | 10 | 165 | 273 |
| 2010 | 13 | 13 | 268 | 319 |
| 2011 | 18 | 24 | 441 | 789 |
| 2012 | 16 | 20 | 267 | 759 |
| 2013 | 29 | 40 | 631 | 1463 |
| 2014 | 33 | 41 | 689 | 1331 |
| 2015 | 25 | 40 | 760 | 1306 |
| 2016 | 14 | 22 | 411 | 741 |
| 2017 | 14 | 19 | 324 | 581 |
| 2018 | 12 | 19 | 309 | 603 |
| 2019 | 10 | 15 | 231 | 429 |

Table 4: Summary of the number of trips, samples, and fish weights used in the commercial coastwide proportion female calculations for freezer trawlers only. Note that there are no actual weight samples for freezer trawlers and the number of weights shown here were calculated from lengths using length-weight parameters calculated from the wet boat fleet.

| Year | Number of trips | Number of samples | Number of weights - Male | Number of weights - Female |
|---|---|---|---|---|
| 2006 | 2 | 3 | 97 | 82 |
| 2007 | 5 | 7 | 86 | 251 |
| 2008 | 1 | 4 | 59 | 195 |
| 2011 | 2 | 8 | 159 | 288 |
| 2012 | 5 | 8 | 121 | 327 |
| 2013 | 15 | 26 | 460 | 944 |
| 2014 | 15 | 23 | 399 | 833 |
| 2015 | 13 | 28 | 473 | 968 |
| 2016 | 10 | 18 | 366 | 608 |
| 2017 | 5 | 9 | 198 | 269 |
| 2018 | 7 | 14 | 194 | 470 |
| 2019 | 7 | 11 | 190 | 368 |

Table 5: Summary of the number of trips, samples, and fish weights used in the commercial coastwide proportion female calculations for wet boats only.

| Year | Number of trips | Number of samples | Number of weights - Male | Number of weights - Female |
|---|---|---|---|---|
| 1996 | 1 | 6 | 195 | 479 |
| 1998 | 1 | 2 | 48 | 51 |
| 1999 | 2 | 2 | 16 | 62 |
| 2000 | 7 | 7 | 98 | 267 |
| 2001 | 22 | 23 | 379 | 808 |
| 2002 | 11 | 11 | 177 | 451 |

| Year | Number of trips | Number of samples | Number of weights - Male | Number of weights - Female |
|---|---|---|---|---|
| 2003 | 17 | 19 | 225 | 673 |
| 2004 | 23 | 23 | 327 | 864 |
| 2005 | 40 | 43 | 676 | 1596 |
| 2006 | 22 | 22 | 215 | 898 |
| 2007 | 20 | 21 | 336 | 715 |
| 2008 | 1 | 1 | 6 | 53 |
| 2009 | 10 | 10 | 165 | 273 |
| 2010 | 13 | 13 | 268 | 319 |
| 2011 | 16 | 16 | 282 | 501 |
| 2012 | 11 | 12 | 146 | 432 |
| 2013 | 14 | 14 | 171 | 519 |
| 2014 | 18 | 18 | 290 | 498 |
| 2015 | 12 | 12 | 287 | 338 |
| 2016 | 4 | 4 | 45 | 133 |
| 2017 | 9 | 10 | 126 | 312 |
| 2018 | 5 | 5 | 115 | 133 |
| 2019 | 3 | 4 | 41 | 61 |

Table 6: Proportions of female Arrowtooth Flounder calculated for Synoptic surveys and the Hecate Strait multispecies assemblage survey.

| Year | QCS Synoptic | HS Multispecies | HS Synoptic | WCVI Synoptic |
|---|---|---|---|---|
| 1998 | | 0.71 | | |
| 2000 | | 0.91 | | |
| 2002 | | 0.85 | | |
| 2003 | 0.84 | 0.85 | | |
| 2004 | 0.88 | | | 0.85 |
| 2005 | 0.90 | | 0.82 | |
| 2006 | | | | 0.85 |
| 2007 | 0.76 | | 0.78 | |
| 2008 | | | | 0.85 |
| 2009 | 0.80 | | 0.75 | |
| 2010 | | | | 0.82 |
| 2011 | 0.75 | | 0.79 | |
| 2012 | | | | 0.75 |
| 2013 | 0.72 | | 0.73 | |
| 2014 | | | | 0.77 |
| 2015 | 0.74 | | 0.74 | |
| 2016 | | | | 0.72 |
| 2017 | 0.75 | | 0.77 | |
| 2018 | | | | 0.77 |
| 2019 | 0.77 | | 0.78 | |

Table 7: Summary of the number of samples and fish weights used in the survey proportion female calculations.

| Survey | Year | Number of samples | Number of weights - Male | Number of weights - Female |
|---|---|---|---|---|
| HS Multispecies | 1998 | 1 | 20 | 30 |
| HS Multispecies | 2000 | 3 | 51 | 197 |
| HS Multispecies | 2002 | 29 | 1438 | 2769 |
| HS Multispecies | 2003 | 33 | 1187 | 2144 |
| HS Synoptic | 2005 | 166 | 3405 | 5270 |
| HS Synoptic | 2007 | 43 | 726 | 1242 |
| HS Synoptic | 2009 | 75 | 1572 | 2436 |

| Survey | Year | Number of samples | Number of weights - Male | Number of weights - Female |
|---|---|---|---|---|
| HS Synoptic | 2011 | 122 | 1131 | 2112 |
| HS Synoptic | 2013 | 112 | 1106 | 1693 |
| HS Synoptic | 2015 | 105 | 1232 | 1787 |
| HS Synoptic | 2017 | 68 | 709 | 1122 |
| HS Synoptic | 2019 | 75 | 762 | 1323 |
| QCS Synoptic | 2003 | 95 | 1486 | 1994 |
| QCS Synoptic | 2004 | 97 | 1190 | 1654 |
| QCS Synoptic | 2005 | 86 | 1464 | 2142 |
| QCS Synoptic | 2007 | 87 | 1595 | 2278 |
| QCS Synoptic | 2009 | 138 | 1459 | 2195 |
| QCS Synoptic | 2011 | 160 | 1614 | 2237 |
| QCS Synoptic | 2013 | 134 | 1567 | 1783 |
| QCS Synoptic | 2015 | 146 | 1552 | 2245 |
| QCS Synoptic | 2017 | 111 | 1257 | 1765 |
| QCS Synoptic | 2019 | 130 | 1412 | 2546 |
| WCVI Synoptic | 2004 | 38 | 511 | 951 |
| WCVI Synoptic | 2006 | 36 | 567 | 1432 |
| WCVI Synoptic | 2008 | 64 | 930 | 1811 |
| WCVI Synoptic | 2010 | 87 | 774 | 1627 |
| WCVI Synoptic | 2012 | 102 | 865 | 1364 |
| WCVI Synoptic | 2014 | 102 | 1026 | 1684 |
| WCVI Synoptic | 2016 | 97 | 1009 | 1480 |
| WCVI Synoptic | 2018 | 80 | 816 | 1318 |

# 2 Catch series split by freezer trawlers and wet boats
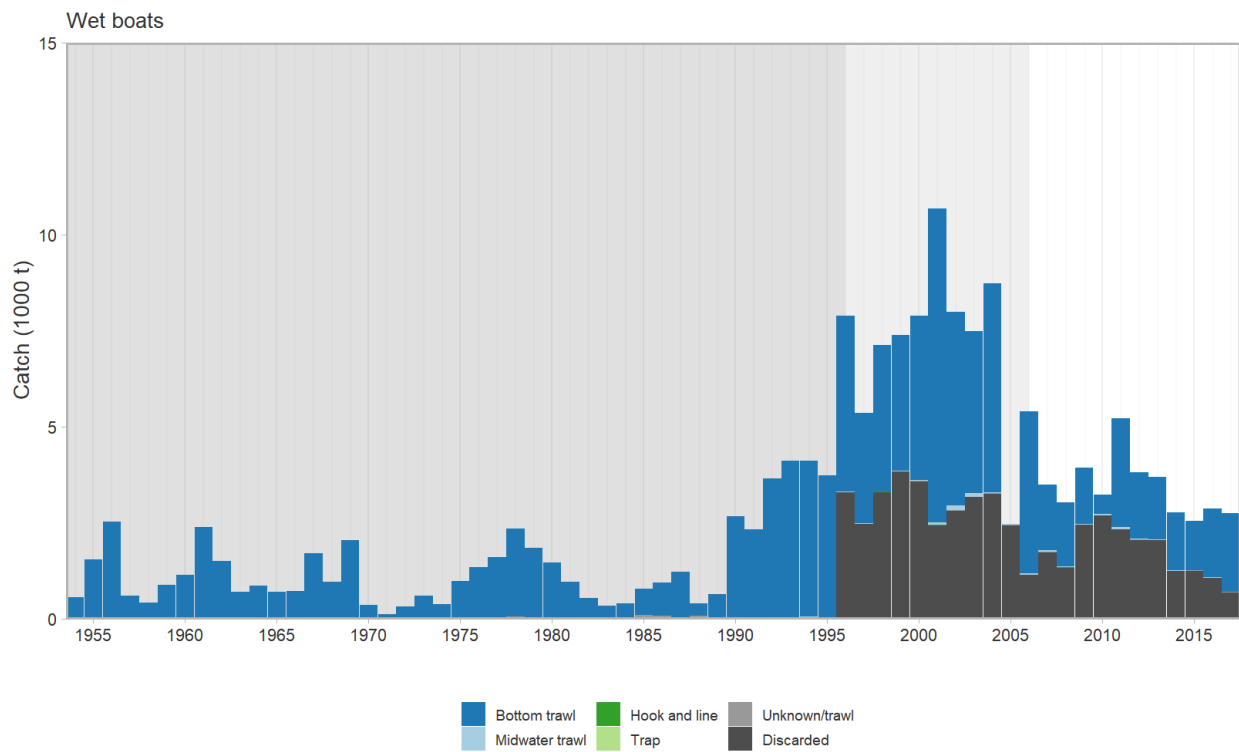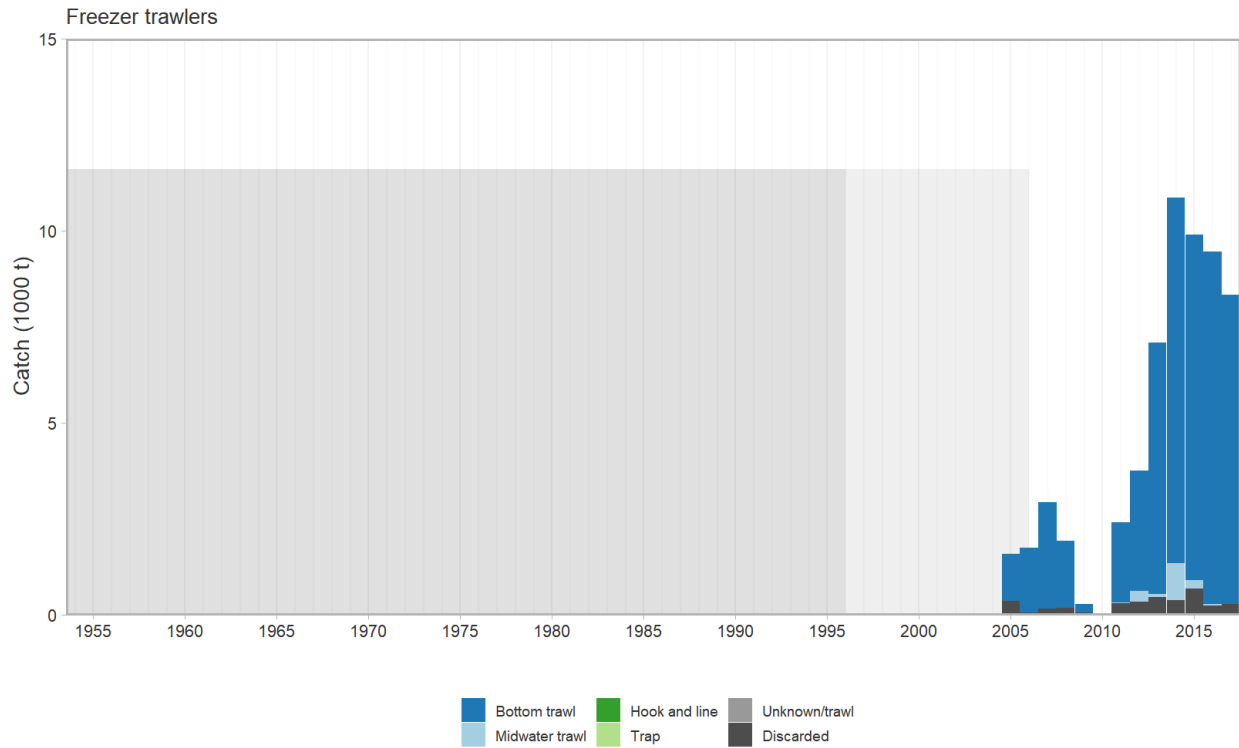
# 3 Show von Bertalanffy fits and parameter values for survey data. Produce a plot comparing vonB parameter values among surveys.
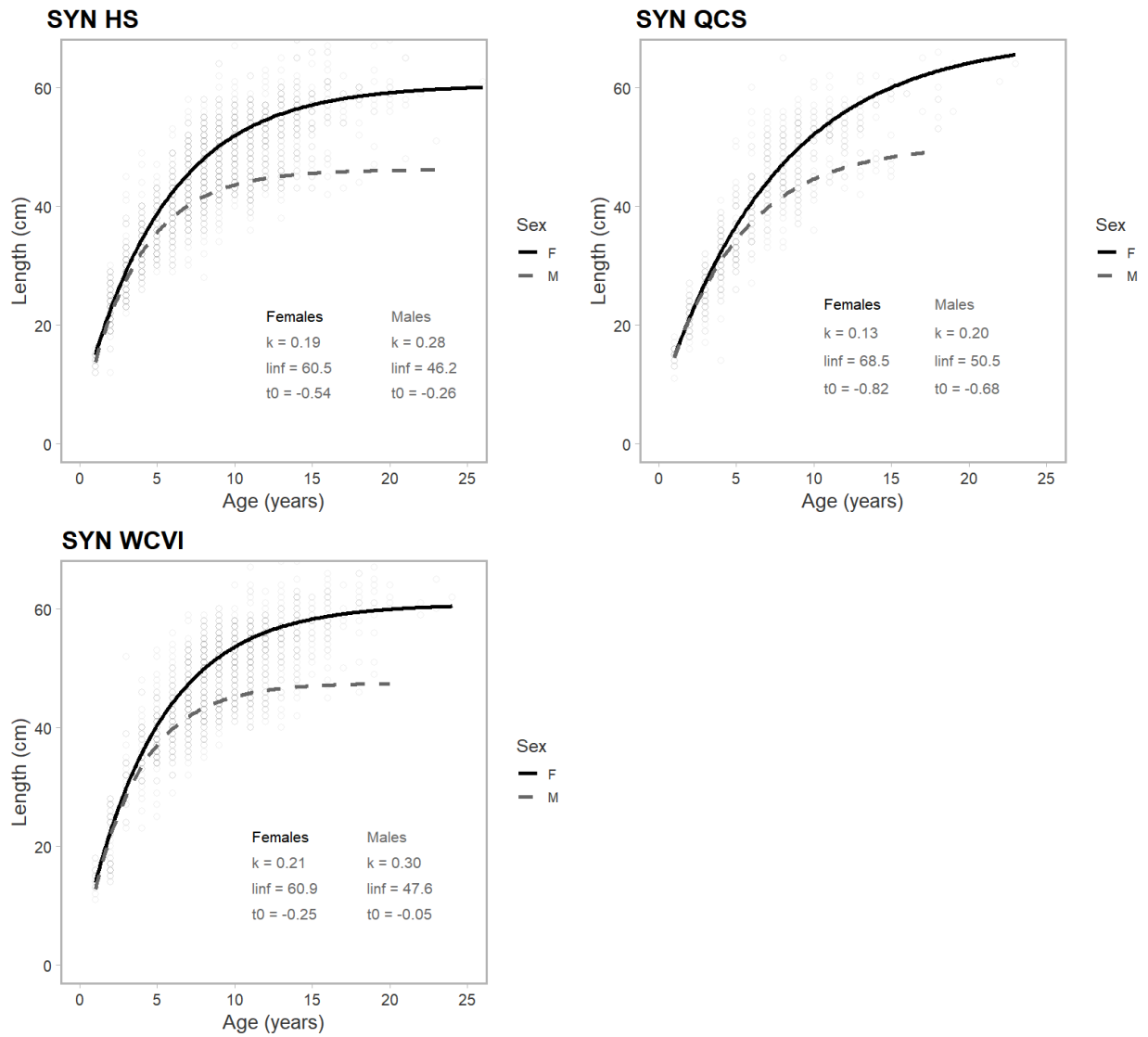


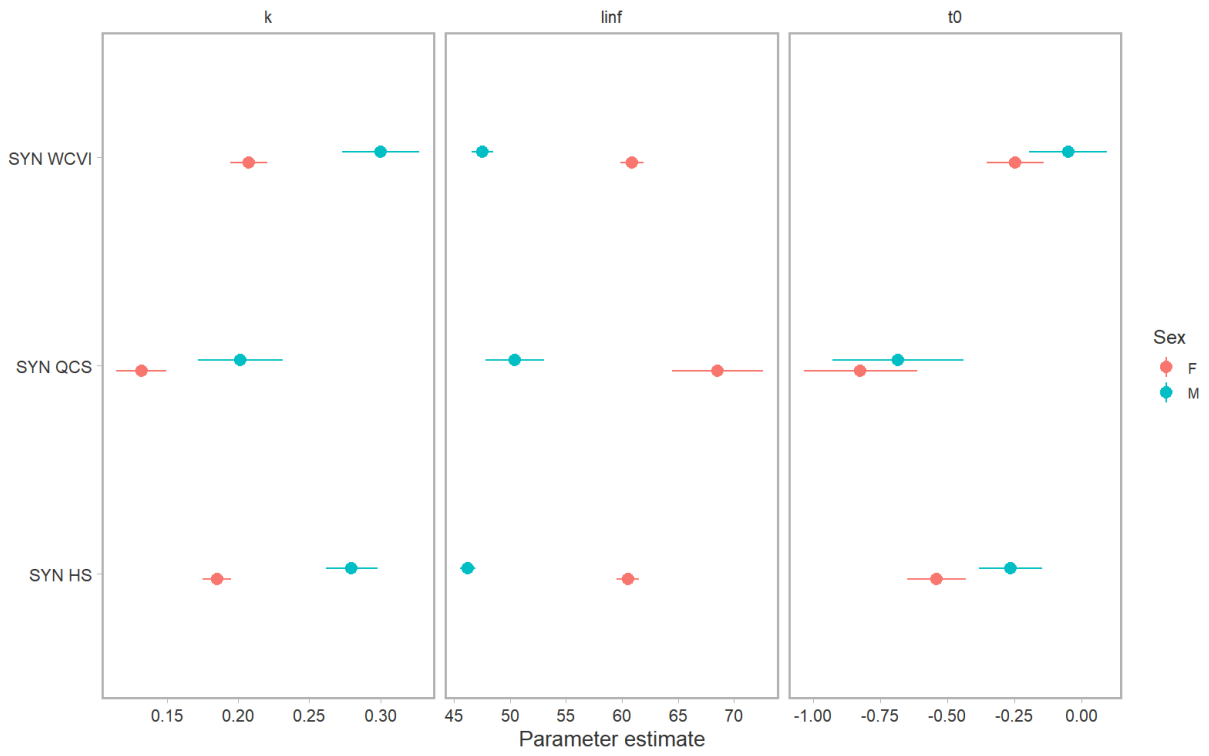Figure 4: von Bertalanffy fits to survey data.
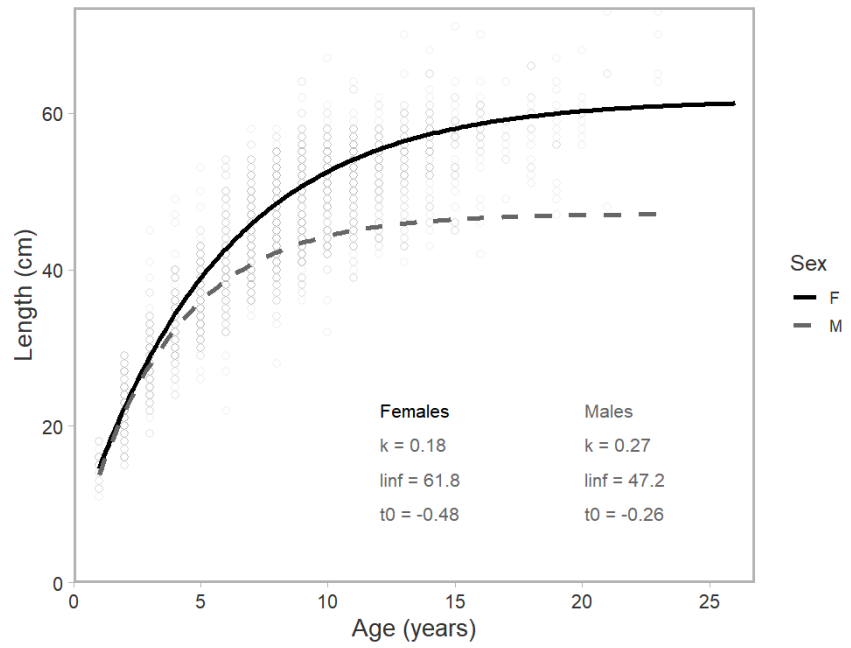
Figure 5: von Bertalanffy parameters.



Figure 6: von Bertalanffy fits to all survey data.
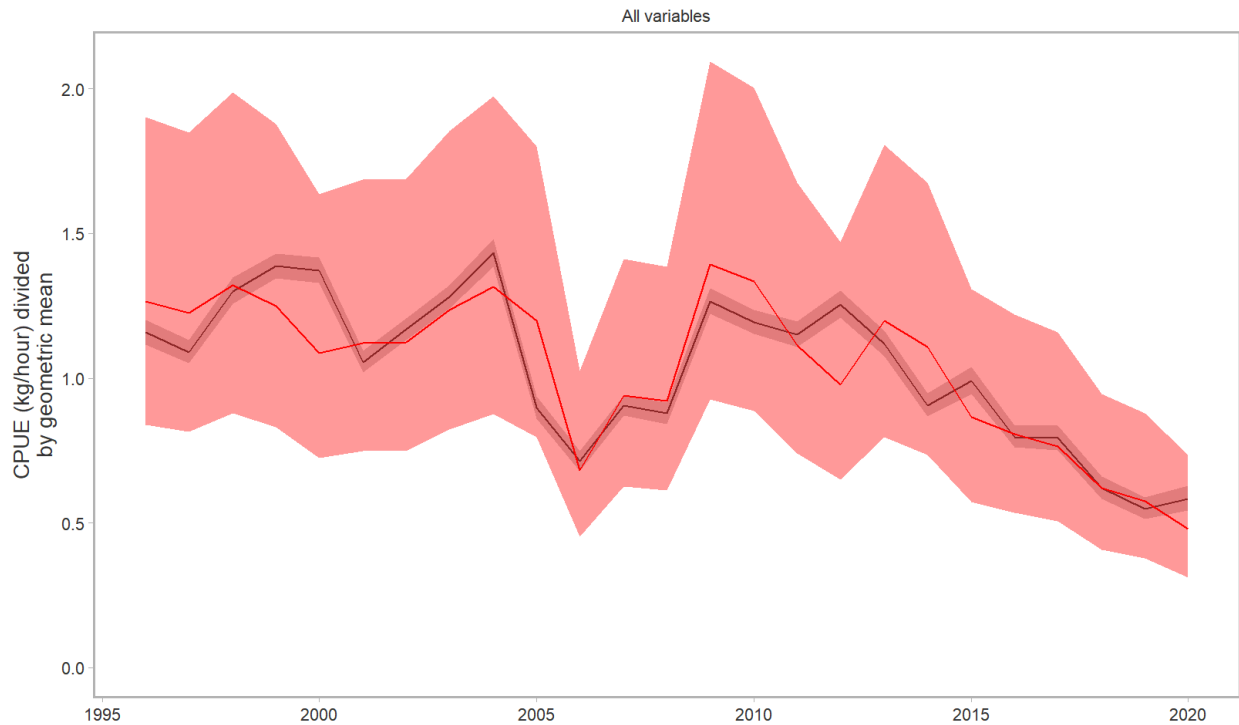
# 4 Create a 'Discard' CPUE by filtering



Figure 7: Discard CPUE index. Red is the index standardized for depth, vessel, latitude, and locality. Black is the unstandardized geometric mean assuming a Tweedie observation error. This index was calculated by first retaining only fishing events some arrowtooth discards and 0 landed arrowtooth catch and then applying the following fleet definition: a minimum of 100 positive tows for arrowtooth overall, a minimum of 5 years with 5 positive trips for arrowtooth. The standardized and unstandardized means are relatively similar, this index has less variance than the whole 'fleet' index, and this index matches the survey index relatively well (see last plot).

# 5 Request 4 - Why was the coastwide stitched synoptic index going up in the last year despite the only survey data (WCHG) going down?
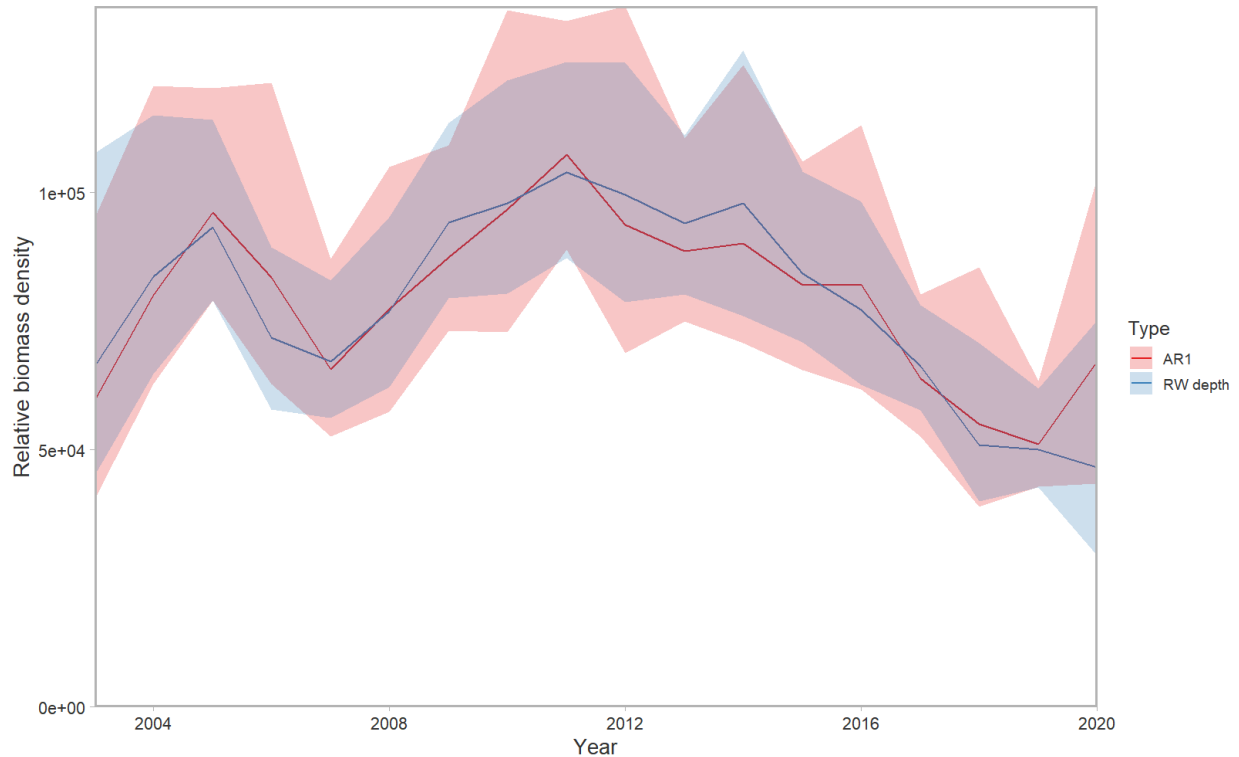


Figure 8: Coastwide geostatistical synoptic index: mean-reverting AR1 spatiotemporal model (as originally shown) vs. a random walk (RW) spatiotemporal model. The issue was that there were almost no data in the final year, 2020, (just WCHG, which has very low Arrowtooth biomass density in comparison to the other surveys) and the mean-reverting AR1 process was therefore drifting back towards the mean. Here I have instead used a random walk model that does not have this property. Note how the final year does not revert towards the mean in the RW model where there are almost no data. Alternatively, we could omit the 2020 coastwide index if this is used in a sensitivity run.

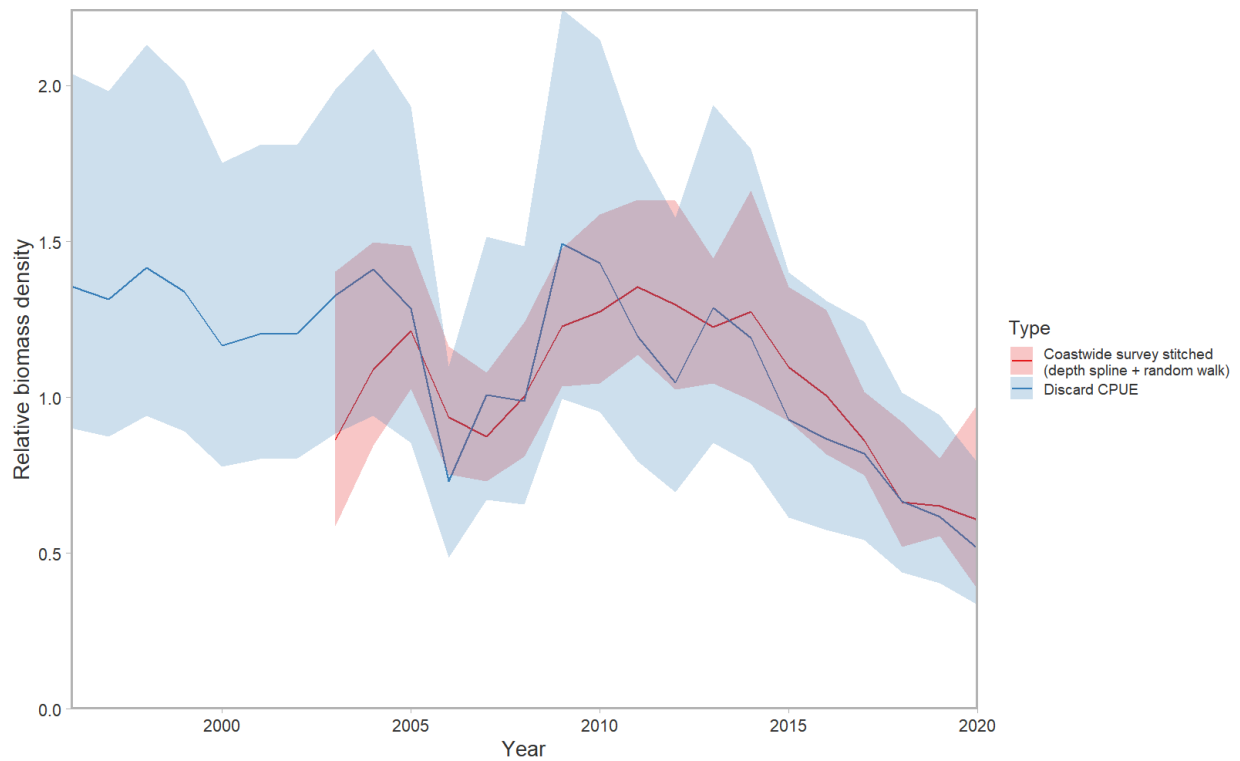# 6  How do the coastwide CPUE and synoptic index compare?



Figure 9: Synoptic survey coastwide index compared with the discard CPUE index. Centered on geometric mean for years after 2002.