# Update to the hake Reference Case model incorporating the 2019 commercial and 2020 survey data

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**Summary**

The Reference Case Ricker model is updated with 2019 commercial and 2020 survey data. The updated data points lie within the bounds predicted by OMP2018 projections, except for the proportion of *M. capensis* in the South Coast offshore trawl fishery catch, which continues to lie outside the 95% probability envelope predicted by OMP2018, as it did for the 2019 RC. The updated assessment results are compatible with the previous (2019) Reference Case results and suggest a continued steady increase in spawning biomass since for *M. capensis* but a small decrease for *M. paradoxus*.

**Key words**: hake, assessment, 2020 update, South Africa

## Introduction

The current (2019) Reference Case assessment model (the Ricker-like model with a central catch year of 1958), is updated with the latest available commercial and survey data. Survey abundance indices from the 2020 summer survey have been included[2] (T. Fairweather*, pers. comm*.). Commercial catches are included to 2019 and the commercial CPUE has been re-standardised using data from 1978-2019 and applying the Model A6b species splitting algorithm (J. Glazer *pers. comm.*). Further updates to survey proportions-at-length and commercial catches-at-age are currently not available[3]. The updated data used for this assessment are presented in Appendix A.

During a comparison exercise with OLRAC, two minor coding glitches in the 2019 Reference Case model were uncovered, which have now been corrected: (a) recruitment residuals had accidentally been estimated to 2017 instead of 2018 (should be to the last year of model, less one); and (b) a coding glitch in summing the catches-at-length for the plus group was corrected. These corrections had minimal impact on the assessment results.

## Results

Results have been presented for three assessment models.

(1) **2019 RC:** The RC as last presented to the DWG in 2019 (FISHERIES/2019/OCT/SWG-DEM/22rev).

(2) **2019 RC corrected:** The update to the 2019 RC that incorporates corrections to the two minor coding glitches listed above.

(3) **2020 RC:** The 2020 updated RC, which uses the same methodology as model (2), but incorporates the 2019-2020 data update.

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[2] No autumn survey was conducted during 2020.

[3] For the results presented in this paper, survey proportions-at-length to 2019 and commercial catches-at-length to 2016 have been used.

Table 1 lists the key outputs for these three assessment models. Table 2 gives a break-down of the negative log-likelihood components for the models.

Figure 1 shows the spawning biomass trajectories for both species in absolute and relative terms. Figure 2 plots the estimated stock-recruitment relationships, recruitment time series and standardized recruitment residuals. Figure 3 shows the fits to the commercial CPUE data, while Figure 4 shows the fits to the survey relative abundance estimates.

**Discussion**

A few key points arising from the results are discussed below.

*Data updates*

- Appendix B superimposes the updated commercial and survey data points onto the OMP2018 projections to ascertain whether these points lie within the range projected by the OMP when simulation tested, or whether Exceptional Circumstances should perhaps be triggered. The commercial CPUE and survey abundance estimates all lie within the error bounds projected by the OMP. The 2019 proportion of *M. capensis* catch in the South Coast offshore catch continues to be higher than expected and outside the 95% probability bound, but a little lower and now closer to the upper 95% probability bound than it was in 2018. These figures have already been presented to the Demersal Working group (FISHERIES/2020/OCT/SWG-DEM/23rev), and it was decided then that possible concern arising from this higher proportion was not sufficient to trigger Exceptional Circumstances.

- Commercial CPUE estimates for both species and both coasts are lower in 2019 than in 2018. The 2020 summer survey abundance estimate for *M. paradoxus* is very similar to the 2019 estimate, but the 2020 *M. capensis* survey abundance estimate is higher than the 2019 estimate.

*Assessment update*

- The 2020 Hake RC results are very similar to the 2019 Hake RC results.

- The assessment results suggest a continued steady increase in spawning biomass for *M. capensis* (increasing from 0.68 relative to $K^{sp}$ in 2019 to 0.72 in 2020). *M. paradoxus* has shown a small decrease from 0.32 in 2019 to 0.30 in 2020.

**Table 1:** Key assessment outputs for the models reported upon in this document. The first column (1) lists the results for the RC assessment model in 2019 as they were reported on in FISHERIES_2019_OCT_SWG-DEM_22rev. The second column (2) shows results for a subsequent update incorporating corrections to some minor coding glitches. The final column shows the results for the 2020 Reference Case model, which uses the same methodology as (2), but with the 2019-2020 data updates included.

| | | (1) 2019 RC | (2) 2019 RC corrected | (3) 2020 RC |
|---|---|---|---|---|
| | lnLtotal | -3253.87 | -3254.01 | -3257.96 |
| *M. paradoxus* | $K^{sp}$ | 329 | 328 | 337 |
| | $B^{sp}_{MSY}$ | 55 | 55 | 55 |
| | $B^{sp}_{2019}$ | 104 | 103 | 103 |
| | $B^{sp}_{2019}/K^{sp}$ | 0.31 | 0.32 | 0.31 |
| | $B^{sp}_{2019}/B^{sp}_{MSY}$ | 1.87 | 1.87 | 1.88 |
| | $B^{sp}_{2020}$ | - | - | 101 |
| | $B^{sp}_{2020}/K^{sp}$ | - | - | 0.30 |
| | $B^{sp}_{2020}/B^{sp}_{MSY}$ | - | - | 1.84 |
| | *MSY* | 142 | 142 | 139 |
| *M. capensis* | $K^{sp}$ | 342 | 342 | 341 |
| | $B^{sp}_{MSY}$ | 96 | 97 | 95 |
| | $B^{sp}_{2019}$ | 235 | 236 | 232 |
| | $B^{sp}_{2019}/K^{sp}$ | 0.69 | 0.69 | 0.68 |
| | $B^{sp}_{2019}/B^{sp}_{MSY}$ | 2.44 | 2.43 | 2.44 |
| | $B^{sp}_{2020}$ | - | - | 244 |
| | $B^{sp}_{2020}/K^{sp}$ | - | - | 0.72 |
| | $B^{sp}_{2020}/B^{sp}_{MSY}$ | - | - | 2.57 |
| | *MSY* | 82 | 82 | 81 |

**Table 2:** Negative log-likelihood components for the three assessment model runs reported in this document. Cells in grey indicate that those components are not comparable for the 2020 update in relation to the earlier models, because of the additional data included in this update. The likelihood components for Models (1) and (2) are all comparable.

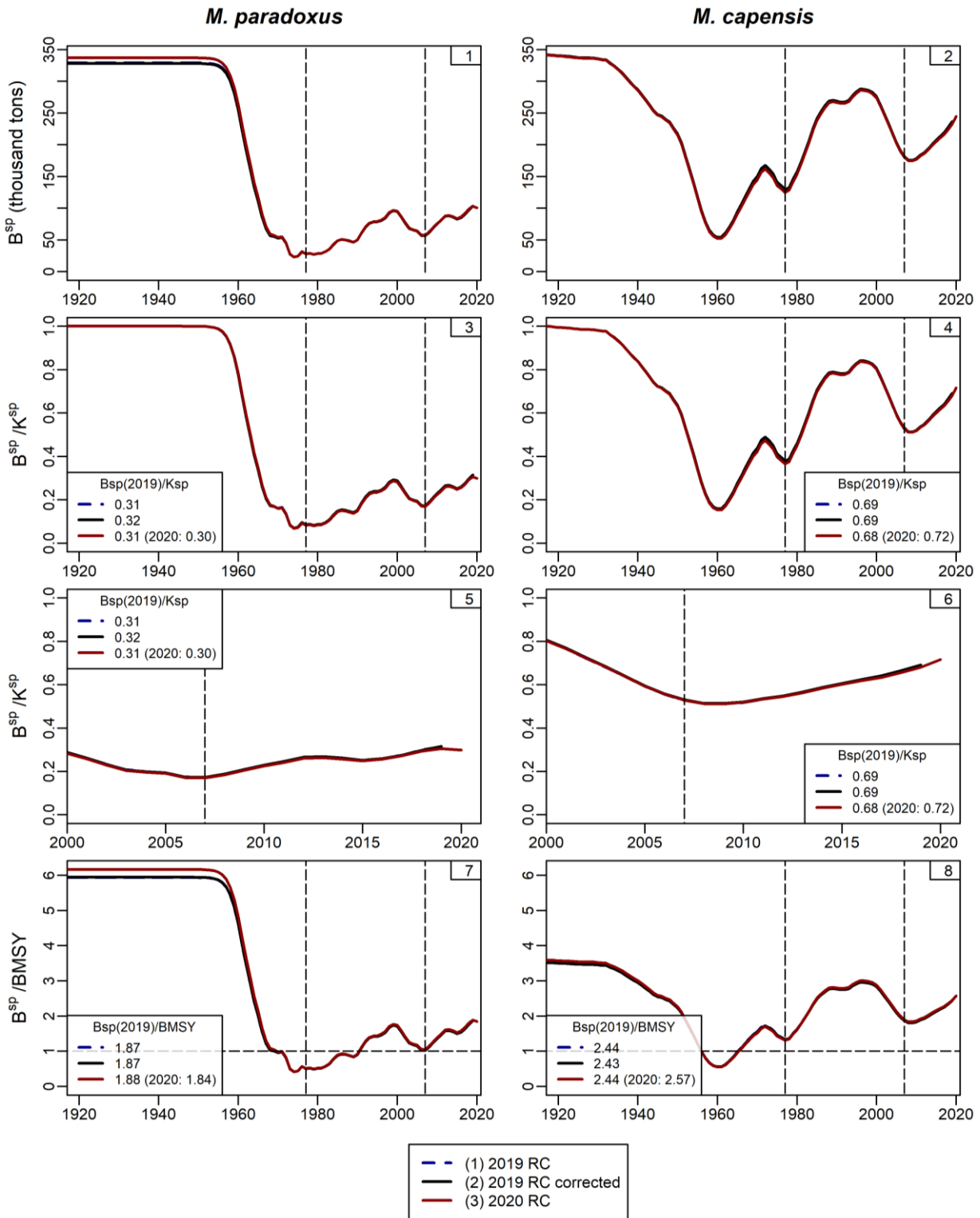| Run | GLM CPUE | ICSEAF CPUE | Survey abun. | Comm. CAL | Survey CAL | Recruit. resid. | ALKs | Penalties | Total (w/o pen.) |
|---|---|---|---|---|---|---|---|---|---|
| (1) 2019 RC | -215.33 | -36.86 | -35.28 | -1514.93 | -1591.28 | 8.93 | 130.78 | 0.12 | -3253.99 |
| (2) 2019 RC corrected | -215.42 | -36.86 | -35.51 | -1514.91 | -1590.76 | 8.80 | 130.65 | 0.12 | -3254.01 |
| (3) 2020 RC | -221.14 | -37.21 | -37.50 | -1510.88 | -1591.19 | 9.35 | 130.61 | 0.10 | -3257.96 |

**Figure 1:** Female spawning biomass is shown for each species in absolute terms (top row), relative to pristine spawning biomass (second row), relative to pristine spawning biomass but for the 2000-2020 time period (third row) and relative to $B_{MSY}$ (fourth row).
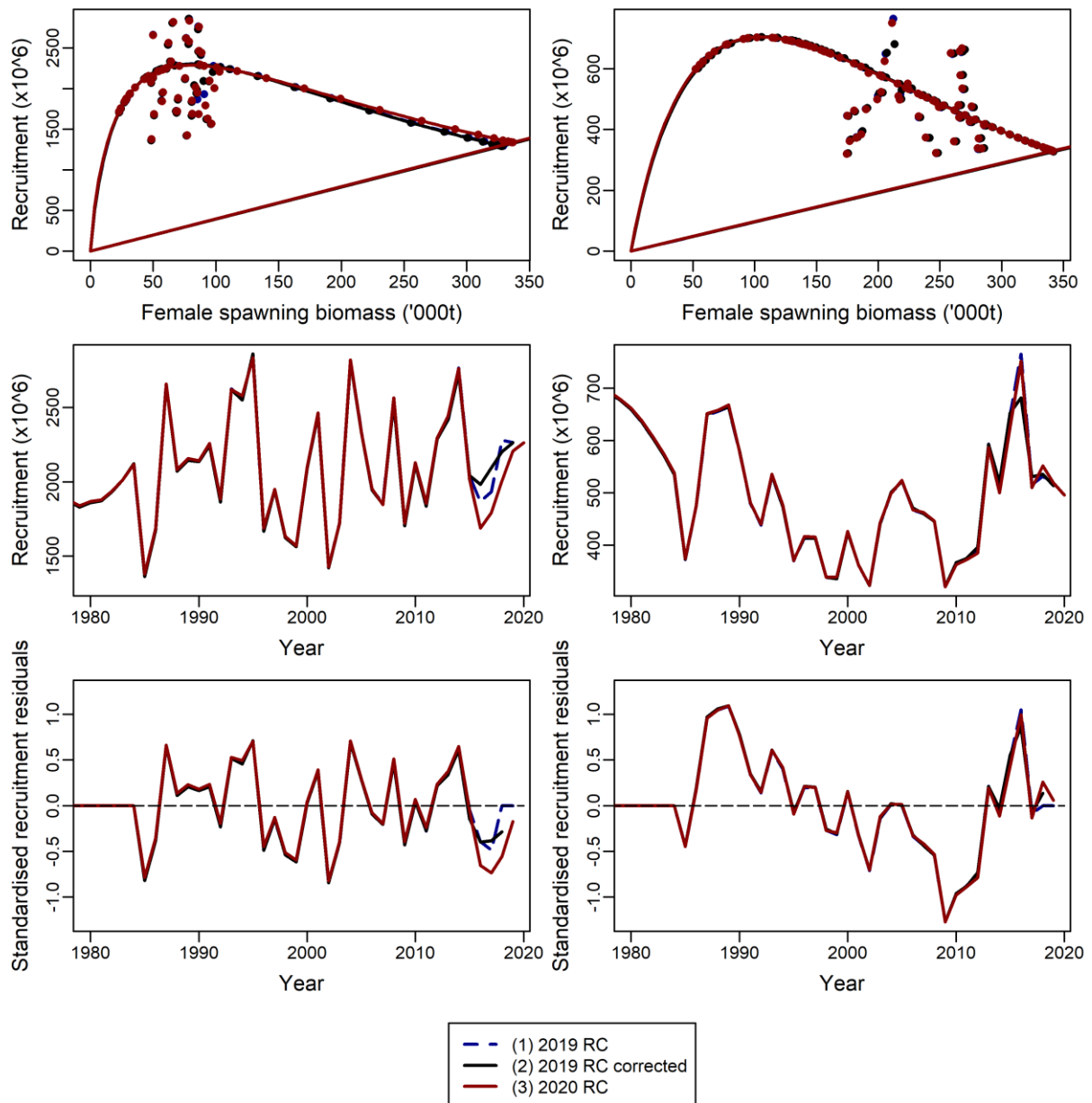
**Figure 2:** The top row shows the estimated recruitment relationship for the three assessment models. The middle row plots the recruitment time series, while the bottom row shows the standardized estimated recruitment residuals.
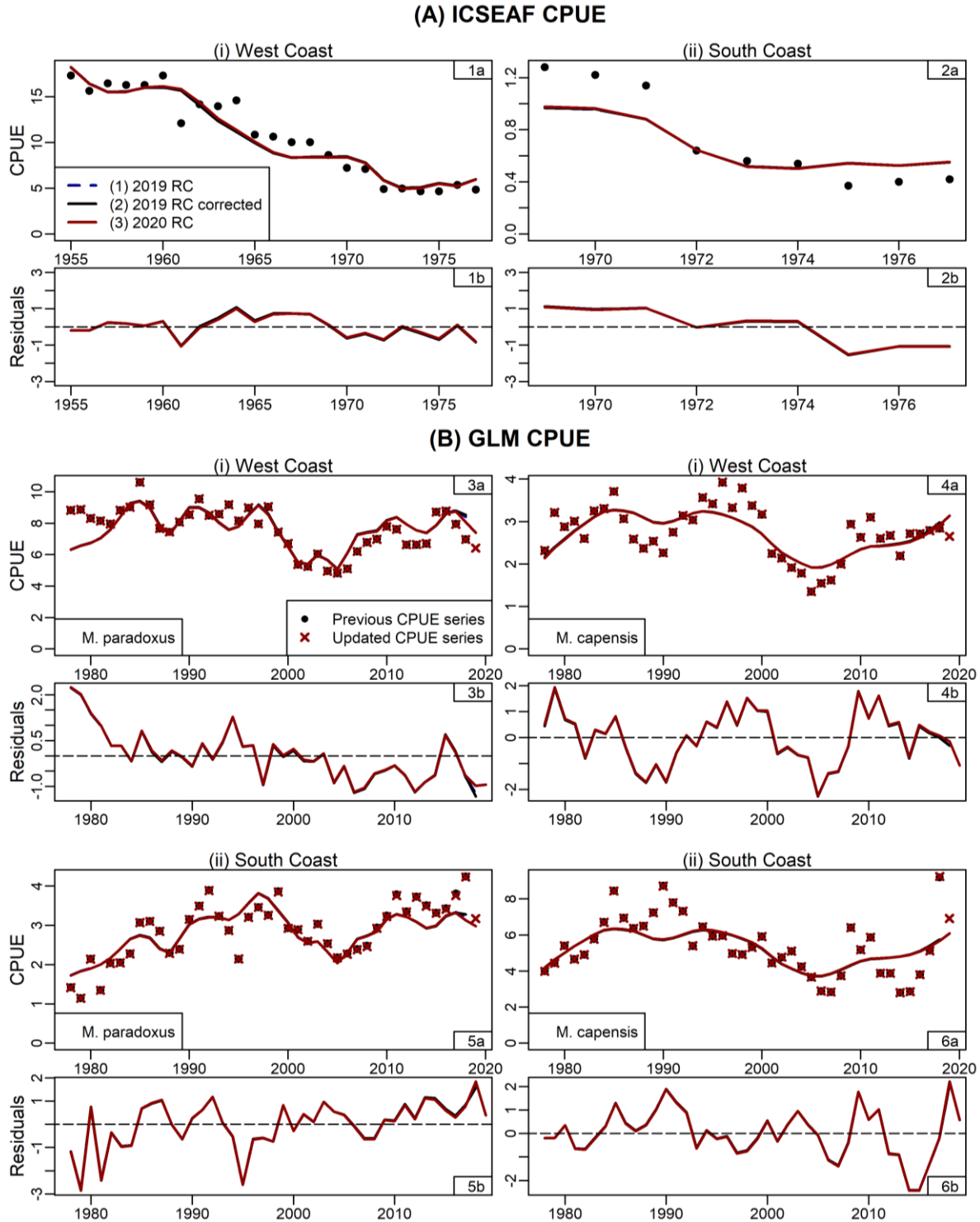
**Figure 3:** Fits to (A) the historical ICSEAF CPUE data and (B) the commercial GLM-standardized CPUE data are shown. For the GLM CPUE, the series used to date (which include data from 1978-2018) are indicated by black filled circles, while the updated 2019 series (data from 1978-2019) are indicated by red crosses.

**Figure 4:** Fits to the survey relative abundance series are shown for the 2020 RC assessment model. The 2020 summer survey abundance estimates are indicated by the last open circle in each respective plot (blue in colour). Standardised residuals are shown underneath each plot.

## Appendix A

This Appendix lists data series which have been updated with new 2019 and 2020 data, namely the commercial catches and GLM-standardized CPUE series, and the survey relative abundance series. No catch-at-length proportion data have been updated at this point.

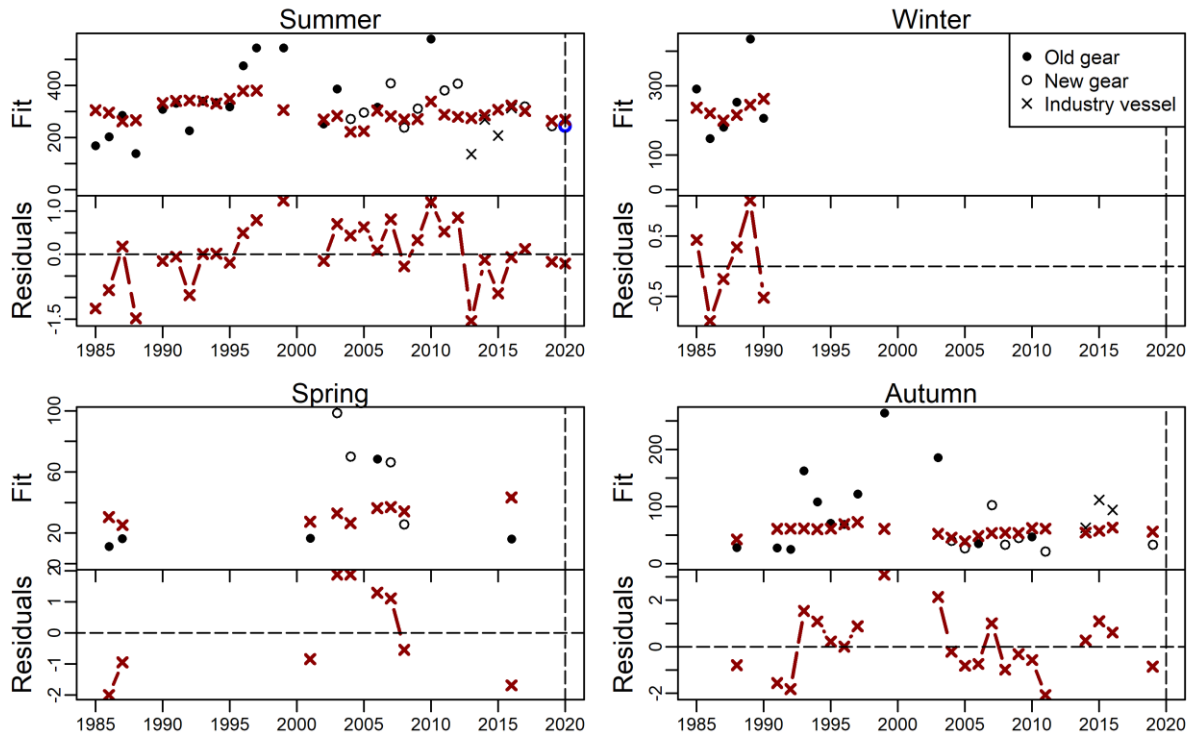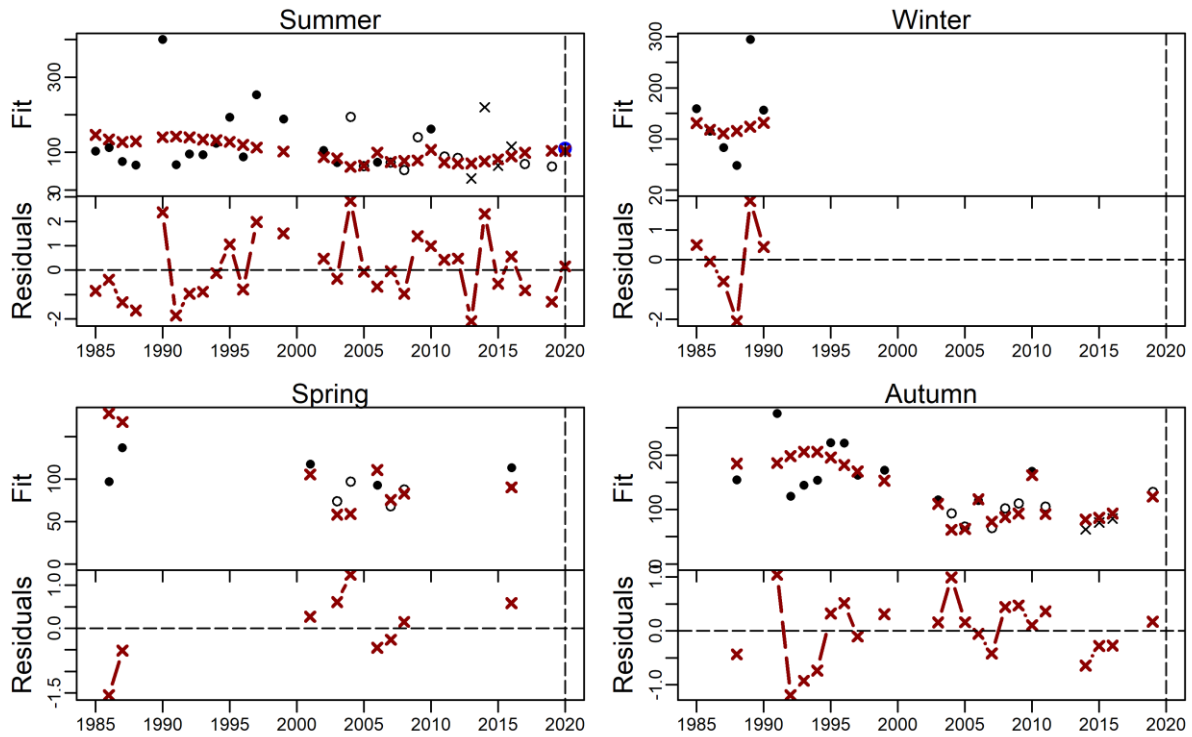**Table A.1**: Species-disaggregated catches (in thousand tons) by fleet of South African hake from the south and west coasts for the period 1978-2019 (J. Glazer, *pers. comm.)*. The new 2019 catch data have been highlighted grey.

| | M. paradoxus | | | | M. capensis | | | | | |
| | Offshore | | Longline | | Offshore | | Inshore | Longline | | Handline |
| | WC | SC | WC | SC | WC | SC | SC | WC | SC | SC |
|---|---|---|---|---|---|---|---|---|---|---|
| 1978 | 101.042 | 3.220 | - | - | 26.470 | 4.365 | 4.931 | - | - | - |
| 1979 | 94.331 | 1.924 | - | - | 39.192 | 4.995 | 6.093 | - | - | - |
| 1980 | 99.654 | 2.206 | - | - | 33.873 | 4.254 | 9.121 | - | - | - |
| 1981 | 88.883 | 0.910 | - | - | 32.048 | 4.575 | 9.400 | - | - | - |
| 1982 | 83.618 | 3.353 | - | - | 29.732 | 8.005 | 8.089 | - | - | - |
| 1983 | 71.238 | 4.723 | 0.126 | - | 23.195 | 7.792 | 7.672 | 0.104 | - | - |
| 1984 | 82.358 | 3.796 | 0.200 | 0.005 | 28.897 | 7.139 | 9.035 | 0.166 | 0.011 | - |
| 1985 | 94.428 | 8.059 | 0.638 | 0.091 | 30.642 | 11.957 | 9.203 | 0.529 | 0.201 | 0.065 |
| 1986 | 103.756 | 8.580 | 0.753 | 0.094 | 30.049 | 7.385 | 8.724 | 0.625 | 0.208 | 0.084 |
| 1987 | 93.517 | 7.459 | 1.952 | 0.110 | 24.008 | 8.225 | 8.607 | 1.619 | 0.243 | 0.096 |
| 1988 | 79.913 | 5.876 | 2.833 | 0.103 | 26.669 | 8.640 | 8.417 | 2.350 | 0.228 | 0.071 |
| 1989 | 82.230 | 6.182 | 0.158 | 0.010 | 25.029 | 12.730 | 10.038 | 0.132 | 0.022 | 0.137 |
| 1990 | 81.996 | 9.341 | 0.211 | - | 21.640 | 13.451 | 10.012 | 0.175 | - | 0.348 |
| 1991 | 87.093 | 12.448 | - | 0.932 | 19.357 | 9.626 | 8.206 | - | 2.068 | 1.270 |
| 1992 | 84.768 | 17.297 | - | 0.466 | 18.519 | 9.165 | 9.252 | - | 1.034 | 1.099 |
| 1993 | 102.125 | 9.880 | - | - | 15.940 | 4.380 | 8.870 | - | - | 0.278 |
| 1994 | 103.541 | 6.726 | 0.882 | 0.194 | 20.327 | 4.326 | 9.569 | 0.732 | 0.432 | 0.449 |
| 1995 | 100.268 | 4.004 | 0.523 | 0.202 | 20.629 | 3.146 | 10.630 | 0.434 | 0.448 | 0.756 |
| 1996 | 107.381 | 8.966 | 1.308 | 0.568 | 21.794 | 4.323 | 11.062 | 1.086 | 1.260 | 1.515 |
| 1997 | 100.654 | 10.509 | 1.410 | 0.582 | 16.500 | 5.327 | 8.834 | 1.170 | 1.290 | 1.404 |
| 1998 | 111.154 | 9.742 | 0.505 | 0.457 | 16.499 | 4.411 | 8.283 | 0.419 | 1.014 | 1.738 |
| 1999 | 88.581 | 11.420 | 1.532 | 1.288 | 15.179 | 3.926 | 8.595 | 1.272 | 2.856 | 2.749 |
| 2000 | 96.587 | 7.700 | 2.706 | 3.105 | 21.114 | 5.830 | 10.906 | 2.000 | 1.977 | 5.500 |
| 2001 | 101.247 | 7.850 | 1.417 | 0.084 | 16.349 | 8.306 | 11.836 | 2.394 | 1.527 | 7.300 |
| 2002 | 91.207 | 12.443 | 4.469 | 1.585 | 13.724 | 6.141 | 9.581 | 2.391 | 2.546 | 3.500 |
| 2003 | 93.711 | 17.397 | 3.305 | 1.252 | 11.665 | 7.636 | 9.883 | 2.526 | 3.078 | 3.000 |
| 2004 | 85.722 | 26.065 | 2.855 | 1.196 | 12.510 | 8.704 | 10.004 | 2.297 | 2.731 | 1.600 |
| 2005 | 85.869 | 21.778 | 3.091 | 0.472 | 9.398 | 7.468 | 7.881 | 2.773 | 3.270 | 0.700 |
| 2006 | 81.513 | 18.050 | 3.241 | 0.485 | 11.984 | 6.578 | 5.524 | 2.520 | 3.227 | 0.400 |
| 2007 | 92.724 | 13.488 | 2.512 | 3.021 | 16.145 | 3.757 | 6.350 | 2.522 | 2.522 | 0.400 |
| 2008 | 85.538 | 13.191 | 2.255 | 0.809 | 13.838 | 4.316 | 5.496 | 1.937 | 1.893 | 0.231 |
| 2009 | 68.202 | 10.895 | 2.410 | 1.069 | 12.296 | 4.806 | 5.639 | 2.828 | 2.520 | 0.265 |
| 2010 | 69.709 | 15.457 | 2.394 | 1.527 | 10.186 | 4.055 | 5.472 | 3.086 | 3.024 | 0.275 |
| 2011 | 76.576 | 17.904 | 2.522 | 0.140 | 15.673 | 4.086 | 6.013 | 3.521 | 3.047 | 0.186 |
| 2012 | 81.411 | 16.542 | 4.358 | 0.306 | 12.928 | 4.584 | 3.223 | 2.570 | 1.737 | 0.008 |
| 2013 | 74.341 | 28.859 | 6.056 | 0.060 | 8.761 | 4.475 | 2.920 | 2.606 | 1.308 | 0.000 |
| 2014 | 73.252 | 41.156 | 6.879 | 0.008 | 9.671 | 6.286 | 2.965 | 2.123 | 0.315 | 0.001 |
| 2015 | 77.521 | 31.745 | 4.001 | 0.018 | 12.727 | 4.035 | 3.077 | 2.325 | 0.053 | 0.001 |
| 2016 | 93.173 | 18.968 | 2.806 | 0.001 | 14.744 | 2.810 | 3.973 | 4.360 | 0.002 | 0.001 |
| 2017 | 72.326 | 30.961 | 5.288 | 0.025 | 15.273 | 4.466 | 2.812 | 2.807 | 0.126 | 0.004 |
| 2018 | 64.252 | 29.218 | 5.156 | 0.089 | 12.689 | 12.863 | 3.983 | 2.615 | 0.481 | 0.024 |
| 2019 | 71.050 | 22.201 | 3.177 | 0.020 | 13.750 | 9.454 | 4.149 | 2.160 | 0.179 | 0.009 |

**Table A.2:** GLM standardized CPUE data for *M. paradoxus* and *M. capensis*, corresponding to the Model A6b species splitting algorithm applied to data from 1978-2019 (J. Glazer, *pers. comm.*).

| | GLM CPUE (kg min$^{-1}$) | | | |
| | *M. paradoxus* | | *M. capensis* | |
| Year | West Coast | South Coast | West Coast | South Coast |
|---|---|---|---|---|
| 1978 | 8.82 | 1.41 | 2.32 | 3.98 |
| 1979 | 8.87 | 1.14 | 3.21 | 4.43 |
| 1980 | 8.30 | 2.14 | 2.88 | 5.39 |
| 1981 | 8.14 | 1.34 | 3.01 | 4.65 |
| 1982 | 7.95 | 2.03 | 2.60 | 4.90 |
| 1983 | 8.81 | 2.04 | 3.25 | 5.76 |
| 1984 | 9.01 | 2.27 | 3.30 | 6.70 |
| 1985 | 10.60 | 3.06 | 3.71 | 8.43 |
| 1986 | 9.17 | 3.10 | 3.07 | 6.93 |
| 1987 | 7.66 | 2.85 | 2.59 | 6.36 |
| 1988 | 7.44 | 2.29 | 2.37 | 6.49 |
| 1989 | 8.07 | 2.39 | 2.54 | 7.23 |
| 1990 | 8.54 | 3.15 | 2.26 | 8.70 |
| 1991 | 9.54 | 3.49 | 2.75 | 7.78 |
| 1992 | 8.49 | 3.88 | 3.14 | 7.31 |
| 1993 | 8.58 | 3.23 | 3.04 | 5.39 |
| 1994 | 9.17 | 2.87 | 3.56 | 6.45 |
| 1995 | 8.15 | 2.14 | 3.42 | 5.94 |
| 1996 | 8.98 | 3.20 | 3.92 | 5.95 |
| 1997 | 7.96 | 3.45 | 3.33 | 4.97 |
| 1998 | 9.05 | 3.25 | 3.79 | 4.91 |
| 1999 | 7.43 | 3.85 | 3.38 | 5.31 |
| 2000 | 6.70 | 2.92 | 3.18 | 5.91 |
| 2001 | 5.37 | 2.89 | 2.25 | 4.45 |
| 2002 | 5.24 | 2.59 | 2.14 | 4.77 |
| 2003 | 6.04 | 3.03 | 1.92 | 5.10 |
| 2004 | 4.95 | 2.53 | 1.78 | 4.24 |
| 2005 | 4.82 | 2.17 | 1.35 | 3.66 |
| 2006 | 5.10 | 2.27 | 1.55 | 2.89 |
| 2007 | 6.20 | 2.38 | 1.62 | 2.83 |
| 2008 | 6.77 | 2.46 | 2.00 | 3.73 |
| 2009 | 6.97 | 2.92 | 2.93 | 6.41 |
| 2010 | 7.78 | 3.22 | 2.62 | 5.18 |
| 2011 | 7.61 | 3.75 | 3.10 | 5.87 |
| 2012 | 6.64 | 3.34 | 2.61 | 3.87 |
| 2013 | 6.64 | 3.71 | 2.67 | 3.87 |
| 2014 | 6.70 | 3.48 | 2.19 | 2.80 |
| 2015 | 8.70 | 3.30 | 2.71 | 2.85 |
| 2016 | 8.77 | 3.41 | 2.71 | 3.80 |
| 2017 | 7.92 | 3.76 | 2.78 | 5.11 |
| 2018 | 6.96 | 4.23 | 2.85 | 9.24 |
| 2019 | 6.41 | 3.17 | 2.65 | 6.92 |

**Table A.3a**: Survey abundance estimates and associated standard errors in thousand tons for **M. paradoxus** for the depth range 0-500m for the South Coast and for the West Coast (T. Fairweather, *pers. comm*.). Values in bold are for the surveys conducted by the *Africana* with the new gear, while underlined values are for the surveys conducted by the *Andromeda* and in 2016 by the *Compass Challenger*. The 2016 spring survey was conducted by the *Africana* - the abundance estimates for this survey were previously unavailable, but have now been included. Grey highlighting has been used to indicate new data points that have been added.

| Year | West coast | | | | South coast | | | |
| | Summer | | Winter | | Spring (Sept) | | Autumn (Apr/May) | |
| | Biomass | (s.e.) | Biomass | (s.e.) | Biomass | (s.e.) | Biomass | (s.e.) |
|---|---|---|---|---|---|---|---|---|
| 1985 | 168.989 | (37.765) | 290.281 | (63.295) | - | - | - | - |
| 1986 | 202.334 | (37.745) | 147.378 | (21.667) | 11.280 | (3.111) | - | - |
| 1987 | 284.434 | (54.165) | 180.158 | (39.047) | 16.381 | (3.033) | - | - |
| 1988 | 138.534 | (20.303) | 252.121 | (71.246) | - | - | 28.293 | (8.673) |
| 1989 | - | - | 434.092 | (142.716) | - | - | - | - |
| 1990 | 307.615 | (87.841) | 205.704 | (43.607) | - | - | - | - |
| 1991 | 331.177 | (81.633) | - | - | - | - | 27.570 | (8.153) |
| 1992 | 225.755 | (33.711) | - | - | - | - | 25.036 | (6.650) |
| 1993 | 340.079 | (51.427) | - | - | - | - | 162.375 | (81.691) |
| 1994 | 333.499 | (56.259) | - | - | - | - | 108.179 | (38.369) |
| 1995 | 317.104 | (76.709) | - | - | - | - | 70.890 | (39.330) |
| 1996 | 474.270 | (92.744) | - | - | - | - | 68.859 | (19.929) |
| 1997 | 543.615 | (96.043) | - | - | - | - | 121.707 | (51.507) |
| 1998 | - | - | - | - | - | - | - | - |
| 1999 | 542.830 | (110.541) | - | - | - | - | 263.256 | (59.439) |
| 2000 | - | - | - | - | - | - | - | - |
| 2001 | - | - | - | - | 16.668 | (7.159) | - | - |
| 2002 | 251.820 | (32.690) | - | - | - | - | - | - |
| 2003 | 386.321 | (63.565) | - | - | **98.434** | (42.249) | 185.345 | (82.188) |
| 2004 | **271.540** | (55.710) | - | - | **70.001** | (22.156) | **39.822** | (22.153) |
| 2005 | **296.065** | (42.409) | - | - | - | - | **26.691** | (6.017) |
| 2006 | 316.247 | (57.332) | - | - | 68.507 | (18.283) | 34.868 | (5.843) |
| 2007 | **407.377** | (77.222) | - | - | **66.267** | (21.966) | **102.195** | (53.688) |
| 2008 | **238.143** | (37.018) | - | - | **25.661** | (8.324) | **33.034** | (9.340) |
| 2009 | **310.760** | (27.768) | - | - | - | - | **45.030** | (15.551) |
| 2010 | 576.848 | (88.202) | - | - | - | - | 46.938 | (12.160) |
| 2011 | **380.185** | (128.013) | - | - | - | - | **21.054** | (6.531) |
| 2012 | **405.865** | (59.099) | - | - | - | - | - | - |
| 2013 | <u>136.260</u> | (25.116) | - | - | - | - | - | - |
| 2014 | <u>269.482</u> | (37.492) | - | - | - | - | <u>62.925</u> | (24.802) |
| 2015 | <u>207.583</u> | (24.057) | - | - | - | - | <u>111.411</u> | (51.852) |
| 2016 | <u>312.876</u> | (33.250) | - | - | **16.147** | (6.862) | <u>94.177</u> | (51.731) |
| 2017 | **319.024** | (58.766) | - | - | - | - | - | - |
| 2018 | - | - | - | - | - | - | - | - |
| 2019 | **243.560** | **(**51.558**)** | **-** | **-** | **-** | **-** | **33.176** | 15.444 |
| 2020 | **243.090** | **(43.989)** | **-** | **-** | **-** | **-** | - | - |

**Table A.3b**: Survey abundance estimates and associated standard errors in thousand tons for **M. capensis**.

| Year | West coast | | | | South coast | | | |
|---|---|---|---|---|---|---|---|---|
| | Summer | | Winter | | Spring (Sept) | | Autumn (Apr/May) | |
| | Biomass | (s.e.) | Biomass | (s.e.) | Biomass | (s.e.) | Biomass | (s.e.) |
| 1985 | 102.929 | (18.888) | 159.198 | (18.982) | - | - | - | - |
| 1986 | 113.154 | (23.474) | 115.218 | (19.733) | 96.768 | (10.737) | - | - |
| 1987 | 75.438 | (9.709) | 83.050 | (10.306) | 137.008 | (13.057) | - | - |
| 1988 | 66.365 | (9.930) | 48.046 | (9.574) | - | - | 154.548 | (23.984) |
| 1989 | - | - | 294.740 | (67.495) | - | - | - | - |
| 1990 | 400.142 | (97.102) | 156.337 | (22.507) | - | - | - | - |
| 1991 | 67.565 | (9.656) | - | - | - | - | 276.607 | (25.274) |
| 1992 | 95.401 | (11.892) | - | - | - | - | 124.495 | (13.600) |
| 1993 | 93.613 | (14.390) | - | - | - | - | 144.551 | (12.379) |
| 1994 | 124.497 | (37.845) | - | - | - | - | 153.790 | (20.310) |
| 1995 | 193.292 | (24.270) | - | - | - | - | 222.464 | (31.245) |
| 1996 | 87.969 | (9.866) | - | - | - | - | 222.176 | (23.144) |
| 1997 | 252.606 | (42.721) | - | - | - | - | 163.163 | (17.274) |
| 1998 | - | - | - | - | - | - | - | - |
| 1999 | 188.624 | (31.362) | - | - | - | - | 171.946 | (13.330) |
| 2000 | - | - | - | - | - | - | - | - |
| 2001 | - | - | - | - | 117.590 | (20.093) | - | - |
| 2002 | 105.093 | (16.130) | - | - | - | - | - | - |
| 2003 | 73.020 | (12.518) | - | - | **73.604** | (9.142) | 117.538 | (17.192) |
| 2004 | **194.294** | (30.714) | - | - | **96.933** | (13.936) | **92.796** | (11.318) |
| 2005 | **63.363** | (11.498) | - | - | - | - | **68.672** | (5.302) |
| 2006 | 73.655 | (17.255) | - | - | 92.831 | (8.998) | 116.298 | (11.931) |
| 2007 | **73.230** | (9.306) | - | - | **67.937** | (6.553) | **65.935** | (5.303) |
| 2008 | **52.577** | (7.069) | - | - | **87.836** | (9.723) | **102.169** | (9.681) |
| 2009 | **140.437** | (26.486) | - | - | - | - | **111.191** | (10.832) |
| 2010 | 162.402 | (34.891) | - | - | - | - | 170.261 | (33.235) |
| 2011 | **89.095** | (23.574) | - | - | - | - | **105.424** | (10.688) |
| 2012 | **84.746** | (8.331) | - | - | - | - | - | - |
| 2013 | 30.383 | (4.575) | - | - | - | - | - | - |
| 2014 | 219.756 | (60.342) | - | - | - | - | 63.389 | (6.415) |
| 2015 | 65.086 | (9.178) | - | - | - | - | 76.059 | (6.873) |
| 2016 | 115.058 | (30.400) | - | - | **113.384** | (13.828) | 83.197 | (6.600) |
| 2017 | **69.289** | (14.486) | - | - | - | - | - | - |
| 2018 | - | - | - | - | - | - | - | - |
| 2019 | **62.560** | (7.697) | - | - | - | - | **132.099** | (14.486) |
| 2020 | **109.983** | (11.836) | | | | | - | - |

**Appendix B**

The 2019/2020 commercial and survey data updates have been superimposed into the OMP2018 projection plots to ascertain whether these points lie within the error range projected by the OMP.
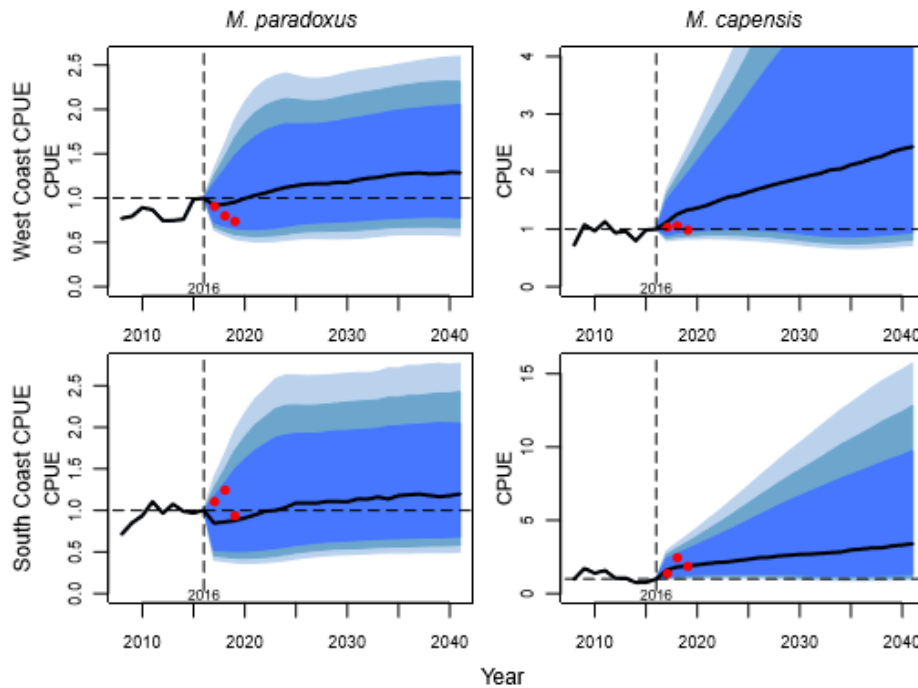


**Fig. B1:** 95, 90, 80% PE and median for the projected GLM-standardised **commercial CPUE** for *M. paradoxus* and *M. capensis* for the updated RS under OMP-2018. The red dots show the 2017-2019 CPUE indices, standardised relative to the 2016 value in the updated GLM series.
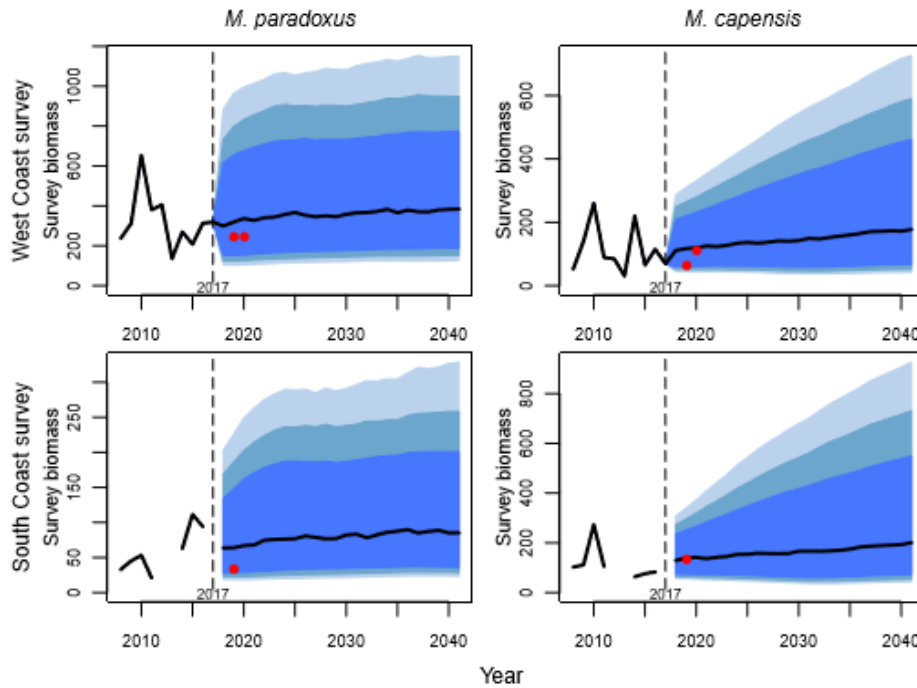
**Fig. B2:** 95, 90, 80% PE and median for the **survey abundance indices** for *M. paradoxus* and *M. capensis* for the updated RS under OMP-2018. Gaps in the median trajectory for the South Coast survey indicate surveys that did not take place. Estimates from the 2019-2020 surveys are indicated by red dots. Note: future surveys are assumed to be carried out using the new gear on the *Africana*; if an industry vessel is used instead, the resultant estimates must be multiplied by 1.25 before comparison with the bounds in these plots.
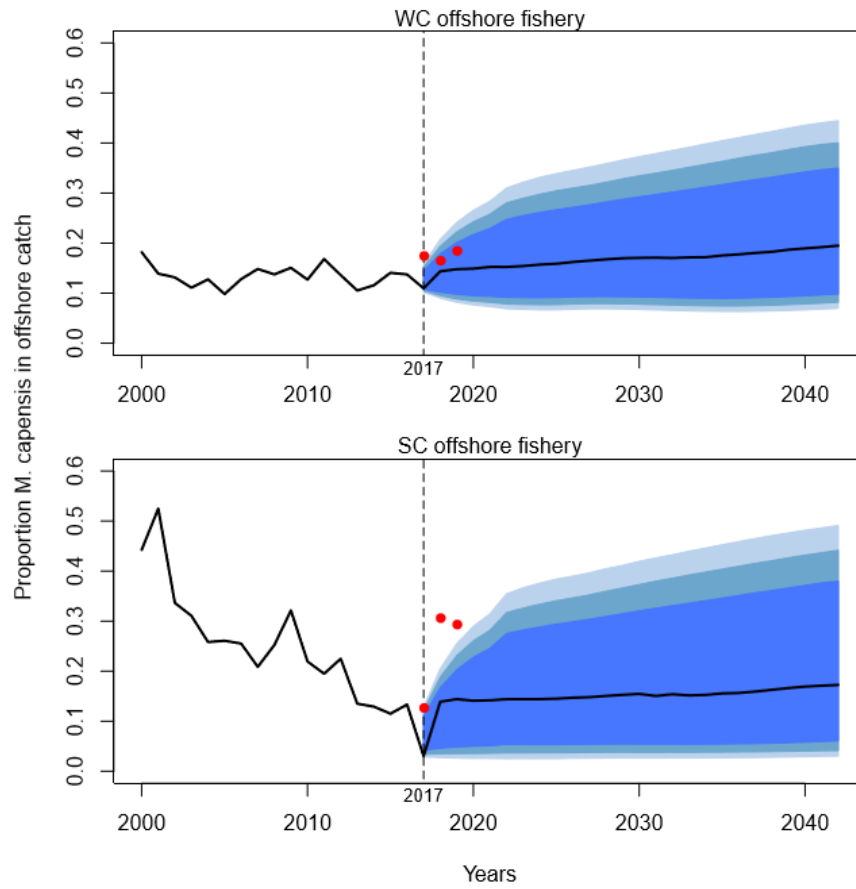
**Fig. B3:** 95, 90, 80% PE and median for the proportion *M. capensis* in the offshore trawl catch, with the 2017-2019 observed proportions indicated by the red dots.