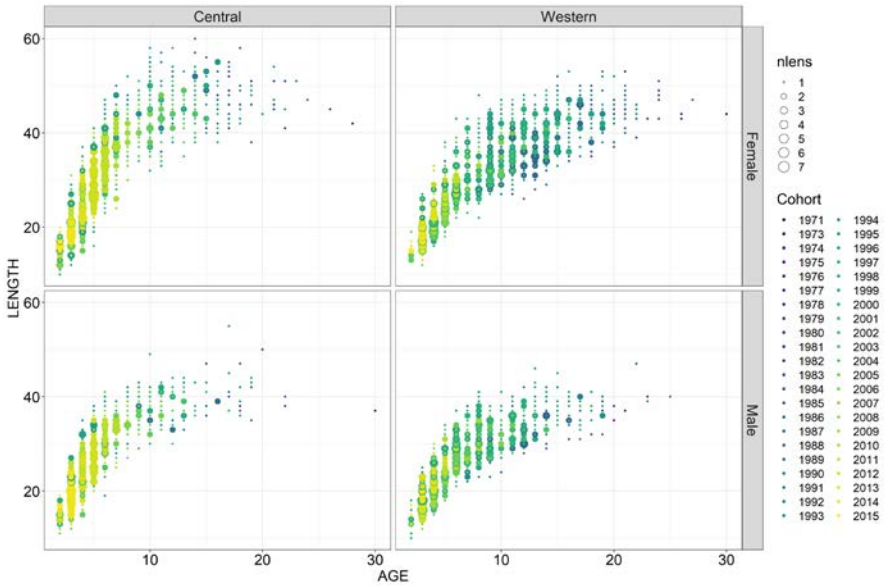
# Outline

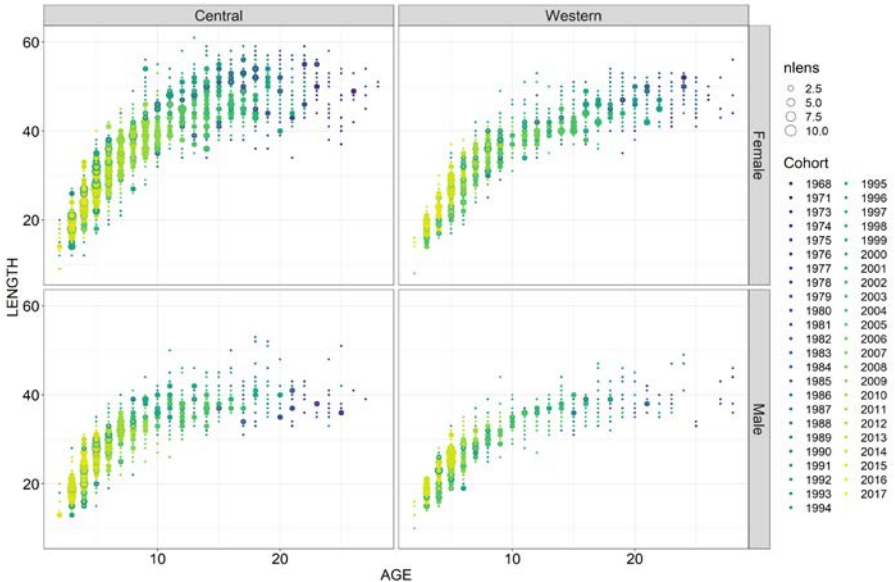
- Where we left off in September
- New data
- Data summary
- Northern rock sole models and results
- Northern rock sole harvest recommendations
- Southern rock sole models and results
- Southern rock sole harvest recommendations
- Future directions

# Where we left off

Northern rock sole




Southern rock sole

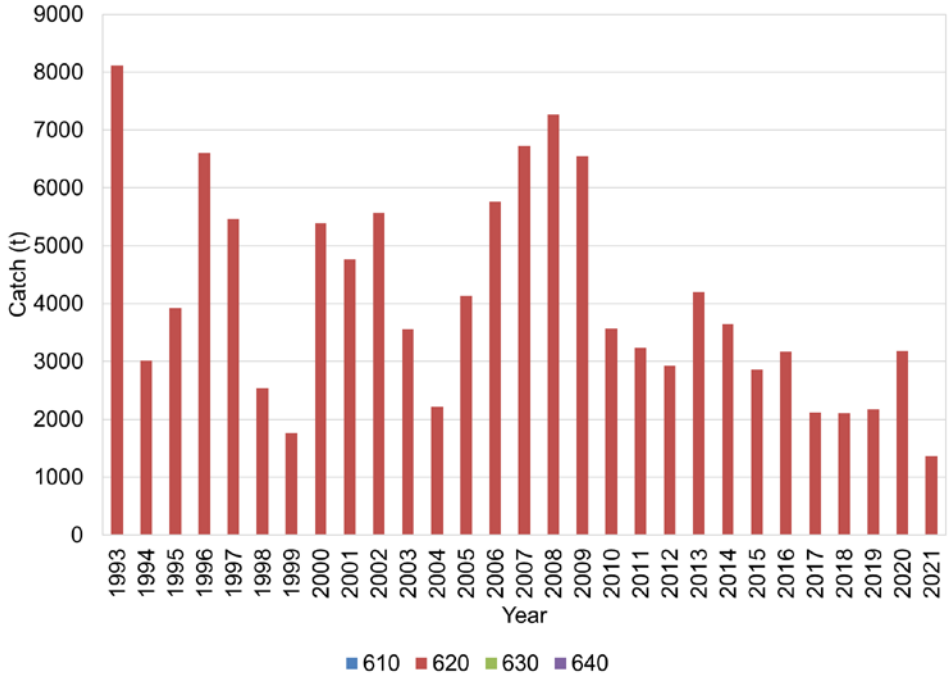


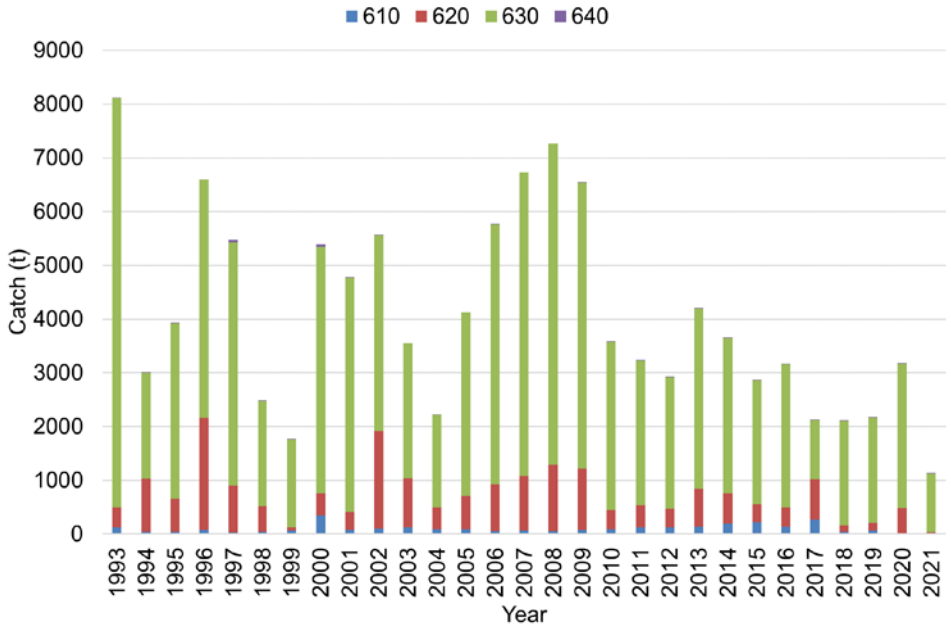

- September PT showed differences in growth by area
- Today presenting minor modifications to last accepted model and a 2-area model
  - 2-area model accounts for differences in growth between central and western GOA

# New data

- Final catch estimates for 2017-2020
- Preliminary estimate of 2021 catch
- 2018 – 2021 fishery lengths (sex-specific)
- 2019 – 2021 GOA bottom trawl survey
  - Biomass
  - Length composition (sex-specific)
- 2017 survey conditional age-at-length data for northern rock sole (sex-specific)
  - Otoliths not collected in 2019
- 2017 and 2019 survey conditional age-at-length data for southern rock sole (sex-specific)

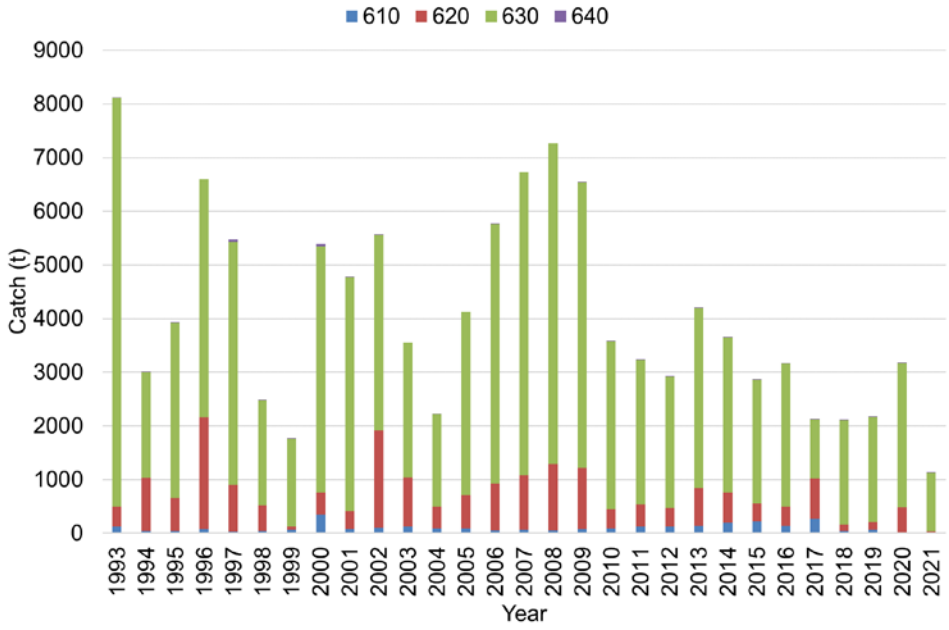
# Catch data

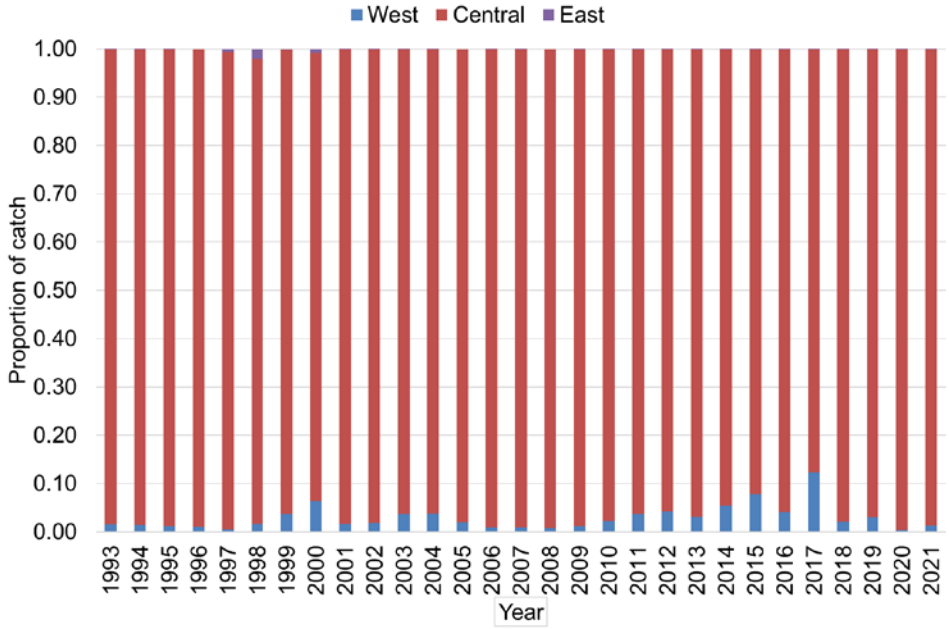



- Catch has declined since 2008 and was quite low in 2021
- Primarily caught in area 630 and 620

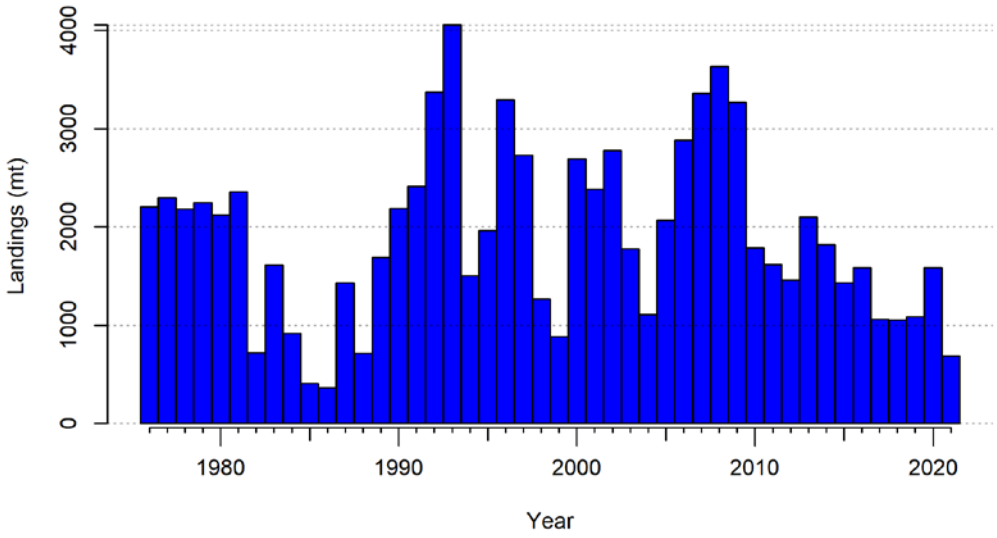
# Catch data

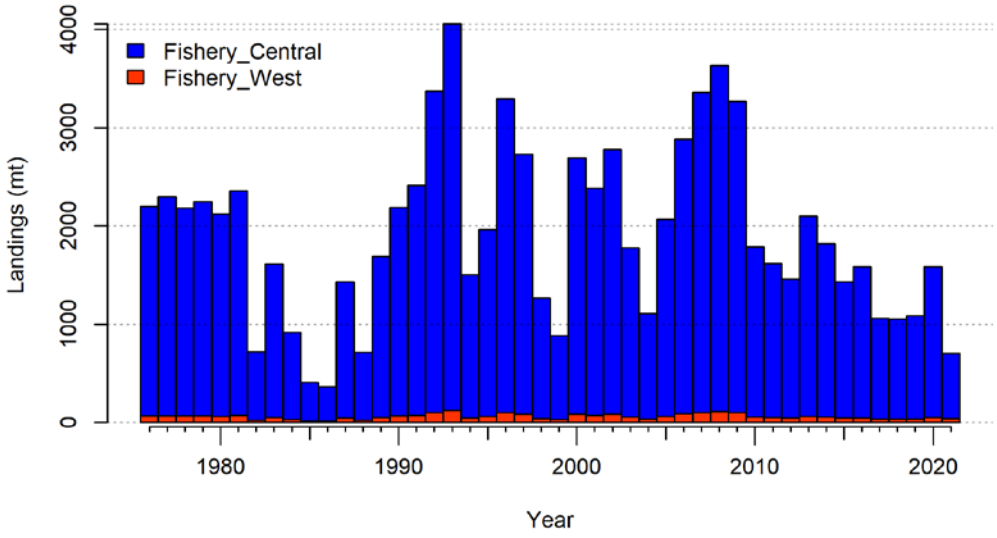



- Since 1993:
  - ~97% caught in central GOA on average
  - ~3% caught in western GOA on average

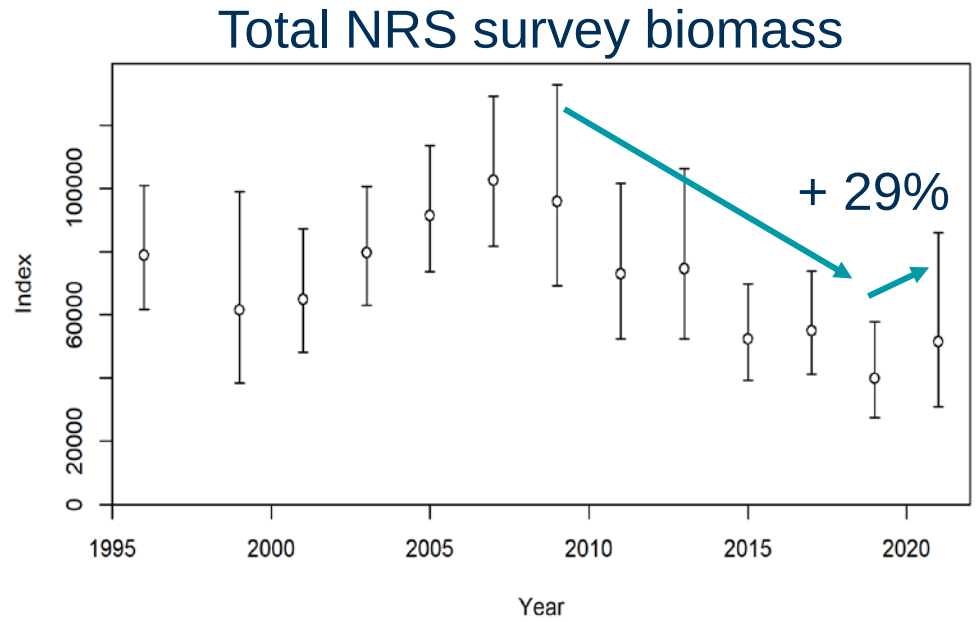
# Catch data

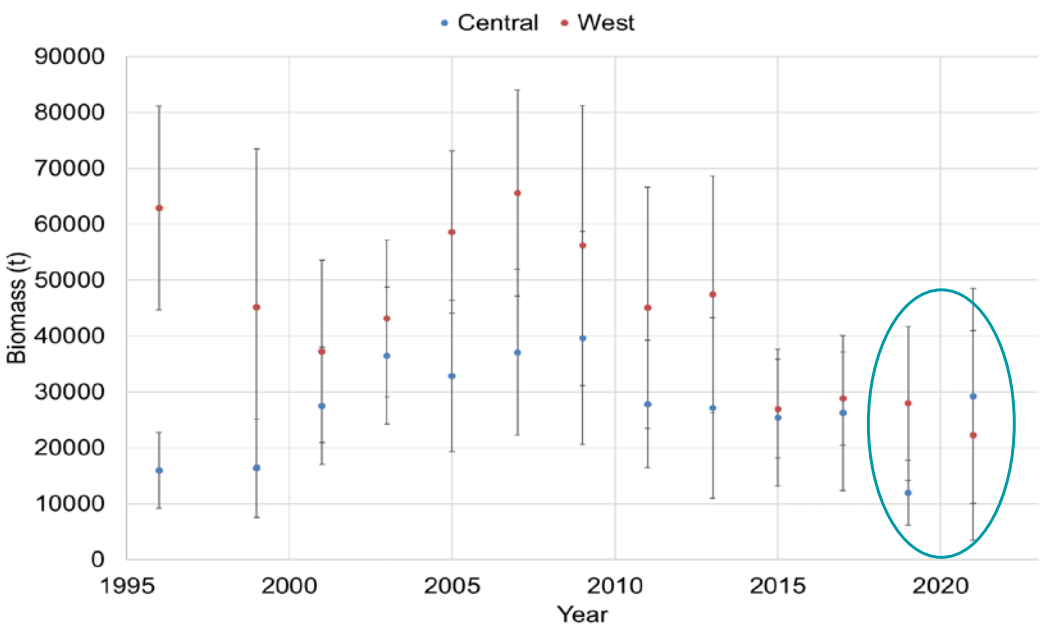



- Assume 50% split of total rock sole catch to derive species-specific catch
  - Input for single area models
- Assumed 97% of catch in central GOA and 3% in western GOA
  - Input for two area models

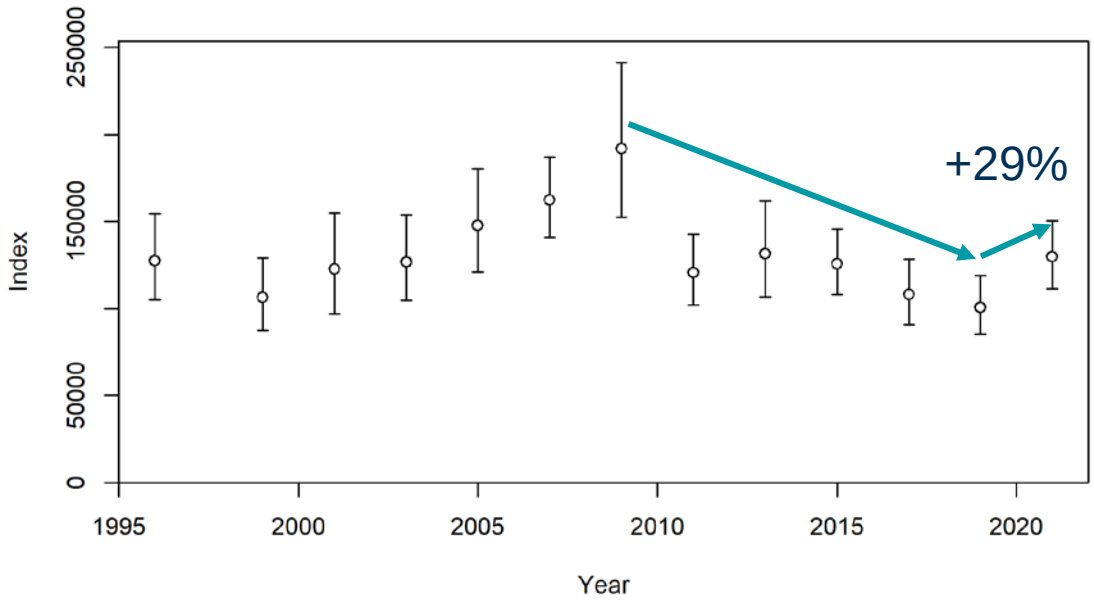
# GOA bottom trawl survey biomass

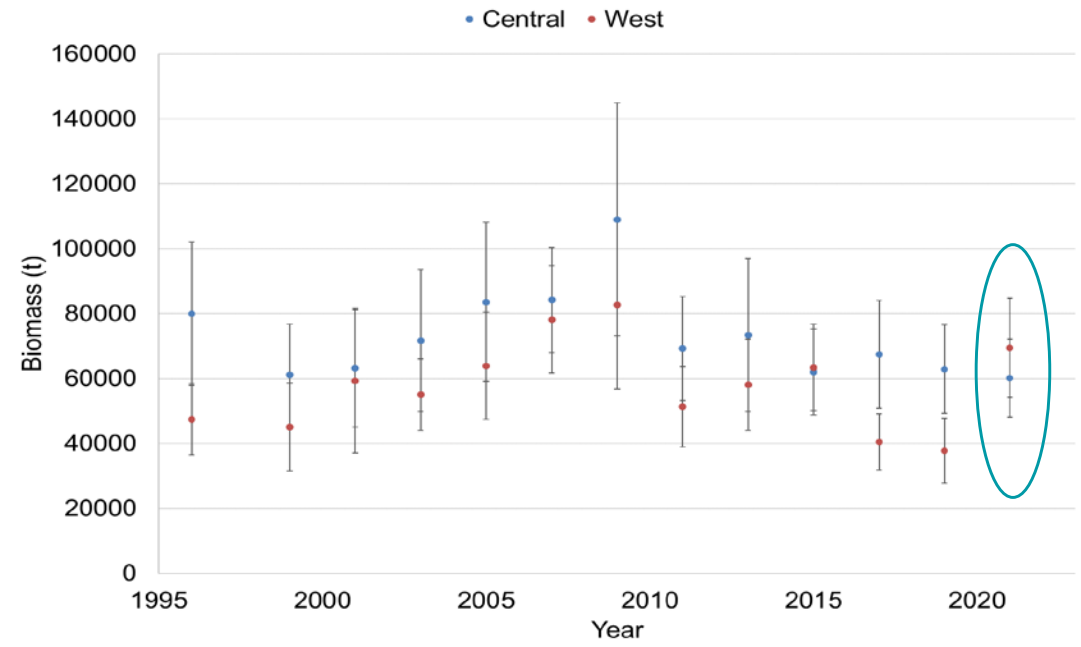



- Northern rock sole
- Total biomass generally follows trends in biomass in western GOA
  - Majority of biomass in west (~64% average over time)
- Recent years similar proportion of biomass (except 2019)
  - 2021 central higher than west (first time)

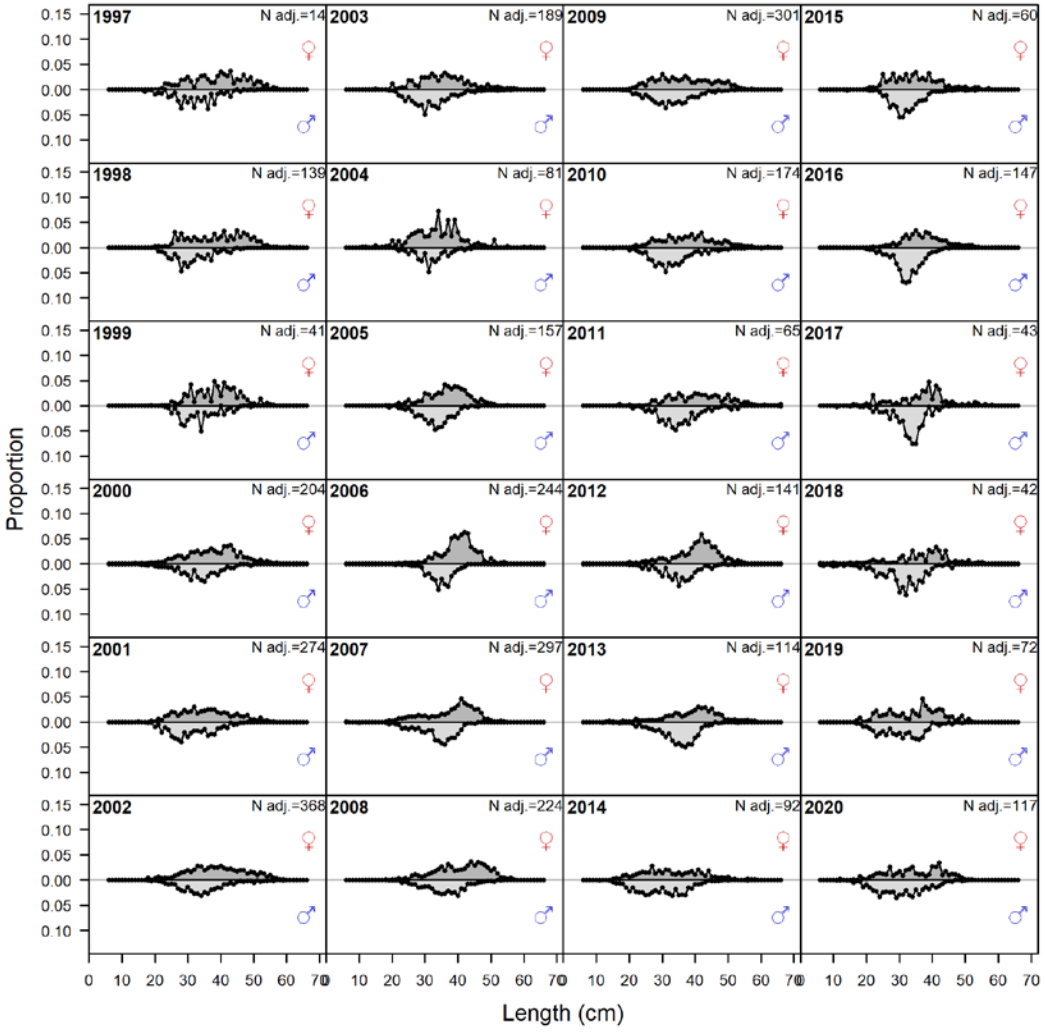
# GOA bottom trawl survey biomass



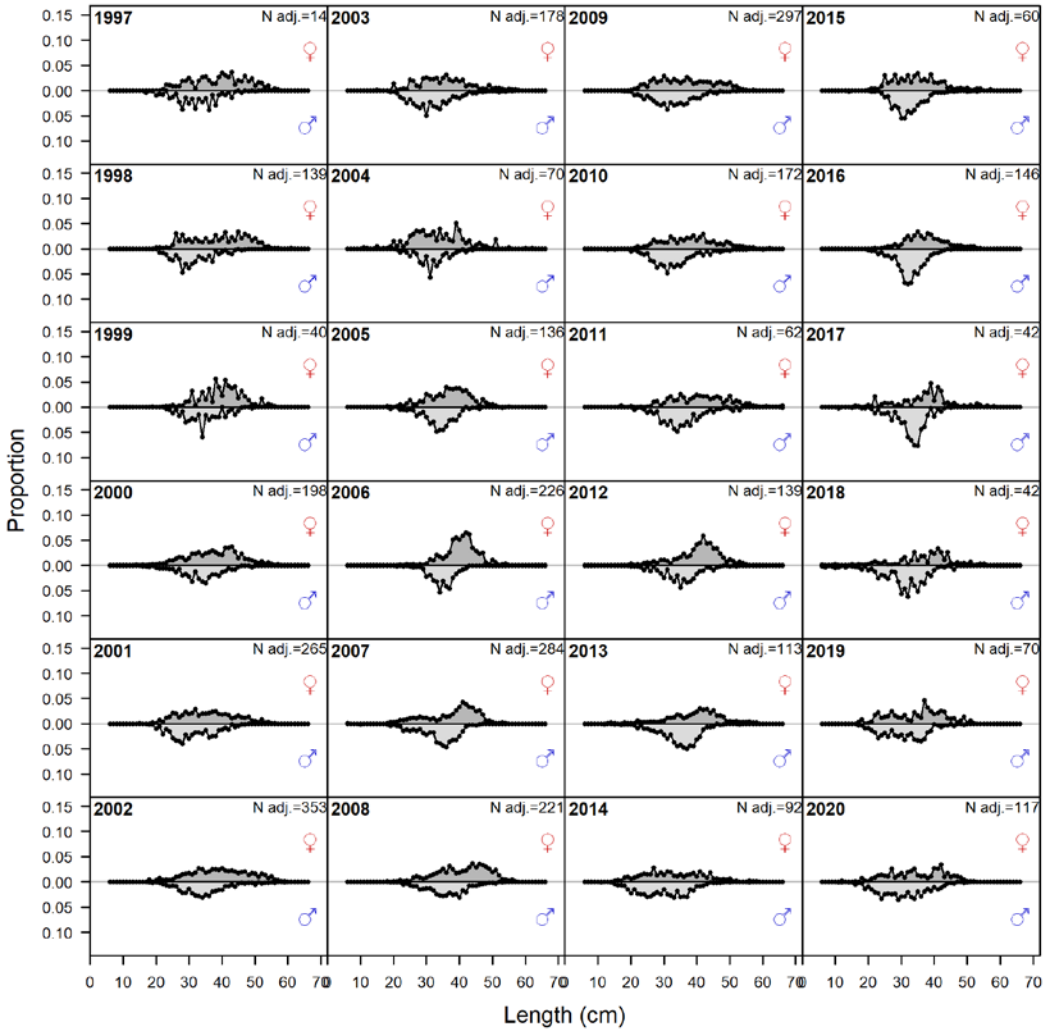

- Southern rock sole
- Trends similar between central and western GOA until 2013
- 2011-2021
  - central GOA flat
  - Western GOA declined in 2017 and in 2021 higher than central (first time)
- Majority of biomass in west (~56% average over time)

# Fishery length composition data




- Northern rock sole
- Annual, sex-specific length composition
- Input sample size
  - Annual number of hauls

# Fishery length composition data



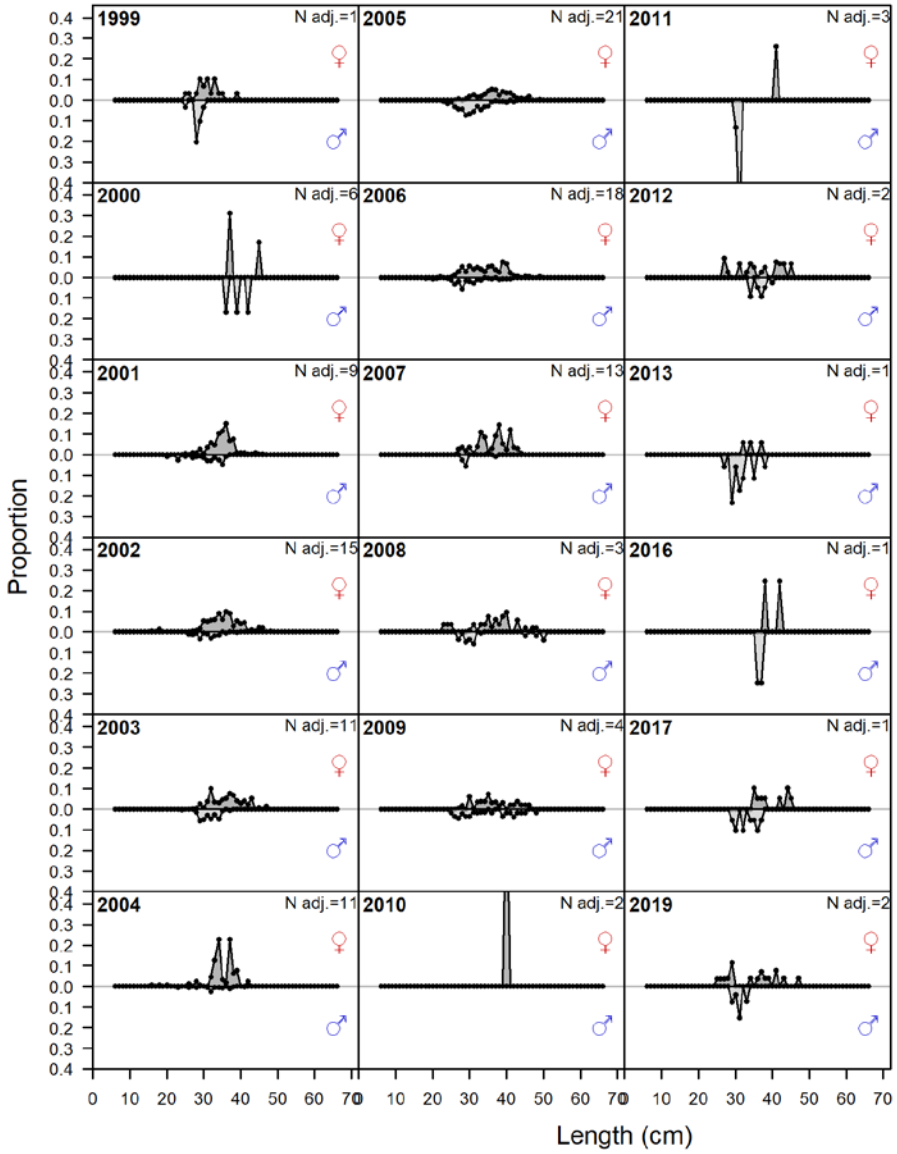

Northern rock sole, central GOA

Annual, sex-specific length composition

Input sample size

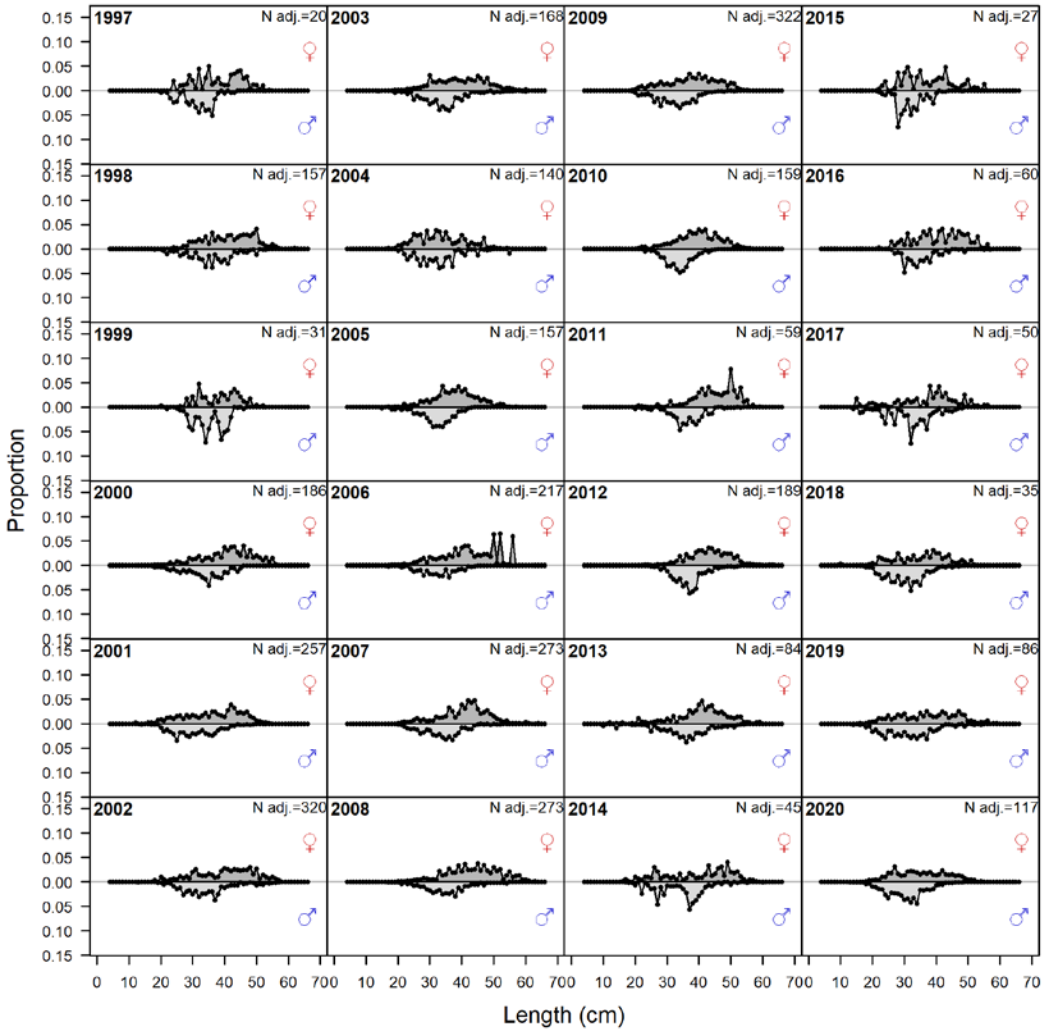
- Annual number of hauls
- Majority of hauls from central GOA

# Fishery length composition data




- Northern rock sole, western GOA
- Annual, sex-specific length composition
- Input sample size
  - Annual number of hauls
  - Small number of hauls per year
    - Several years with 1 haul
    - Max of 21 hauls in 2005
    - Some years no data from western GOA

# Fishery length composition data



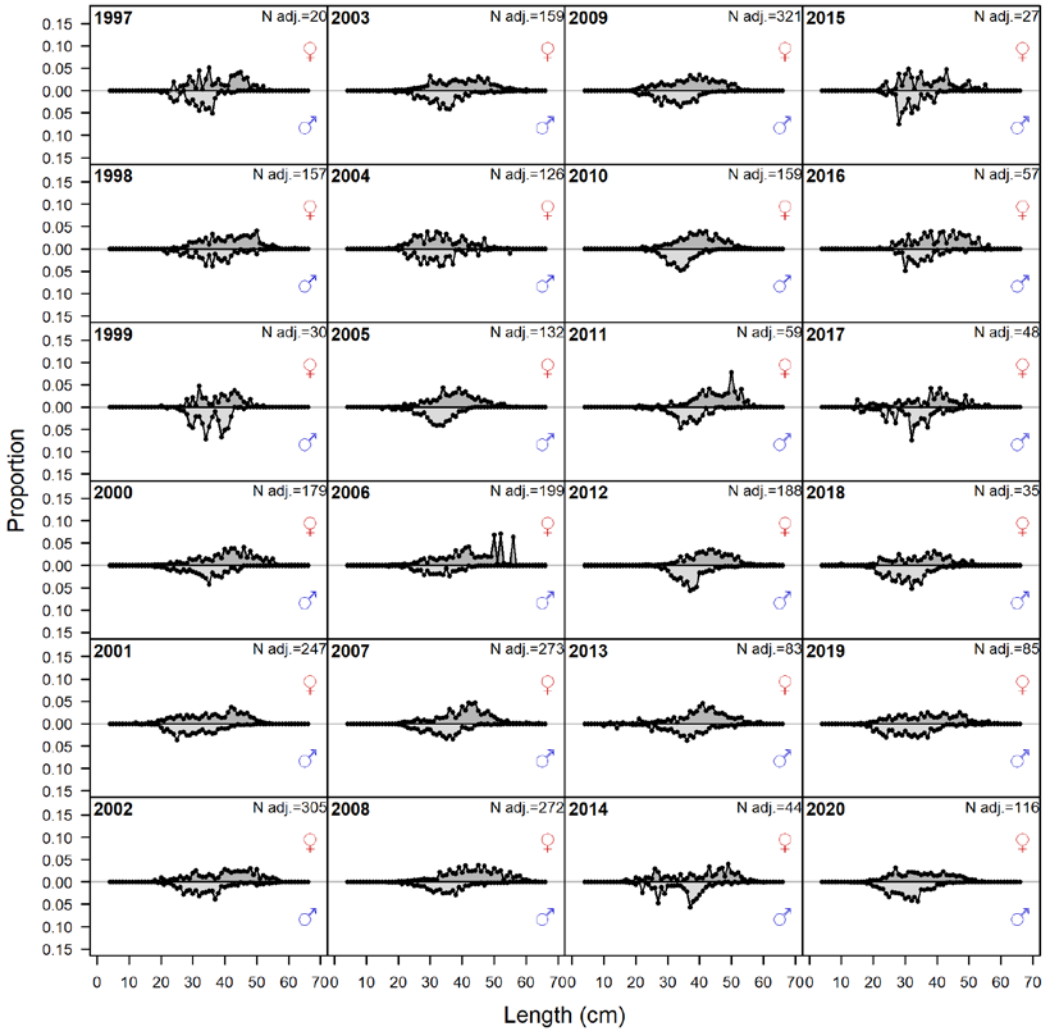

Southern rock sole

Annual, sex-specific length composition

Input sample size

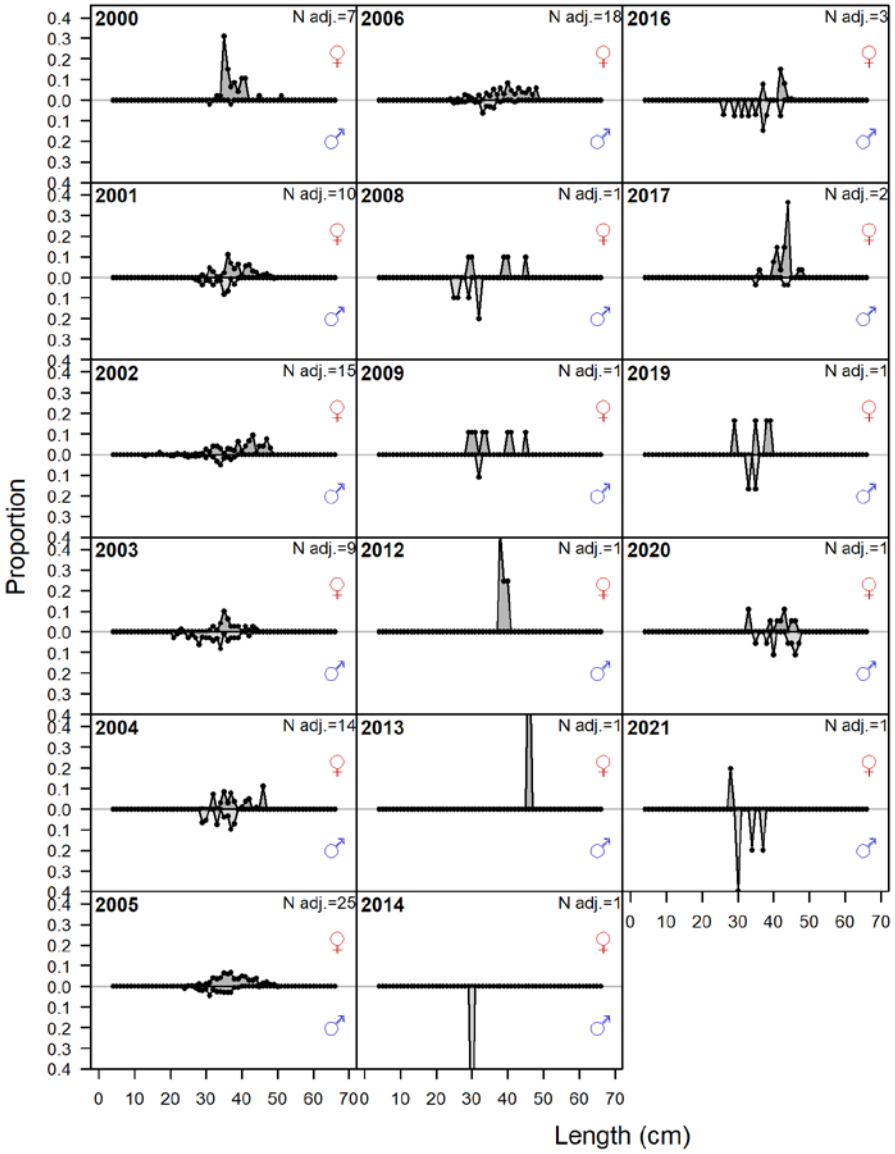
- Annual number of hauls

# Fishery length composition data




- Southern rock sole, central GOA
- Annual, sex-specific length composition
- Input sample size
  - Annual number of hauls
  - Majority of hauls from this area

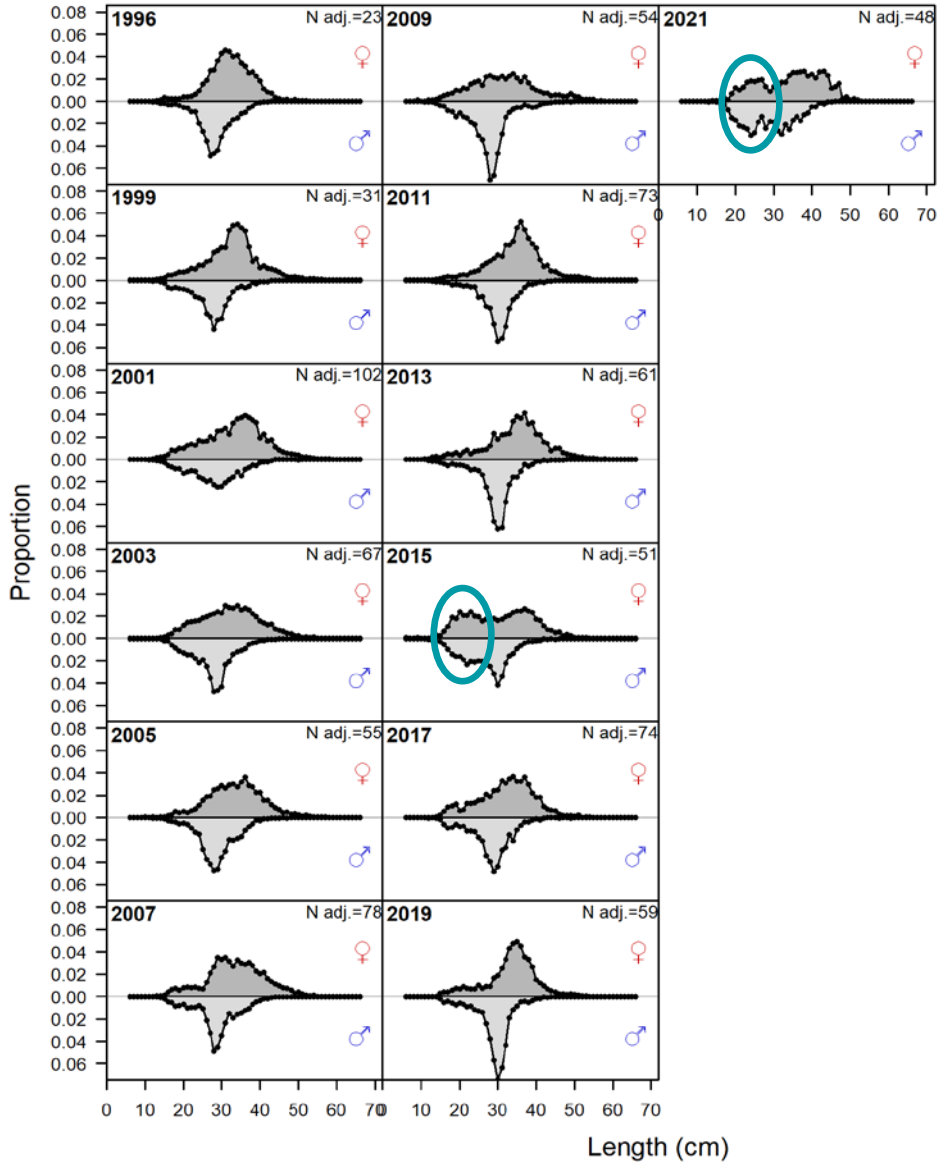
# Fishery length composition data



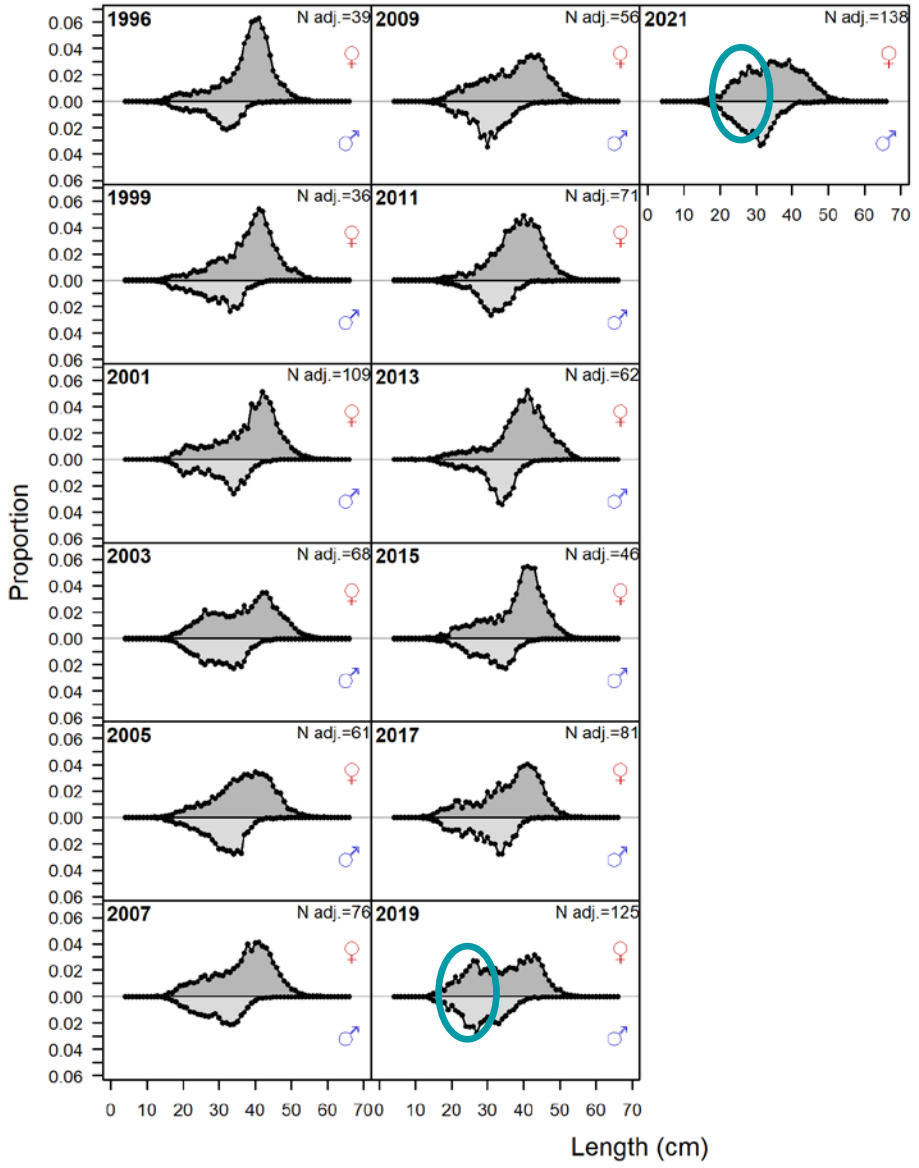

- Southern rock sole, western GOA
- Annual, sex-specific length composition
- Input sample size
  - Annual number of hauls
  - Small number of hauls per year
  - Some years no data from this area

# GOA bottom trawl survey lengths

## Northern rock sole



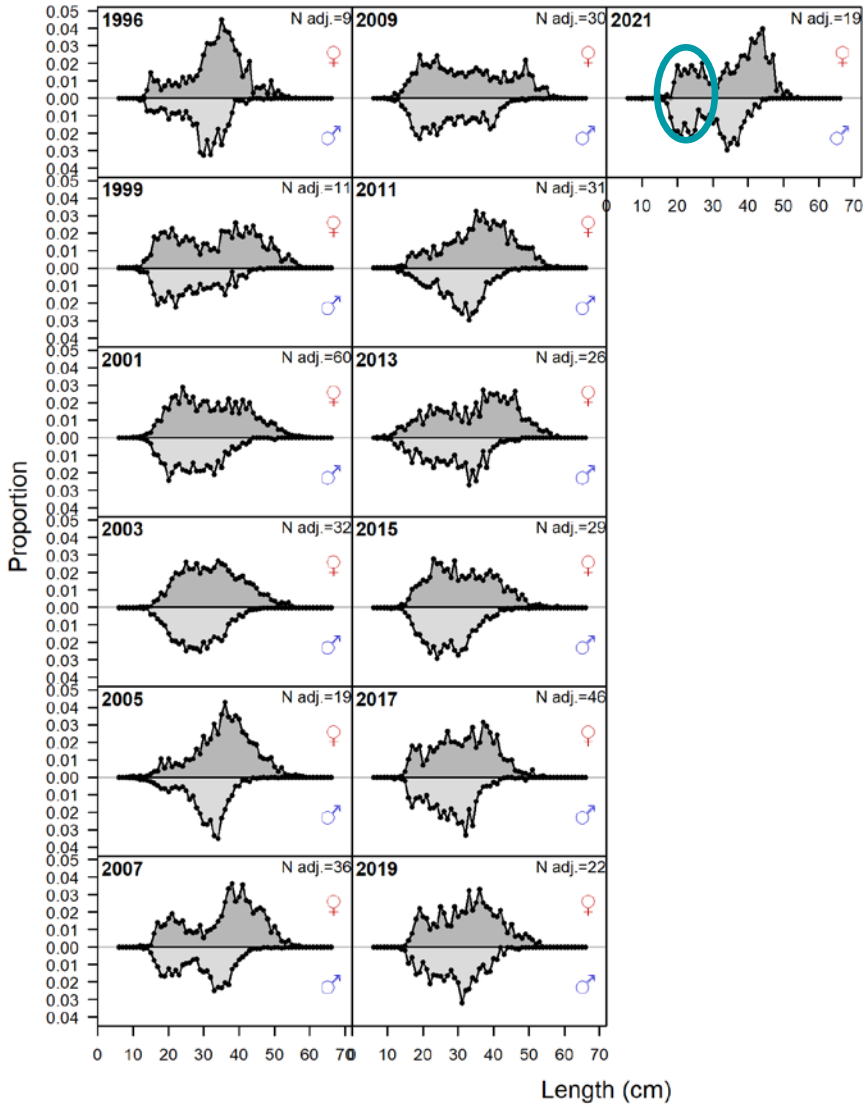

## Southern rock sole



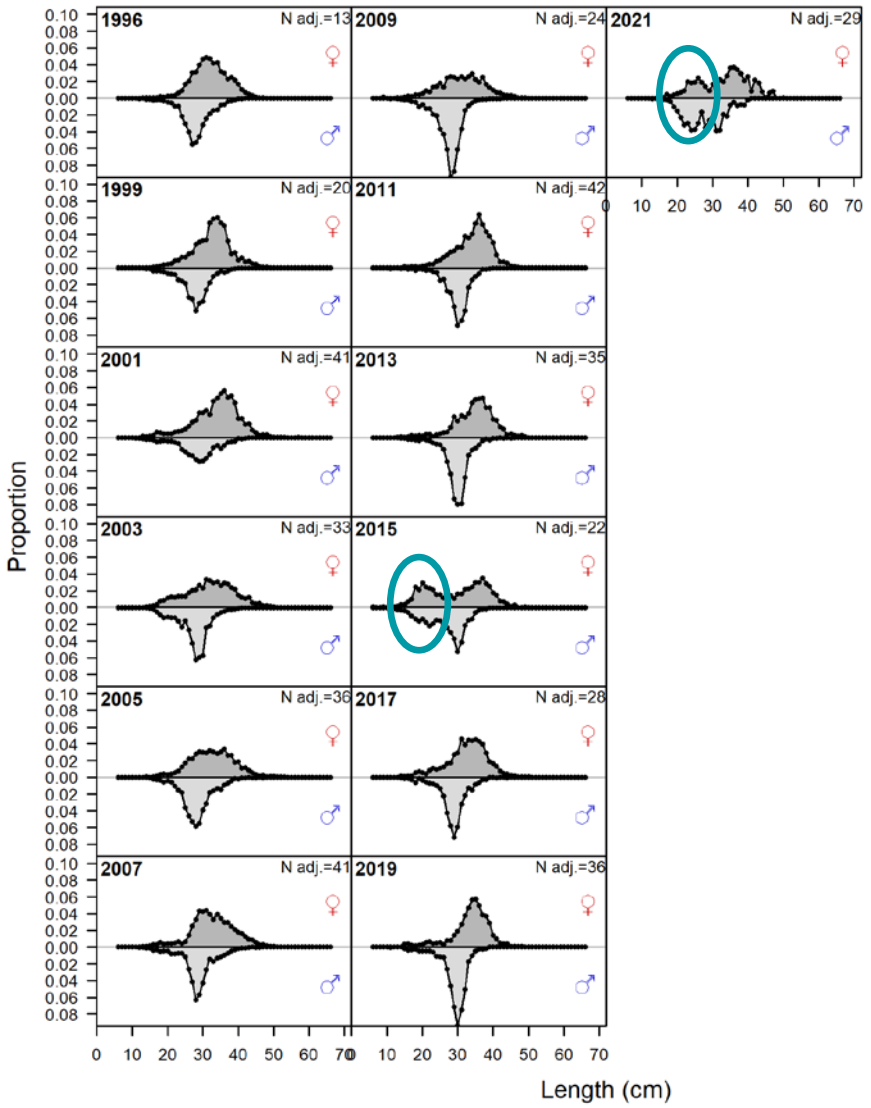
# GOA bottom trawl survey lengths

## Northern rock sole

### central GOA



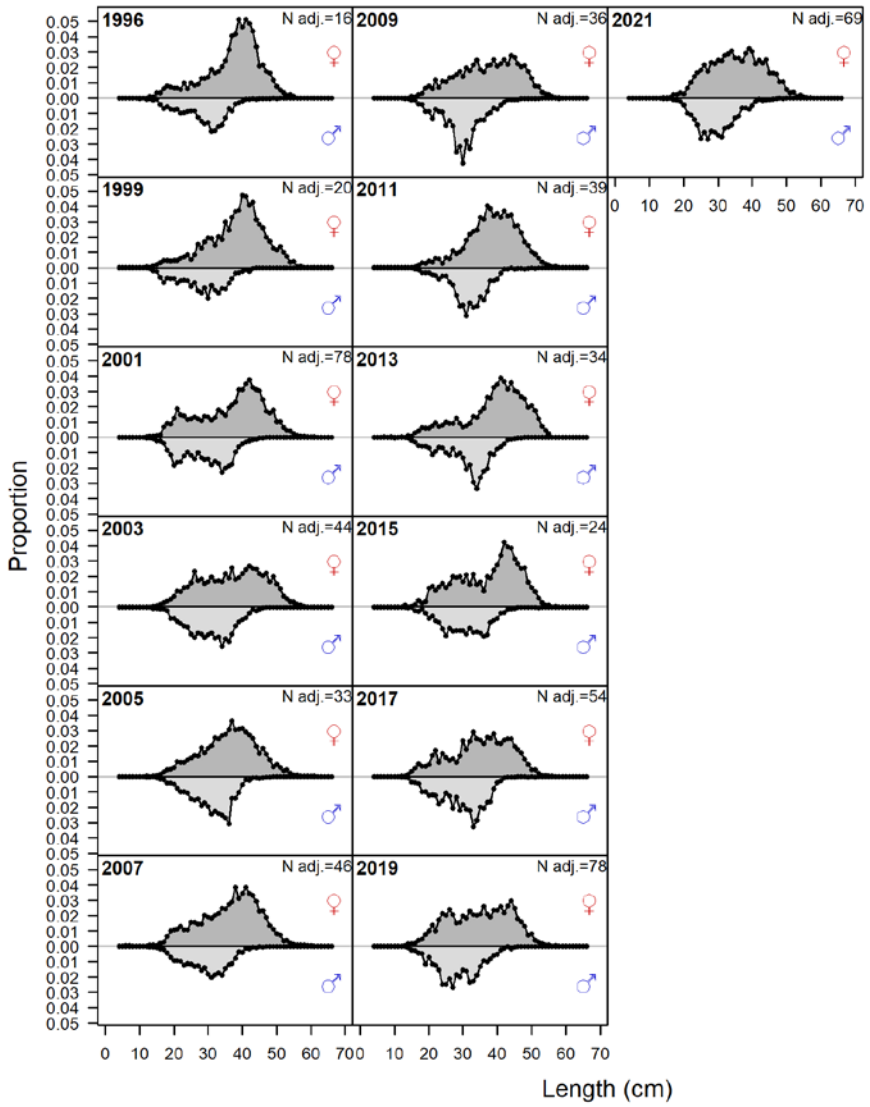

### western GOA



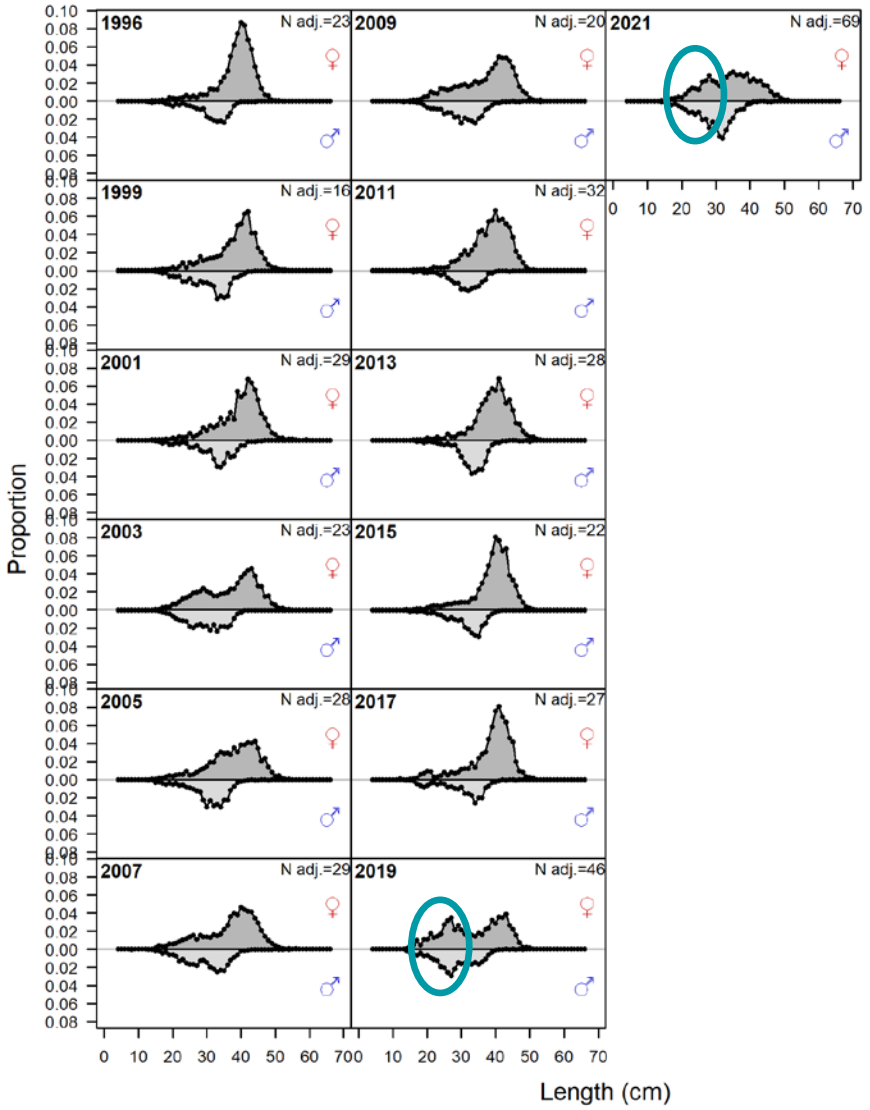
# GOA bottom trawl survey lengths

## Southern rock sole

### central GOA

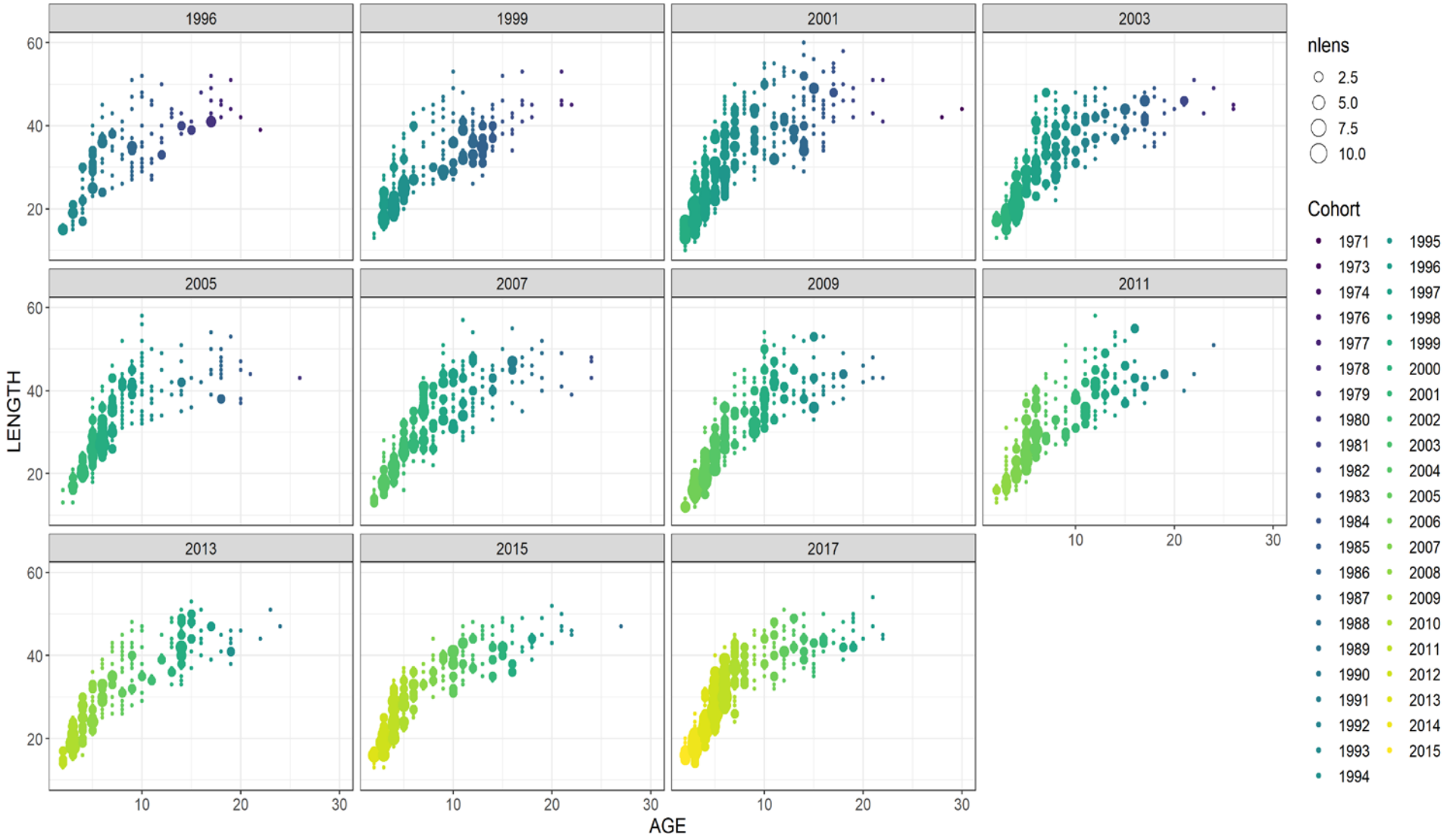



### western GOA



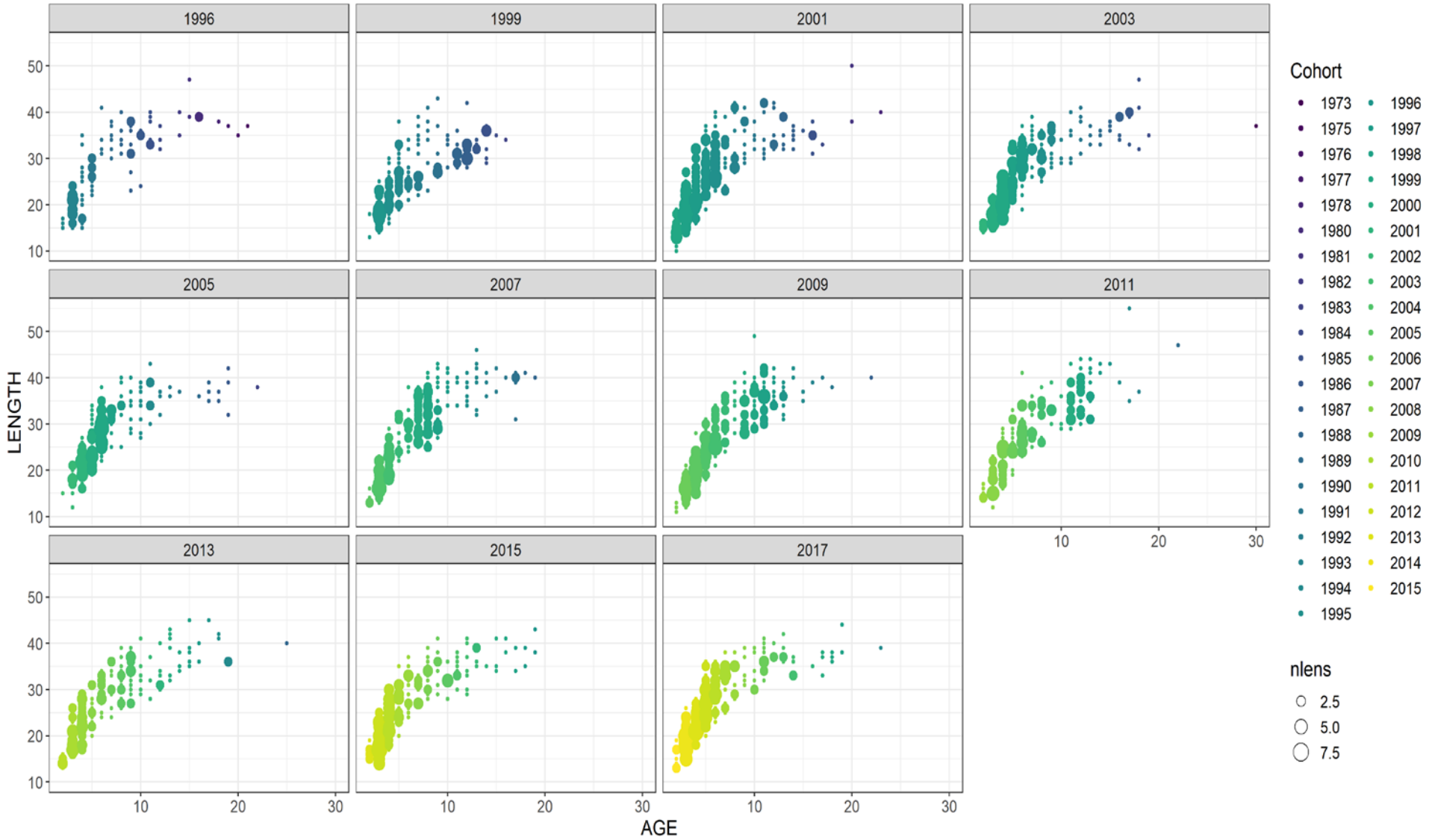
# GOA bottom trawl survey CAAL

## Northern rock sole, females



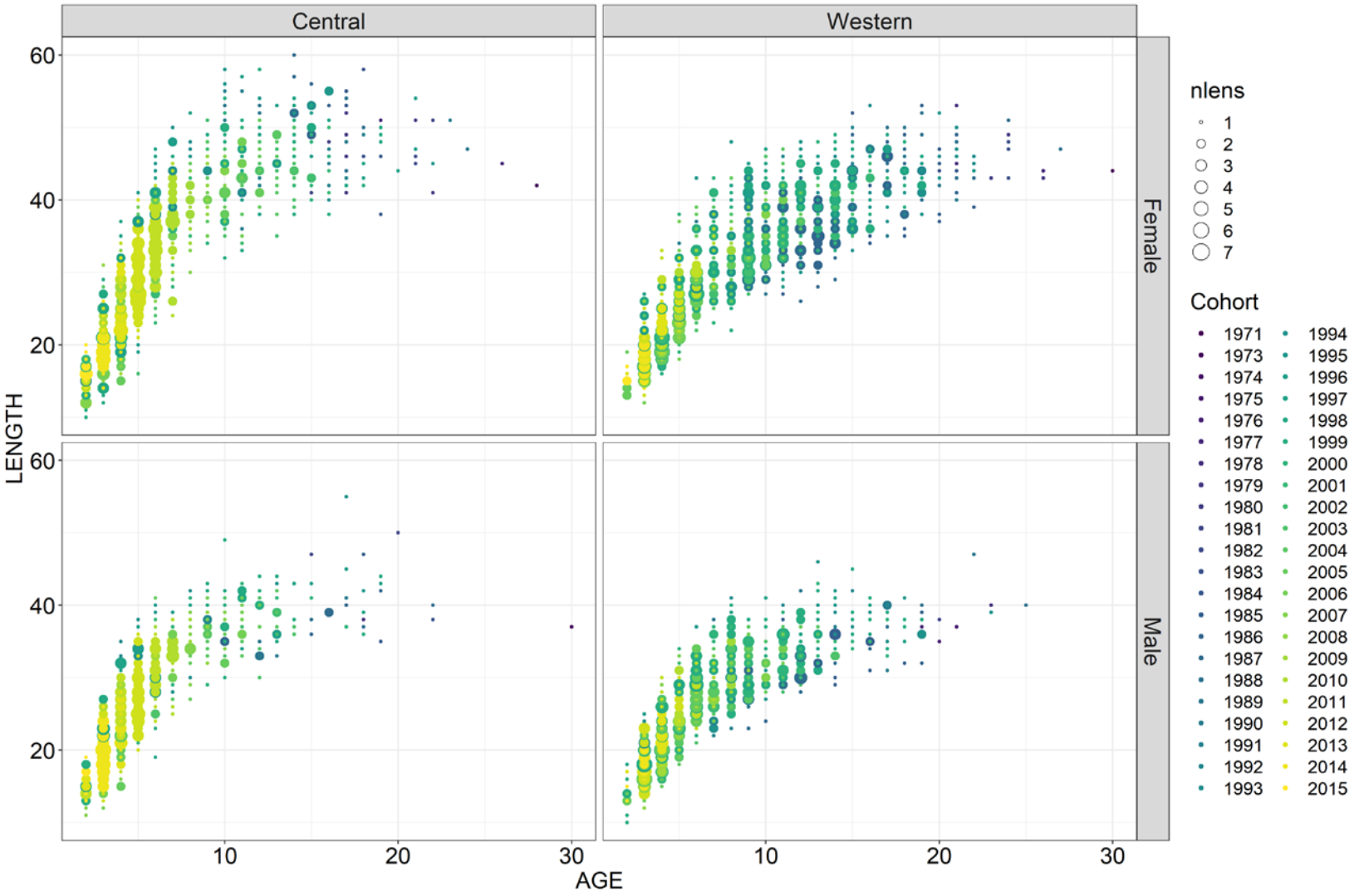
# GOA bottom trawl survey CAAL

## Northern rock sole, males



# GOA bottom trawl survey CAAL

## Northern rock sole by area



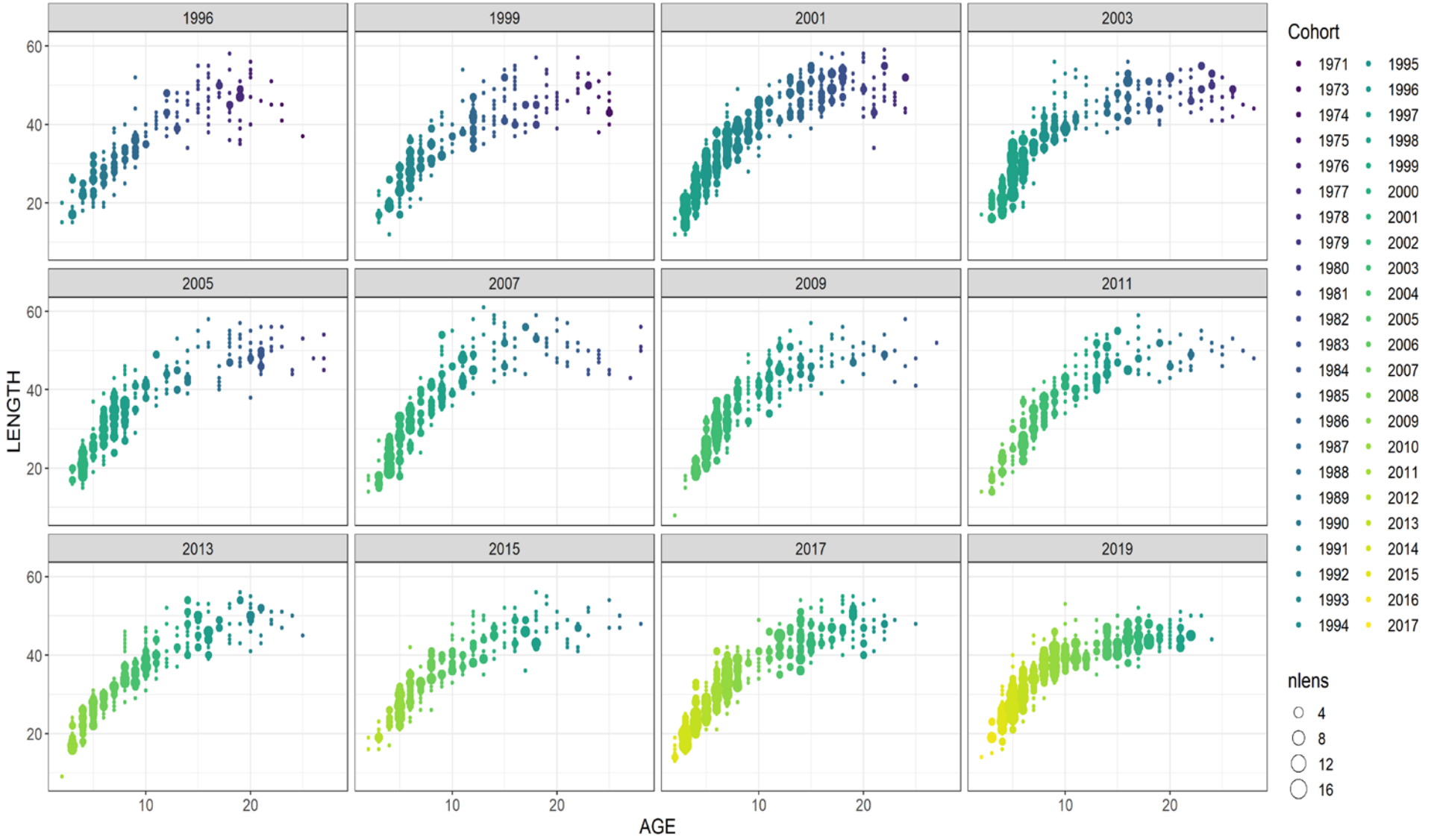
# GOA bottom trawl survey CAAL

Number of age samples by area (northern rock sole)

| | Central | | West | | |
|---|---|---|---|---|---|
| Year | Female | Male | Female | Male | Total |
| 1996 | 65 | 38 | 71 | 56 | 230 |
| 1999 | 64 | 45 | 163 | 110 | 382 |
| 2001 | 180 | 115 | 170 | 125 | 590 |
| 2003 | 114 | 77 | 184 | 129 | 504 |
| 2005 | 69 | 42 | 150 | 124 | 385 |
| 2007 | 77 | 49 | 180 | 146 | 452 |
| 2009 | 121 | 91 | 164 | 131 | 507 |
| 2011 | 78 | 56 | 162 | 114 | 410 |
| 2013 | 100 | 89 | 121 | 82 | 392 |
| 2015 | 129 | 105 | 124 | 93 | 451 |
| 2017 | 251 | 159 | 109 | 72 | 591 |

# GOA bottom trawl survey CAAL

## Southern rock sole, females

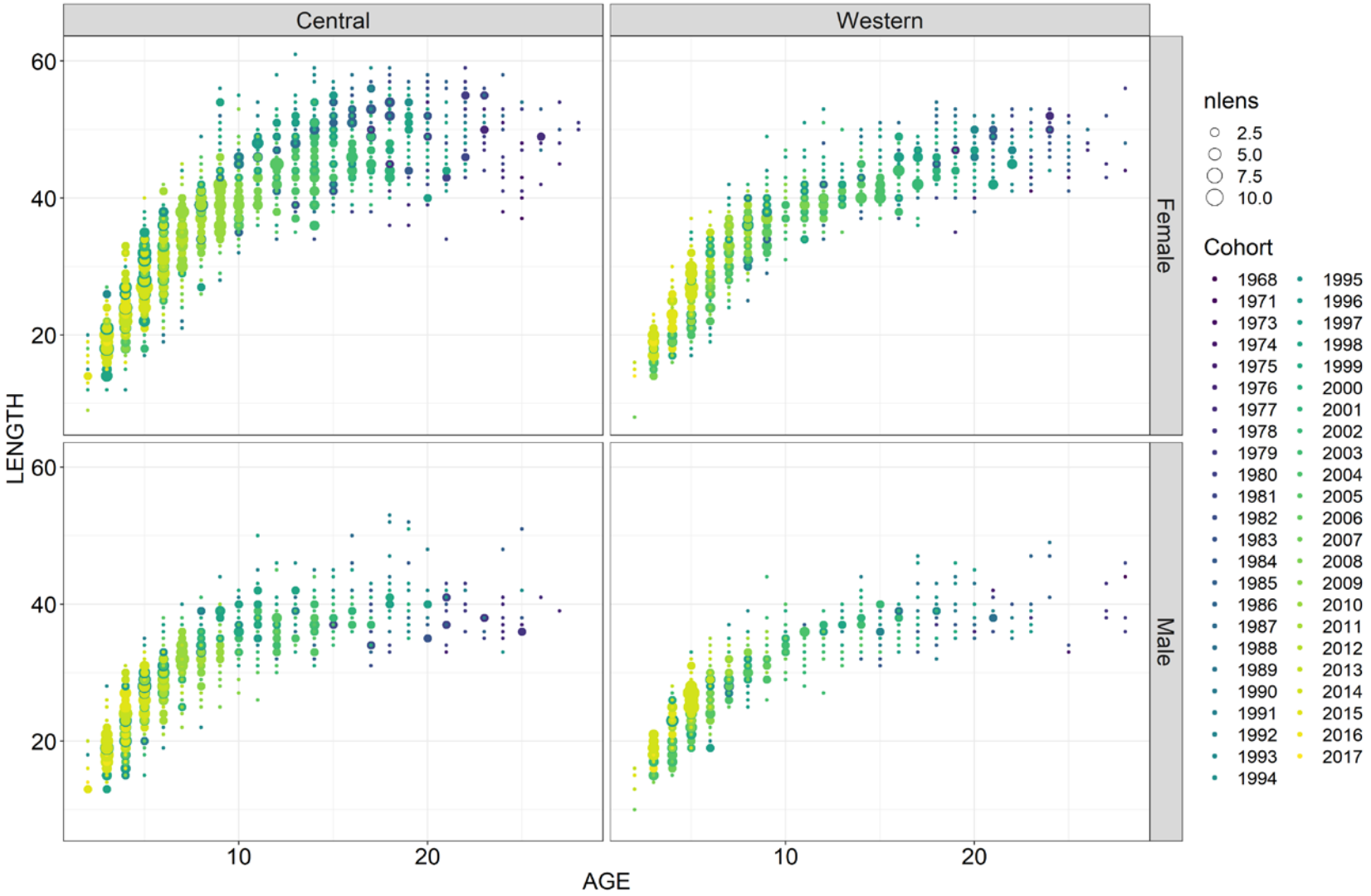


# GOA bottom trawl survey CAAL

## Southern rock sole, males

# GOA bottom trawl survey CAAL

## Southern rock sole by area



# GOA bottom trawl survey CAAL

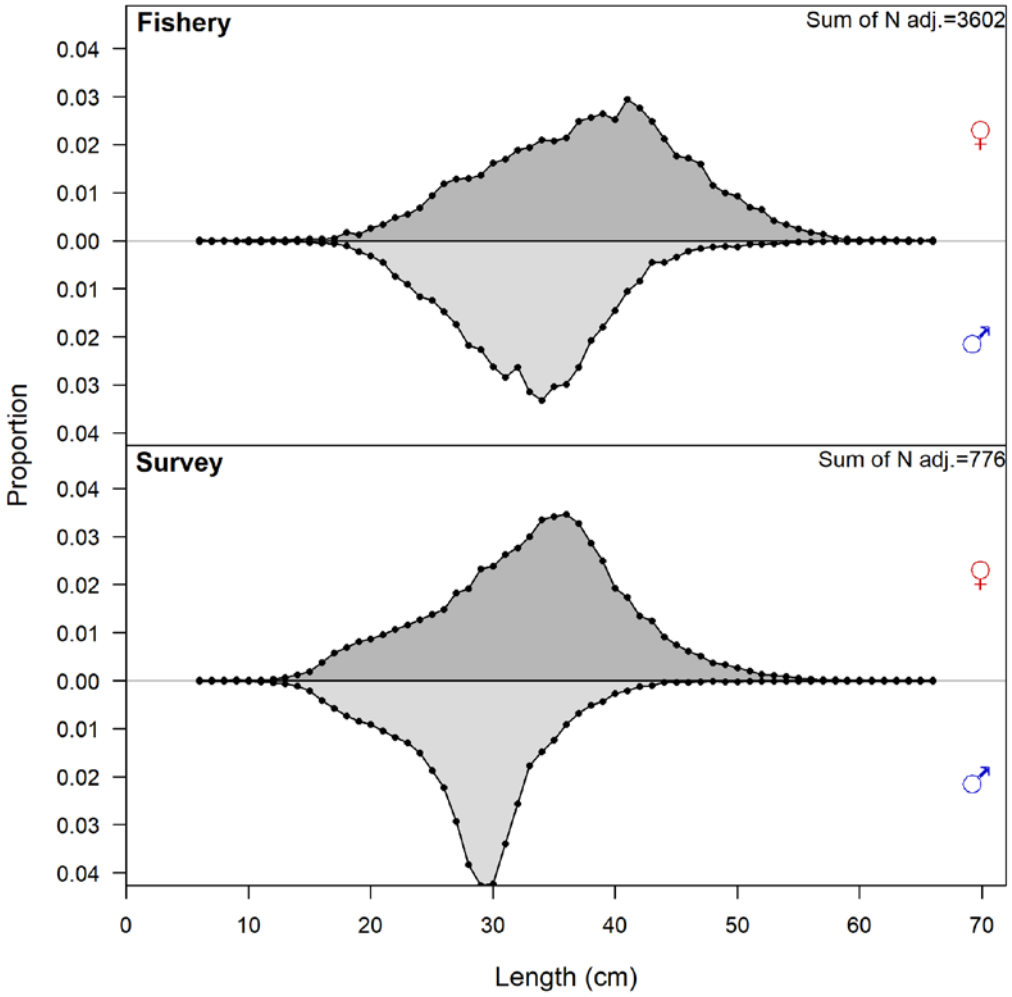
Number of age samples by area (southern rock sole)

| | Central | | West | | |
|---|---|---|---|---|---|
| **Year** | Female | Male | Female | Male | Total |
| **1996** | 98 | 59 | 83 | 28 | 268 |
| **1999** | 134 | 89 | 89 | 43 | 355 |
| **2001** | 339 | 204 | 91 | 63 | 697 |
| **2003** | 240 | 150 | 112 | 69 | 571 |
| **2005** | 150 | 78 | 108 | 73 | 409 |
| **2007** | 158 | 93 | 111 | 79 | 441 |
| **2009** | 192 | 142 | 98 | 75 | 507 |
| **2011** | 135 | 76 | 105 | 66 | 382 |
| **2013** | 152 | 101 | 114 | 77 | 444 |
| **2015** | 134 | 72 | 113 | 79 | 398 |
| **2017** | 314 | 216 | 111 | 77 | 718 |
| **2019** | 291 | 117 | 181 | 79 | 668 |

# Models – northern rock sole

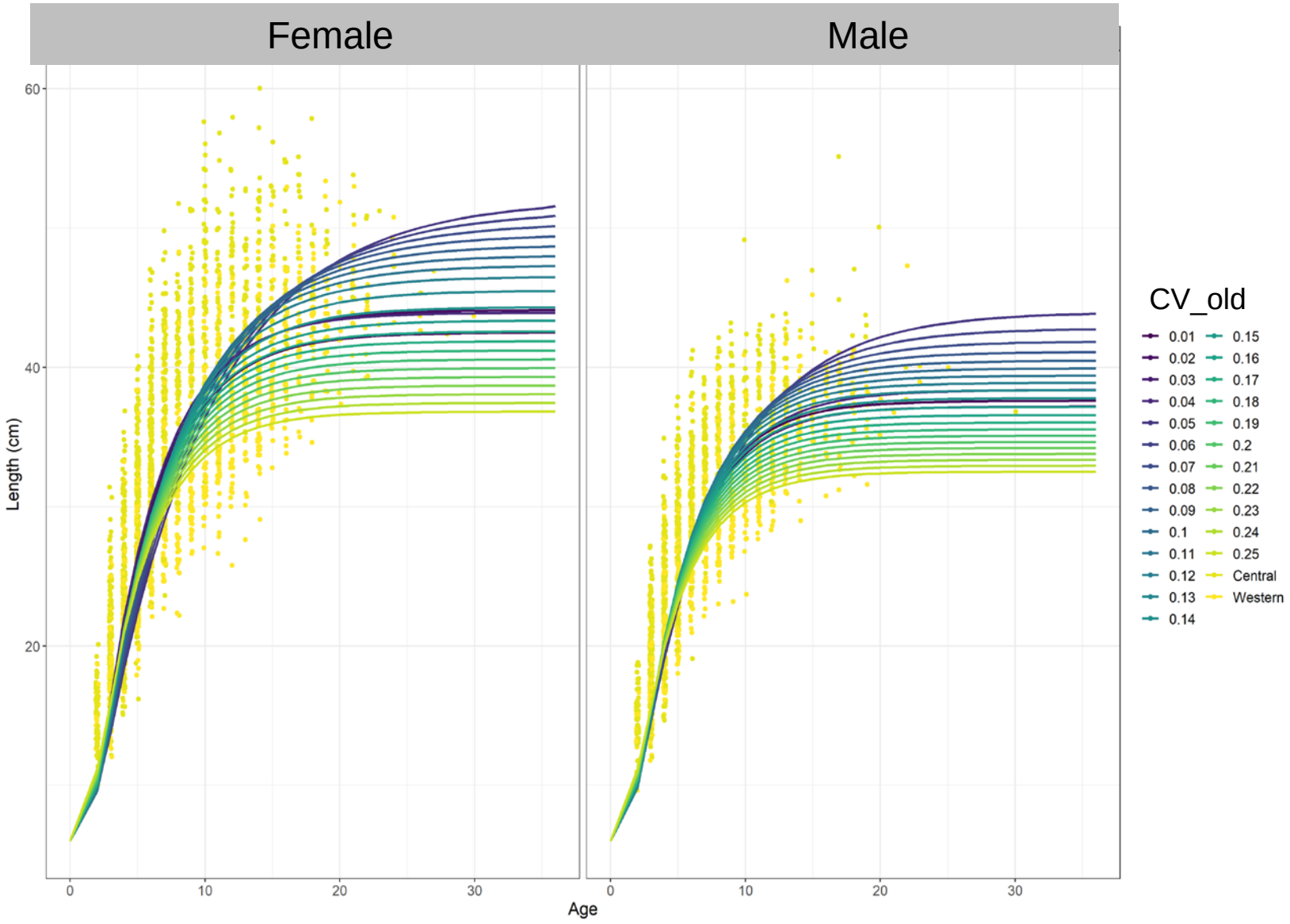
- Model 17.1
  - All growth parameters estimated
  - Female M = 0.2, Male M - estimated
  - Stock-recruitment
    - Ln(R0) – estimated
    - Regime parameter – estimated
    - Recruitment deviations (1977-2021) – estimated
  - Catchability = 1
  - Fishery selectivity – double normal (allowed to dome)
  - Survey selectivity – double normal (asymptotic)
- Model 17.1a
  - Fishery selectivity – double normal (asymptotic)
- Model 17.1b
  - CV_old = 0.1 (CV of the distribution of length-at-oldest age)
- Model 17.1 c
  - Fishery selectivity – double normal (asymptotic)
  - CV_old = 0.1

# Asymptotic selectivity?




- Survey selectivity assumed asymptotic
- Comparing length distributions seems justified to assume fishery selectivity is also asymptotic given it captures larger fish than the survey

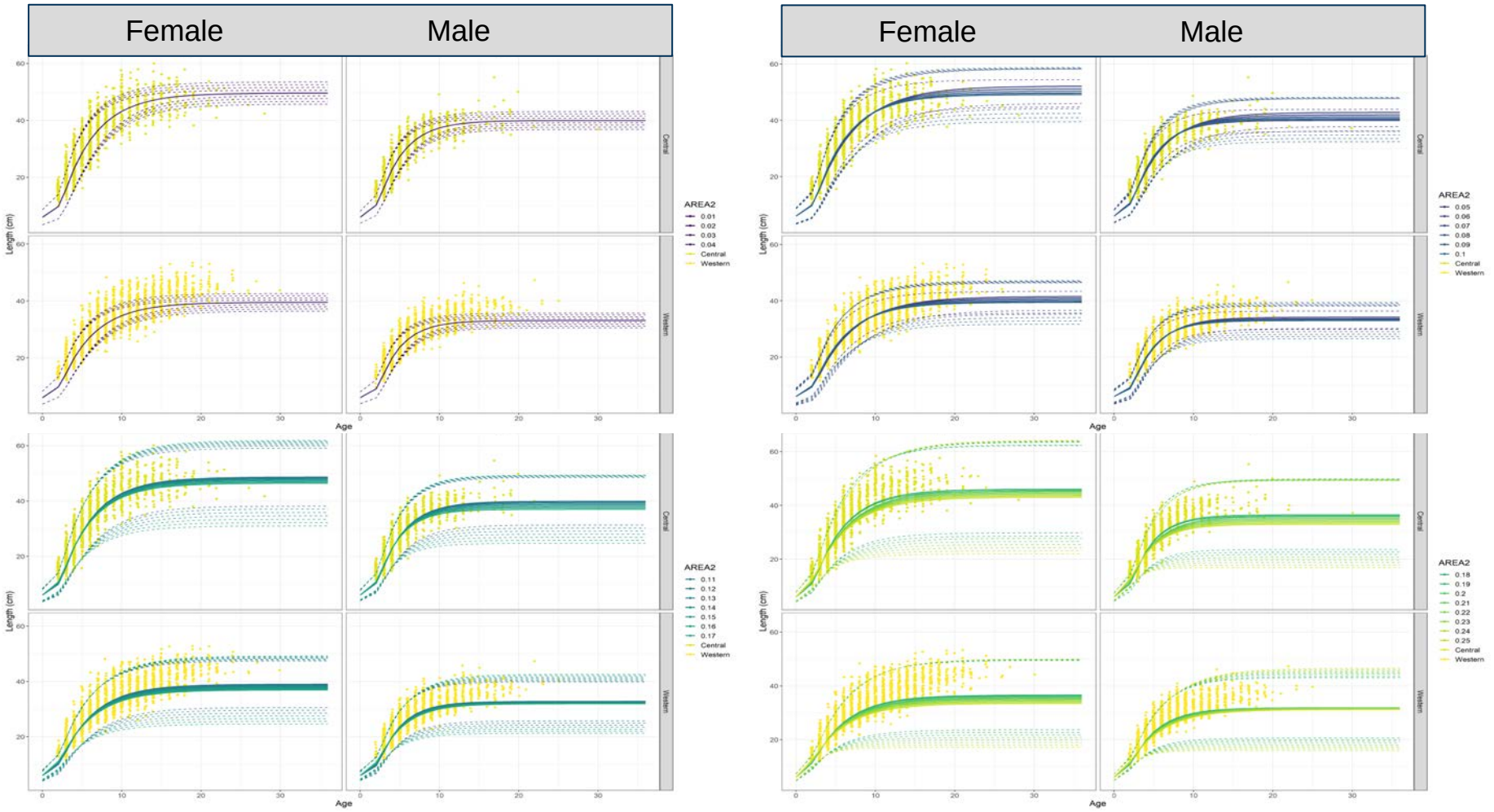
# CV of the length-at-age distribution



# Models – northern rock sole

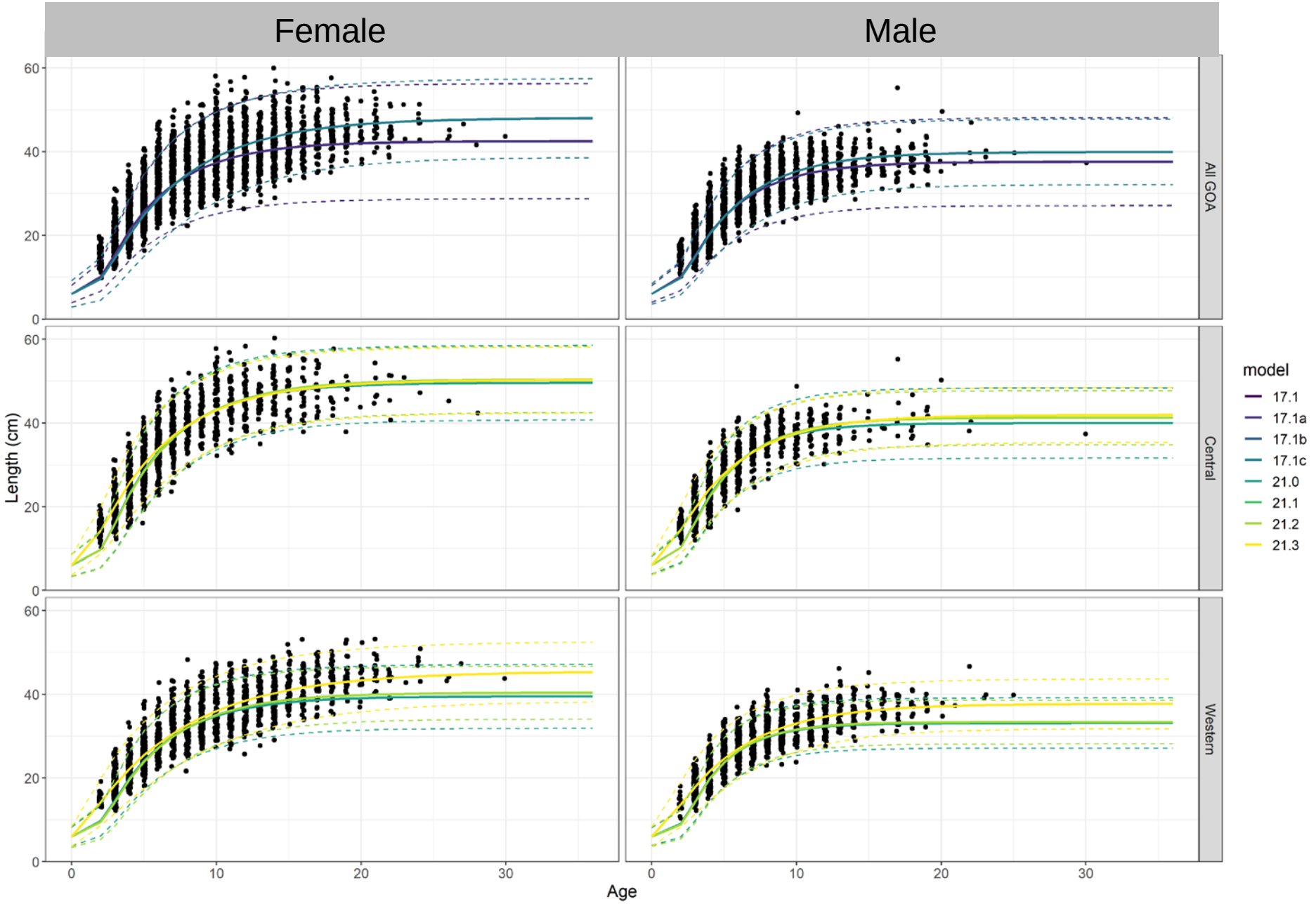
- Model 21.0 (2-area model)
  - All growth parameters estimated
  - Recruitment distribution parameter - estimated
  - Female M = 0.2, Male M = estimated Stock-recruitment
    - Ln(R0) – estimated
    - Regime parameter – estimated
    - Recruitment deviations (1977-2021) – estimated
  - Catchability (central and west) = 1
  - Fishery selectivity (central and west) – double normal (allowed to dome)
  - Survey selectivity (central and west)– double normal (asymptotic)
- Model 21.1 (same as 21.0)
  - CV_old = fixed
- Model 21.2 (same as 21.1)
  - Fishery selectivity – double normal (asymptotic)
- Model 21.3 (same as 21.2)
  - Fixed growth parameters to external estimates

# CV of the length-at-age distribution

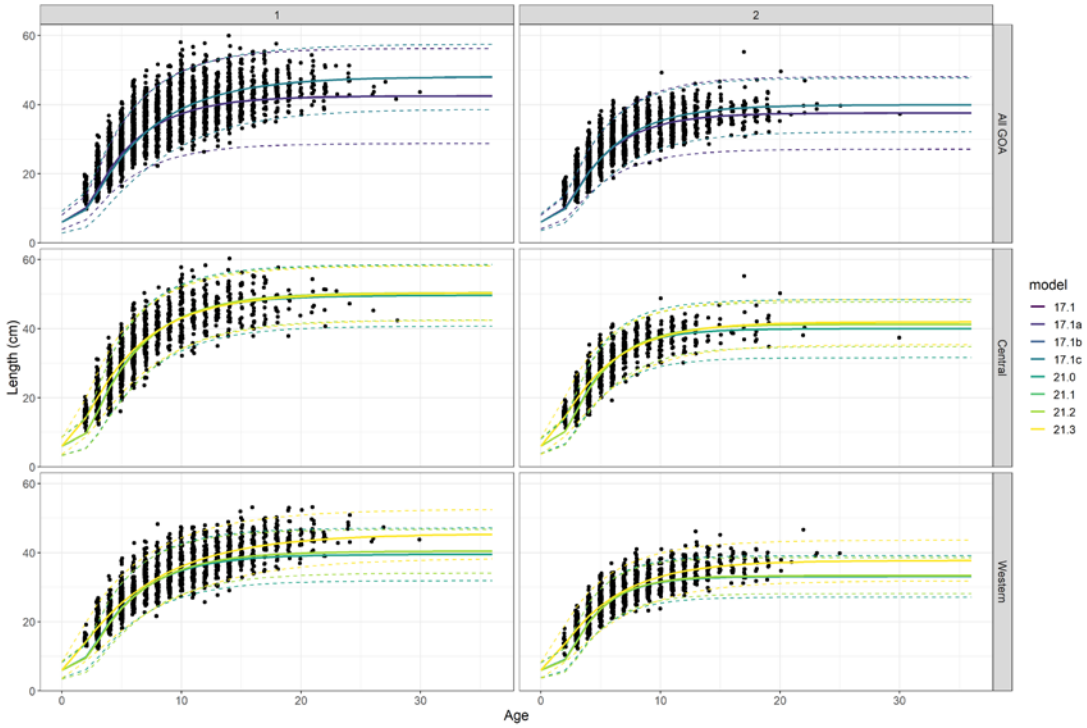



- Negative correlation between CV old and asymptotic length (Linf)
- Central area growth estimates improve with CV old values between 0.06 and 0.1
- Consistent underestimation of Linf in the western area regardless of CV old value

# CAAL – northern rock sole



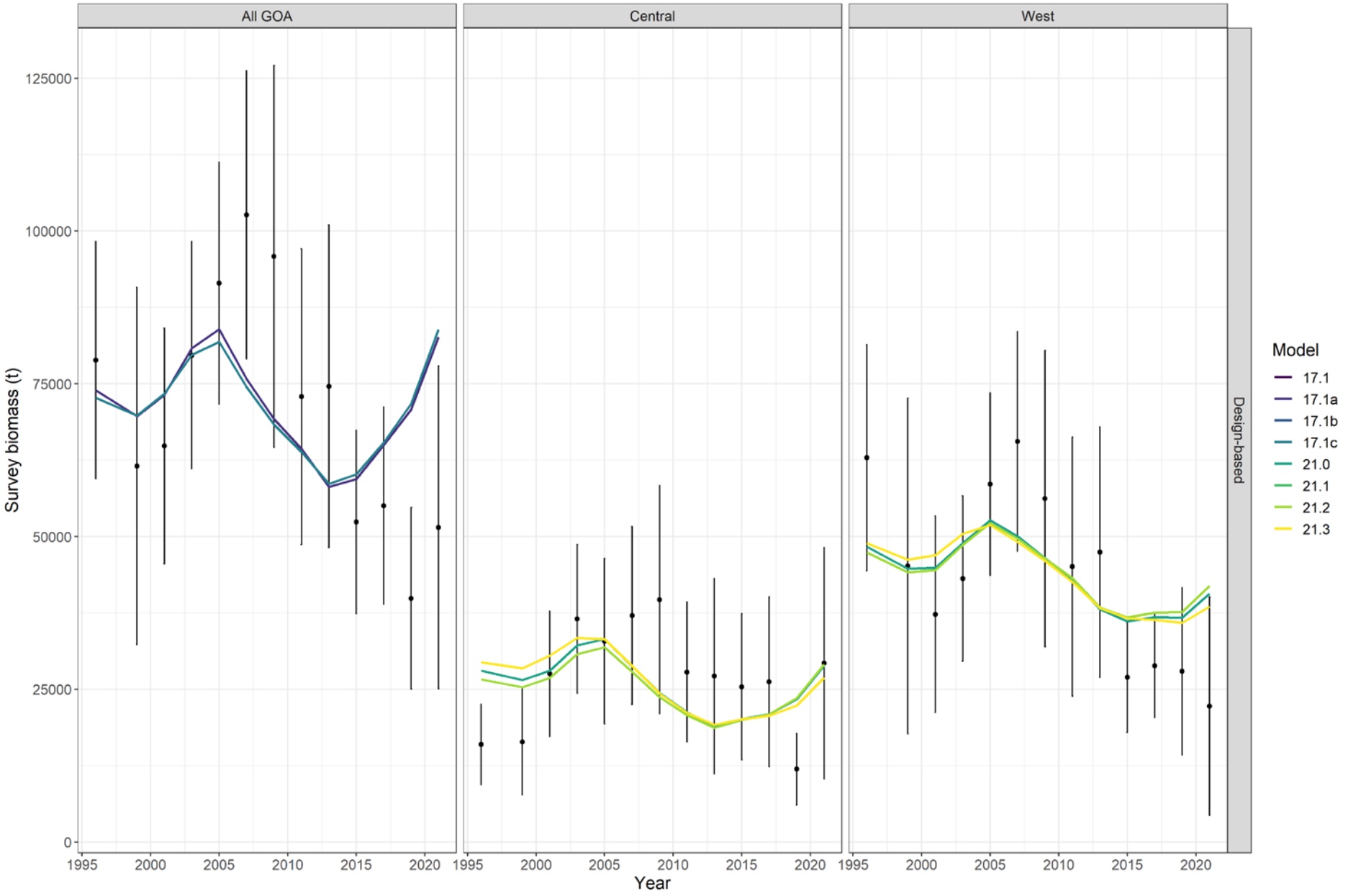
# CAAL – northern rock sole



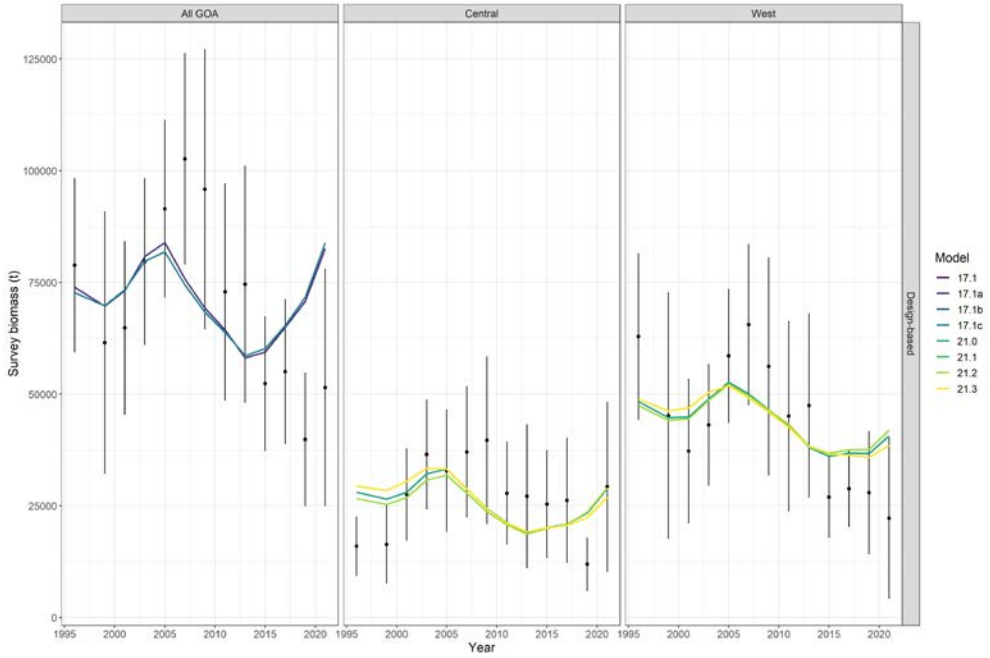

- Parameter correlation
- Male M is estimated and is generally higher than female M
  - Female M may be acting as a constraint

| | L∞ female west | M male west | Rec Dist |
|---|---|---|---|
| L∞ female west | 1 | | |
| M male west | -0.32 | 1 | |
| Rec Dist | -0.51 | 0.65 | 1 |

# Survey biomass – northern rock sole

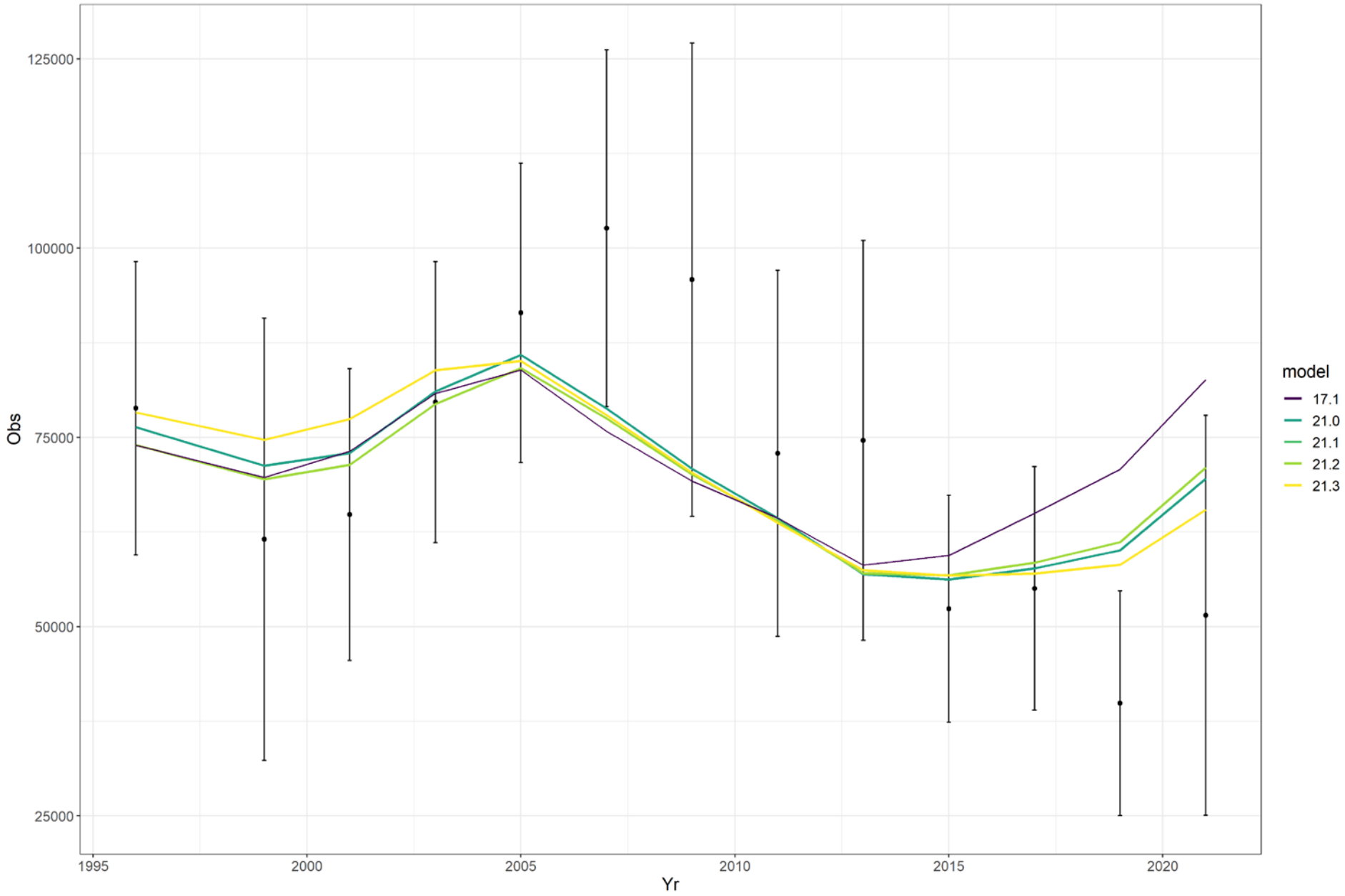


# Survey biomass – northern rock sole

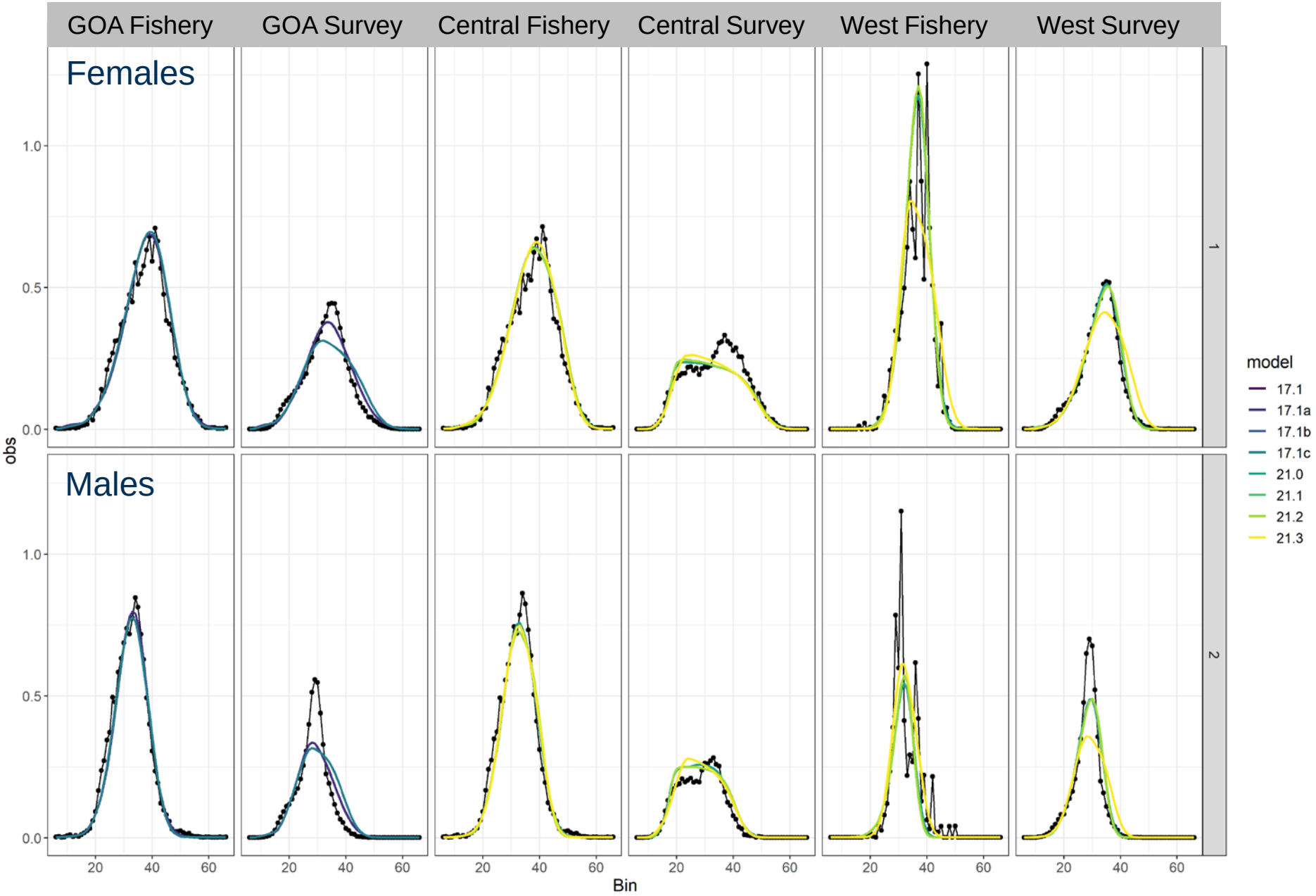



| Model | All GOA | Central | West |
|---|---|---|---|
| 17.1 | 0.27 | - | - |
| 17.1a | 0.27 | - | - |
| 17.1b | 0.27 | - | - |
| 17.1c | 0.27 | - | - |
| 21.0 | - | 0.35 | 0.26 |
| 21.1 | - | 0.35 | 0.27 |
| 21.2 | - | 0.35 | 0.27 |
| 21.3 | - | 0.36 | 0.26 |

# Survey biomass – northern rock sole



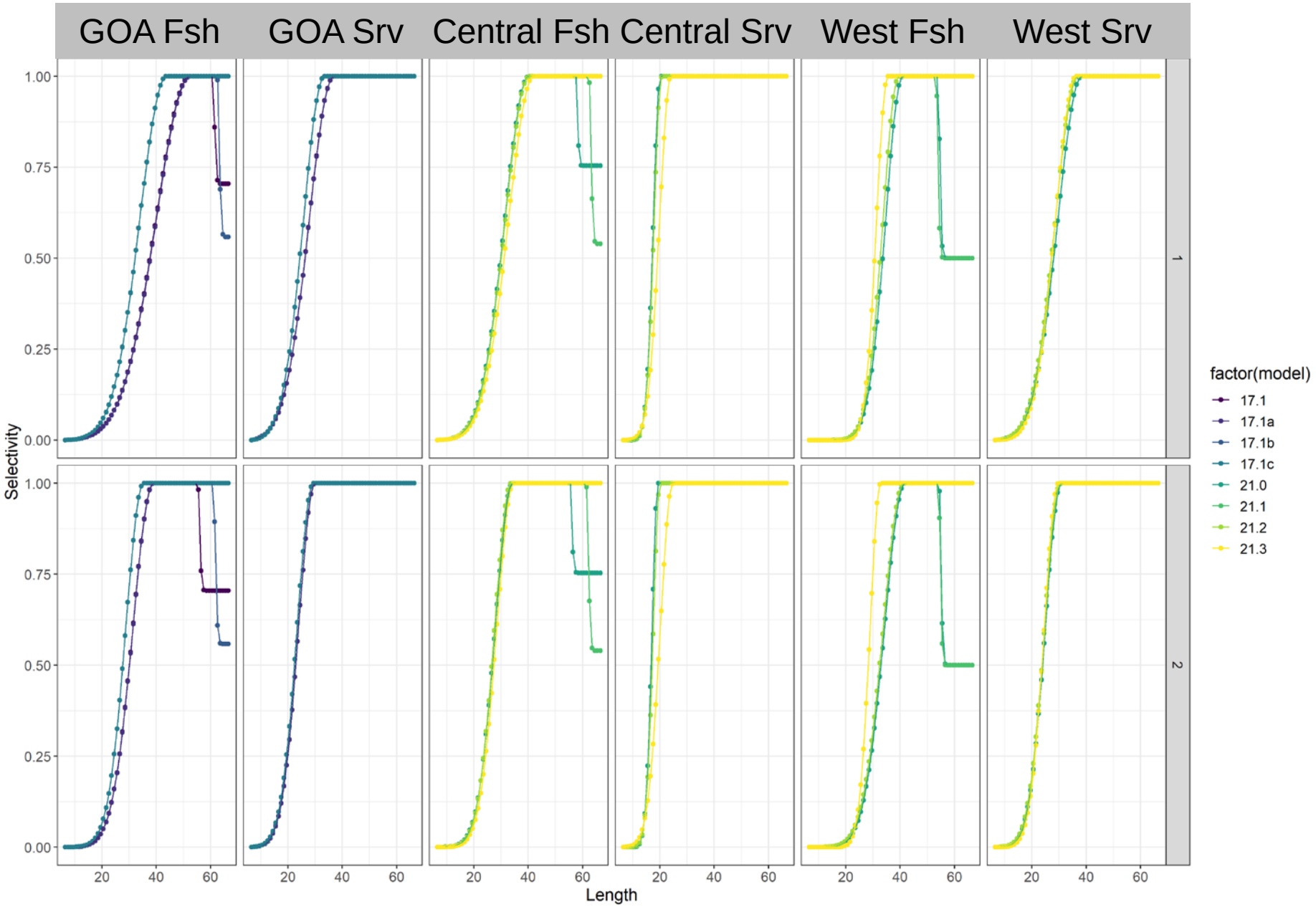
# Length composition – northern rock sole



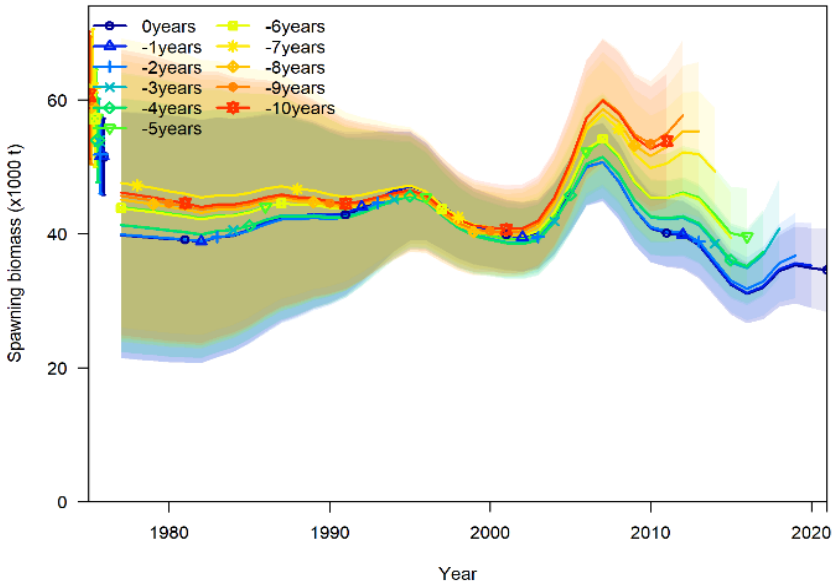
# Likelihoods– northern rock sole

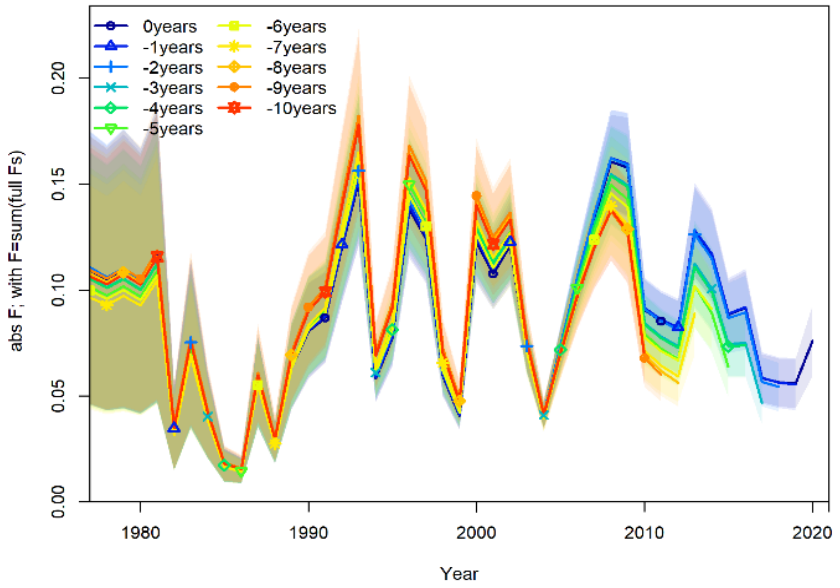
| NORTHERN ROCK SOLE | | | | | |
|---|---|---|---|---|---|
| **Model** | Age_comp | Length_comp | Survey | Total | Npars |
| **17.1** | 780.17 | 527.73 | -9.40 | 1296.47 | 92 |
| **17.1a** | 780.18 | 527.70 | -9.40 | 1296.43 | 90 |
| **17.1b** | 786.63 | 558.05 | -8.14 | 1333.94 | 90 |
| **17.1c** | 786.63 | 558.04 | -8.14 | 1333.87 | 88 |
| **21.0** | 628.81 | 556.17 | -15.61 | 1174.54 | 116 |
| **21.1** | 624.64 | 569.99 | -14.55 | 1184.61 | 112 |
| **21.2** | 624.64 | 569.97 | -14.55 | 1184.54 | 108 |
| **21.3** | 736.50 | 605.82 | -14.75 | 1332.56 | 92 |

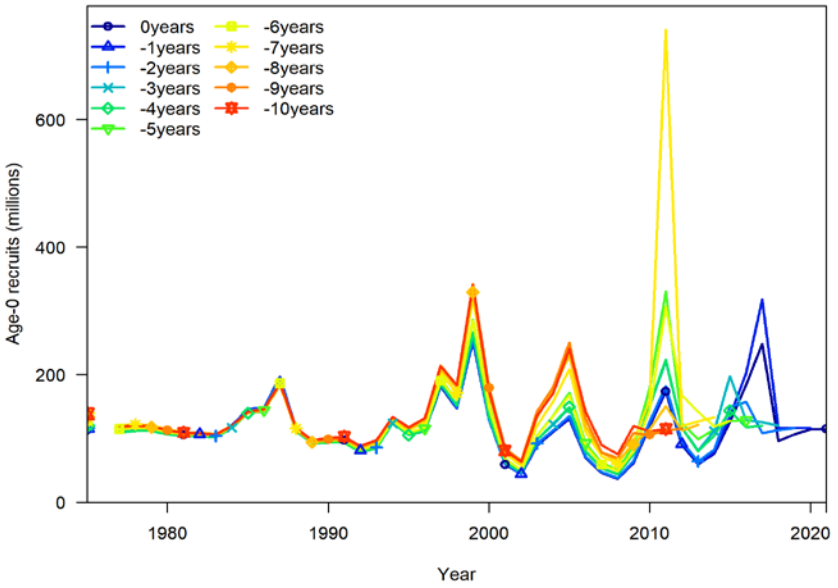
# Selectivity – northern rock sole



# Retrospective – northern rock sole

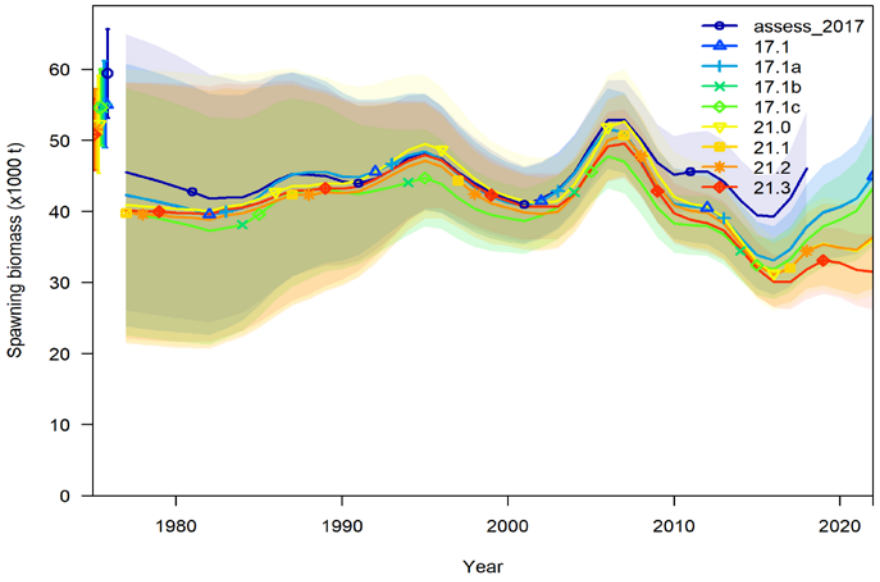


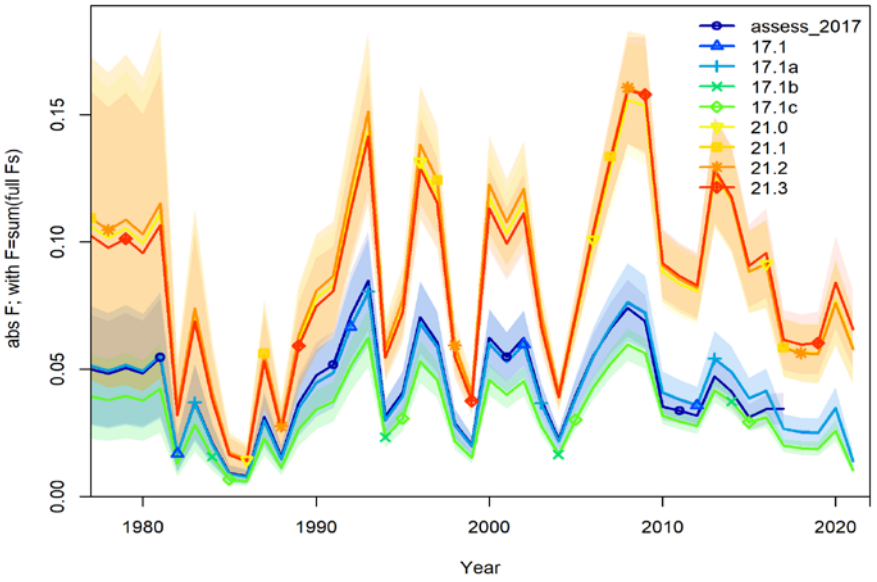



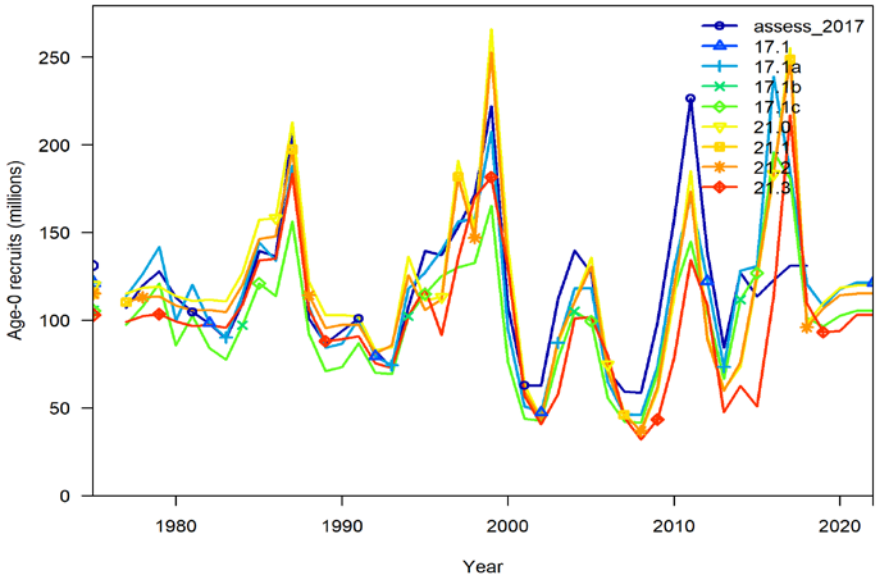




| Model | ρ SSB | ρ Recruitment | ρ Fishing mortality |
|---|---|---|---|
| 17.1 | 0.24 | -0.13 | -0.20 |
| 17.1b | 0.27 | -0.13 | -0.19 |
| 17.1a | 0.25 | -0.12 | -0.18 |
| 17.1c | 0.27 | -0.13 | -0.19 |
| 21.0 | 0.24 | 0.16 | -0.22 |
| 21.1 | 0.25 | 0.13 | -0.24 |
| 21.2 | 0.25 | 0.13 | -0.24 |
| 21.3 | 0.15 | 0.16 | -0.17 |

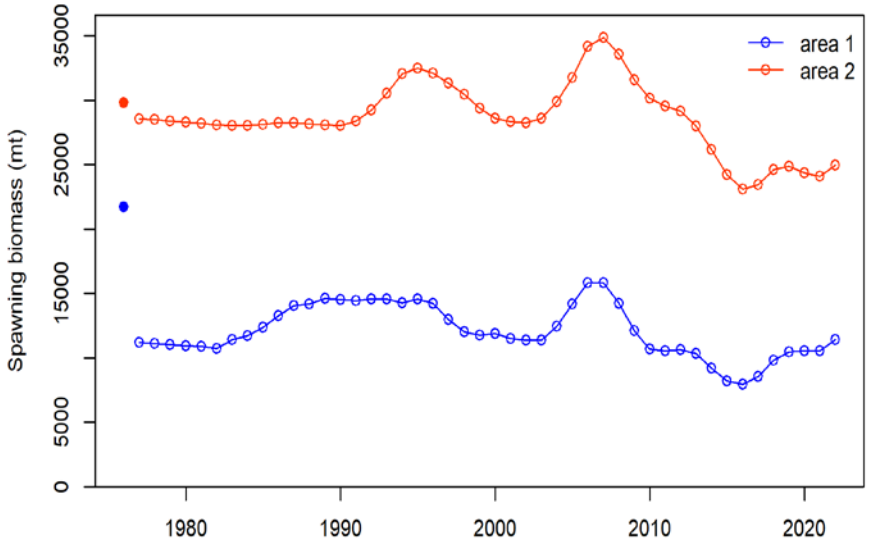
# Time series – northern rock sole

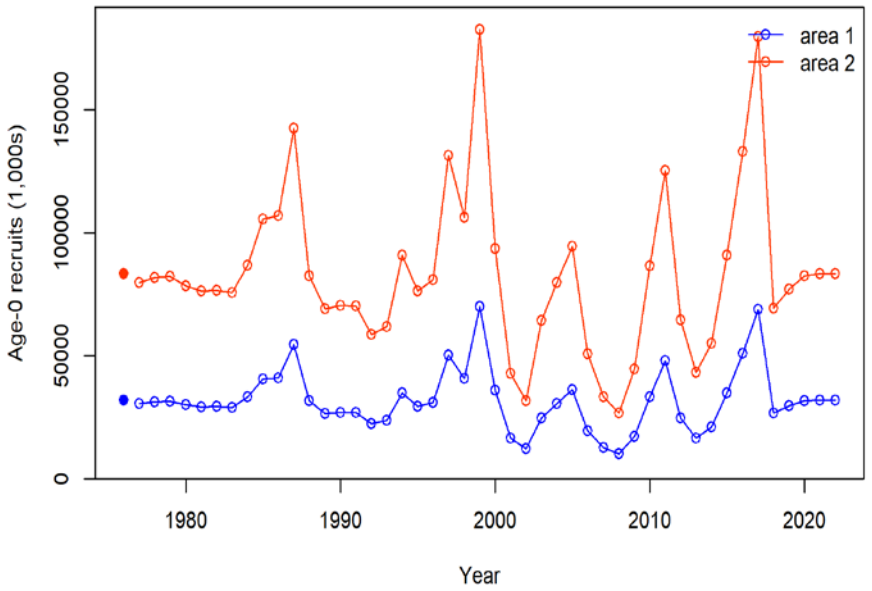


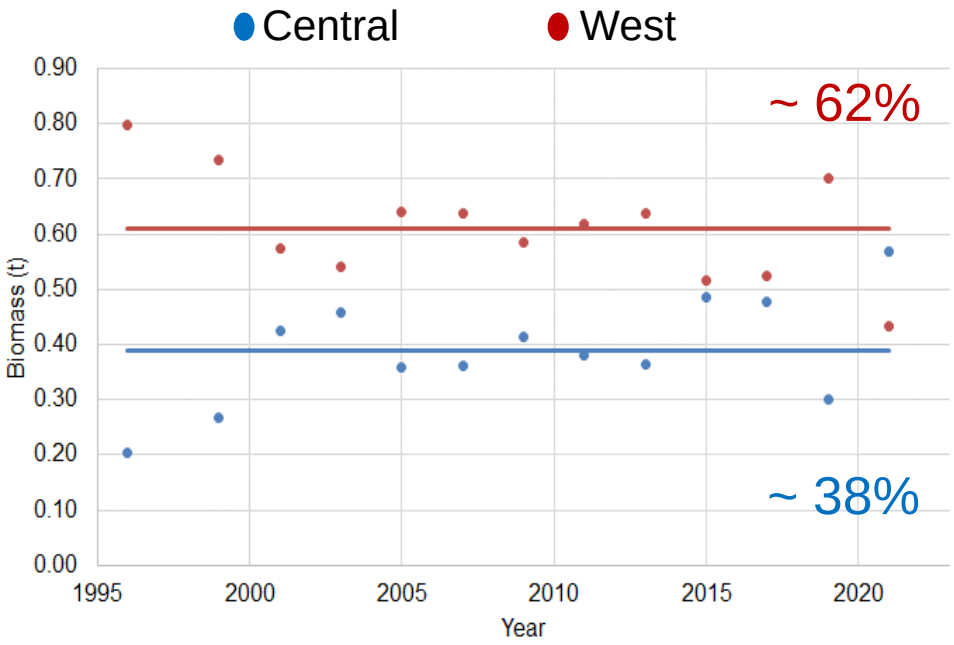



# Time series – northern rock sole




| Model | Rec Dist | Proportion in west |
|---|---|---|
| 21.0 | 1.01 | 0.73 |
| 21.1 | 0.96 | 0.72 |
| 21.2 | 0.96 | 0.72 |
| 21.3 | 0.81 | 0.69 |

# Summary– northern rock sole

- Overall fits to data were similar among the models
  - Some improvement in the fit to survey biomass by 2-area model
    - Indications of non-stationarity for all models
  - All models underestimate peak of male length distribution from survey
- Retrospective results were similar among models
- Preferred model – Model 21.2
  - Biologically appropriate given difference in growth between central and western GOA
  - Estimated growth of central GOA growth morph better described
    - Majority of catch is from central GOA
    - Important for estimating reference points

# Projections – northern rock sole

- AFSC projection model
- Projections done for central and western GOA separately
- Inputs from model 12.2
- Preliminary 2021 catch estimate used for 2022 and 2023 inputs

# Harvest recommendations

| Quantity | As estimated or specified last year for: 2021 | 2022 | As estimated or recommended this year for: 2022+ | 2023+ |
|---|---|---|---|---|
| M (natural mortality rate; female, male) | 0.2, 0.253* | 0.2, 0.253* | See area specific estimates | |
| Tier | 3a | 3a | 3a | 3a |
| Projected total (age 0+) biomass (t) | 94,612 | 94,614 | 98,387 | 100,919 |
| Projected Female spawning biomass (t) | 47,694 | 46,330 | 35,046 | 39,180 |
| $B_{100\%}$ | 51,387 | 51,387 | | |
| $B_{40\%}$ | 20,555 | 20,555 | | |
| $B_{35\%}$ | 17,985 | 17,985 | | |
| $F_{OFL}$ | 0.462 | 0.462 | See area specific estimates | |
| $maxF_{ABC}$ | 0.382 | 0.382 | | |
| $F_{ABC}$ | 0.382 | 0.382 | | |
| OFL (t) | 21,080 | 21,191 | 14,027 | 14,810 |
| maxABC (t) | 17,756 | 17,851 | 11,882 | 12,551 |
| ABC (t) | 17,756 | 17,851 | 11,882 | 12,551 |
| **Status** | **As determined last year for: 2019** | **2020** | **As determined this year for: 2020** | **2021** |
| Overfishing | No | n/a | No | n/a |
| Overfished | n/a | No | n/a | No |
| Approaching overfished | n/a | No | n/a | No |

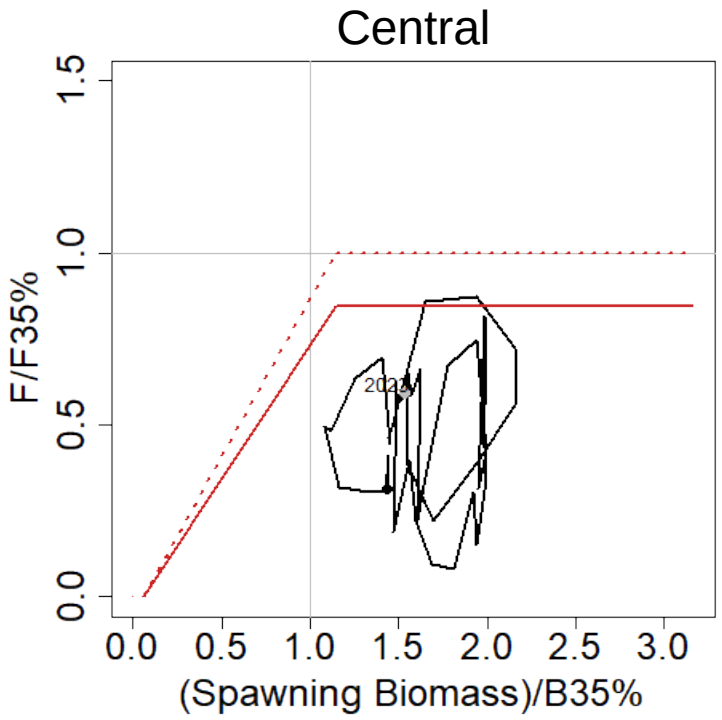
# Harvest recommendations

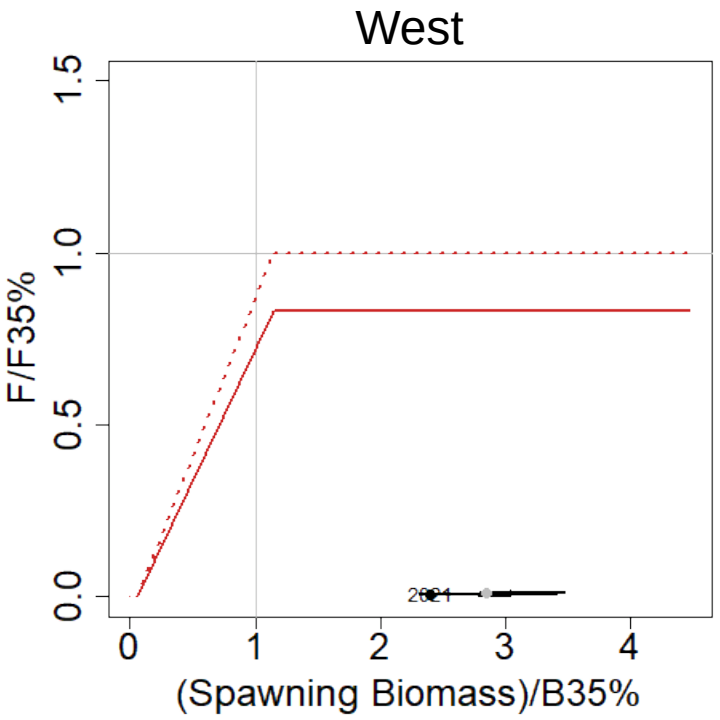
| **Northern rock sole: Central Gulf**<br>**Quantity** | As estimated or *specified last* year for:<br>2021 | 2022 | As estimated or *recommended this* year for:<br>2022 | 2023 |
|---|---|---|---|---|
| *M* (natural mortality rate; female, male) | This was not done in 2017-2020 | | 0.2, 0.232 | 0.2, 0.232 |
| Tier | | | 3a | 3a |
| Projected total (age 0+) biomass (t) | | | 35,089 | 36,945 |
| Projected Female spawning biomass (t) | | | 11,694 | 13,861 |
| $B_{100\%}$ | | | 21,622 | 21,622 |
| $B_{40\%}$ | | | 8,649 | 8,649 |
| $B_{35\%}$ | | | 7,568 | 7,568 |
| $F_{OFL}$ | | | 0.187 | 0.187 |
| $maxF_{ABC}$ | | | 0.157 | 0.157 |
| $F_{ABC}$ | | | 0.157 | 0.157 |
| OFL (t) | | | 4,691 | 5,075 |
| maxABC (t) | | | 3,999 | 4,329 |
| ABC (t) | | | 3,999 | 4,329 |
| **Status** | As determined *last* year for:<br>2019 | 2020 | As determined *this* year for:<br>2020 | 2021 |
| Overfishing | No | n/a | No | n/a |
| Overfished | n/a | No | n/a | No |
| Approaching overfished | n/a | No | n/a | No |

# Harvest recommendations

| **Northern rock sole: Western Gulf**<br><br>**Quantity** | As estimated or *specified last* year for:<br>2021 | 2022 | As estimated or *recommended this* year for:<br>2022 | 2023 |
|---|---|---|---|---|
| *M* (natural mortality rate; female, male) | This was not done in 2017-2020 | | 0.2, 0.254 | 0.2, 0.254 |
| Tier | | | 3a | 3a |
| Projected total (age 0+) biomass (t) | | | 63,298 | 63,974 |
| Projected Female spawning biomass (t) | | | 23,780 | 25,821 |
| $B_{100\%}$ | | | 28,656 | 28,656 |
| $B_{40\%}$ | | | 11,462 | 11,462 |
| $B_{35\%}$ | | | 10,030 | 10,030 |
| $F_{OFL}$ | | | 0.270 | 0.270 |
| $maxF_{ABC}$ | | | 0.225 | 0.225 |
| $F_{ABC}$ | | | 0.225 | 0.225 |
| OFL (t) | | | 9,336 | 9,735 |
| maxABC (t) | | | 7,883 | 8,222 |
| ABC (t) | | | 7,883 | 8,222 |
| **Status** | As determined *last* year for:<br>2019 | 2020 | As determined *this* year for:<br>2020 | 2021 |
| Overfishing | No | n/a | No | n/a |
| Overfished | n/a | No | n/a | No |
| Approaching overfished | n/a | No | n/a | No |

# Projections – northern rock sole



# Models – southern rock sole

- Model 17.1
  - All growth parameters estimated
  - Female M = 0.2, Male M = estimated
  - Stock-recruitment
    - Ln(R0) – estimated
    - Regime parameter – estimated
    - Recruitment deviations (1977-2021) – estimated
  - Catchability = 1
  - Fishery selectivity – double normal (allowed to dome)
  - Survey selectivity – double normal (asymptotic)

- Model 17.1a (same as 17.1)
  - Fishery selectivity – double normal (asymptotic)

- Model 17.1b (same as 17.1a)
  - CV_old = 0.1

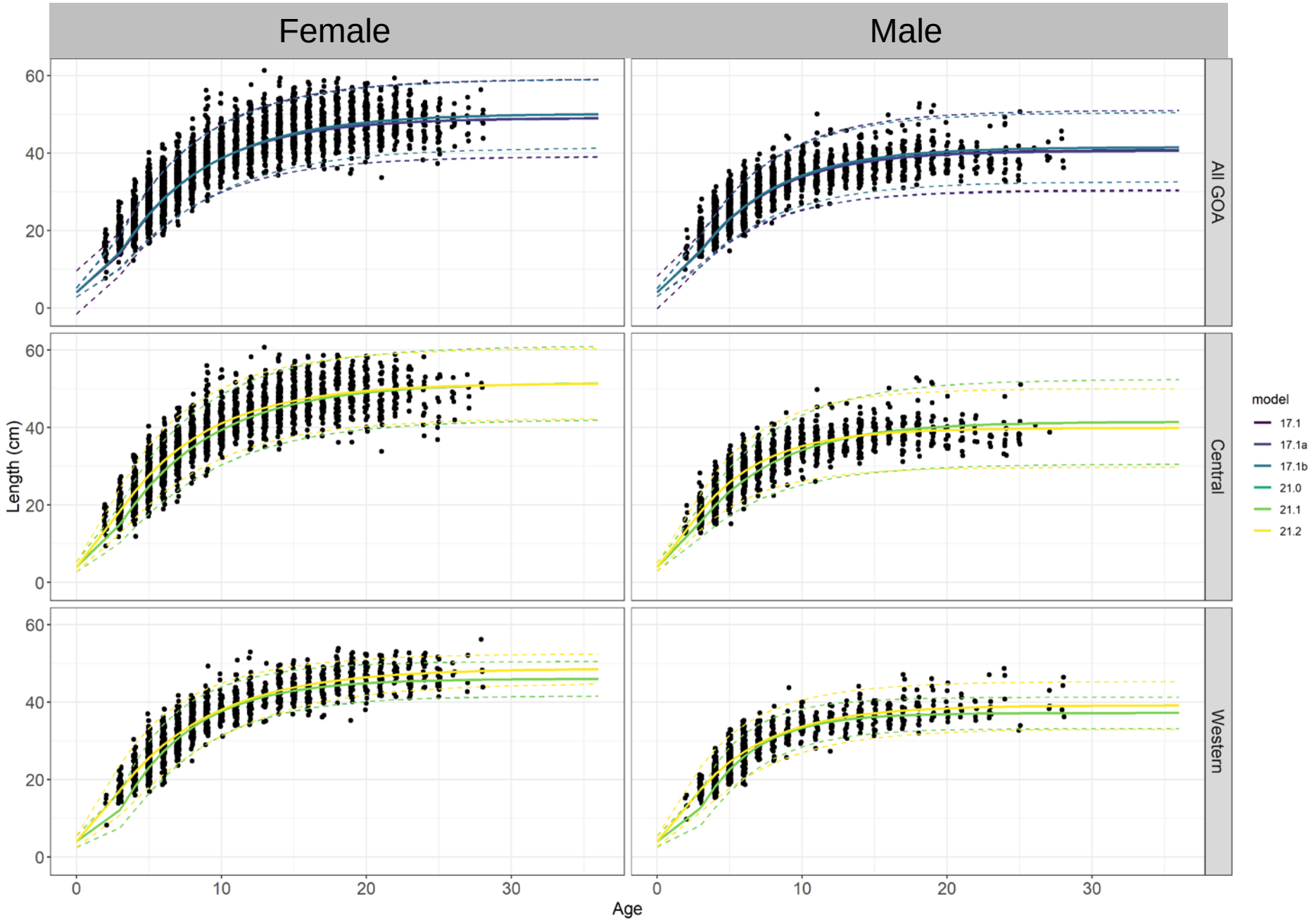
# Models – southern rock sole

- Model 21.0 (2-area model)
  - All growth parameters estimated
  - Female M = 0.2, Male M = estimated
  - Recruitment distribution parameter - estimated
  - Stock-recruitment
    - Ln(R0) – estimated
    - Regime parameter – estimated
    - Recruitment deviations (1977-2021) – estimated
  - Catchability (central and west) = 1
  - Fishery selectivity (central and west) – double normal (allowed to dome)
  - Survey selectivity (central and west)– double normal (asymptotic)

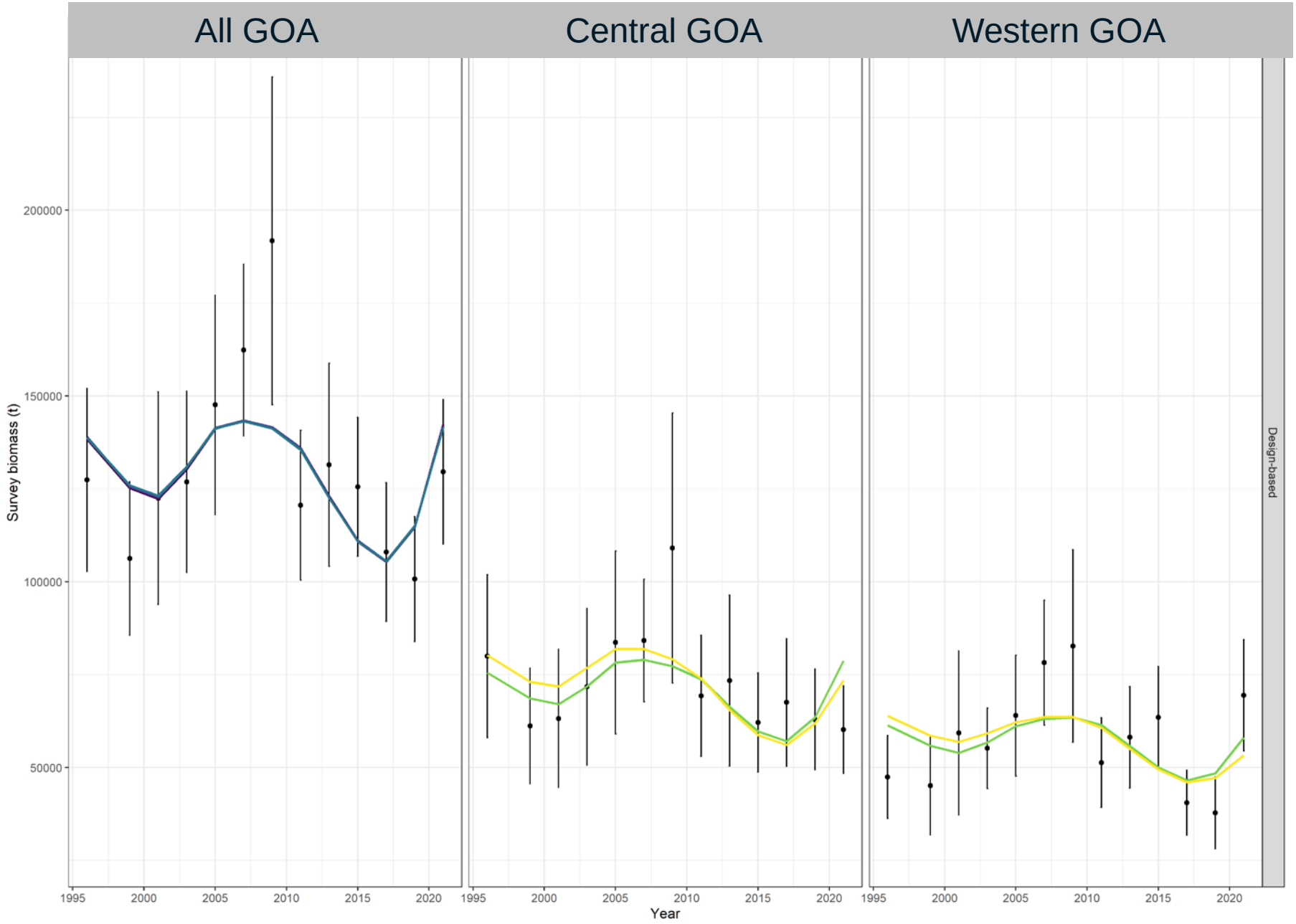
- Model 21.1 (same as 21.0)
  - Fishery selectivity – double normal (asymptotic)

- Model 21.2 (same as 21.1)
  - Fixed growth parameters to external estimates

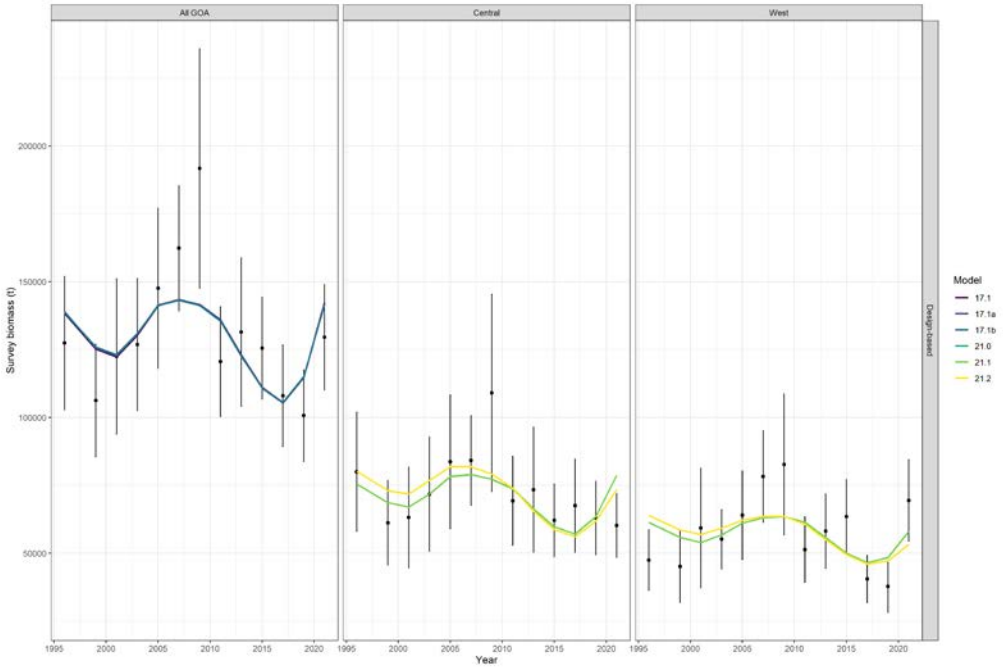
# CAAL – southern rock sole



# Survey biomass – southern rock sole

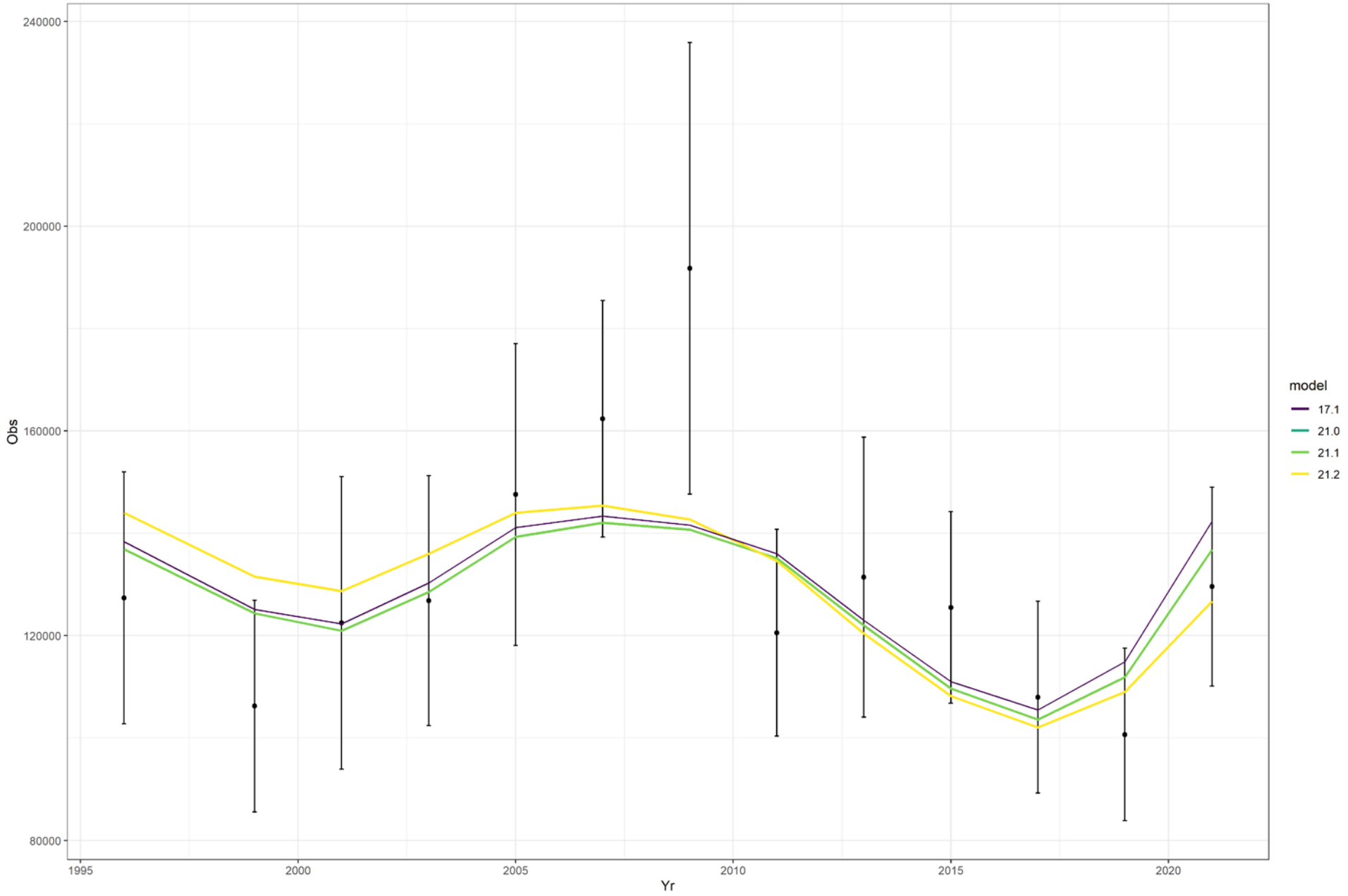


# Survey biomass – southern rock sole

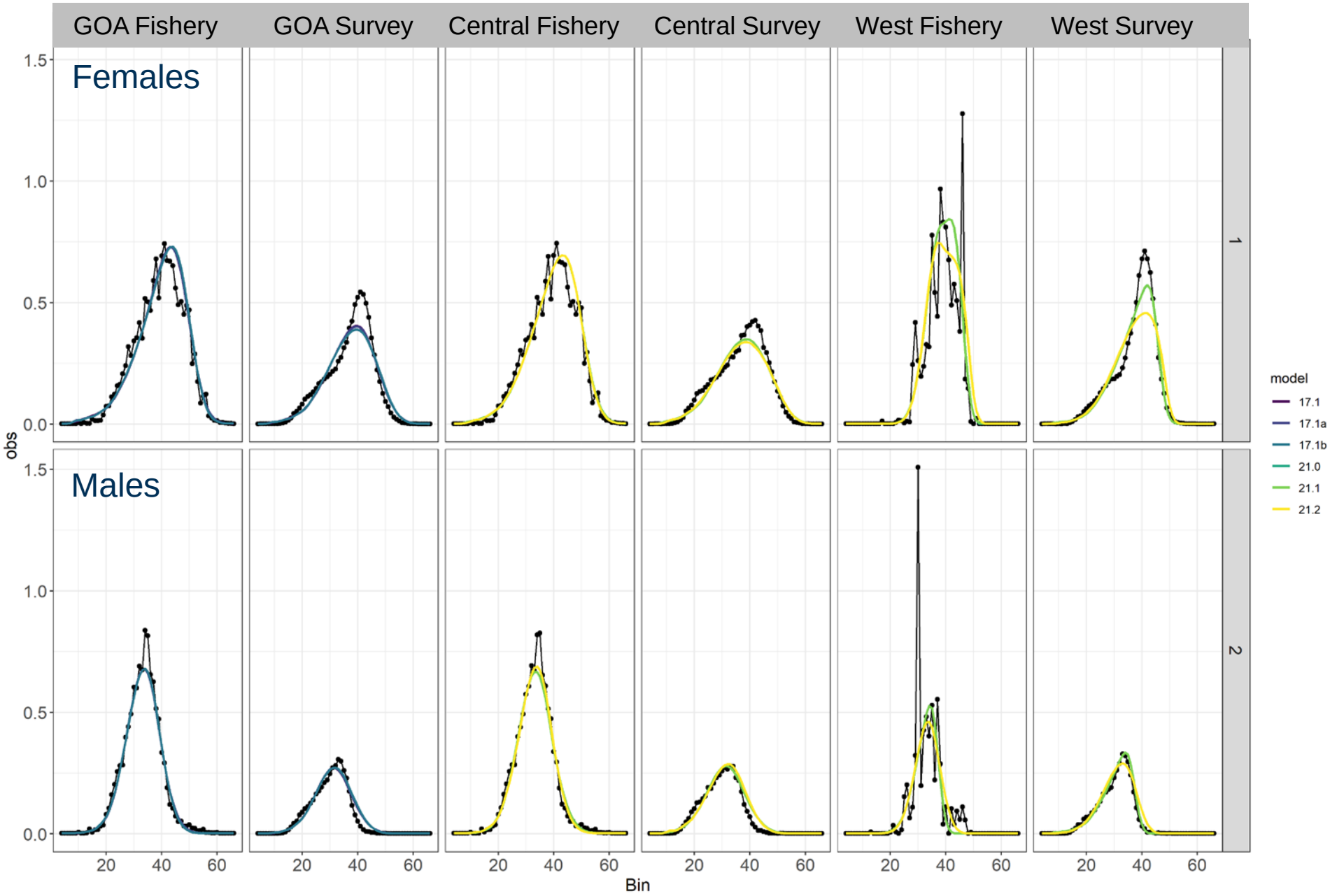



| Model | All GOA | Central | West |
|---|---|---|---|
| 17.1 | 0.13 | - | - |
| 17.1a | 0.13 | - | - |
| 17.1b | 0.13 | - | - |
| 21 | - | 0.14 | 0.18 |
| 21.1 | - | 0.14 | 0.18 |
| 21.2 | - | 0.14 | 0.20 |

# Survey biomass – southern rock sole



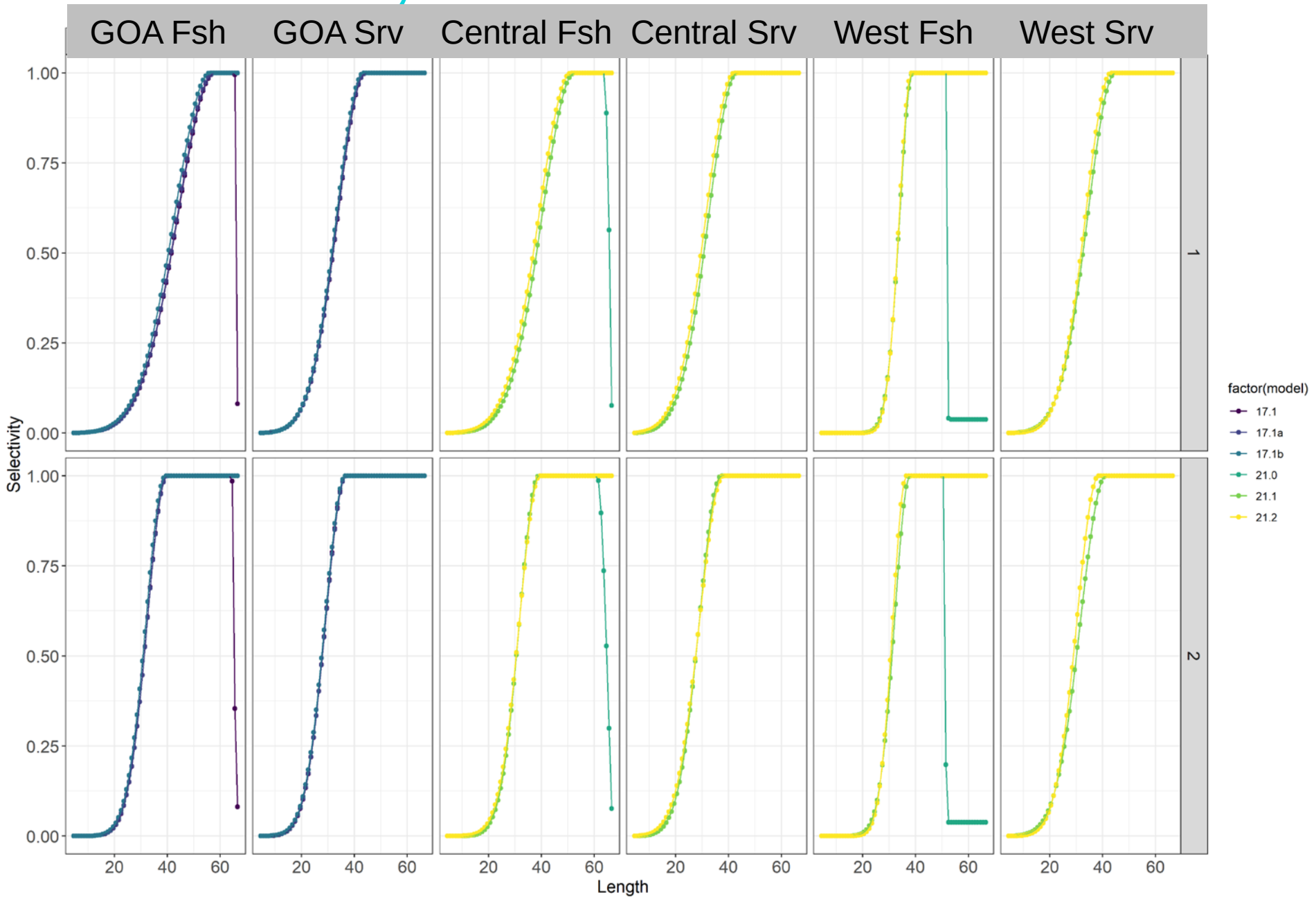
# Length composition – southern rock sole



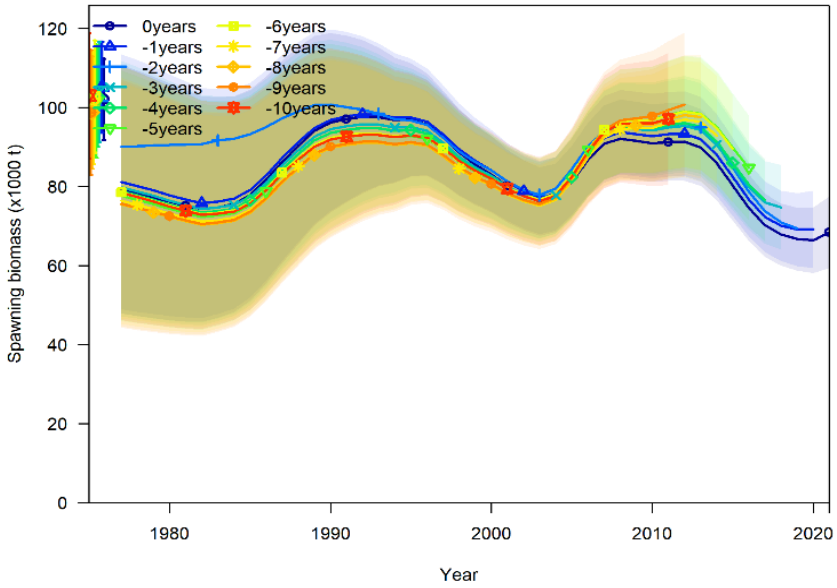
# Likelihoods– southern rock sole

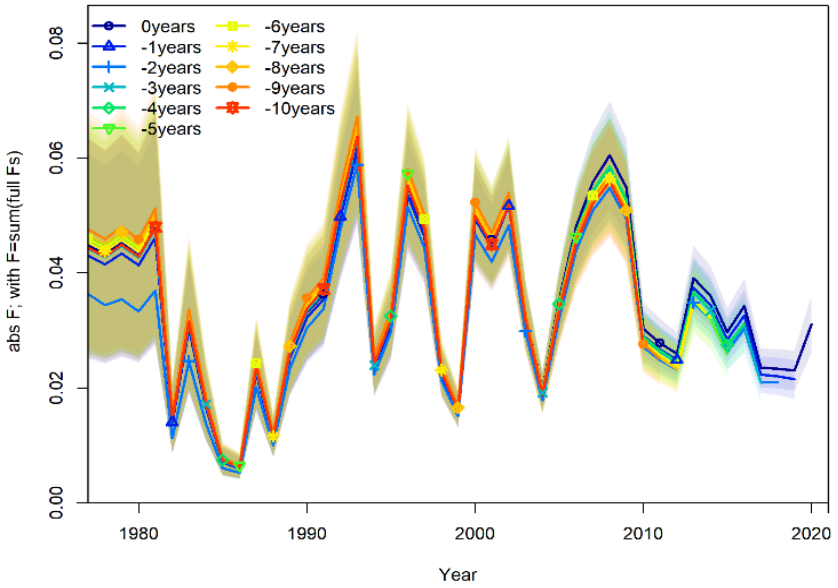
| SOUTHERN ROCK SOLE | | | | | |
|---|---|---|---|---|---|
| Model | Age_comp | Length_comp | Survey | Total | Npars |
| 17.1 | 572.53 | 569.69 | -19.74 | 1122.06 | 95 |
| 17.1a | 572.82 | 568.73 | -19.68 | 1125.39 | 95 |
| 17.1b | 568.17 | 578.64 | -19.58 | 1130.31 | 92 |
| 21 | 776.26 | 622.73 | -31.39 | 1371.69 | 119 |
| 21.1 | 776.24 | 622.78 | -31.39 | 1371.73 | 111 |
| 21.2 | 917.33 | 637.80 | -29.97 | 1527.99 | 95 |

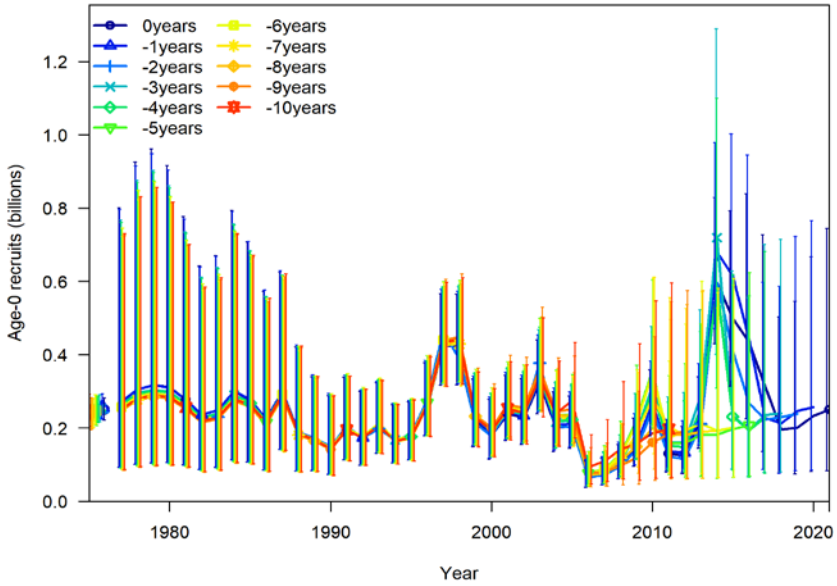
# Selectivity – southern rock sole



# Retrospective – southern rock sole

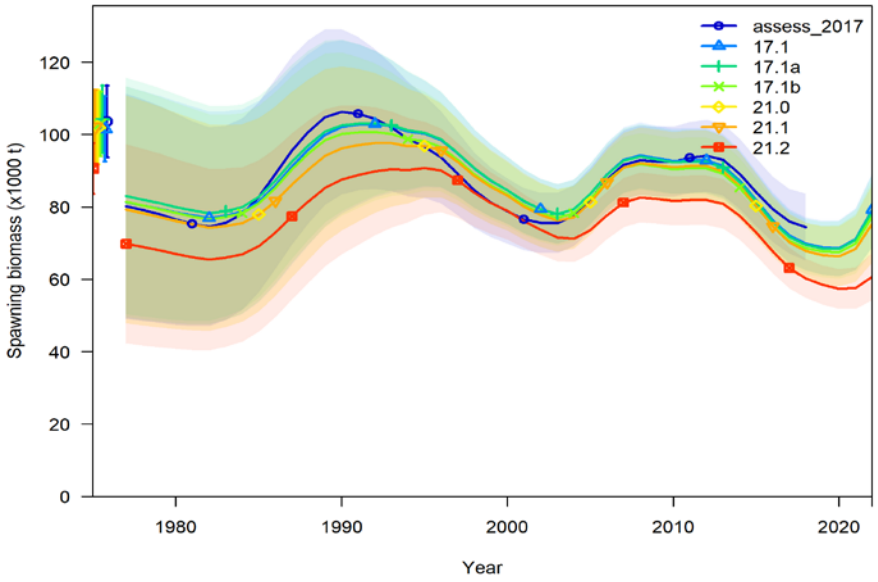


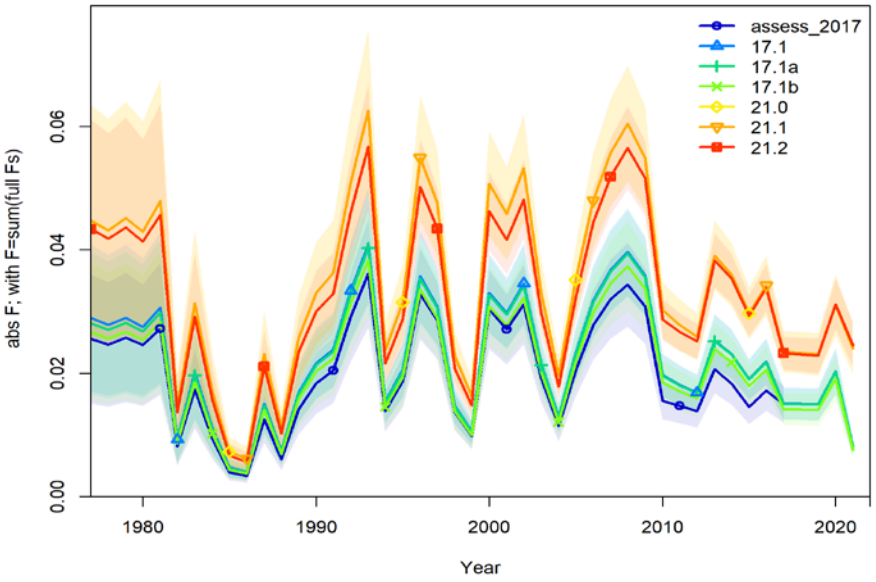



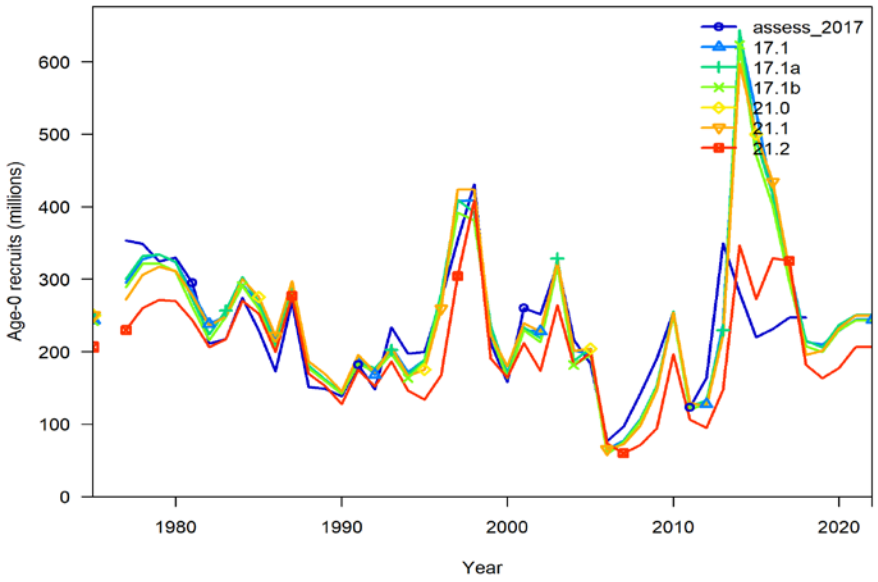




| Model | ρ SSB | ρ Recruitment | ρ Fishing mortality |
|---|---|---|---|
| 17.1 | 0.06 | -0.06 | -0.11 |
| 17.1a | 0.06 | -0.10 | -0.12 |
| 17.1b | 0.05 | -0.11 | -0.12 |
| 21.0 | 0.08 | -0.07 | -0.11 |
| 21.1 | 0.09 | -0.07 | -0.11 |
| 21.2 | 0.05 | 0.00 | -0.01 |

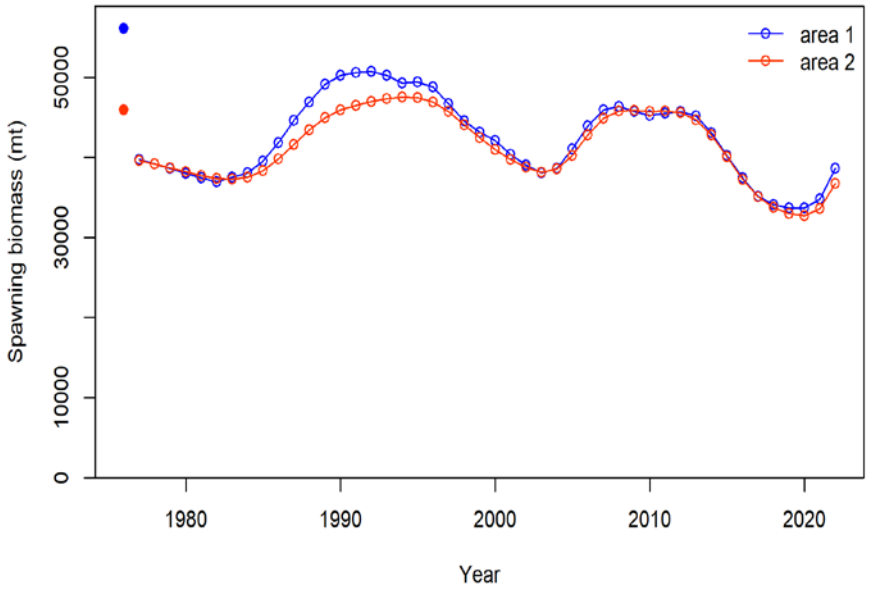
# Time series – southern rock sole

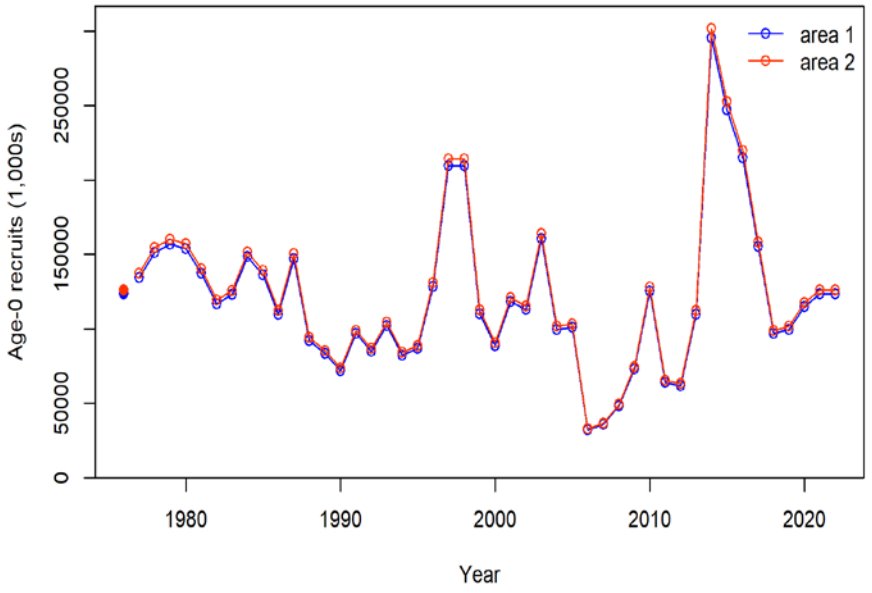


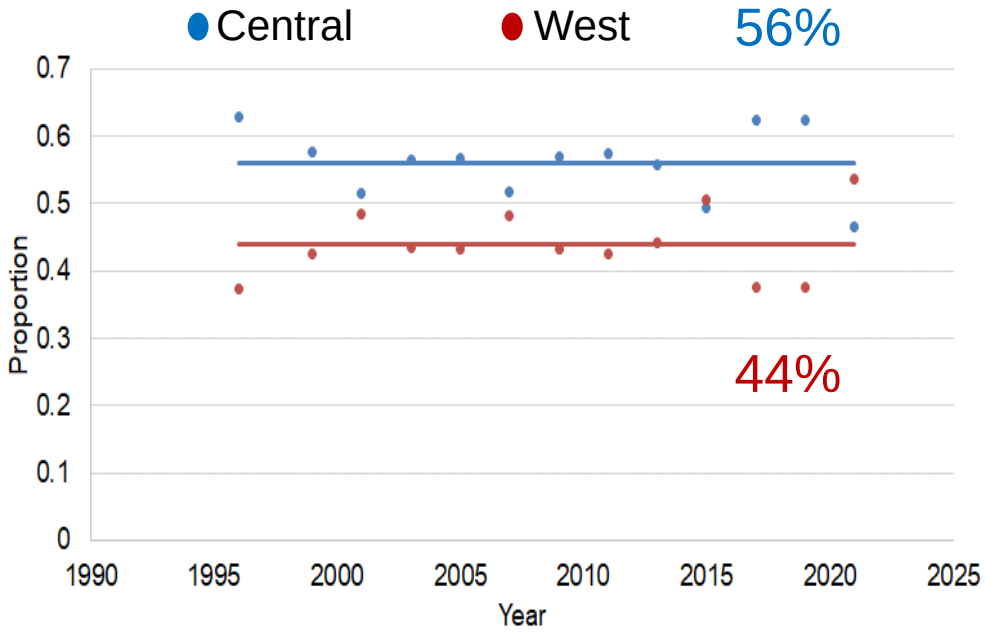



# Time series – southern rock sole




| Model | Rec dist par | Proportion in west |
|---|---|---|
| 21 | 0.02 | 0.51 |
| 21.1 | 0.02 | 0.51 |
| 21.2 | 0.02 | 0.50 |

# Summary– southern rock sole

- Overall fits to data were similar among the models
  - All models underestimate peak of female length distribution from survey
- Retrospective analysis results were similar
- Preferred model – Model 21.1
  - Biologically appropriate given difference in growth between central and western GOA (albeit subtle)
  - Adequately estimates growth in central and western GOA
  - Adequately estimates recruitment distribution

# Projections – southern rock sole

- AFSC projection model
- Projections done for central and western GOA separately
- Inputs from model 12.1
- Preliminary 2021 catch estimate used for 2022 and 2023 inputs

# Harvest recommendations

| **Quantity** | As estimated or *specified last* year for: 2020 | 2021 | As estimated or *recommended this* year for: 2021 | 2022 |
|---|---|---|---|---|
| *M* (natural mortality rate; female, male) | 0.2, 0.248* | 0.2, 0.248* | See area specific rates | |
| Tier | 3a | 3a | 3a | 3a |
| Projected total (age 0+) biomass (t) | 144,833 | 148,917 | 163,731 | 173,609 |
| Projected Female spawning biomass (t) | 72,973 | 73,930 | 73,114 | 83,900 |
| $B_{100\%}$ | 93,518 | 93,518 | | |
| $B_{40\%}$ | 37,407 | 37,407 | | |
| $B_{35\%}$ | 32,731 | 32,731 | See area specific estimates | |
| $F_{OFL}$ | 0.326 | 0.326 | | |
| $maxF_{ABC}$ | 0.271 | 0.271 | | |
| $F_{ABC}$ | 0.271 | 0.271 | | |
| OFL (t) | 27,204 | 27,943 | 30,288 | 32,514 |
| maxABC (t) | 22,990 | 23,614 | 25,555 | 27,441 |
| ABC (t) | 22,990 | 23,614 | 25,555 | 27,441 |
| **Status** | As determined *last* year for: 2019 | 2020 | As determined *this* year for: 2020 | 2021 |
| Overfishing | No | n/a | No | n/a |
| Overfished | n/a | No | n/a | No |
| Approaching overfished | n/a | No | n/a | No |

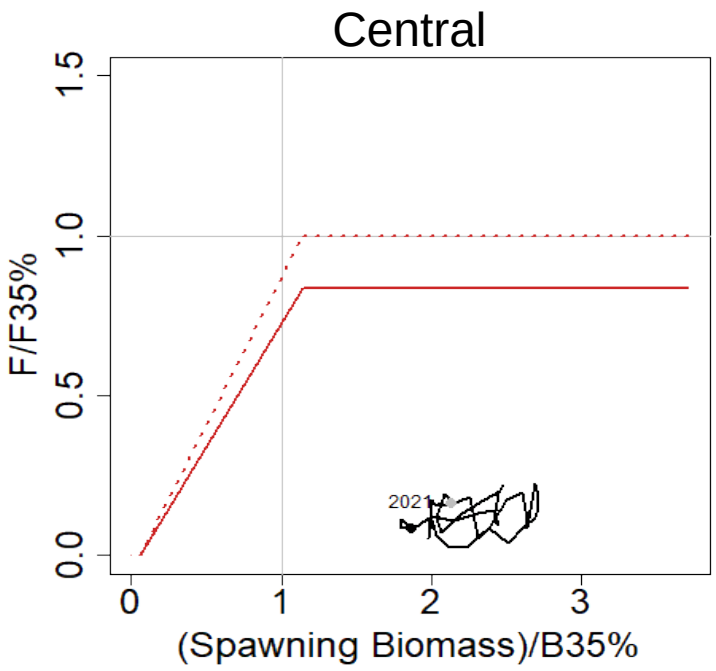
# Harvest recommendations

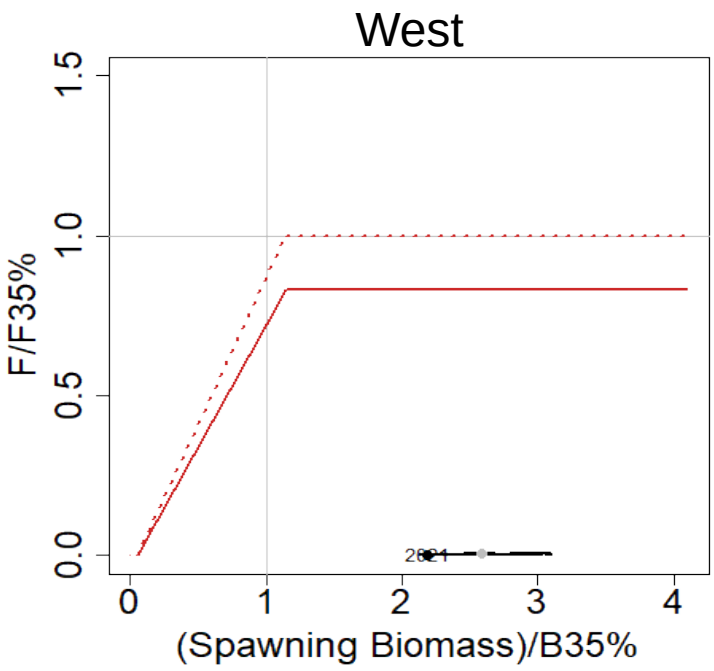
| **Southern rock sole Central Gulf**<br>**Quantity** | As estimated or *specified last* year for:<br>2021 | 2022 | As estimated or *recommended this* year for:<br>2022 | 2023 |
|---|---|---|---|---|
| *M* (natural mortality rate; female, male) | This was not done in 2017-2020 | | 0.2, 0.253 | 0.2, 0.253 |
| Tier | | | 3a | 3a |
| Projected total (age 0+) biomass (t) | | | 88,386 | 94,092 |
| Projected Female spawning biomass (t) | | | 37,555 | 43,470 |
| $B_{100\%}$ | | | 54,433 | 54,433 |
| $B_{40\%}$ | | | 21,374 | 21,374 |
| $B_{35\%}$ | | | 18,701 | 18,701 |
| $F_{OFL}$ | | | 0.268 | 0.268 |
| $maxF_{ABC}$ | | | 0.224 | 0.224 |
| $F_{ABC}$ | | | 0.224 | 0.224 |
| OFL (t) | | | 15,622 | 16,853 |
| maxABC (t) | | | 13,185 | 14,229 |
| ABC (t) | | | 13,185 | 14,229 |
| **Status** | As determined *last* year for:<br>2019 | 2020 | As determined *this* year for:<br>2020 | 2021 |
| Overfishing | No | n/a | No | n/a |
| Overfished | n/a | No | n/a | No |
| Approaching overfished | n/a | No | n/a | No |

# Harvest recommendations

| **Southern rock sole Western Gulf**<br>**Quantity** | As estimated or *specified last* year for:<br>2021 | 2022 | As estimated or *recommended this* year for:<br>2022 | 2023 |
|---|---|---|---|---|
| *M* (natural mortality rate; female, male) | This was not done in 2017-2020 | | 0.2, 0.271 | 0.2, 0.271 |
| Tier | | | 3a | 3a |
| Projected total (age 0+) biomass (t) | | | 75,345.4 | 79,517 |
| Projected Female spawning biomass (t) | | | 35,559 | 40,430 |
| $B_{100\%}$ | | | 43,788 | 43,788 |
| $B_{40\%}$ | | | 17,515 | 17,515 |
| $B_{35\%}$ | | | 15,326 | 15,326 |
| $F_{OFL}$ | | | 0.335 | 0.335 |
| $maxF_{ABC}$ | | | 0.278 | 0.278 |
| $F_{ABC}$ | | | 0.278 | 0.278 |
| OFL (t) | | | 14,666 | 15,661 |
| maxABC (t) | | | 12,370 | 13,212 |
| ABC (t) | | | 12,370 | 13,212 |
| **Status** | As determined *last* year for:<br>2019 | 2020 | As determined *this* year for:<br>2020 | 2021 |
| Overfishing | No | n/a | No | n/a |
| Overfished | n/a | No | n/a | No |
| Approaching overfished | n/a | No | n/a | No |

# Projections – southern rock sole



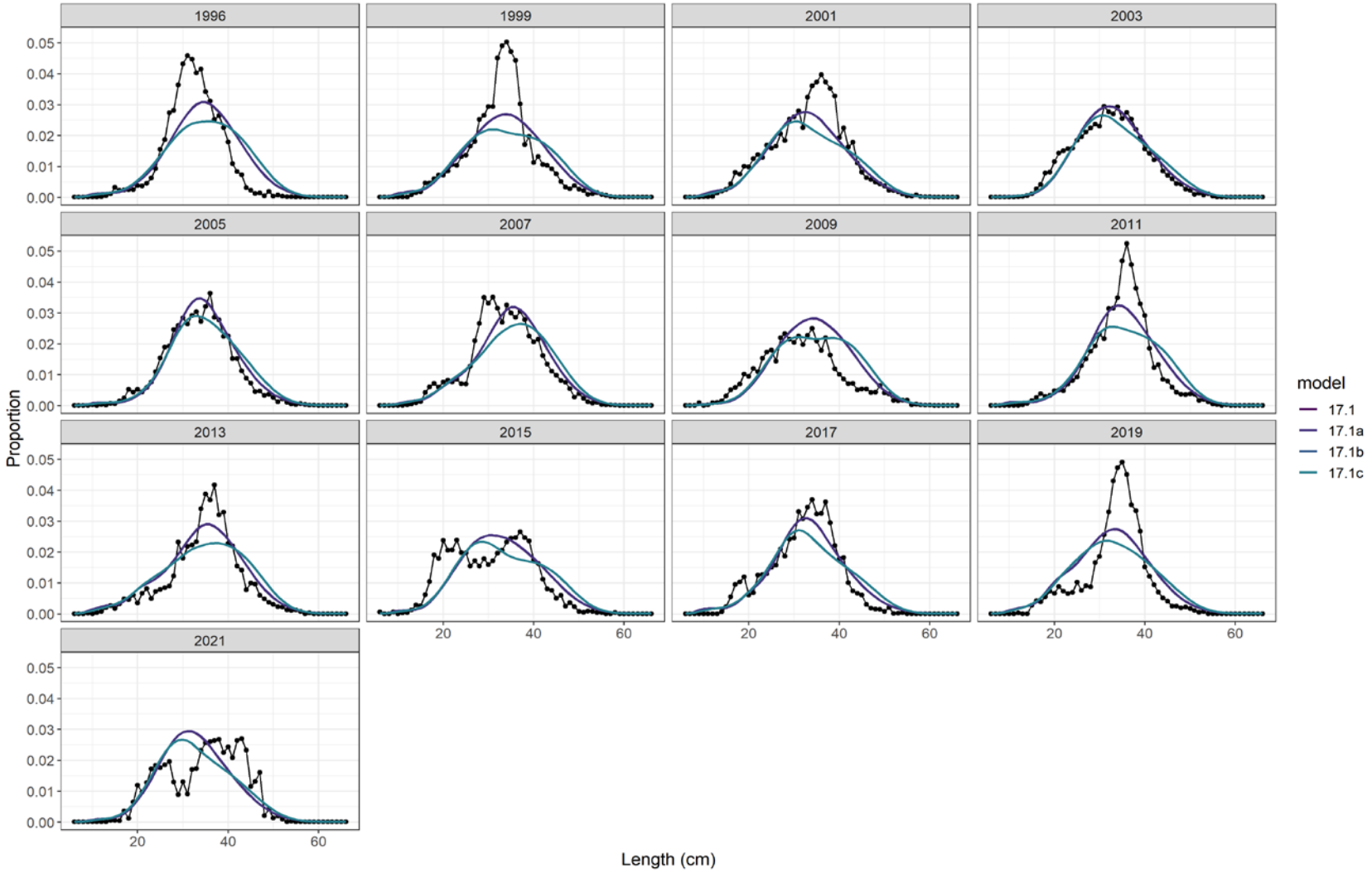



# Future directions

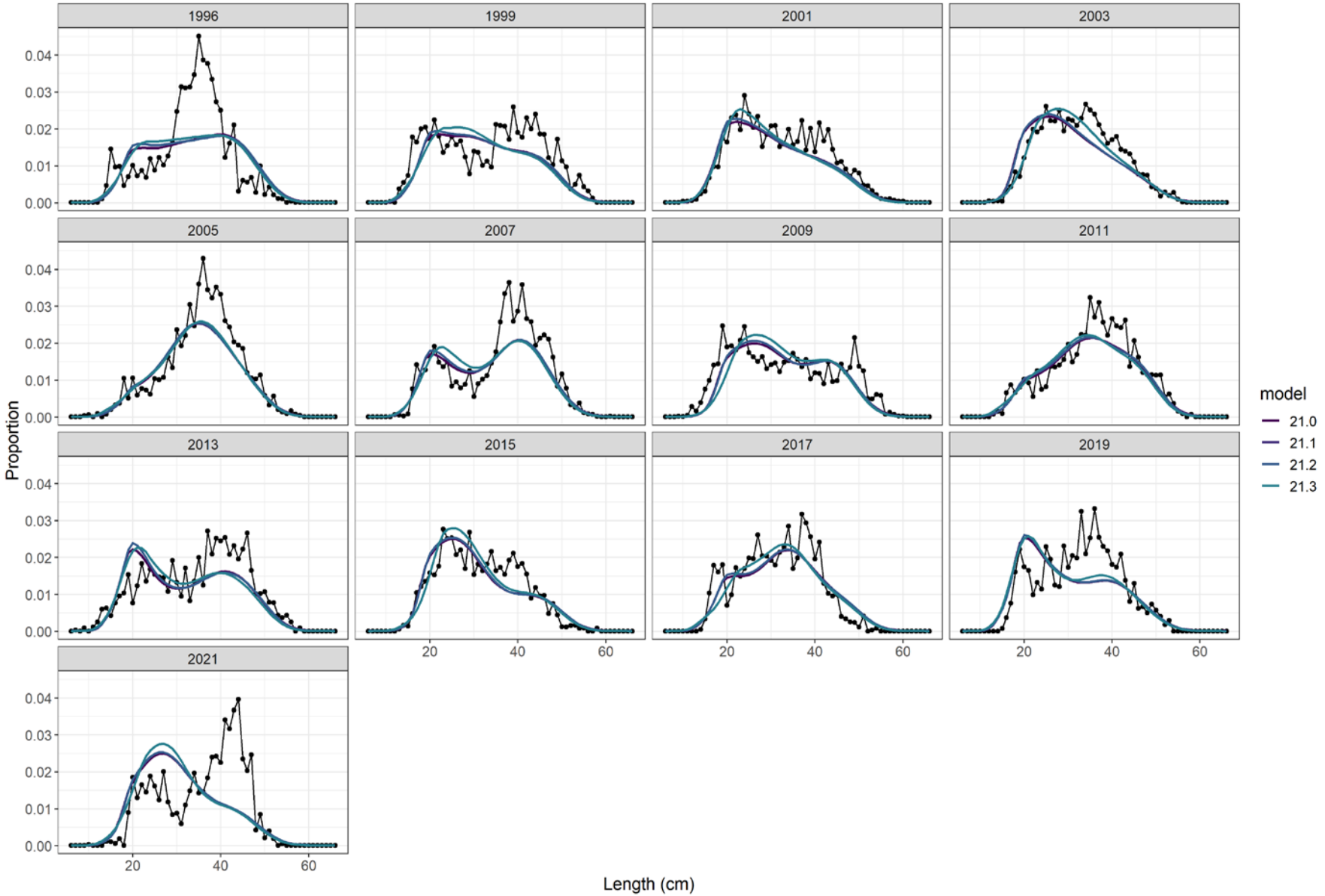
- Address non-stationarity in fit to survey biomass data
  - Time-varying catchability?
- Catch data split between species should be explored and addressed
- Accounting of uncertainty in catch

# Extra slides

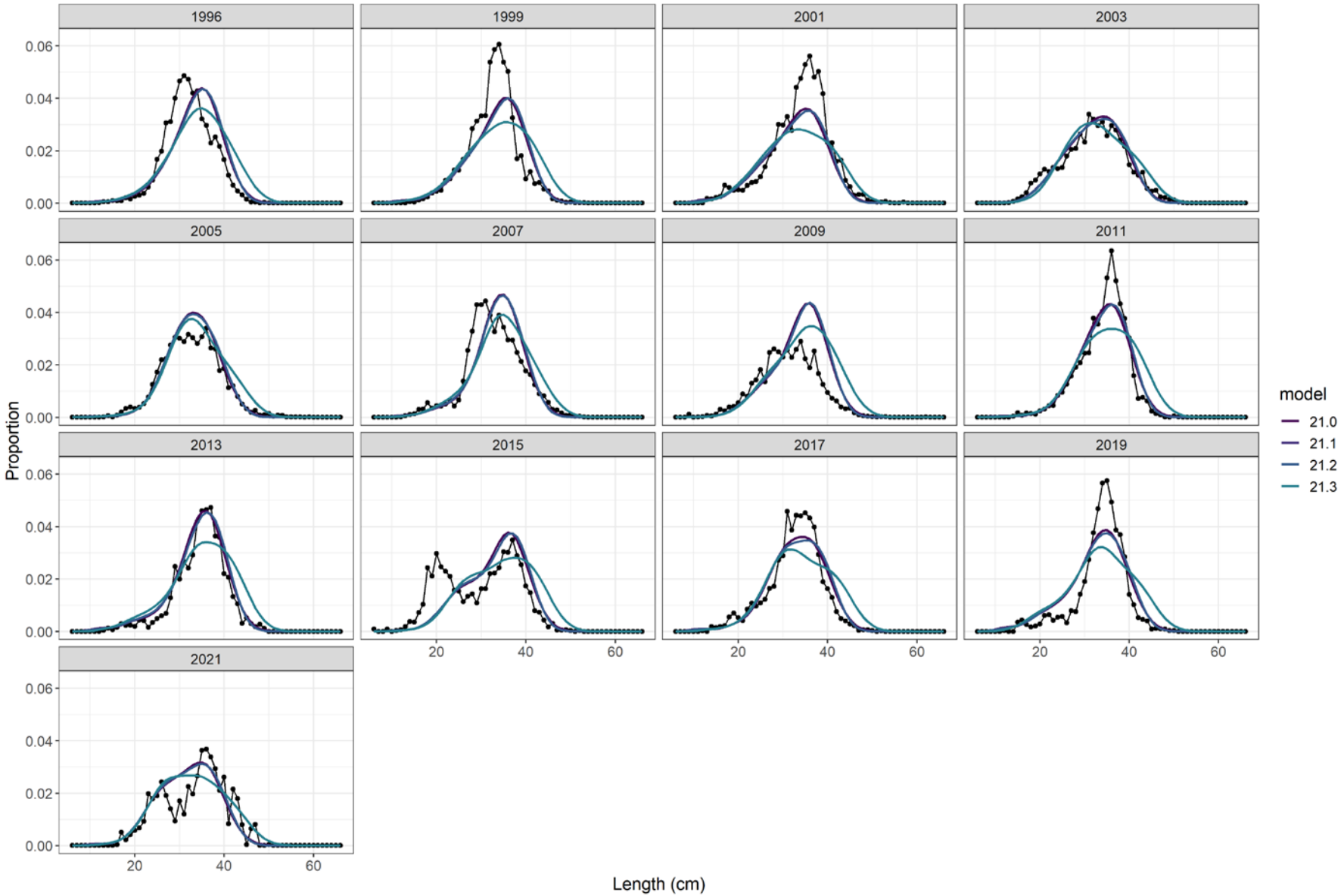
# Female survey length– northern rock sole



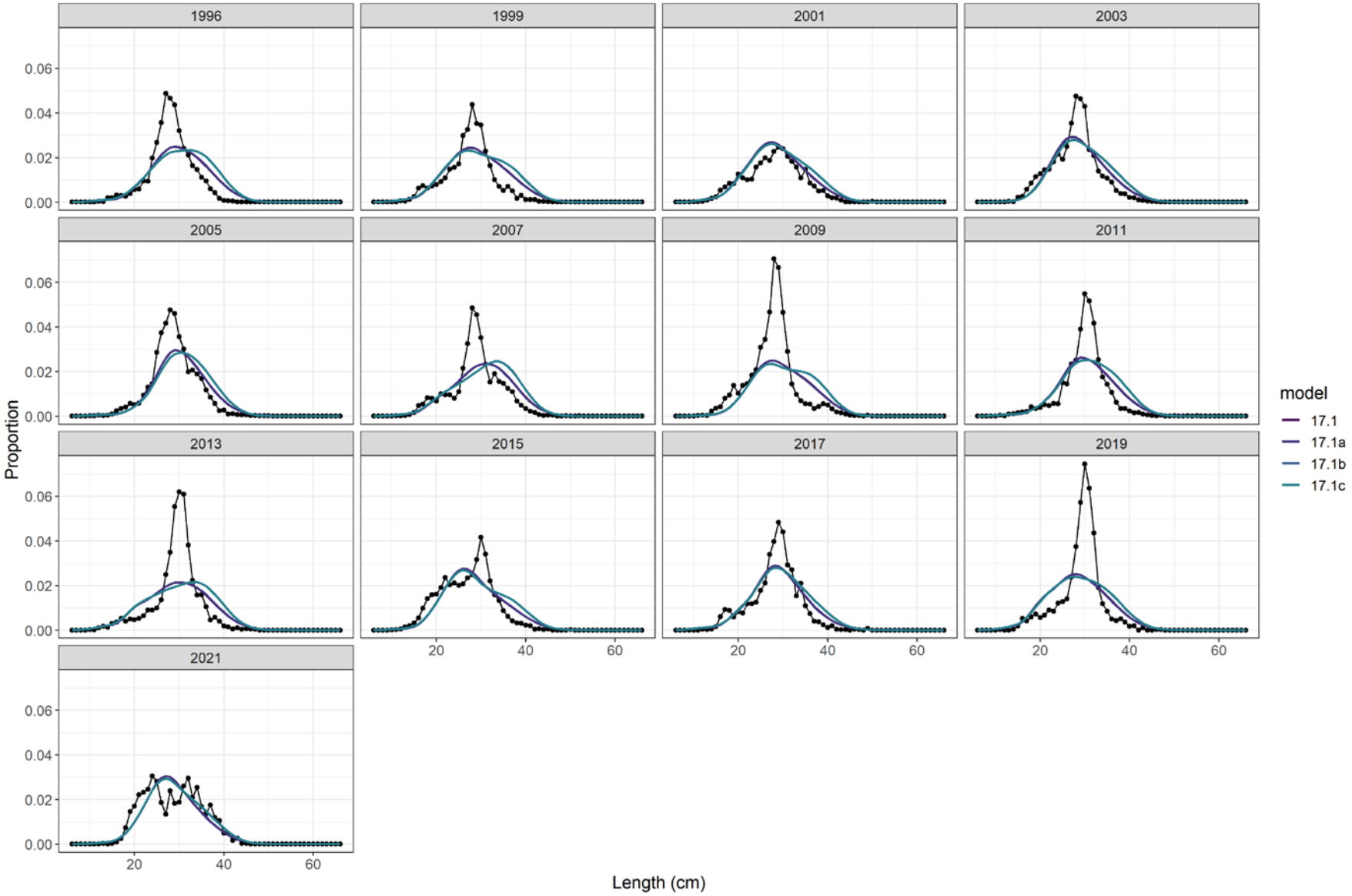
# Female survey length - central - northern rock sole



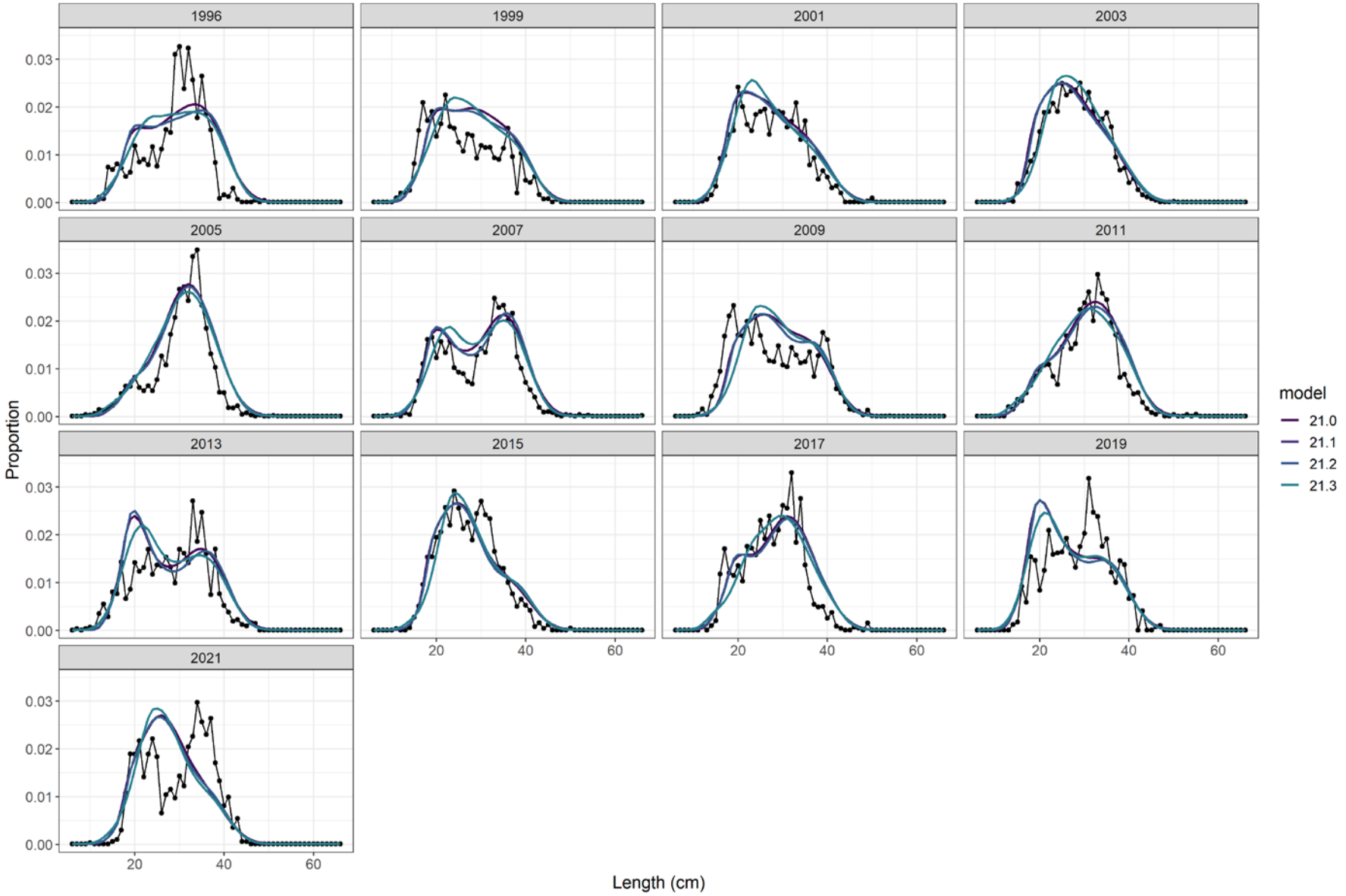
# Female survey length - west - northern rock sole



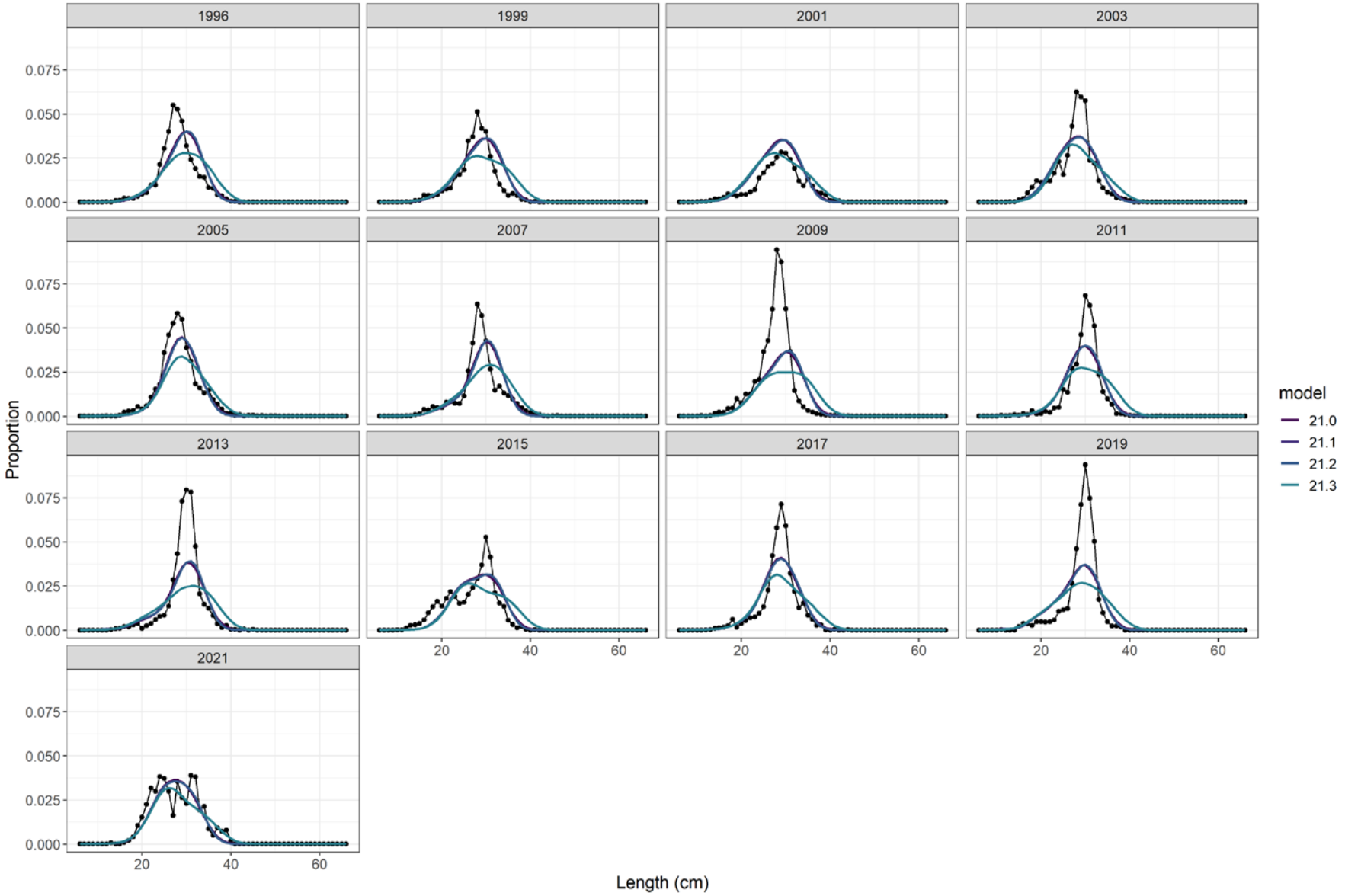
# Male survey length– northern rock sole



# Male survey length - central - northern rock sole



# Male survey length - west - northern rock sole

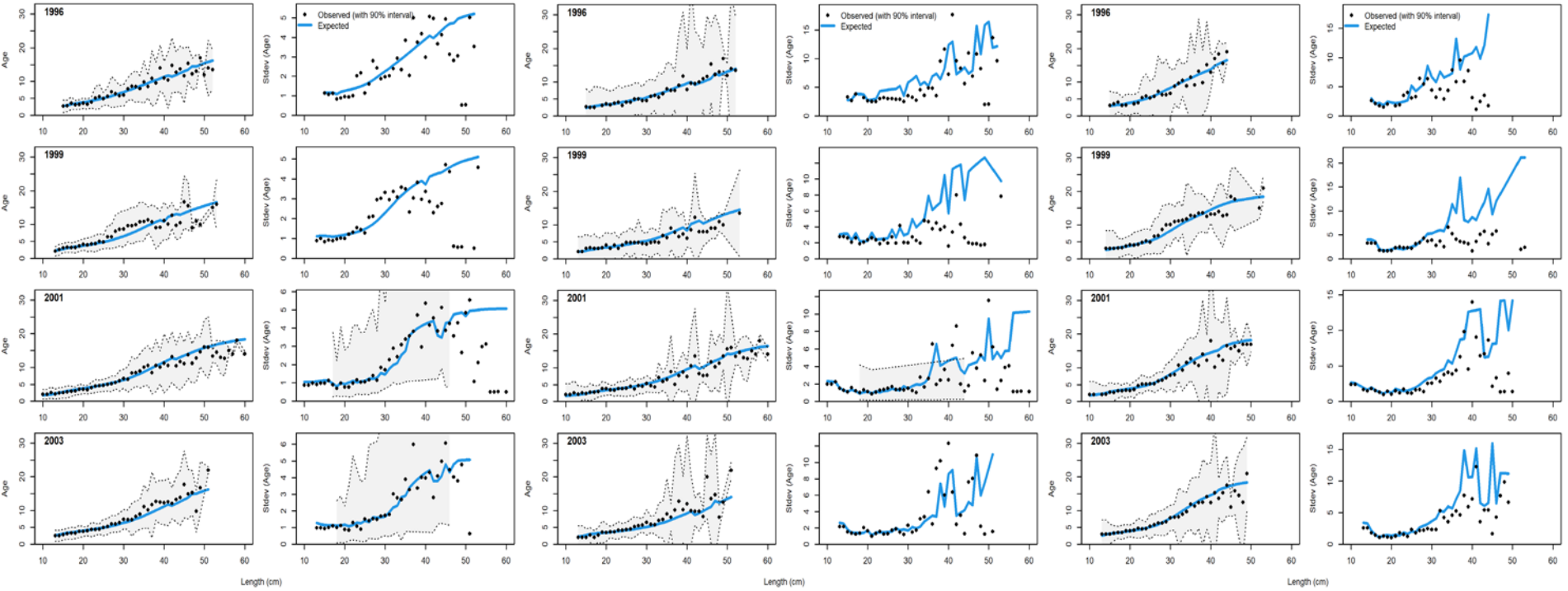


# CAAL – northern rock sole

All GOA

central GOA

western GOA

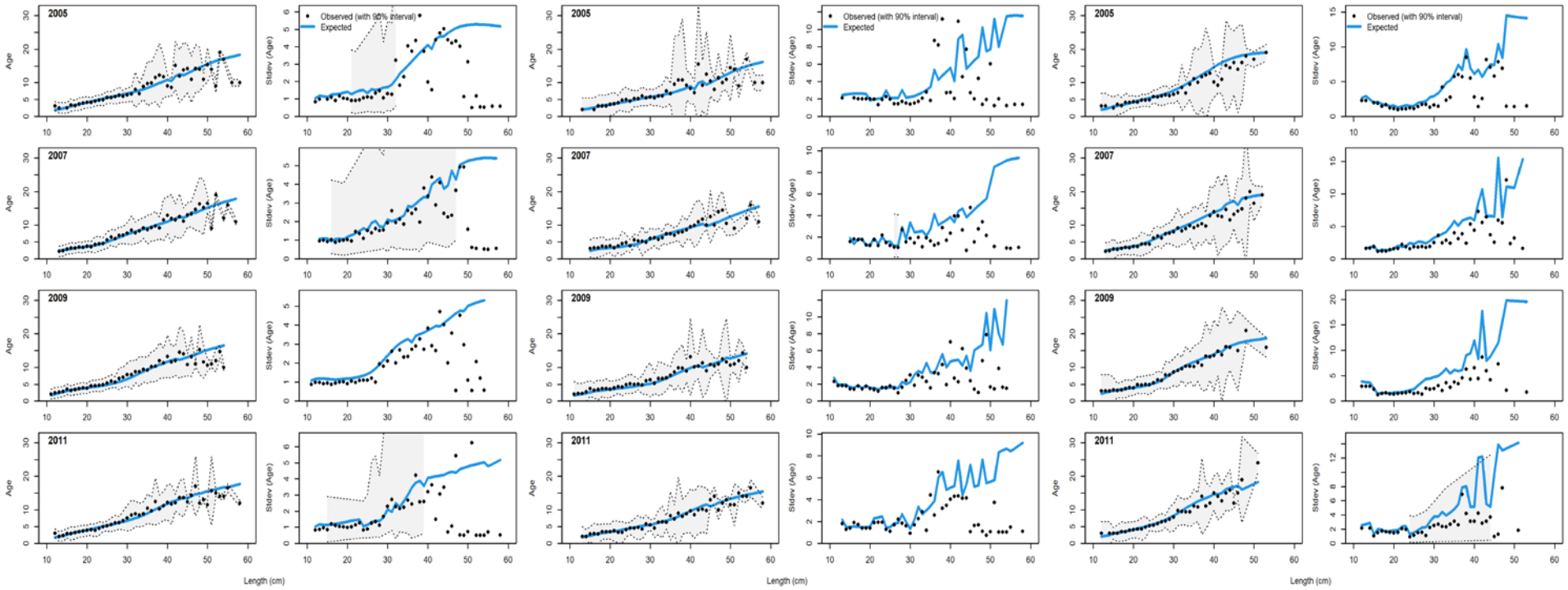


# CAAL – northern rock sole

All GOA

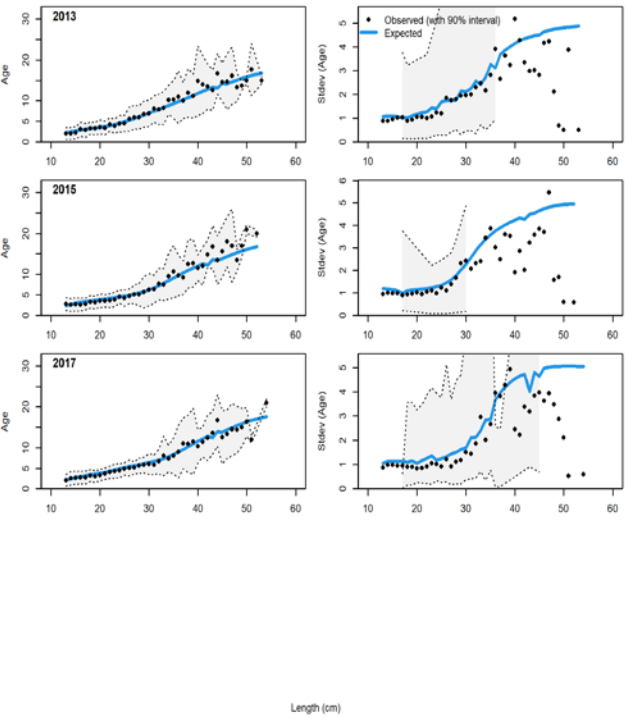
central GOA

western GOA

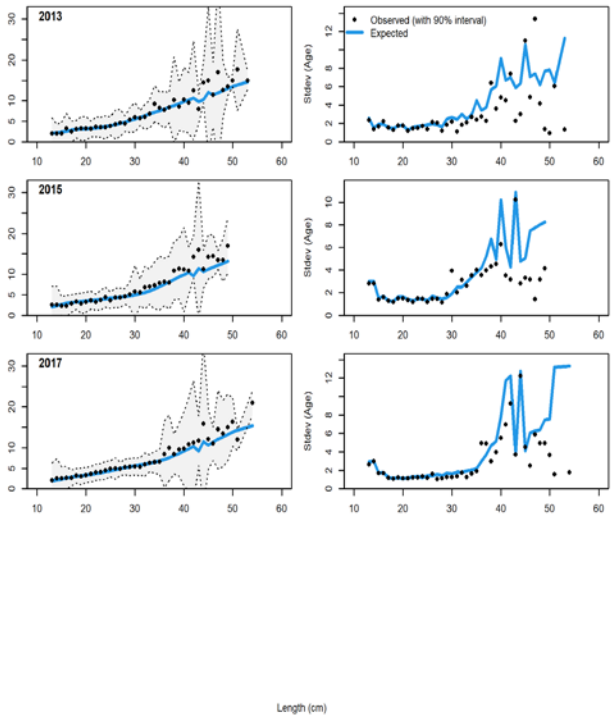


# CAAL – northern rock sole

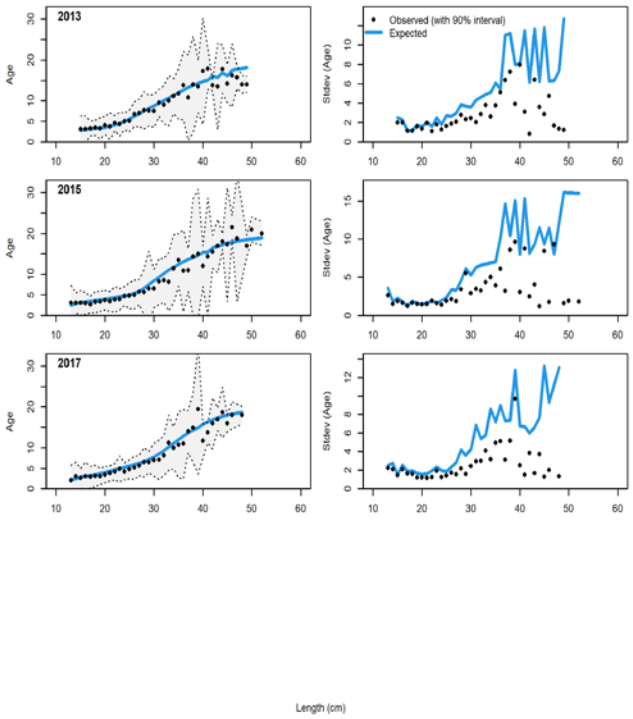
All GOA



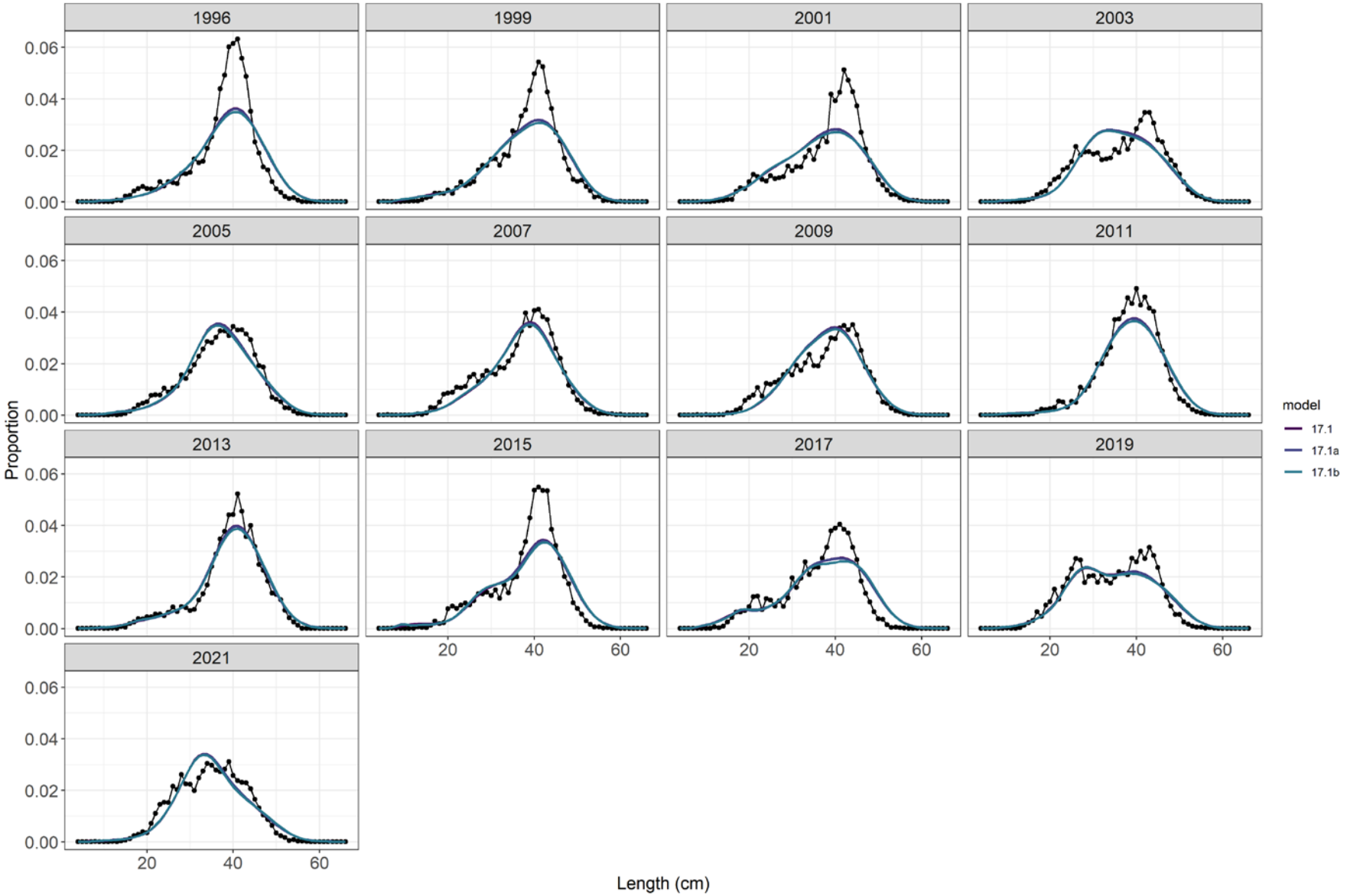

central GOA



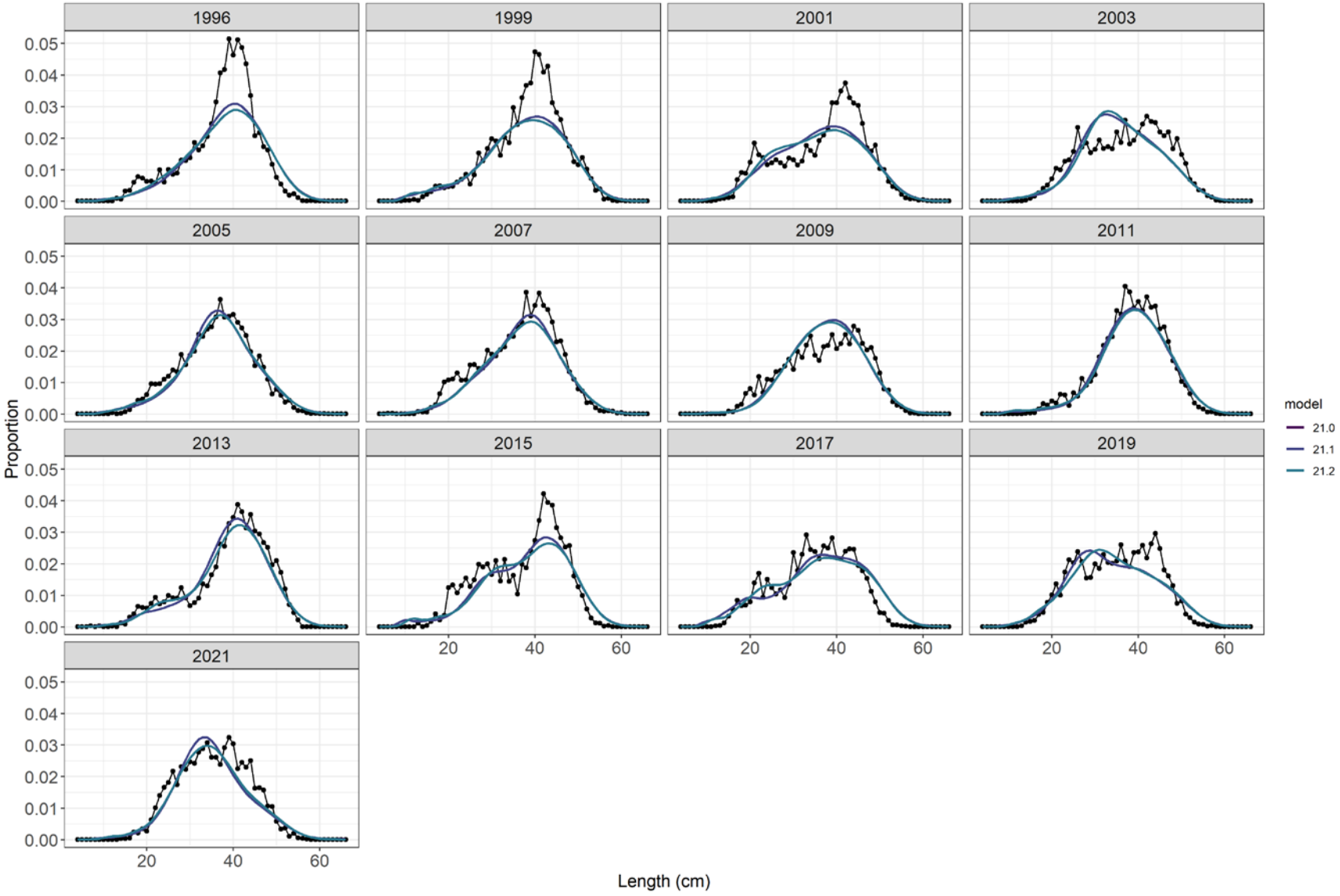

western GOA



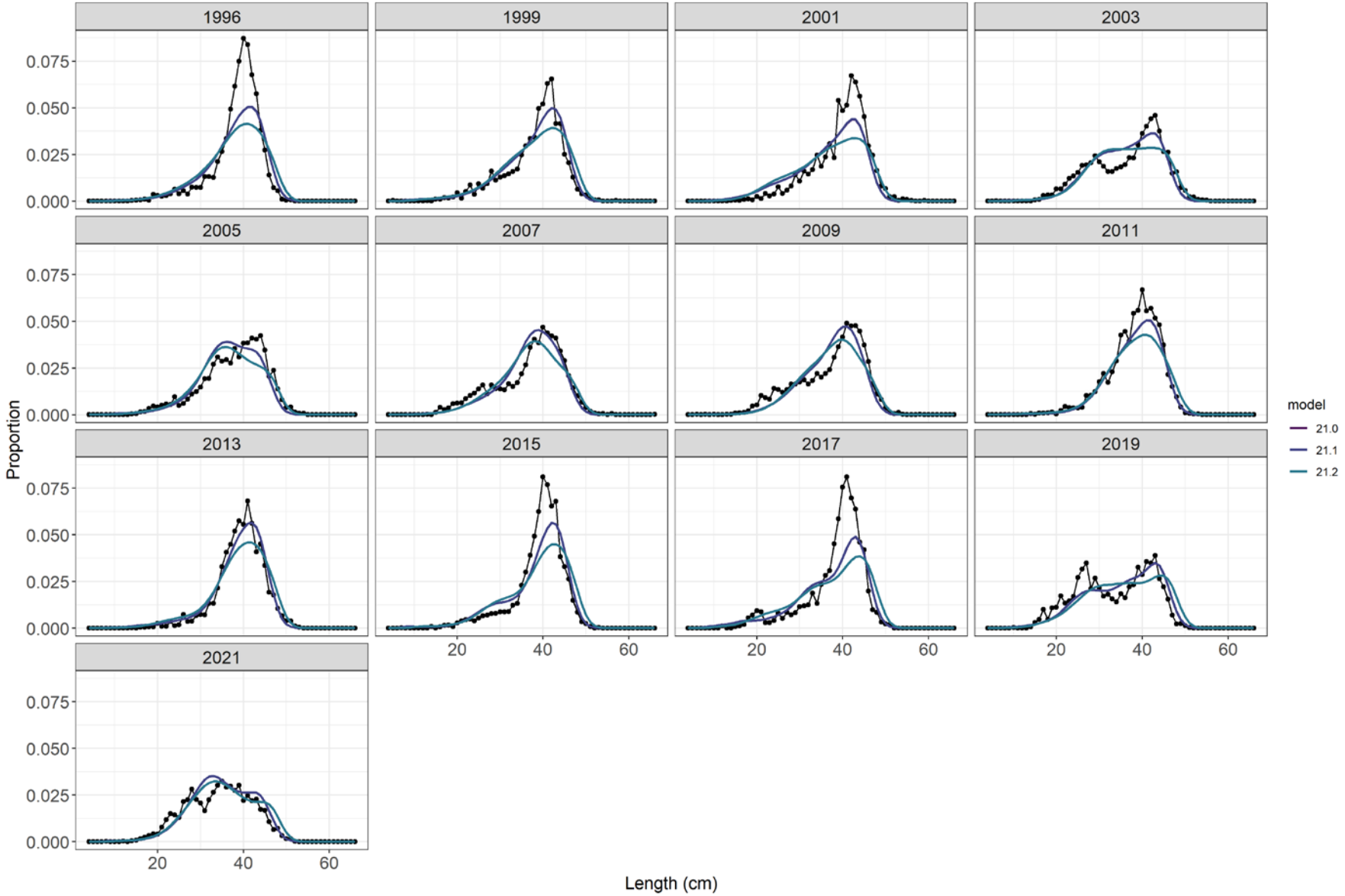
# Female survey length– southern rock sole



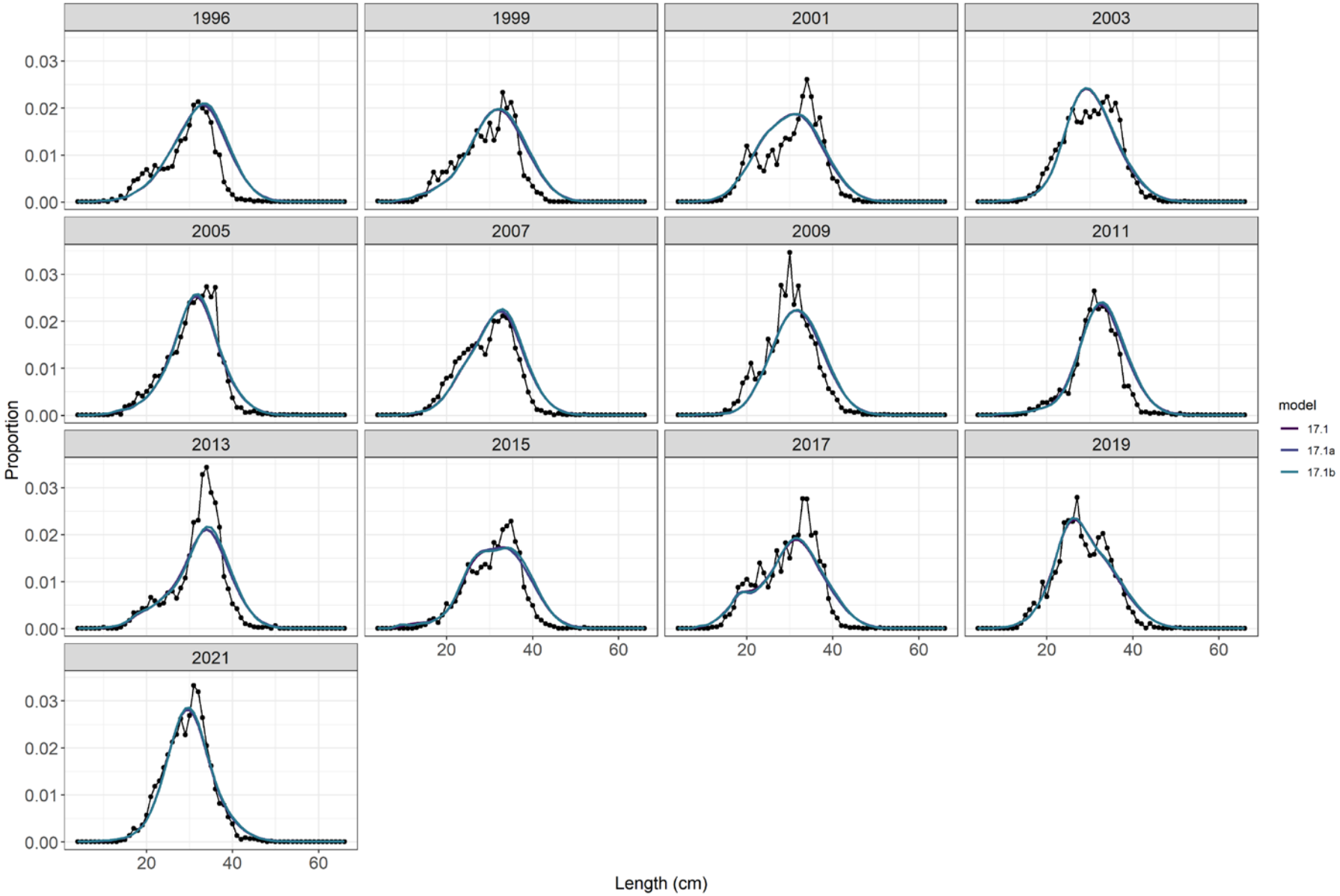
# Female survey length - central - southern rock sole



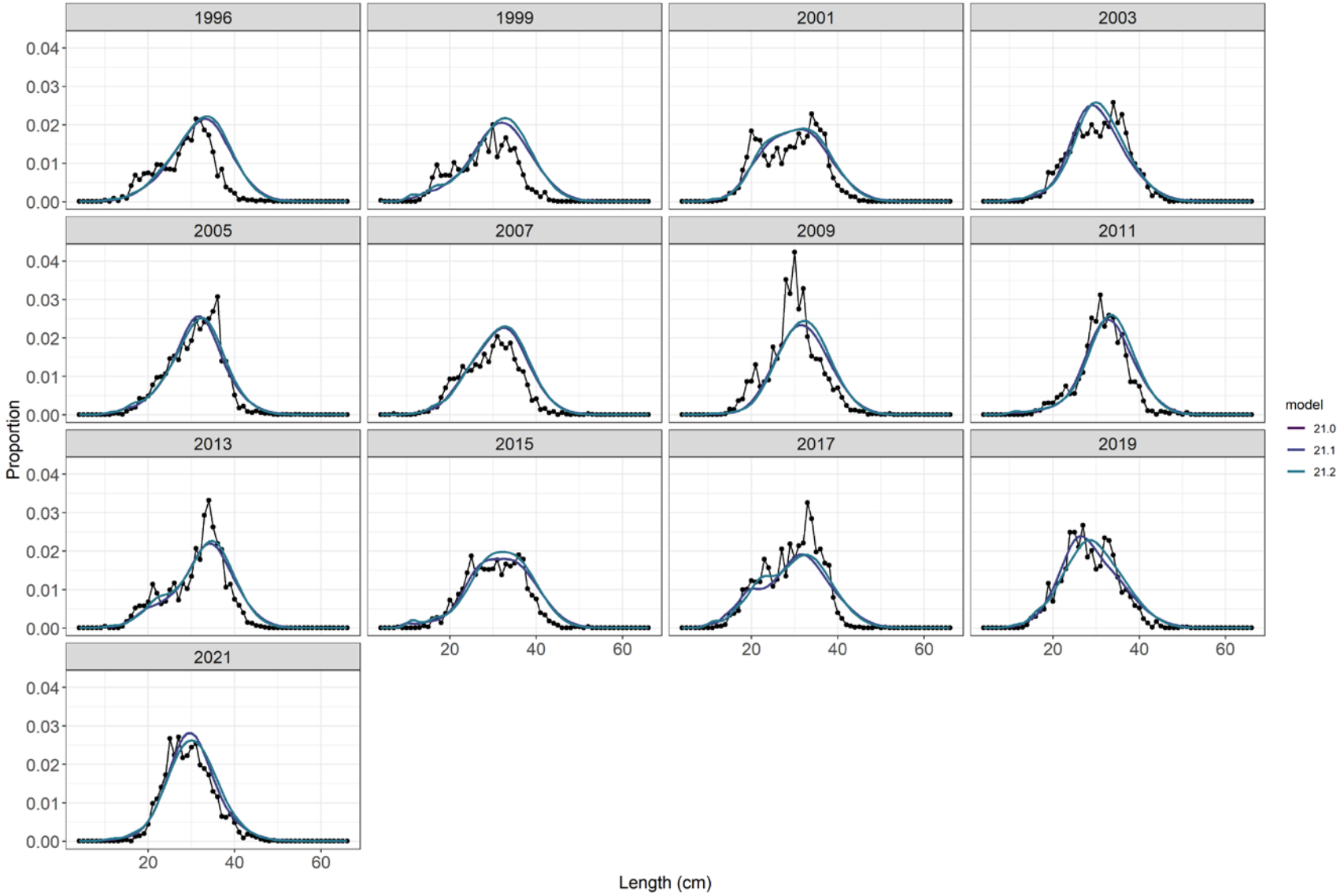
# Female survey length - west - southern rock sole



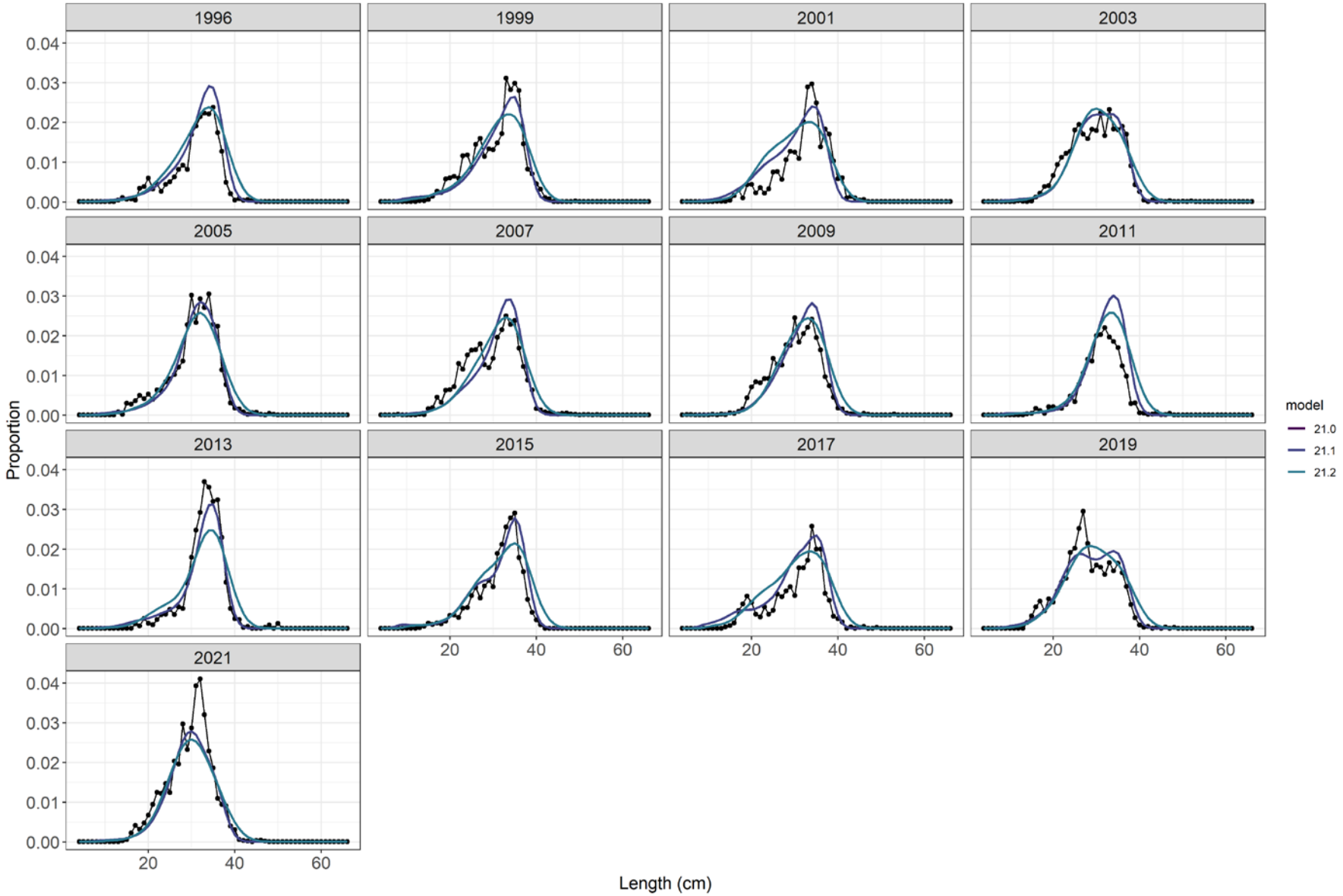
# Male survey length– southern rock sole



# Male survey length - central - southern rock sole



# Male survey length - west - southern rock sole

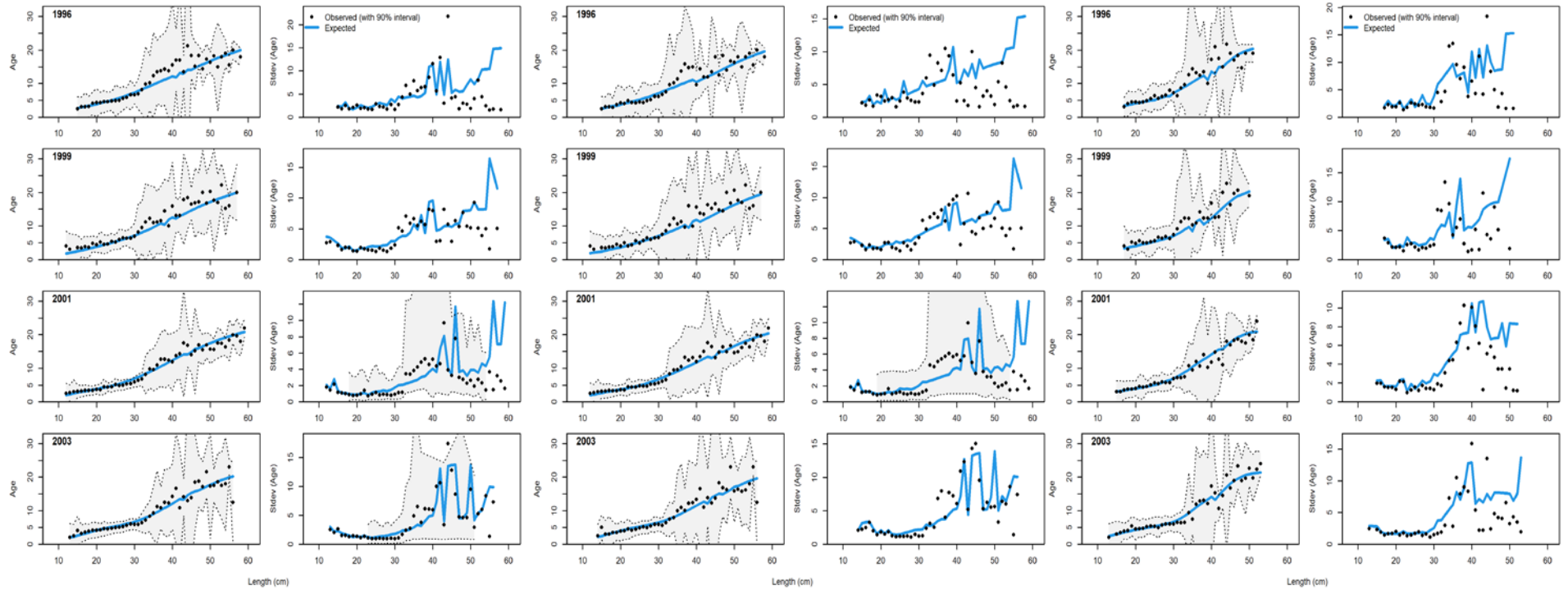


# CAAL – southern rock sole

All GOA

central GOA

western GOA

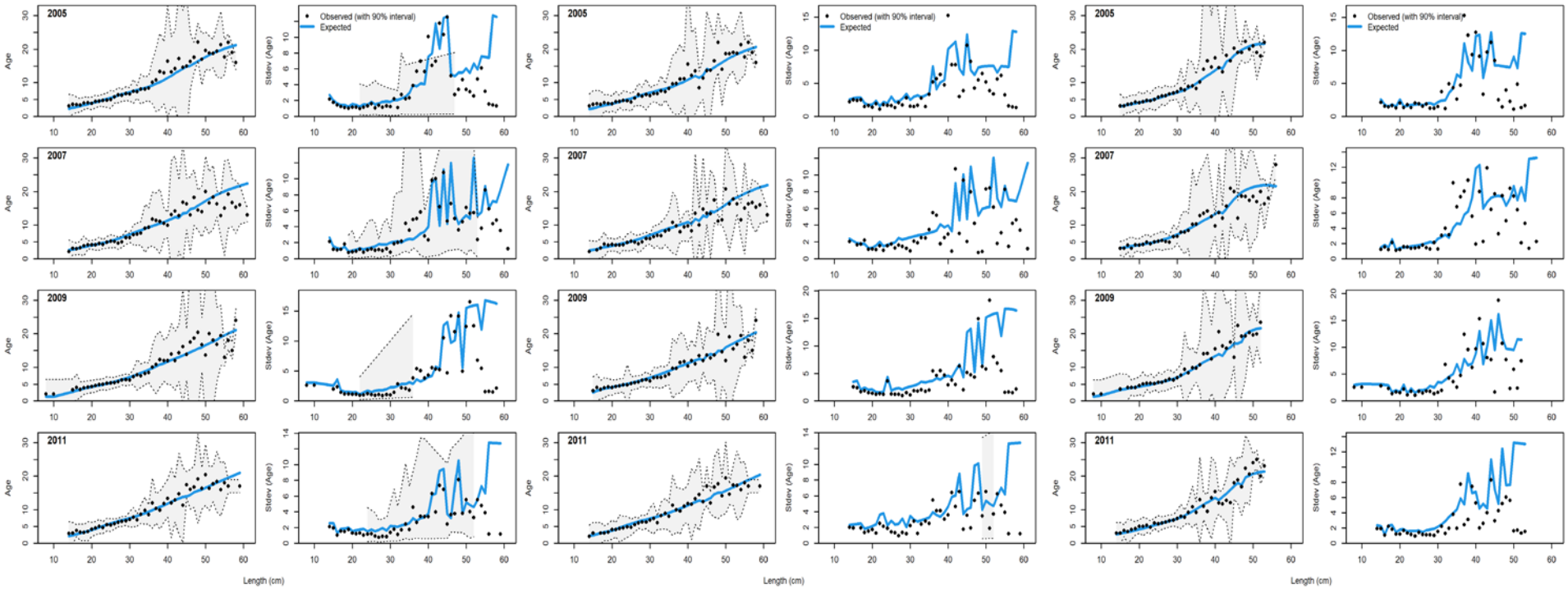


# CAAL – southern rock sole

All GOA

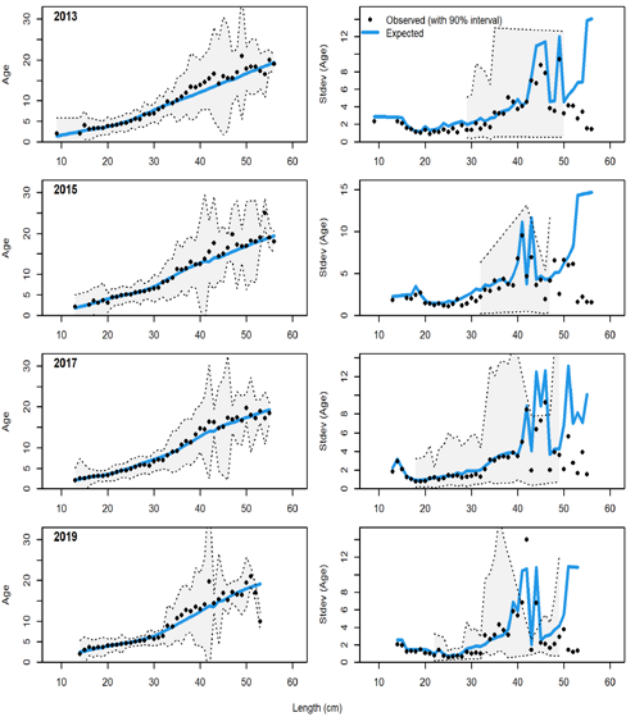
central GOA

western GOA

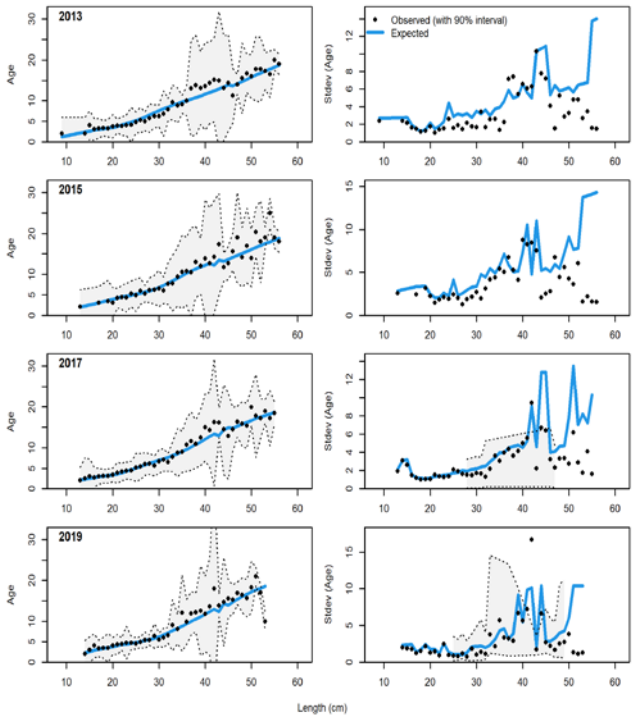


# CAAL – southern rock sole

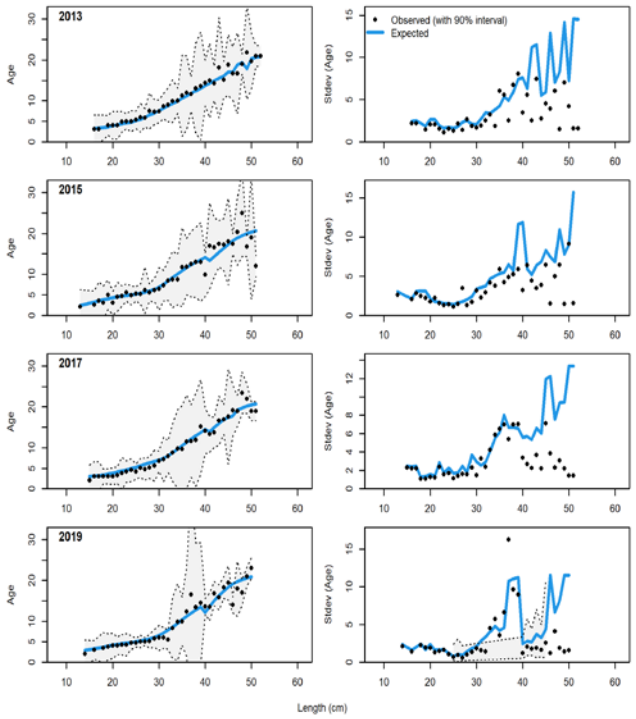
All GOA

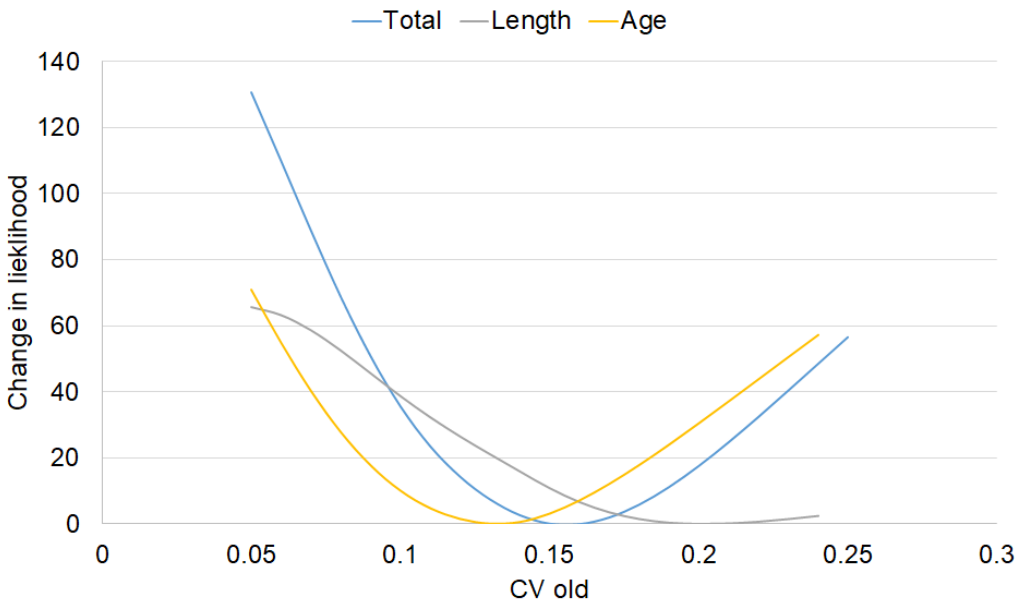


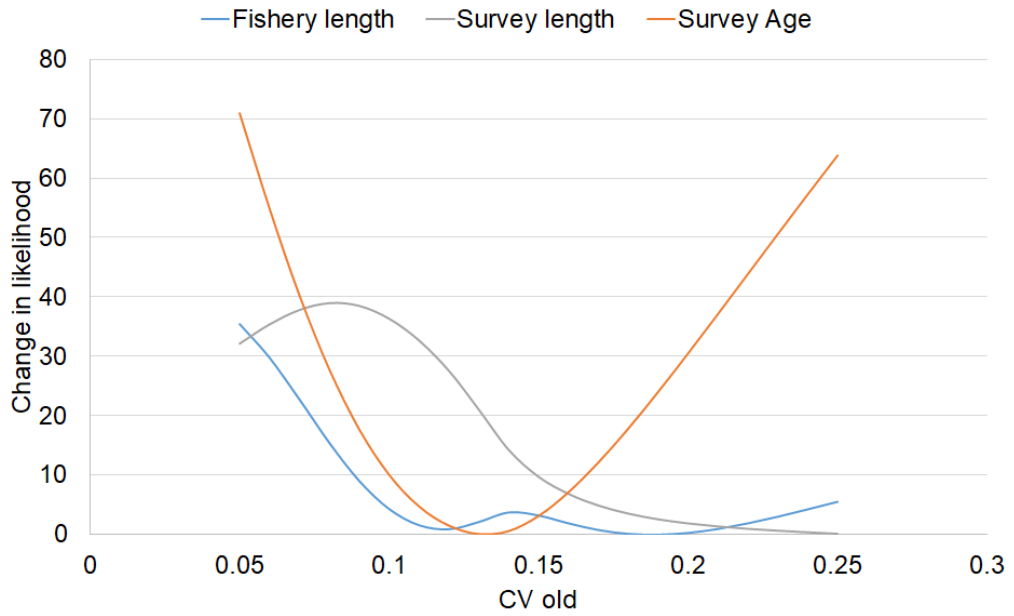

central GOA




western GOA






- Likelihood profile of CV of the distribution of the length-at-oldest age
- From model 17.1
- Assumed CV_old was the same for females and males
  - Changed simultaneously



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