St. Matthew Blue King Crab

May 2022 proposed models

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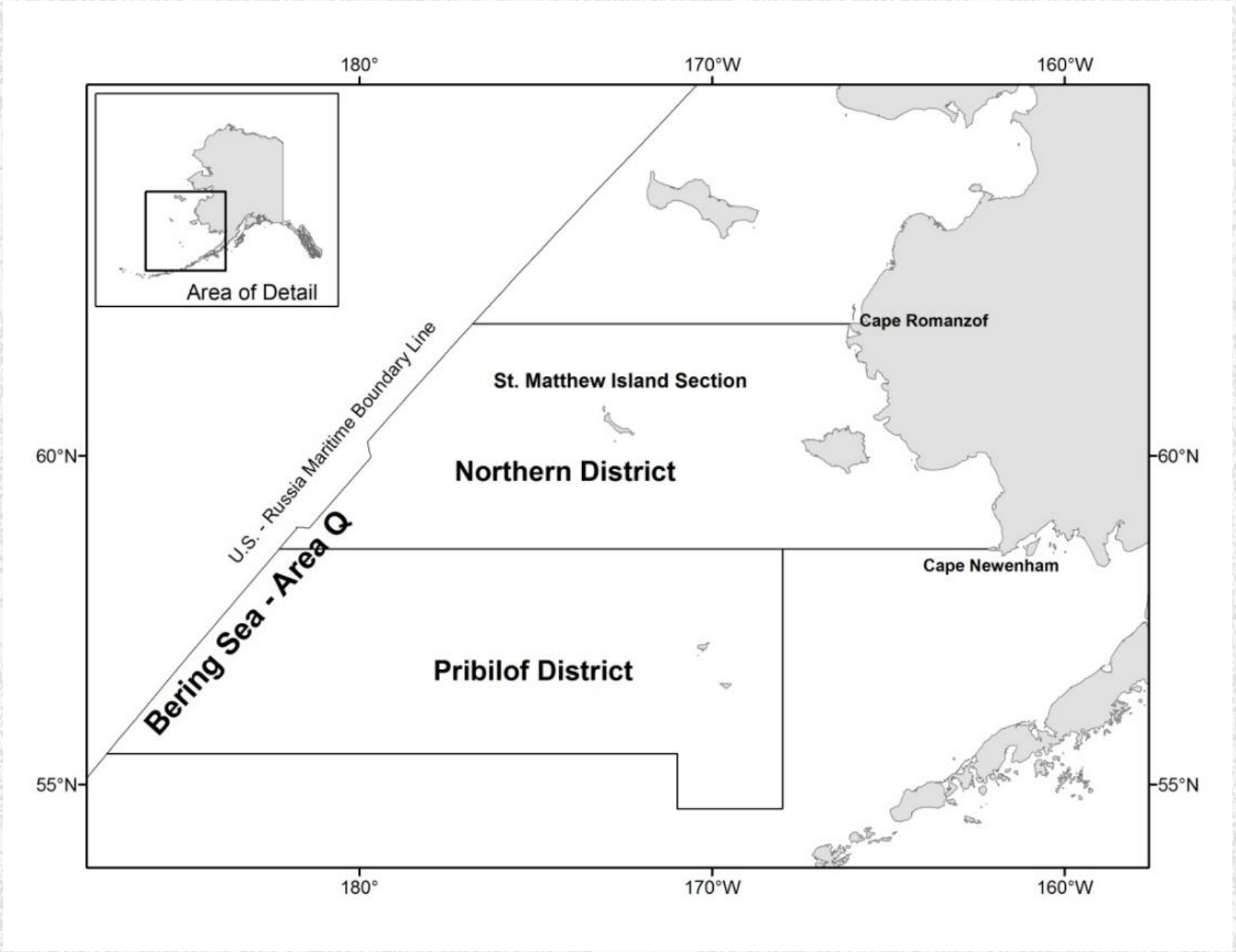
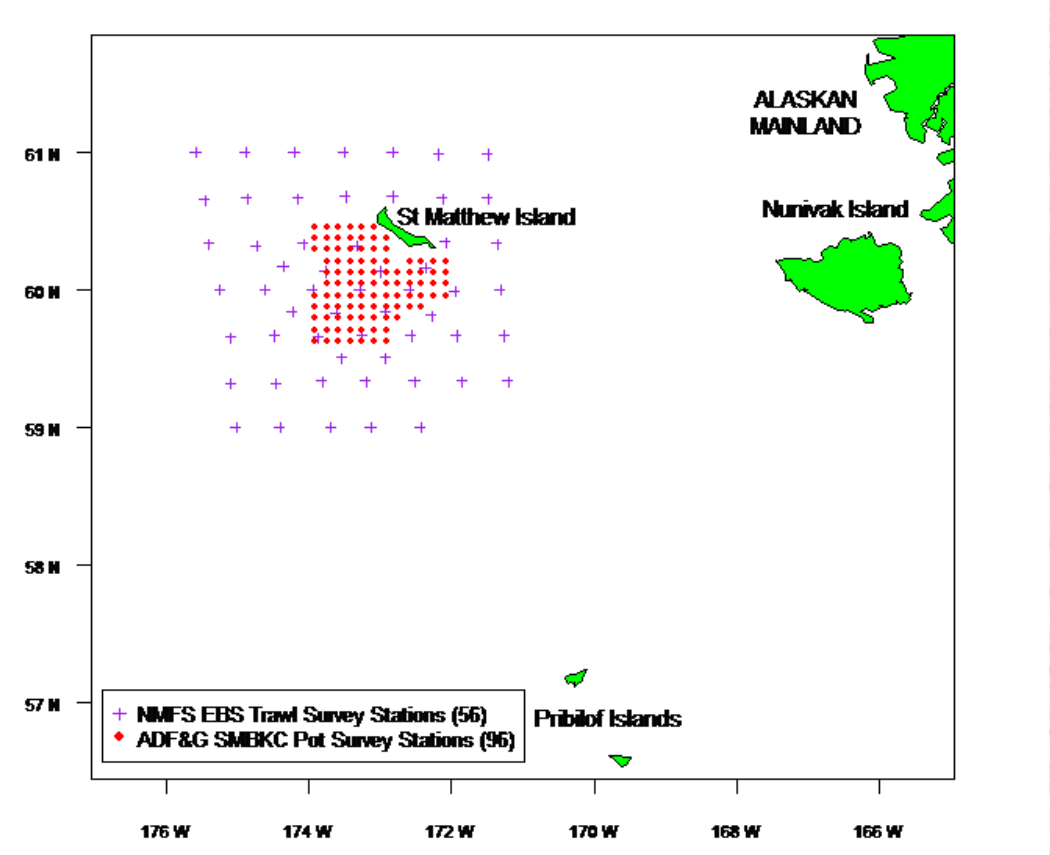
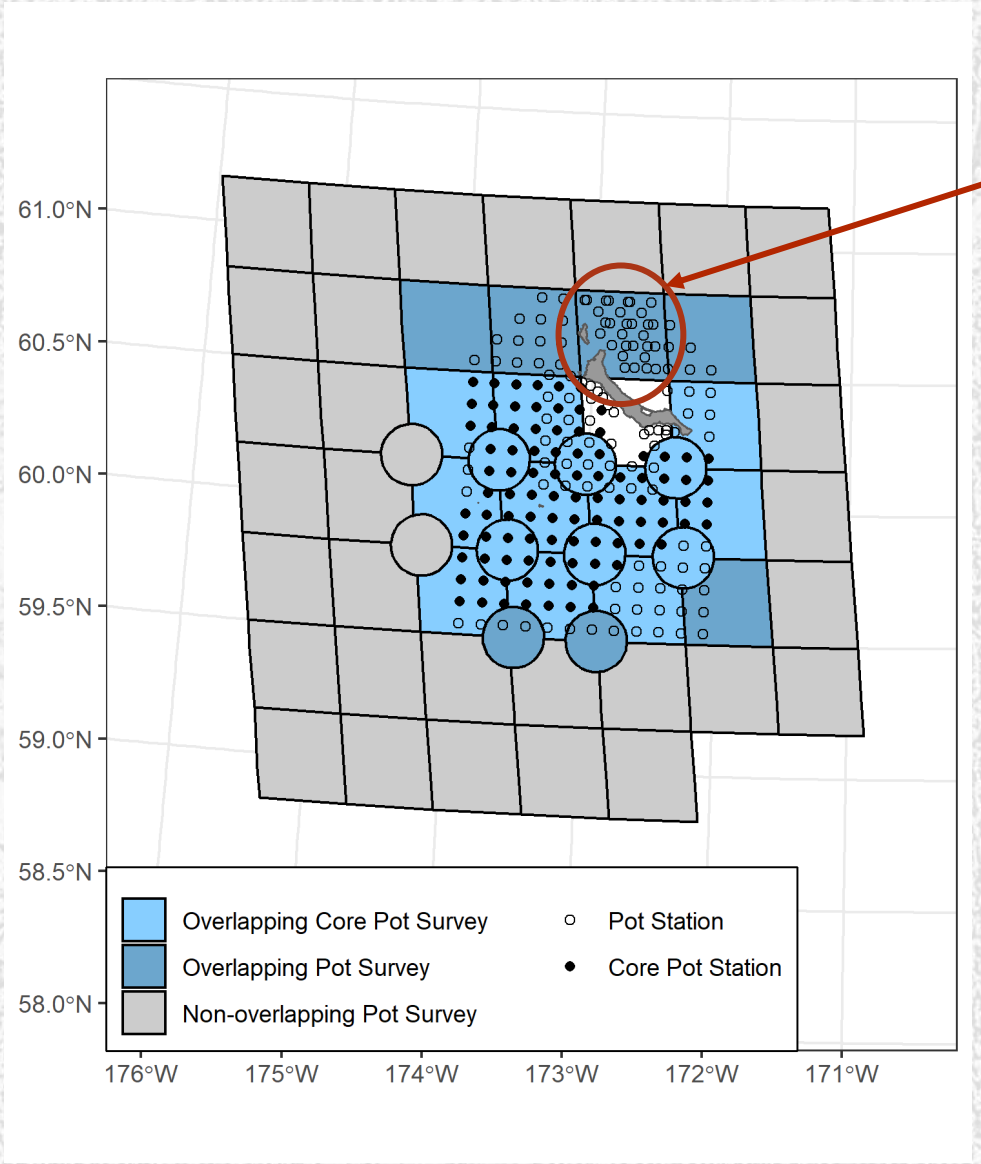
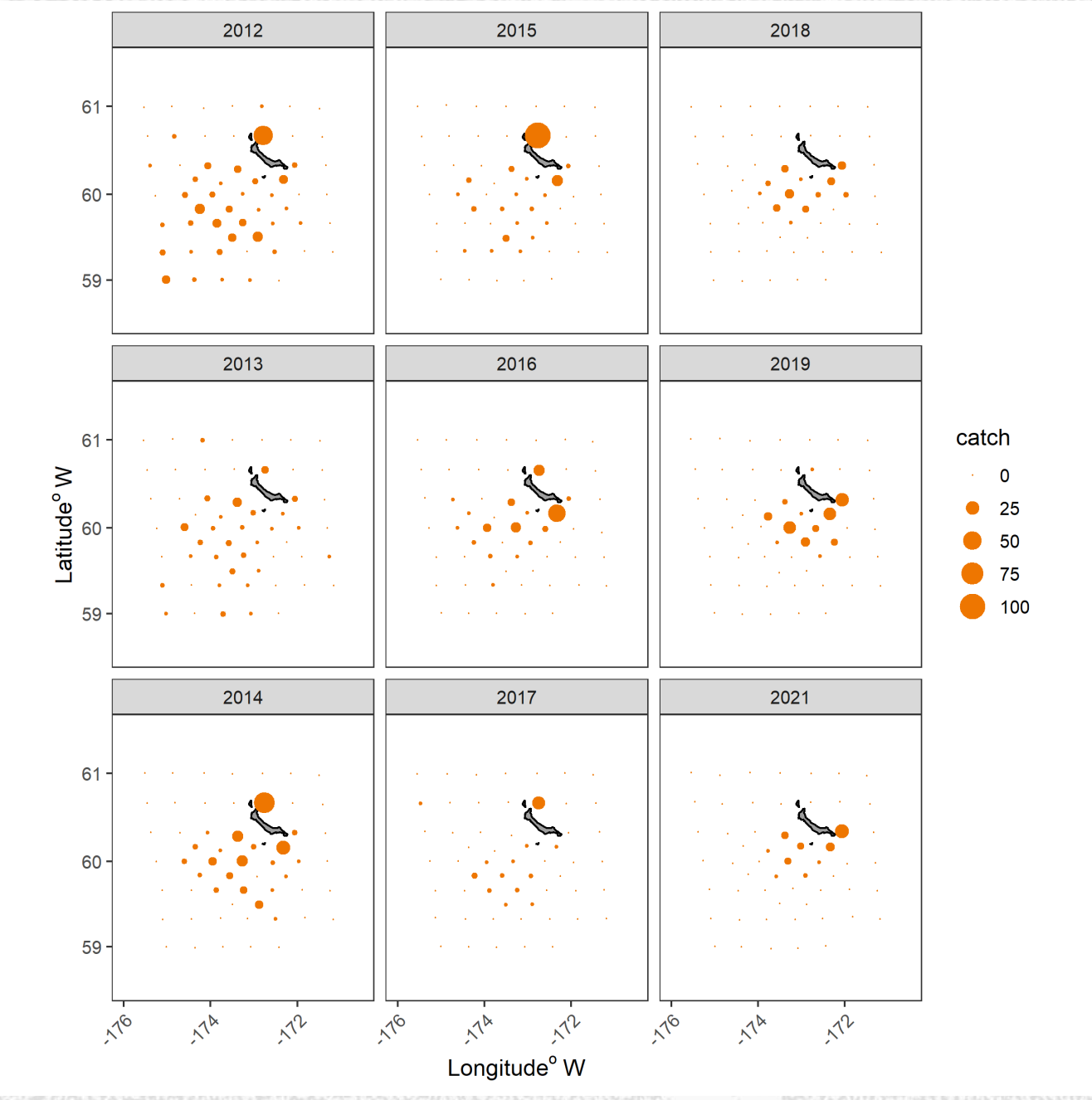
Current Status

- Last full assessment Sept. 2020 (moved to biennial cycle)
- Overfished
- Under rebuilding plan to be updated this fall (2022)
  - No changes to fishing regulations
  - No further bycatch restrictions
  - Focused on recruitment expectations
- Core model issues
  - Discrepancies in trends between pot survey and trawl survey
  - Spatial hot spots in surveys
  - Poor fit of models to recent years survey data (2010+)


180°
170°W
160°W
Area of Detail
Cape Romanzof
St. Matthew Island Section
U.S. - Russia Maritime Boundary Line
60°N
Northern District
Bering Sea - Area Q
Cape Newenham
Pribilof District
55°N
180°
170°W
160°W


ALASKAN MAINLAND
Nunivak Island
St Matthew Island
Pribilof Islands
61 N
60 N
59 N
58 N
57 N
176 W
174 W
172 W
170 W
168 W
166 W
NMFS EBS Trawl Survey Stations (56)
ADF&G SMBKC Pot Survey Stations (96)


R-24
61.0°N
60.5°N
60.0°N
59.5°N
59.0°N
58.5°N
58.0°N
176°W
175°W
174°W
173°W
172°W
171°W
Overlapping Core Pot Survey
Overlapping Pot Survey
Non-overlapping Pot Survey
Pot Station
Core Pot Station



Trawl survey (area-swept) spatial breakdown in catch

CPT / SSC comments

Explore potential explanations for the discrepancy in the time trends of the two types of survey data, including movement hypotheses using spatial models (not necessarily VAST)

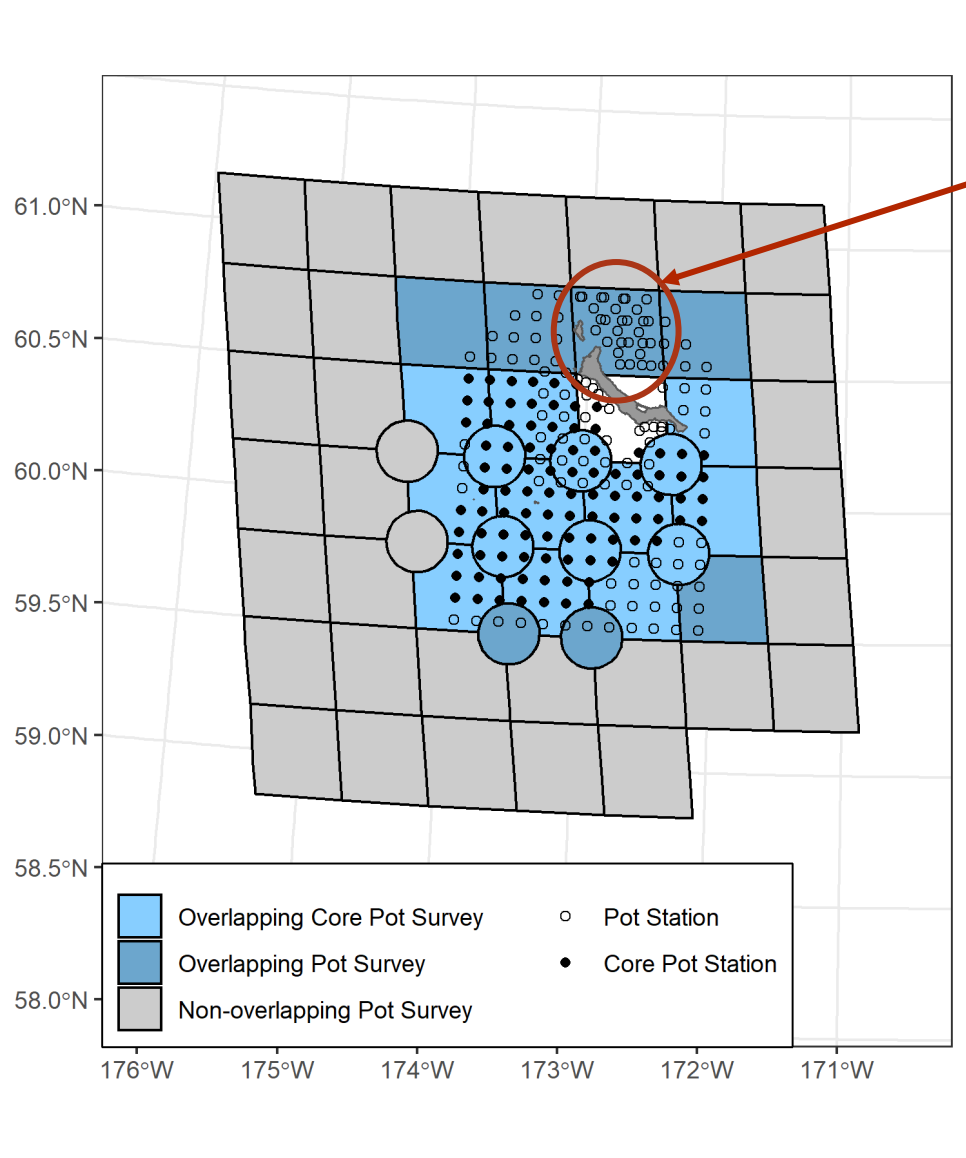
Exploration of the spatial extent and density differences between the surveys was done on all male crab included in the model (Appendix C). The authors plan to use this and further analyses to better characterize catchability/availability for the pot survey.

Random walk or exploration of catchability

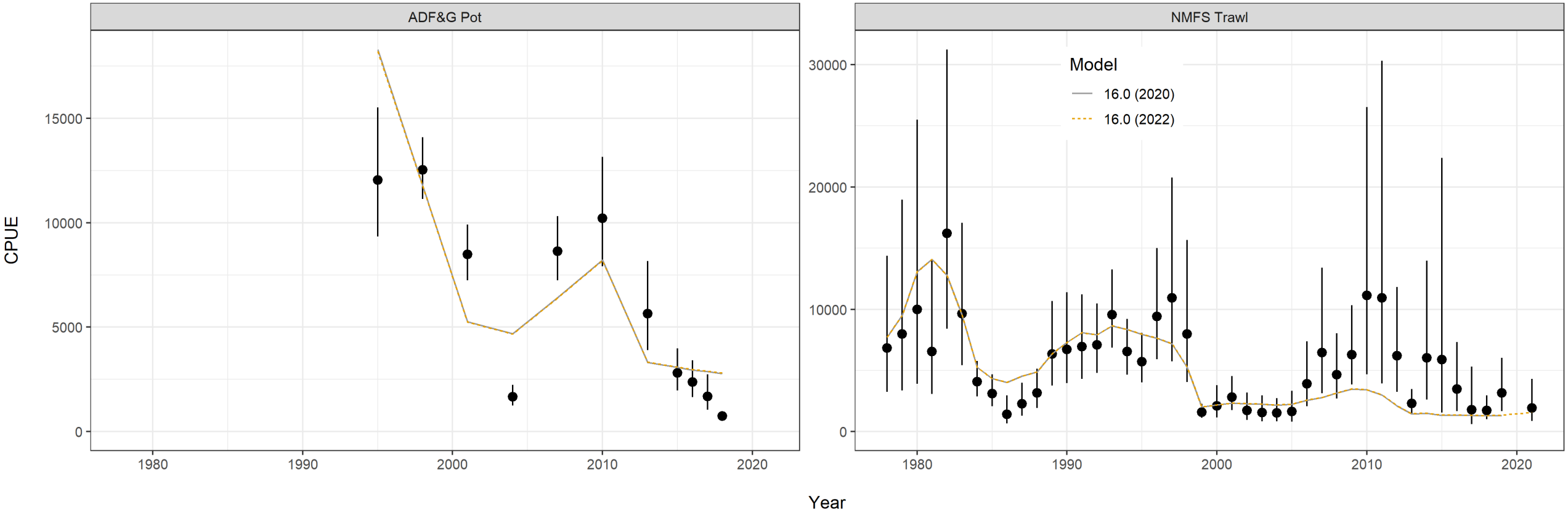
The initial model of time blocks for Q did not show much potential for this in May 2020, therefore time blocks were not a focus for May 2022. More coding work is needed to make a true random walk for catchability in GMACS and this will be added to model development.

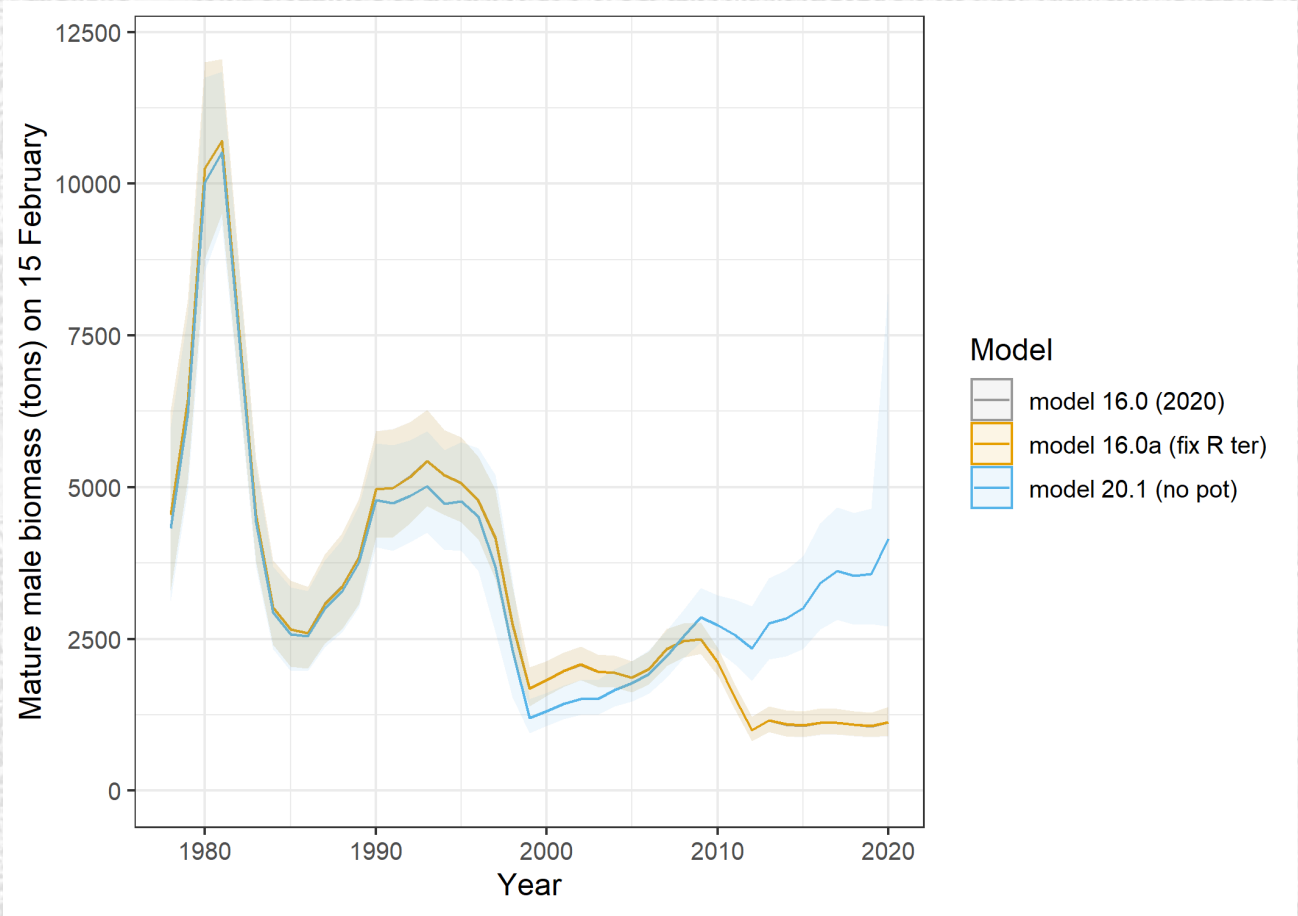
Explore the assumed and estimated life history parameters (e.g., natural mortality, growth, and maturity) to ensure the best available science is being used to assess this stock.

Specific research on St. Matthew blue king crab life history parameters is not available and therefore these are borrowed from other stocks/species. At this time only sensitivities of the model to increased natural mortality (M) were looked at here (Models 22.0a and 22.0b). Sensitivities to the model assumptions on growth and maturity will be explored at a later date.

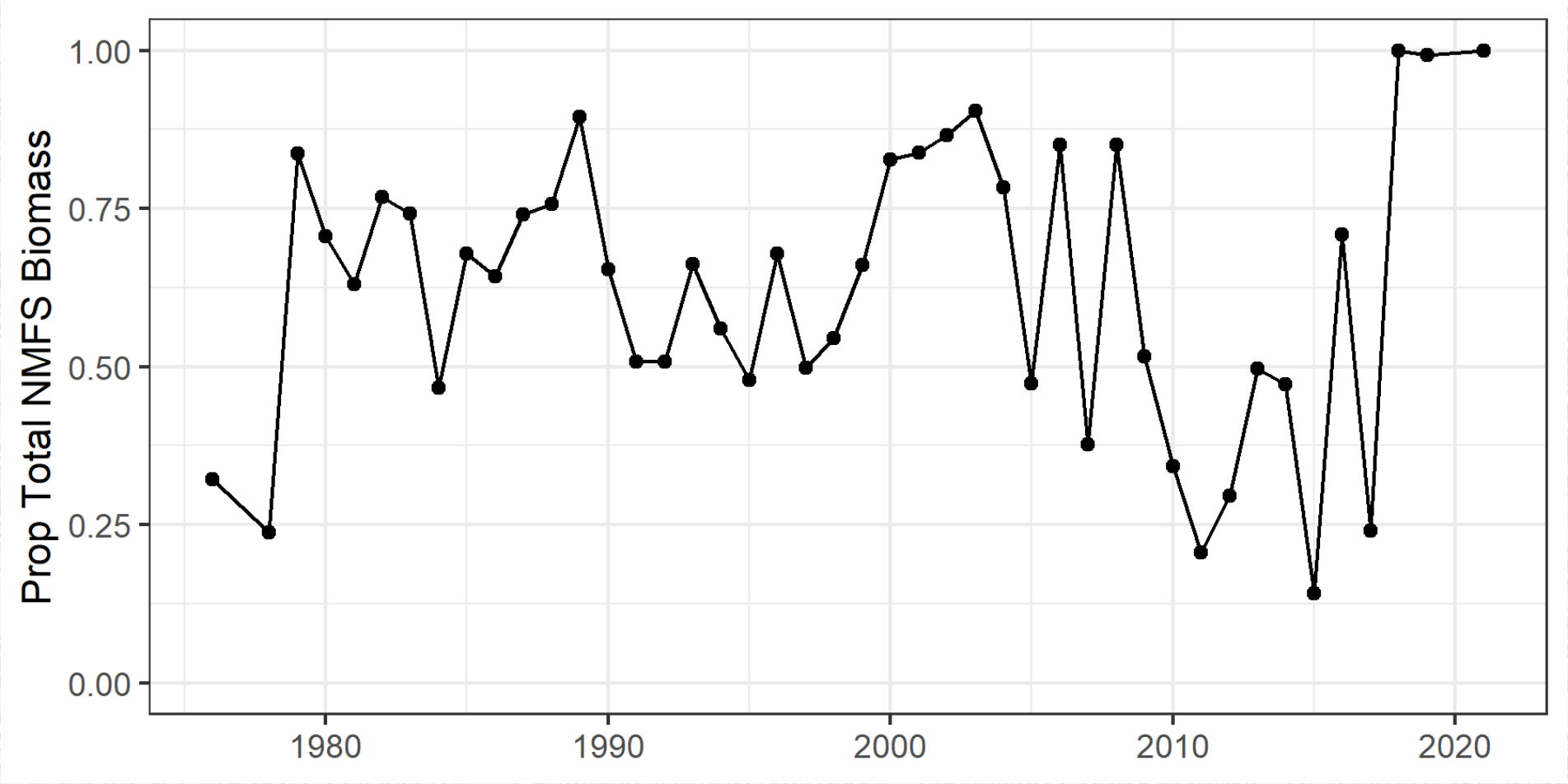


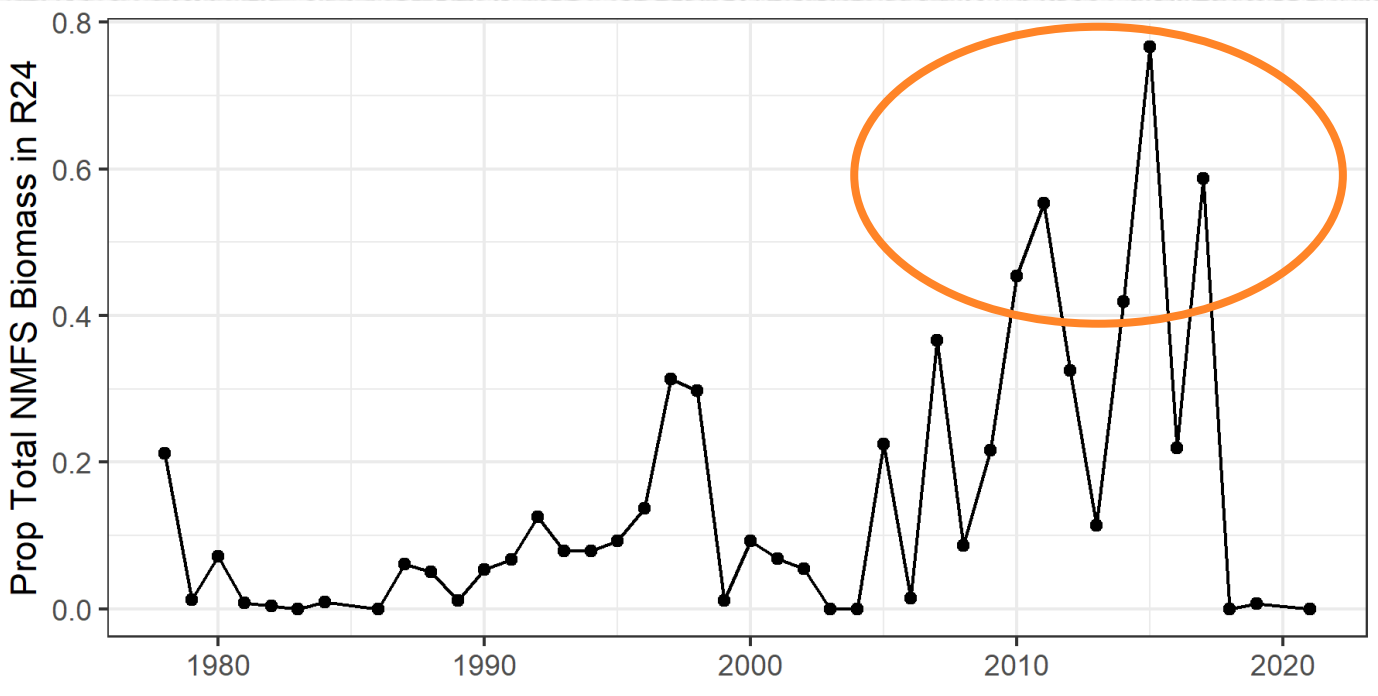
- Blue (survey overlap)
- Light blue core pot survey overlap
- Sampling density differences
- NMFS trawl survey samples in R-24 annually
- ADF&G pot survey R-24 sampling is opportunistically

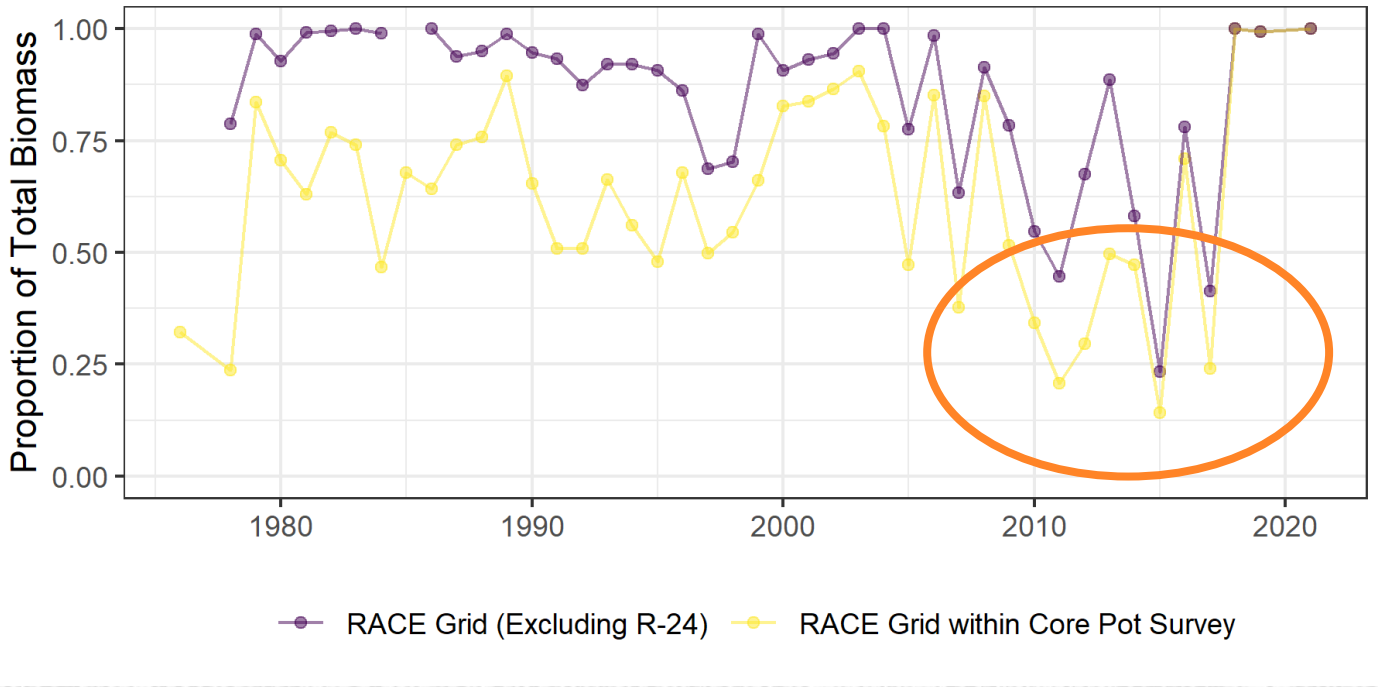

ADF&G Pot
NMFS Trawl
CPUE
Year
Model
16.0 (2020)
16.0 (2022)
0
5000
10000
15000
20000
30000
1980
1990
2000
2010
2020


Mature male biomass (tons) on 15 February
12500
10000
7500
5000
2500
0
1980
1990
2000
2010
2020
Year
Model
model 16.0 (2020)
model 16.0a (fix R ter)
model 20.1 (no pot)

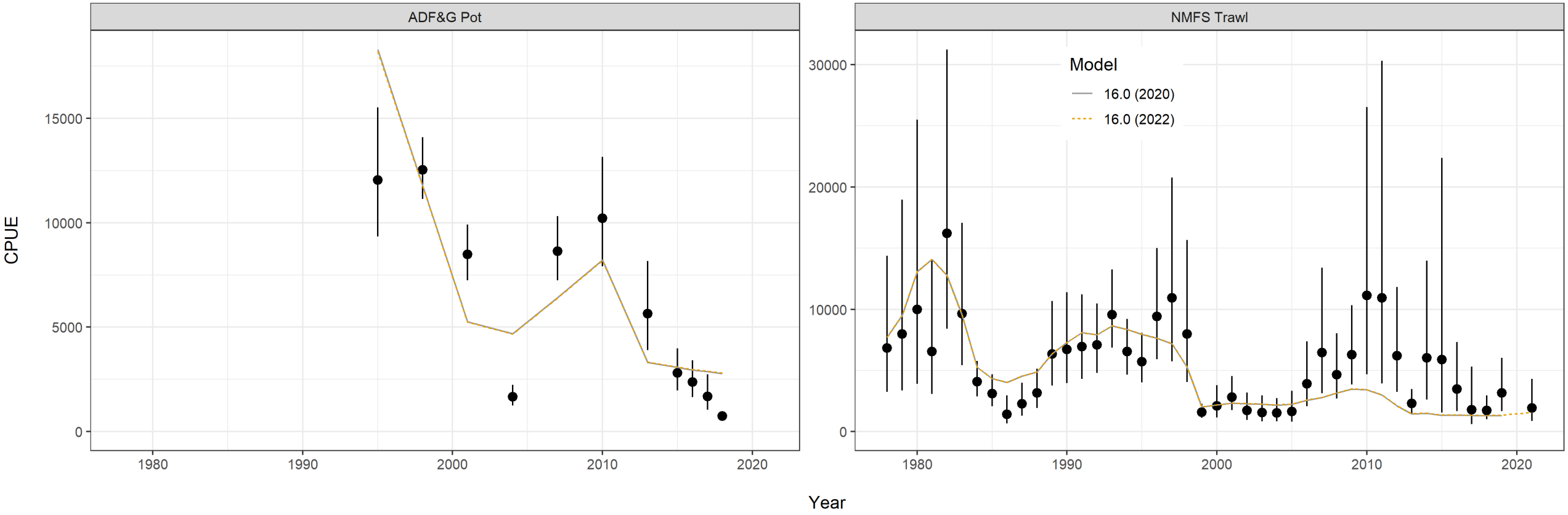
Proportion of NMFS biomass in core 96 ADF&G pot stations

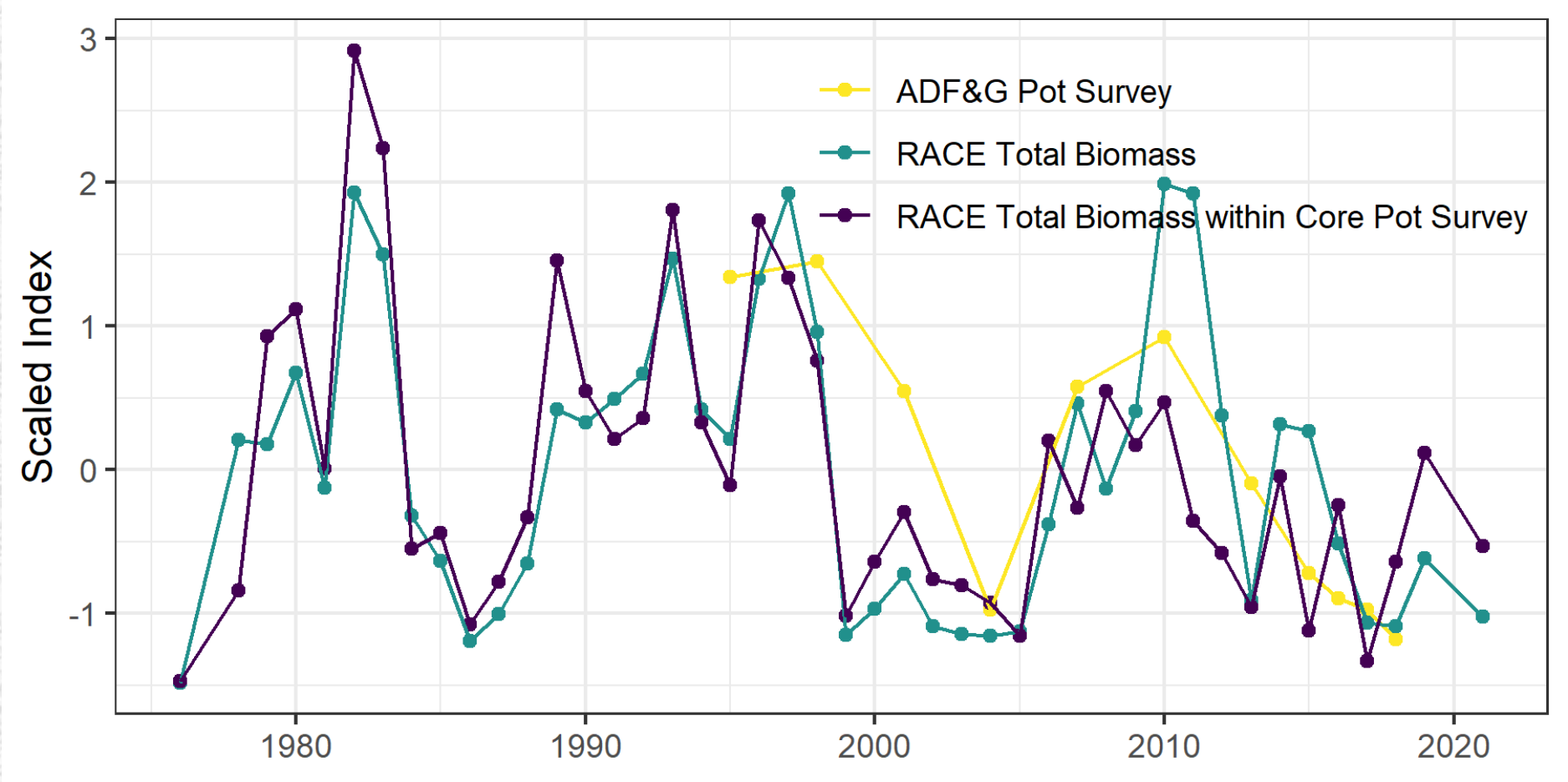






Influence of R-24


ADF&G Pot
NMFS Trawl
CPUE
Year
Model
16.0 (2020)
16.0 (2022)
0
5000
10000
15000
20000
30000
1980
1990
2000
2010
2020


ADF&G Pot Survey
RACE Total Biomass
RACE Total Biomass within Core Pot Survey
Scaled Index
3
2
1
0
-1
1980
1990
2000
2010
2020

Recommendations from survey explorations

- time blocks for Q in the NMFS data set to accommodate the changes observed from 2005 to 2017
- inclusion of additional pot survey data outside the 96 in-common stations, with accommodating “availability” parameters in these years
- using the NMFS trawl survey data with the same spatial footprint as the pot survey (purple trend line compared to green in Figure 9)

Model explorations

16.0 - 2020 Reference Model:

- Base model accepted in Sept. 2020

16.0 - 2022 Reference Model:

- model 16.0 with updated 2021 NMFS trawl data (biomass and size comps) and groundfish and crab bycatch data up to 2020/21 (removals)

22.0a - fixed M = 0.21:

- Model 16.0 with natural mortality increased to 0.21

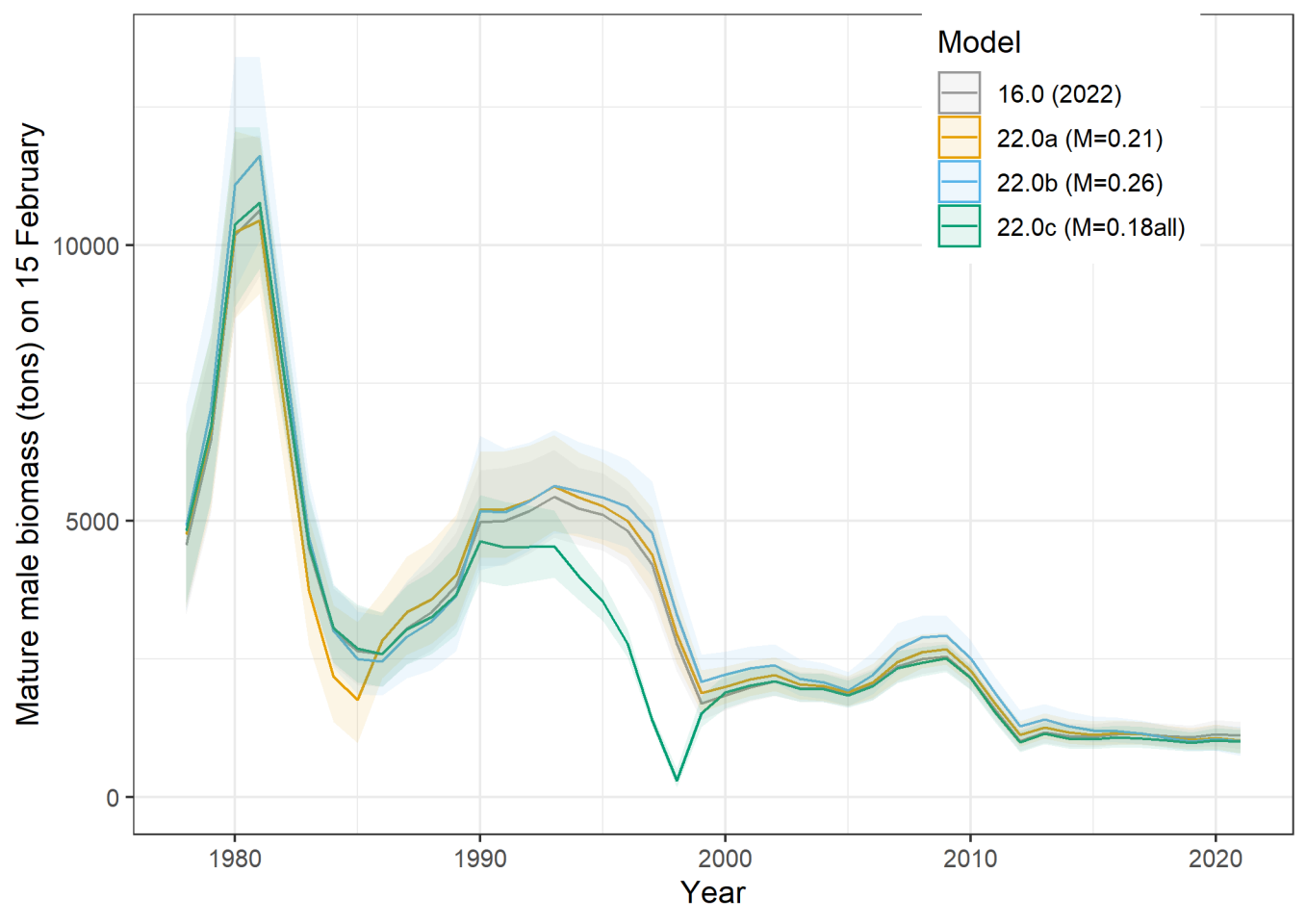
22.0a - fixed M = 0.26:

- Model 16.0 with natural mortality increased to 0.26

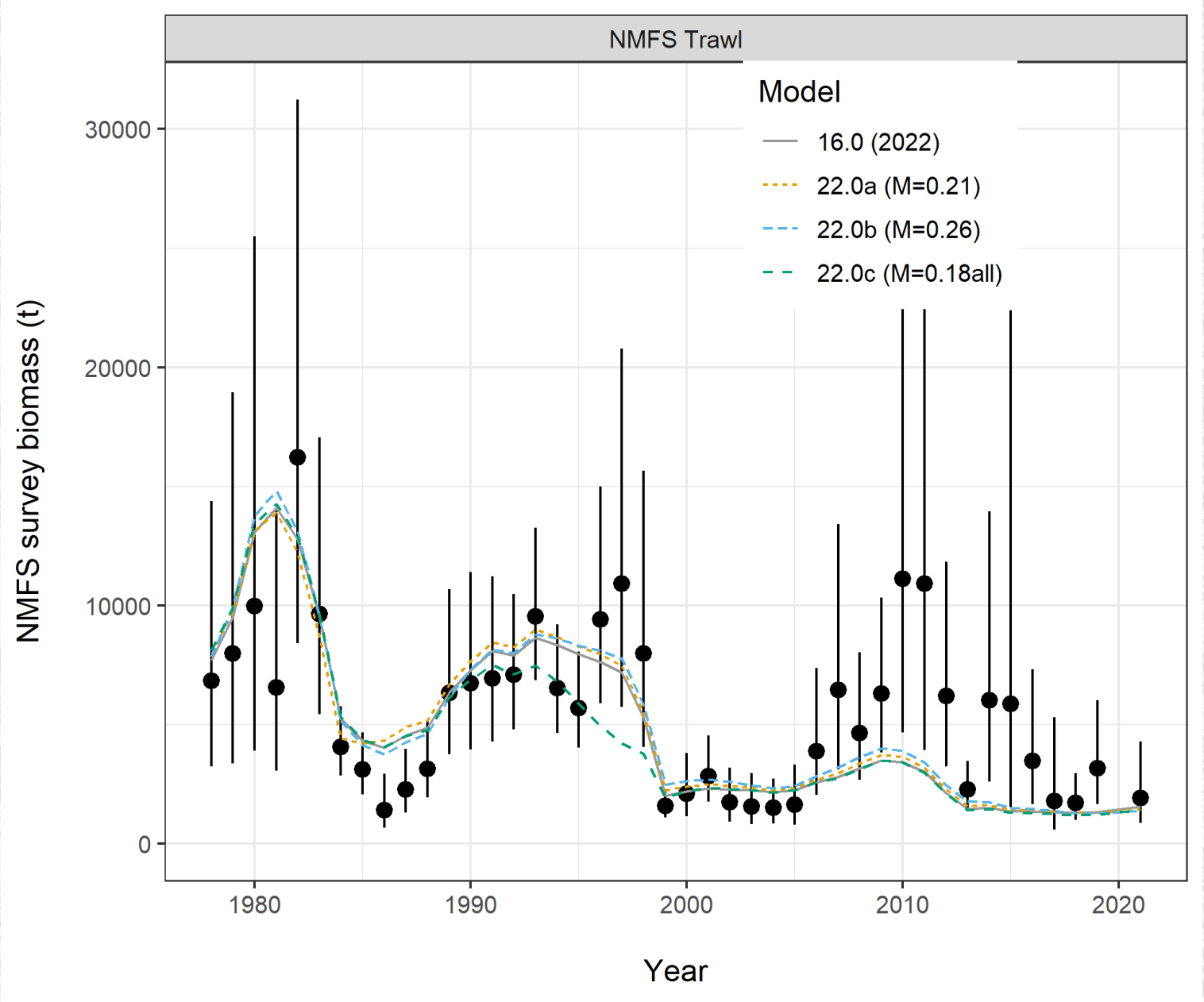
22.0c – no time blocks for M

- Natural mortality is fixed for all years at 0.18, no time blocks for large decrease in 1998

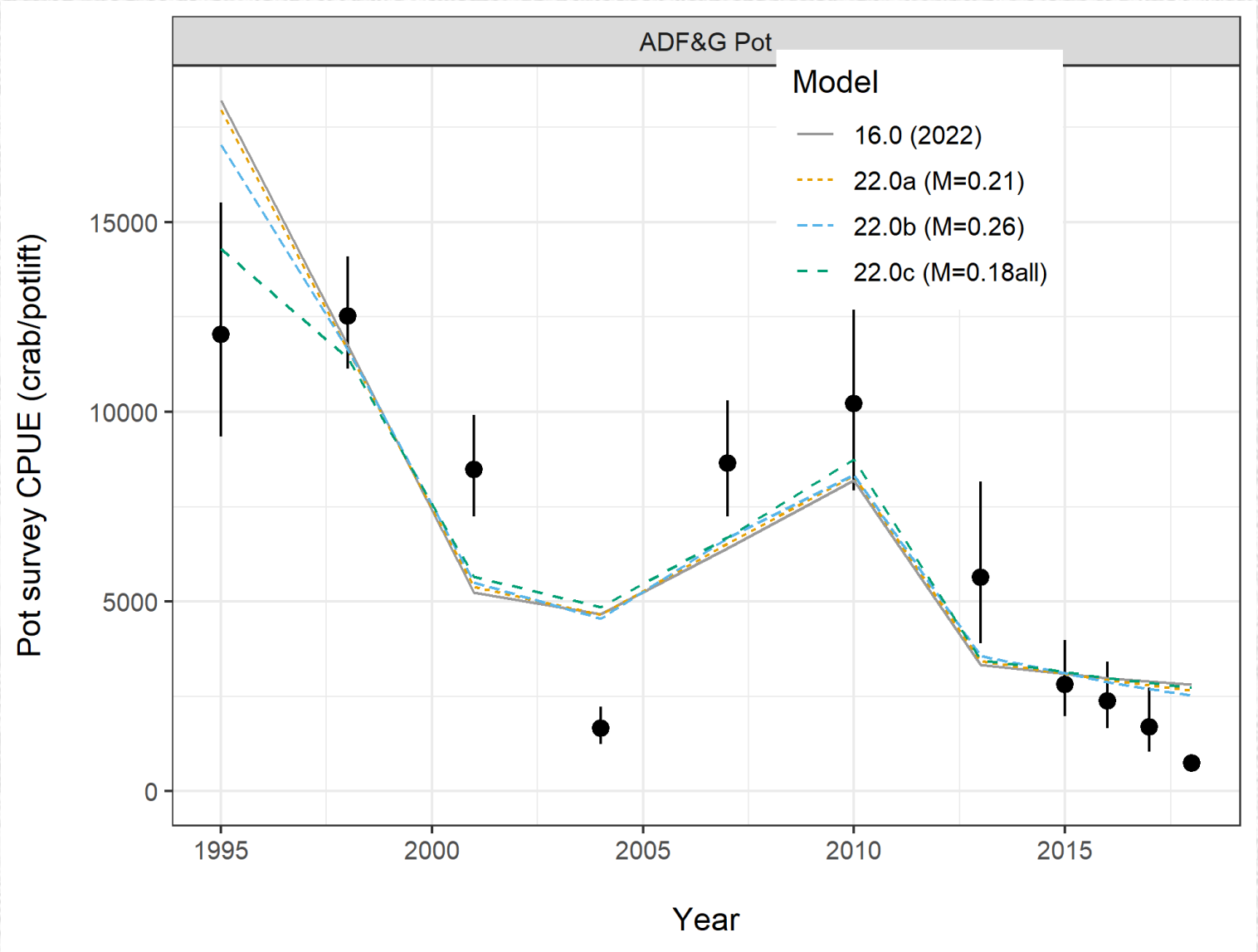
- No discernable difference with updated reference model 2020 to 2022 (fig 6-9)
- Model without time block (22.0c) largest change in MMB



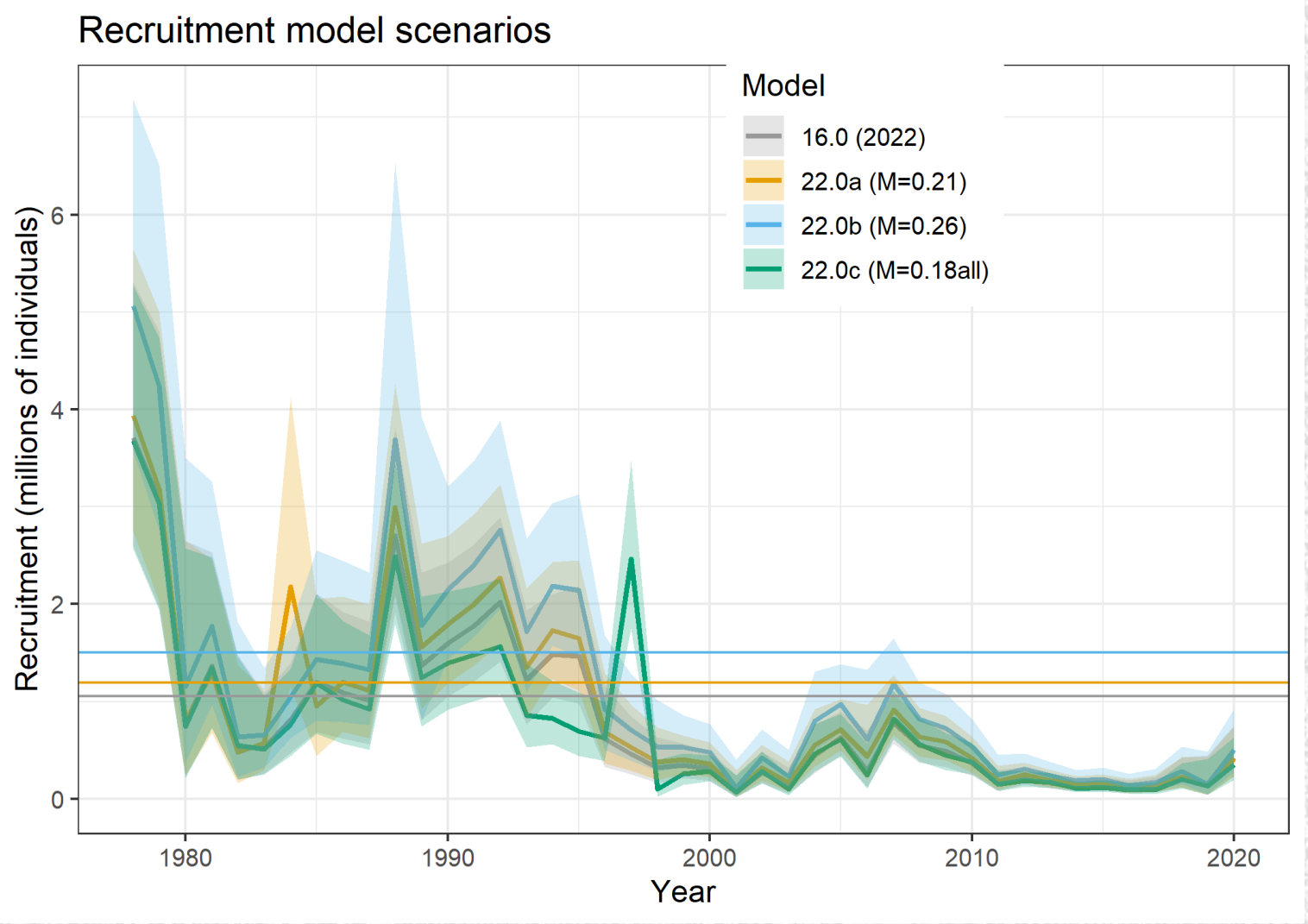
Model without time blocks fits data differently in late 90s.

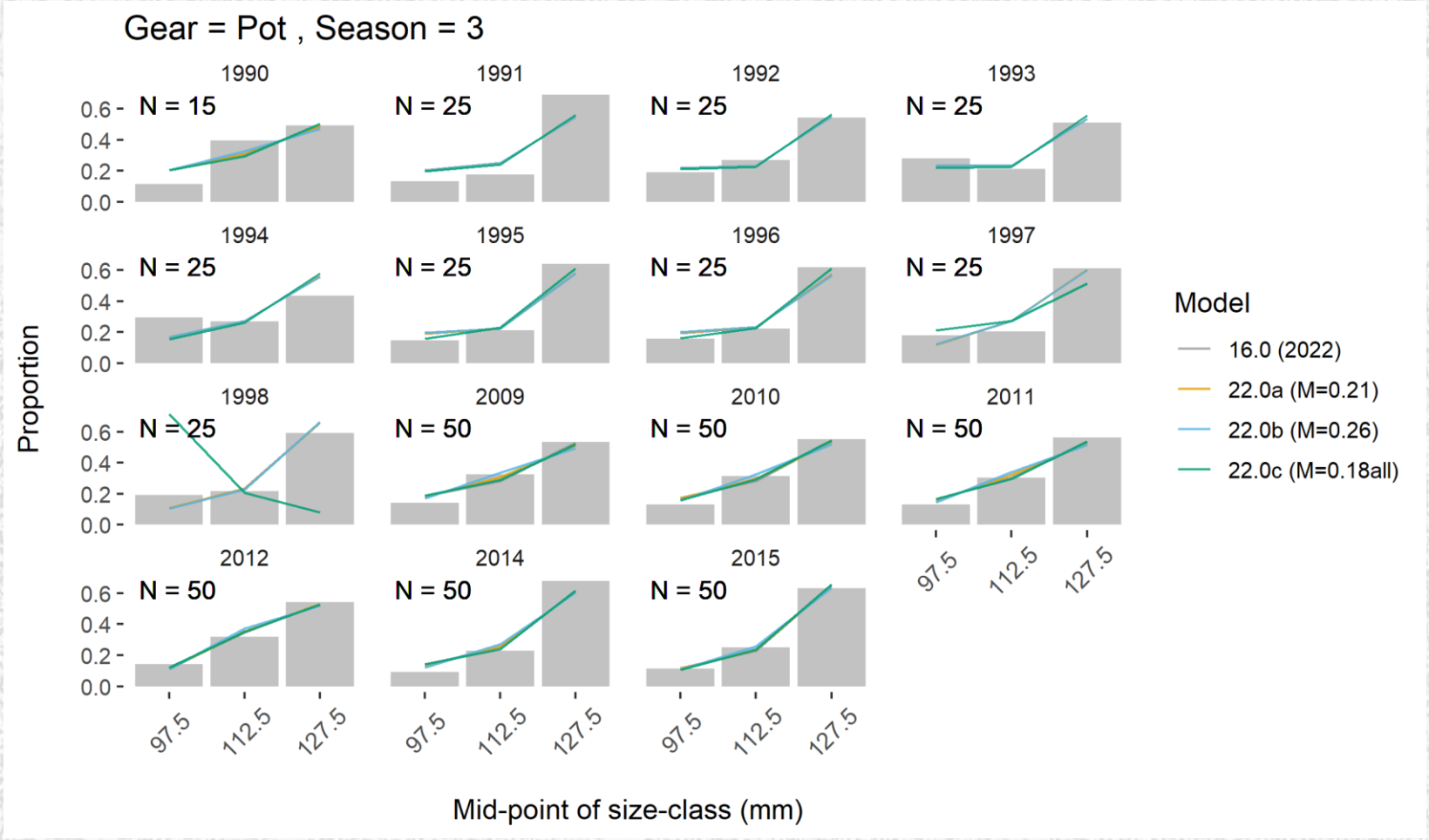


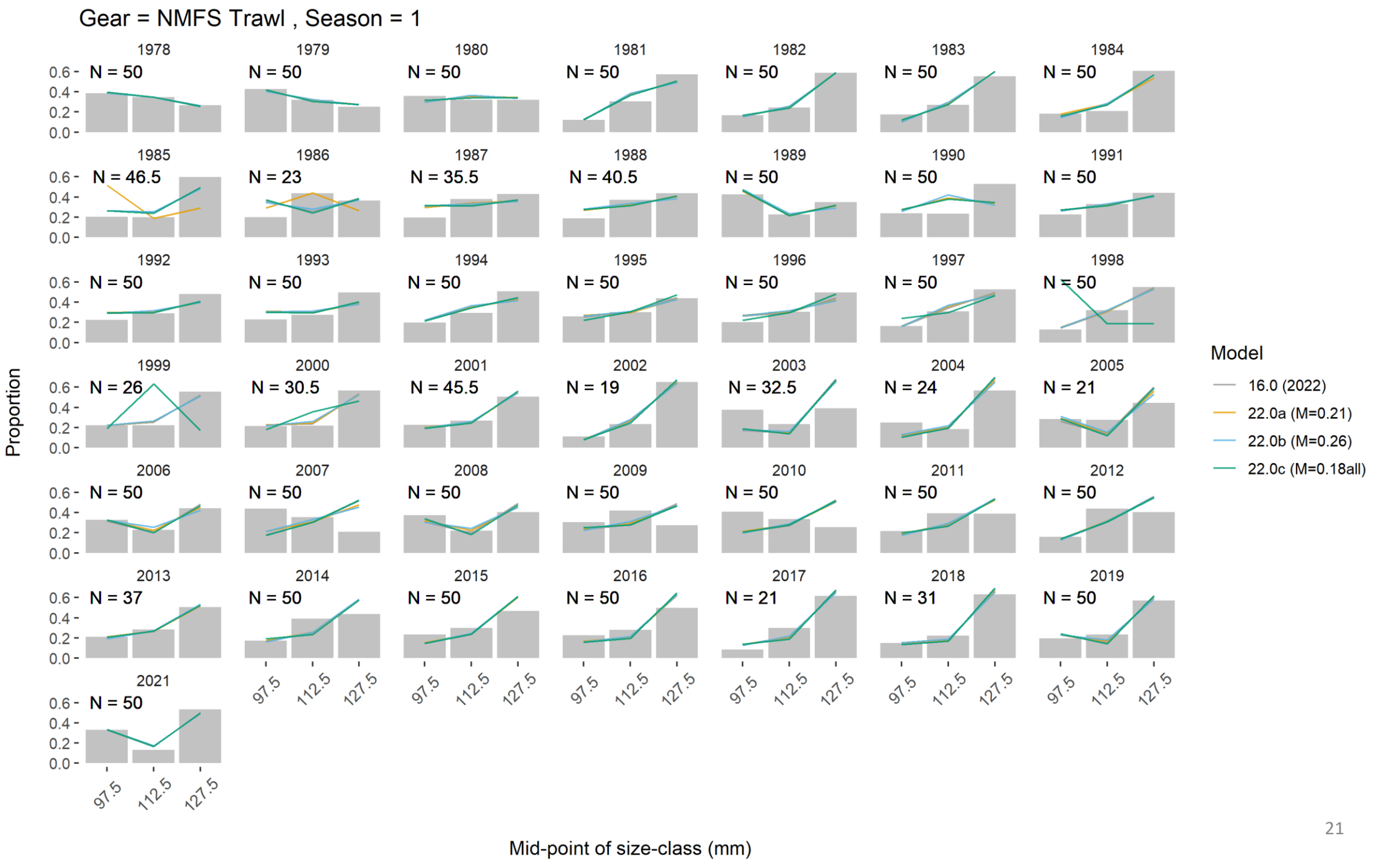
Model without time blocks fits data differently in late 90s.

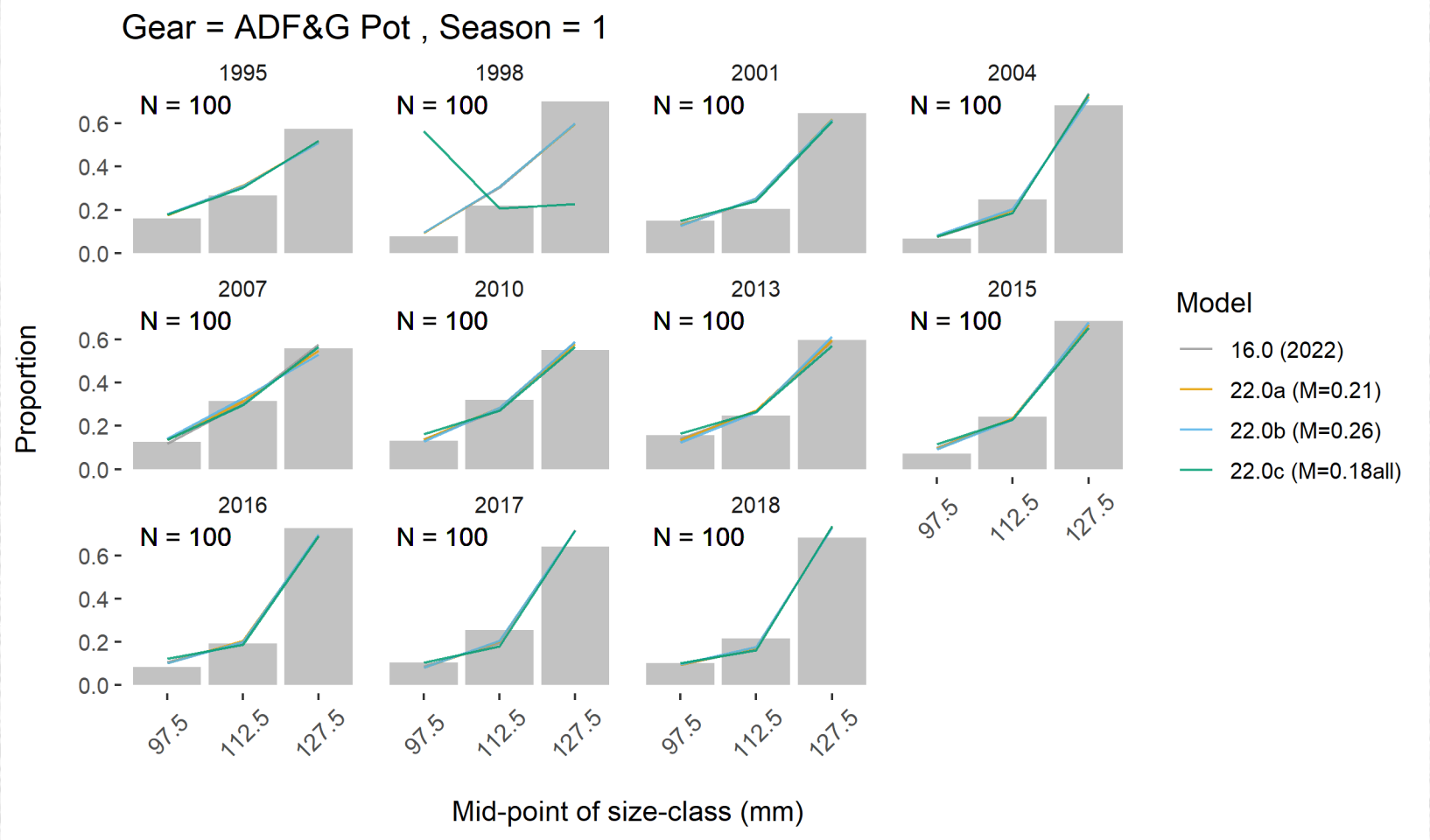


Model without time block has spike in late 90s.

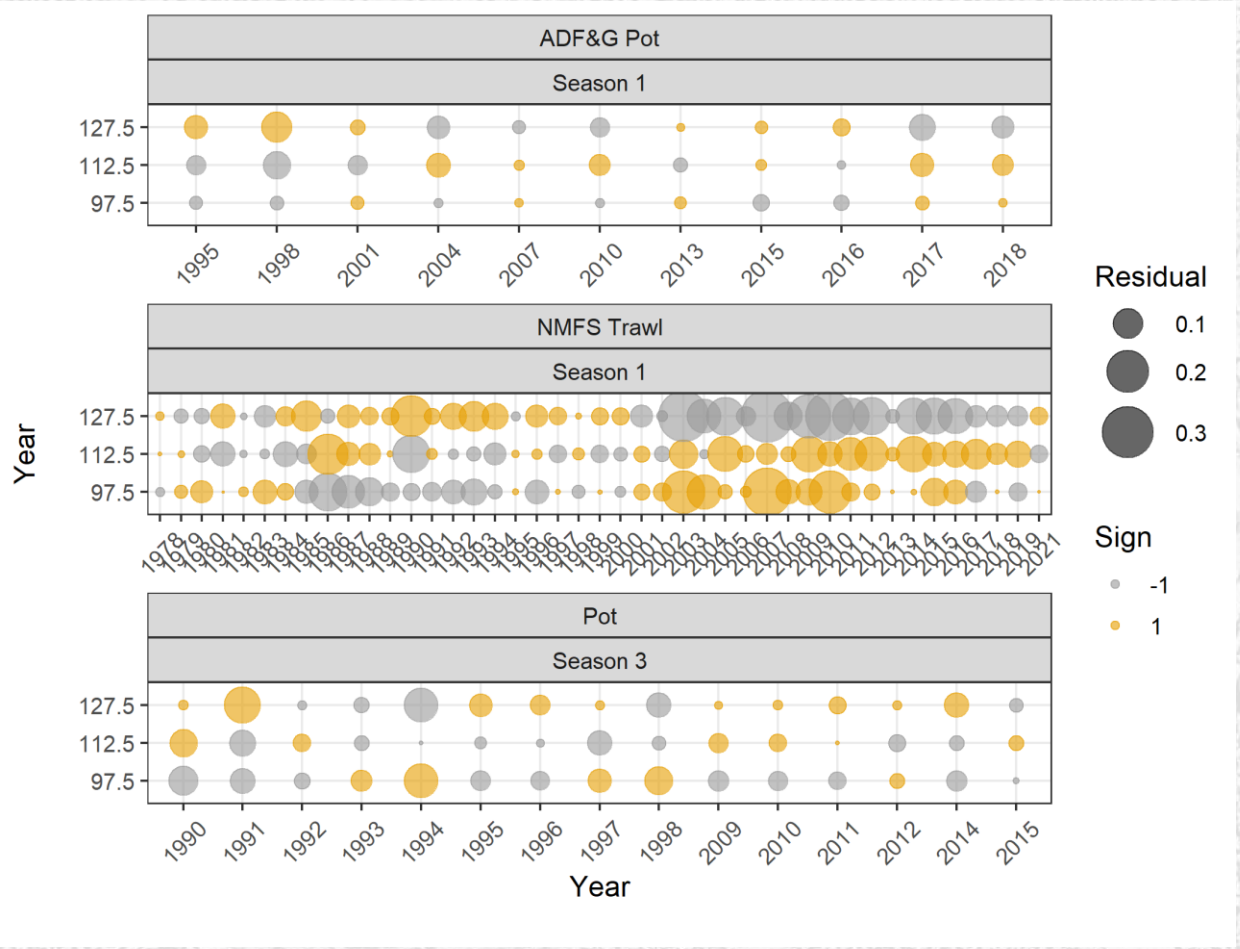



Gear = Pot , Season = 3
1990
N = 15
1991
N = 25
1992
N = 25
1993
N = 25
1994
N = 25
1995
N = 25
1996
N = 25
1997
N = 25
1998
N = 25
2009
N = 50
2010
N = 50
2011
N = 50
2012
N = 50
2014
N = 50
2015
N = 50
0.0
0.2
0.4
0.6
97.5
112.5
127.5
Proportion
Mid-point of size-class (mm)
Model
16.0 (2022)
22.0a (M=0.21)
22.0b (M=0.26)
22.0c (M=0.18all)

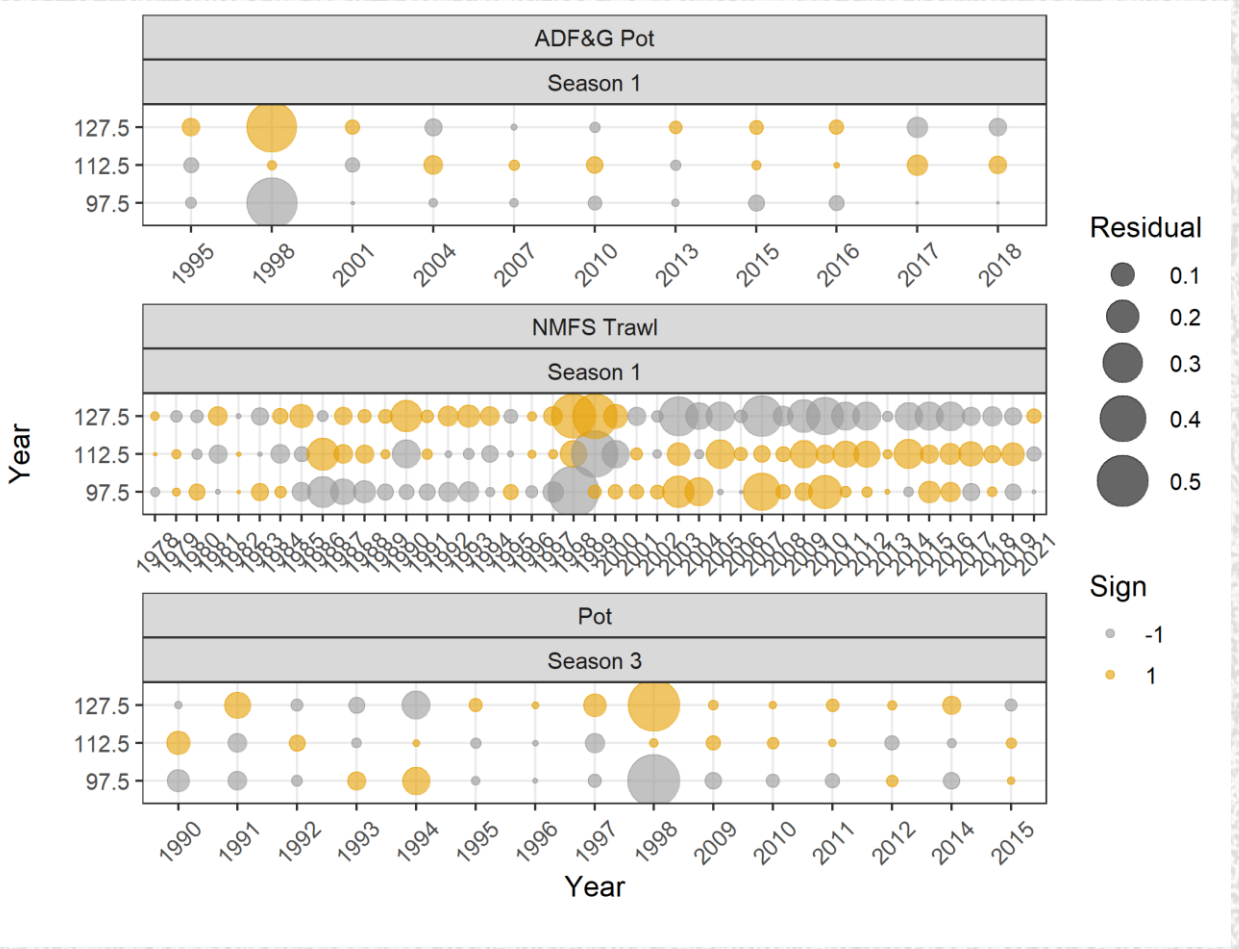

Gear = NMFS Trawl , Season = 1
1978 N = 50
1979 N = 50
1980 N = 50
1981 N = 50
1982 N = 50
1983 N = 50
1984 N = 50
1985 N = 46.5
1986 N = 23
1987 N = 35.5
1988 N = 40.5
1989 N = 50
1990 N = 50
1991 N = 50
1992 N = 50
1993 N = 50
1994 N = 50
1995 N = 50
1996 N = 50
1997 N = 50
1998 N = 50
1999 N = 26
2000 N = 30.5
2001 N = 45.5
2002 N = 19
2003 N = 32.5
2004 N = 24
2005 N = 21
2006 N = 50
2007 N = 50
2008 N = 50
2009 N = 50
2010 N = 50
2011 N = 50
2012 N = 50
2013 N = 37
2014 N = 50
2015 N = 50
2016 N = 50
2017 N = 21
2018 N = 31
2019 N = 50
2021 N = 50
0.0
0.2
0.4
0.6
97.5
112.5
127.5
Proportion
Mid-point of size-class (mm)
Model
16.0 (2022)
22.0a (M=0.21)
22.0b (M=0.26)
22.0c (M=0.18all)


Gear = ADF&G Pot , Season = 1
1995
1998
2001
2004
2007
2010
2013
2015
2016
2017
2018
N = 100
0.0
0.2
0.4
0.6
Proportion
97.5
112.5
127.5
Mid-point of size-class (mm)
Model
16.0 (2022)
22.0a (M=0.21)
22.0b (M=0.26)
22.0c (M=0.18all)

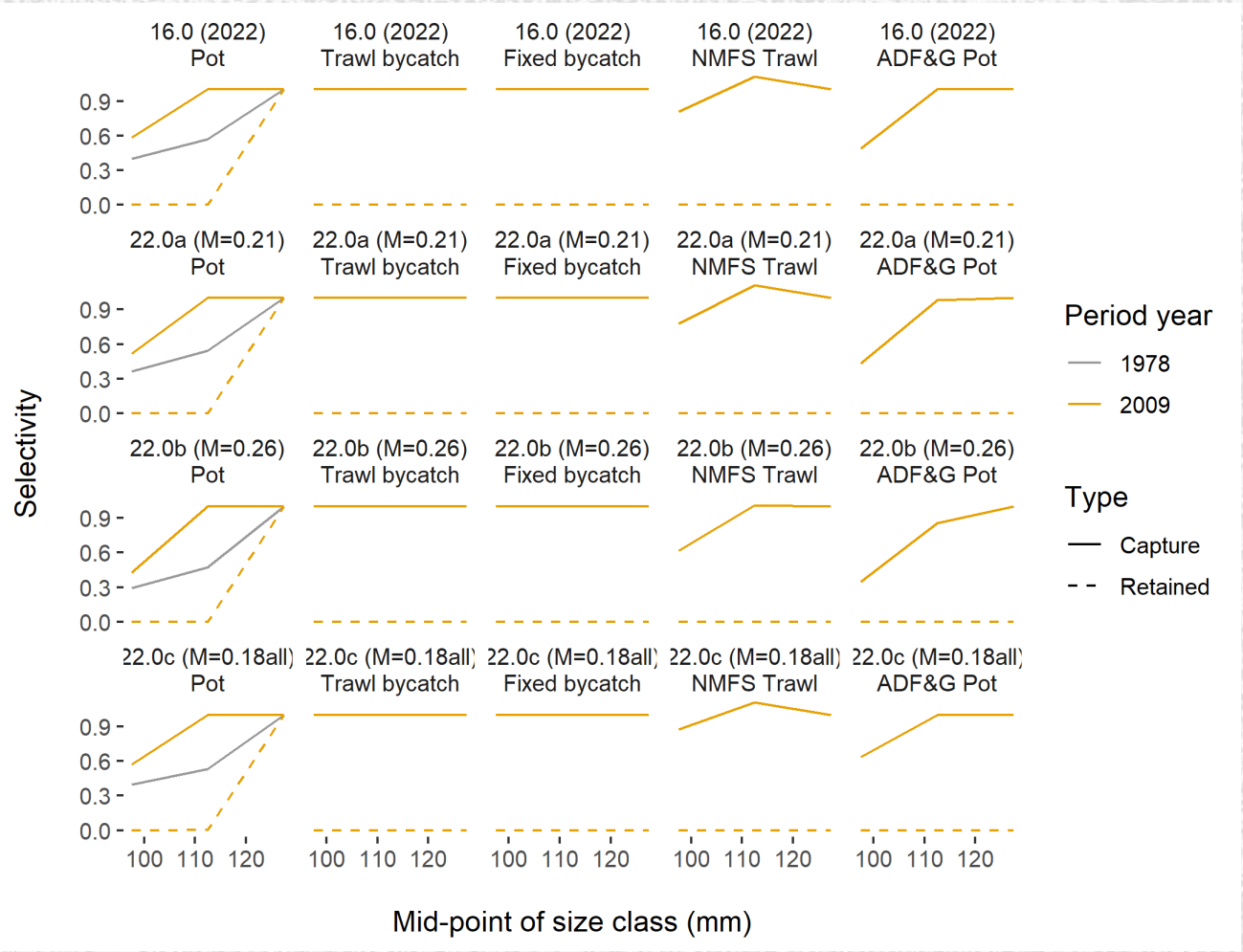
Reference model (16.0)



No time blocks (22.0c)



Selectivity



16.0 22.0a 22.0b 22.0c

Table 16: Comparisons of parameter estimates for the model scenarios.

Parameter	Ref	M0.21	M0.26	Mall
$\log(\bar{F}^{\mathrm{df}})$	-2.130	-2.112	-2.145	-1.947
$\log(\bar{F}^{\mathrm{fb}})$	-8.082	-8.131	-8.216	-7.987
$\log(\bar{F}^{\mathrm{tb}})$	-9.636	-9.685	-9.769	-9.541
$\log(\bar{R})$	13.868	13.995	14.224	13.768
$\log(n_1^0)$	14.954	15.027	15.239	14.950
$\log(n_2^0)$	14.511	14.544	14.623	14.568
$\log(n_3^0)$	14.327	14.366	14.358	14.366
F_{OFL}	0.048	0.049	0.000	0.047
q_{pot}	3.786	3.635	3.456	3.925
log Stage-1 ADF&G pot selectivity	-0.720	-0.840	-1.050	-0.453
log Stage-1 directed pot selectivity 1978-2008	-0.920	-1.013	-1.234	-0.926
log Stage-1 directed pot selectivity 2009-2017	-0.542	-0.658	-0.853	-0.558
log Stage-1 NMFS trawl selectivity	-0.316	-0.360	-0.592	-0.242
log Stage-2 ADF&G pot selectivity	-0.000	-0.018	-0.155	-0.000
log Stage-2 directed pot selectivity 1978-2008	-0.561	-0.610	-0.754	-0.632
log Stage-2 directed pot selectivity 2009-2017	-0.000	-0.000	-0.000	-0.000
log Stage-2 NMFS trawl selectivity	-0.000	-0.000	-0.094	-0.000
Natural mortality deviation in 1998/99 (δ^M_{1998})	1.581	1.372	1.205	-
OFL	49.323	45.887	1.207	44.021

Table 18: Comparisons of negative log-likelihood values for the selected model scenarios. It is important to note that comparisons among models may be limited since the number of parameters between models changes (e.g., **nopot** model).

Component	Ref	M0.21	M0.26	Notimeblock
Pot Retained Catch	-68.46	-68.88	-69.26	-68.63
Pot Discarded Catch	6.67	5.62	4.27	12.05
Trawl bycatch Discarded Catch	-8.26	-8.26	-8.26	-8.26
Fixed bycatch Discarded Catch	-8.23	-8.24	-8.25	-8.23
NMFS Trawl Survey	6.56	5.43	0.35	15.12
ADF&G Pot Survey CPUE	85.15	77.52	68.75	73.22
Directed Pot LF	-104.67	-104.81	-104.64	-96.15
NMFS Trawl LF	-260.01	-259.01	-261.38	-237.57
ADF&G Pot LF	-91.22	-91.91	-91.92	-84.16
Recruitment deviations	61.86	61.96	61.54	63.16
F penalty	9.66	9.66	9.66	9.66
M penalty	6.46	6.45	6.45	0.00
Prior	13.71	13.71	13.71	13.02
Total	-350.76	-360.75	-378.98	-316.77
Total estimated parameters	150.00	150.00	150.00	149.00

Table 4: Comparisons of management measures for the model scenarios. Biomass and OFL are in tons.

Component	Ref	M0.21	M0.26	Notimeblock
MMB_{2021}	1144.575	1077.861	1047.205	1032.327
B_{MSY}	3298.391	3333.337	3531.318	3005.061
MMB/B_{MSY}	0.339	0.308	0.288	0.336
F_{OFL}	0.048	0.049	0.000	0.047
OFL_{2021}	49.323	45.887	1.207	44.021
ABC_{2021}	36.992	34.415	0.905	33.016

- Management quantities are similar (error with M0.26 model in OFL)

Summary

- Model is not very sensitive to increases in natural mortality
- Removal of 1998 spike in M leads to changes in MMB and recruitment, and doesn’t fit size comp data
- Reference model still best option for this stock
- Update on rebuilding in fall
- Future work
  - Focus on Q – random walk or time blocks