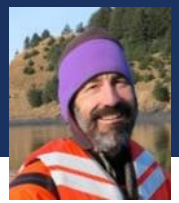
C3 BSAI CRAB STOCKS

KATIE PALOF & MIKE LITZOW,

CPT MEETING MINUTES – MAY 16 – 19TH, 2022



BSAI CRAB STOCKS MANAGEMENT TIMING

Aleutian Islands golden king crab
Pribilof Islands blue king crab *
Pribilof Islands golden king crab *
Western Aleutian Islands(Adak) red king crab *

Biennial cycle, next assessment in 2023

Assessed in May/June

Triennial cycle, next assessment in 2023

EBS snow crab
Bristol Bay red king crab
EBS Tanner crab
Pribilof Islands red king crab *
St. Matthew blue king crab *

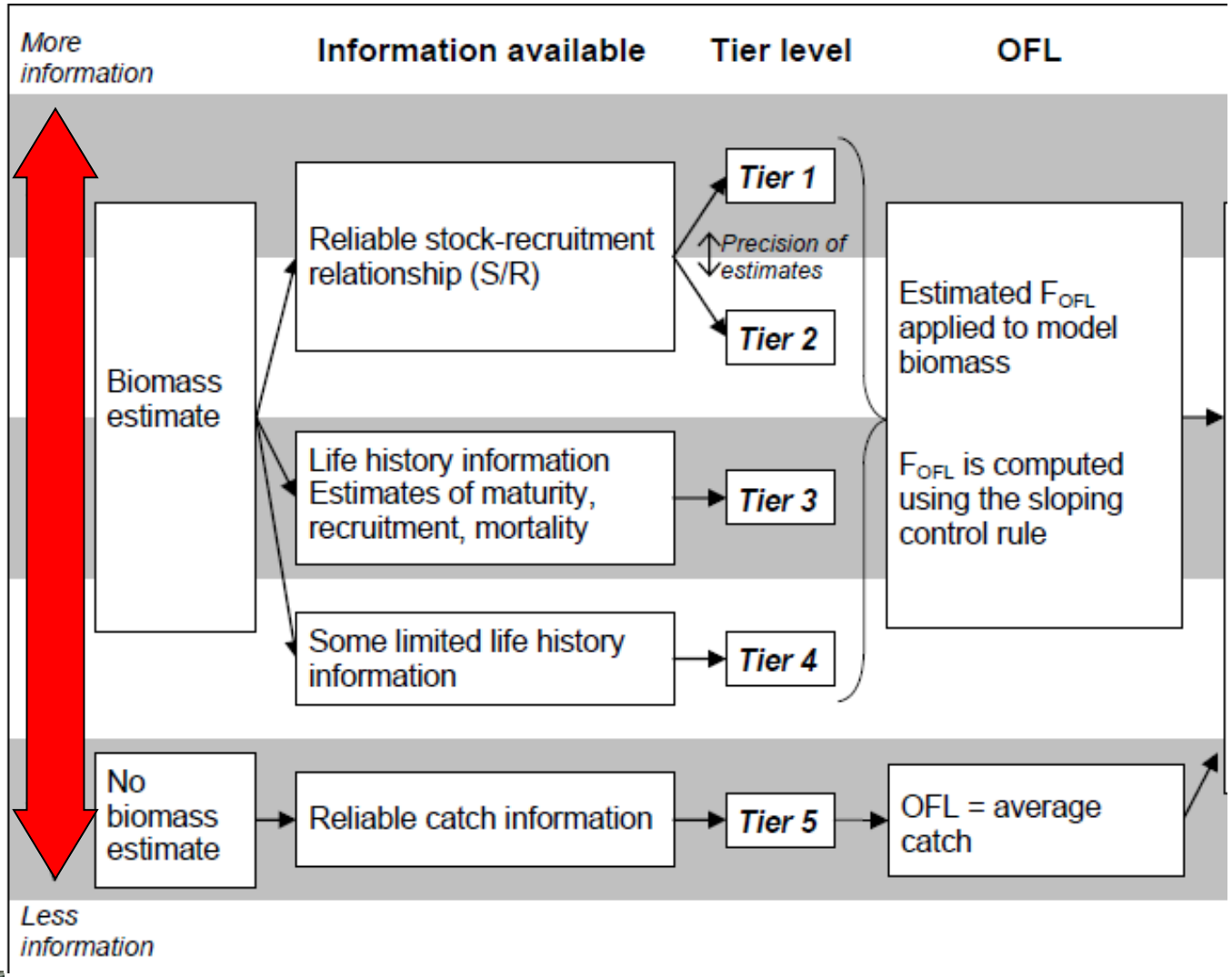
Assessed in September/ October

Triennial cycle, next assessment in 2022

Biennial cycle, next assessment in 2022

Norton Sound red king crab

Assessed in January/ February



ABC buffer

10-20%

10-25%

25-40%

MAY 2022 AGENDA

AIGKC final assessment, OFL and ABC

Proposed model runs for September:

- BBRKC, Tanner, SMBKC, PIRKC

Proposed model runs/GMACS adoption for snow crab (Cody)

Snow crab rebuilding plan (Cody)

Survey updates – corner station removal & BBRKC resampling protocols

Draft risk table updates - BBRKC

Research presentations – spatial assessment model for snow crab, snow crab IBM, BSFRF research projects

EFH next steps

Discussion on F35% and potential future alternatives

Timing of crab assessments discussion

BBRKC discussion paper planning (Oct)

Crab handling morality rate review

ALEUTIAN ISLAND GOLDEN KING CRAB (AIGKC)

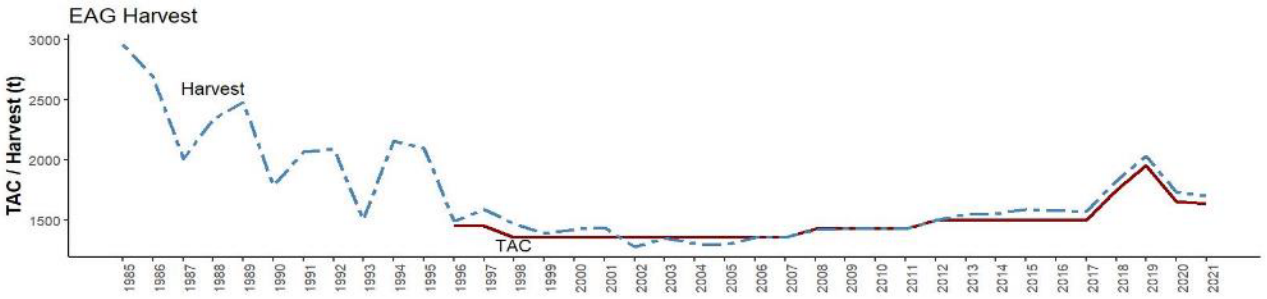
FINAL ASSESSMENT 2022

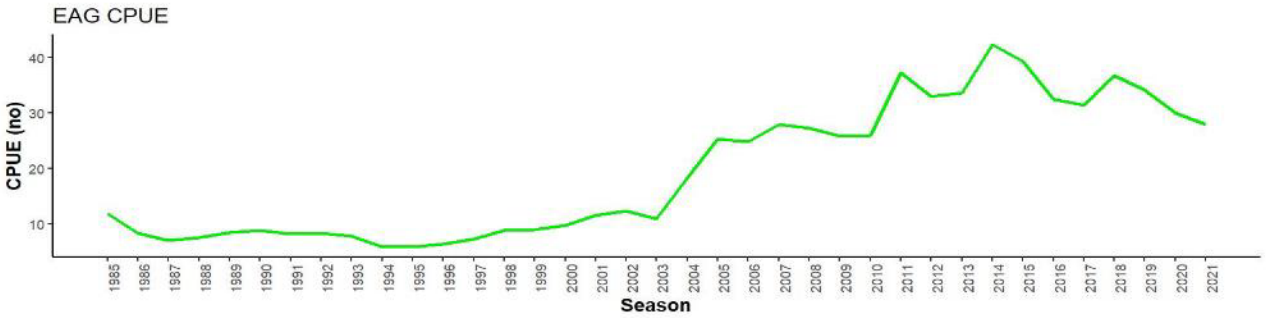
AIGKC MODELING APPROACH

- Integrated male-only length-based models fitted to fishery dependent catch and CPUE data.
- *Constant M* of 0.21yr^{-1}.
- Projected the abundance from unfished equilibrium in 1960 to initialize the 1985 abundance.
- 5 models with GMACS counterparts for EAG and WAG.
- Models were presented with knife-edge maturity size of 111 mm CL (status quo) and updated 116 mm CL maturity size (new data)
- Francis re-weighting method for Stage-2 effective sample sizes calculation for all models.

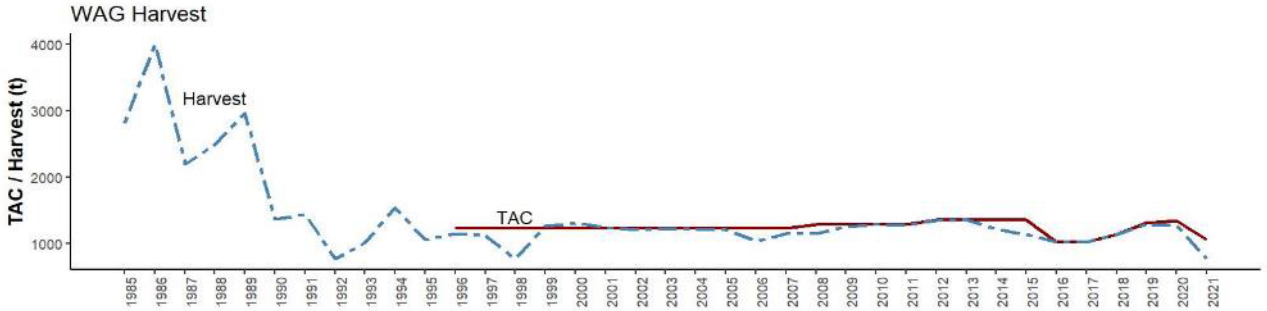
Catch (t) and CPUE (number of crab per pot lift), 1985/86–2021/22

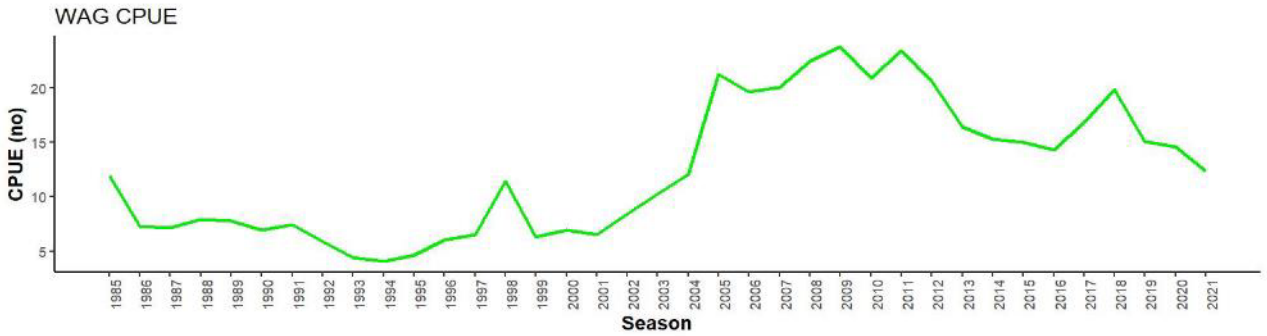
EAG





WAG





TACs :
2021/22:
(1) EAG: 3.61 million lbs
(2) WAG: 2.32 million lbs

*As of March 13, 2022, WAG fishery is ongoing (73%TAC harvested)

CPT/SSC COMMENTS

- Author addressed many of the CPT/SSC comments and concerns
- Updated model structure with 3 catchability coefficients (base model assumes catchability is the same for fish ticket and early observer CPUE series)
- Maturity analysis – in Appendix C
  - 116 mm CL vs 111 mm CL (currently used in assessment)
- Retrospective pattern in the EAG
- CPUE standardization
  - Provided plots asked for in Jan, but CPT did not see a retrospective run for this model
- GMACS versions of models – (Appendix E) good progress, some small issues with reference points (resolved in the last few weeks)

APPENDIX C: MALE MATURITY

			Breakpoint					
Source and Season	Region	Method	Mean	Median	SE	Upper Bound	Lower Bound	Remarks
NMFS samples (1984/85)	WAG	Ln (CH/CL) ~CL	108.825	107.564	0.162	126.000	103.847	CPT accepted method since 2007/08
	AI	Ln (CH/CL) ~CL	109.024	108.344	0.106	116.488	104.260	ditto
ADFG pot survey samples (1991/92)	EAG	Ln (CH/CL) ~CL	104.140	107.000	0.233	111.821	84.527	ditto
Co-operative survey, Observer and retained catch samples (2018/19 – 2020/21)	EAG	CH~CL	108.322	110.460	0.427	126.504	88.405	CPT suggested method since 2020/21
ditto	WAG	CH~CL	120.812	120.378	0.105	126.102	112.573	ditto
ditto	AI	CH~CL	116.795	118.105	0.147	122.804	105.757	ditto
All samples combined (1984/85 – 2020/21)	AI	CH~CL	122.908	122.783	0.039	125.097	120.455	ditto

AIGKC MODELS PRESENTED

Model	CPUE Data Type and Maturity Option	Period for Mean Number of Recruit Calculation
21.1a (accepted in May 2021, implemented with up to 2021/22 data)-base model	Observer data 1995/96–2021/22; Fish ticket data 1985/86–1998/99; minimum maturity size 111 mm CL; two catchability and CVs for the 1985/86–2004/05 and 2005/06–2021/22 periods.	1987–2017.
21.1e	21.1a+ three catchability and CVs (1985/86–1998/99; 1995/96–2004/05; and 2005/06–2021/22).	ditto
21.1f	21.1e+ observer Year:Area interaction CPUE.	ditto
21.1e2	21.1e+ minimum maturity size 116 mm CL.	ditto
21.1f2	21.1f+ minimum maturity size 116 mm CL.	ditto
GMACS Ver. of the above five models: 21.1aG, 21.1eG, 21.1fG, 21.1e2G, 21.1f2G		

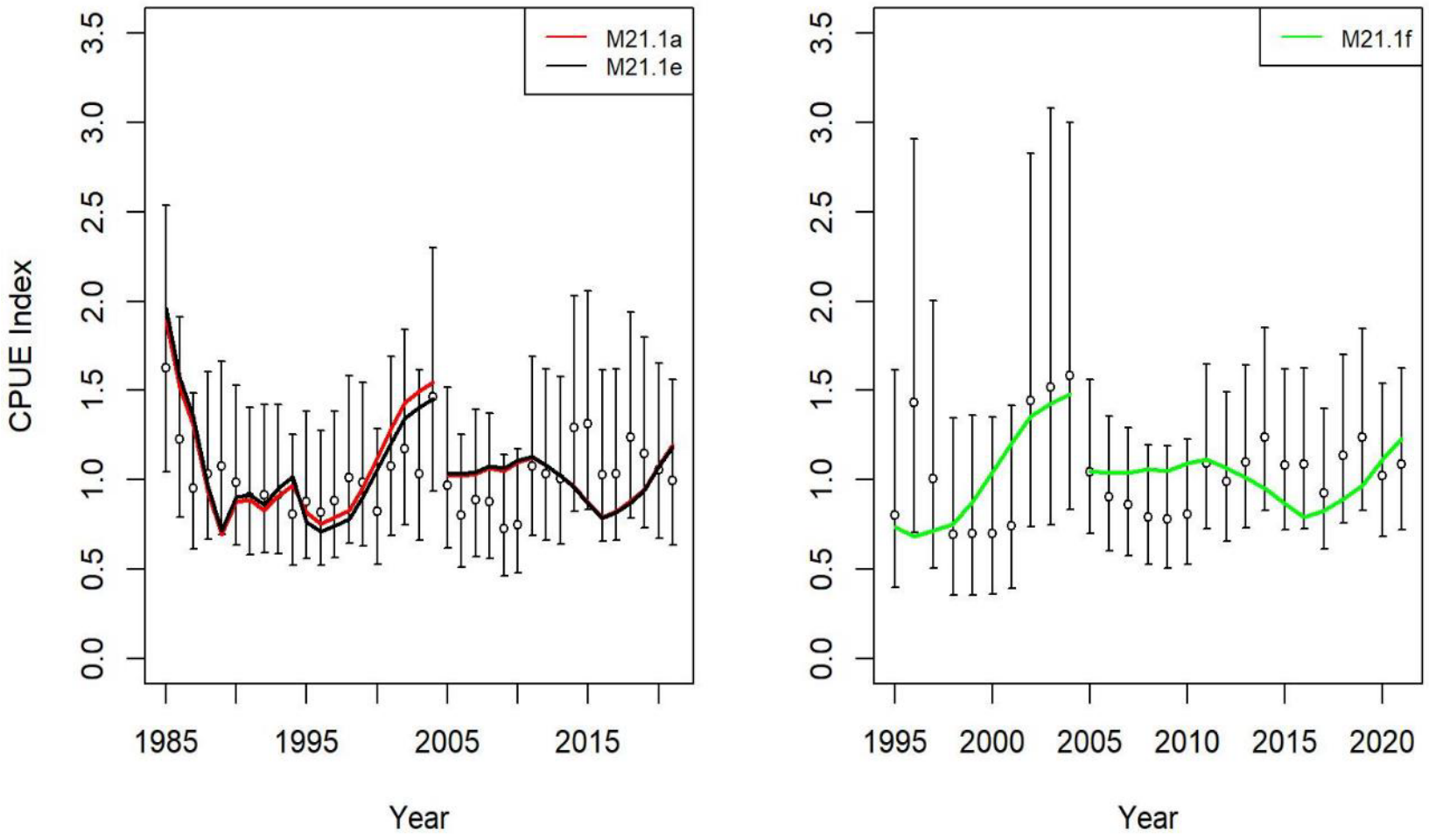


Figure 22. Comparison of input CPUE indices [open circles with +/- 2 SE for model 21.1a (left) and model 21.1f (right)] with predicted CPUE indices (colored solid lines) under 21.1a (red) and 21.1e (black)[left]; and 21.1f (green) [right] for EAG golden king crab data, 1985/86–2021/22. Model estimated additional standard error was added to each input standard error.

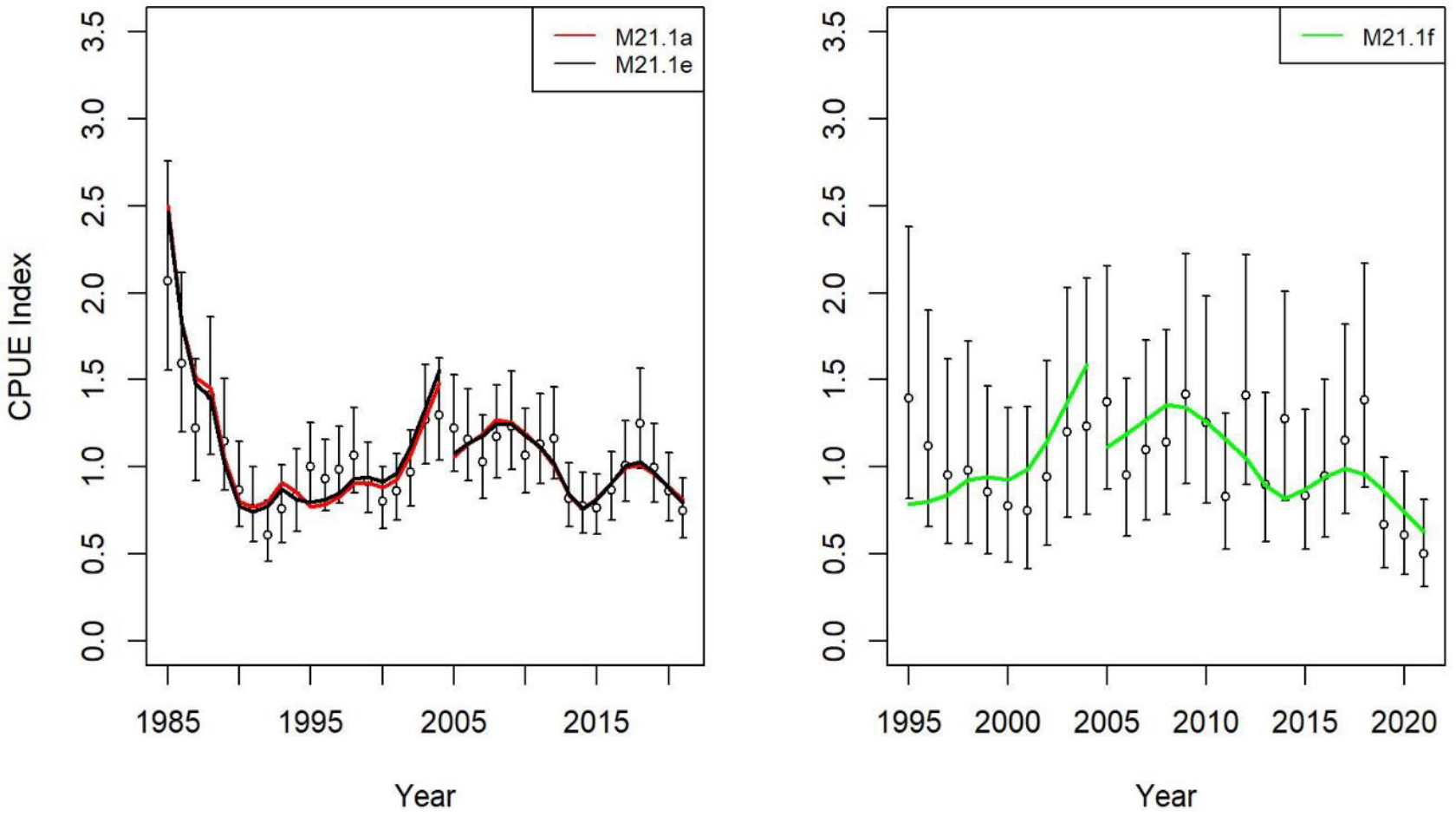
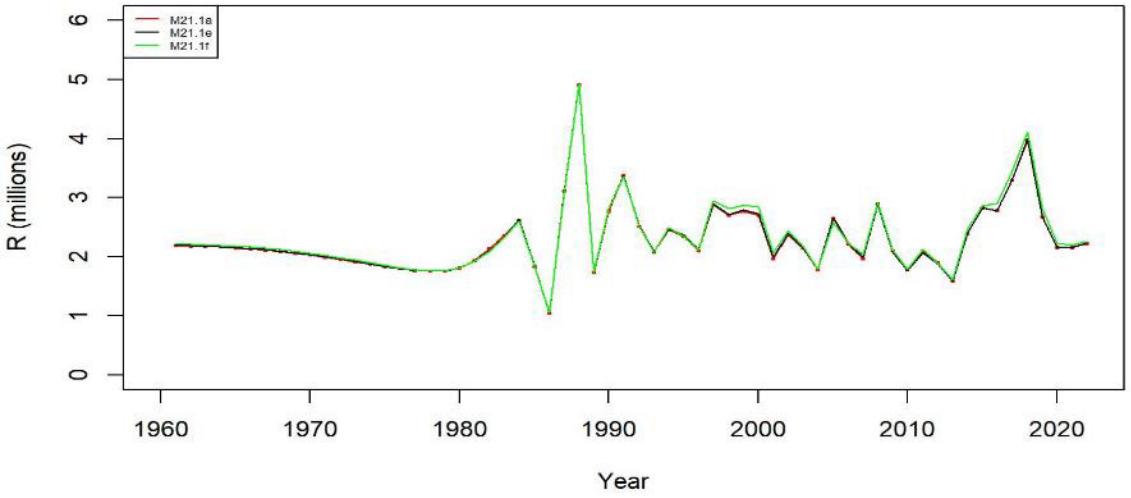


Figure 38. Comparison of input CPUE indices [open circles with +/- 2 SE for model 21.1a (left) and model 21.1f (right)] with predicted CPUE indices (colored solid lines) under 21.1a (red) and 21.1e (black)[left]; and 21.1f (green) [right] for WAG golden king crab data, 1985/86–2021/22. Model estimated additional standard error was added to each input standard error.

ESTIMATED NUMBER OF MALE RECRUITS (CRAB SIZE ≥ 101 MM CL) TO THE ASSESSMENT MODEL UNDER MODELS 21.1A (RED), 21.1E (BLACK), AND 21.1F (GREEN) FITS TO EAG AND WAG GOLDEN KING CRAB DATA, 1961–2022.

EAG
Fig. 14



WAG
Fig. 30

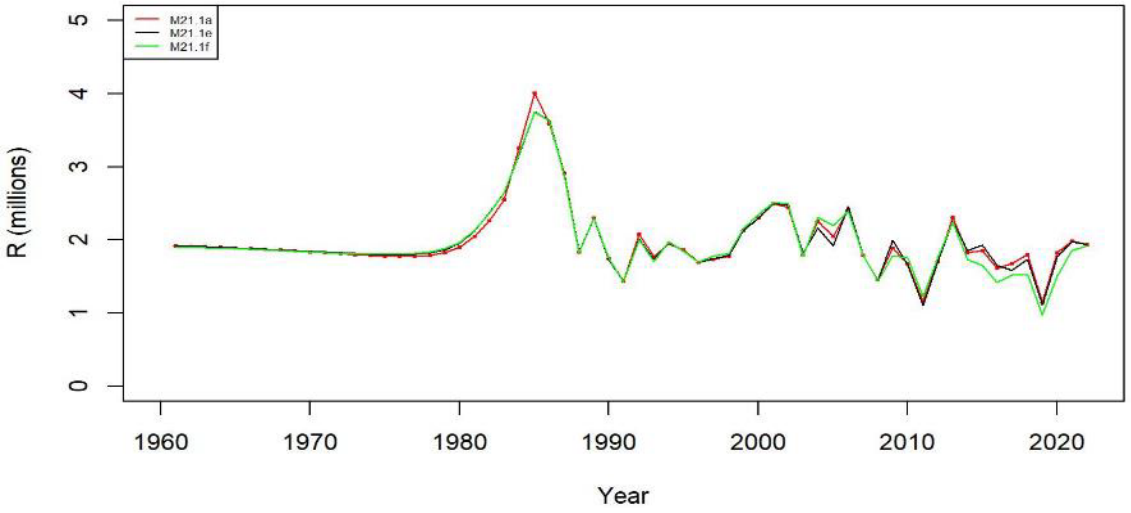
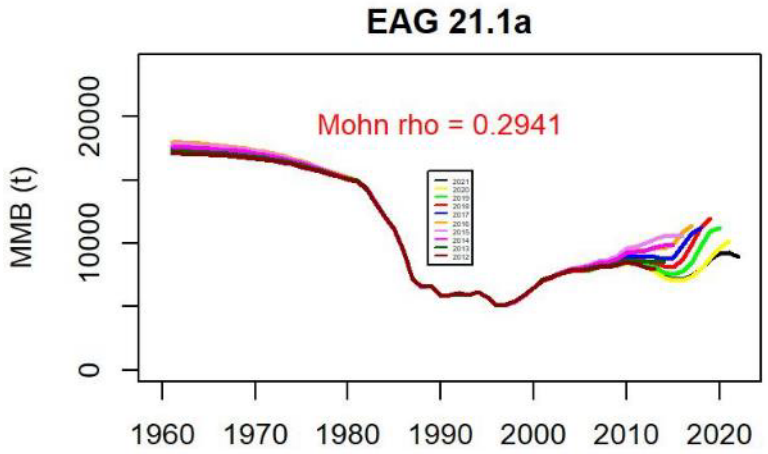
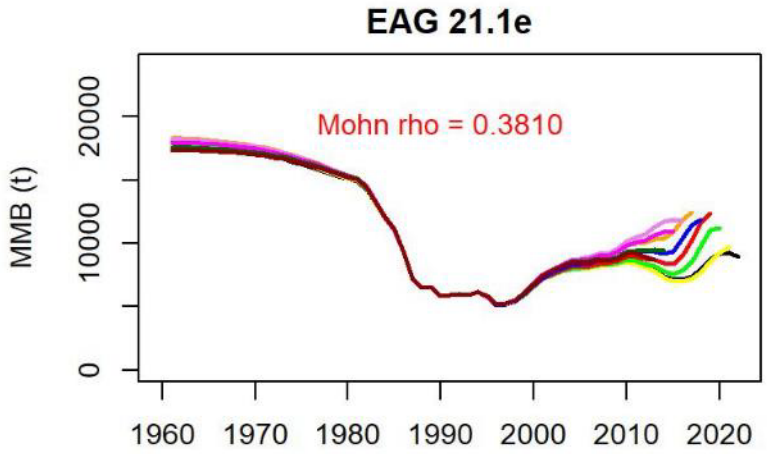


FIGURE 21. RETROSPECTIVE FITS OF MMB (WITH 9 PEELS) - 21.1A, 21.1E, AND 21.1EQ (VARIABLE CATCHABILITY DURING THE POST-RATIONALIZATION PERIOD) FOR GOLDEN KING CRAB IN THE EAG, 1961–2022.





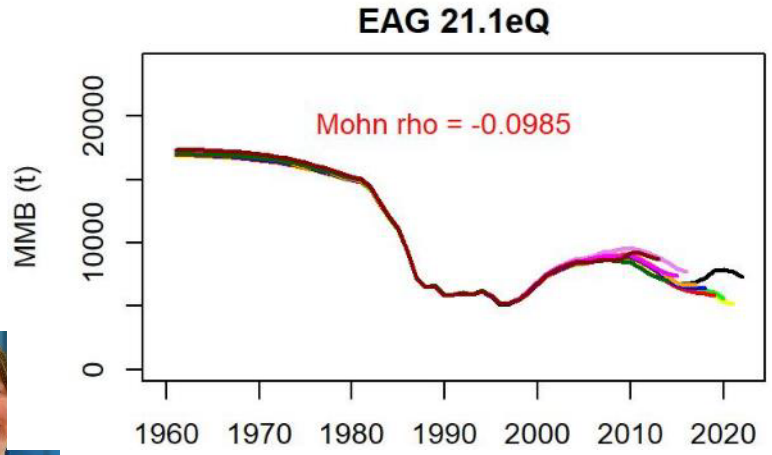
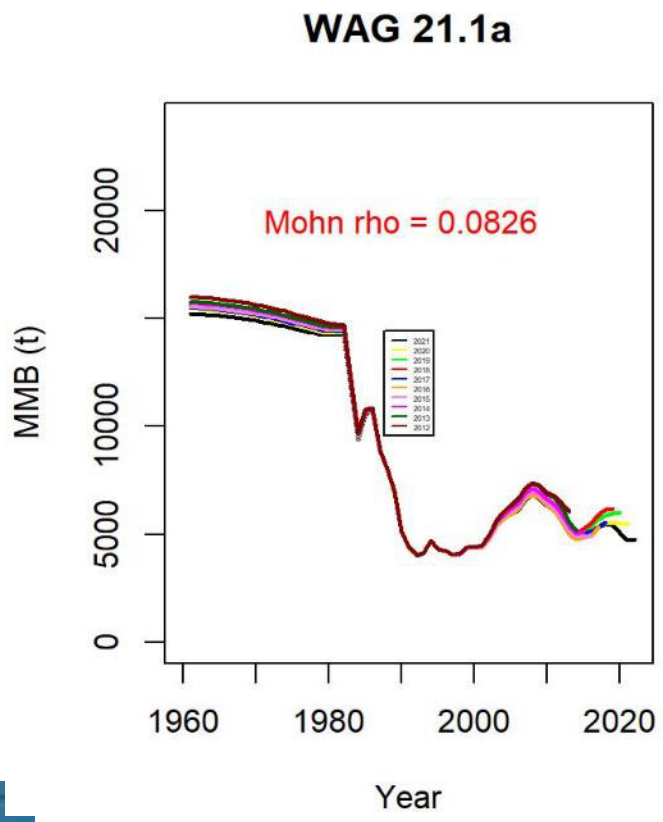
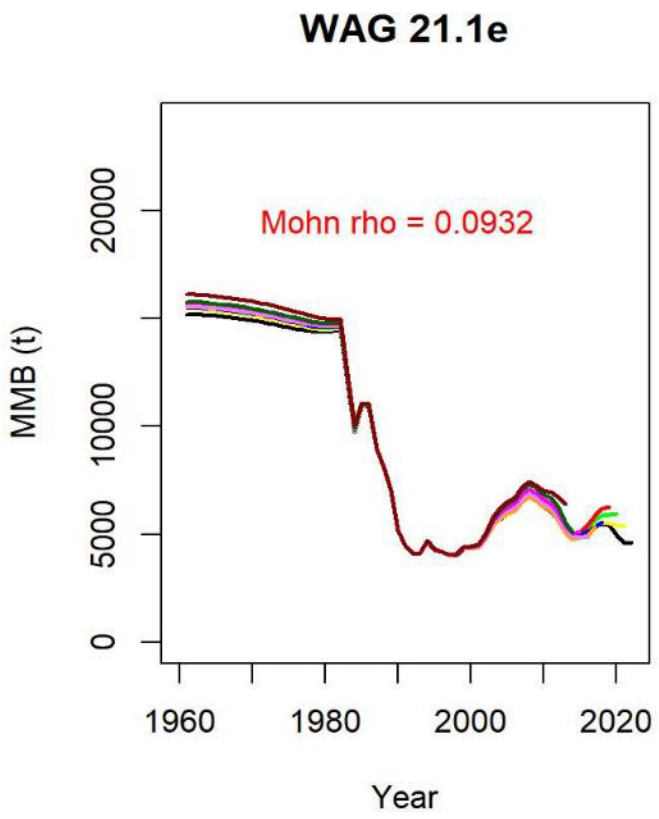
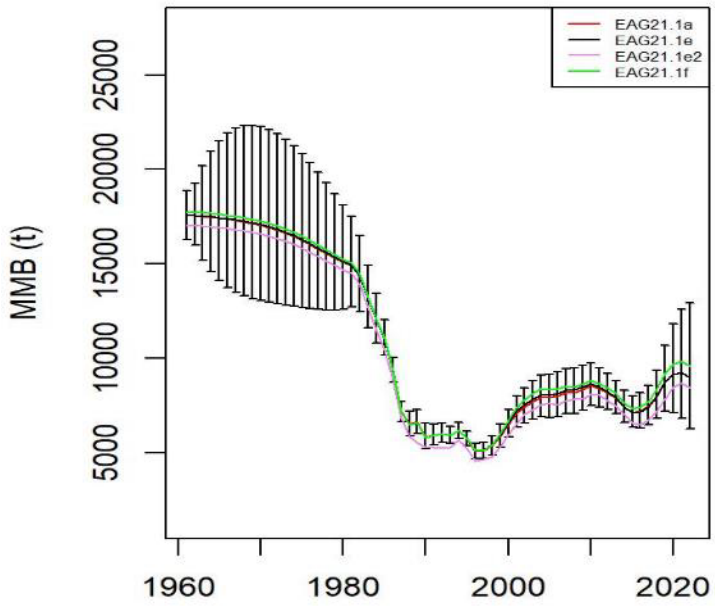


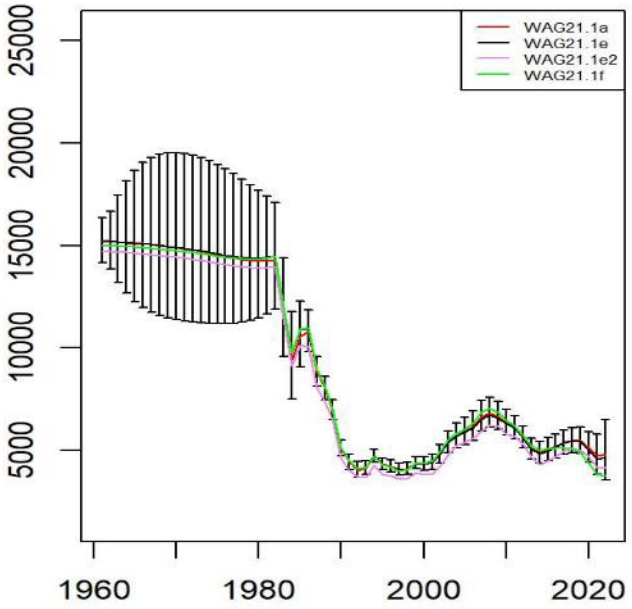
FIGURE 37. RETROSPECTIVE FITS OF MMB (WITH 9 PEELS) FOLLOWING REMOVAL OF TERMINAL YEAR DATA UNDER MODELS 21.1A AND 21.1E FOR GOLDEN KING CRAB IN THE WAG, 1961–2022.

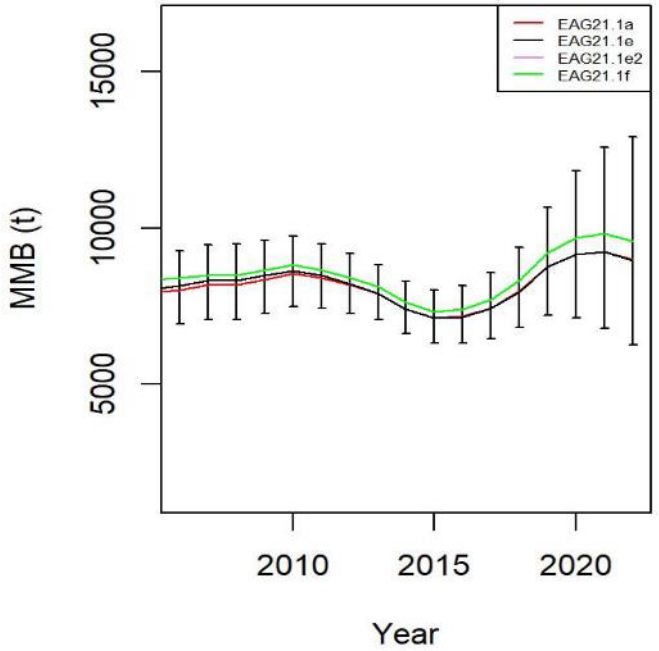


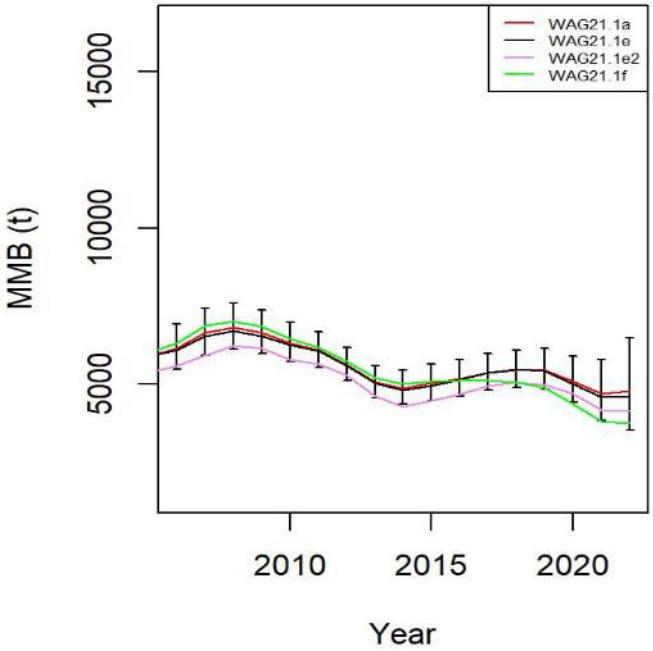


AIGKC final assessment 2022









Status and catch specifications for the entire Aleutian Islands fisheries (million lb)

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch[a]	OFL	ABC[b]
2018/19	12.964	39.348	6.356	6.536	7.433	12.157	9.118
2019/20	13.041	36.124	7.180	7.317	8.222	11.572	8.679
2020/21	13.259	34.043	6.610	6.614	7.759	10.579	7.934
2021/22	12.917[c]	27.760[c]	5.930	5.460	6.007	10.620[d]	7.434[d,e]
2022/23		26.326[c]				8.291[c]	6.219[c,f]

a. Total retained catch plus estimated bycatch mortality of discarded bycatch during crab fisheries and groundfish fisheries.
b. 25% buffer was applied to total catch OFL to determine ABC.
c. Model 21.1e2 with hypothetical completed fisheries data from WAG was used to estimate MSST, MMB, and MMB projection for 2022/23.
d. OFL and ABC were estimated by the accepted model 21.1a in May 2021 assessment when the WAG fishery was not completed.
e. 30% buffer was applied to total catch OFL to determine ABC for the 2021/22 fishing season after SSC/Council's recommendation.
f. A proposed 25% buffer was applied to total catch OFL to determine ABC for the 2022/23 fishing season.

AIGKC RECOMMENDATIONS

- Model 21.1e2 chosen as recommended model by CPT
  - 3 catchability parameters (improvement to base model)
  - 116 mm CL size-at-maturity
    - Sample size increased (new data 10,815 vs. old data 3,755)
    - Combined data not valid due to change in sampling protocols
    - Future work on area specific size-at-maturity?
- Buffer 25%
  - “base” buffer from last year
  - Similar concerns from the past year with some improvements but none to lower buffer
- Future recommendations (more in minutes):
  - Transition to GMACS
  - Cooperative survey index included in EAG model
  - Investigate retrospective pattern in EAG

BBRKC PROPOSED MODEL RUNS

- Change in authorship
- Model scenarios explored:
  - Starting date for time series (status quo vs 1985)
  - M assumptions
    - Fixed or estimated in model
    - Additional mortality periods (late 70s/early 80s, 2015-2018)
  - Impacts of BSFRF data – specifically on selectivity
    - Q potentially higher than 1 due to herding
    - Removal decreases retrospective patterns
    - Not greatly influential data set in current model

MODEL EXPLORATIONS

21.1: the base model from September 2021.

21.1a: model 21.1 + using the **recently updated version of GMACS** (version 2.01.E).

21.1b: model 21.1a + **updated groundfish fisheries bycatch** data.

22.0: model 21.1b + starting in 1985.

22.0a: model 22.0 (start in 1985) + estimating a constant *M* for males.

22.0b: model 22.0a + estimating a catchability Q for the BSFRF survey.

22.0c: model 22.0a + no BSFRF survey data.

22.0d: model 22.0c (start in 1985, no BSFRF) + fixing $M = 0.18$ for males.

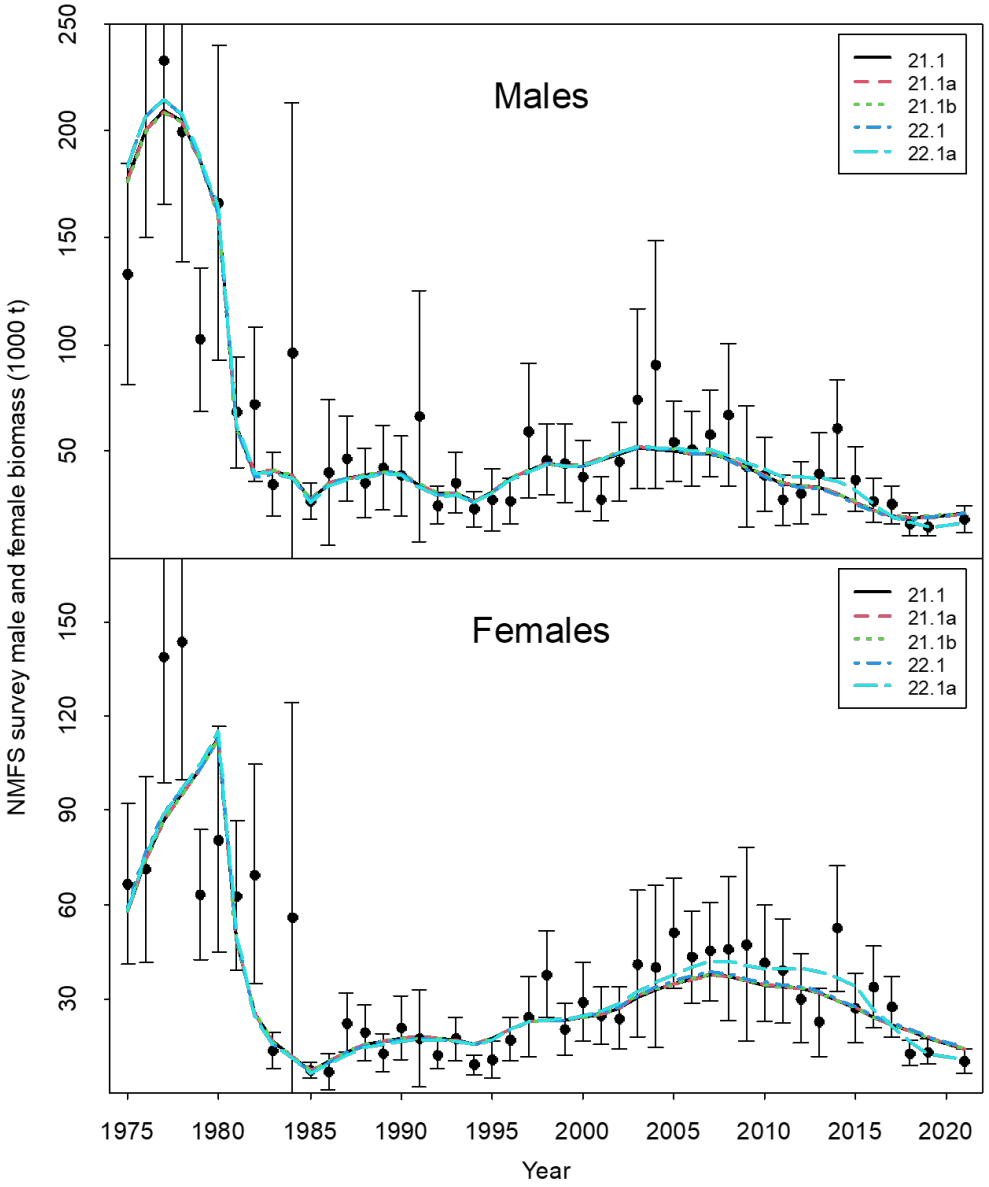
22.0e: model 22.0d + estimating a constant *M* for males during 2015-2018.

22.1: model 21.1b + no BSFRF survey data.

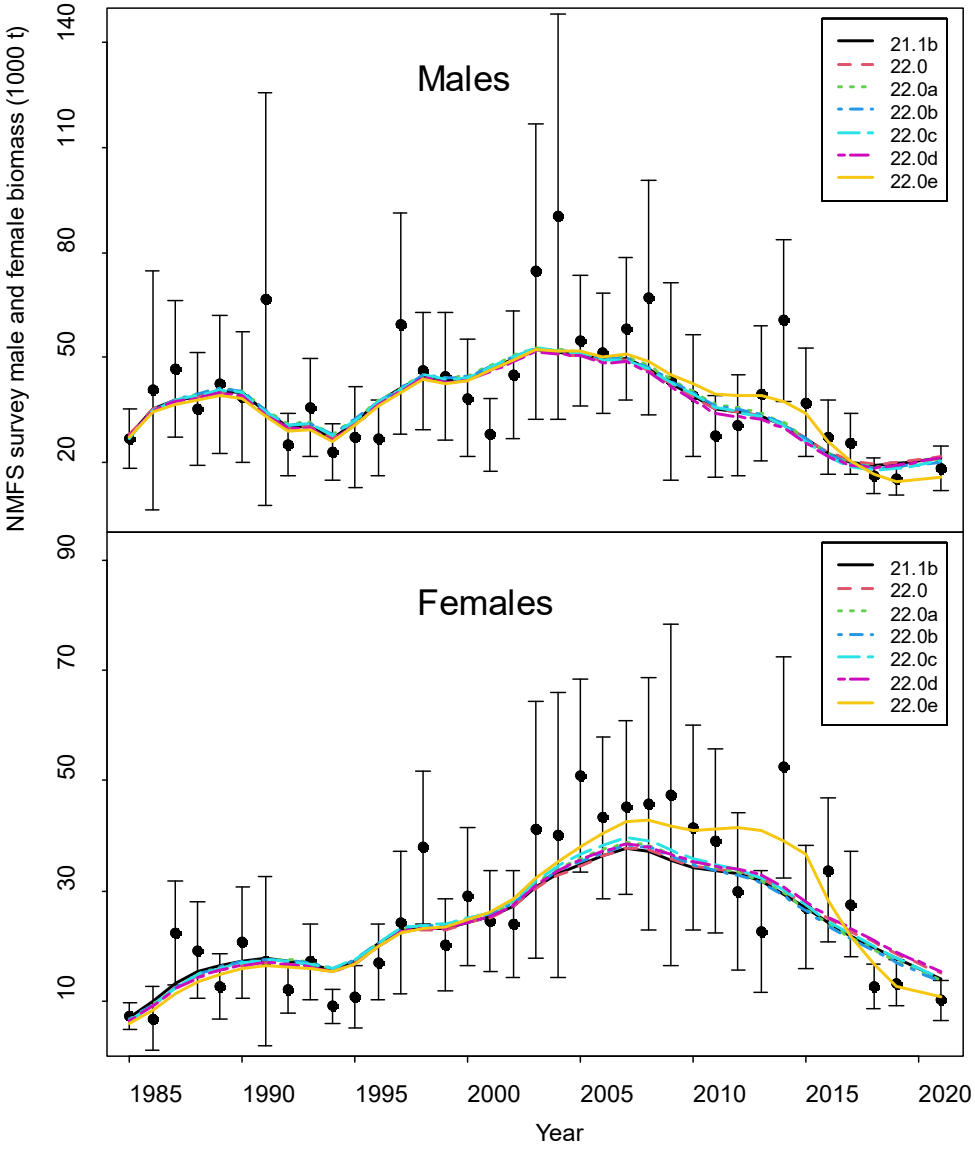
22.1a: model 22.1 + estimating a constant *M* for males during 2015-2018.

COMPARISON OF MODELS

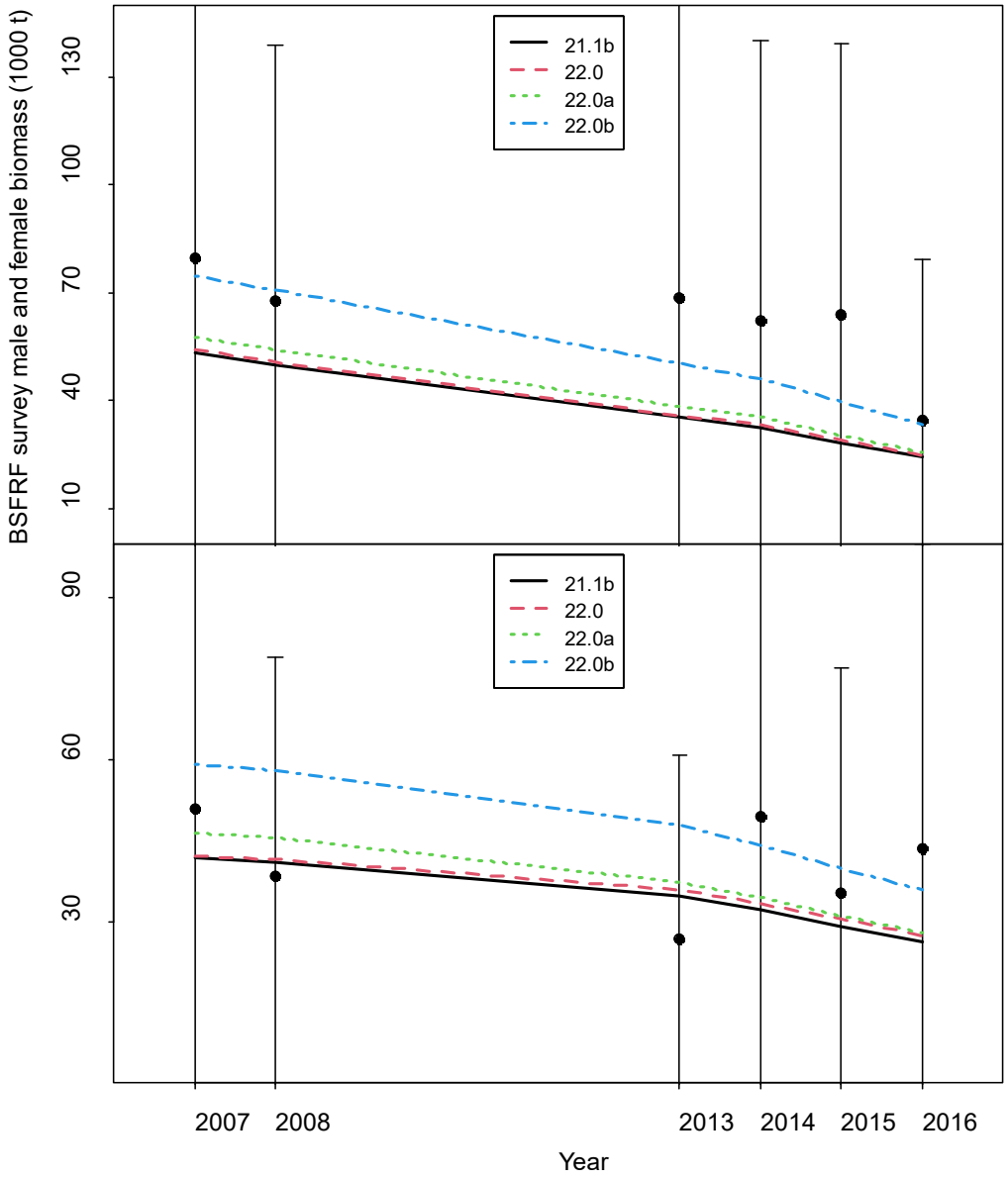
Model	New?	Male M	Starting date	M time block (2015-2018)	BSFRF data	BSFRF Q
21.1		80-84:M1, others: 0.18		N	Y	1.0
21.1a	GMACS version	80-84:M1, others: 0.18		N	Y	1.0
21.1b	21.1a + GF bycatch	80-84:M1, others: 0.18		N	Y	1.0
22.0		M = 0.18	1985	N	Y	1.0
22.0a		M = M1	1985	N	Y	1.0
22.0b		M = M1	1985	N	Y	Estimated
22.0c		M = M1	1985	N	N	--
22.0d		M = 0.18	1985	N	N	--
22.0e		M = 0.18, 15-18: M1	1985	Y	N	--
22.1		80-84:M1, others: 0.18		N	N	--
22.1a		80-84:M1, 15-18: M2, others: 0.18		Y	N	--



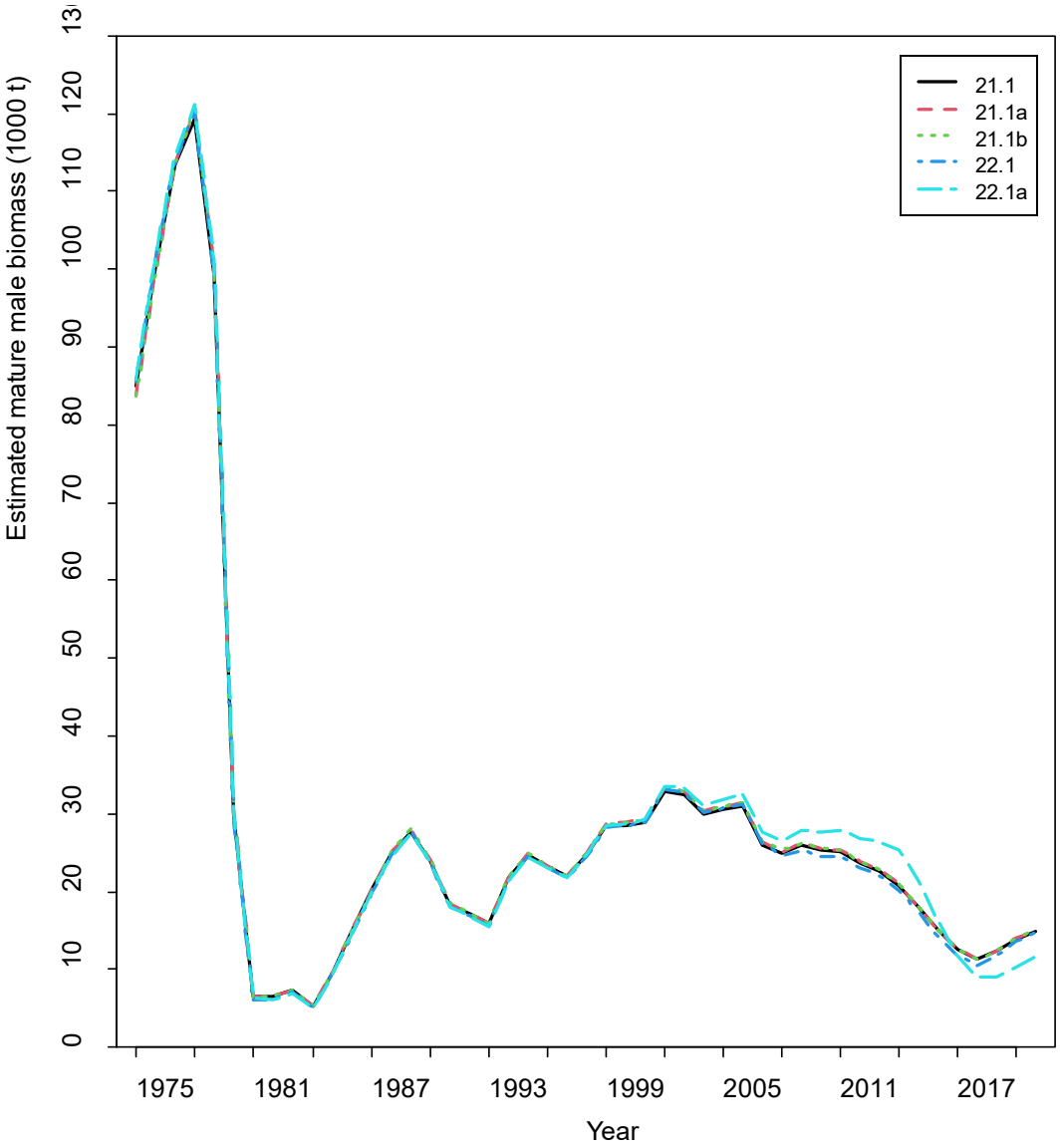
- Error bars are + 2SD of model 21.1b
- Models start in 1975
- Models 22.1/22.1a (no BSFRF data)
- Model 22.1a has extra time block for M (2015-18)



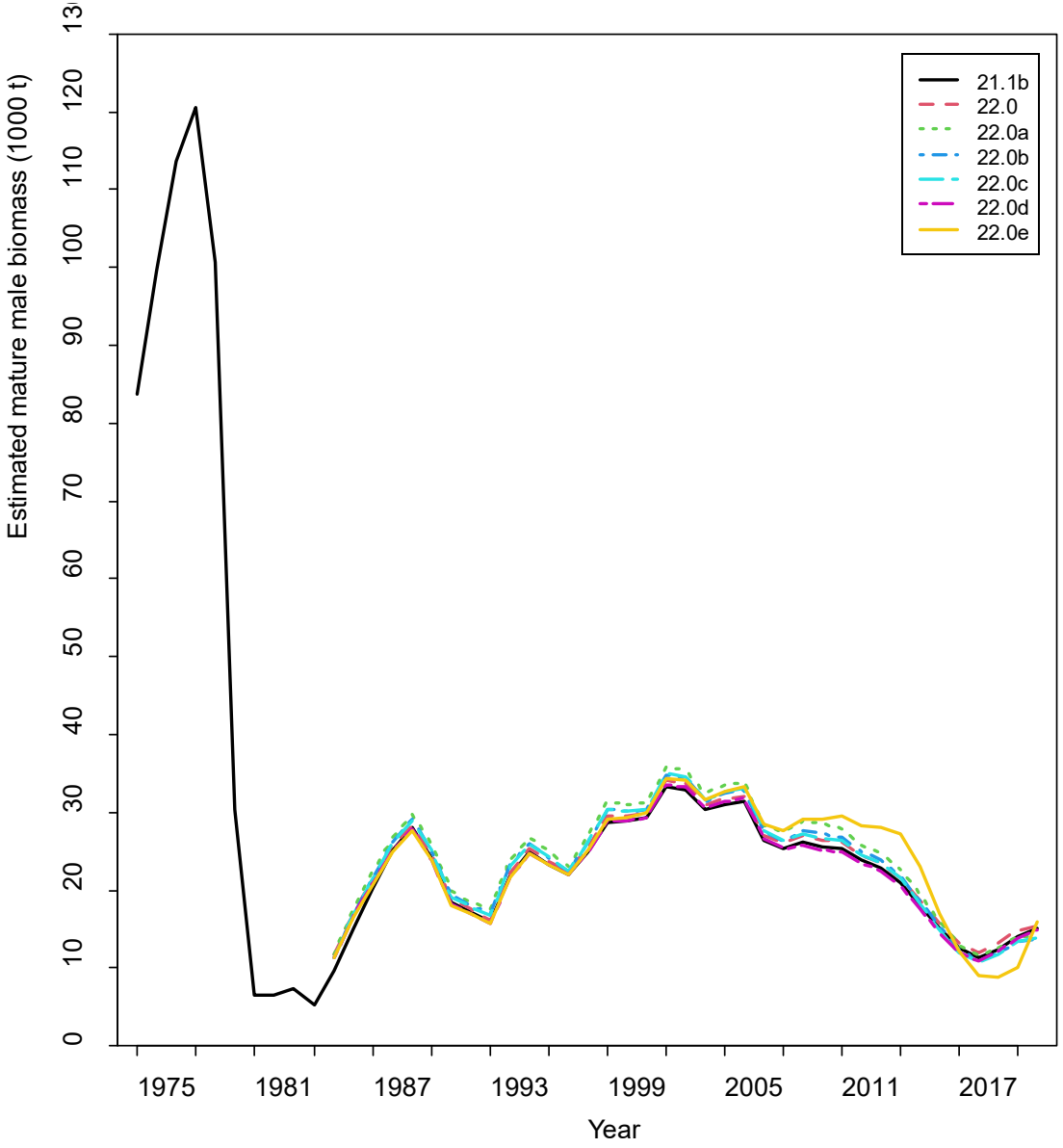
- Error bars are ± 2SD of model 22.0 (base at 1985 start)
- Models start in 1985
- Model 22.0e has extra time block for M (2015-18)



- Error bars are plus and minus 2 standard deviations of model 21.1b.
- BSFRF survey catchability is assumed to be 1.0 for all models except for model 22.0b which estimates the catchability.
- 22.0b –
  - Q =1.36



Estimated absolute mature male biomasses during 1975-2021 for models 21.1, 21.1a, 21.1b, 22.1, and 22.1a. Mature male biomass is estimated on Feb. 15, year+1.



Estimated absolute mature male biomasses during 1975-2021 for models:

- 21.1b

1985-2021 for models:

- 22.0, 22.0a, 22.0b, 22.0c, 22.0d, and 22.0e.

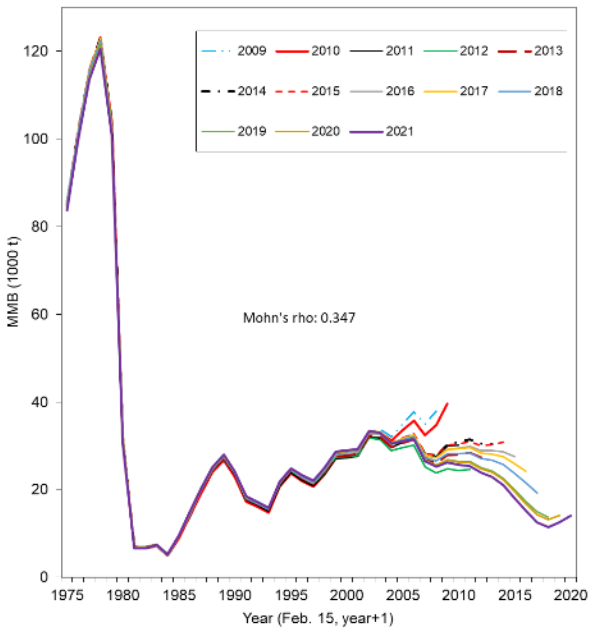
22.0e (extra M time block, no BSFRF data)

Table 7. **Natural mortality estimates** for nine model scenarios during different year blocks. Rows denoted with “base” indicate the estimate defaulted to the base value in the first column or third column.

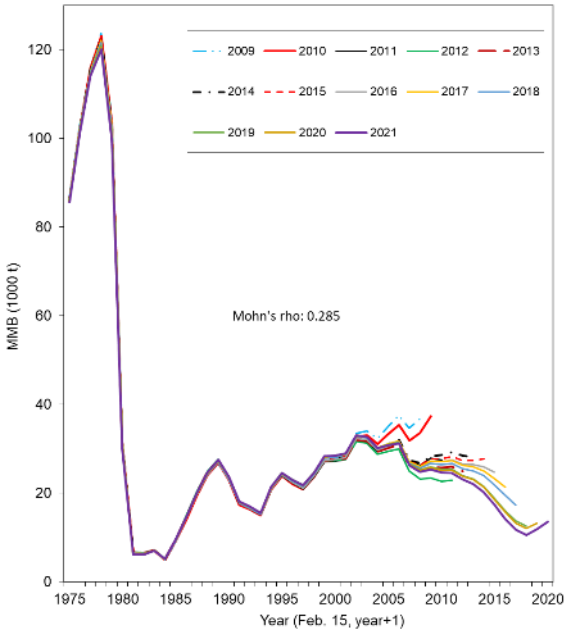
Model	Sex	1975-1979, 1985-2014, 2019-2021	1980-1984	1985-2014 2019-2021	2015-2018
21.1b	Males	0.180	0.890		base
	Females	0.238	1.179		base
22.0	Males			0.180	base
	Females			0.232	base
22.0a	Males			0.226	base
	Females			0.261	base
22.0b	Males			0.225	base
	Females			0.261	base
22.0c	Males			0.223	base
	Females			0.260	base
22.0d	Males			0.180	base
	Females			0.231	base
22.0e	Males			0.180	0.333
	Females			0.220	0.406
22.1	Males	0.180	0.883		base
	Females	0.239	1.172		base
22.1a	Males	0.180	0.909		0.304
	Females	0.231	1.164		0.389

RETROSPECTIVE PATTERNS FOR MMB FOR RECOMMENDED MODELS

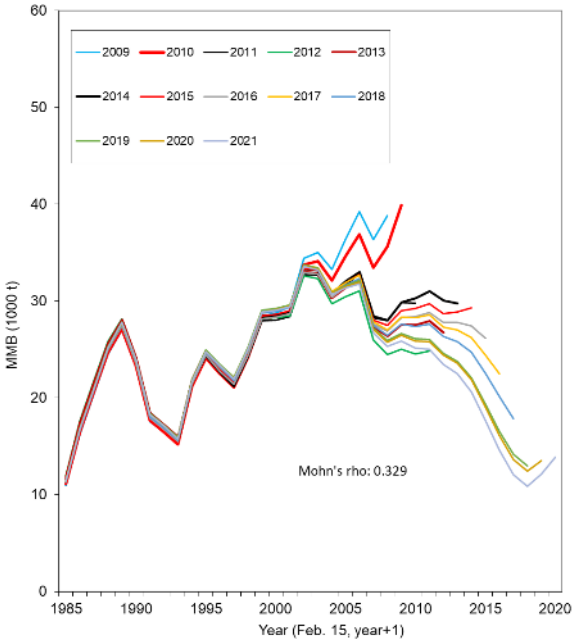
Model 21.1b



Model 22.1



Model 22.0d



SUMMARY - BBRKC

- Model 21.1b represents updated base – updates to GMACS and bycatch data
- Reducing the date time series produces similar results without complicated of M time block
- Estimating M results in higher M and higher F35%, confounding issues
- Estimating Q for BSFRF data >1.0, not much difference
- Dropping BSFRF data allows for better fits to other data and reduces some retrospective (Mohn's rho decreased)
- Extra time block – fits recent NMFS survey data better, reduces retrospective
- Two factors in model choice:
  - Assumption of BSFRF survey catchability
  - Estimation of M

CPT RECOMMENDATIONS - BBRKC

- Model runs for September:
  - Model 21.1b – updated status quo model
  - Model 22.0a – starts in 1985, estimates national mortality
  - Model 22.0 (not 22.0d) – starts in 1985,
- Additional future explorations:
  - Explore initial conditions parameterization

TANNER PROPOSED MODEL RUNS

- Impacts on assessment
  - potential loss of EBS shelf survey corner stations
  - changes in bycatch estimation in groundfish fisheries
  - revised input sample sizes for survey size compositions
- Model simplifications
  - fit to ADFG management area-specific directed fishery catch data rather than aggregated data
    - may simplify selectivity for the directed fishery
  - start in 1982 to avoid
    - uncertain foreign fleet catch data
    - No elevated mortality period
    - major changes in survey gear, areal coverage
    - long initialization period
- Model additions
  - ability to estimate non-equilibrium initial numbers-at-XMSZ
  - multiyear projections with a range of potential F's
- Proposed models for September assessment

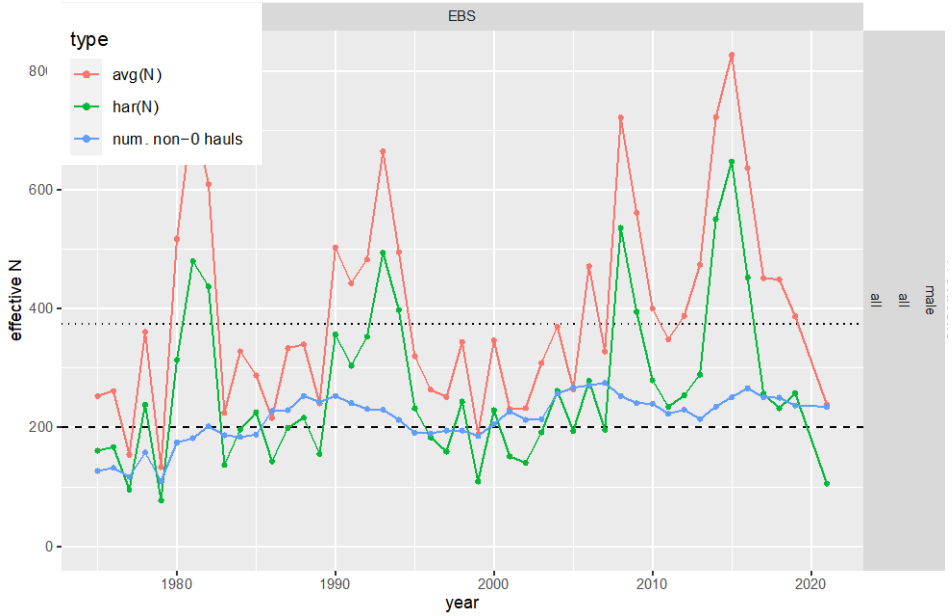
TANNER MODEL EXPLORATIONS

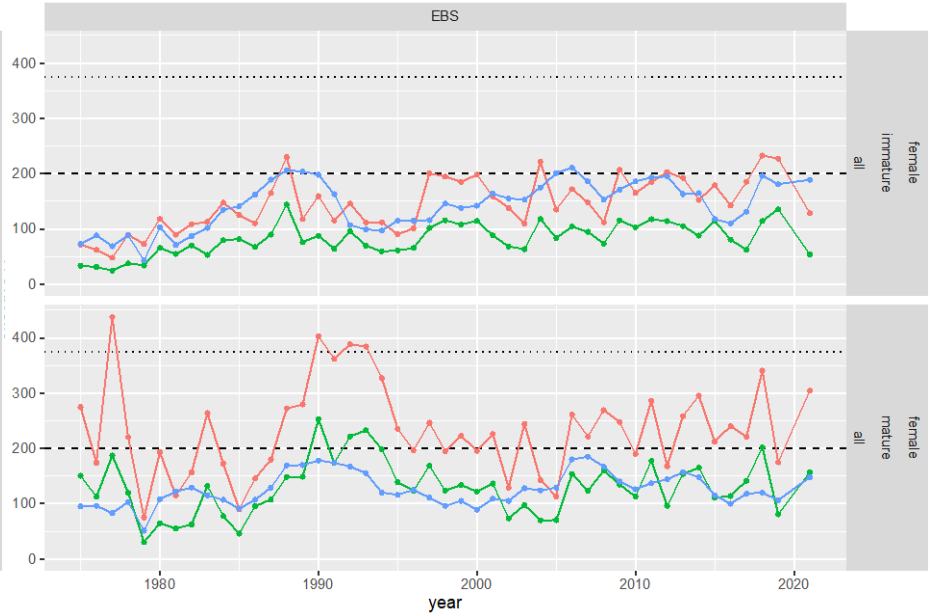
model configuration	parent	changes	number of parameters
21.22a	--	2021 assessment model	346
No Corner Stations	21.22a	survey biomass time series and size compositions calculated using NMFS trawl survey hauls with the "corner" stations removed for all years	346
22.01	21.22a	using updated bycatch estimates for the groundfish fisheries used in place of old versions	346
22.02	21.22a	using input sample sizes for survey size compositions based on effective sample sizes from bootstrapping in place of default value of 200	346
22.03	21.22a	fits to fishery catch data changed from sex-specific to aggregated, corresponding fits to size composition data changed to extended versions	346
22.04a	21.22a	using directed fishery data by ADFG management areas from 2005 on + changes to selectivity functions for directed fishery and snow crab fishery	350
22.04b	21.22a	fishery biomass likelihoods change from lognormal to normal	350
22.05a, b, c, d	21.22a	Starting model in 1982, all data prior to 1982 dropped, estimating initial population size using individual parameters on log scale, a-d: increased weights	403
22.06a, b, c, d	21.22a	Starting model in 1982, all data prior to 1982 dropped, estimating initial population size using individual parameters on logistic scale, a-d: increased weights	404

MOTIVATIONS: 22.02—REVISED SURVEY SAMPLE SIZES

22.02: revised input sample sizes for survey size comps

- current input sample sizes are fixed at 200
- concerned that size comps may be overweighted
- used bootstrapping to estimate effective sample sizes
  - effective sizes higher than current input sample sizes

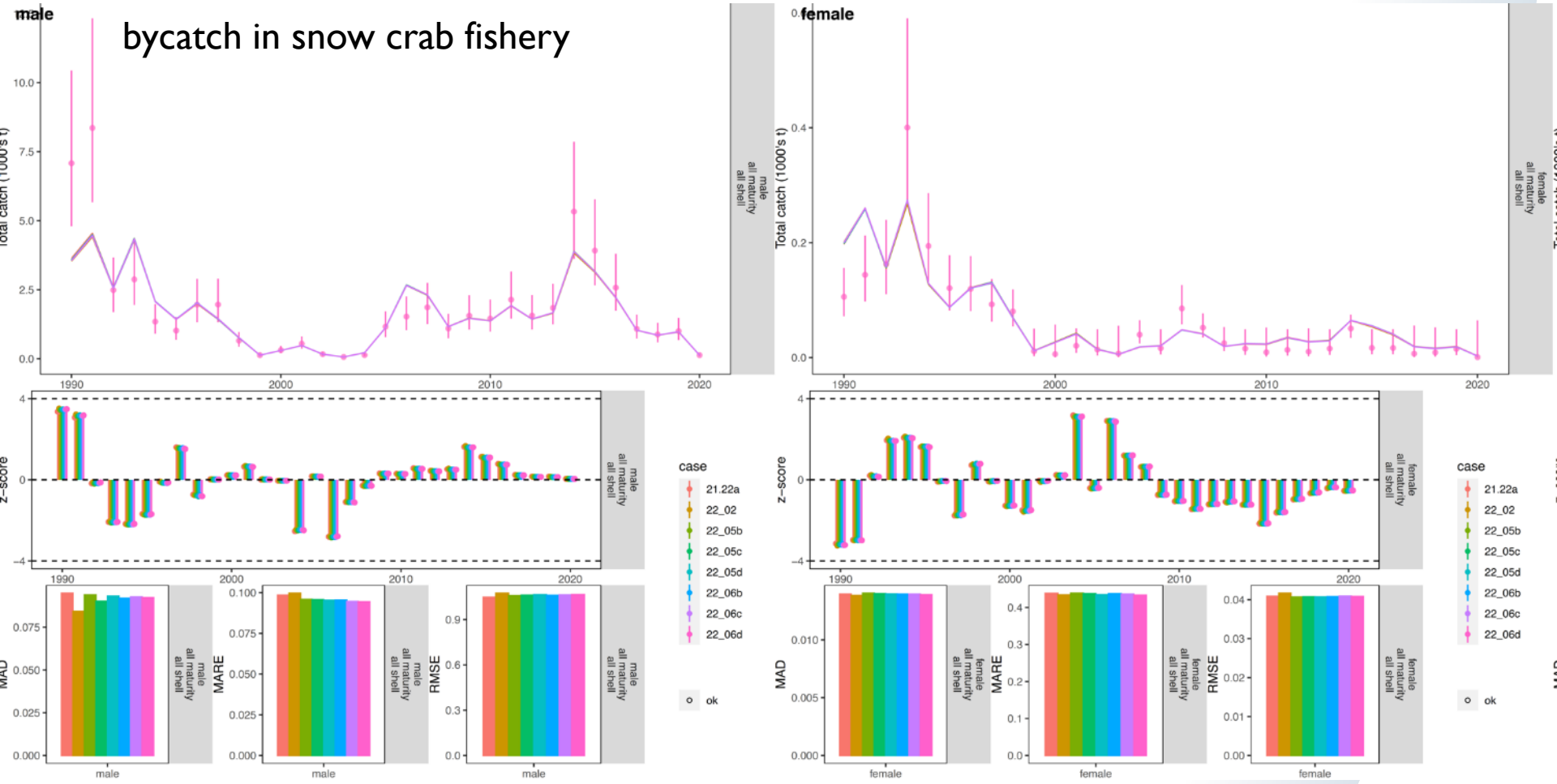




FISHERIES

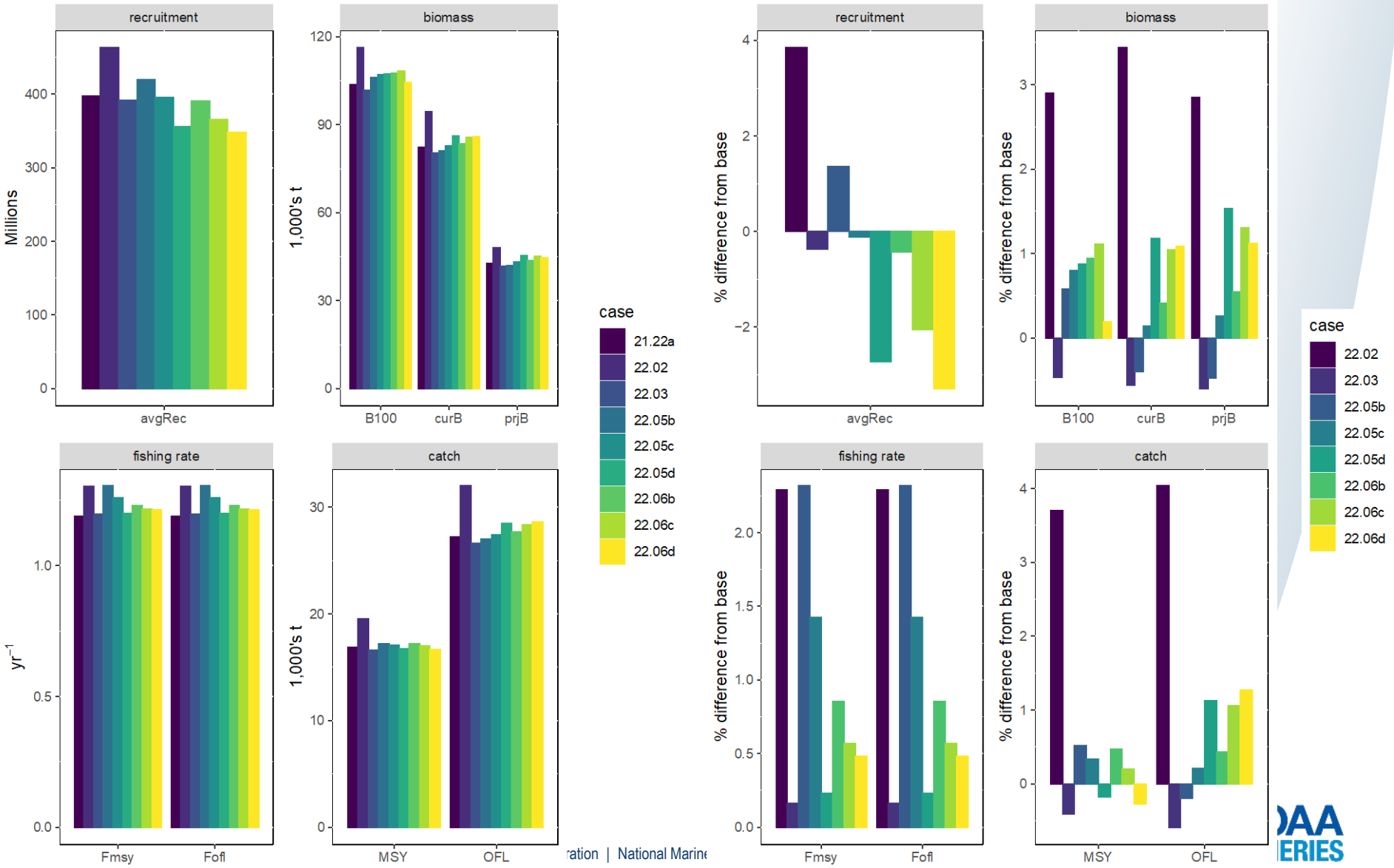
MOTIVATIONS: 22.03--FIT TO TOTAL CATCH BIOMASS

bycatch in snow crab fishery

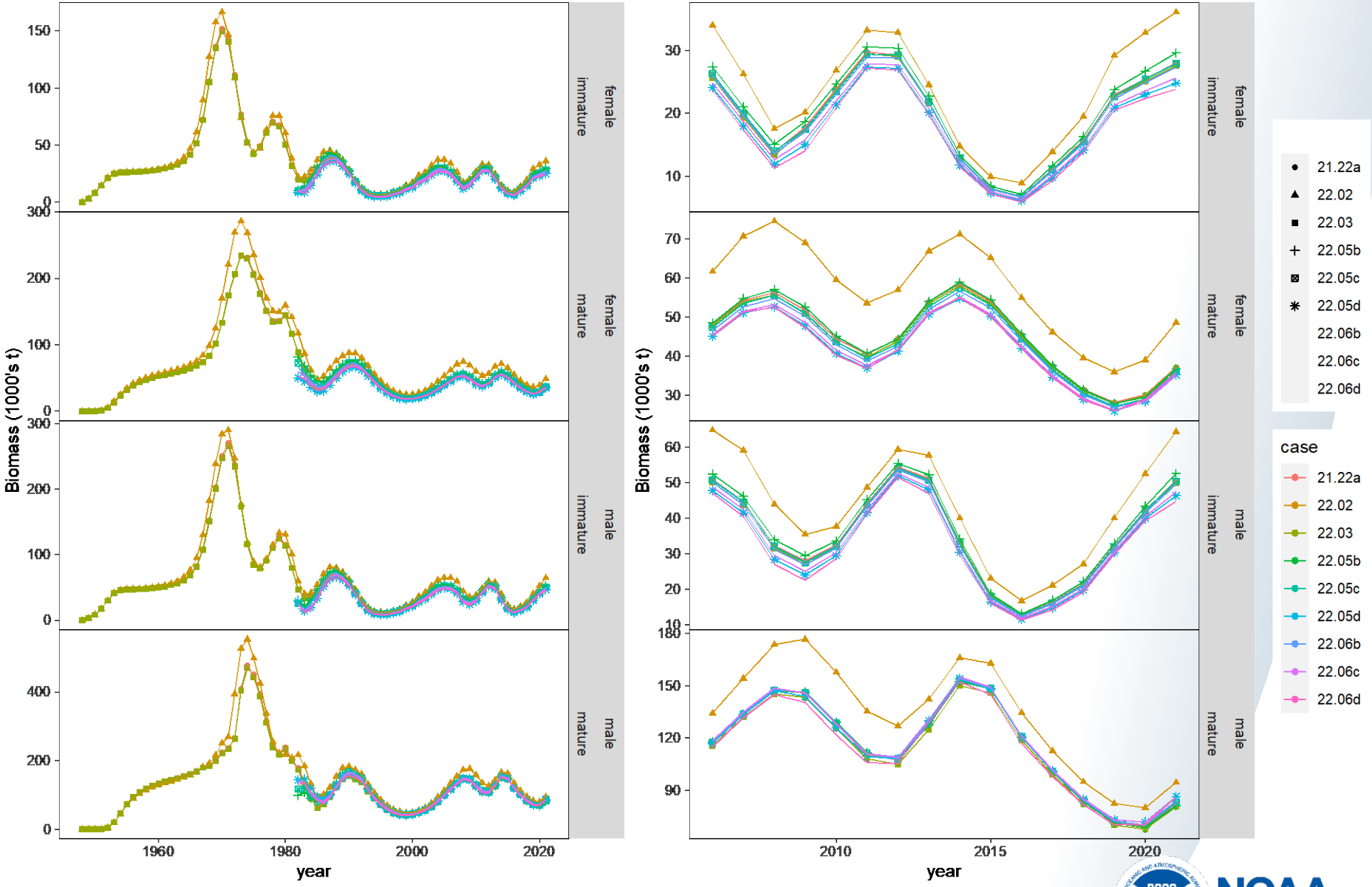


NOAA FISHERIES

MANAGEMENT QUANTITIES

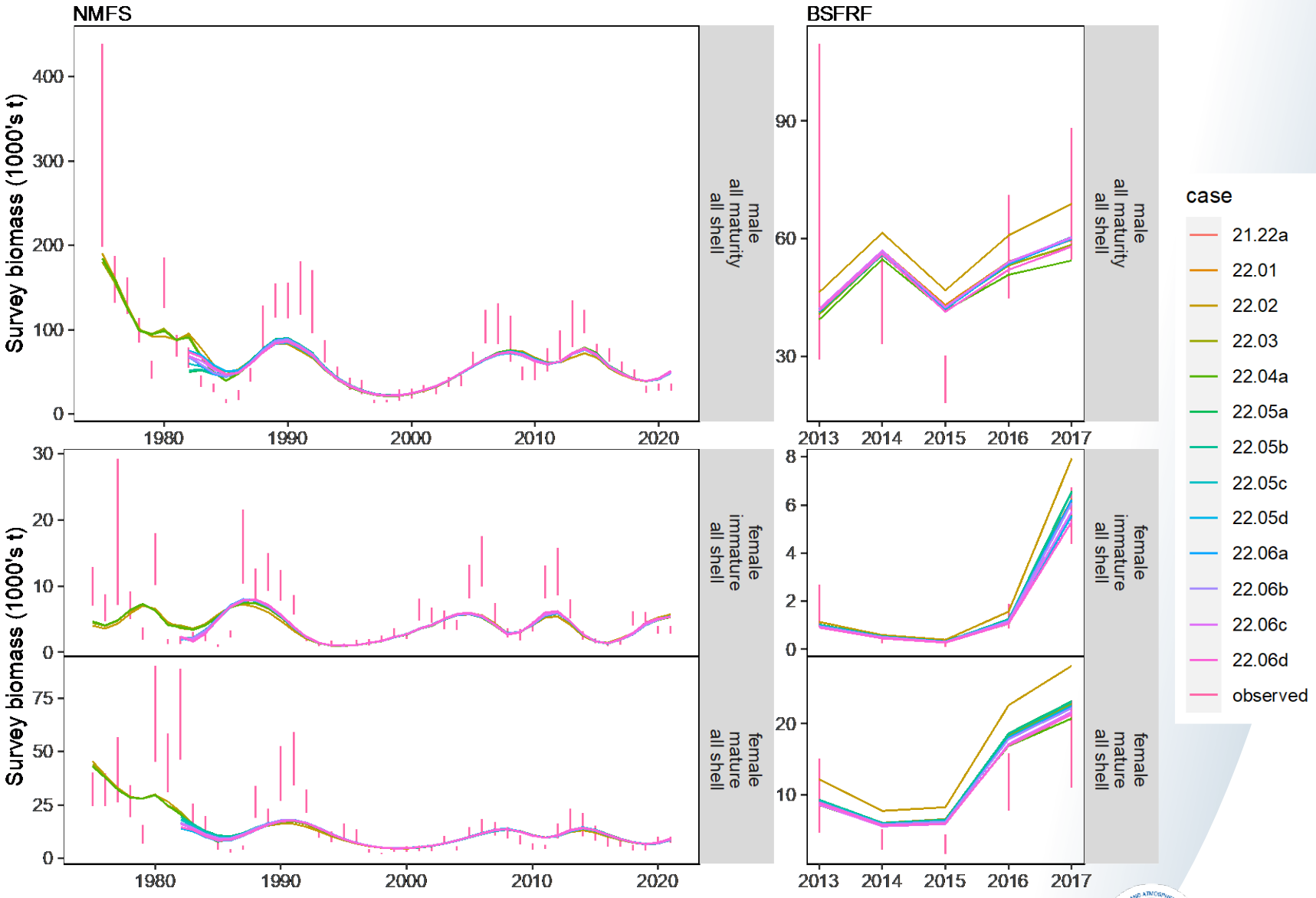


POPULATION BIOMASS



NOAA FISHERIES

FITS TO SURVEY BIOMASS



NOAA FISHERIES

CPT RECOMMENDATIONS – TANNER CRAB

Models for September:

- Model 22.01: Base model from last year updated with new data
- Model 22.03: Updated bycatch estimates for the groundfish fisheries, and fitting to fishery aggregate biomass. (improvement of model)
- Modified model 22.06a: Initial size composition in 1982 with a smoothing weight of 0.1, and initial composition parameters estimated on a logit scale, but also including the features of model 22.03. (model start date & initial condition change)
- Modified model 22.06a as described above plus bootstrap estimates of input sample sizes.

Future work:

- Approaches to incorporate BSFRF survey data
- Modeling ADF&G management areas as separate fisheries
- GMACS progress

SMBKC PROPOSED MODEL RUNS

Last full assessment Sept. 2020 (moved to biennial cycle)

Overfished & under a 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+)

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)

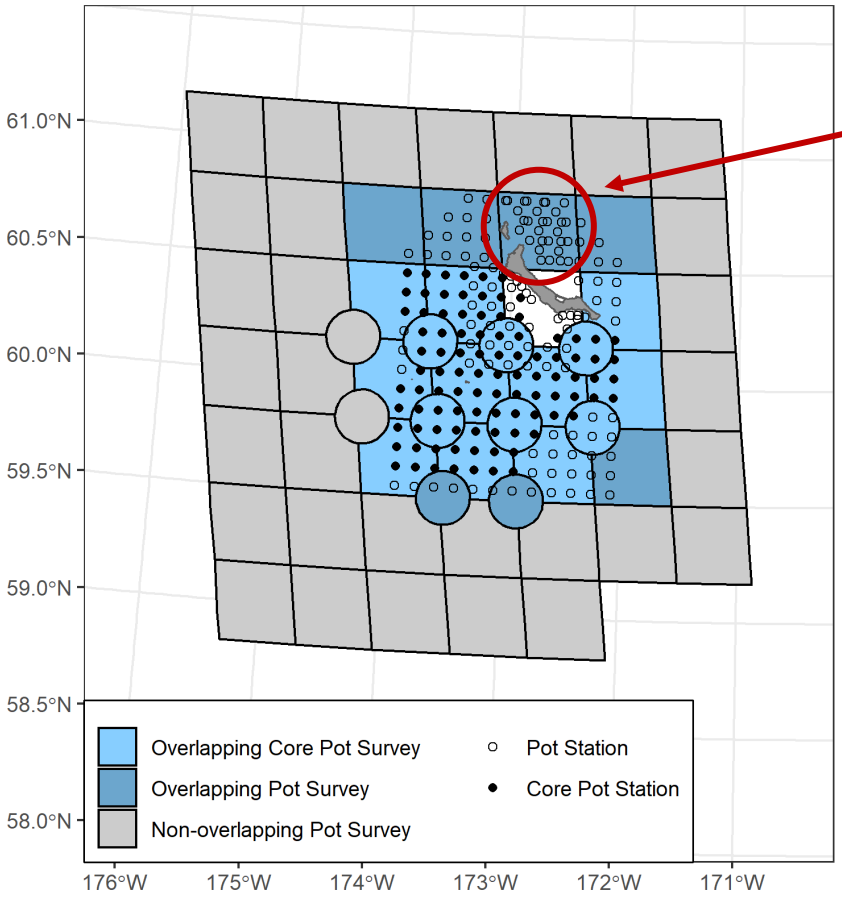
Exploration of the spatial extent and density differences between the surveys was done on all male crab included in the model (Appendix C). The authors plan to use this and further analyses to better characterize catchability/availability for the pot survey.

Random walk or exploration of catchability

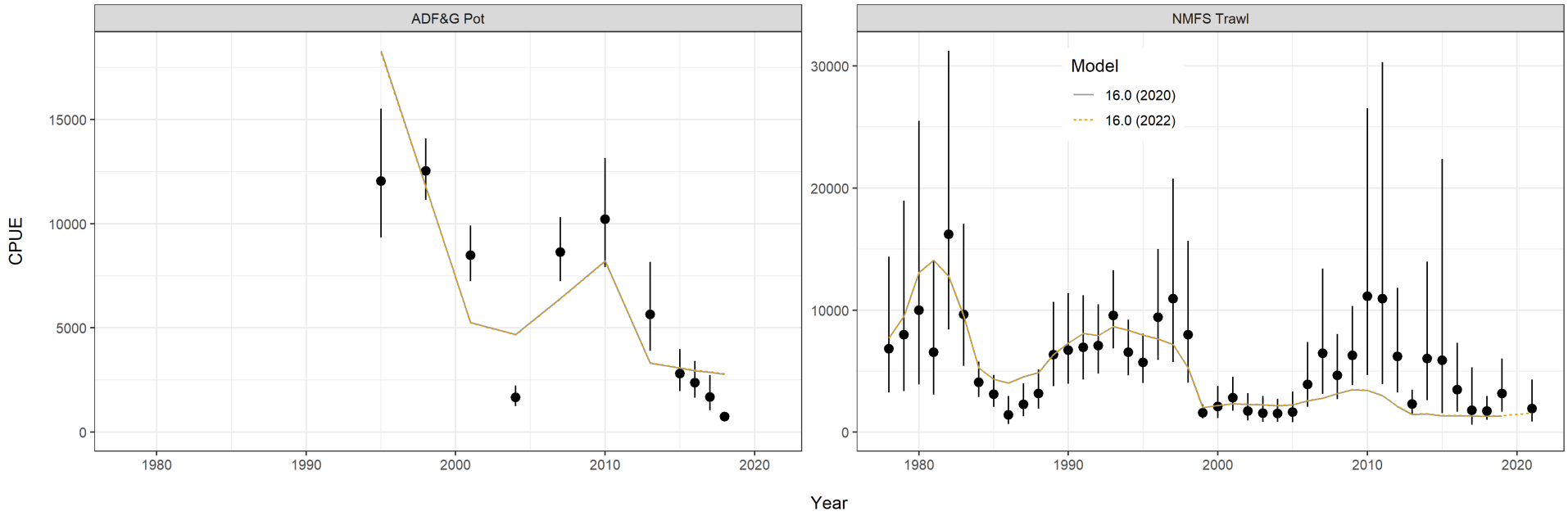
The initial model of time blocks for Q did not show much potential for this in May 2020, therefore time blocks were not a focus for May 2022. More coding work is needed to make a true random walk for catchability in GMACS and this will be added to model development.

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.

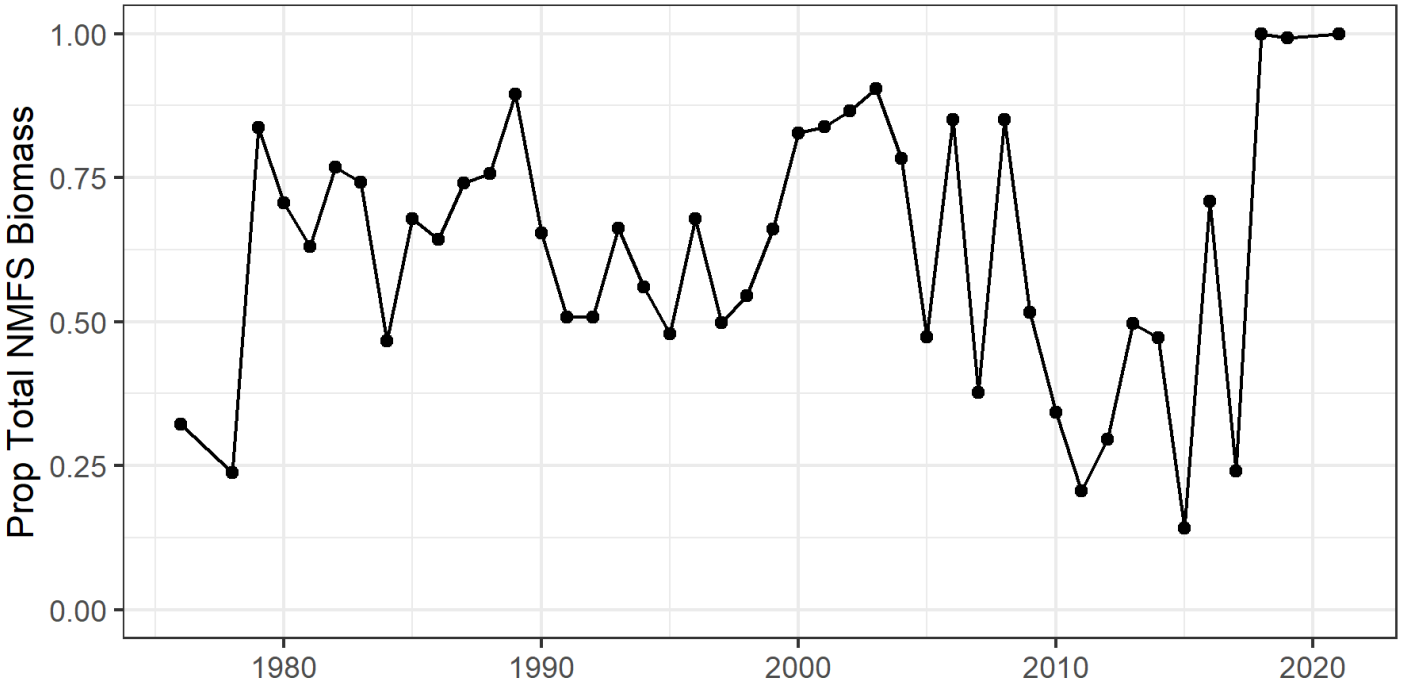
Specific research on St. Matthew blue king crab life history parameters is not available and therefore these are borrowed from other stocks/species. At this time only sensitivities of the model to increased natural mortality (M) were looked at here (Models 22.0a and 22.0b). Sensitivities to the model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



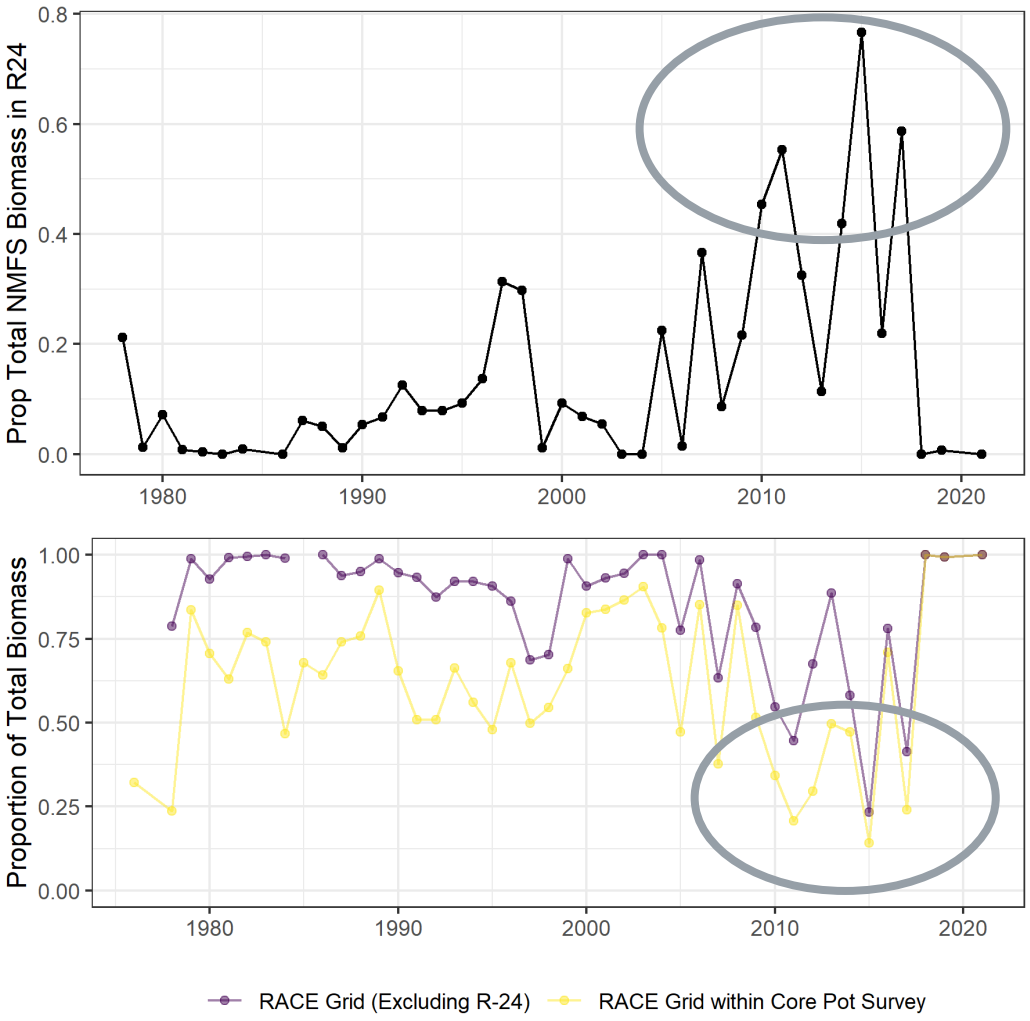
- Blue (survey overlap)
- Light blue core pot survey overlap
- Sampling density differences
- NMFS trawl survey samples in R-24 annually
- ADF&G pot survey R-24 sampling is opportunistically

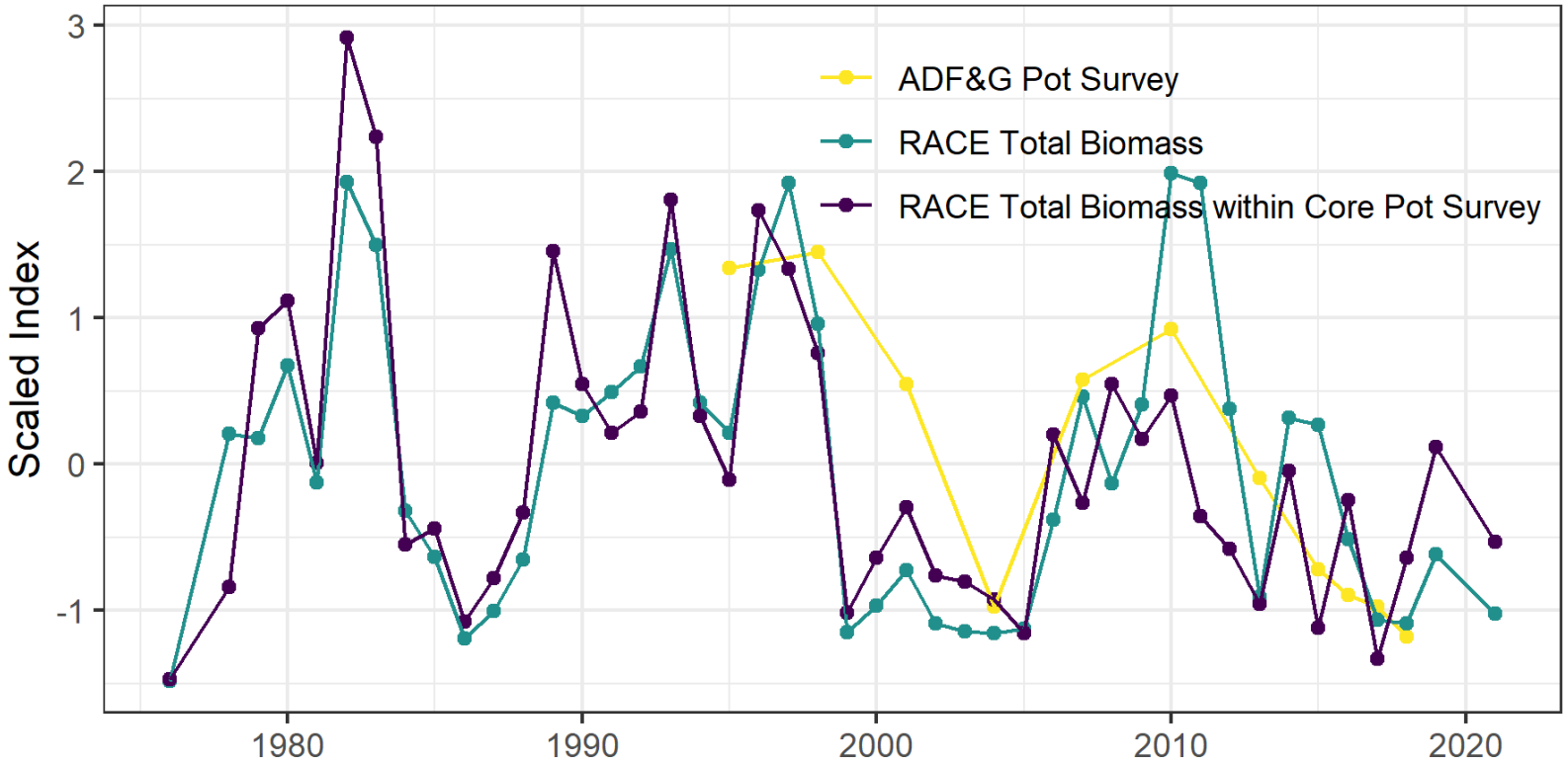

ADF&G Pot
NMFS Trawl
CPUE
Year
Model
16.0 (2020)
16.0 (2022)
0
5000
10000
15000
20000
30000
1980
1990
2000
2010
2020

PROPORTION OF NMFS BIOMASS IN CORE 96 ADF&G POT STATIONS



INFLUENCE OF R-24





- 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)
- Updated GMACS version

22.0a - fixed M = 0.21:

- Model 16.0 with natural mortality increased to 0.21

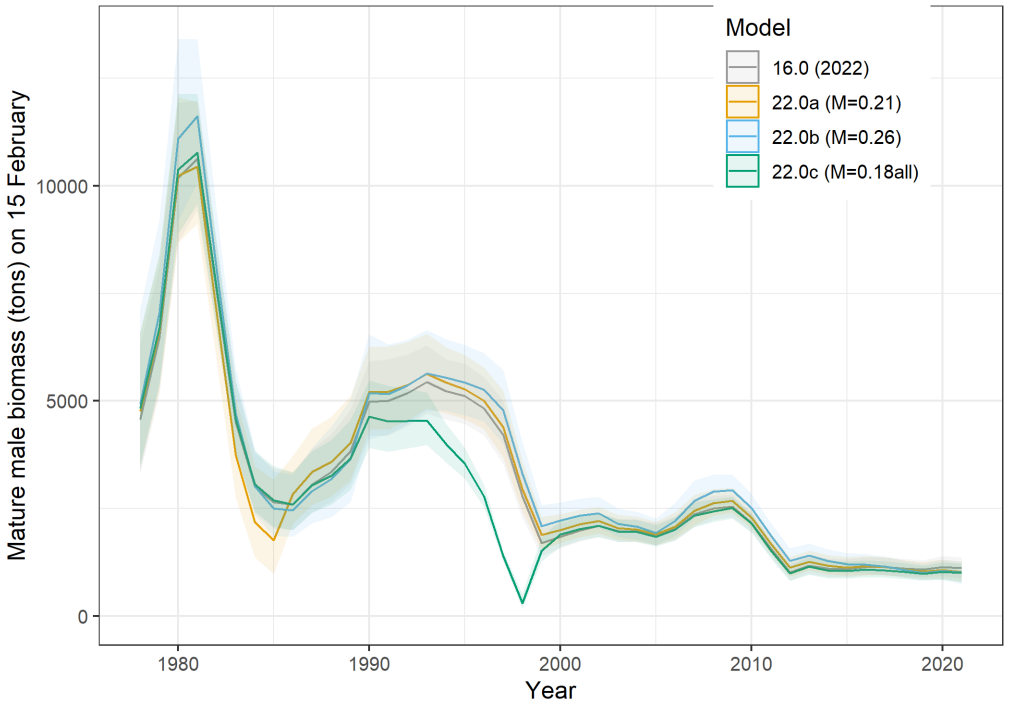
22.0b - fixed M = 0.26:

- Model 16.0 with natural mortality increased to 0.26

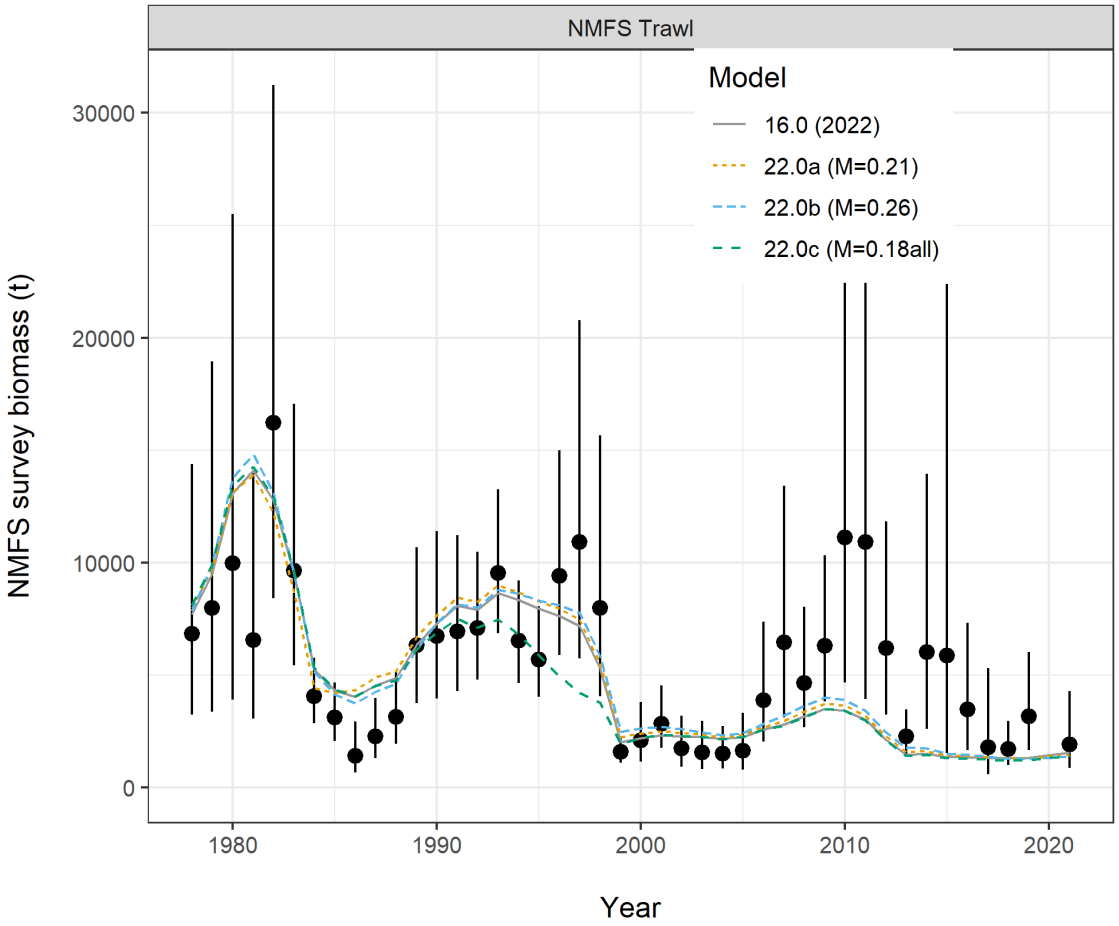
22.0c – no time blocks for M

- 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.




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)

CPT RECOMMENDATIONS – SMBKC

Summary of model runs:

- 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

Models for September:

- Model 16.0 – 2020 version
- Model 16.0 – updated with data for 2022
- Update on rebuilding in fall

Future work:

- Focus on Q
- Increase size bins

PIRKC PROPOSED MODEL RUNS

- Triennial assessment cycle
- Current GMACS model (accepted in 2019)
- B_{MSY} redefined in 2019 as 35% of the average MMB observed from 2000 – present
- Input data:
  - Survey & bycatch data updated for 2019, 2020
  - Data for 2021/22 will be incorporated in Sept.
- CPT/SSC comments
  - Weighting of length comps (some here)
  - Explore ADF&G pot survey data (on-going)
  - Bering Sea wide exploration of RKC – stock structure (started in this document)

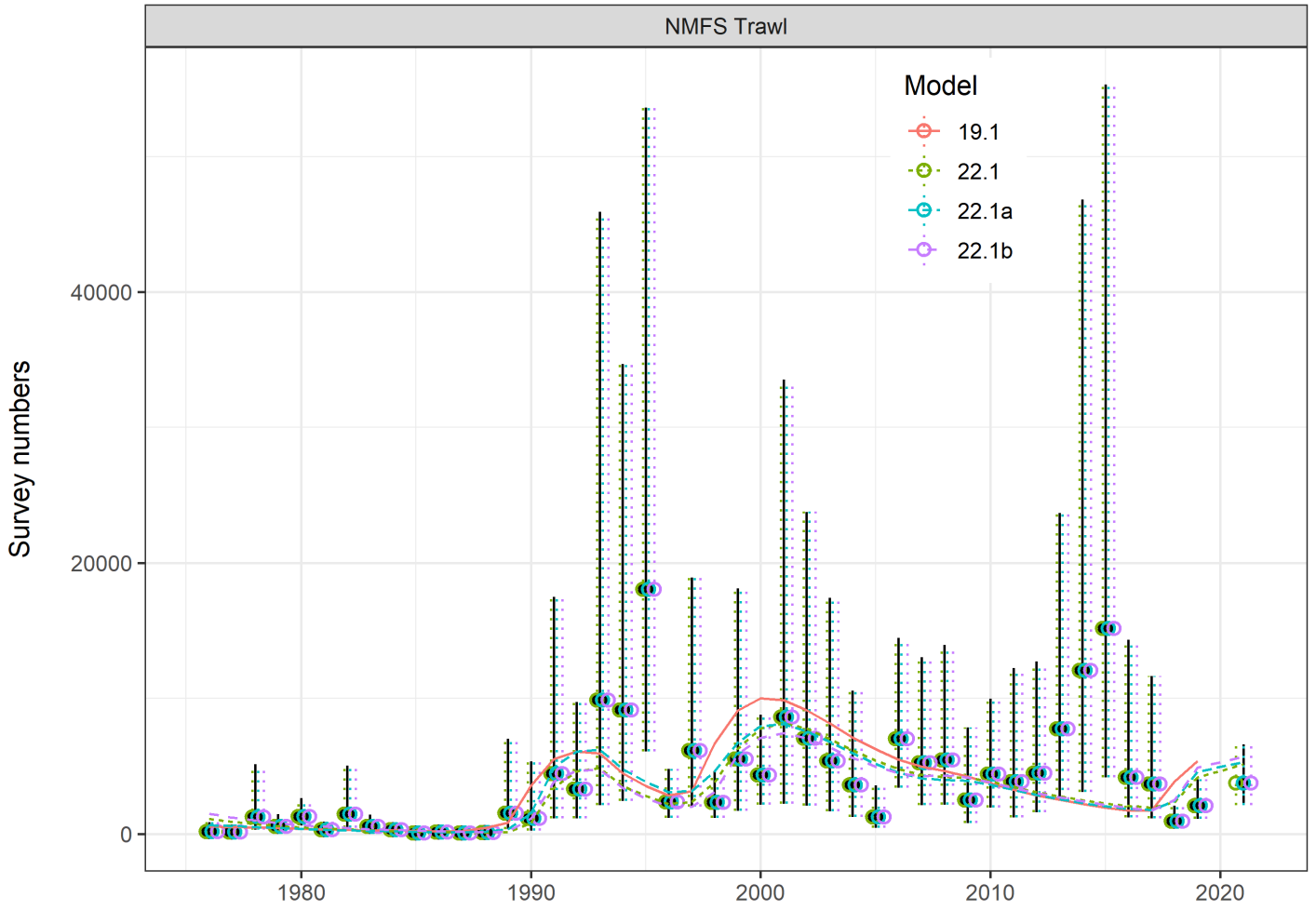
META-POPULATION DYNAMICS OF RKC IN THE BERING SEA

- Cody presented exploratory figures on survey distributions, size composition comparisons
- Work on this topic is on-going
- These bring up further questions such as:
  - Are recruitment events in Pribs and Bristol Bay associated with each other?
  - Are linkages between the areas related to migration or larval settlement?
  - What conditions support linkages?
  - What might these linkages look like under a changing climate?
  - How do crab in the Northern District fit into this?

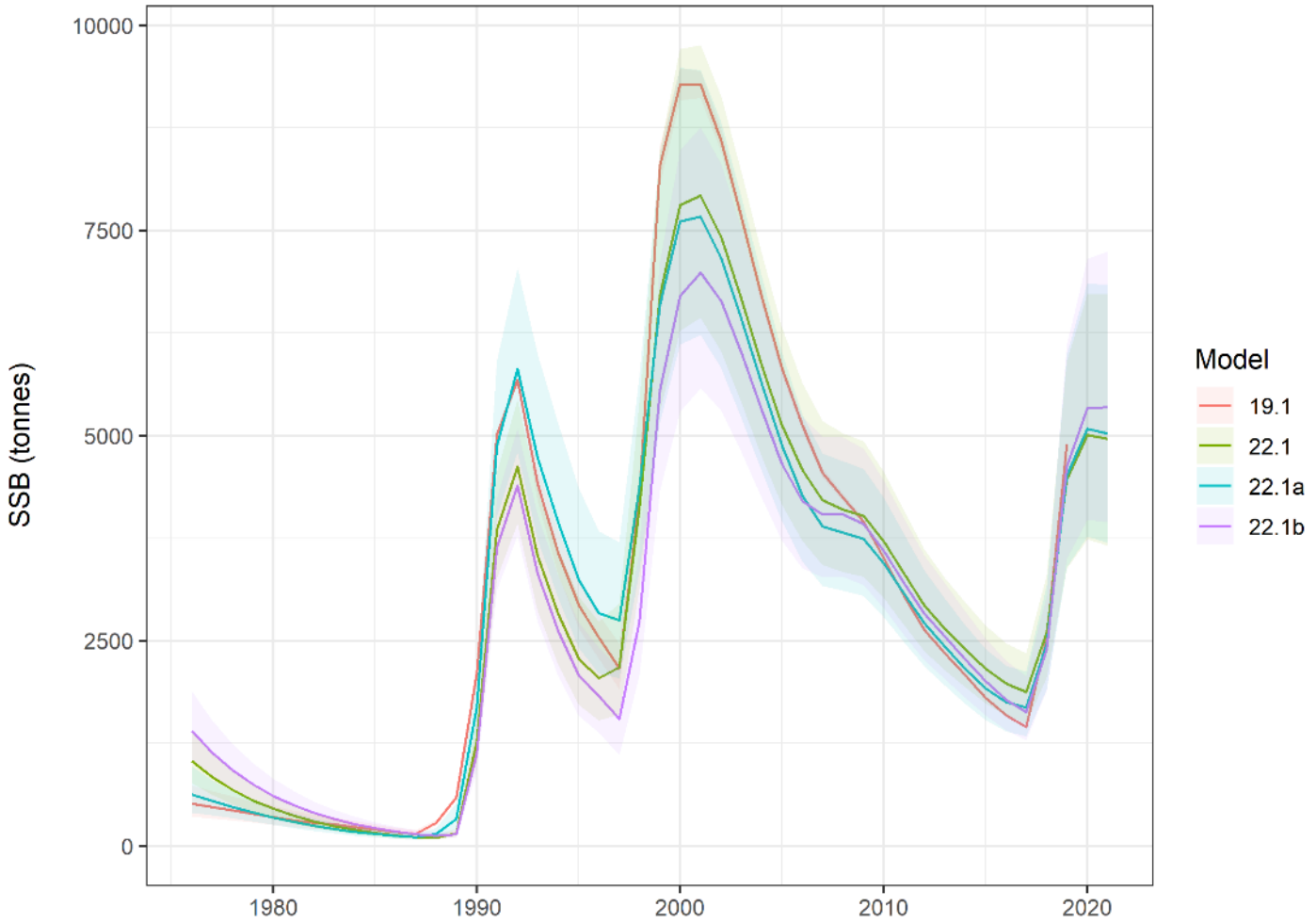
MODELS EXPLORED

- 19.1: accepted GMACS model
- 22.1: 19.1 + updated data (should be 19.1 with updated data)
- 22.1a: 22.1 + all size comp weights set to 50
- 22.1b: 22.1 + all size comp weights divided by 2

SURVEY FIT


NMFS Trawl
Model
19.1
22.1
22.1a
22.1b
Survey numbers
40000
20000
0
1980
1990
2000
2010
2020

SSB


SSB (tonnes)
10000
7500
5000
2500
0
1980
1990
2000
2010
2020
Model
19.1
22.1
22.1a
22.1b

CPT RECOMMENDATIONS – PIRKC

Summary:

- Trends in SSB and overall model fit were similar, slight decline in biomass from 2019
- Healthy B_{MSY} proxy (3.25) – No overfishing
- Future work:
  - Sensitivity to life history characteristics (currently borrowed from BBRKC)
  - Exploration of potential Bering sea wide population connectivity

Recommended models for September:

- Model 19.1 (base model accepted in 2019)
- Model 19.1 (2022 updated data)
- (a) Model 19.1 (2022 updated data) + ADF&G pot survey data
- (b) Model 19.1 (2022 updated data) + trawl survey size composition (estimate bycatch selectivity)
- Model combining (a) and (b)

SSC REQUESTS

1. *"…the SSC supports plans to provide additional bridging information before discontinuing the status quo model…"*
2. *"As requested in October 2021, the SSC reiterates that the Tier 4 calculations of OFL and ABC be brought forward in October as a backup to all other modeling approaches."*
3. **"The SSC recommends that the survey team make the development of a VAST model-based index for snow crab a high priority, even if the index does not include the most recent year's survey data due to survey data availability and fall-assessment timing. "**
4. **The SSC looks forward to "what happened" analyses and notes that it will be important to have a sufficient range of GMACs models to consider in June that represent different hypotheses, such as crab movement out of the area or a mixture of movement and mortality.**
5. **"The SSC also looks forward to updated mapping of the time series of observed data as well as model predictions. "**
6. **"The SSC recommends that further exploration focus on best representing the biology of the species and the selectivity of the fishery in the modeled population dynamics."**
7. **The SSC recommends working with BSFRF and ABSC to summarize observations from harvesters participating in the 2021/2022 season.**
8. **"Specifically, the SSC supports alternatives including recruitment periods of status quo (1982-2020), 1989-2020, each with and without continued high M. For each of these alternatives, a comparison should be provided of trajectories with no fishing mortality, bycatch only (including other crab fisheries), and an approximation of the state harvest control rule."**
9. **"The SSC recommends that each alternative use consistent assumptions (i.e., M and recruitment) for the population trajectory and the reference points. "**
10. **"The SSC recommends inclusion of the uncertainty in the time series estimates of MMB, as well as in the BMSY calculation, based on estimation of model parameters, noting that the covariance in these quantities will need to be accounted for as well. It may be helpful to plot the ratio of these quantities with associated uncertainty."**

SSC REQUESTS

Given the number of requests from the SSC in February, the author prioritized the provision of information to support the transition to GMACS.

SNOW CRAB AND GMACS

HISTORY OF TRANSITION AND CURRENT STATUS

GMACS

1. History of transition
2. Differences between GMACS and status quo
3. Comparison of most recent GMACS and status quo model
4. Recommendations

GMACS

The CPT accepted GMACS in September 2019. The SSC rejected GMACS in October 2019. The problems identified by the SSC in 2019 were:

1. Important 'features' of GMACS that addressed failings of the status quo model (e.g. the estimated recruitment),

2. Misidentified problems (e.g. high fishing mortality for GMACS),

3. Shared problems of GMACS and the status quo (e.g. retrospective patterns).

GMACS VS. STATUS QUO

Population dynamics

- **Identical except fishing mortality**

Likelihoods

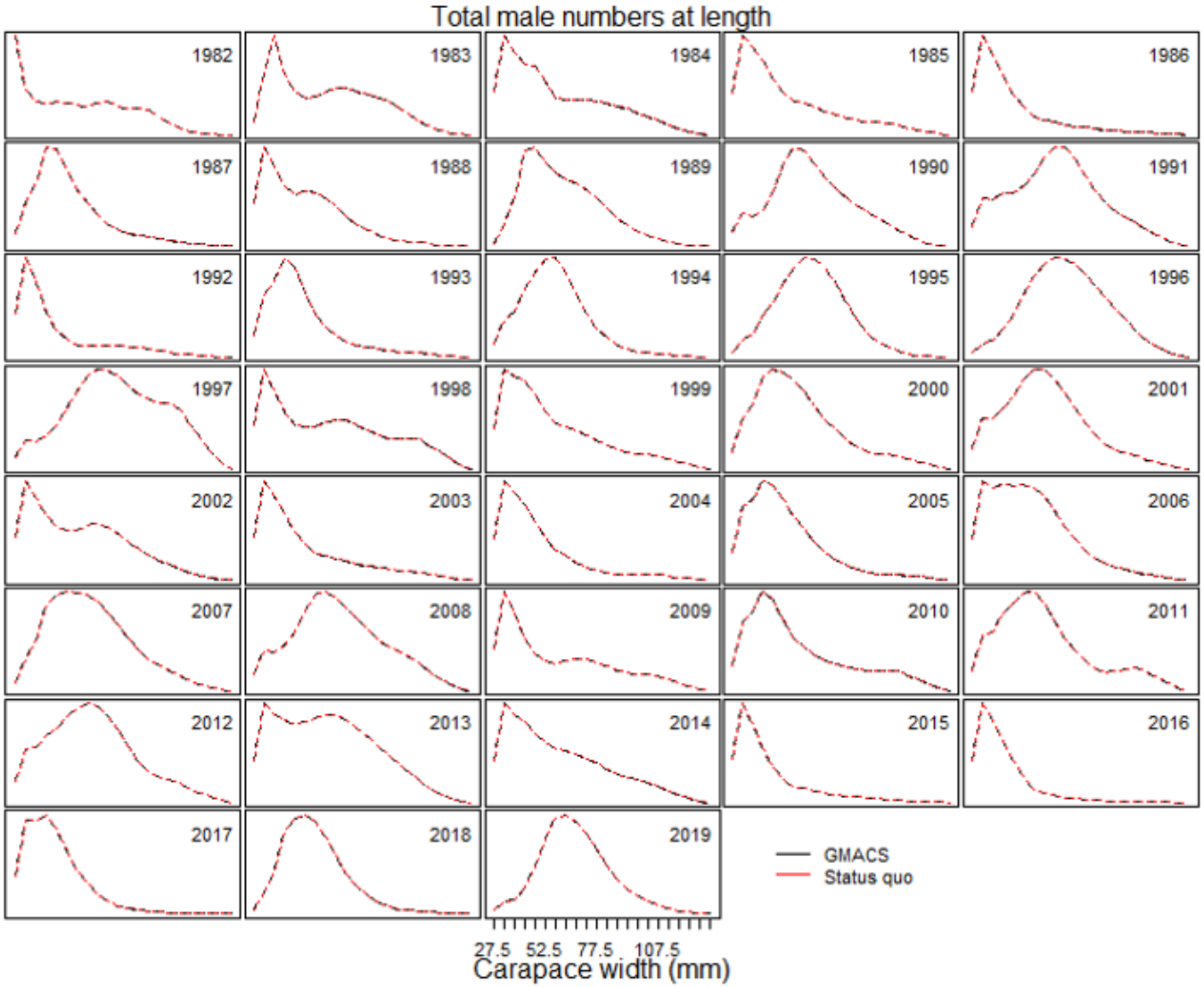
- Number
- Format

Weightings

- Weights vs. coefficients of variation or standard deviations

Convergence

GMACS VS. STATUS QUO



GMACS VS. STATUS QUO

Population dynamics

- Identical except fishing mortality

Likelihoods

- **Number**
- **Format**

Weightings

- **Weights vs. coefficients of variation or standard deviations**

Convergence

Likelihood	Description	in.GMACS	Same.form	SQ.weight	Translated.CV	GMACS.wt
Smoothness for recruitment	norm2(devs)		No	1	0.71	1
Constraint on intial numbers of small old shell males	square(exp(numbers))	No		0.000001	707.1	
Retained fishery length comp	Multinomial			100	NA	100
Total fishery length comp	Multinomial			100	NA	100
Female length comp	Multinomial			100	NA	100
Survey length comp	fit to by sex and maturity state			100	NA	100
Trawl length comp	Multinomial			100	NA	100
2009 BSFRF length comp	Multinomial			100	NA	100
2009 NMFS length comp	Multinomial			100	NA	100
Prior on natural mortality	square(multiplier -1)/input_variance		No	0.0154	NA	0.0154
Prior and smoothness on maturity	norm2(second_diff(prob_molt))		No	50	0.1	60
Growth data (male)	sum of squares, no CV		No	1	0.71	0.03
Growth data (female)	sum of squares, no CV		No	1	0.71	0.03
2009 BSFRF mature biomass	log normal, no constants			cv	NA	cv
2009 NMFS mature biomass	log normal, no constants			cv	NA	cv
Fishery CPUE	normal with input 'cv'	No		5	0.32	
Retained catch	normal with input weight, no constants		No	1000	0.02	0.04
Total catch	normal with input weight, no constants		No	20	0.16	0.07
Trawl catch	normal with input weight, no constants		No	1000	0.02	0.1
Female discards	normal with input weight, no constants		No	30000	0	0.07
Survey mature biomass	lognormal with input cv			cv	NA	cv
Penalties on directed F	norm2(F-1.15)	No		10	0.22	
Penalties on trawl F	norm2(F)	No		2	0.5	
Penalties on all but last year of directed F	norm2(F)	No		0.1	2.24	
2010 BSFRF mature biomass	lognormal with input cv			cv	NA	cv
2010 NMFS mature biomass	lognormal with input cv			cv	NA	cv
First year survey length comp additional weight	Multinomial, adds if molt_prob>0.99	No		100	NA	
2010 BSFRF length comp	Multinomial			100	NA	100
2010 NMFS length comp	Multinomial			100	NA	100
Smoothness of selectivity experiment	normal with input SD, if used	No		1	0.71	
Smoothness of female discards	norm2 on first differences of predicted discard	No		10	0.22	

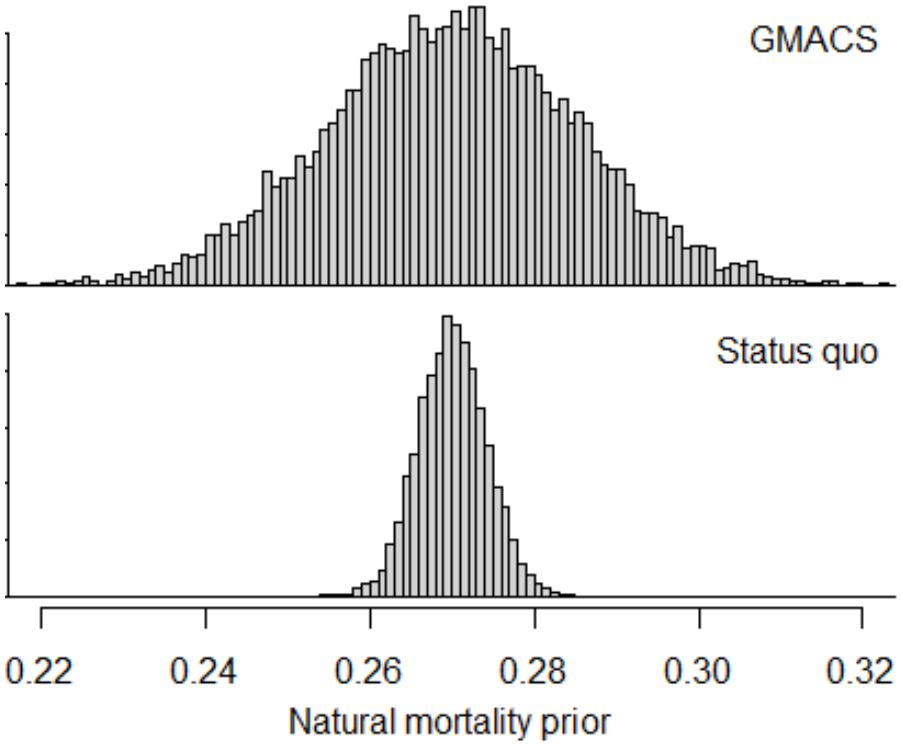
GMACS VS. STATUS QUO

Extra likelihood components in the status quo

Lognormal vs. normal for catches and growth data

Prior on natural mortality

Differences in relative weightings of the catches



Differences in GMACS are improvements at best, lateral moves at worst

GMACS VS. STATUS QUO

Population dynamics

- Identical except fishing mortality

Likelihoods

- Number
- Format

Weightings

- Weights vs. coefficients of variation or standard deviations

Convergence

GMACS VS. STATUS QUO

Cutoff close to 0 to demonstrate a lack of non-convergence.

The status quo model was accepted in spite of the potential issues with convergence.

A similarly configured GMACS model (21.g) did not have convergence issues.

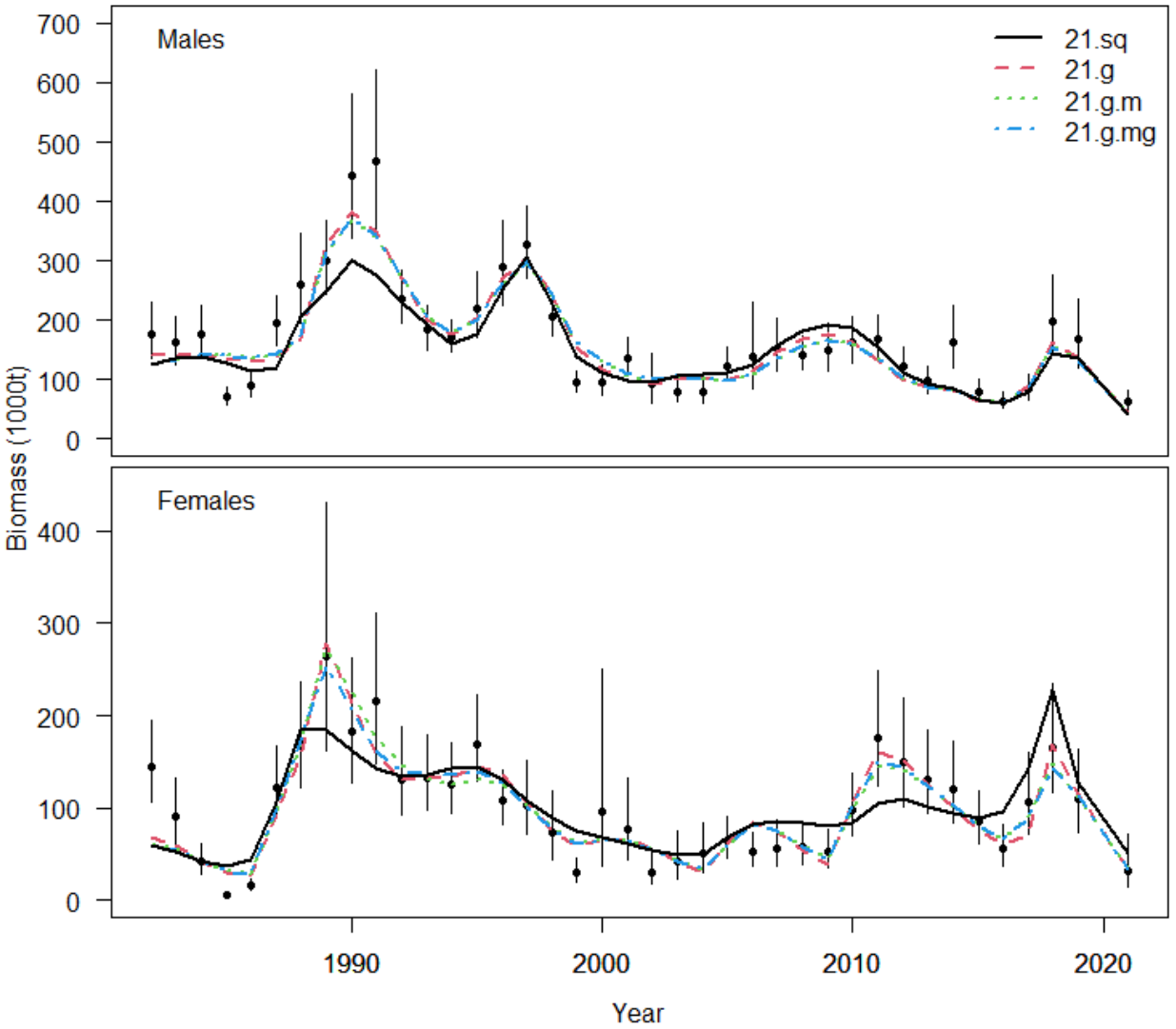
Model	Maximum gradient component	Parameter associated with max gradient
21.sq	0.18	1991 rec dev (f and M also > 0.01)
21.g	0.002	1985 Sex ratio recruitment
21.g.m	0.0004	Log avg recruitment
21.g.m.g	0.0006	2014 sex ratio recruitment

GMACS VS. STATUS QUO

Differences between the status quo and GMACS include:

- **Linear growth models for males and females are estimated in GMACS**, but the parameters associated with growth are estimated outside of the status quo model and specified because the model will not converge linear growth models
- Availability curves in the status quo were freely estimated vectors of parameters with smoothing components for males, but logistic curves for females. Empirical availability curves were adopted last year. In GMACS**, both sexes have freely estimated vectors of parameters estimated for the availability** of the population to the BSFRF experiments. A better method for incorporating these data will be implemented after the adoption of GMACS.
- The status quo model estimates 3 natural mortality parameters for mature males, mature females and immature crab of both sexes. **GMACS estimates 4 natural mortality parameters** for mature males, mature females, immature males, and immature females.
- The status quo model estimates an average recruitment and yearly deviations for both sexes. GMACS estimates a single average recruitment and yearly deviations, then another time series of sex ratios to divide the recruitment between the sexes.

GMACS VS. STATUS QUO



GMACS VS. STATUS QUO

GMACS fits compared to status quo:

Mature biomass: better fits in early years, comparable in later

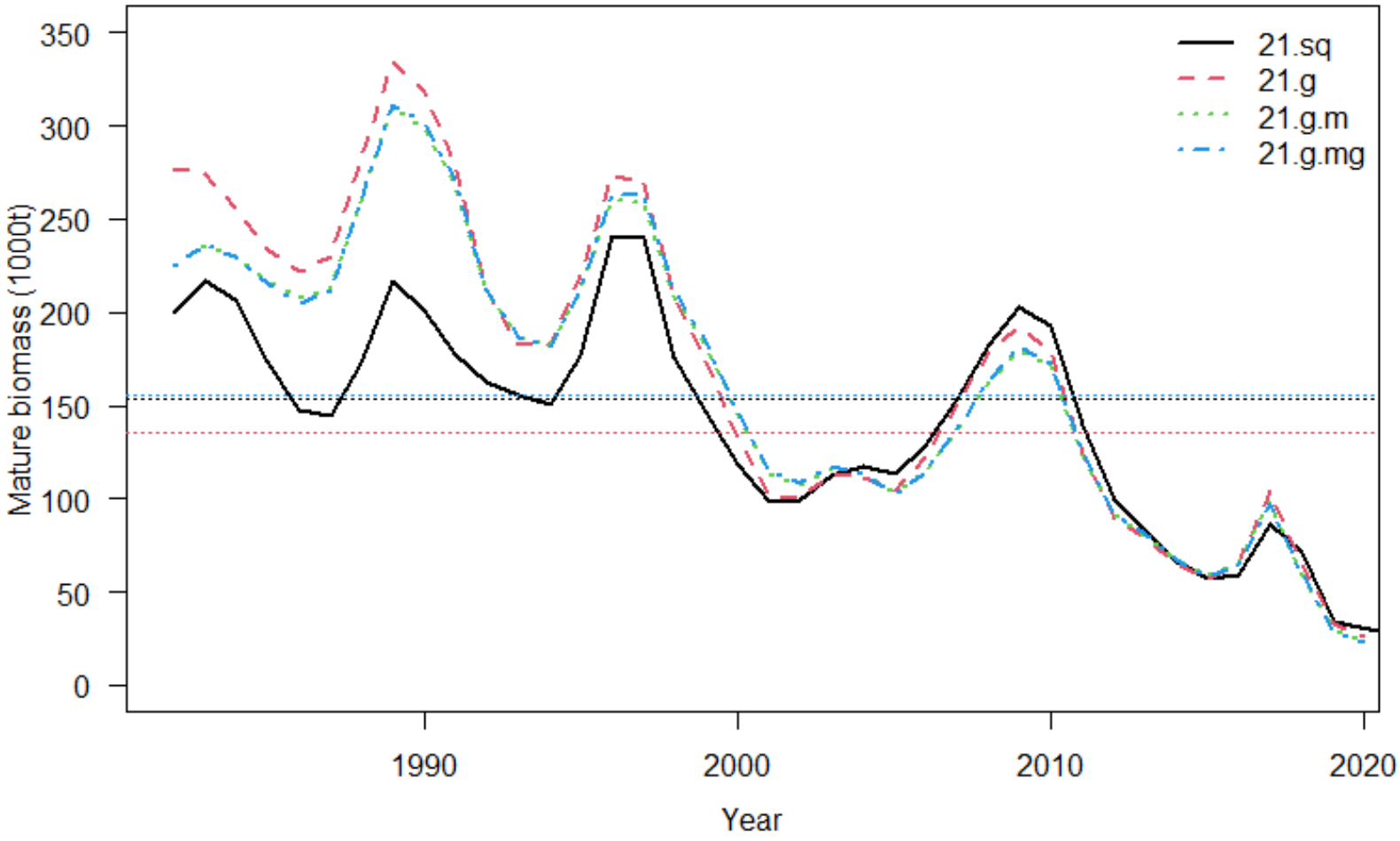
Growth: slightly worse for GMACS, but it is estimated in the model

Catches: all but retained catches fit better

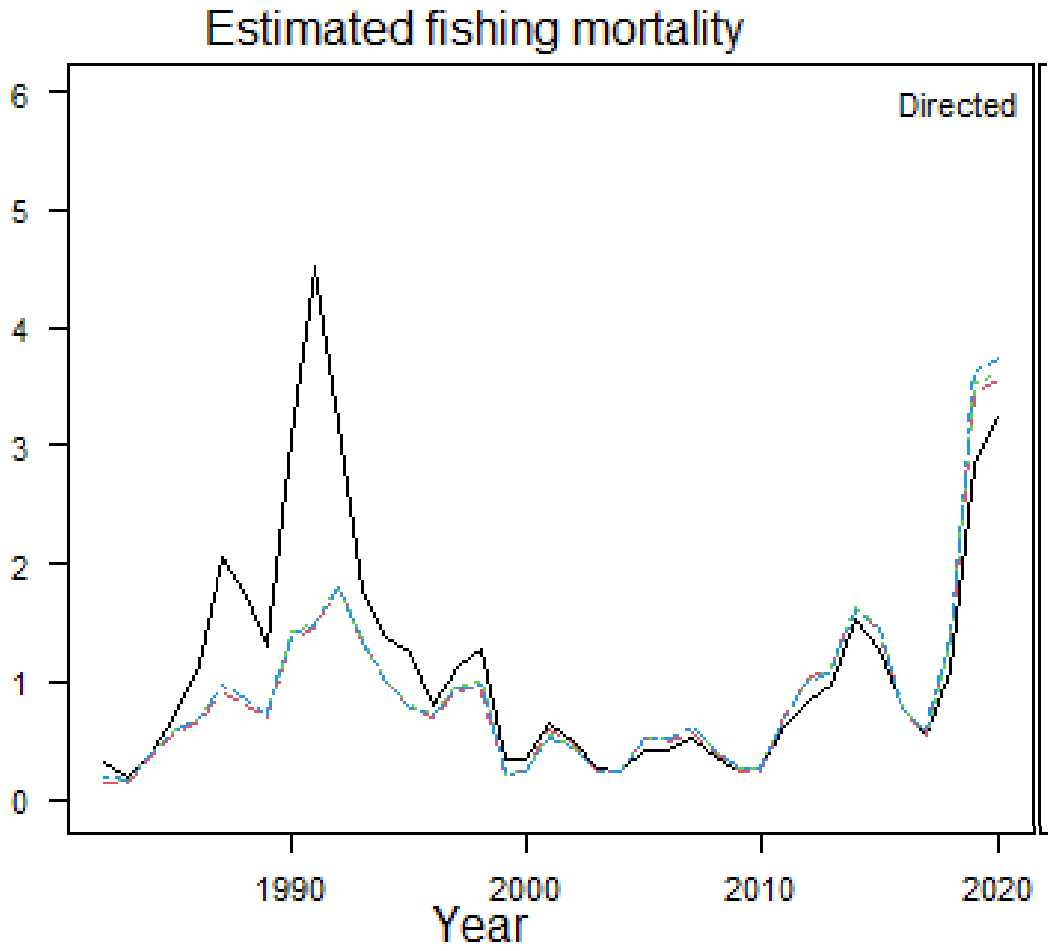
Size comps:

- Retained catches worse in first two years, similar in others
- Total catches better in last two years, mostly the similar in others
- Trawl just generally poorly fit
- Immature males survey mostly the same, better in final year
- Immature females survey much better fit
- Mature males similar
- Mature females peaks fit better

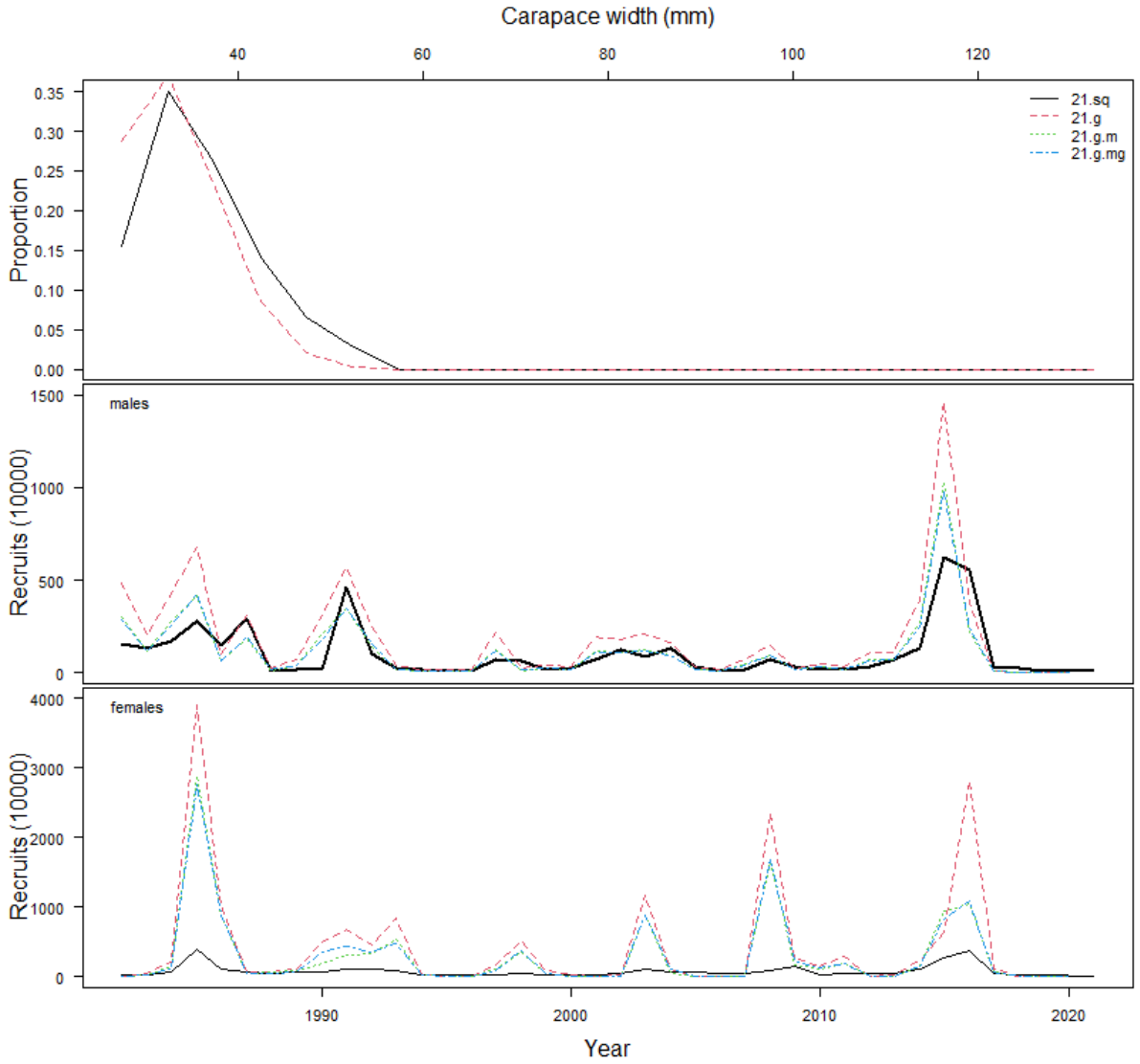
GMACS VS. STATUS QUO



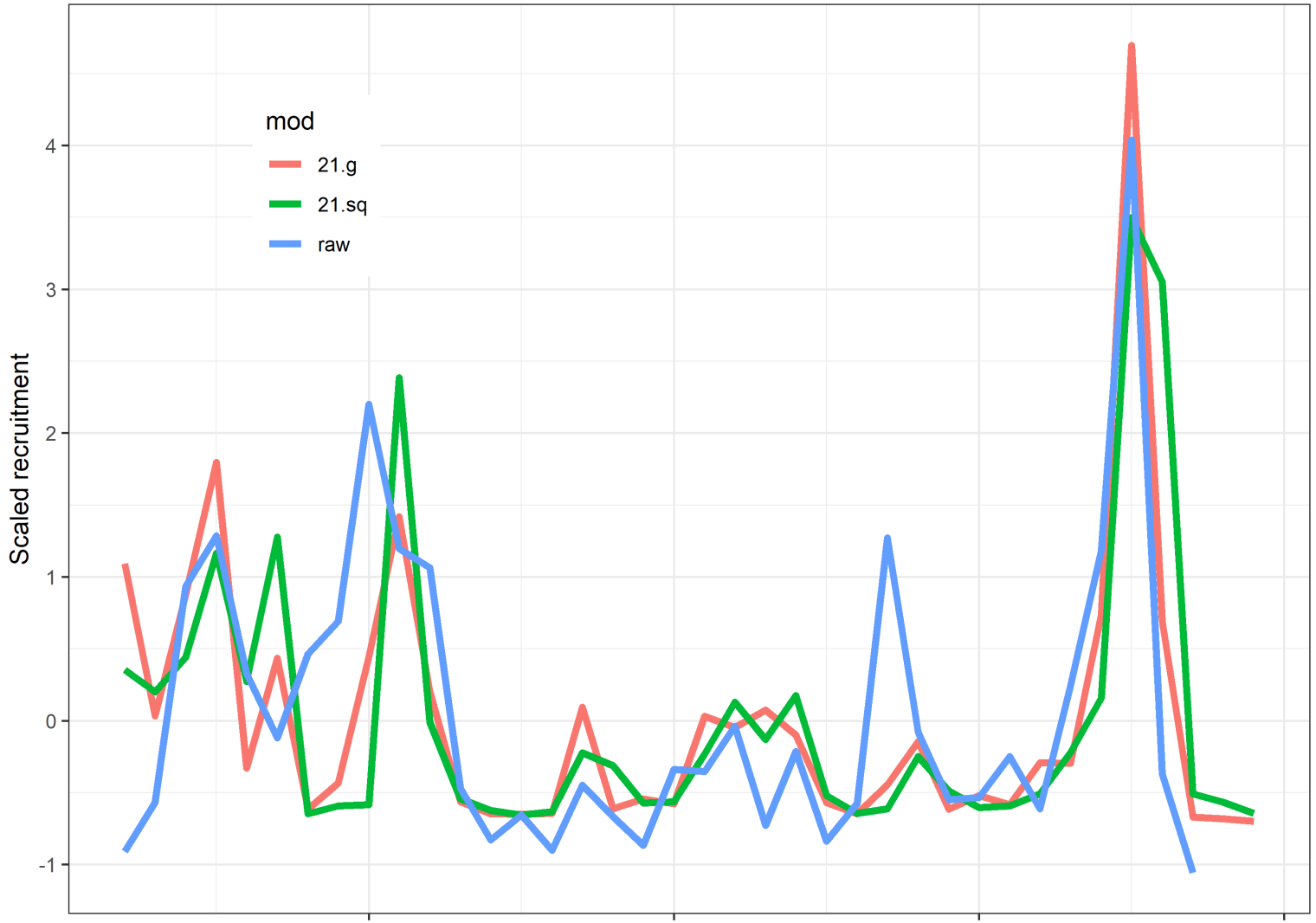
GMACS VS. STATUS QUO



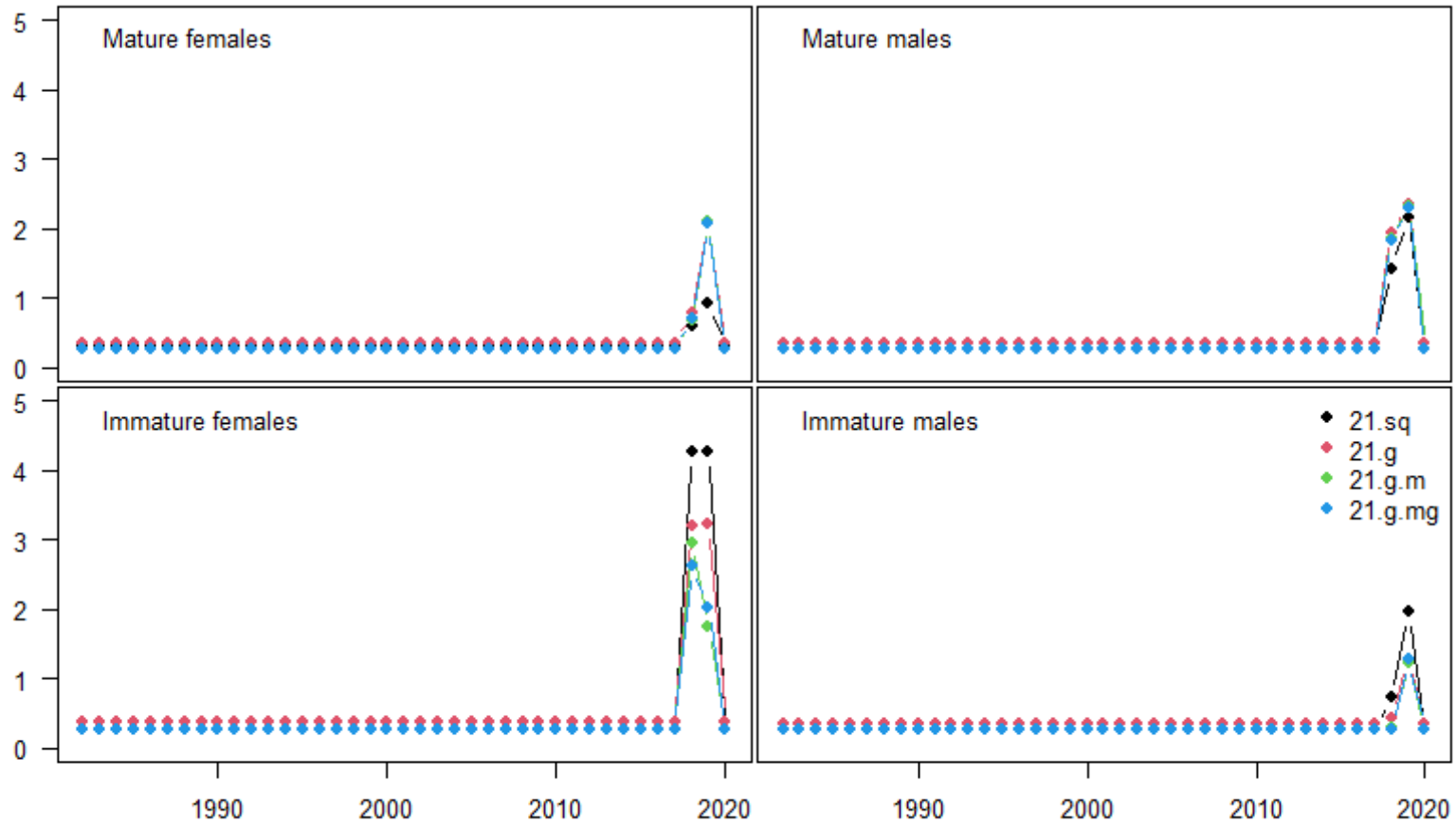
GMACS VS. STATUS QUO



GMACS VS. STATUS QUO



GMACS VS. STATUS QUO



GMACS VS. STATUS QUO

Comparison of estimated processes

- MMB more pronounced downward trend
- Much lower female survey catchability; slightly lower male survey catchability. Both more in line with the BSFRF inferred selectivity.
- Higher probability of terminally molted for females; slight differences for males
- Lower fishing mortality in early period, similar in later
- Differences in selectivity as a result of the way fishing mortality is modeled
- Higher recruitment in 2015 for males; higher overall for females
- Higher average natural mortality
- Lower mortality events for immature; larger mortality events for mature

GMACS VS. STATUS QUO

Model	MMB	B35	F35	FOFL	OFL	M	avg_rec
21.sq	26.74	153.42	1.43	0.37	7.5	0.27	106.14
21.g	25.53	135.32	2.31	0.00	0.1	0.36	189.52
21.g.m	23.37	155.94	1.51	0.00	0.1	0.27	119.89
21.g.mg	22.55	155.66	1.52	0.00	0.1	0.27	117.36

Changes in management quantities for each scenario considered. Reported management quantities are derived from maximum likelihood estimates. Reported natural mortality is for mature males and average recruitment is for males. MMB is Feb 15, 2021 not the projected MMB off of which the OFL is calculated.

GMACS VS. STATUS QUO

Model	MMB	B35	F35	FOFL	OFL	M	avg_rec
21.sq	26.74	153.42	1.43	0.37	7.5	0.27	106.14
21.g	25.53	135.32	2.31	0.57	11.24	0.36	189.52
21.g.m	23.37	155.94	1.51	0.34	7.53	0.27	119.89
21.g.mg	22.55	155.66	1.52	0.33	6.92	0.27	117.36

Changes in management quantities for each scenario considered. Reported management quantities are derived from maximum likelihood estimates. Reported natural mortality is for mature males and average recruitment is for males. MMB is Feb 15, 2021 not the projected MMB off of which the OFL is calculated.

AUTHOR RECOMMENDATIONS

Use GMACS as is based on:

- Superior convergence statistics
- Improved model assumptions
- Better fits to data sources
- Improvements in transparency and reproducibility

Do not pursue further matching exercises

Spend time working on actual problems instead of trying to match the dynamics of the status quo with GMACS

- Time-variation in population processes
- Currency of management and issues with F35%
- Treatment of maturity and BSFRF data
- Reference points in a changing environment
- Spatial issues

CPT RECOMMENDATIONS

The **CPT supported the use of GMACS for the September 2022 assessment** of snow crab given that the fits are better, the model specification process is more transparent and hence easier to review, and GMACS is set up for projections unlike the status-quo model. The improvements of GMACS over the status-quo model substantially outweigh the minor concerns with the GMACS model. The CPT agreed that the models for the September meeting should:

- **Implement alternative specifications for the initial numbers-at-age** vector to eliminate the overestimation of catch and abundance of large animals in 1982-1984 – this change will improve the fits visually but will have little impact on final model outcomes.
- Use a **prior on *M*** that matches that used in the status-quo model.
- Both #1 and #2.
- The CPT also recommended that a jitter analysis be conducted on the GMACS models to further examine the convergence properties of GMACS for EBS snow crab.

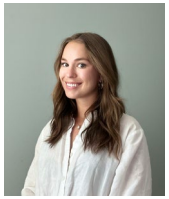
SNOW CRAB REBUILDING

Outline

1. Rebuilding timeline
2. What happened?
3. Projections
4. Additional context
    a) ESP update
    b) Climate change outlook
    c) Unobserved mortality research
5. CPT recommendations

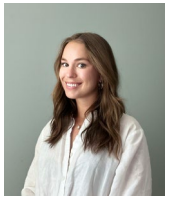
COUNCIL SNOW CRAB REBUILDING TIMELINE

- **October 19, 2019:** Snow Crab was declared overfished
  - Rebuilding of overfished stocks is required by the MSA section 304 within 2 years (October 2023)
    - MSA section 304 and the NS 1 guidelines for rebuilding overfished stocks
- **June 2022:** Select snow crab rebuilding alternatives for analysis
  - Summer 2022 – Staff will analyze the impacts of each of the alternatives
- **October 2022:** initial review of the snow crab rebuilding plan and potentially selected a preliminary preferred alternative
- **December 2022:** Council will take final action and select a preferred alternative to recommend to the Secretary of Commerce
  - Following selection of preferred alternative, NMFS prepares proposed FMP amendment text, draft notice of availability, draft Environmental Assessment, and, if required, a draft regulatory package



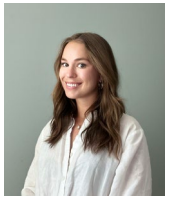

ADDITIONAL REFERENCE POINTS

- **January 2023:** Council action should be submitted to NMFS within 15 mo. of notification of overfished to ensure sufficient time for Secretary of Commerce to implement the rebuilding measures
- **October 19, 2023:** Council has selected a preferred recommended rebuilding plan and Secretary of Commerce has implemented the rebuilding plan



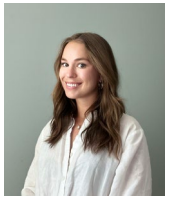

OVERFISHING AND REBUILDING PLANS

- Council must specify a time period for rebuilding the stock (T_{target}) based on being as short as possible taking into account:
  - Status and biology of the stock
  - Needs of fishing communities
  - Recommendation by international organizations in which the U.S. participates, and
  - Interaction of the overfished stock within the marine ecosystem
- Time period shall not exceed 10 year, except where biology of the stock, other environmental conditions, or management measures under an international agreement dictate otherwise
- **Seeking recommendations from the SSC on the parameters utilized in the model projections to aid in establishing the rebuilding plan for Snow crab**

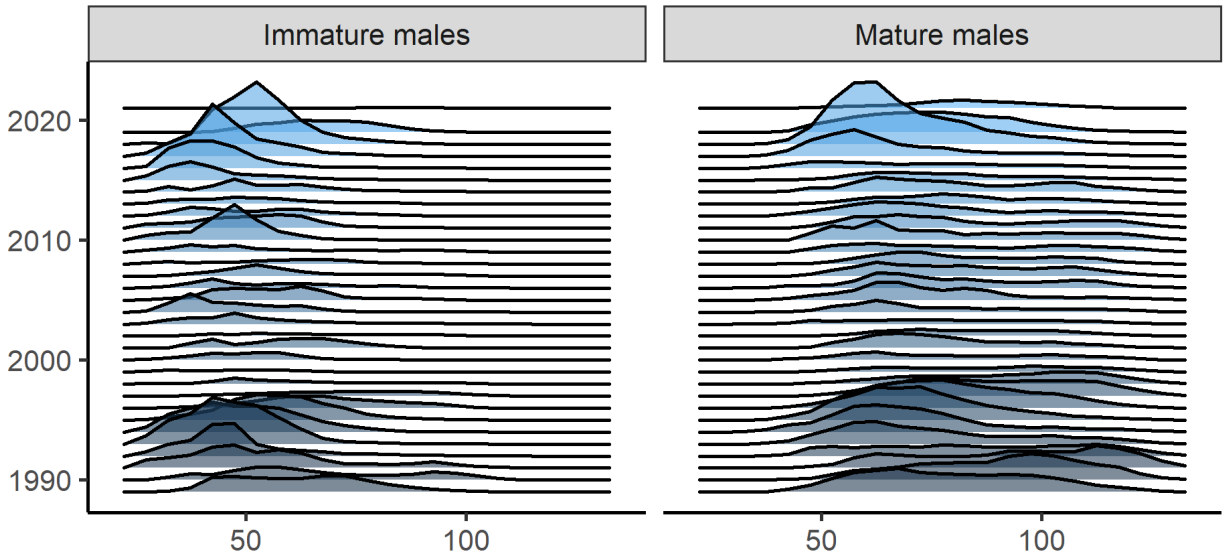


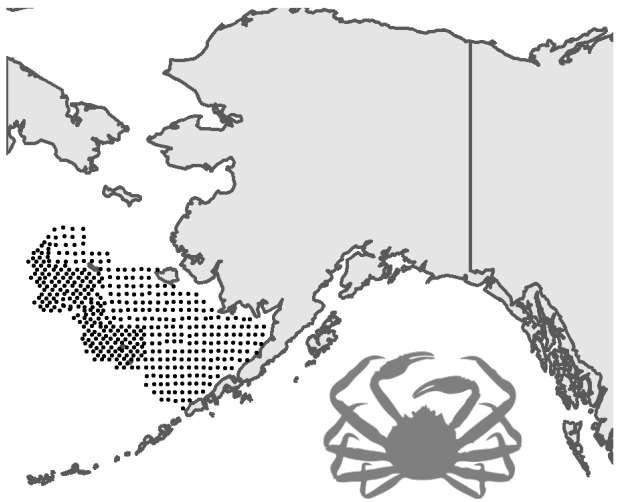

OVERFISHING AND REBUILDING PLANS

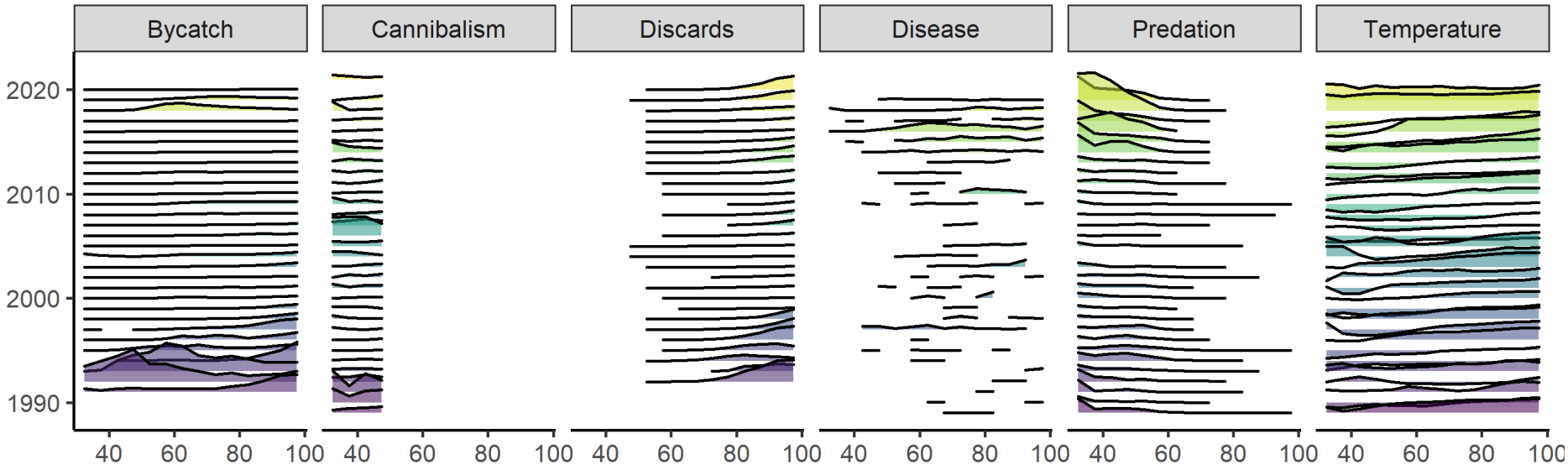
- The shortest rebuilding time (T_{min}) is calculated based on time frame to rebuild the stock to its MSY biomass (B_{MSY}) in the absence of no fishing mortality (F=0)
  - If T_{min} is ≤ 10 years, then the maximum rebuilding time (T_{max}) is 10 years for rebuilding a stock to its B_{MSY}
  - If T_{min} for the stock exceeds 10 years, then one of the following methods can be used to determine T_{max}:
    - T_{min} plus the length of time associated with one generation time for the stock
    - Amount of time the stock is expected to take to rebuild to B_{msy} if fished at 75% of maximum fishing mortality threshold, or
    - T_{min} multiplied by 2
  - If T_{min} exceeds 10 years, T_{max} establishes a max time for rebuilding that is linked to the biology of the stock. When selecting a method for determining T_{max} the Council, **in consultation with the SSC, should consider the relevant biological data and scientific uncertainty of that data, and must provide a rationale for its decision based on the best scientific information available.**




WHAT HAPPENED?



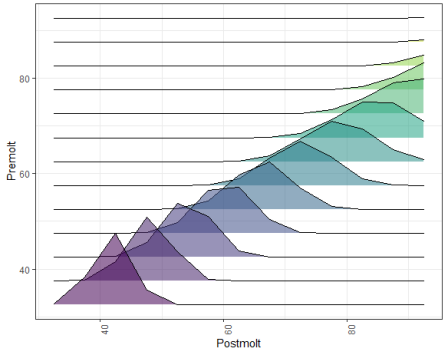


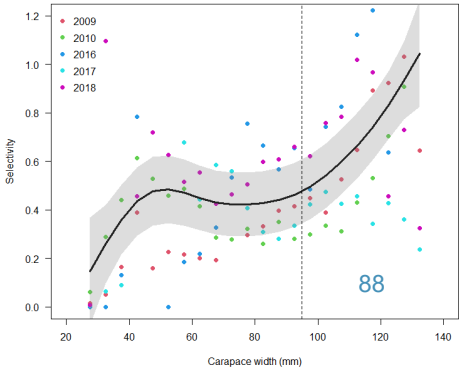


WHAT HAPPENED?

- *Goal: explain the observed changes in immature and mature male abundance by estimating recruitment, mortality, and catchability*

- Model details
- Spans 1989 to 2021 (survey coverage consistent then)
- Male only
- Sizes 30-95mm carapace width, 5 mm size bins
- Fit to immature and mature indices of abundance (not biomass) + size composition data
- Estimated parameters
  - Initial numbers for immature and mature males
  - Mean mortality for immature and mature males
  - Yearly deviations for mortality and survey catchability by maturity state (why?)
  - Yearly recruitment
  - Proportion of recruitment falling in the first size bins (size bin 2 gets 1-p)
- Input processes
  - Growth
  - Survey selectivity derived from BSFRF data
  - Yearly probability of having undergone terminal molt data
- Sensitivity analyses, simulation studies, and stress tests of the models were presented
- Will write up and present fully soon

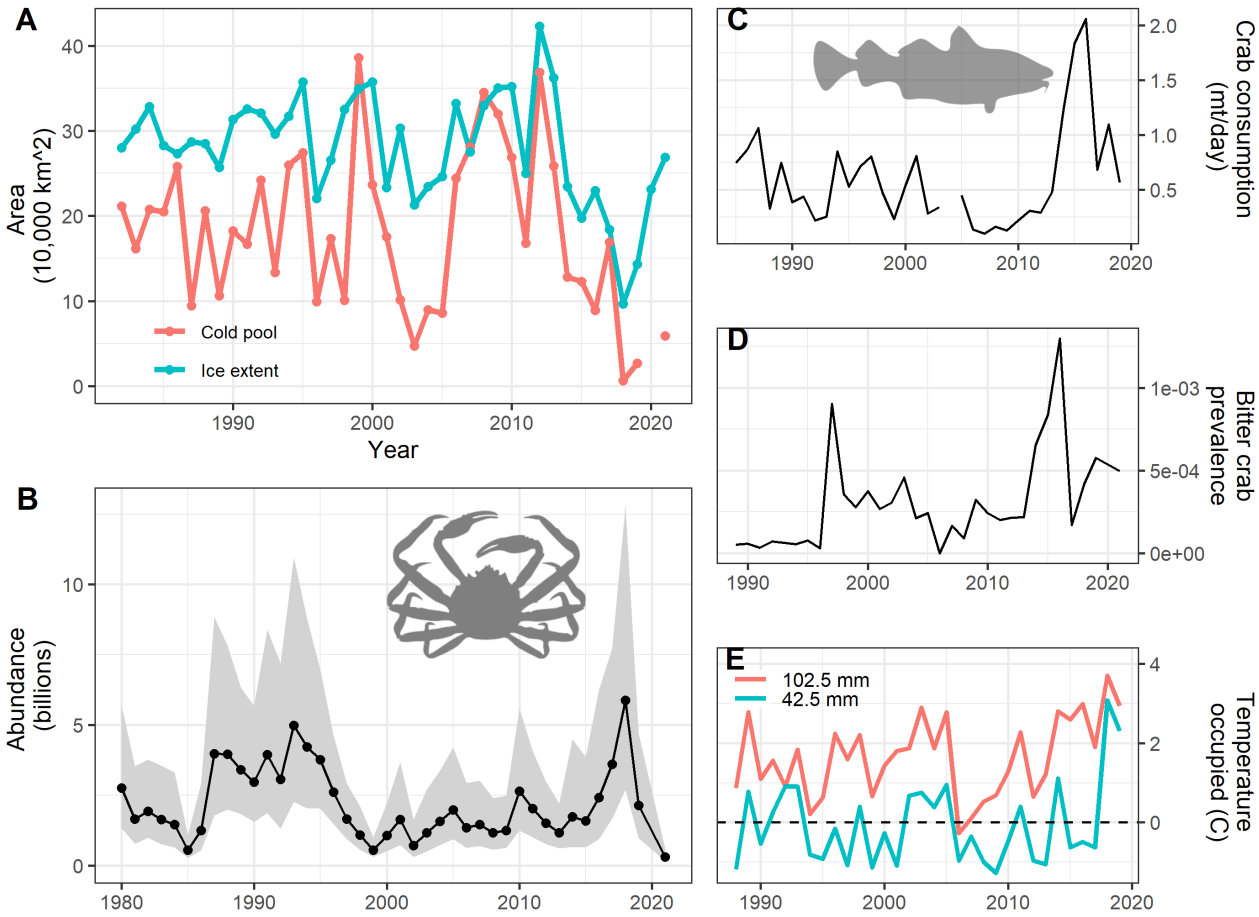




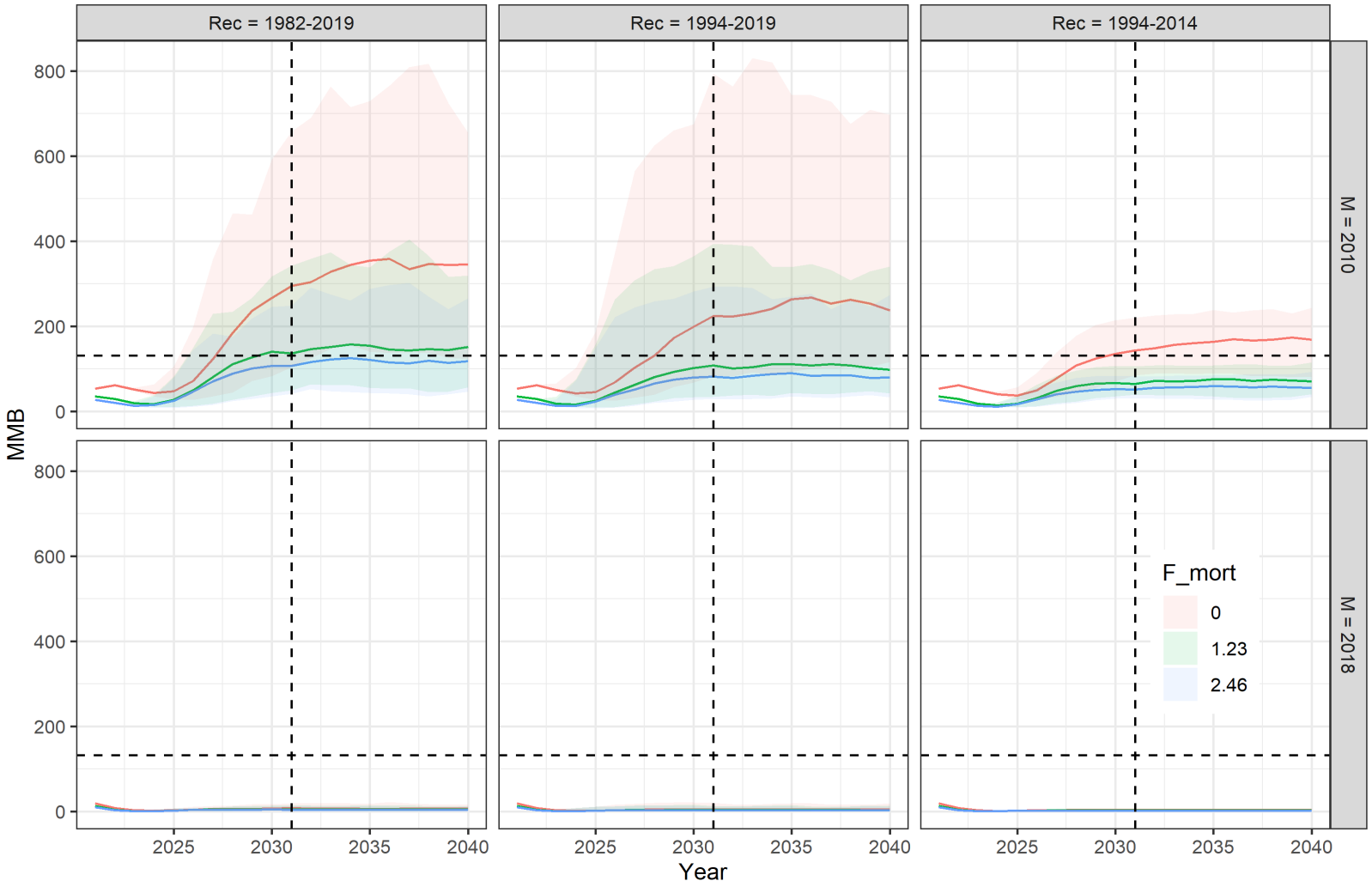
WHAT HAPPENED?

High temperatures seem to be the best correlate with mortality in 2018 and 2019

This is somewhat unsatisfying because it does not provide a mechanism

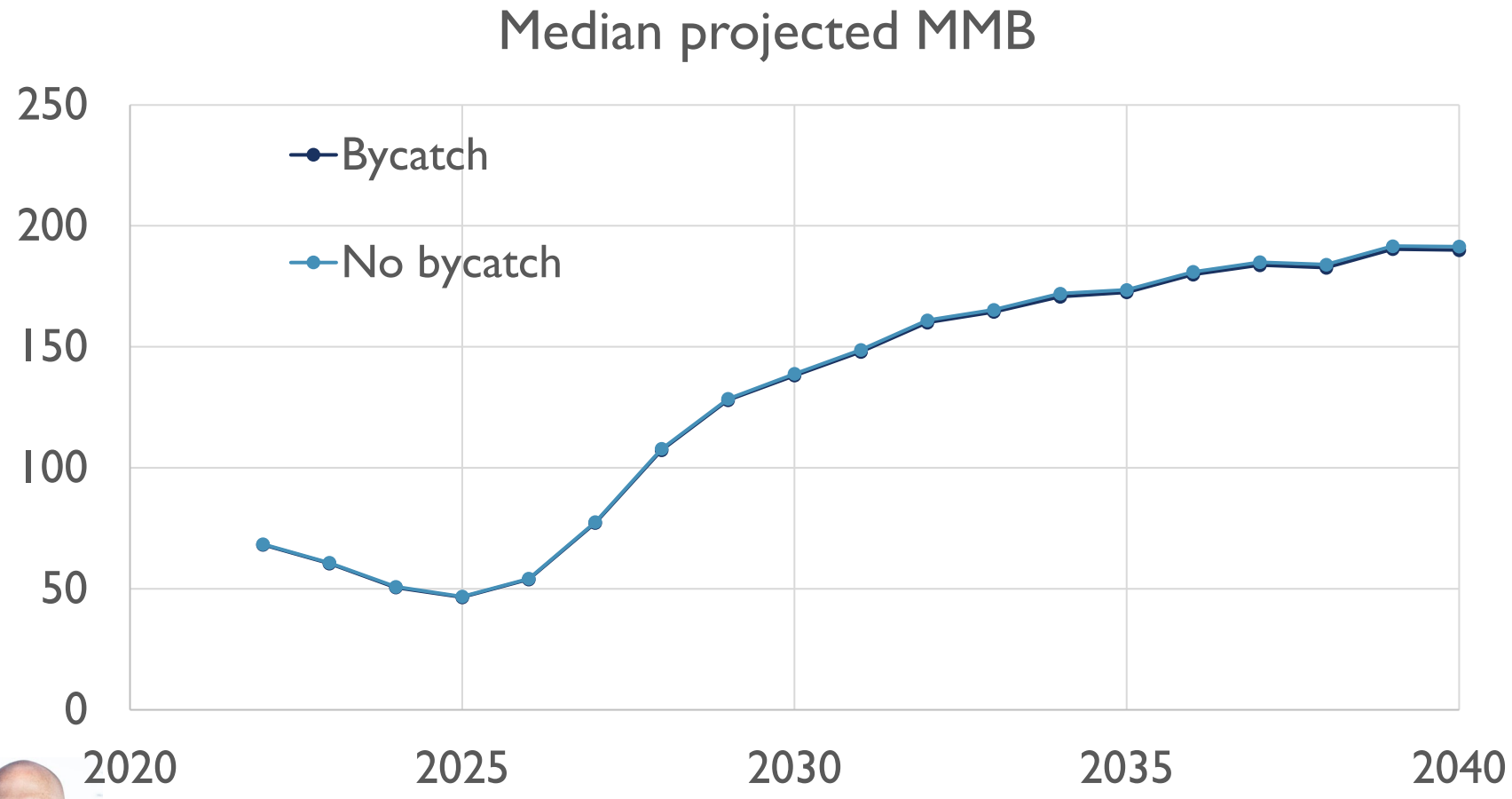


WHAT HAPPENED?



T min ranged from 7 years to infinity.

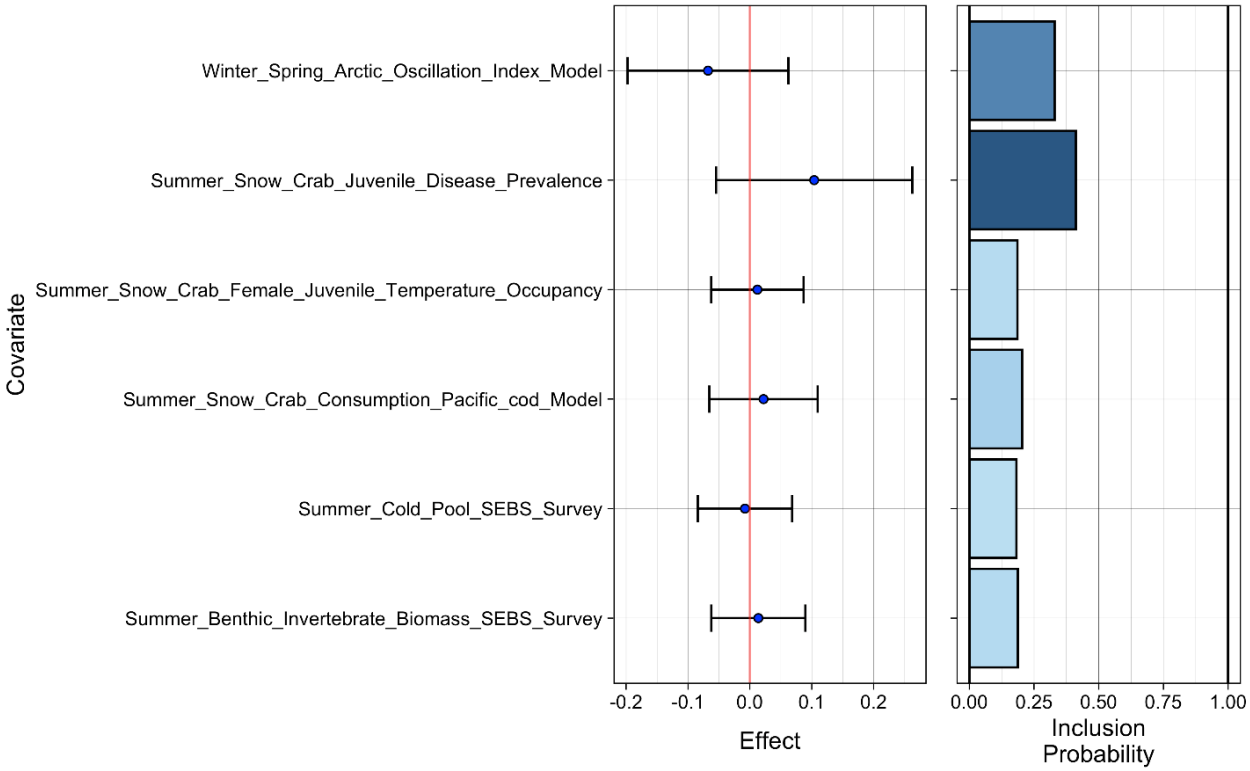
GMACS VS. STATUS QUO



CONTEXT - ESP UPDATE

- Ecosystem summary
  - 2020 Arctic Oscillation highest on record
  - 2021 cold pool north of St. Matthew
  - Bitter crab incidence down from 2016 high
  - Temperature occupied by immature snow crab above average in 2021
  - Mature male center of abundance shifted far northwest in 2021
  - Size at 50% maturity declined dramatically in 2021
- Socioeconomic summary
  - 2022 fleet consolidated to 37 vessels (60% of recent mean fleet size)
  - Strong market demand and high prices through 2020

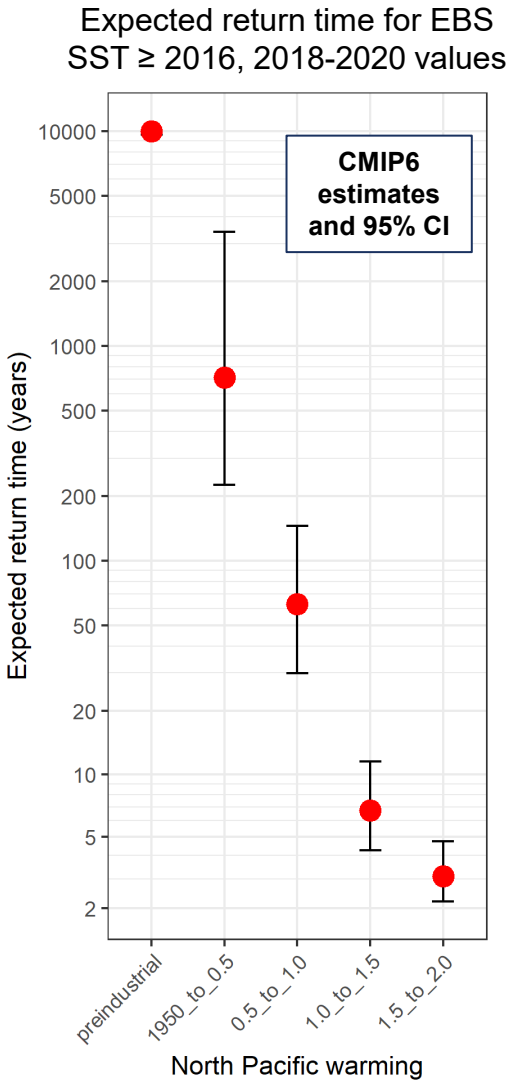
CONTEXT - ESP UPDATE



CPT discussion

- None of the indicators have predictive skill that can be distinguished from 0
- IBM and benthic cohort modeling not ready for inclusion

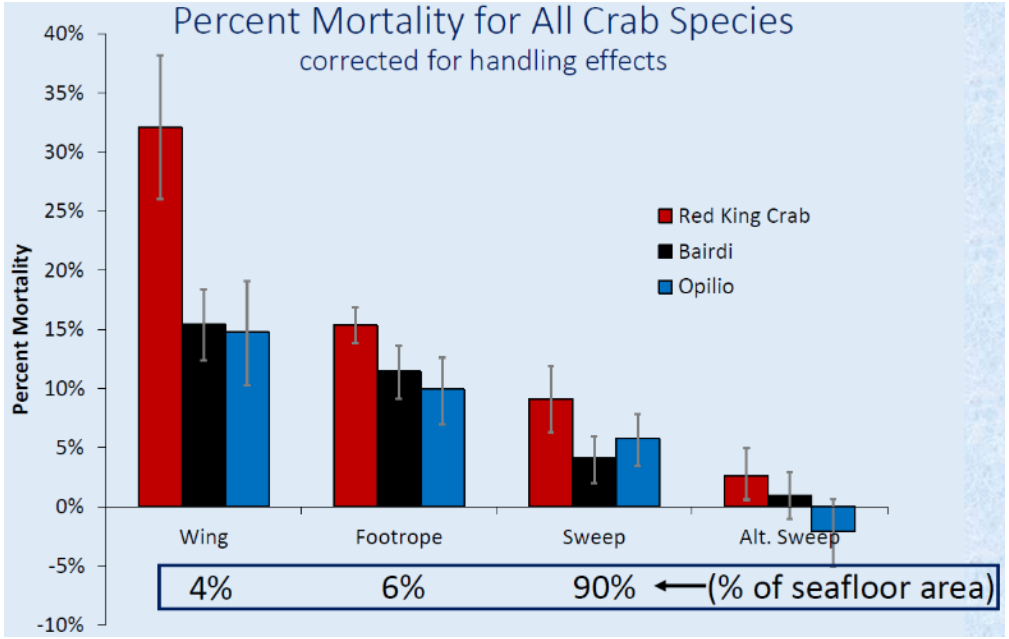
CONTEXT – CLIMATE OUTLOOK



- Apparent snow crab collapse was associated with an index of EBS borealization
- ~100% of risk for EBS temperature as warm as 2014-2020 is human-induced
  - *M* is “non-fishing” mortality rather than “natural” mortality
  - Expected return time for extreme temperatures associated with high borealization / low snow crab abundance
    - every ~ 65 years in 2003-2019 climate
    - every ~ 7 years in current climate
    - every ~ 3 years by 2030s/2040s, depending on emissions scenarios

CONTEXT - UNOBSERVED MORTALITY

- Craig Rose presented an extensive body of research
- Research considered bottom trawl effects, not effects of pelagic gear on bottom
- Estimated mortality for crab interacting with gear but not captured:
  - RKC highest, Tanner and snow crab lower
  - Differences in mortality rates and area contacted by different gear components
- Presentation noted modifications to footrope and sweeps that may reduce mortality
- Mortality higher for discarded crab than crab interacting with gear but not captured



CONTEXT - UNOBSERVED MORTALITY

CPT Discussion

- The CPT discussed using a multiplier for observed bycatch numbers to estimate combined observed and unobserved mortality.
  - Results would be highly dependent on choice of multiplier
- The CPT recognizes that this is a difficult area of research and continues to encourage studies designed to improve mortality estimates and quantify long term, delayed mortality following interactions with trawl gear.
- The CPT also emphasized that the timing of crab-gear encounters is of great importance and recommends that further efforts be made to protect post-molt (soft shell) crab.

REBUILDING PLAN: CPT DISCUSSION & RECOMMENDATION

- The CPT recommends that the rebuilding analysis be based on GMACS because of the ability to conduct projections
- CPT based rebuilding considerations on model 21.g
  - Closest to the CPT-recommended model from September 2021
  - This is the model used in projections
  - Discussion of model with a M prior similar to the one in the status quo model would be ideal (timing issue with not seeing these projections at the May meeting)
  - CPT and public interest in including new survey data point from 2022 but not feasible due to timing of rebuilding plan
    - Additional data point would likely not drastically change projection outcome into the future


REBUILDING PLAN: CPT DISCUSSION & RECOMMENDATION

- CPT discussion on “levers” in rebuilding projection scenarios:
  - Period for generating future recruitment (R)
  - Period for calculating proxy for B_{MSY} (here $B_{35\%}$)
    - All projections available use the same value
  - Values for future M (natural / non-fishing mortality)
  - Harvest strategies (ranges of fishing mortality (F) values) to consider in the analysis
- Uncertainty regarding appropriate choices for recruitment and M in projections
  - Do these reflect population and climate considerations


CPT DISCUSSION & RECOMMENDATION

Recruitment

- Three scenarios considered
  - 1982-2019 mean (currently used for calculating reference points)
  - 1994-2019 mean (starting after the decline in recruitment that precipitated last overfished declaration)
  - 1994-2015 mean (as above, but excluding large recruitment event beginning in 2015)
- CPT noted that estimates of T_{MAX} are not sensitive to recruitment since all projections presented here have a T_{MIN} <10

Generation time (for estimating T_{MAX} in some situations)

- Value of 5.5 years used in previous rebuilding appears too low
- CPT requested a new estimate from the stock assessment lead
- Not a consideration in the range of projections CPT discussed


CPT DISCUSSION & RECOMMENDATION

Non-fishing mortality (or natural mortality)

- Two scenarios considered
  - 1982-2017 mean
  - 2018 estimate (reflecting rate during recent mortality event)
- Estimates T_{MIN} and T_{MAX} are largely dependent on M
- CPT noted that 1982-2017 mean is likely too optimistic, but 2018 estimate is likely much too pessimistic
- CPT recommends 1982-2017 mean be used for projections
- Results in T_{MIN} < 10 years and T_{MAX} = 10 years for all combinations of R


CPT DISCUSSION & RECOMMENDATION

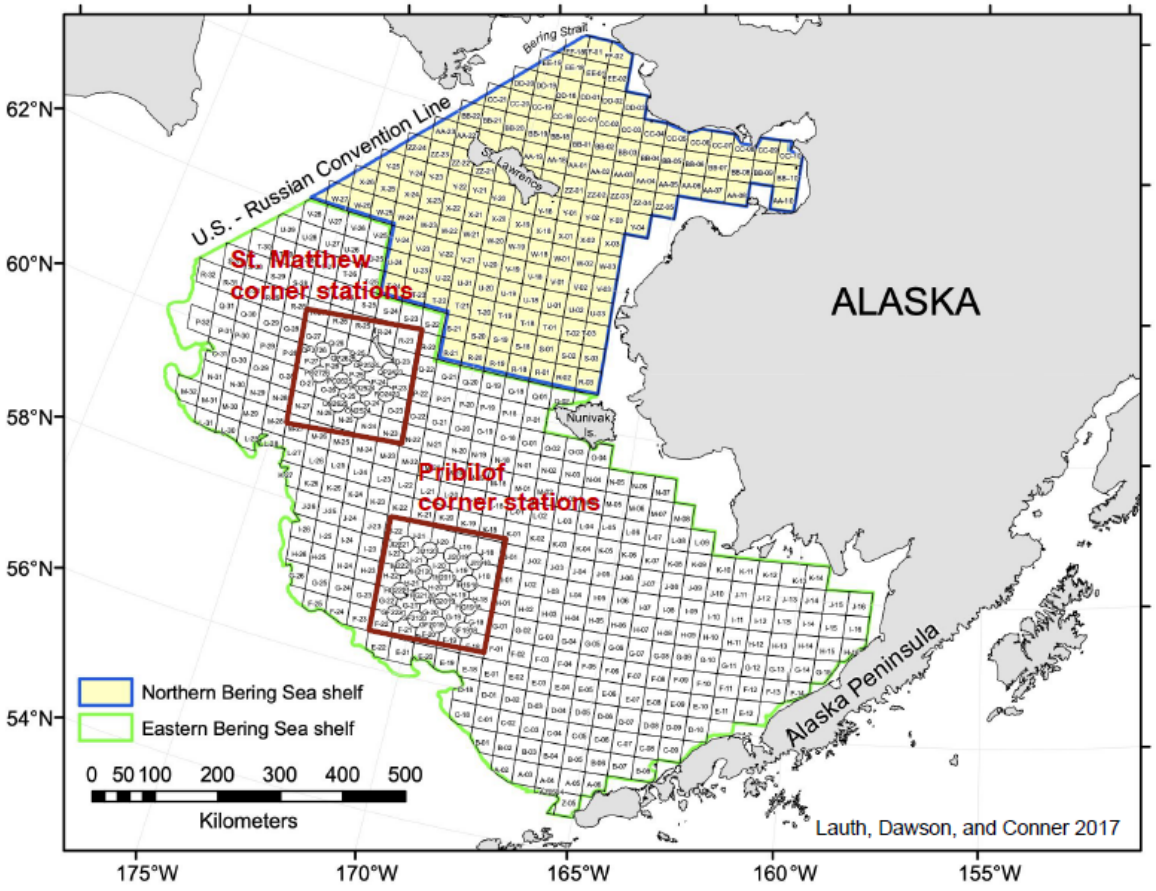
Fishing morality

- Three harvest scenarios considered
  - No removals (F=0)
  - Bycatch only (F= average bycatch levels)
  - State harvest strategy (ABC control rule multiplied by average of TAC:ABC ratio)
- CPT discussed the likelihood that bycatch in groundfish fisheries has a greater effect during rebuilding than when stock above B_{MSY}
- CPT discussed the fact that unobserved mortality is absent from bycatch estimates and may be an important consideration in rebuilding
- Council could consider:
  - Expanding COBLZ boundary
  - Revising PSC limits (currently independent of abundance below 4.5 billion crabs)
  - Revise PSC formulas to focus on size-classes more vulnerable to bycatch


BALANCE OF THE CPT REPORT

MAY 2022

SURVEY UPDATES – CORNER STATIONS



SURVEY UPDATES – CORNER STATIONS

- Effects on abundance estimates
  - Little effect on precision / accuracy for Tanner and snow crab
  - Larger effects on precision / accuracy for Pribilof / St. Matt RKC & BKC
    - Largest effects for species for which precision / accuracy already low
    - Effects of removing corner stations mitigated with model-based estimators
- Effects on size composition estimates
  - Generally negligible or small effect
  - Increased uncertainty for RKC/BKC stocks with high inherent uncertainty
- Effects on stock assessments
  - Tanner: little effect on recruitment, biomass, or reference points
  - SMBKC: lower biomass, OFL; no difference in stock trajectory

SURVEY UPDATES – CORNER STATIONS

Survey group perspective

- Cost-benefit approach supports dropping
  - No appreciable effect on Tanner crab assessment
  - Stocks with largest effect (PIRKC, PIBKC, SMBKC)
    - Effects can be handled (e.g., with model-based estimates)
    - Affected overfished stocks showing no signs of recovery
    - Corner stations can be re-instituted if biomass trends improve
- Some flexibility is needed in survey effort
  - Need to balance standardized design vs. avoiding permanent commitments to low-information sampling
  - Flexibility allows allocation to other areas (e.g. deeper NW stations)
  - Adding NBS has increased workload – high injury rates, staff stretched thin

SURVEY UPDATES – CORNER STATIONS

CPT discussion

- Concern over value of stable long-term design e.g. for ecological information
- Discussed possibility of dropping a subset of corner stations (e.g. St. Matthew I. only)
- Discussed other options for dropping stations, e.g. dropping random NBS stations
- Supports adding deeper stations, but other options should be explored (e.g., industry survey)
- CPT does not recommend dropping corner stations at this time, and invites further explorations of this topic from the survey group

SURVEY UPDATES – BBRKC RESAMPLING

Proposed changes to survey protocol

- Threshold % of females having not completed molt-mate for triggering resample: change from 10% to 25%
- Standardize the number of stations resampled (20 stations)

SURVEY UPDATES – BBRKC RESAMPLING

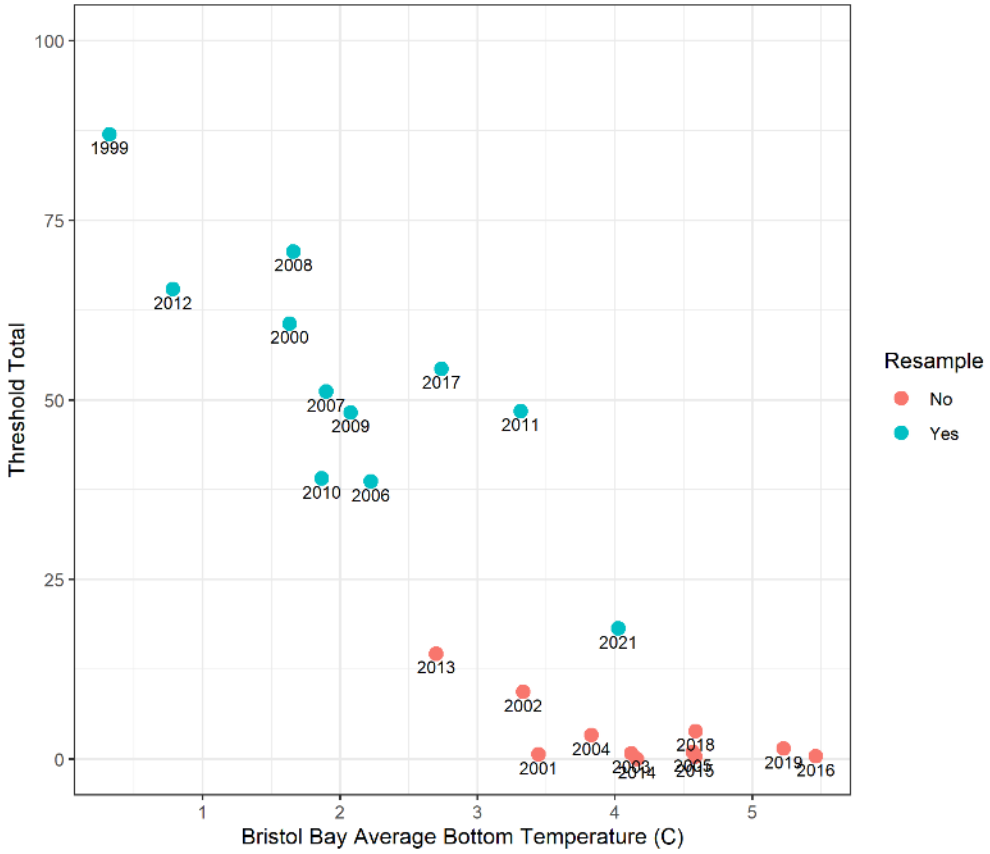
February 2022 SSC request: Clarify goals of resampling

- Primary goal: Improve the accuracy of size composition data for post-molt females
- Secondary goal: Improve abundance estimates for mature females by including post-molt females potentially unavailable to Leg 1
- Tertiary goal: Improve estimates of reproductive status

SURVEY UPDATES – BBRKC RESAMPLING

February 2022 SSC request: Examine temperature effects on molt-mate cycle and need to resample

- Strong temperature effect on % of pre-molt/mate females
- 2021 was not an outlier
- ROMS forecast for June 2022 = 2.3° C, indicates high chance for resampling under current protocol



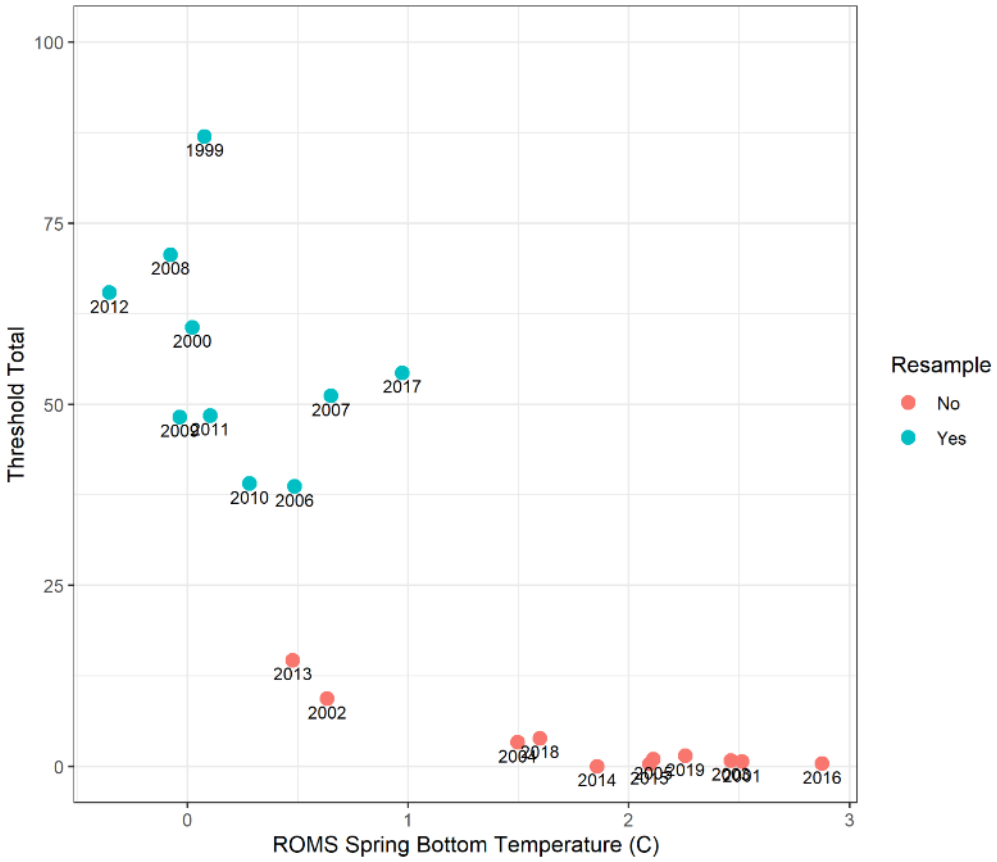
SURVEY UPDATES – BBRKC RESAMPLING

February 2022 SSC request: Examine spring (pre-survey) temperature effects on molt-mate cycle and need to resample

- Similar temperature effect

Other predictors for molt/mate phenology, e.g. prey availability

- Not tractable with data in hand



SURVEY UPDATES – BBRKC RESAMPLING

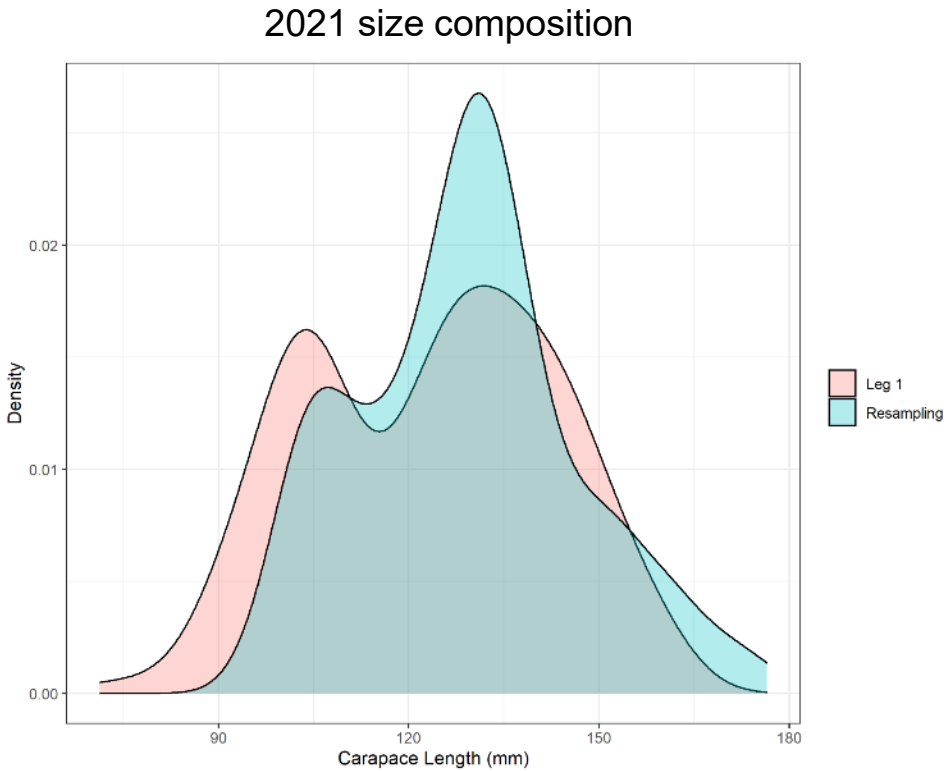
February 2022 SSC request: Standardize resample station selection

- Resample stations will continue to target high-abundance stations from leg 1
- Predicting movement from nearshore areas to select resample stations not practicable
- Goal is to resample stations containing 80% of mature female abundance on leg 1
- Priority is given to contiguous sets of stations

SURVEY UPDATES – BBRKC RESAMPLING

Effects on survey data in 2021

- Size composition similar between sampling events; shift reflecting molt is evident
- Abundance estimates similar
  - 6.2 million on leg 1
  - 6.3 million on resample



SURVEY UPDATES – BBRKC RESAMPLING

CPT discussion

- Comfortable with the demonstrated effects on data collection
- Noted that the proposed change would only have affected 2021; in most resampling years > 40% have not completed molt-mate
- Noted that resampling is likely to become less common as the Bering continues to warm
- CPT supports the proposed change

BBRKC DRAFT RISK TABLE

- Using template from groundfish
- Reviewed SAFE doc and minutes to fill in each subject area
- ESP provided helpful information for areas 3 and 4
- Current buffer for BBRKC 20% - reflects increased concerns over a “baseline”
- Uncertainty about level of concern baseline
  - CPT discussion: level of concern should be based on an “ideal” crab model
  - Adjustments made to level to reflect this following CPT
- CPT discussion:
  - Who would put risk table together? Author but with modifications by CPT
  - Need to be able to flag ‘on-going’ concerns vs. ‘new’ concerns in risk table

BBRKC

Draft Risk Table Evaluation in 2022

Assessment-related considerations	**Population dynamics considerations**	**Environmental/ecosystem considerations**	**Fishery Performance**
-Strong retrospective pattern in MMB (high Mohn's rho) -Natural mortality time blocks -Have 2021 survey data point, no need for extra uncertainty for missing survey in 2020 -Stable GMACS reference model **Conclusion: ~~Level 1, No increased concerns~~** **Level 2, substantially increased concerns**	Poor recruitment in recent years led to a declining trends in mature biomass. No signs of recruitment improvements. Potential shifting spatial distributions? Decrease in female biomass below management threshold **Conclusion: Level 2, substantially increased concerns**	Increased potential predation of early life stages (BB salmon increases) Poor larval recruitment conditions last few years (ESP) Cold pool distributional shifts **Conclusion: ~~Level 1, No increased concerns~~** **Level 2, substantially increased concerns**	2020/21 fishery CPUE was up relative to previous yr Fishery in traditional grounds 75% of the catch in first week of fishery Bycatch typical levels in other fisheries. **Conclusion: Level 1, No increased concerns**

Sept/Oct 2021 recommended ABC = 80% of max ABC (20% buffer).

QUESTIONS?

- Thanks to all CPT members and crab authors.