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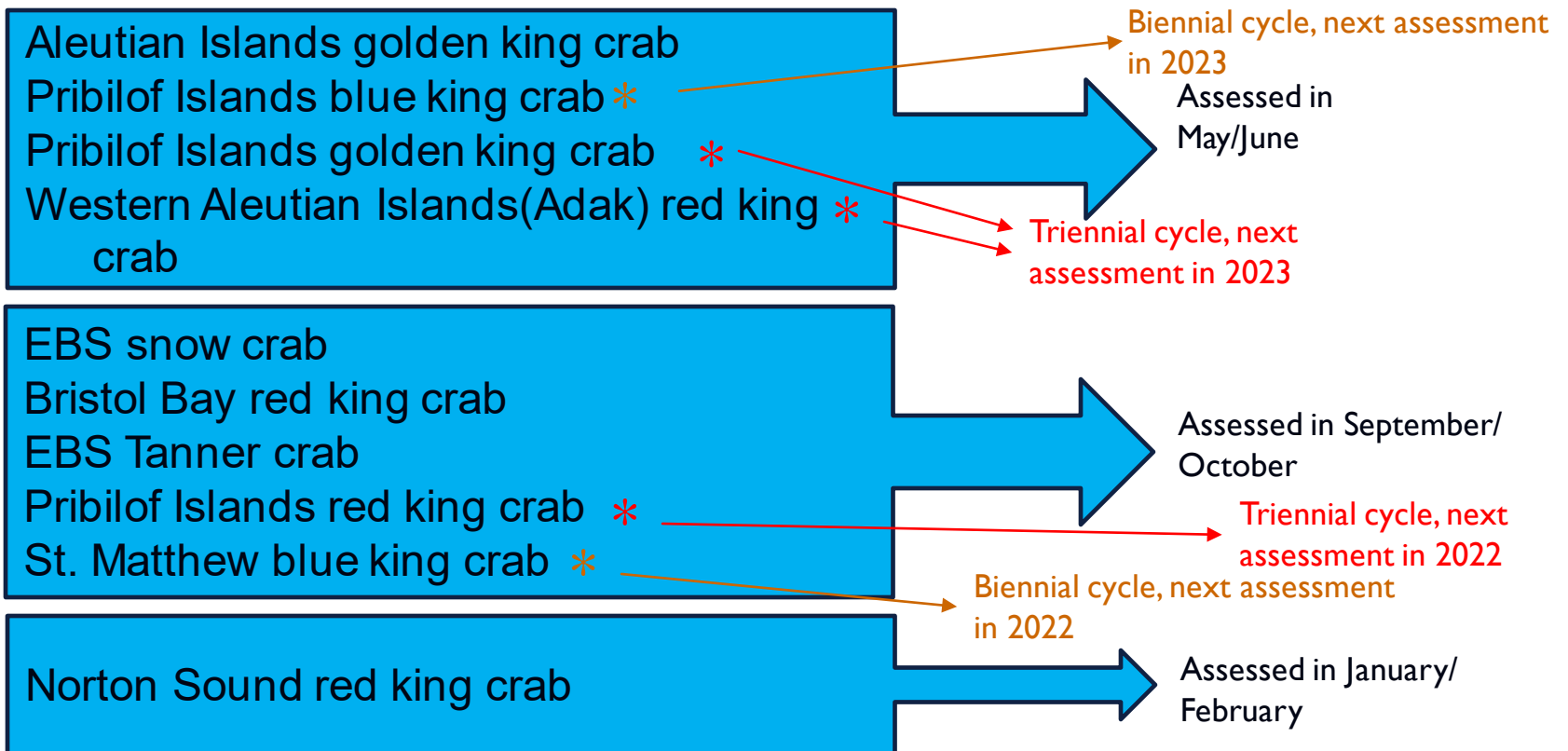
# C2 BSAI CRAB STOCKS

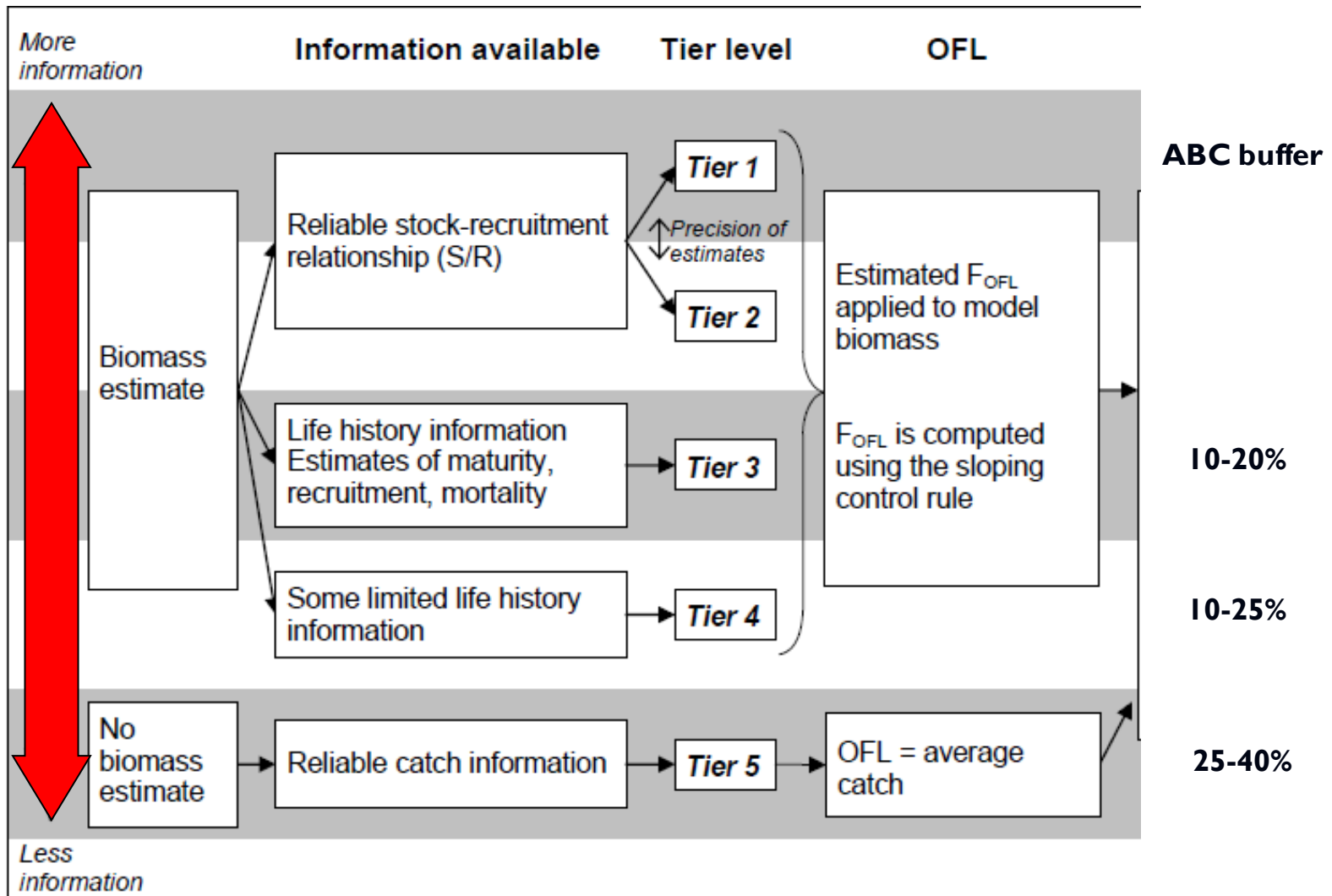
KATIE PALOF & MIKE LITZOW,

CPT MEETING MINUTES – JANUARY 10 – 15<sup>TH</sup>, 2022



# BSAI CRAB STOCKS MANAGEMENT TIMING





# JANUARY 2022 AGENDA

## **NSRKC final assessment, OFL and ABC**

Modeling workshop/GMACS updates and progress

AIGKC proposed model runs for May/June

Bering Sea trawl survey updates

EFH components 1 & 2 feedback

Updating TOR for crab SAFEs

Snow crab rebuilding progress update

Crab Economic SAFE

ESP snow crab indicators updates

Discussion on F35% origin and potential future alternatives

ACLIM management scenarios for Bering Sea stocks

Research updates: BSFRF research projects

Risk table draft planning



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# NORTON SOUND RED KING CRAB (NSRKC)

FINAL ASSESSMENT 2022



# NSRKC MODEL APPROACH

- Male only assessment
- Seven size bins
- Fit to NMFS bottom trawl survey and ADF&G trawl survey in Norton Sound
- $M = 0.18$  for length class 1-6, higher mortality for length classes 7 and 8
- Discard mortality = 0.2
- Fishery harvests occur instantaneously:
  - Winter fishery: Feb 01: Nov – May
  - Summer fishery: July 01: Jun – Sept



# FISHERY & SURVEY DATA

## Winter fishery 2021

- Commercial: 320
- Subsistence: 4655 (total), 2892 (retained)
- Retained data: Not collected 0

## Summer commercial fishery 2021

- 6/25-9/03: 0
- Discards 0, Bycatch from other fisheries: 0.
- No tag recovery

Total harvest: **0.007** mill. lb < ABC (0.35 mill. lb.)

- No overfishing occurred in 2021.

All data **FINALIZED**

Standardized CPUE **Appendix B**

ADF&G 2021 Summer trawl survey

- **7/19-8/03: 2400.0 k, CV = 0.60**

NOAA 2021 NBS trawl survey

- **7/29-8/7: 2370.0 k, CV = 0.43**



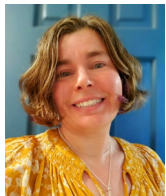
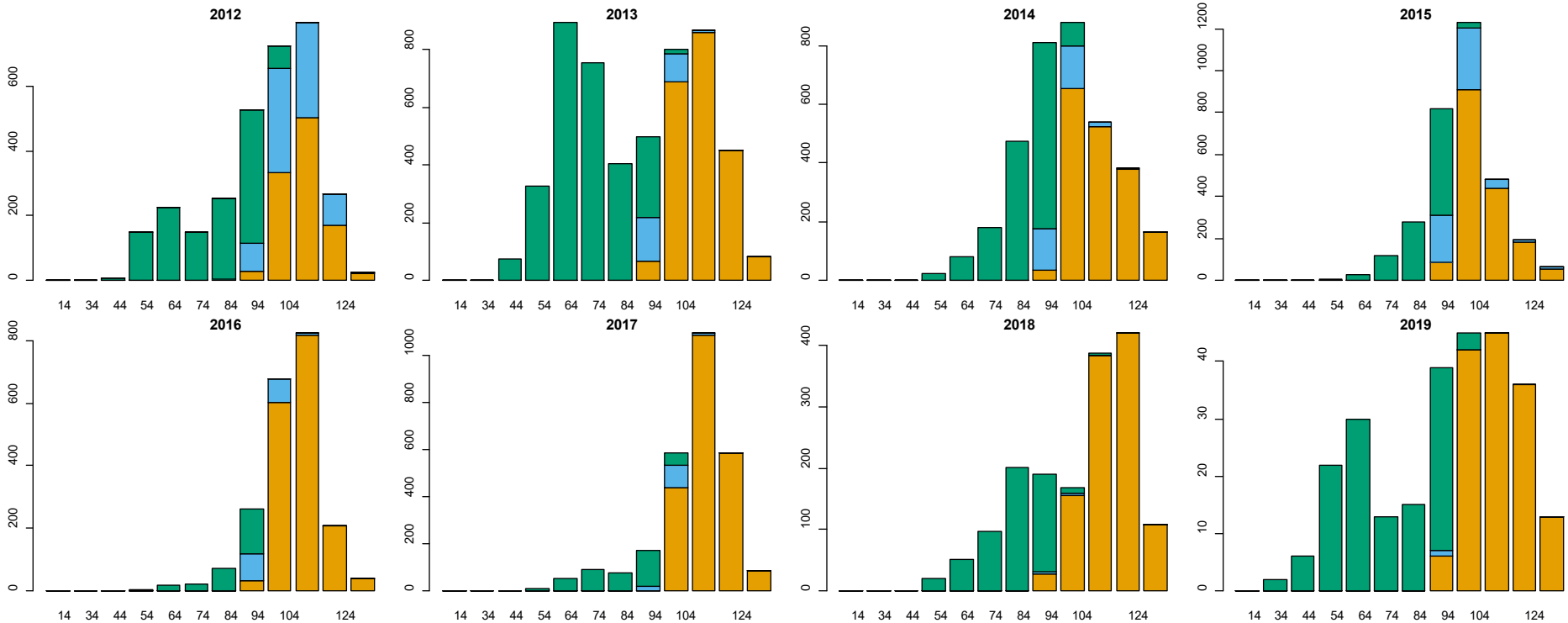
## RESPONSES TO CPT-SSC (SEPT-OCT 2021)

- Marketable crab in the legal sized crab
- Discard biomass estimates in the absence of observer data
  - How to deal with estimating total catch without observer data (example to follow)
    - Option 1: calculate discards lb/retained crab coefficient from past observed surveys
    - Option 2: Use trawl survey size comp, model estimated selectivity, and retention probability
    - Other options?
- Models to evaluate natural mortality options – fixed and estimated





# ESTIMATE DISCARDS BIOMASS ( $D_B$ ) IN THE ABSENCE OF OBSERVER SURVEY: OPTION 1



Orange: Legal retained  
 Green: Sublegal unretained  
 Aqua: Legal unretained

Unobserved unretained crab size and abundance are highly variable.

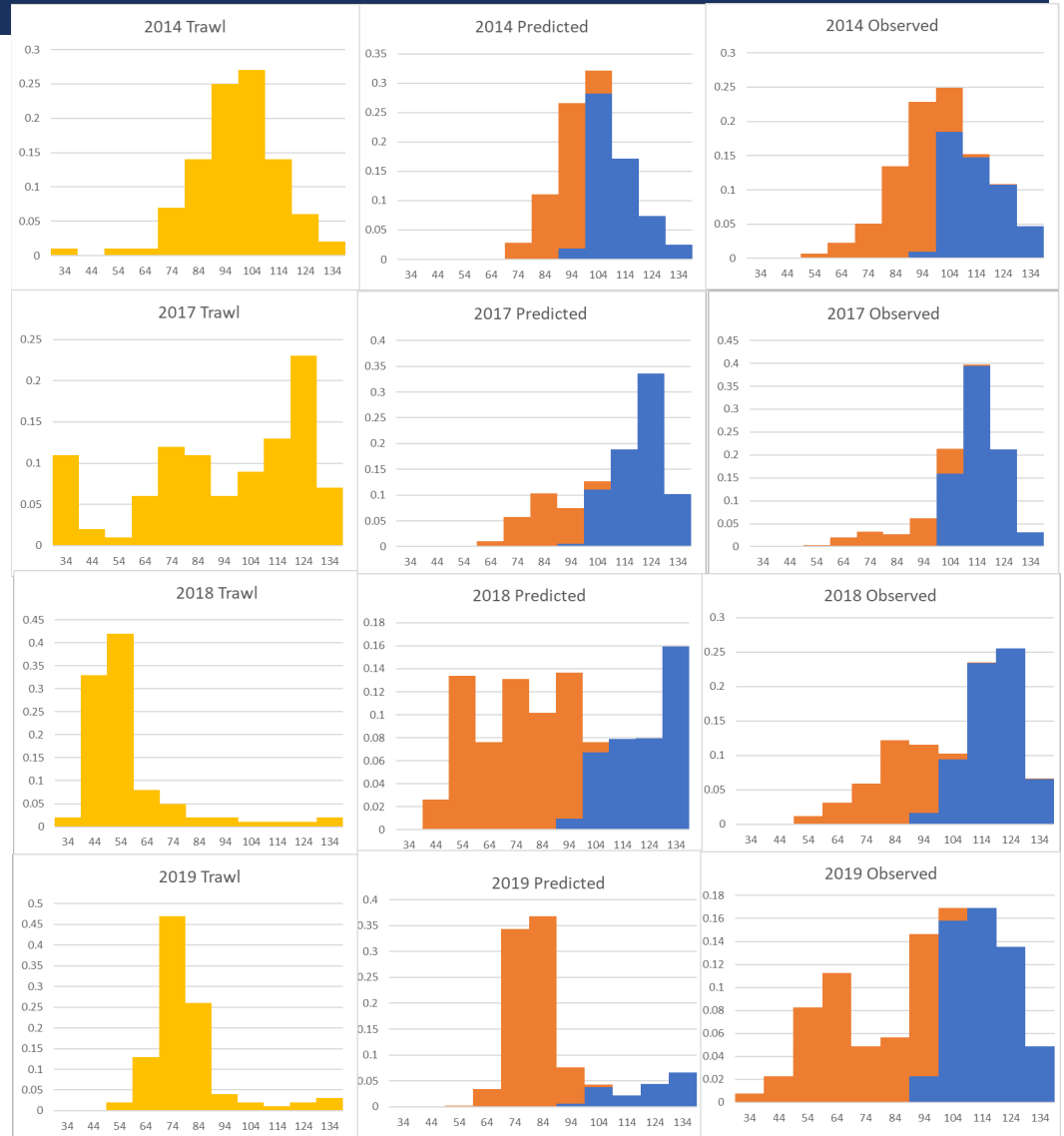
# OPTION 2: USE TRAWL SURVEY SIZE COMP, AND MODEL ESTIMATED SELECTIVITY, AND RETENTION PROBABILITY

Trawl survey not representing true size distribution?

Incorrect trawl survey selectivity?  
(1.0 across all lengths)

Incorrect selectivity-retention probability?

Need to examine this further



# MODEL OPTIONS

- Model 19.0e: with updated data (base with “proportional” discard estimate)
- **Model 21.0: Model 19.0e+ St CPUE with 3q’s + 2 summer commercial retention probabilities**
- Model 21.1: Model 21.0 with  $M = 0.18$  for all length size classes (constant M)
- Model 21.2: Model 19.0e + St CPUE data updated with 3qs. (bridging 1)
- Model 21.3: Model 19.0e + 2 summer commercial retention probability (bridging 2)
- Model 21.4: Model 21.0 with M estimated equally for all length size classes (estimated constant M for all size classes)
- Model 21.5: Model 21.0 with M estimated for two length size classes (< 124mm, >123mm CL). (estimated M for two groups of size bins)

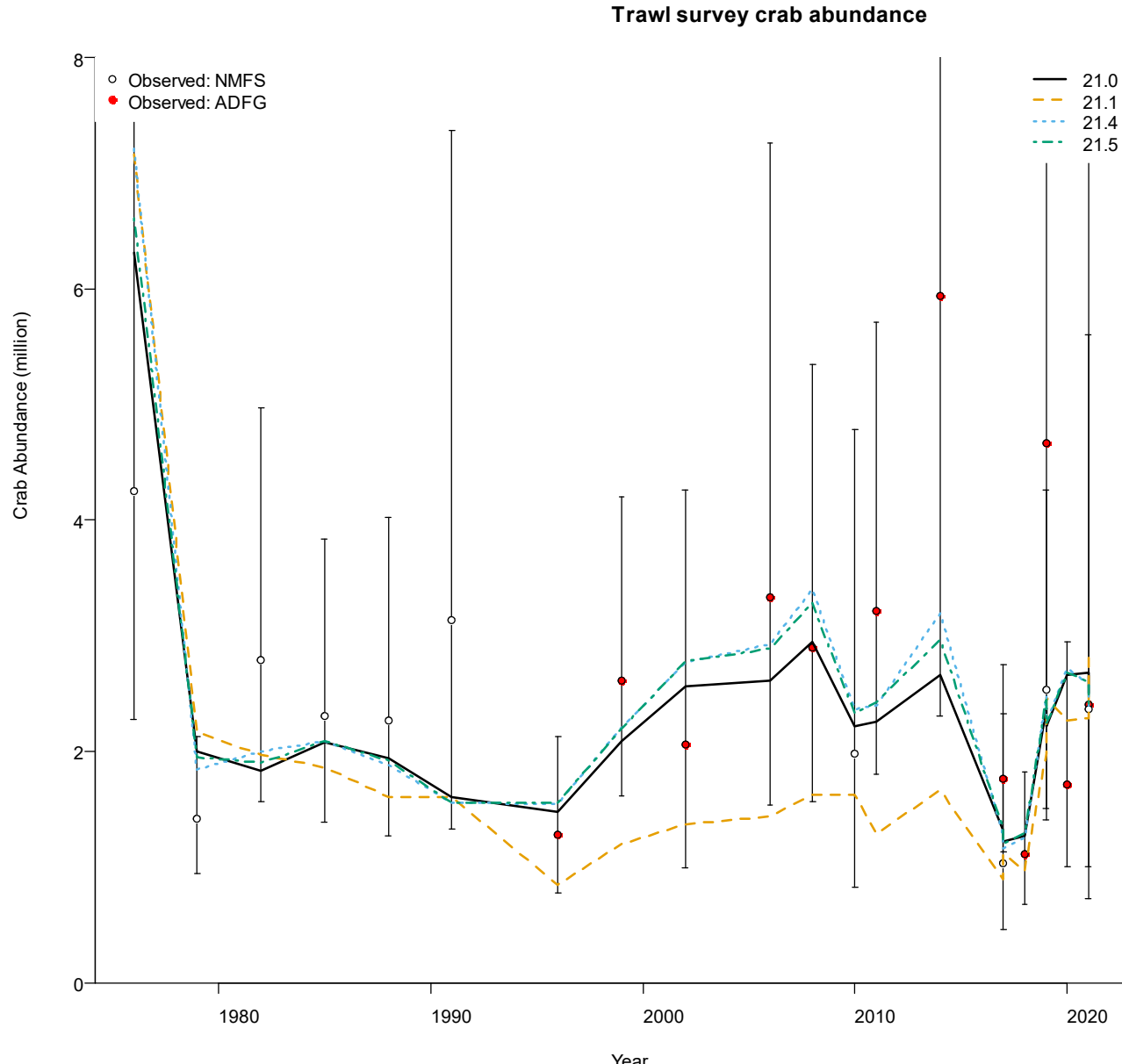


# NSRKC FINAL ASSESSMENT MODELS: SUMMARY

- Explore  $M$ : Model 21.0, 21.1, 21.4, 21.5:
  - (rehash of NPFMC 2019 model alternatives).
  - No changes in overall results (as expected)
- Length-independent  $M = 0.18$  (21.1) generates the poorest model fit.
- Length-independent higher  $M$  (21.4) moderately improves model fit.
- Length-dependent  $M$  (21.0) showed great improvement in model fit.
- Length-dependent higher  $M$  (21.5) had the best model fit.
- **None of the model alternatives greatly reduced misfit.**
  - **Large crabs, Oldshell crabs**

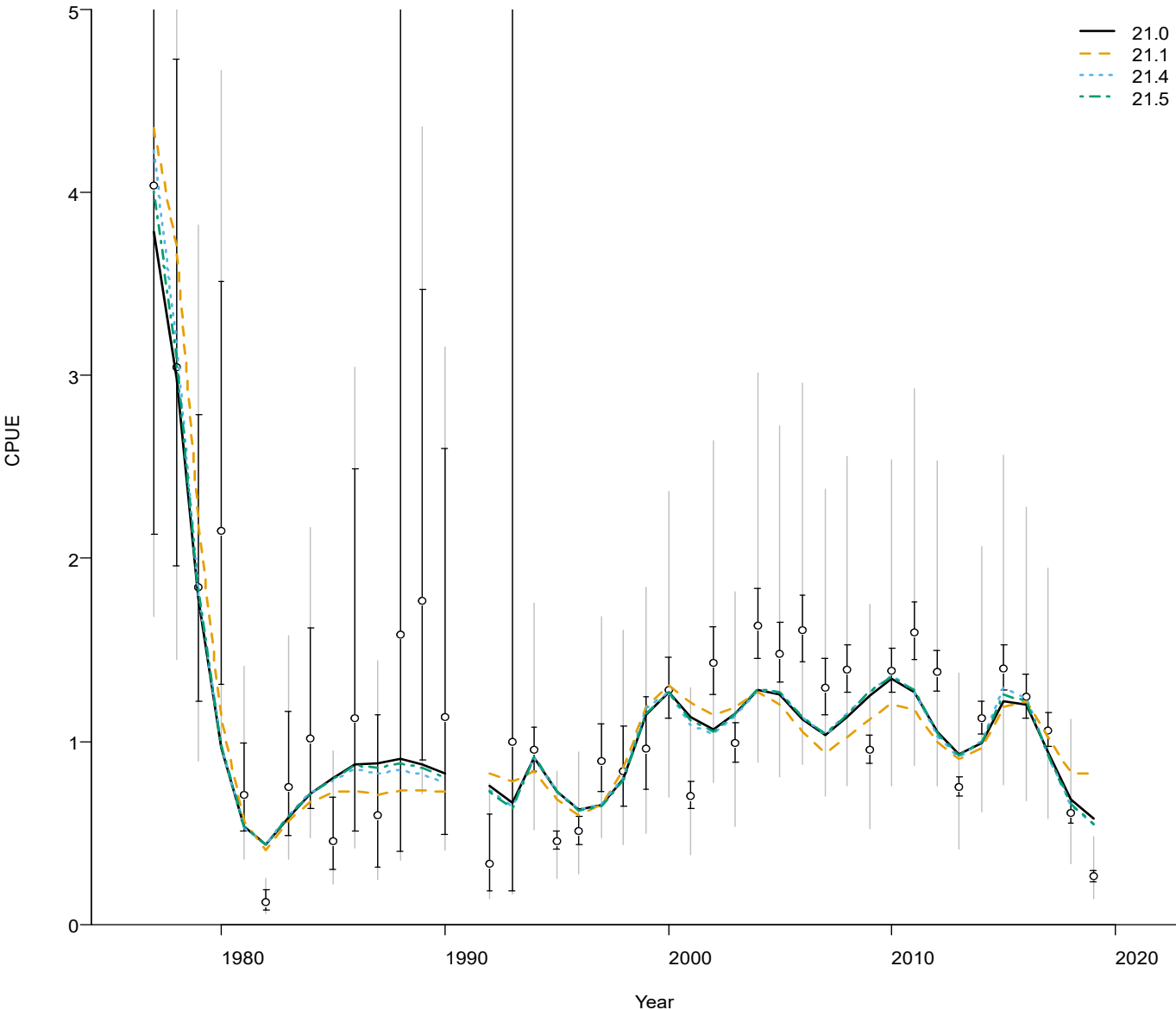


# TRAWL SURVEY: HIGHER $M$ SLIGHTLY BETTER FIT

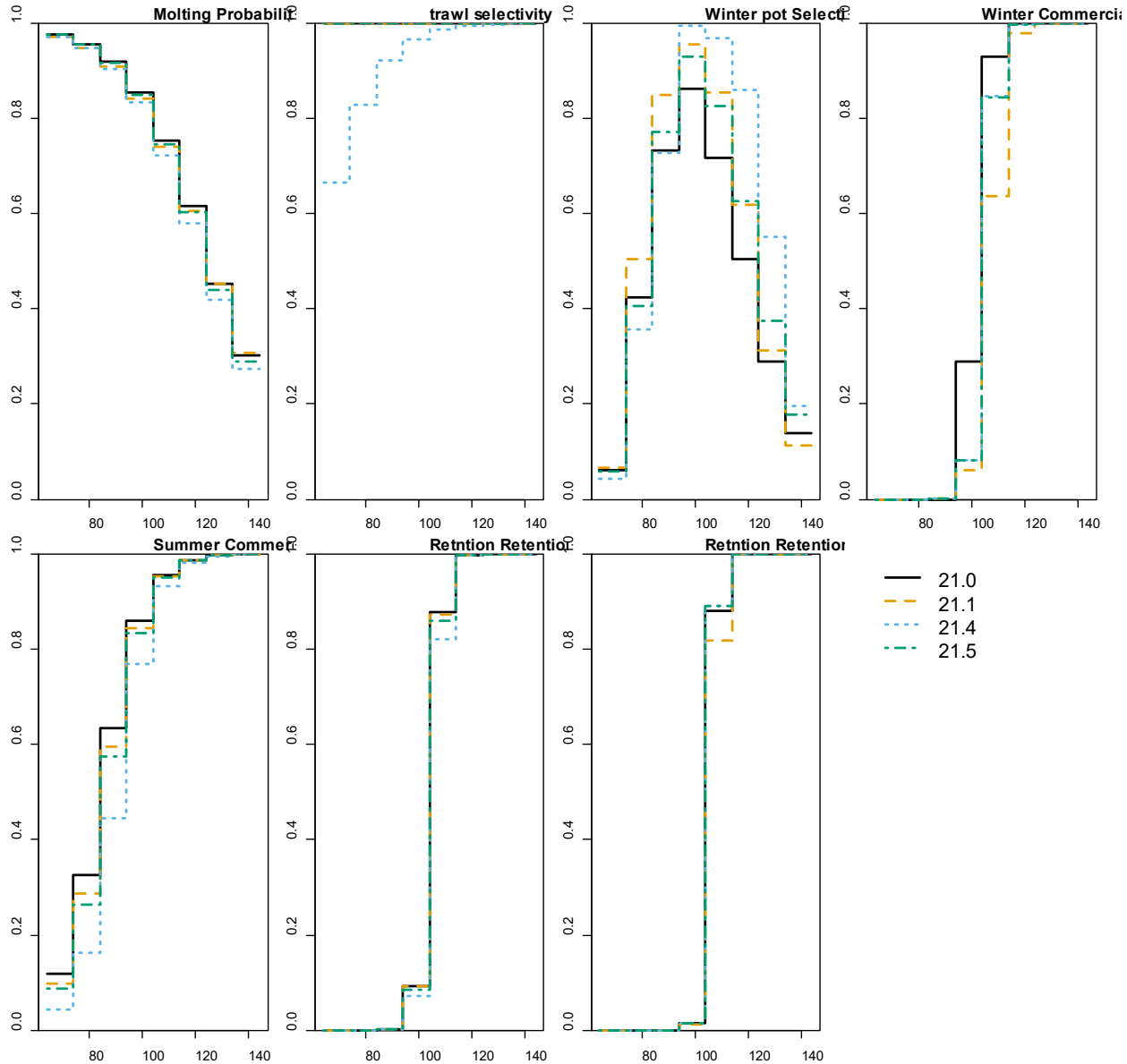


# CPUE

Summer commercial standardized cpue

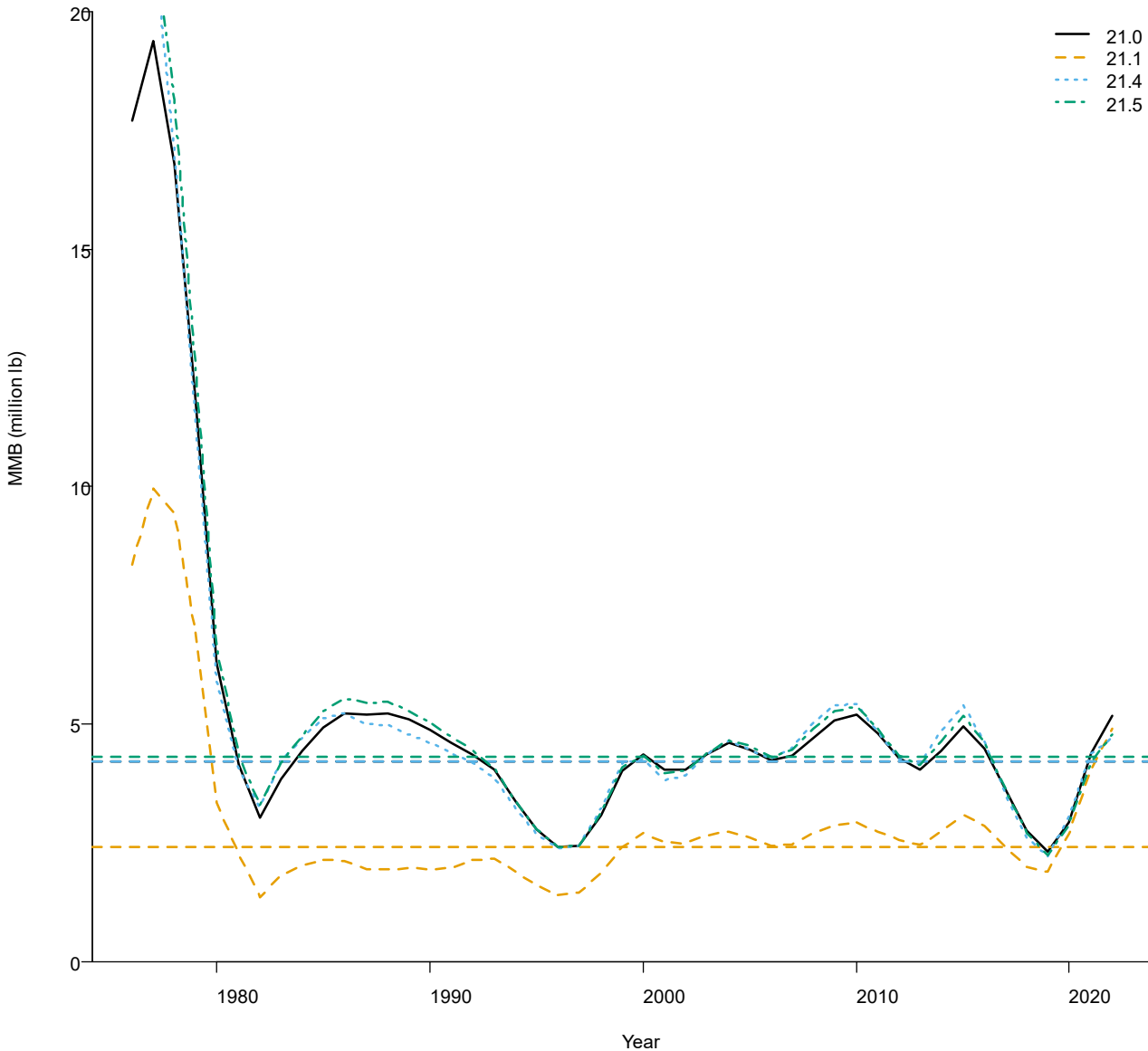


# MOLTING, SELECTIVITY, RETENTION



# MMB

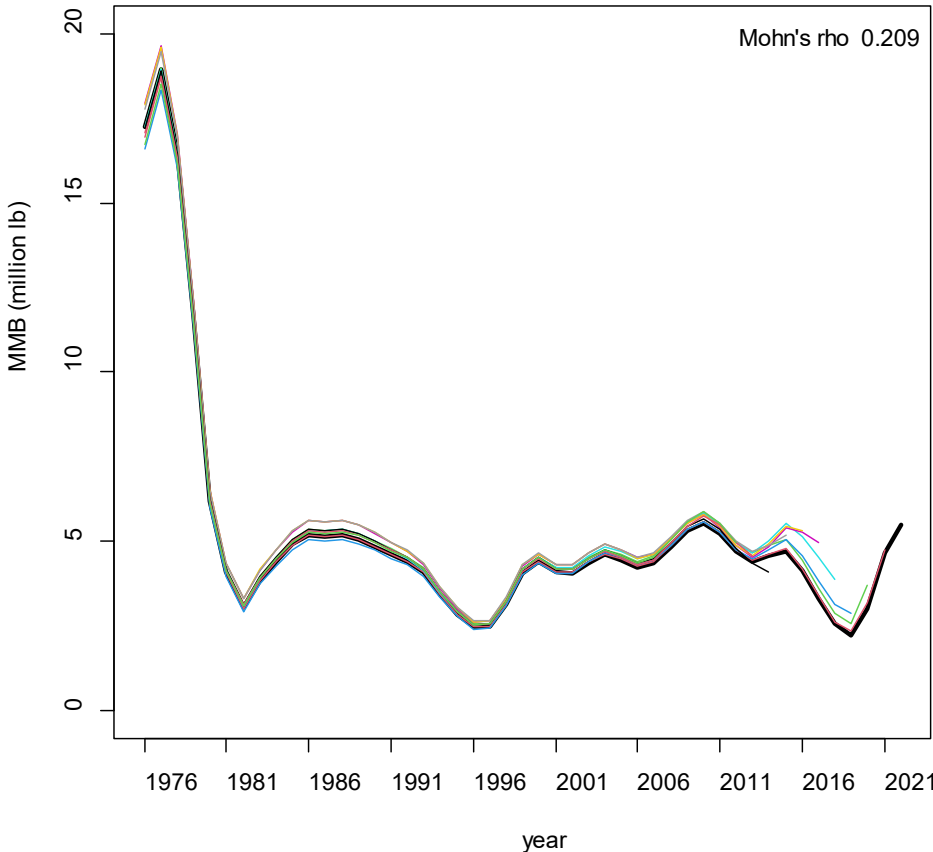
MMB Feb 01



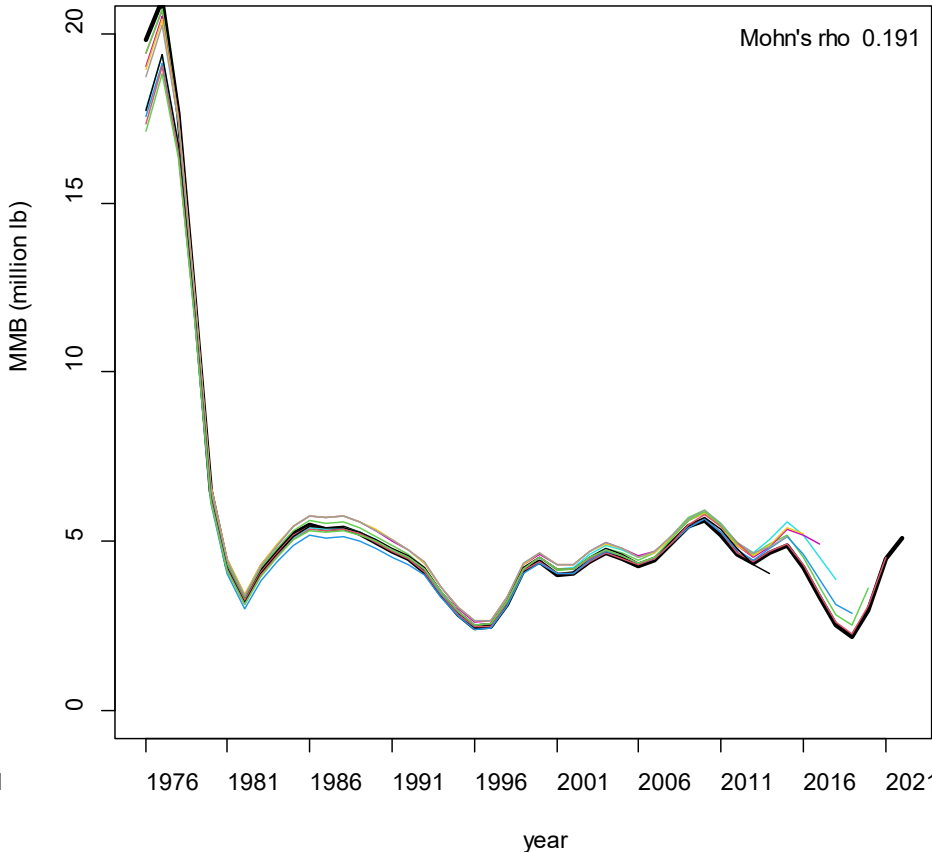


# RETROSPECTIVE

Retrospective Analysis Model 21.0



Retrospective Analysis Model 21.1



# NSRKC: CPT RECOMMENDATIONS

- Author recommended model 21.0 or 21.5 and length-dependent OFL
  - Consistent with model structure
  - Deal with uncertainty about length-dependent  $M$  in ABC buffer
- CPT recommended model 21.0 and length independent OFL
  - Concern that estimating two  $M$ 's in model 21.5 was an overreach of the depth of the data available for this model
  - CPT would like to review length-dependent OFL calcs before moving to them; Tier 4 control rule does not cover this situation currently
- Buffer considerations (see Table in CPT minutes):
  - Some improvement in the stock but many concerns unresolved
    - Retrospective patterns, shortage of discard data, high  $M$  for large size classes, low fishery CPUE, some evidence of recruitment in survey size comps, selectivity parameters hitting bounds
  - Keep 40% buffer that was adopted in 2021



# NSRKC FINAL OFL/ABC

*Status and catch specifications (million lb.)*

Year	MSST	Biomass (MMB)	GHL	Retained Catch Mortality <sup>1</sup>	Total Catch Mortality <sup>2</sup>	OFL <sup>3</sup>	ABC <sup>3</sup>
2018	2.41	4.08	0.30	0.31	0.34	0.43	0.35
2019	2.24	3.12	0.15	0.08	0.08	0.24	0.19
2020	2.28	3.67	0.17	Conf.	Conf.	0.29	0.20
2021	2.26	5.00	0.31	0.007	0.007	0.59	0.35
2022	2.08	5.33				0.67	0.40

*Status and catch specifications (1000 t)*

Year	MSST	Biomass (MMB)	GHL	Retained Catch Mortality <sup>1</sup>	Total Catch Mortality <sup>2</sup>	OFL <sup>3</sup>	ABC <sup>3</sup>
2018	1.09	1.85	0.13	0.14	0.15	0.20	0.16
2019	1.03	1.41	0.07	0.04	0.04	0.11	0.09
2020	1.04	1.66	0.08	Conf.	Conf.	0.13	0.09
2021	1.03	2.27	0.14	0.003	0.003	0.20	0.16
2022	0.93	2.17				0.30	0.18

Notes:

<sup>1</sup>2018:2020: Refers to commercial fisheries only; 2021: refers to all (commercial + subsistence) retained catch

<sup>2</sup>2018:2020: Does not include discard mortality (total retained catch only; 2021: includes estimated discard mortality)

<sup>3</sup>OFL/ABC are total catch values starting 2021. (These were retained catch OFL/ABCs in previous years)

# NSRKC: CPT RECOMMENDATIONS FOR FUTURE ASSESSMENTS

- Housekeeping improvements:
  - presenting last years base model, listing management quantities for all models in SAFE, improved editorial error checking, etc.
- Table of discard estimation methods to compare/contrast
- Evaluation of length-dependent vs length independent OFL calcs for Tier 4
- Progress towards GMACS version
- Consider using a simpler model (e.g., a random-effects model similar to that used for Pribilof Islands blue king crab);
- Evaluate how the spatial distribution of catch impacts the ability to estimate discards using Option 2 (survey size compositions); and
- Re-examine the evidence for shell condition-specific discard rates and evaluate their implications for the assessment model (e.g., would this affect the overestimation of large crab).



# MODELING WORKSHOP: GMACS UPDATES

- AIGKC GMACS model will be presented as an option in May 2022
- Post-doc for GMACS (Mathieu Veron) – progress report in May 2022
  - Goal of unifying the king crab branch of GMACS with terminally molting branch
  - Documentation
  - Improved output/visualization package for R
- GMACS improvements
  - Size composition data modeling updates (can now choose survey or catch)
  - Jittering and retrospective option in GMACS were tested and appear to be working on SMBKC and BBRKC
  - Updated projection module to allow for differing conditions in terminal year OFL calc and projections (e.g. natural mortality, selectivity)
    - Projection module documentation and output was improved



# AIGKC MODELING APPROACH

- Integrated male-only length-based models fitted to fishery dependent catch and CPUE data.
- *Constant M* of  $0.21\text{yr}^{-1}$ .
- Projected the abundance from unfished equilibrium in 1960 to initialize the 1985 abundance.
- 5 models for **EAG** and 6 models for **WAG**.
- Francis re-weighting method for Stage-2 effective sample sizes calculation for all models.



# CPT/SSC COMMENTS

- Author addressed many of the CPT/SSC comments and concerns
- Maturity analysis – repeated in Appendix B
  - 116 mm CL vs 111 mm CL (currently used in assessment)
  - CPT requested more background on the 111 mm CL for May
- Pre-lim look at NMFS Aleutian Islands trawl survey data – Appendix D
  - No sex or size data available
  - There is spatial overlap
- CPUE standardization
  - Some additional plots needed for May
  - Need to compare design-based estimate of CPUE by area with those predicted from model with year\*area interactions



# AIGKC MODELS PRESENTED

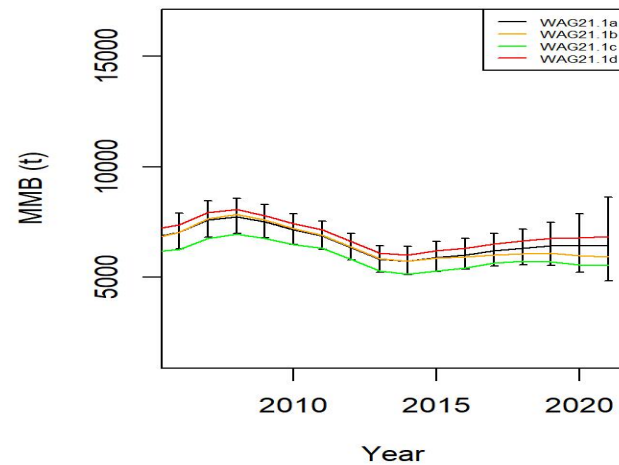
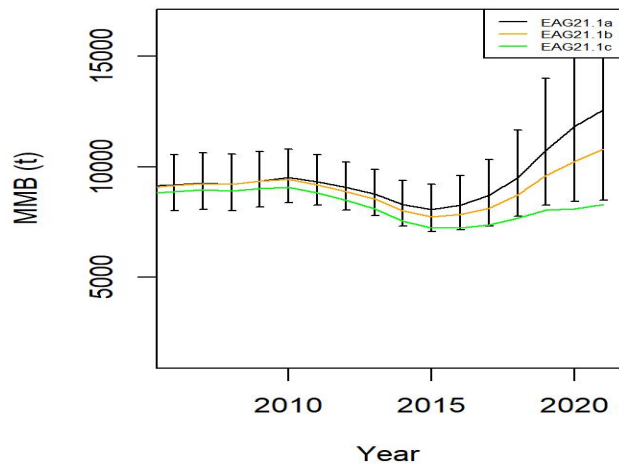
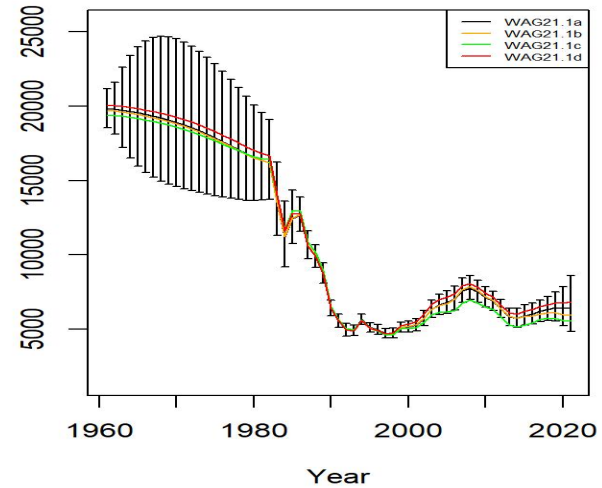
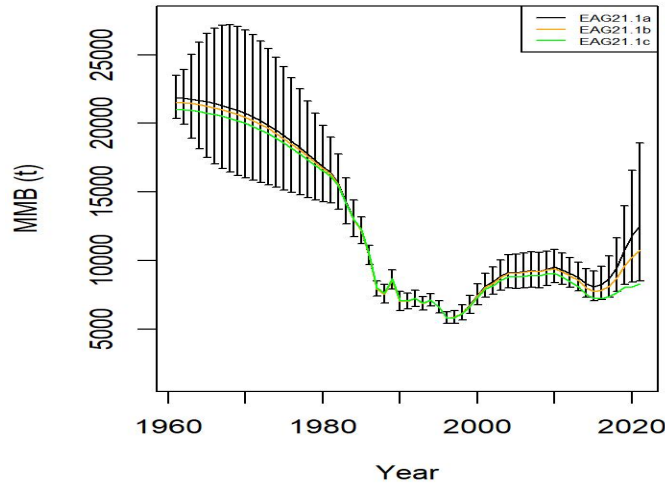
- Model 21.1a: The model on which the 2021 assessment was based.
- Model 21.1a1: As for model 21.1a, except  $M$  is increased from 0.21yr<sup>-1</sup> to 0.38yr<sup>-1</sup> to reduce retrospective patterns (EAG assessment only)
- Model 21.1b: As for model 21.1a, except that the CPUE standardization considered year\*area interactions.
- Model 21.1c: As for model 21.1a, except that separate catchability coefficients and additional CV parameters are estimated for the fish ticket, and early (1995-2004) observer and late (2005+) observer CPUE series. Model 21.1a assumed that the catchability coefficient for the fish ticket and early observer CPUE series were the same, while it also assumed that the additional CV was the same for the two observer CPUE series. The fish ticket CPUE series was restricted to 1985-1994 for this model scenario.
- Model 21.1d: As for model 21.1a, except that the data for one vessel was omitted from the CPUE standardization (WAG assessment only). [Sensitivity model ONLY](#)
- Model 21.a2: As for model 21.1a, but with the size-at-maturity increased from 111mm to 116mm.
- Model 21.b2: As for model 21.1b, but with the size-at-maturity increased from 111mm to 116mm.





# AIGKC proposed models for May 2022

FIGURE 12. TRENDS IN GOLDEN KING CRAB MATURE MALE BIOMASS FOR 21.1A, 21.1B, AND 21.1C MODEL FITS TO **EAG** (LEFT) AND FOR 21.1A, 21.1B, 21.1C, AND 21.1D MODEL FITS TO **WAG** (RIGHT) DATA. TOP: 1960/61–2020/21, BOTTOM: 2005/06–2020/21. MODEL 21.1A ESTIMATE HAS TWO STANDARD ERROR CONFIDENCE LIMITS.



## CPT RECOMMENDED MODELS FOR MAY 2022

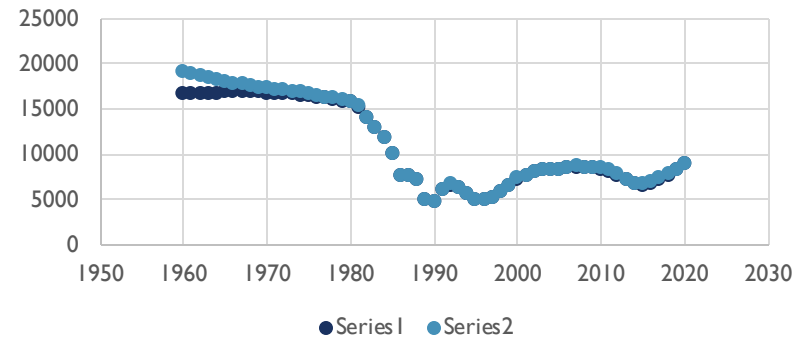
- **Model 21.1a:** The model on which the 2021 assessment was based.
- **Model 21.1e:** As for model 21.1a, except that separate catchability coefficients and additional CV parameters are estimated for the fish ticket (1985-1998), early (1995-2004) observer and late (2005+) observer CPUE series.
- **Model 21.1f:** As for model 21.1e, except that the CPUE standardization is based on year\*area interactions
- **Model 21.1e2:** As for model 21.1e, but with the size-at-maturity increased from 111mm to 116mm.
- **Model 21.1f2:** As for model 21.1f, but with the size-at-maturity increased from 111mm to 116mm.
- GMACS model versions of all models if possible, but at least Model 21.1e and 21.1f



# AIGKC EAG GMACS PROGRESS

- Bridging model achieved with Dec work and Modeling workshop
- N matrix was replicated
- Model output – both likelihoods and management quantities are similar
- CPT members at the modeling workshop endorsed seeing a GMACS version of models in May

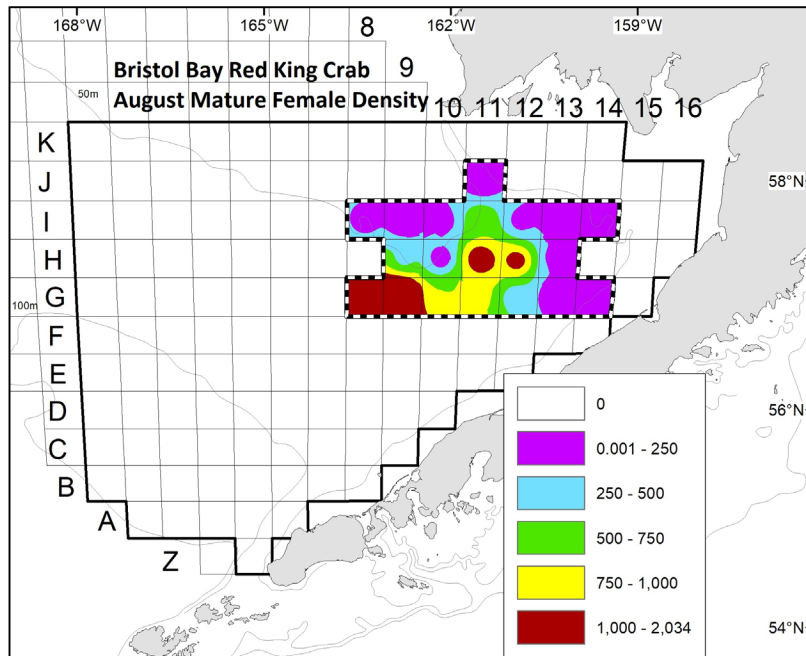
ChartTitle



- Series 1: EAG21\_6: Siddeek's model with GMACS formulations (OFL: 2532.39)
- Series 2: GMACS fitted (OFL: 2546.57)



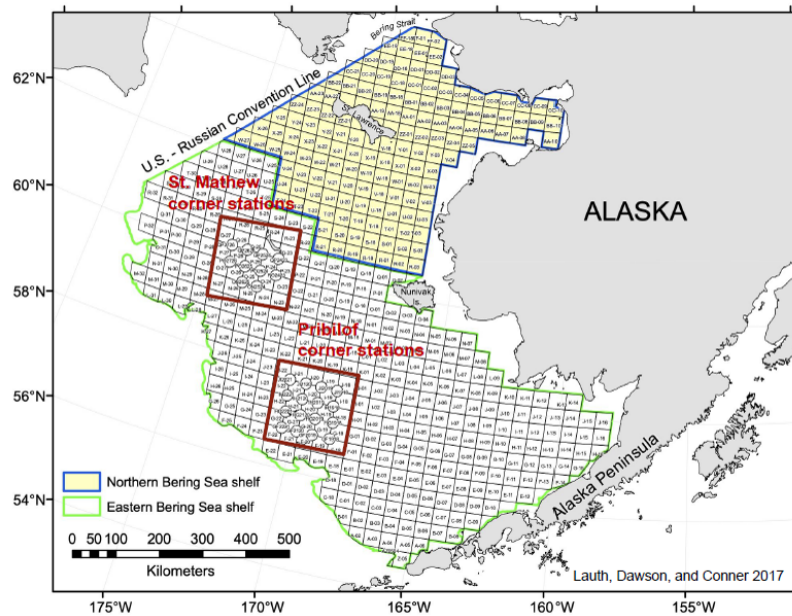
# SURVEY UPDATE – BRISTOL BAY RESAMPLING



- Evaluation of 10% threshold for resampling female red king crab
- CPT feedback:
  - Distinguish two goals: evaluating female reproductive status and abundance
  - Evaluate impact different threshold would have had on resampling decision in past years
  - Evaluate effects of resampling on reproductive status and abundance data
  - Consider standardizing station selection for resampling
  - Additional presentation and possible decision in May 2022



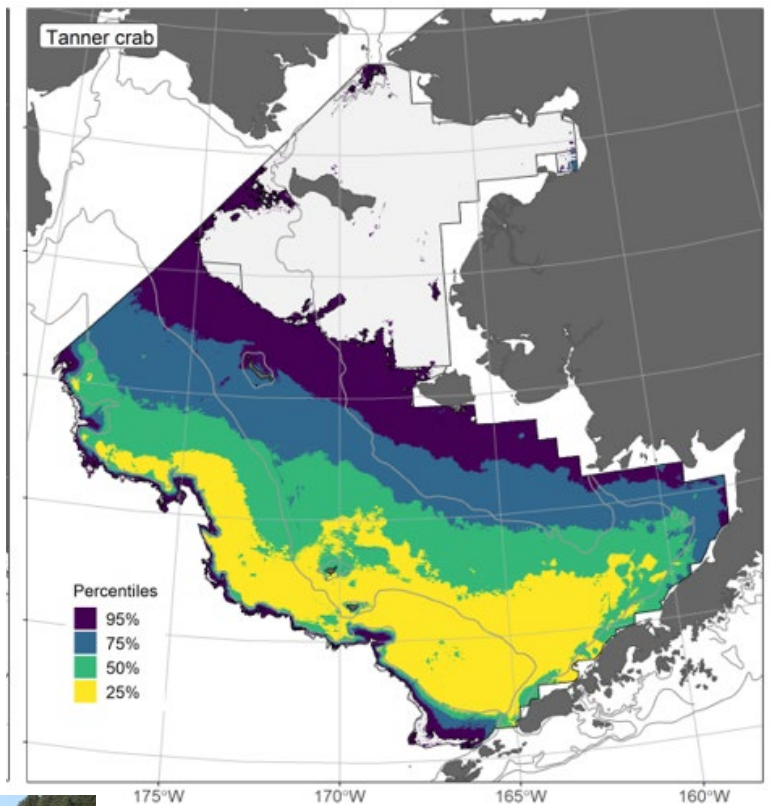
# SURVEY UPDATE – CORNER STATIONS



- Analysis of dropping St. Matthew and Pribilof Islands corner stations
- CPT feedback:
  - Concerns about survey reduction and comparability over time
  - Extend analysis to size compositions and stock assessments
  - Additional presentation requested for May 2022



# ESSENTIAL FISH HABITAT UPDATE



- Five-year review: EFH description and assessment of fishing effects
- CPT feedback on fishing effects model:
  - Requests a flowchart for evaluating fishing effects on overfished crab stocks
  - Requests SSC to discuss potentially reducing 10% CEA threshold for overfished stocks
  - Further research on contact adjustment and gear footprint
  - Include non-fishing effects and Alaska-specific gear effects
  - Split out EFH products by management area

# UPDATES OF TOR: REVISIONS TO GUIDELINES FOR CRAB SAFE REPORT CHAPTERS

- Word document with changes provided to the SSC on agenda
- Many edits were housekeeping to reflect current best practices and information needed for CPT, SSC, and Council recommendations
- CPT suggested a few further edits
  - Simplify document and reduce redundances
  - Migrate CPT tables in intro to be like those used by SSC/Council
  - Reference point summary table for all model runs begin considered for ease of switching between models at CPT or SSC meetings
- Future work:
  - Work towards standardizing figures and table output in SAFE chapters (potential collaboration with GPTs on this)



# QUESTIONS?

- Thanks to all CPT members and crab authors.
- Many thanks to Martin Dorn for his time served as CPT co-chair

