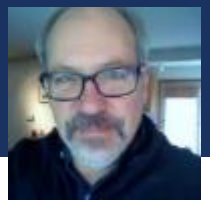
C3 BSAI CRAB STOCKS

KATIE PALOF & MARTIN DORN,

CPT MEETING MINUTES – MAY 17-20, 2021



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 2021

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 *

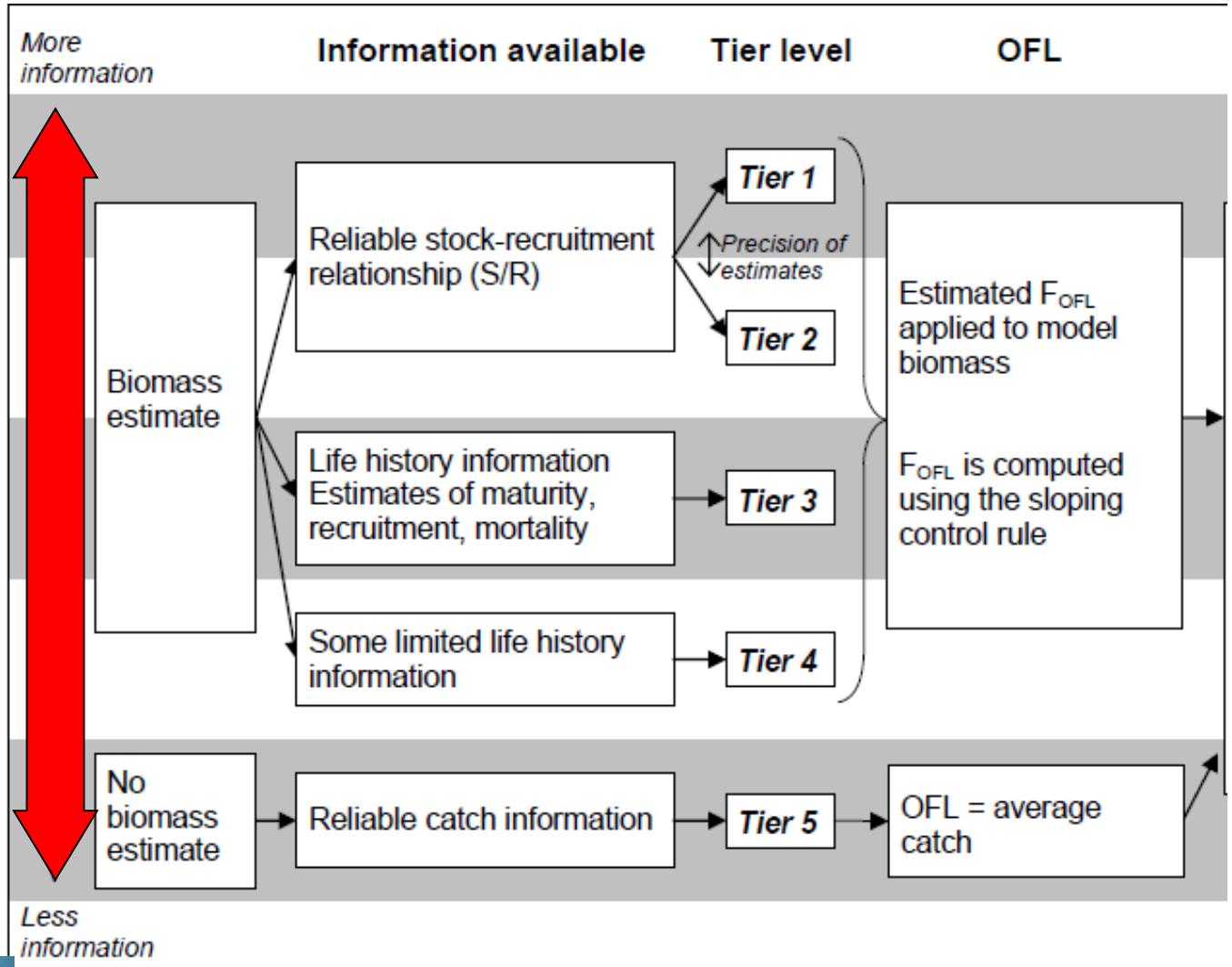
Assessed in September/ October

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%

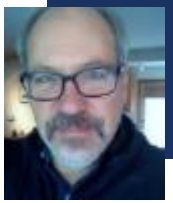
25-40%

MAY 2021 AGENDA

- **AIGKC final assessment, OFL and ABC**
- **PIBKC final assessment, OFL and ABC**
- Proposed model runs:
  - Snow crab
  - Tanner crab
  - BBRKC
- 2021 crab survey planning
- BSFRF survey selectivity progress
- Risk table drafts/progress
- VAST progress
- Research priorities
- Length-weight regression work
- ADF&G catch standardization work
- Final EFP for king crab
- NSRKC growth study updates
- GMACS updates/check-in
- EFH 5-year review
- Update TOR for crab SAFE documents

AIGKC

FINAL ASSESSMENT 2021

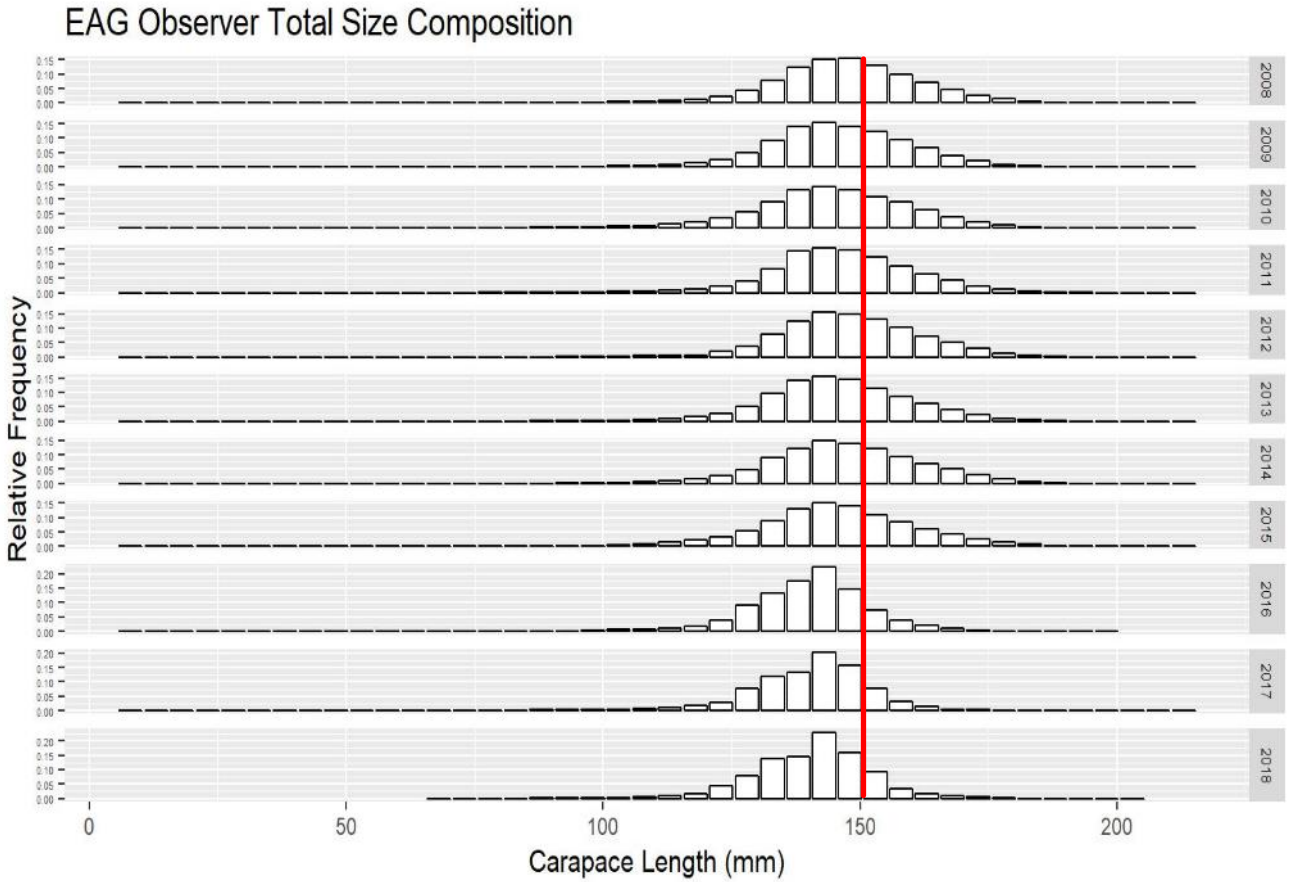


AIGKC MODEL APPROACH

- Integrated male-only length-based models fitted to fishery dependent catch, CPUE, and tagging data.
- Constant M of 0.21 yr-1.
- Model initialized in 1985.
- 4 main and 6 modified models for EAG and WAG.
- Knife-edge maturity size of 111 mm CL for MMB calculation.

RESPONSES TO CPT AND SSC COMMENTS

Rationale for selectivity block: truncation of size composition starting in 2016



RESPONSES TO CPT AND SSC COMMENTS

- CPUE index considering Year:Area interaction GLM model

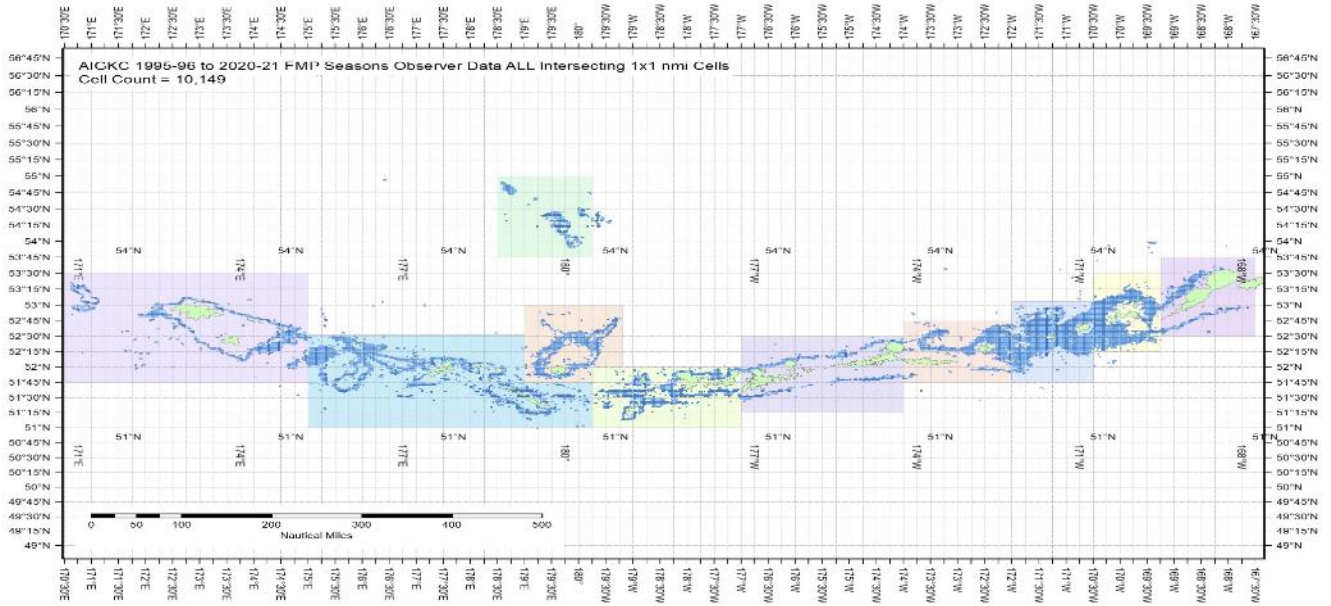
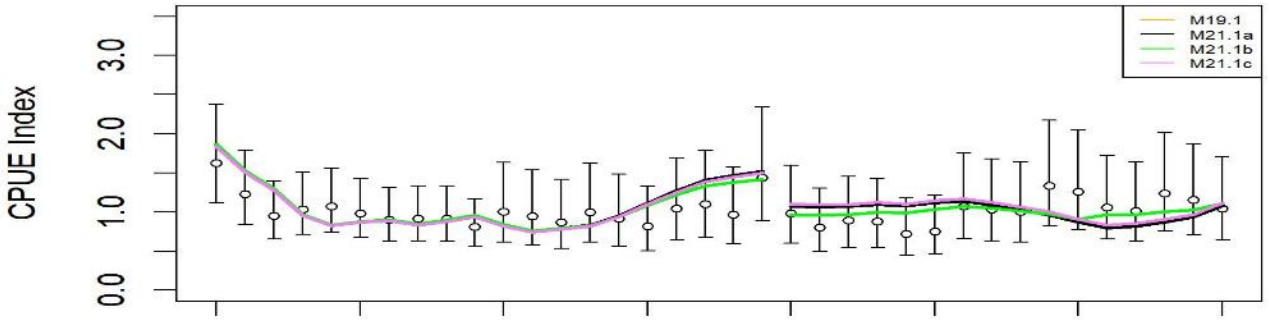


Figure B.3. The 1995/96–2020/21 observer pot samples enmeshed in 10 blocks for the Aleutian Islands golden king crab. The blocks were determined from visually exploring each year's pot distribution locations. The blocks contain observed patches of crab distribution during this period.

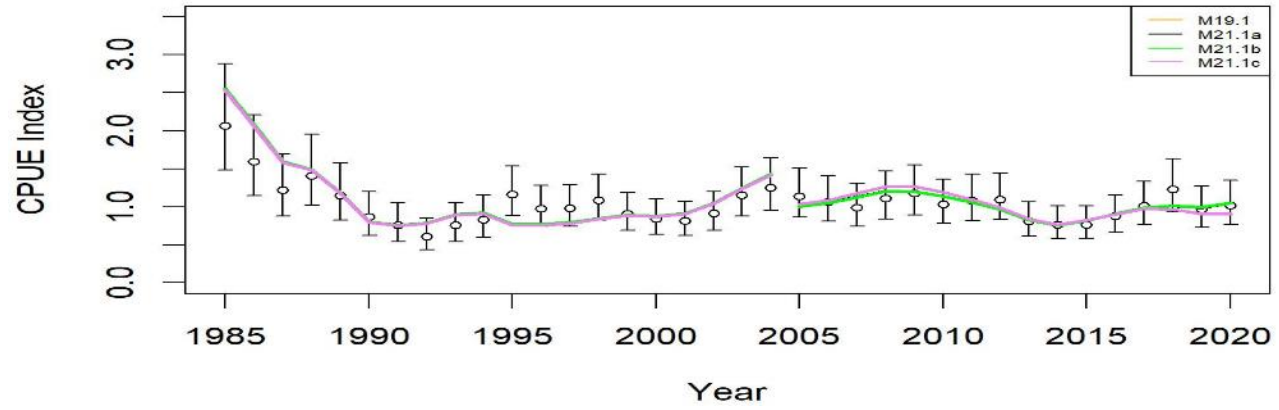
Proposed Models	CPUE Data Type and Maturity Option	Period for Mean Number of Recruit Calculation for (a) Initial Equilibrium Abundance and (b) Reference Points Estimations and Remarks
19.1 (accepted model in May 2019, implemented with up to 2020/21 data)	Observer data from 1995/96–2020/21 Fish ticket data from 1985/86–1998/99; Observer and fish ticket CPUE standardization by negative binomial model; a knife-edge minimum maturity size of 111 mm CL.	1987–2012; CPT/SSC suggested base model.
21.1a	19.1+	1987–2017; CPT/SSC suggested model.
21.1b	21.1a+ three total selectivity periods (1960–2004; 2005–2015; 2016+).	CPT/SSC suggested model.
21.1c	21.1a+ the observer CPUE data standardized including Year:Area interactions.	CPT/SSC suggested model.

AIGKC MODEL FITS

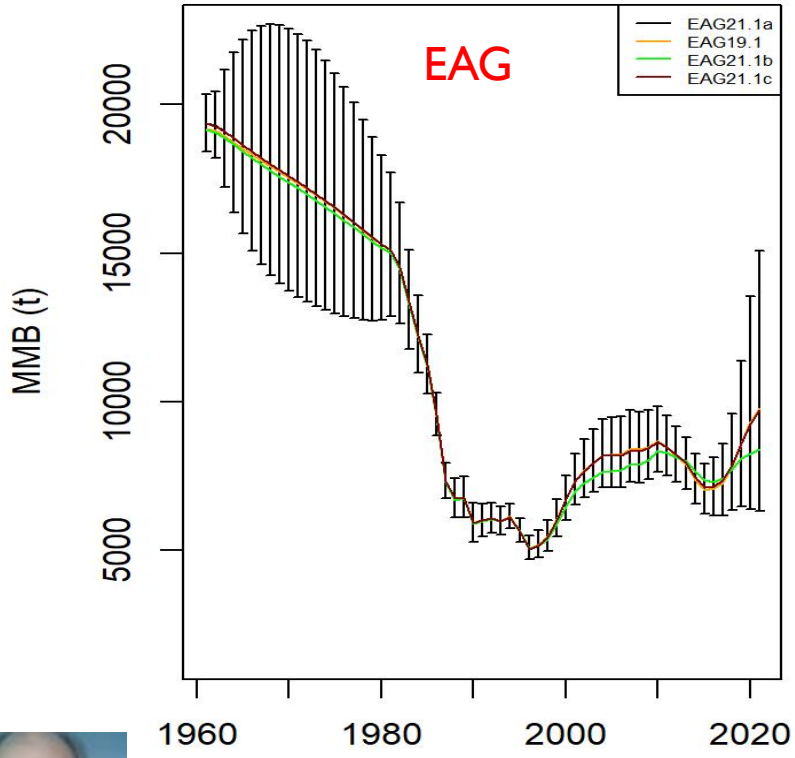
EAG

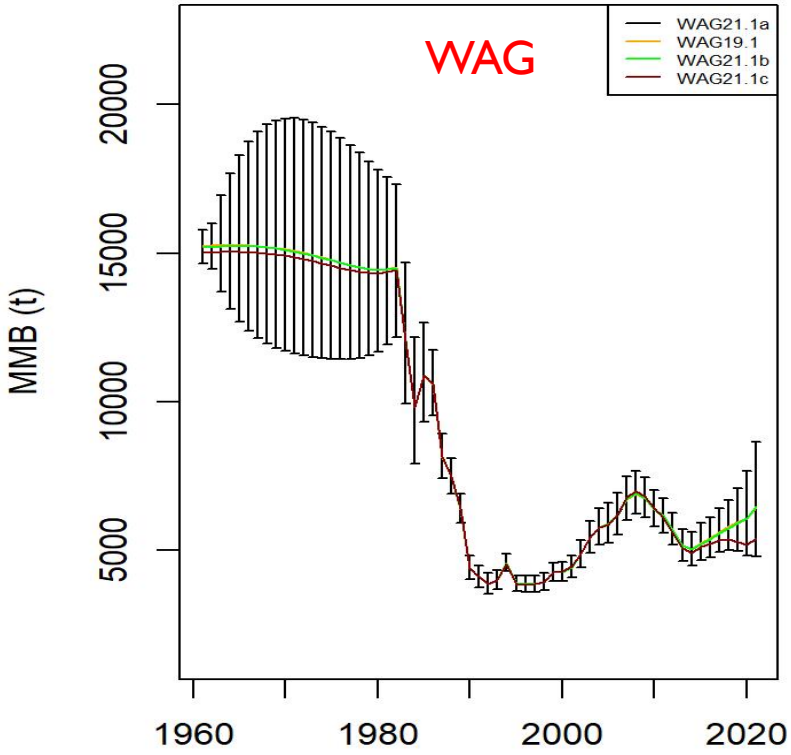


WAG

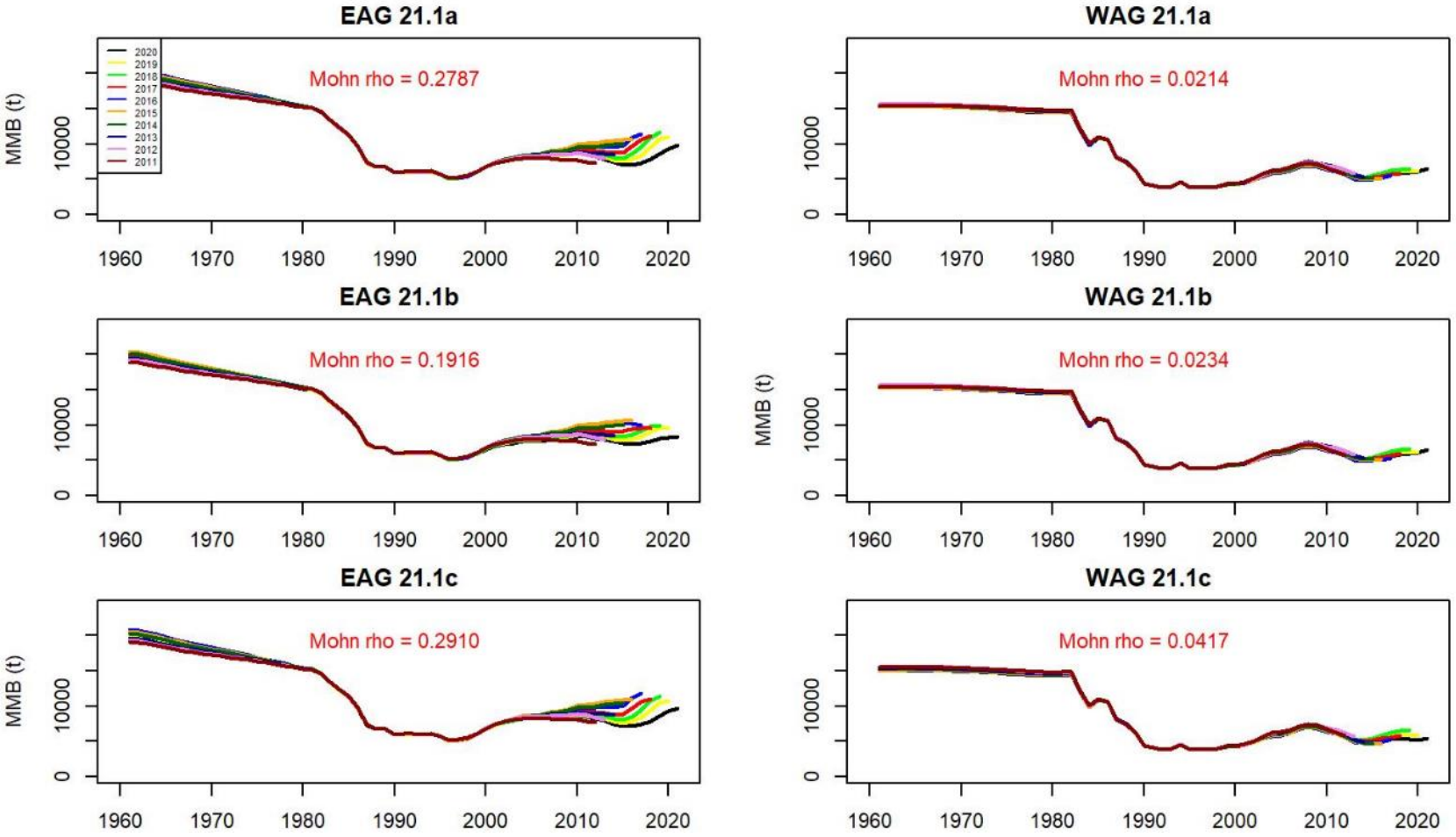


TRENDS IN GOLDEN KING CRAB MATURE MALE BIOMASS FOR MODEL ALTERNATIVES





AIGKC RETROSPECTIVE PATTERNS



AIGKC: CPT RECOMMENDATIONS ON OFL/ABC

- Model 21.1b, with three selectivity periods, led to a less extreme retrospective pattern for the EAG. However, that model appeared to converge to a local minimum.
- Model 21.1c involves accounting for the year*area interactions when constructing the CPUE index for the post- rationalization period.
  - However, the basis for selecting the degree of the smooth for soak time was not clear
  - The reduction in CPUE for the WAG for the last three years for the standardization with area*year interactions should be understood.
- The CPT therefore agreed that status determination and the OFL and ABC should be based on Model 21.1a.

AIGKC: HARVEST SPECIFICATIONS TABLE

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2016/17	N/A	N/A	2.515	2.593	2.947	5.69	4.26
2017/18	6.044	14.205	2.515	2.585	2.942	6.048	4.536
2018/19	5.880	17.848	2.883	2.965	3.355	5.514	4.136
2019/20	5.909	16.323	3.257	3.319	3.735	5.249	3.937
2020/21	6.026	16.207		2.770 [a]	3.148[a]	4.798	3.599
2021/22		14.816				4.817	3.613

Status and catch specifications (million lb) for Aleutian Islands golden king crab. Shaded values are new estimates or projections based on the current assessment. Other table entries are based on historical assessments and are not updated except for total and retained catch.

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2016/17	N/A	N/A	5.545	5.716	6.497	12.53	9.40
2017/18	13.325	31.315	5.545	5.699	6.487	13.333	10.000
2018/19	12.964	39.348	6.356	6.536	7.396	12.157	9.118
2019/20	13.027	35.985	7.180	7.317	8.234	11.572	8.679
2020/21	13.284	35.730		6.107[a]	6.940[a]	10.579	7.934
2021/22		32.662				10.620	7.965

[a] WAG fishery was still being prosecuted when the assessment was conducted.

Total fishery mortality in 2020/21 (to date) was 3.148 kt (6.940 million lb), less than the OFL of 4.798 kt (10.579 million lb). The CPT will revisit total mortality in September 2021 when final catch statistics are available to determine overfishing status .

AIGKC: CPT RECOMMENDATIONS FOR ABC BUFFER

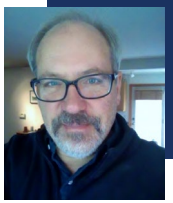
- The current buffer of 25% reflects the following considerations by the SSC:
  - The standardized CPUE index is the only index of abundance in the model (unlike other crab assessments)
  - Uncertainty in size at maturity and natural mortality
  - Limited spatial coverage of the fishery with respect to the total stock distribution
  - Small number of vessels on which the CPUE index is based.
- All of these considerations are still relevant.
- New considerations identified this year are:
  - There have been fewer large animals in the total catch length-frequency for the EAG between 2016 and 2020,
  - There were catches in 2021 from the WAG that were not included in the assessment.
  - The CPUE index for the WAG declined more when account was taken of year*area interactions
  - The size at maturation may be larger than currently assumed.
- The CPT concluded that these considerations did not merit changing buffer at this time. The CPT recommends that these issues be addressed through additional research and continued monitoring.

AIGKC: SSC RECOMMENDATIONS FOR ABC BUFFER

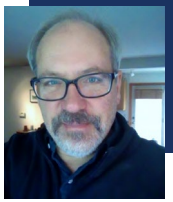
- The SSC is recommending that the buffer be increased to 30%, reflecting the following additional considerations by the SSC:
  - Large retrospective pattern in EAG
  - Other?

PIBKC

FINAL ASSESSMENT 2021

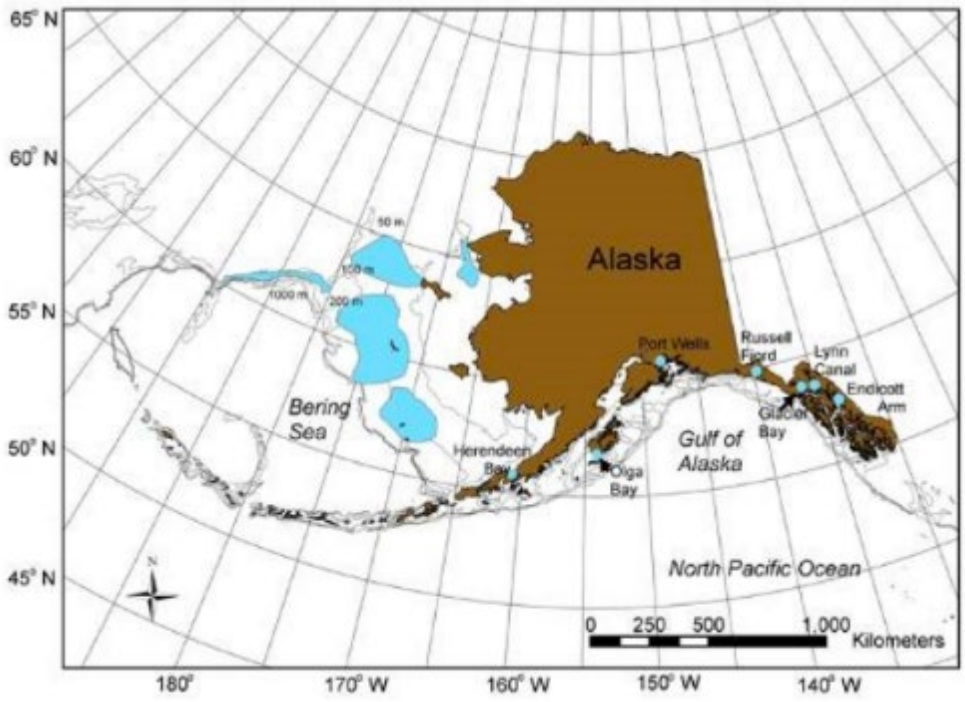


PIBKC

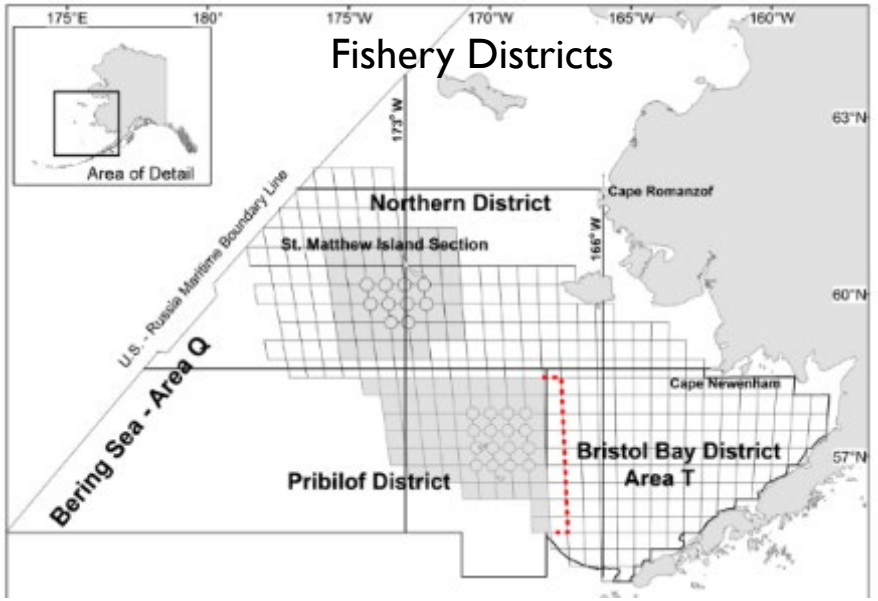


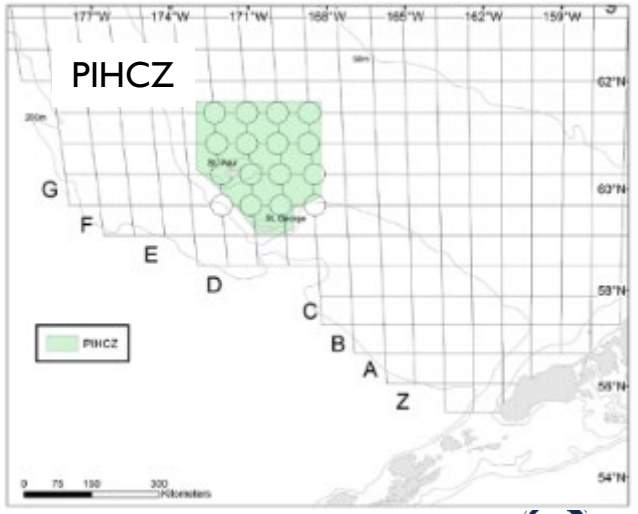
- Biennial assessment schedule (last full assessment 2019)
- Approach to status determination identical to that in 2019 (approved 2015)
- NMFS survey data to 2019 (no 2020 survey)
  - requires projecting survey MMB for 2020, 2021
- No evidence for progress towards rebuilding (survey data)

Stock Distribution



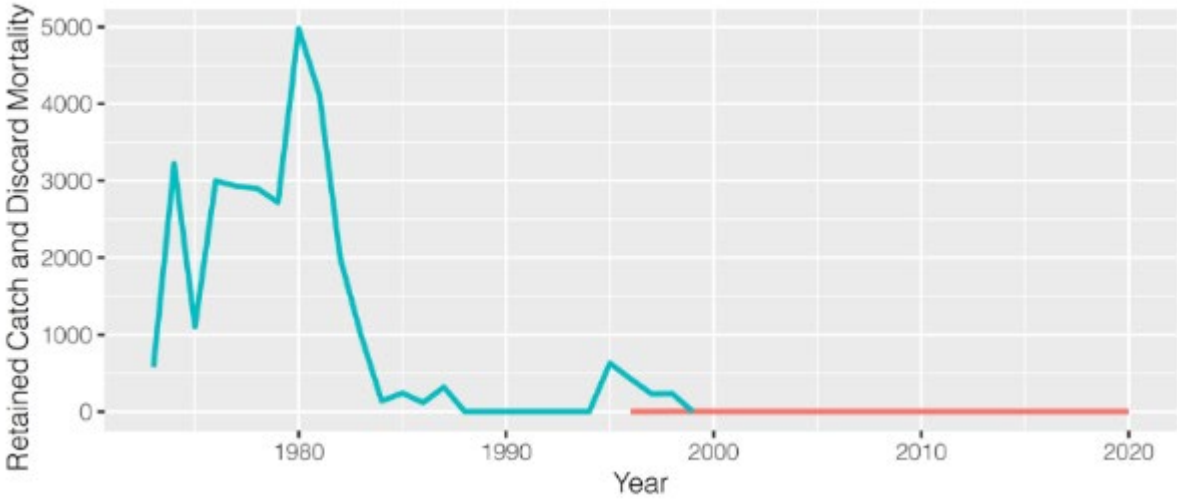
Fishery Districts

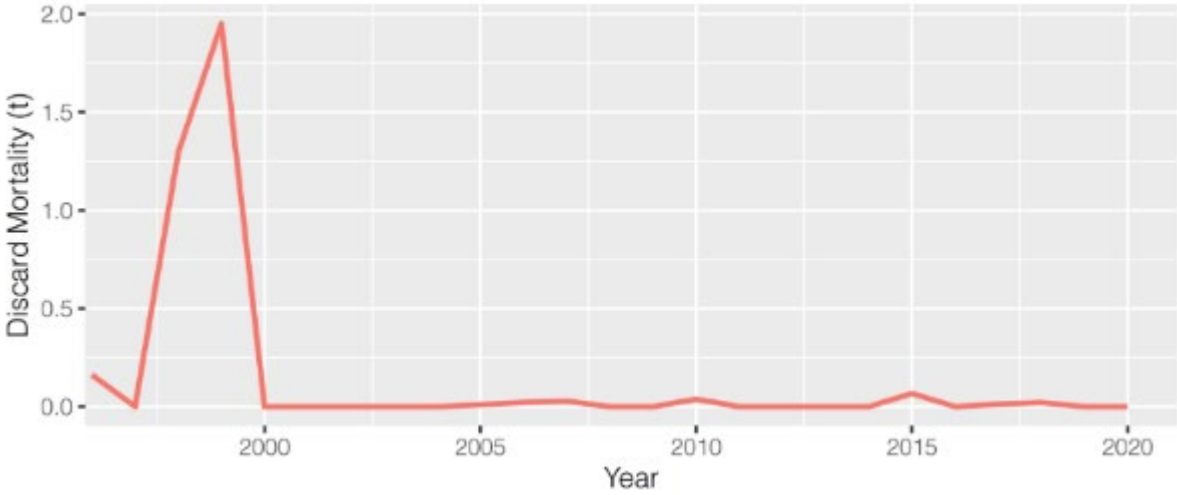


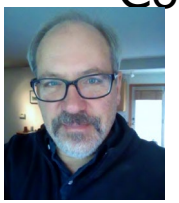


CATCH HISTORY IN THE CRAB FISHERIES

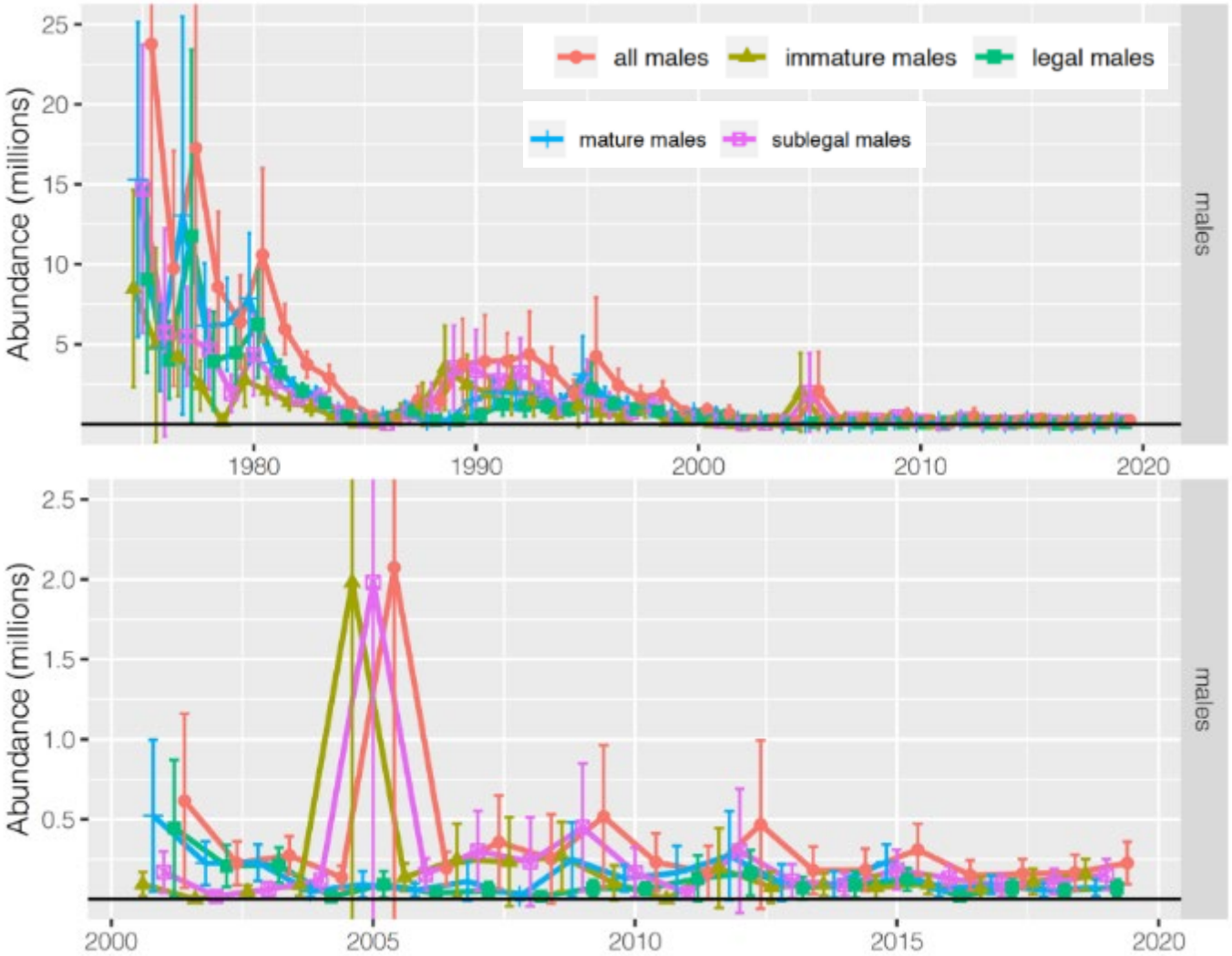
- Trawling excluded from Pribilof Islands Habitat Conservation Area in 1996
- Directed fishery closed since 1999/2000
- Stock declared overfished in 2002
- Revised rebuilding plan approved in 2015 (estimated rebuilding time ~50 years)
  - Pot fishing for Pacific cod excluded from the Pribilof Islands Habitat Conservation Zone





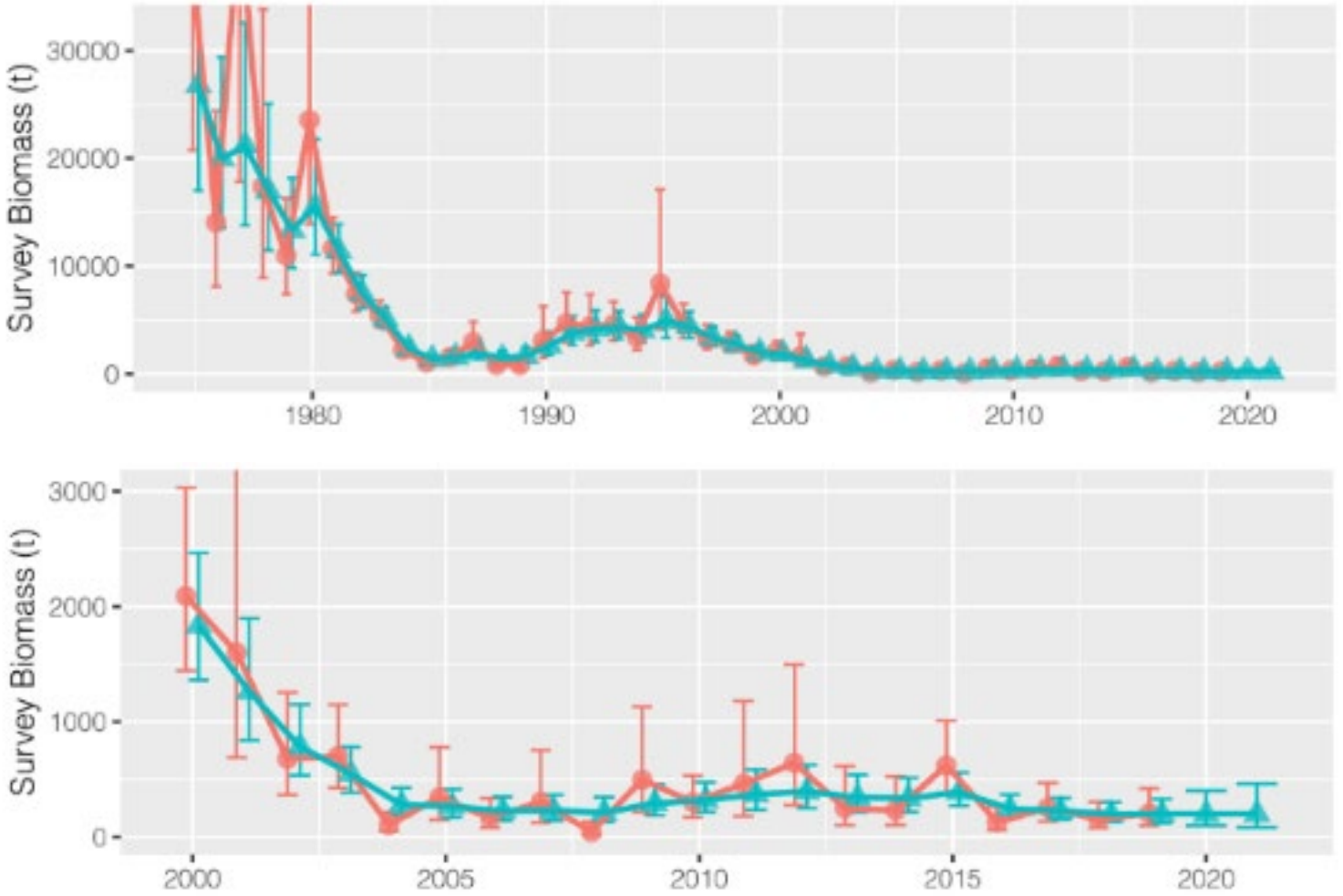


SURVEY ABUNDANCE: MALES



Note: annual values are slightly offset to improve visibility

SMOOTHING RESULTS



STATUS DETERMINATION AND OFL

- stock remains overfished
- overfishing will be evaluated at September CPT meeting (but has not occurred yet)
- Tier 5 OFL based on average fishing mortality 1999/2000-2005/06: 1.16 t
- ABC is based on a 25% buffer to the OFL: 0.87

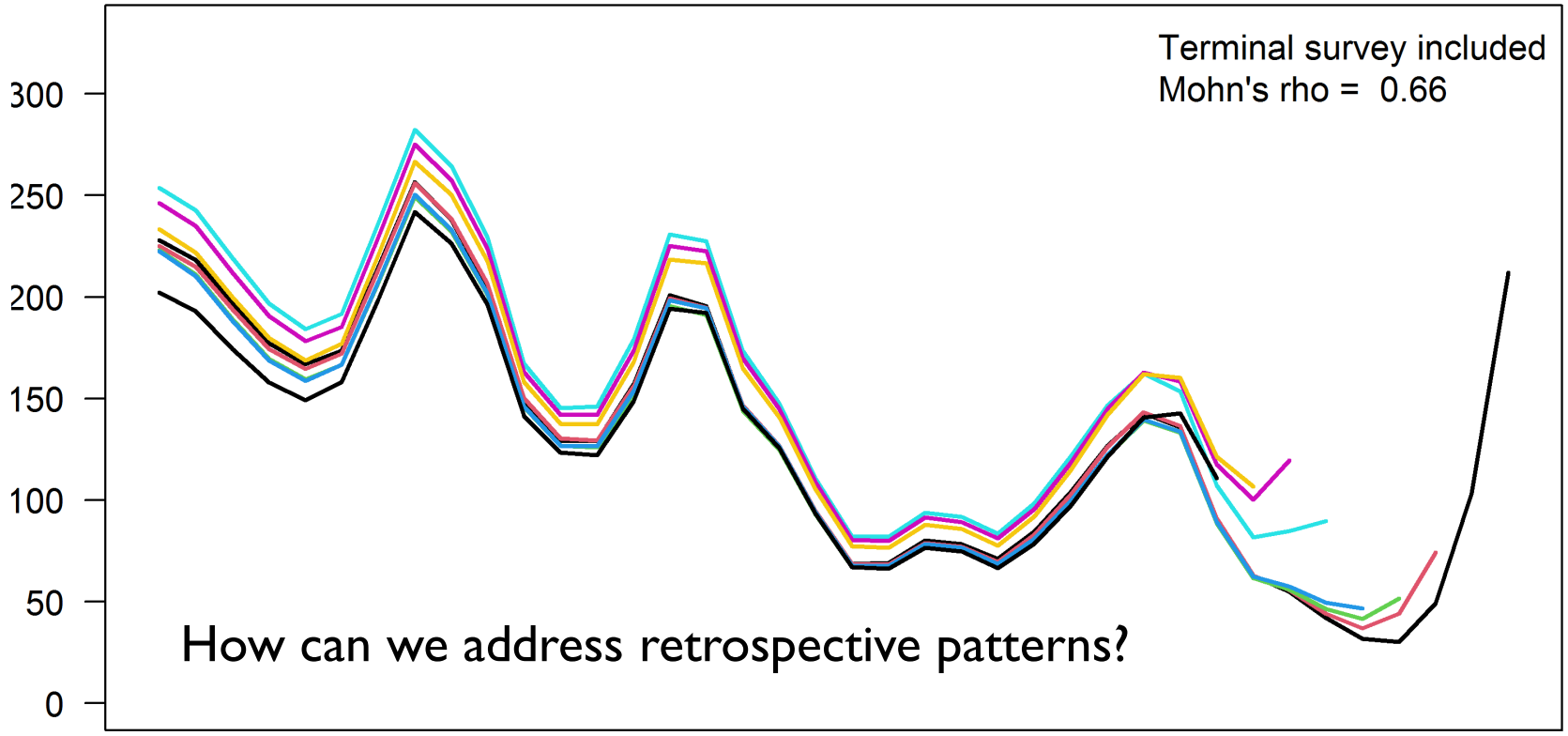
year	MSST	MMB at mating	TAC	Retained catch	Total catch mortality	OFL	ABC
2017/18	2,053	230	0	0	0.33	1.16	0.87
2018/19	2,053	230	0	0	0.41	1.16	0.87
2019/20	2,049	180	0	0	0.42	1.16	0.87
2020/21	2,049	181	0	0	0.00	1.16	0.87
2021/22	–	180	–	–	–	1.16	0.87
2022/23	–	180	–	–	–	1.16	0.87

year	Tier	MMB at mating	B/B_{MSY}	γ	Years to define B_{MSY}	M yr^{-1}	P*
2017/18	4c	230	0.06	1	1980/81-1984/85 & 1990/91-1997/98	0.18	25% buffer
2018/19	4c	230	0.06	1	1980/81-1984/85 & 1990/91-1997/98	0.18	25% buffer
2019/20	4c	175	0.04	1	1980/81-1984/85 & 1990/91-1997/98	0.18	25% buffer
2020/21	4c	175	0.04	1	1980/81-1984/85 & 1990/91-1997/98	0.18	25% buffer
2021/22	4c	180	0.04	1	1980/81-1984/85 & 1990/91-1997/98	0.18	25% buffer
2022/23	4c	180	0.04	1	1980/81-1984/85 & 1990/91-1997/98	0.18	25% buffer

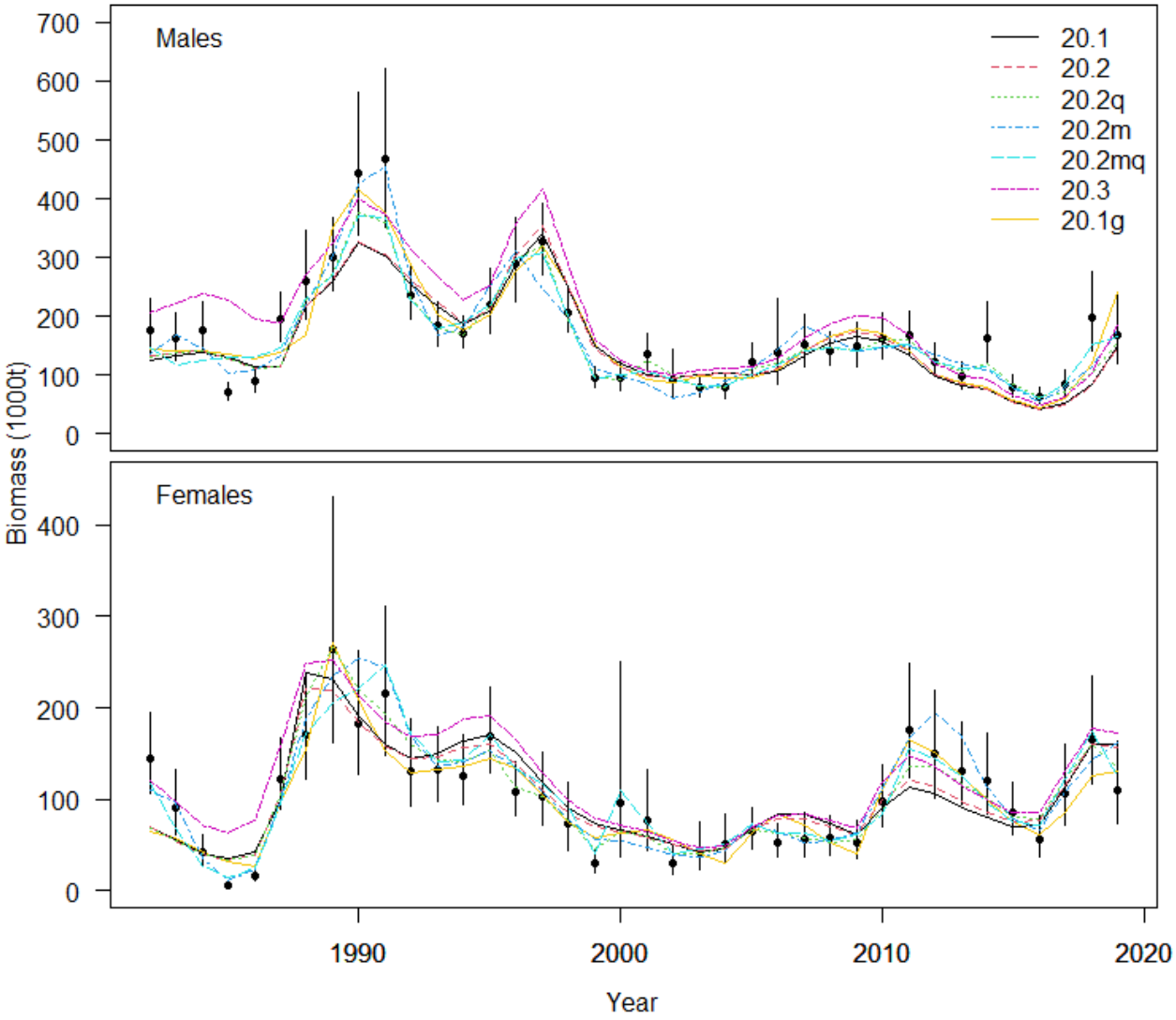
SNOW CRAB: PROPOSED MODEL RUNS FOR SEPT 2021

- Author considered ways to reduce the retrospective pattern in the assessment
- Allowing for time-varying catchability or natural mortality or both reduced the retrospective pattern, but did not lead to results that were considered satisfactory
- Author also evaluated an alternative assessment approach (Tier 3.5) that fit a smooth to survey trends

Snow crab proposed model runs 2021



Snow crab proposed model runs 2021



CPT RECOMMENDATIONS

- CPT *does NOT* recommend pursuing “Tier 3.5” approach for status determination, but information may be helpful to TAC setting process
- Proposed models for Sept:
  - 20.1: status quo model
  - 20.1g: GMACS version of 20.1
  - 20.2: status quo + down-weighted size compositions
  - 20.2q: 20.2 + time-varying fishery selectivity
- Future recommendations:
  - Continue development of the GMACS model

TANNER CRAB: PROPOSED MODEL RUNS FOR SEPT 2021

- Reducing the number of parameters hitting bounds
  - Author stepped through many changes to address these bound issues
- Using VAST estimates for survey biomass data
  - Reduces CVs for NMFS survey biomass
  - Low CVs result in better fit to survey biomass at expense of size composition data
- Growth vs. terminal molt

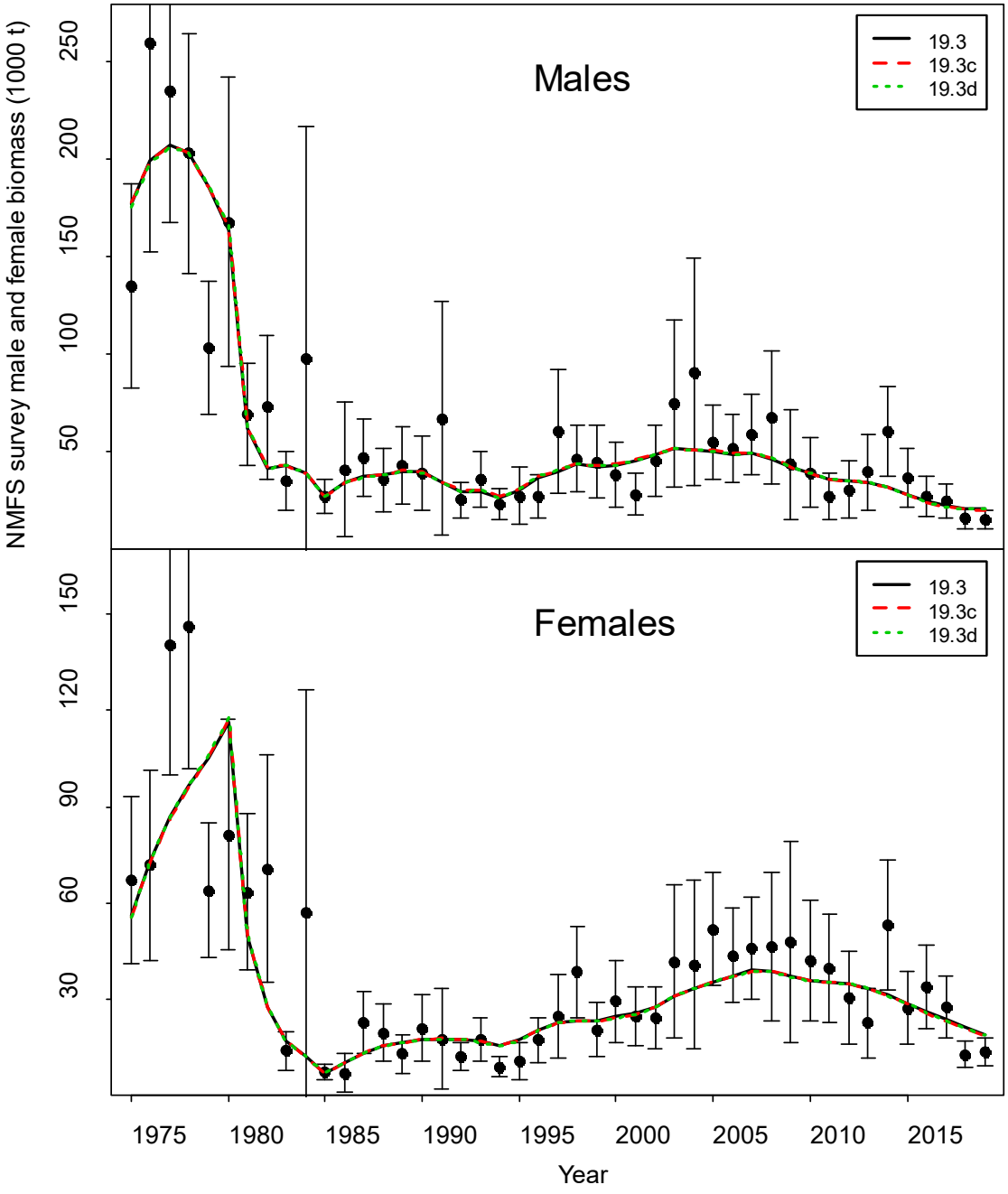
CPT RECOMMENDATIONS FOR SEPTEMBER

- Proposed model runs:
  - 20.07: base model
  - 21.22: implemented all changes that eliminated parameter bound issues, and uses Dirichlet-multinomial likelihood for size comps
  - 21.22 + pre-specifying growth increments per molt based on estimates obtained outside the model

BRISTOL BAY RED KING CRAB: PROPOSED MODEL RUNS FOR SEPT 2021

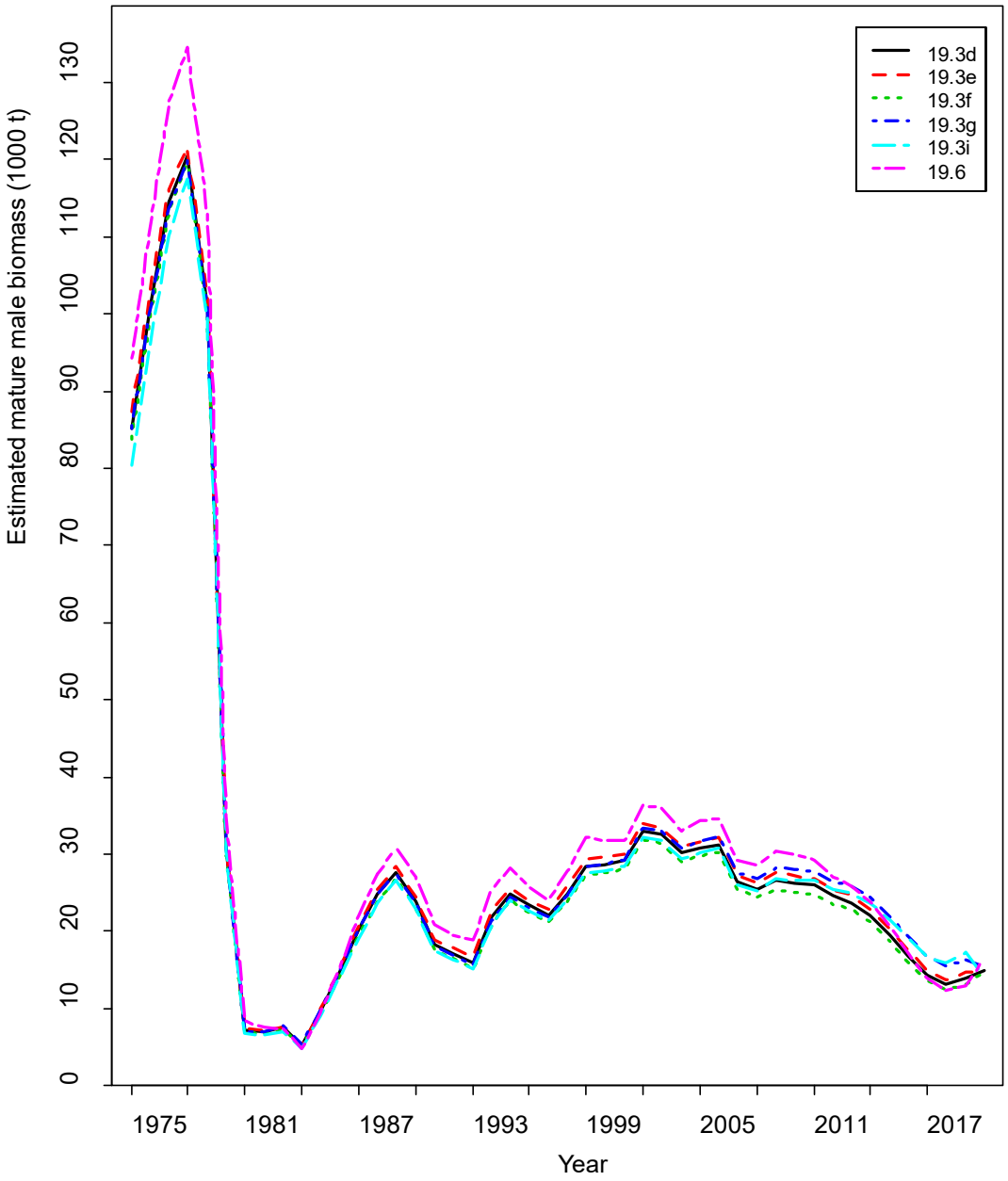
- Minor model fixes
  - Updated observer data
  - Improved sample sizes
- Estimating separate survey catchabilities for the males and females
- Using VAST estimates for survey biomass data

BBRKC proposed model runs 2021



Comparisons of area-swept estimates of male and female NMFS survey biomass and model prediction for model estimates in 2021 under three models. The error bars are plus and minus 2 standard deviations of model 19.3.

BBRKC proposed model runs 2021

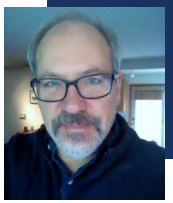


Comparisons of mature male biomass on Feb. 15 under eight models.

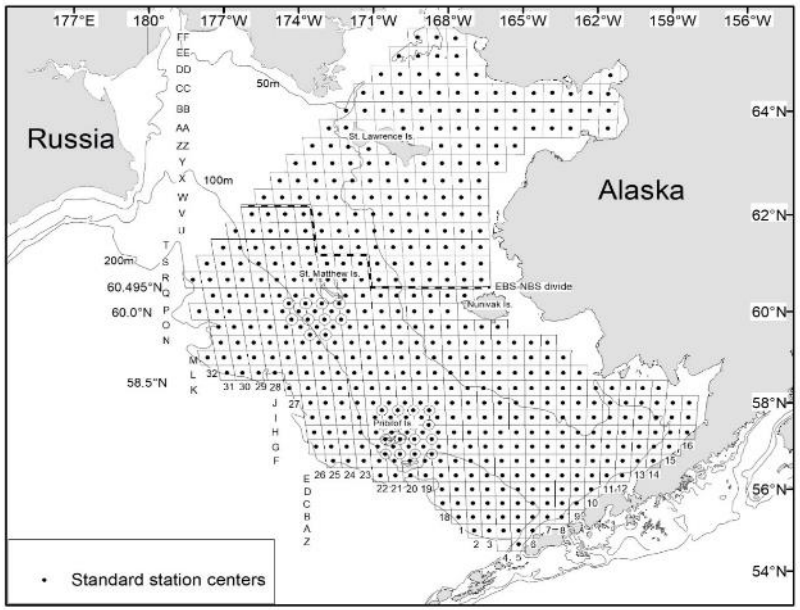
BBRKC PROPOSED MODELS FOR SEPT 2021

- The CPT is recommending Models 19.3d, 19.3e, and 19.3g for September with updated data.
- Model 19.3d includes both the updated observer data and improved sample sizes, which were seen as clear improvements over the status quo.
- Model 19.3e incorporates different survey catchability coefficients for males and females.
- Model 19.3f uses VAST estimates for the NMFS summer survey.

BALANCE OF CPT REPORT



2021 SURVEY PLANNING

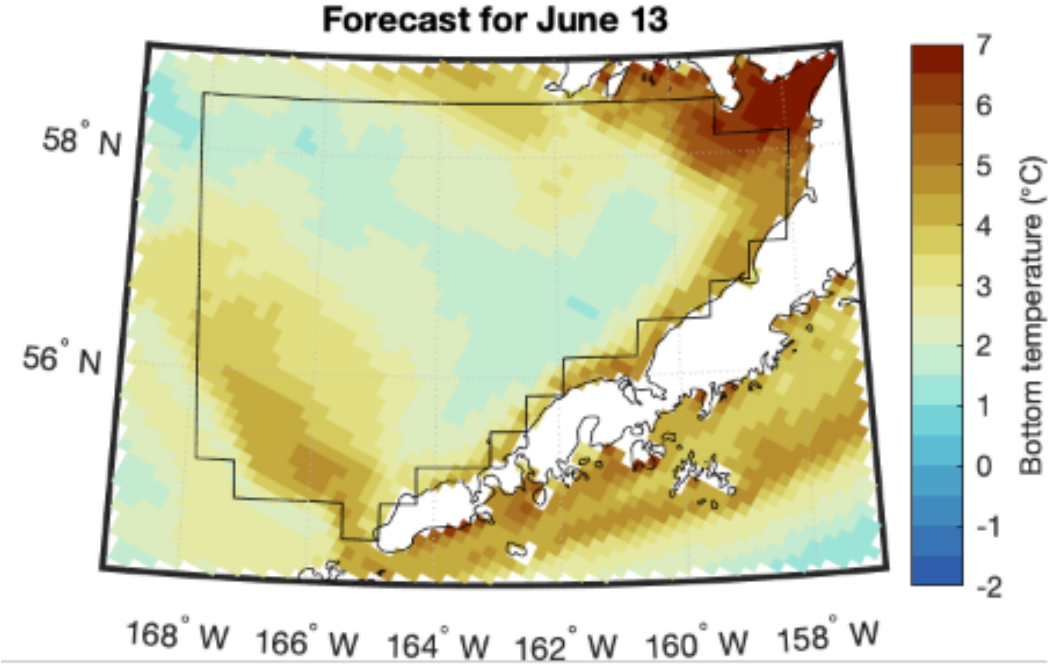


- Full EBS and NBS survey
- One of the two vessels delayed 6 days
- Date of data delivery delayed (only by 2 days)
- May be a delay in BBRKC if retows are necessary (forecasted conditions suggest they may be)
- Tight turn around for potential VAST models

Bristol Bay retow

K. Kearney and K. Aydin

ROMS (Bering10K) forecasts for Bristol Bay on June 13th: 2021 looking very average, though colder than average bottom temperatures over the inner domain

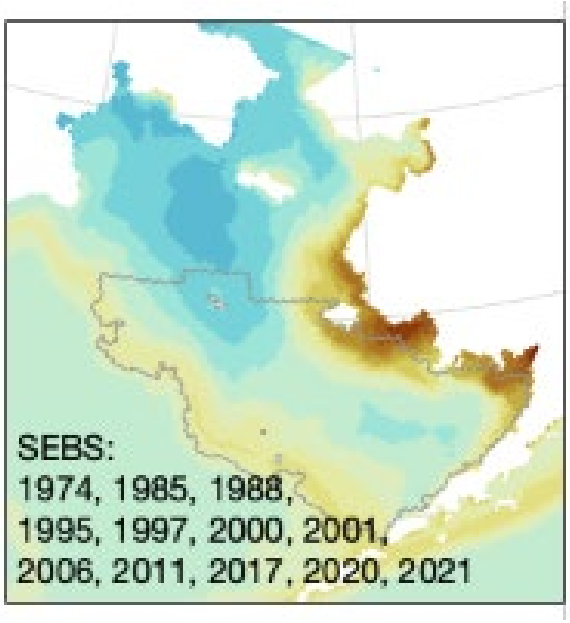


Bristol Bay retow possible?

K. Kearney and K. Aydin

Bottom temperatures forecast to be similar to retow years 2011, 2017

Similar based on bottom temp. patterns



Retow Survey Year	Avg BB Bottom Temperature
2000	2.23°C
2006	2.43°C
2007	2.14°C
2008	1.65°C
2009	1.44°C
2010	1.77°C
2011	2.84°C
2012	1.22°C
2017	2.83°C
2021 Forecast	**2.79°C**

BSFRF SURVEY CATCHABILITY/SELECTIVITY

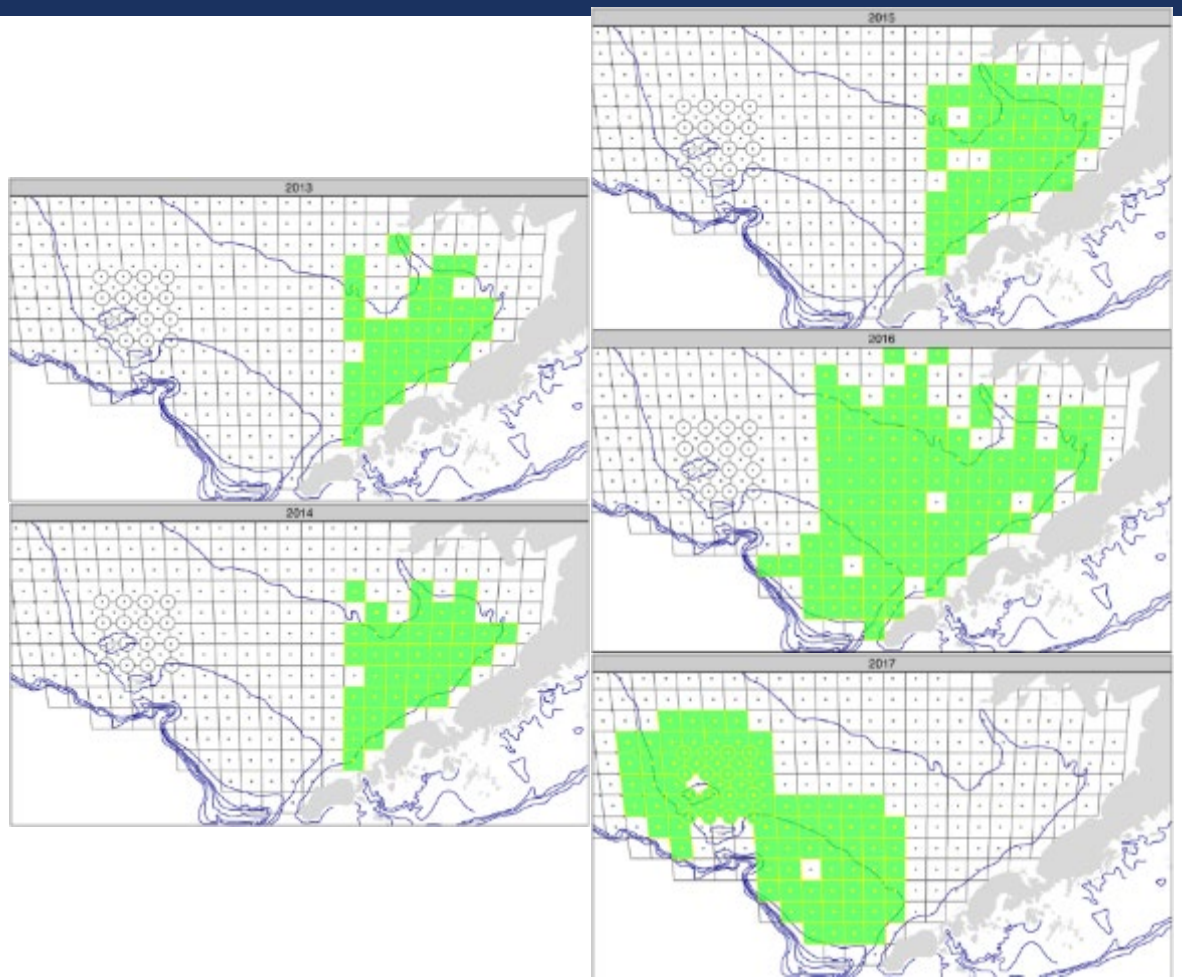
BSFRF and NMFS conducted joint catchability studies focused on Tanner crab in 2013-2018: side-by-side (SBS) tows (paired hauls), simultaneous start, 0.5 nmi separation, same tow direction (2018 not yet available)

BSFRF:

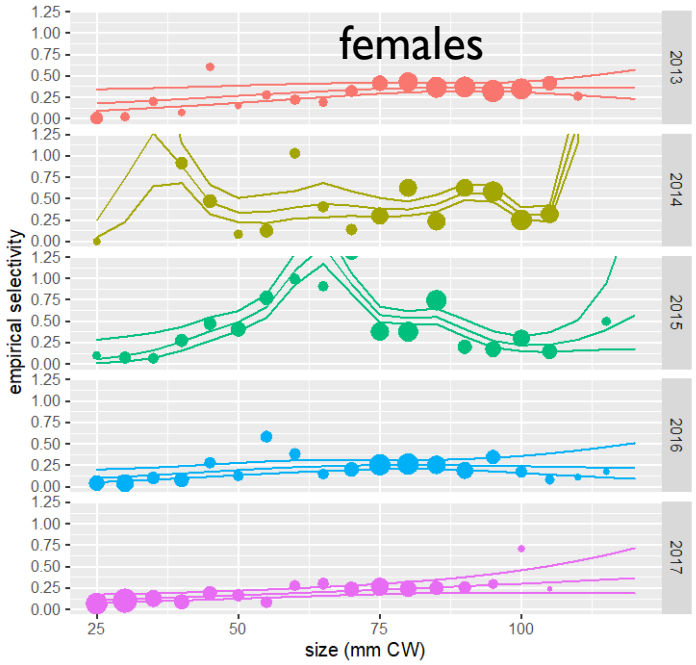
- modified *Nephrops* trawl assumed to capture ALL crab in gear path
- 5-minute tow

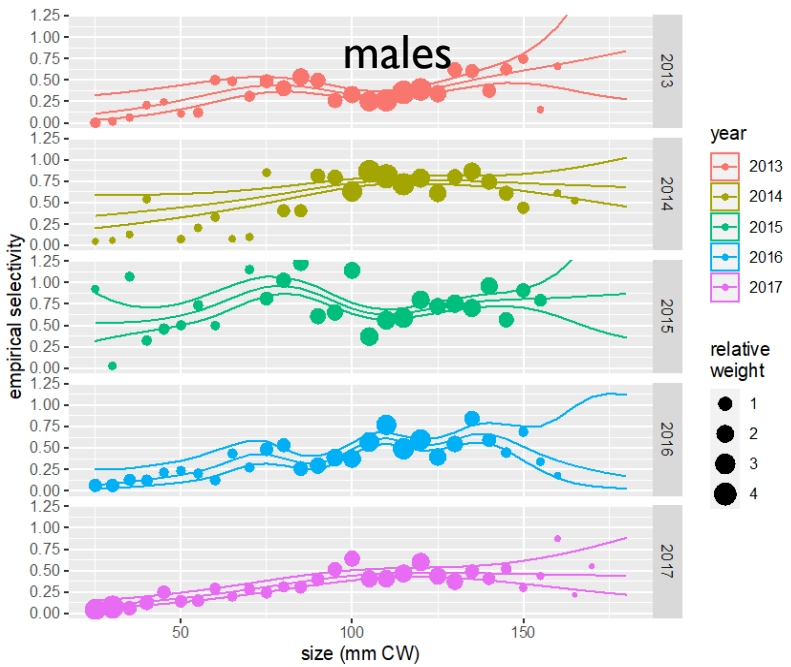
NMFS

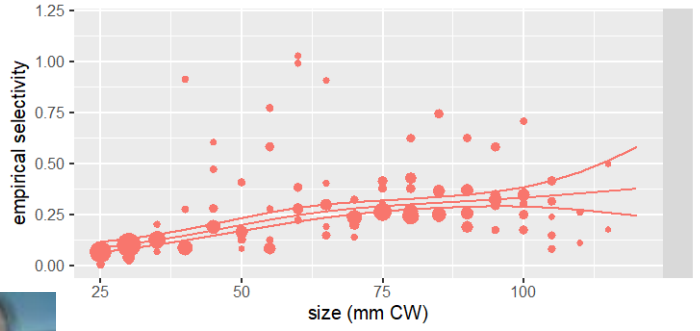
- standard EBS 83-112 bottom trawl gear
- standard 30-minute tow

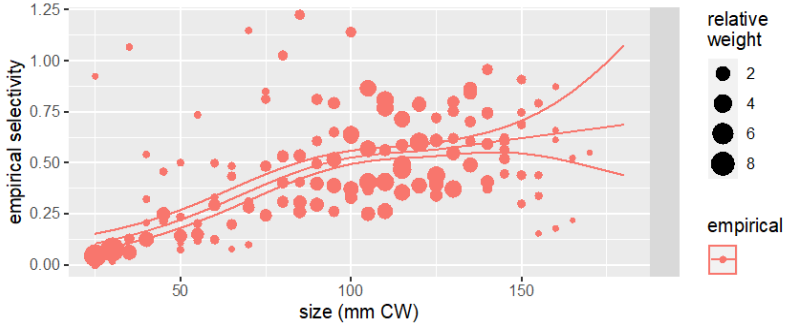


CATCHABILITY ESTIMATES









CPT DISCUSSION ON RISK TABLES

- CPT reviewed draft risk tables for snow crab and SMBKC
- The CPT agreed that risk table would be helpful in justifying buffers and would provide a clear historical record of how buffers have been set historically.
- CPT members from ADF&G stated that the state already does something similar when setting the TACs and it might be helpful if the CPT also went through this process.
- The CPT recommends that the snow crab and Bristol Bay red king crab (BBRKC) assessments include draft risk tables for September 2021.