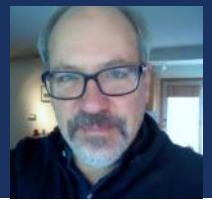
C2 CRAB PLAN TEAM REPORT MAY 4-7, 2020

KATIE PALOF & MARTIN DORN, JUNE 2, 2020



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 *

→ Assessed in May/June

→ Triennial cycle, next assessment in 2020

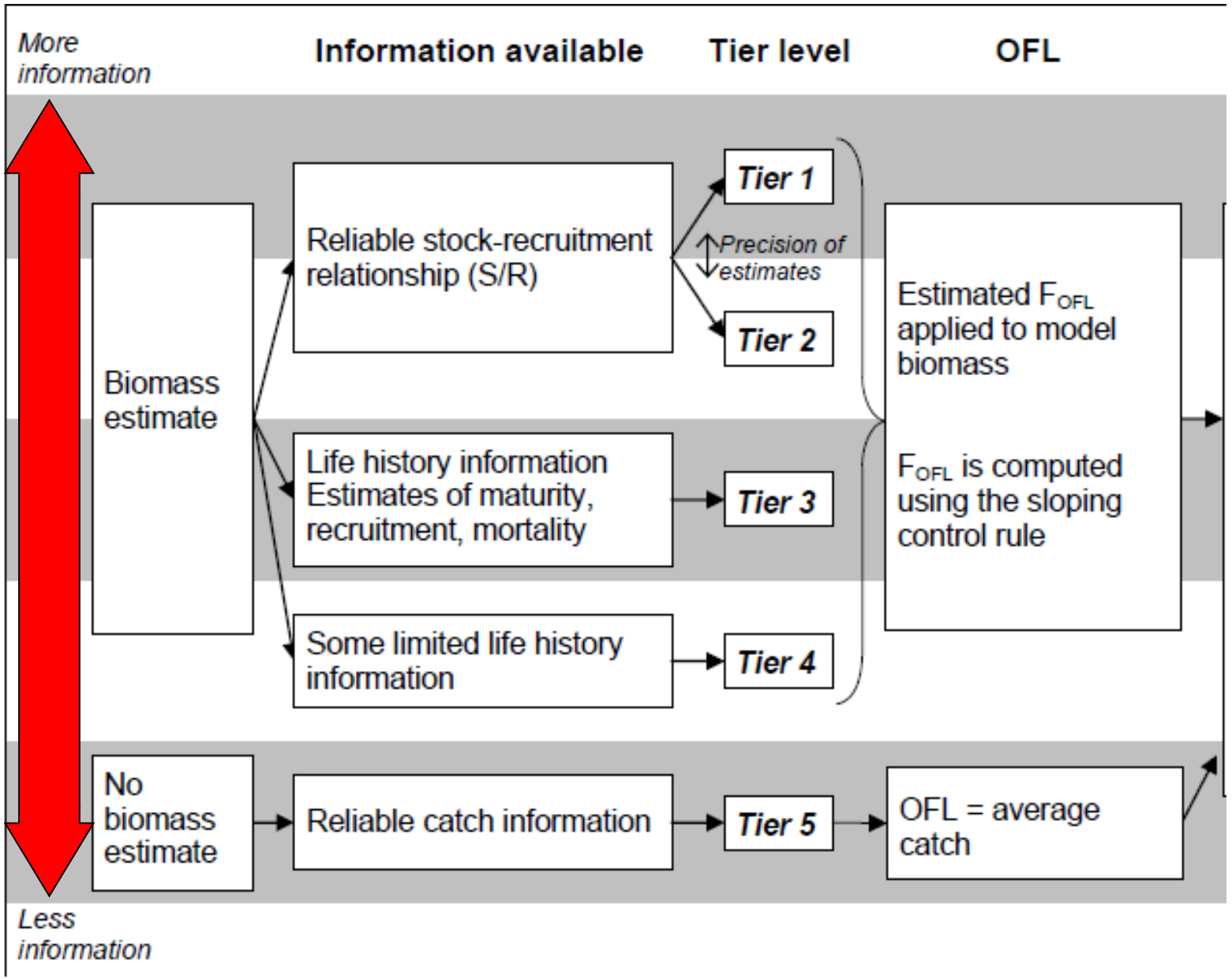
EBS snow crab
Bristol Bay red king crab
EBS Tanner crab
Pribilof Islands red king crab *
St. Matthew blue king crab

→ Assessed in September/ October

→ Biennial cycle, next assessment in 2021

Norton Sound red king crab

→ Assessed in January/ February



ABC buffer

10-20%

10-25%

25-40%

AGENDA

- Survey updates
- VAST model for crab data
- BSFRF survey selectivity work
- **AIGKC final assessment, OFL and ABC**
- **WAIRKC final assessment, OFL and ABC**
- **PIGKC final assessment, OFL and ABC**
- Model runs for Sept:
  - BBRKC
  - Tanner crab / BOF update
  - Snow crab
  - SMBKC
- Draft ESP for BBRKC
- Other agenda items

SUMMER TRAWL SURVEY PLANNING

- Lyle Britt of GAP presented possible scenarios for summer 2020 EBS trawl surveys.
- At the time of the CPT meeting there were four scenarios being considered:
  - June 20 start
  - July 11 start
  - Aug 1 start
  - No survey

SUMMER TRAWL SURVEY PLANNING

- June 20 start: Data available for BBRKC and Tanner, snow crab data and assessment delayed.
- July 11 start: Data available for BBRKC and Tanner, snow crab data and assessment delayed.
- Aug 1 start: No data available for any crab stock for Sept. All assessments will be delayed.
- No survey: No data available for any crab stock. No delay in assessments.
  - CPT recommended that stock assessment authors use last year's accepted model, incorporating updated fishery data (complete for 2019/2020 fishing year). This is subject to SSC approval…
  - CPT suggested that a meeting in November could review delayed snow and Tanner crab assessments.

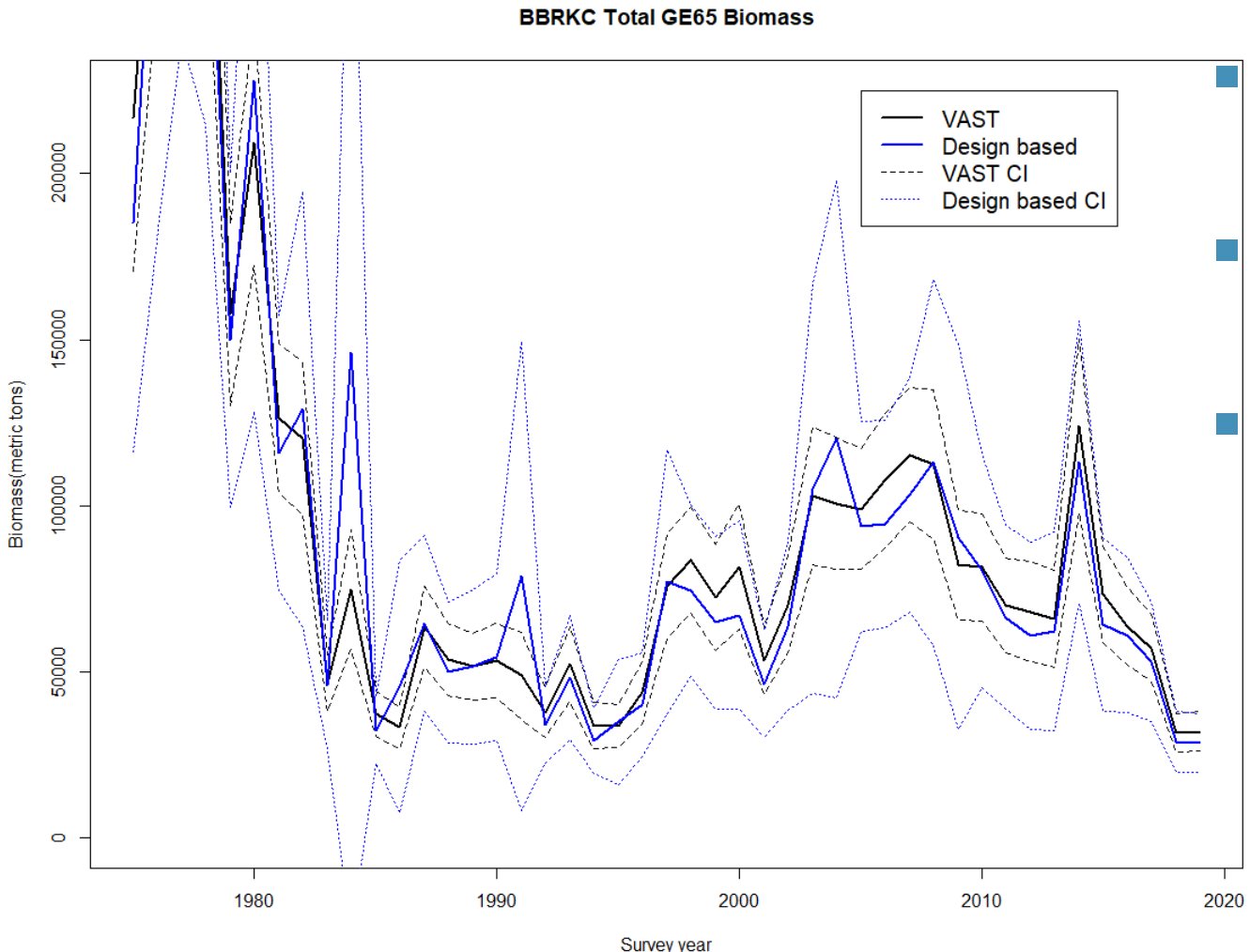
VAST MODEL

- GAP/SAP has developed a standard approach for producing VAST estimates for use in assessment models
  - Gamma for positive part, "poisson link" for presence/absence, 500 knots etc.
- Jon Richar provided VAST estimates to crab assessment authors in April, sufficiently early for assessment authors to include exploratory model runs for the May CPT meeting
- If a model with VAST is accepted, GAP/SAP believes that it can produce VAST estimates in the fall in time for final model runs.

VAST MODEL

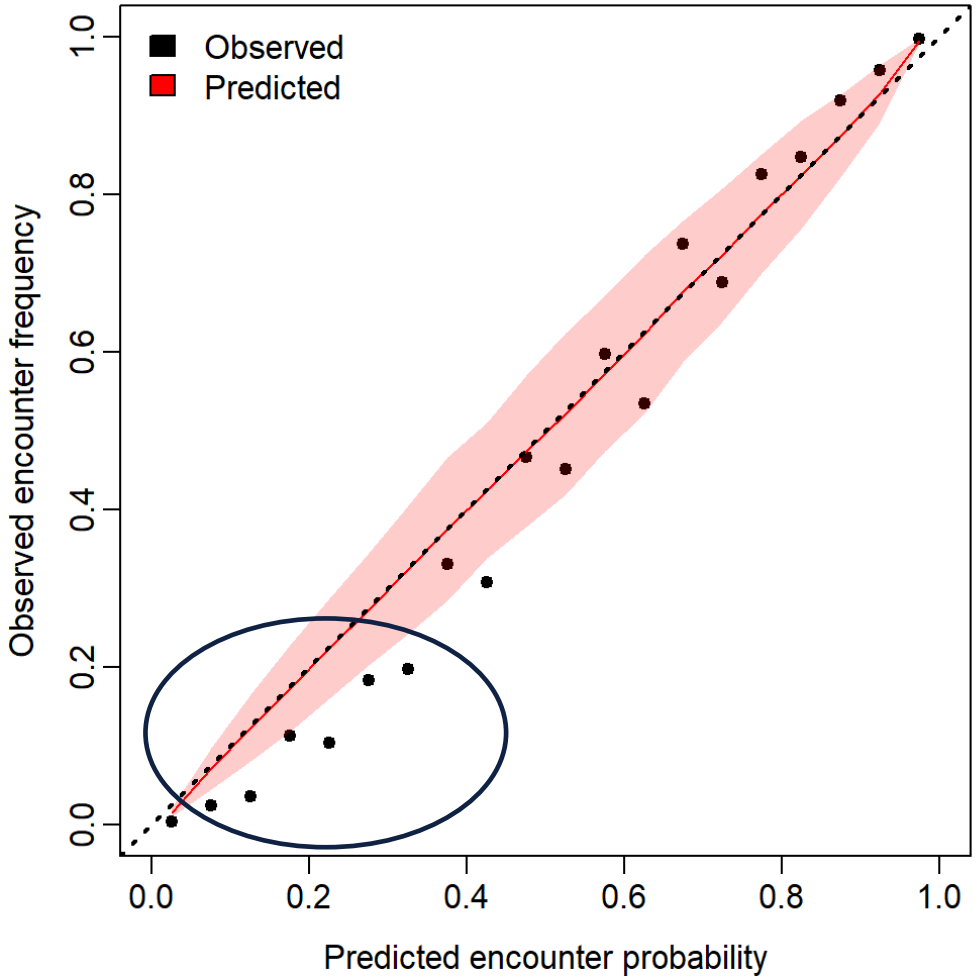
- Jon Richar presented VAST model results and diagnostics for BBRKC
- Design-based and VAST trends track each other fairly well
- Model diagnostics suggest VAST estimates not ready for assessment
- It was not clear to the CPT what diagnostics would indicate a reasonable model, as opposed those that would lead a model to be rejected
- CPT would like to revisit VAST estimates at Jan meeting

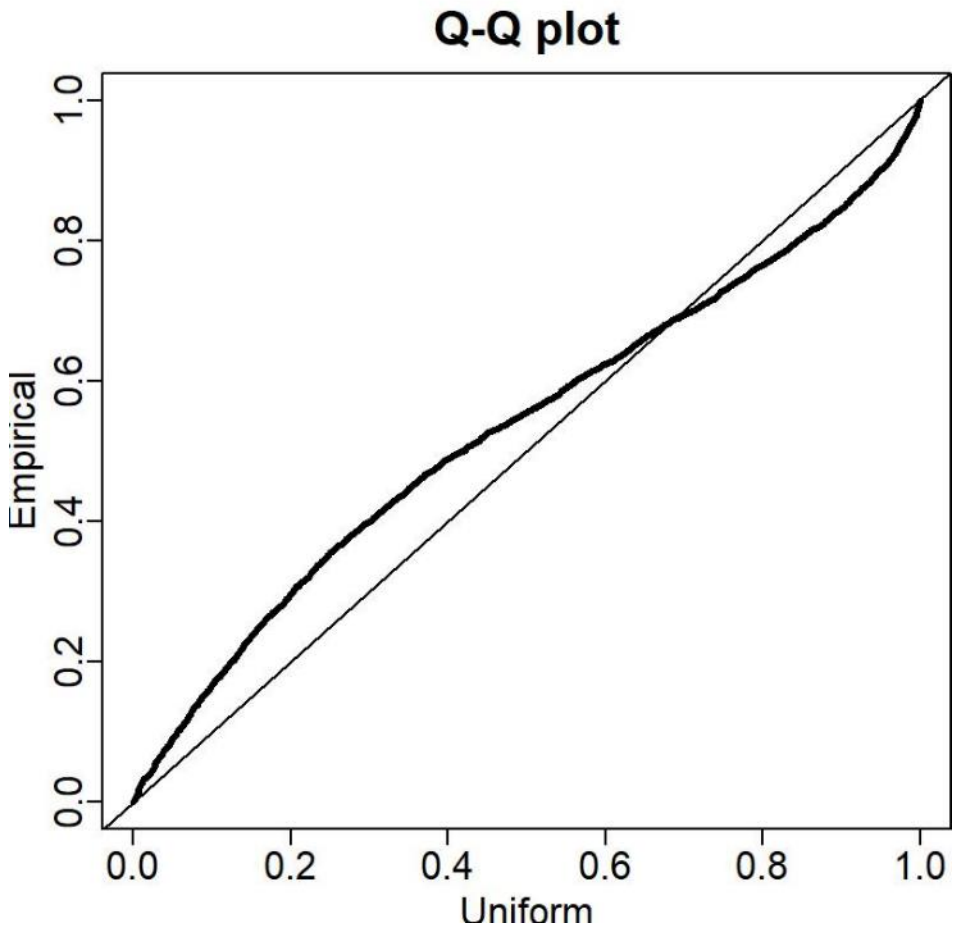
VAST MODEL



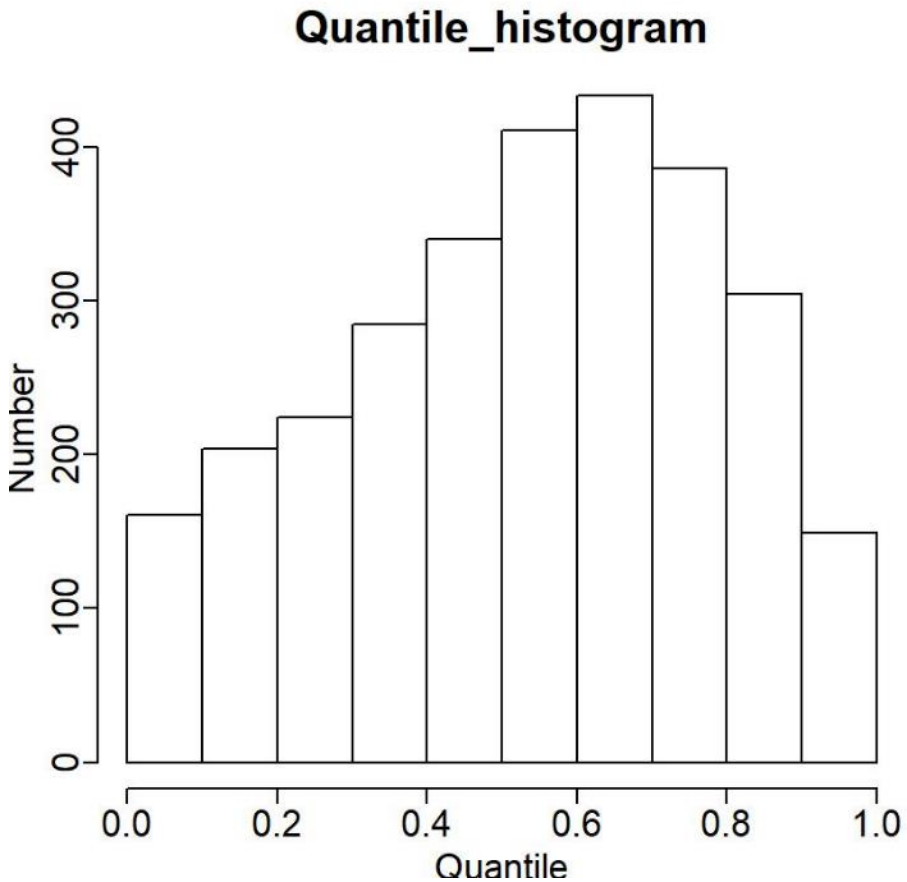
- Overall estimates are similar
- VAST estimates 2-3% higher.
- Note smaller CIs for VAST

VAST MODEL


Observed
Predicted
Observed encounter frequency
Predicted encounter probability
0.0
0.2
0.4
0.6
0.8
1.0


Q-Q plot
Empirical
Uniform
0.0
0.2
0.4
0.6
0.8
1.0

VAST MODEL



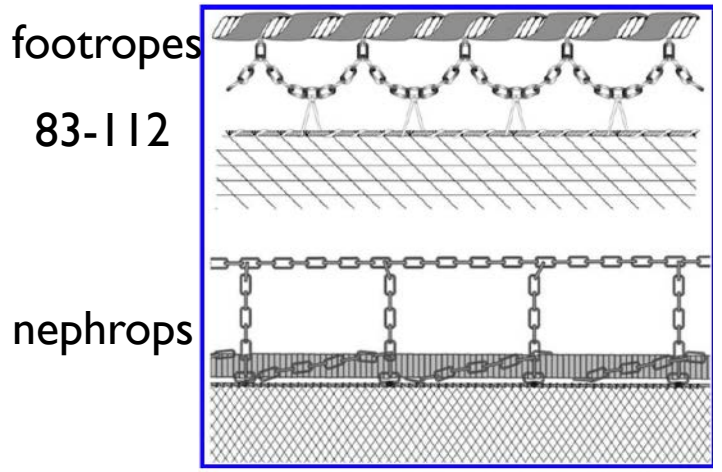
- Some model difficulty with high/low encounter probabilities
- Positive catch rate Q-Q plots "thin tailed"—extremes somewhat underpopulated relative to distribution assumptions, particularly on low ends
- Some skew

BSFRF SURVEY SELECTIVITY

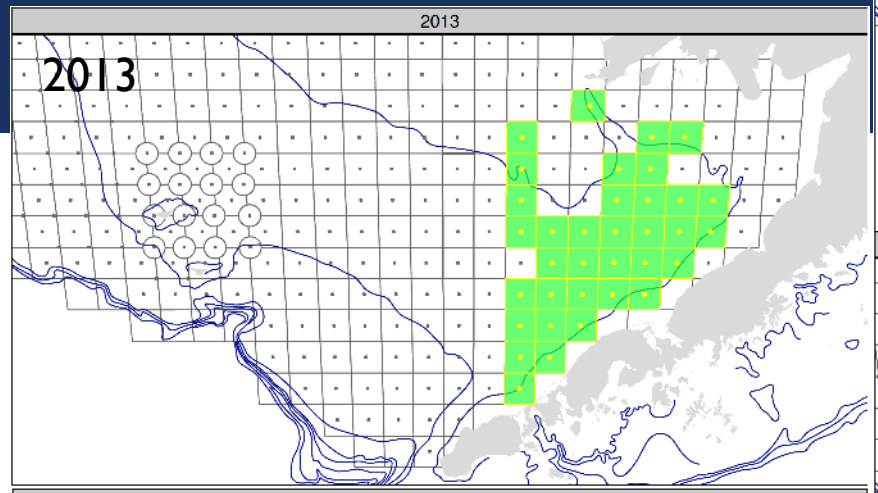
- Dr. Buck Stockhausen gave a summary of method he and others have used to incorporate the BSFRF survey selectivity data into crab assessments
- Goals
  - Review and update of methods currently examined and used
  - Eventually adopt similar methods to incorporate this data set in Tanner, snow, and BBRKC models

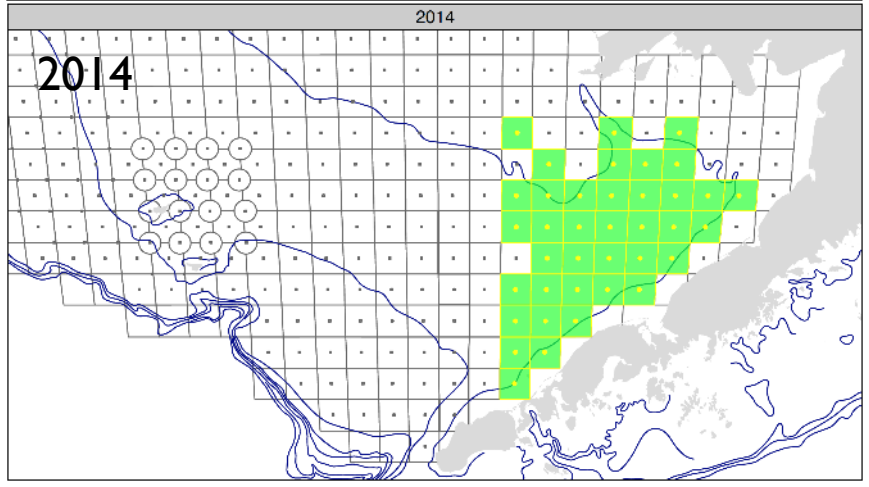
BSFRF SURVEY SELECTIVITY INTRODUCTION

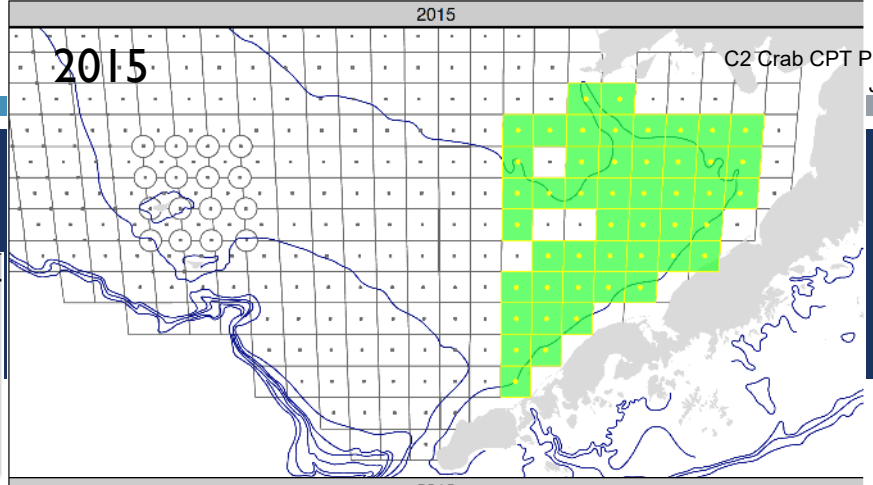
- BSFRF and NMFS conducted joint catchability studies focused on Tanner crab
  - 2013-2018
  - side-by-side (SBS) tow, simultaneous start, 0.5 nmi separation, same tow direction
- BSFRF
  - modified Nephrops trawl assumed* to capture ALL crab in gear path
  - 5-minute tow,
  - net equipped with mensuration gear to determine area swept
- NMFS
  - standard EBS 83-112 bottom trawl gear
  - standard 30-minute tow
  - standard net mensuration gear to determine area swept

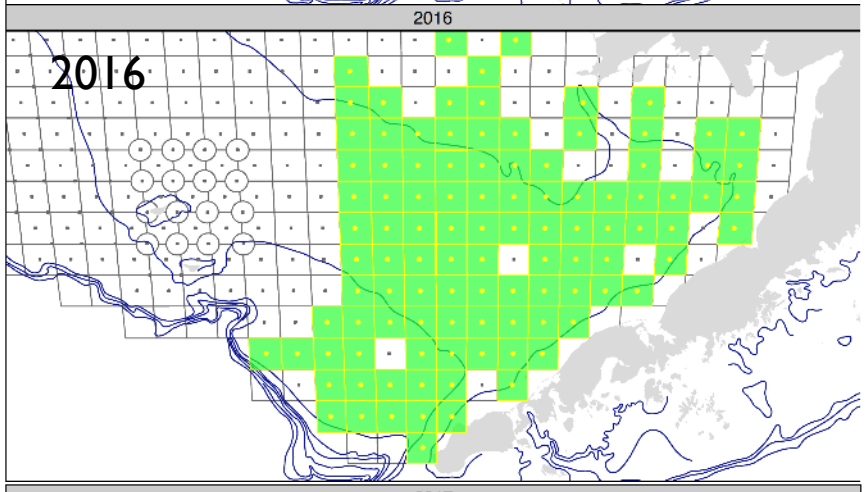


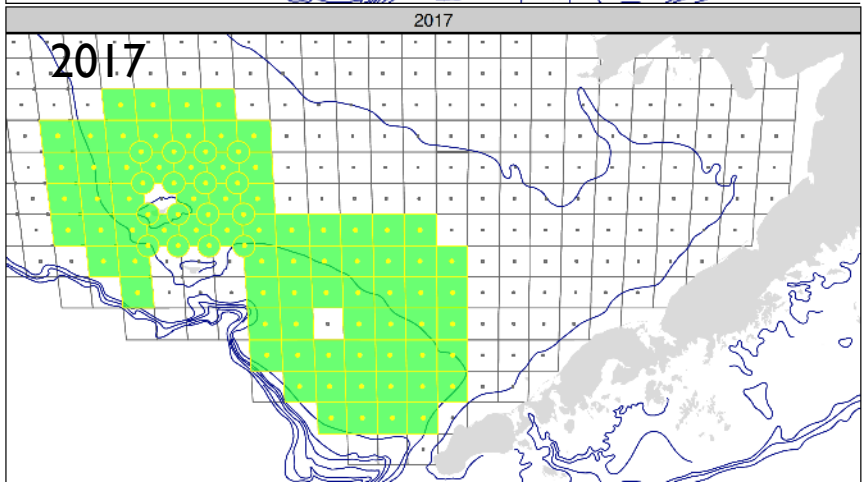
SBS STUDY AREAS



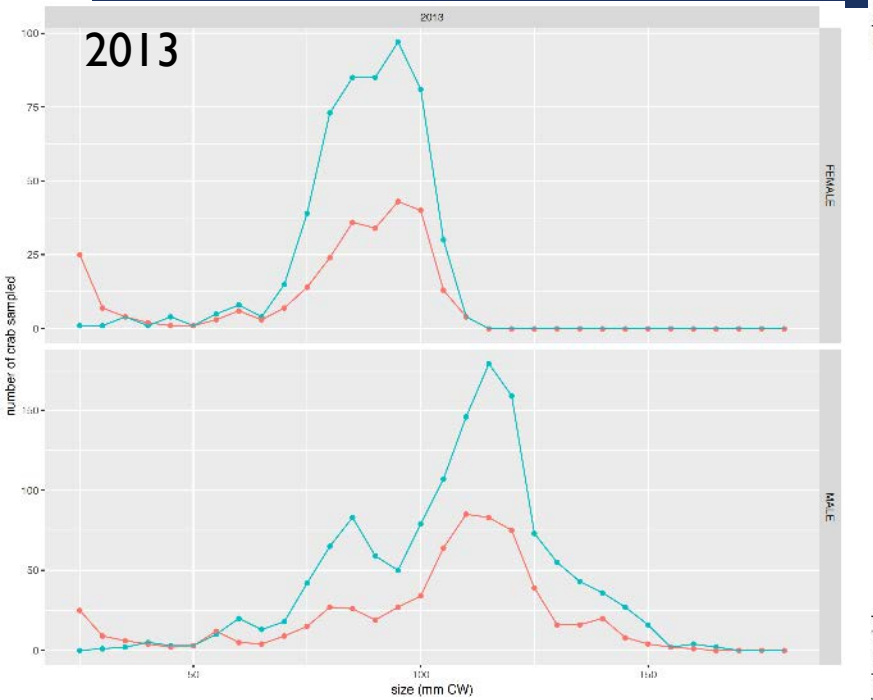


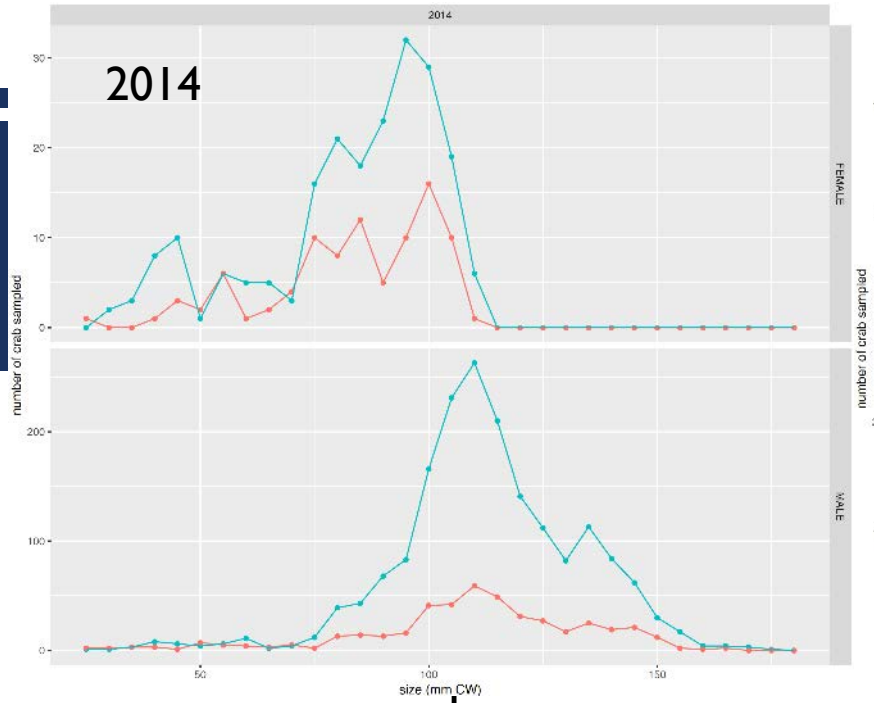


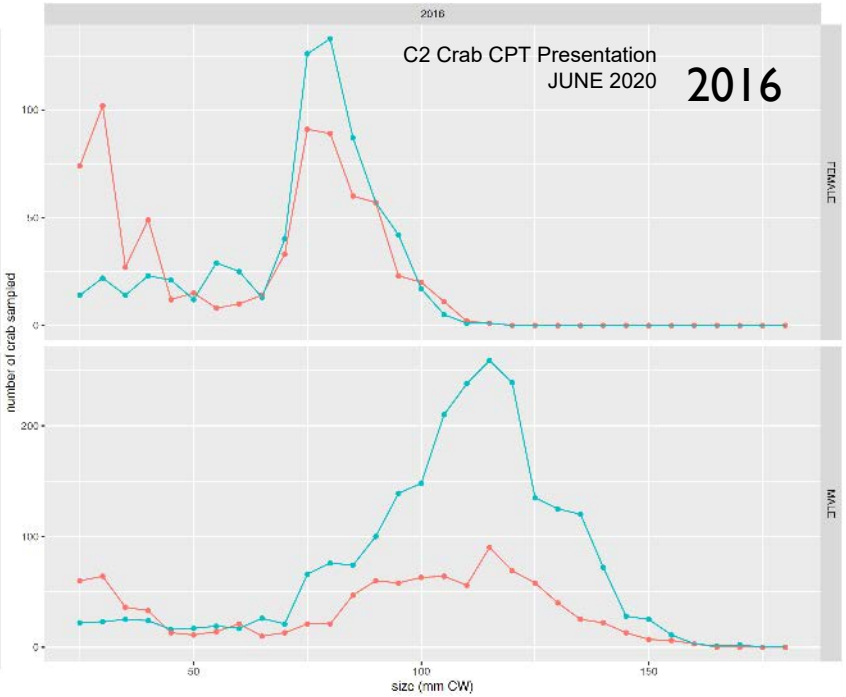




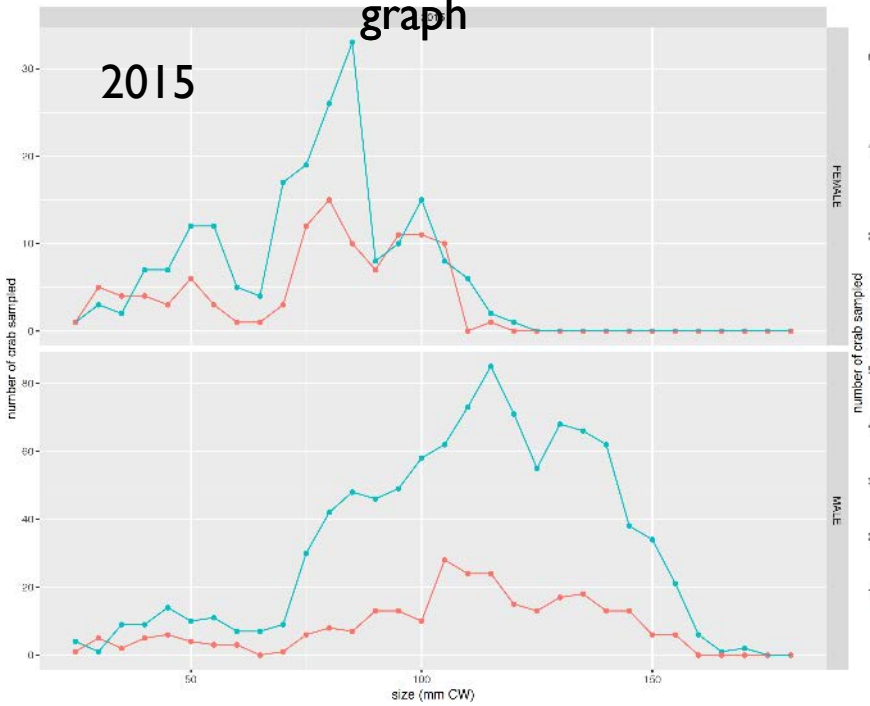
SBS CATCHABILITY STUDIES: NUMBER OF CRAB CAUGHT

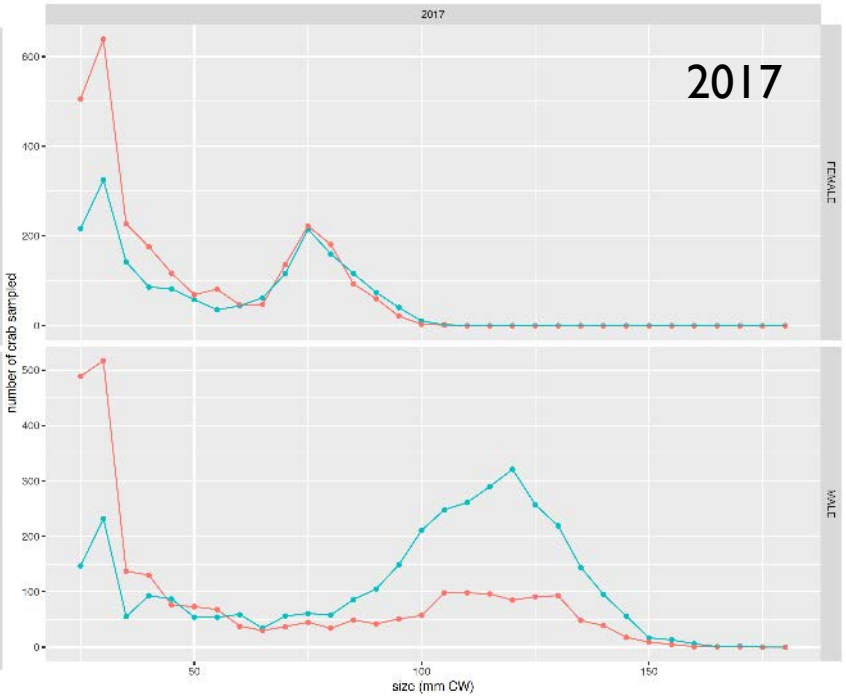






graph



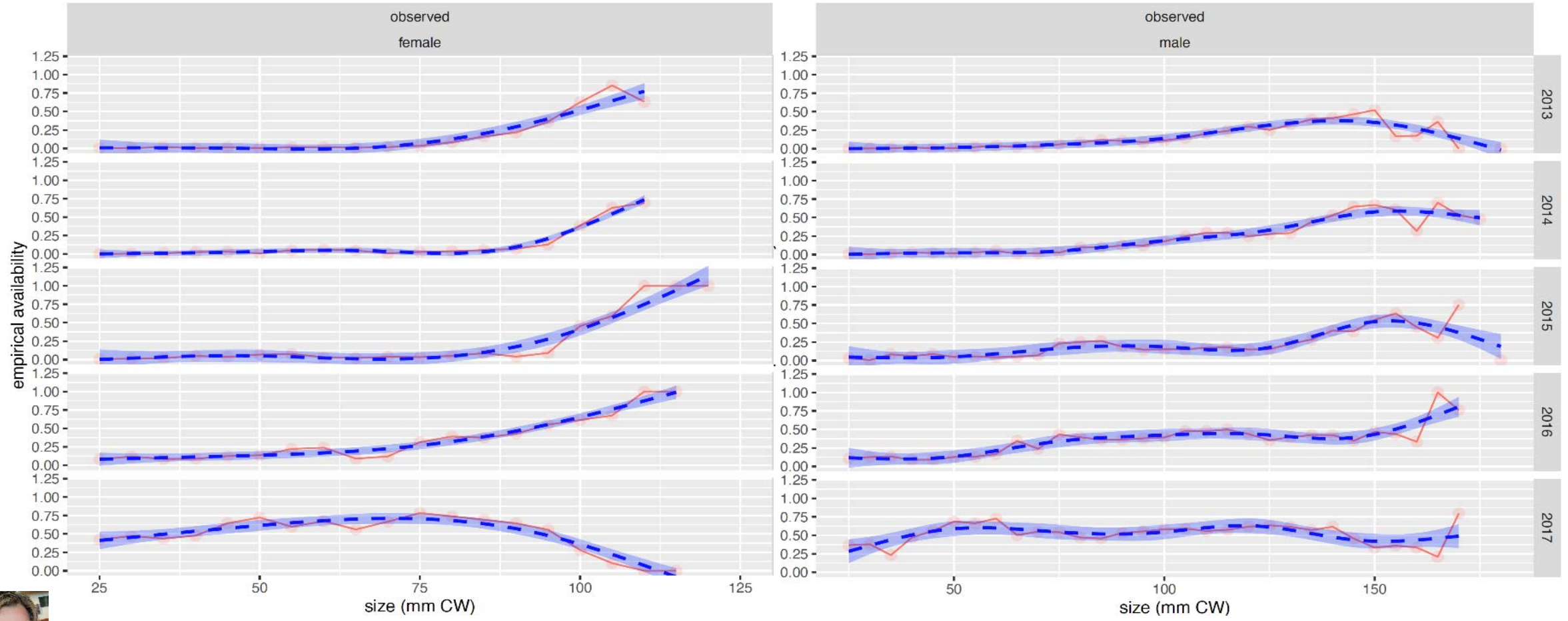


survey

- BSFRF
- NMFS

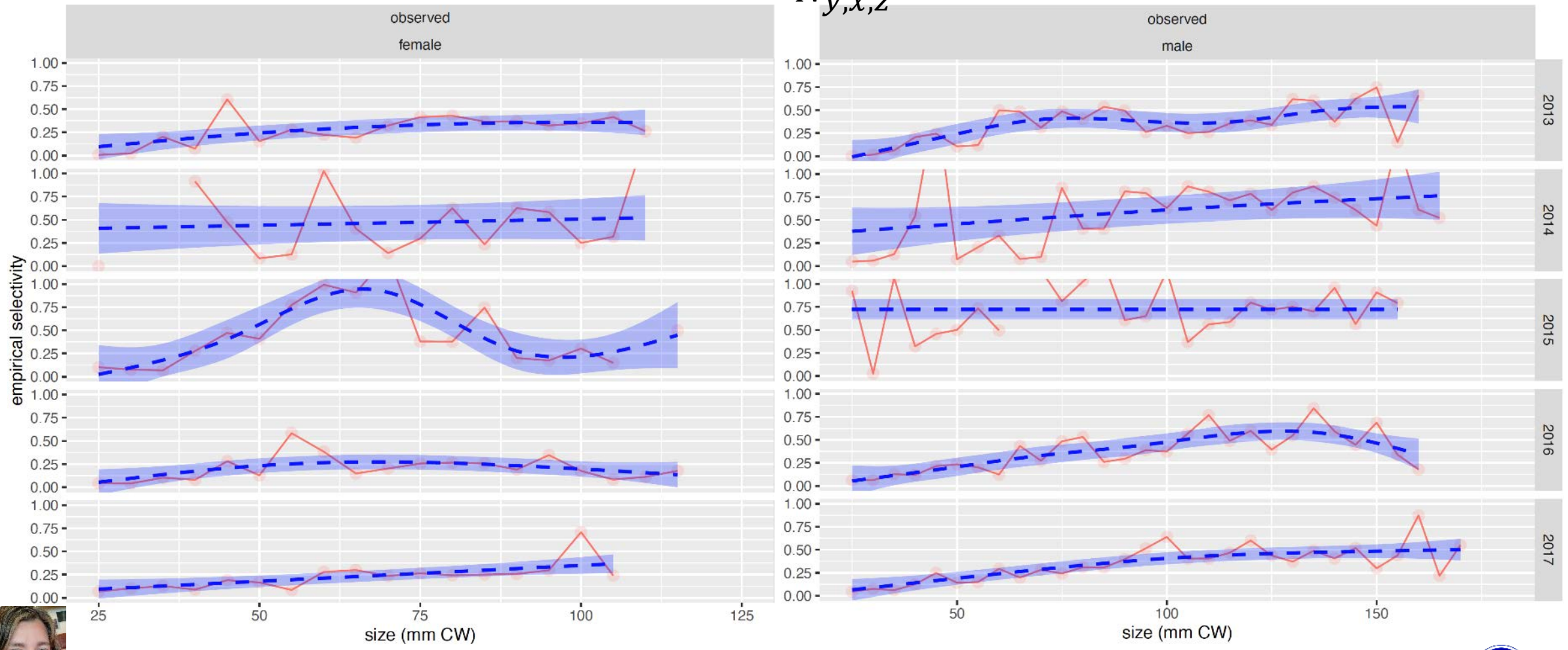
EMPIRICAL AVAILABILITY

$$A_{y,x,z}^{SBS} = \frac{N_{y,x,z}^{NMFS\ SBS}}{N_{y,x,z}^{NMFS\ EBS}}$$



EMPIRICAL CATCHABILITY

$$C_{y,x,z}^{NMFS\ EBS} = \frac{N_{y,x,z}^{NMFS\ SBS}}{N_{y,x,z}^{BSFRF\ SBS}}$$



"smooth " estimates are cubic splines

BSFRF SURVEY SELECTIVITY

- Future work (some of in Tanner model runs in this presentation)
  - Catchability and availability estimated inside the model by fitting all data simultaneously (NMFS EBS, NMFS SBS, BSFRF SBS)
  - Availability outside the model and catchability inside the model by fitting NMFS EBS and BSFRF SBS simultaneously
  - Catchability outside the model and fit only NMFS EBS data inside the model
  - Models that use availability or catchability from bootstrap analyses
  - Models that apply priors on model estimated availability and catchability from bootstrapping
- Recommendations:
  - Address the use of samples sizes in the model (number of crab per size bin)
  - Explore GAMM's to treat "year" as a random effect on catchability
  - Address large differences in annual estimates of empirical catchability by incorporating differences in catchability across years.

ALEUTIAN ISLAND GOLDEN KING CRAB: LENGTH BASED MODELING APPROACH

- Integrated male-only length-based models fitted to fishery dependent catch, CPUE, and tagging data.
- *Constant M* of 0.21yr^{-1}.
- Projected the abundance from unfished equilibrium in 1960 to initialize the 1985 abundance.
- 6 models for EAG and 3 models for WAG.
- Knife-edge maturity size of 111 mm CL for MMB calculation.
- Francis re-weighting method for Stage-2 effective sample sizes calculation for all models.

ALEUTIAN IS. GOLDEN KING CRAB

- Specific focus of these models was:
  - CPUE standardization using negative binomial
  - Year: area interaction of observer CPUE data
  - Including the cooperative survey CPUE as an additional index in the model
  - Time period used to calculate mean recruitment

JANUARY 2020 CPT COMMENTS CONTINUED

Comment 2: *Revised approach to select mean recruitment*: The proposed approach sets mean recruitment to the average over the years for which the standard deviations of the recruitment estimates is 70% of R_{sigma}. The choice of 70% is the lowest percentage at which a contiguous set of years would be selected. The CPT agrees with the general approach, and requests that the authors include the basis for the 70% in the next report.

.

Response:

The 70% value is an arbitrary choice satisfying the need to remove a few years from the tail end of the recruitment time series.

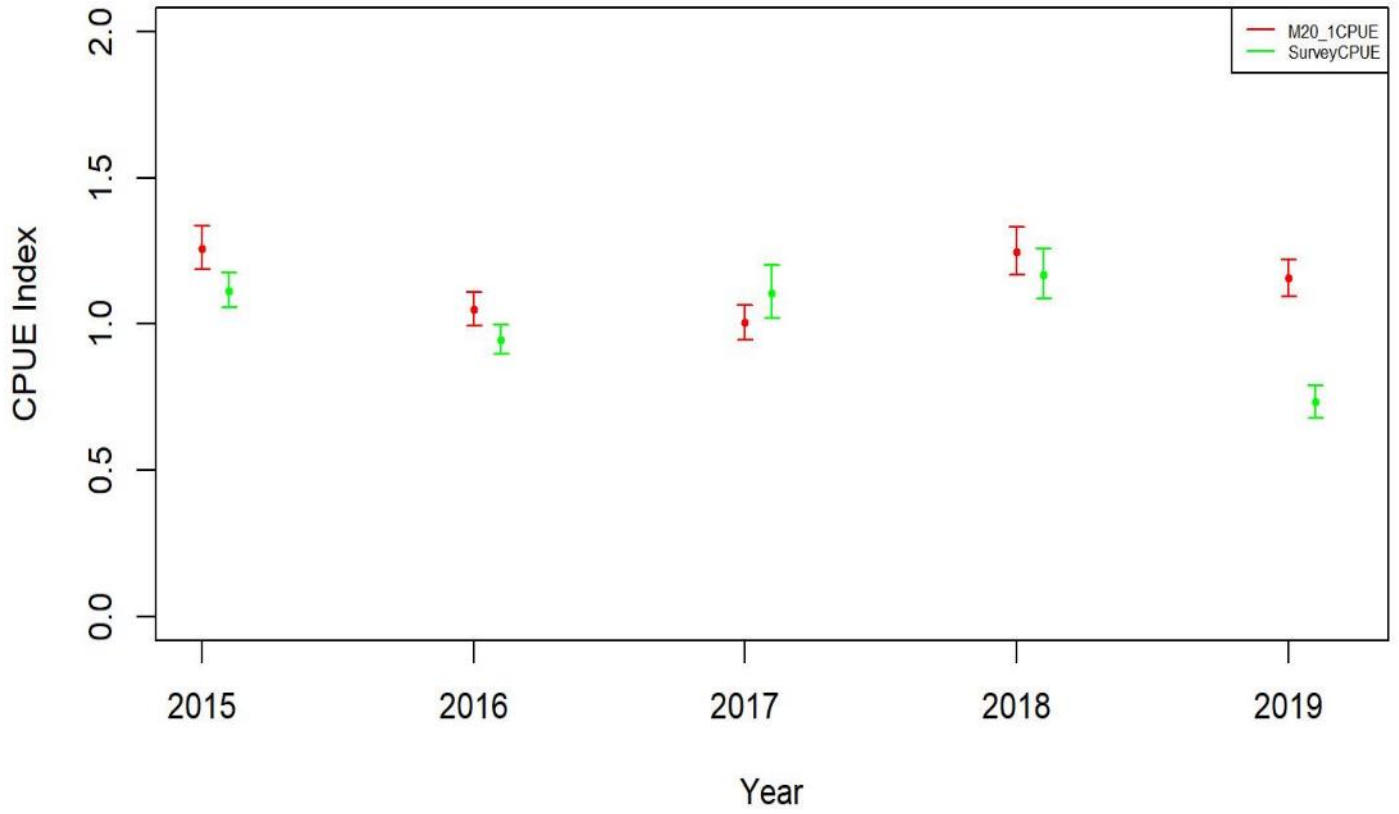
Instead of using 70%, we used the 90th percentile cutoff level based on 1986 to 2020 recruit standard errors estimated by the base model 20_1 to exclude years with high recruit standard deviations. This revised approach uses actual recruitment standard errors to obtain the cutoff level instead of $R_{sigma.}$

AIGKC MODEL OPTIONS

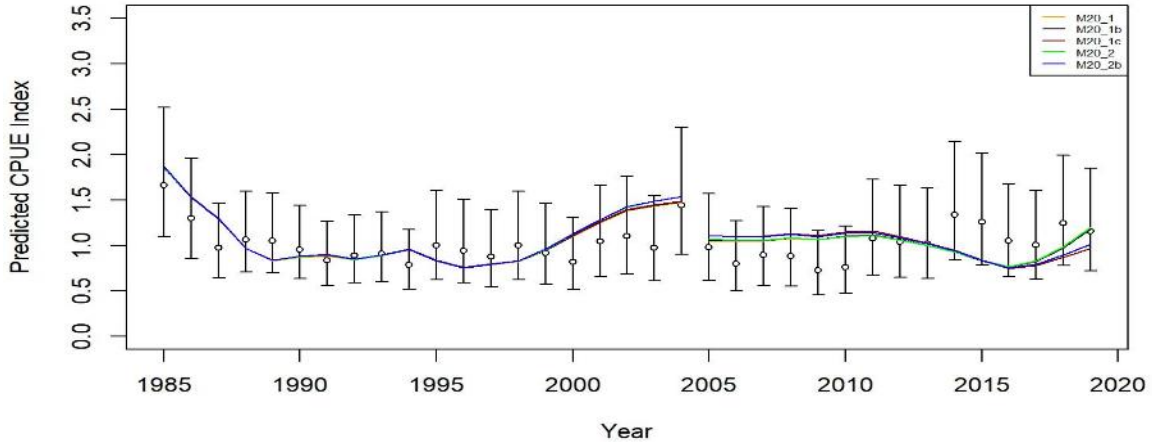
Model	CPUE Data Type	Time Period for Mean Number of Recruit Calculation
20_1 (accepted model in May 2019, implemented with up to 2019/20 data)	Observer data from 1995/96–2019/20 Fish ticket data from 1985/86–1998/99. Observer CPUE standardization by negative binomial and Fish ticket CPUE standardization by lognormal models	1987–2012
20_1b	20_1+ Fish ticket CPUE standardization by negative binomial	EAG:1986–2017; WAG:1987–2018
20_1c	20_1b+ cooperative survey CPUE indices for 2015–2019. Cooperative survey CPUE standardization by random effects model	EAG:1986–2017
20_1d	20_1b+ restrict cooperative survey CPUE indices to 2015–2018	EAG:1986–2017
20_2	20_1b+ Year:Area interaction for observer CPUE standardization.	EAG:1986–2017; WAG:1987–2018
20_2b	20_2+ cooperative survey CPUE indices for 2015–2019	EAG:1986–2017

Fig. C5. Comparison of cooperative survey CPUE indices (green) and model 20_1 CPUE indices (red). The confidence limits are determined with ±2SE.

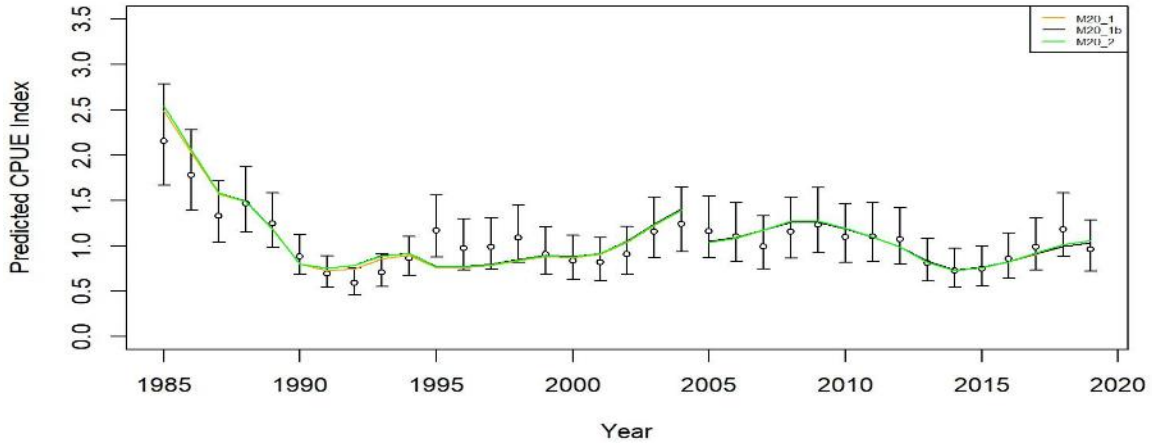
COMPARISON OF COOPERATIVE SURVEY AND MODEL CPUE INDICES



EAG

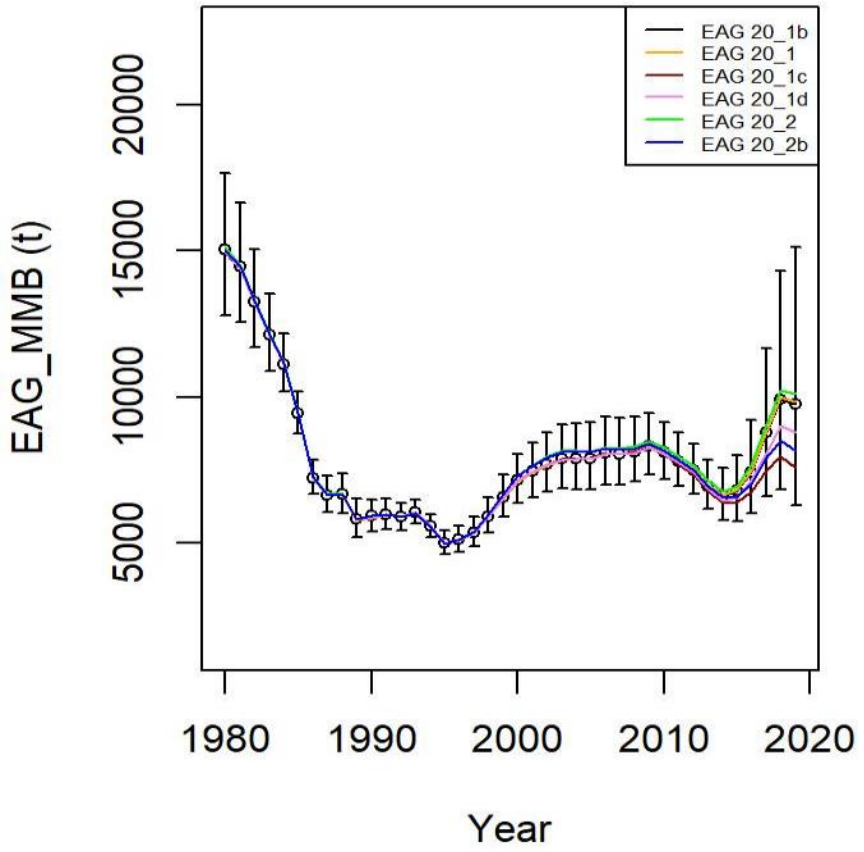


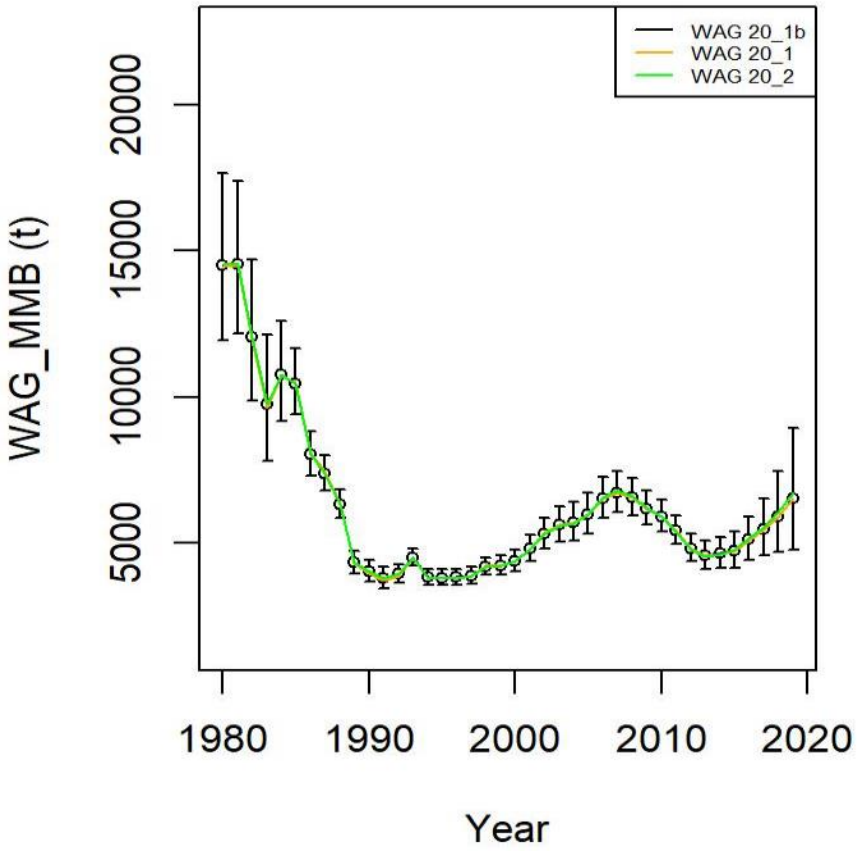
WAG



Figs. 24 and 42. Comparison of input CPUE indices [with +/- 2 SE for model 20_1 (black small circles)] with predicted CPUE indices (colored solid lines) by M20_1, M20_1b, M20_1c, M20_2, and M20_2b for EAG and M20_1, M20_1b, and M20_2 for WAG, 1985/86–2019/20. Model estimated additional standard error was added to each input standard error.

FIG. 26. TRENDS IN GOLDEN KING CRAB MATURE MALE BIOMASS FOR MODELS 20_1, 20_1B, 20_1C, 20_1D, 20_2, AND 20_2B FITS TO EAG (LEFT) AND MODELS 20_1, 20_1B, AND 20_2 FITS TO WAG (RIGHT) DATA, 1960/61–2019/20. MODEL 20_1B ESTIMATE HAS TWO STANDARD ERROR CONFIDENCE LIMITS..





Stock status, reference biomass, OFL fishing mortality, OFL (total catch), and ABC for various models for EAG.
Biomass, OFL, and ABC are in t. Current MMB = MMB on 15 Feb. 2021.

EAG:

Model	Tier	$MMB_{35\%}$	Current MMB	MMB/ $MMB_{35\%}$	F_{OFL}	Recruitment Years to Define $MMB_{35\%}$	$F_{35\%}$	OFL	ABC (P*=0.49)	ABC (0.75*OFL)
EAG20_1	3a	6.601	8.532	1.29	0.61	1987–2012	0.61	3,015.592	2,997.858	2,261.694
EAG20_1b	3a	6.774	8.470	1.25	0.61	1986–2017	0.61	2,985.928	2,968.143	2,239.446
EAG20_1c	3a	6.568	6.937	1.06	0.61	1986–2017	0.61	2,260.998	2,504.178	1,695.748
EAG20_1d	3a	6.679	7.790	1.17	0.61	1986–2017	0.61	2,653.436	2,642.813	1,990.077
EAG20_2	3a	6.794	8.665	1.28	0.61	1986–2017	0.61	3,133.485	3,115.767	2,350.114
EAG20_2b	3a	6.613	7.338	1.11	0.61	1986–2017	0.61	2,484.903	2,466.646	1,863.677

Stock status, reference biomass, OFL fishing mortality, OFL (total catch), and ABC for various models for WAG.
Biomass, OFL, and ABC are in t. Current MMB = MMB on 15 Feb. 2021.

WAG:

Model	Tier	$MMB_{35\%}$	Current MMB	MMB / $MMB_{35\%}$	F_{OFL}	Recruitment Years to Define $MMB_{35\%}$	$F_{35\%}$	OFL	ABC (P*=0.49)	ABC (0.75*OFL)
WAG20_1	3a	5.204	6.279	1.21	0.56	1987–2012	0.56	1,802.747	1,795.486	1,352.060
WAG20_1b	3a	5.319	6.290	1.18	0.56	1987–2018	0.56	1,806.903	1,799.775	1,355.177
WAG20_2	3a	5.343	6.441	1.21	0.56	1987–2018	0.56	1,859.828	1,852.480	1,394.871

ALEUTIAN IS. GOLDEN KING CRAB

- Issues
  - Changes in recruitment parameterization in the models after the base model was problematic for moving forward with those models for specifications
  - Year:Area models need better documentation and review (20.2 and 20.2b), the variance calculation specifically
  - Cooperative survey CPUE indices (only for EAG) need review of 2019 data, also sensitivity of this new data set to the model output needed (20.1c and 20.1d)
- Recommendations:
  - Model 20.1b
    - uses the 70% recruitment calcs previously used
    - Improvement to the base model with the use of the negative binomial
  - Explore the sensitivity of the results to levels of Rsigma in the future
  - Improved graphical depictions, and additional figures needed for cooperative survey data
  - GMACS version in the near future

AIGKC SPECIFICATIONS USING MODEL 20.1B USING 70% RECRUITMENT

Status and catch specifications (1000 t) 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	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	3.275	3.693	5.249	3.937
2020/21		14.774				4.798	3.599

WESTERN ALEUTIAN IS. RED KING CRAB

- Tier 5 stock, last assessment May 2017 (3-yr cycle)
- No changes in assessment methodologies (status quo)
- Updated catch history
- Overfishing did not occur during 2017/18, 2018/19, and 2019/20 seasons
- 2016 Petrel Bank survey indicates low population abundance

WAIRKC RECOMMENDED SPECIFICATIONS

Management Performance Table (values in t)

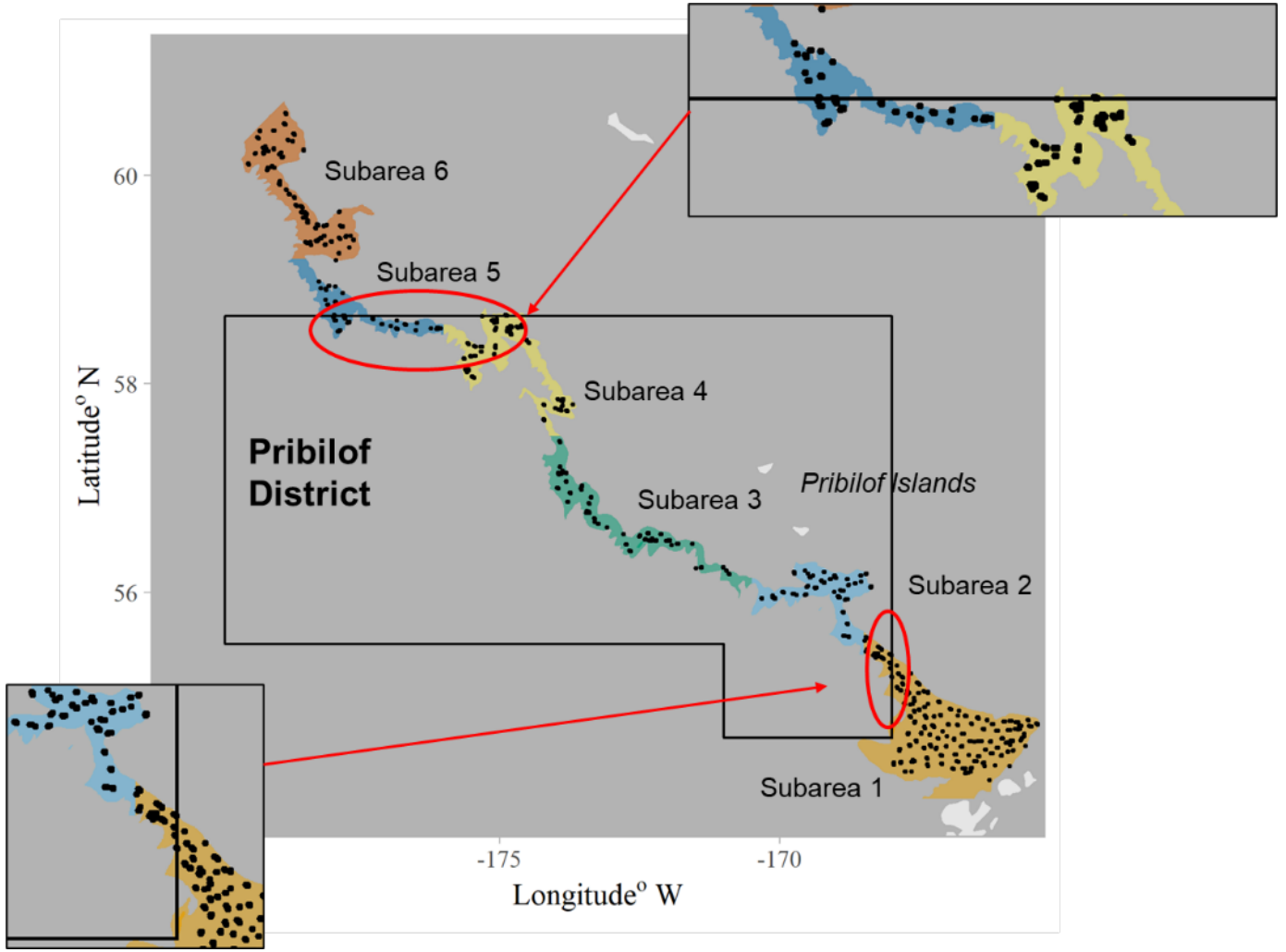
Fishing Year	MSST	Biomass (MMB)	TAC[a]	Retained Catch	Total Catch	OFL	ABC
2015/16	N/A	N/A	Closed	0	1.3	56	34
2016/17	N/A	N/A	Closed	0	<1	56	34
2017/18	N/A	N/A	Closed	0	<1	56	14
2018/19	N/A	N/A	Closed	0	<1	56	14
2019/20	N/A	N/A	Closed	0	<1	56	14
2020/21	N/A	N/A				56	14
2021/22	N/A	N/A				56	14
2022/23	N/A	N/A				56	14

a. Pre-season harvest levels are established as total allowable catch for the rationalized fishery west of 179° W longitude and as a guideline harvest level for the non-rationalized fishery east of 179° W longitude.

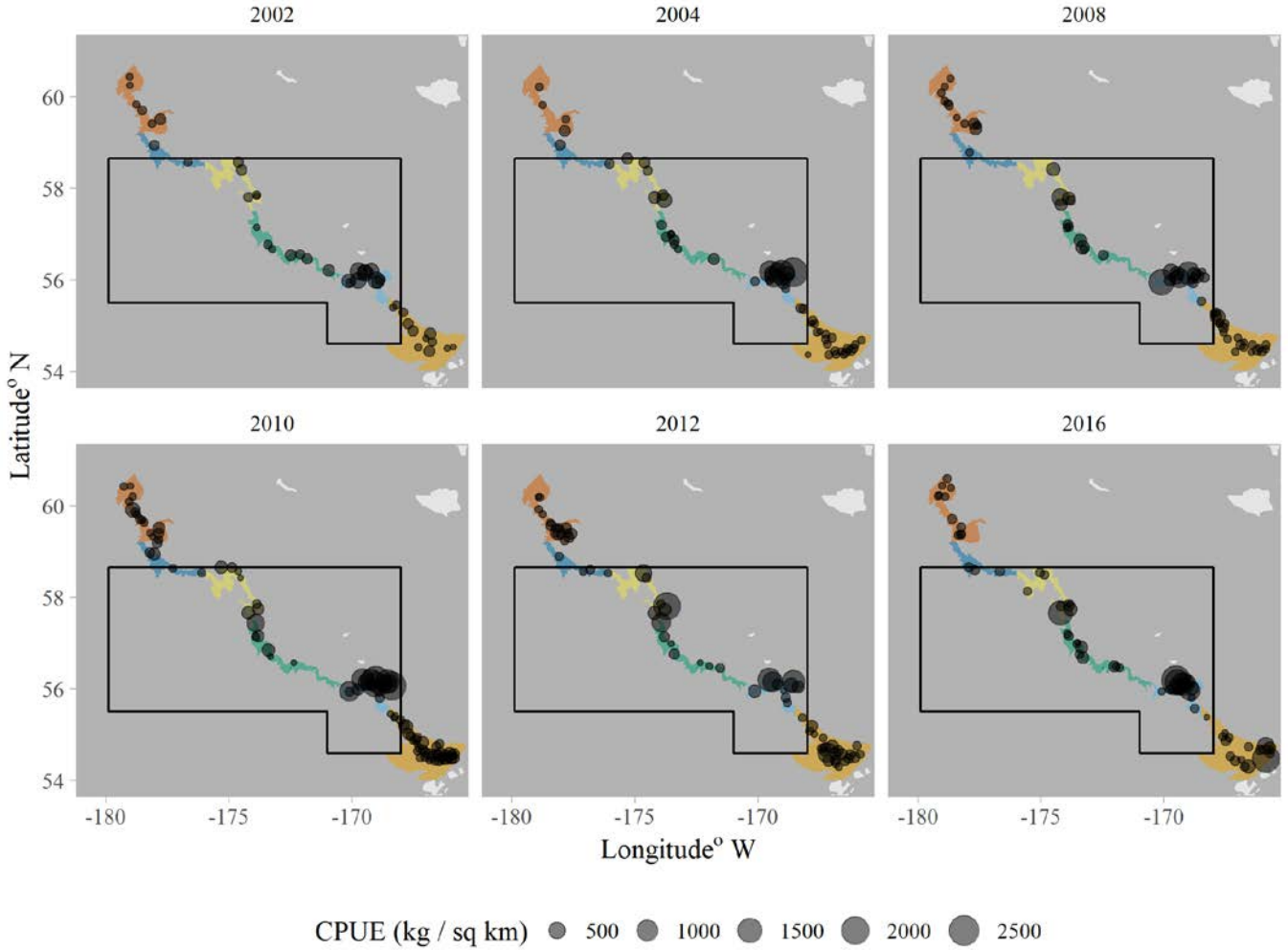
PRIBILOF IS. GOLDEN KING CRAB

- Tier 5; last assessment May 2017 (3-yr cycle)
- Managed by calendar year: Jan1-Dec 31
- Fishery data
  - 100% observer coverage
  - 100% dockside sampled
- Commissioner's Permit fishery
- Increased interest
  - Decline in other BSAI crab fisheries
- Requests for increased GHLs
  - currently 130,000 lb
- Tier 4 RE model development
  - Slope survey results

PIGKC : PRIBILOF DISTRICT MANAGEMENT AREA INTERSECTS SUBAREAS 1, 4, 5

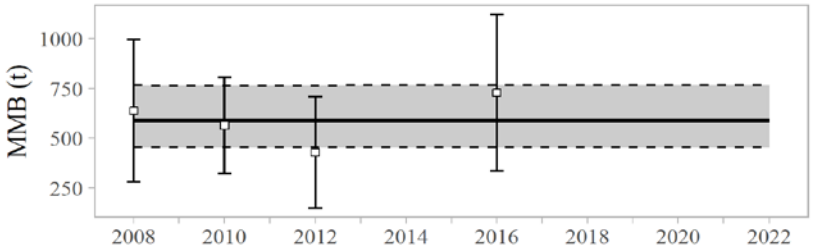


PIGKC : SLOPE SURVEY

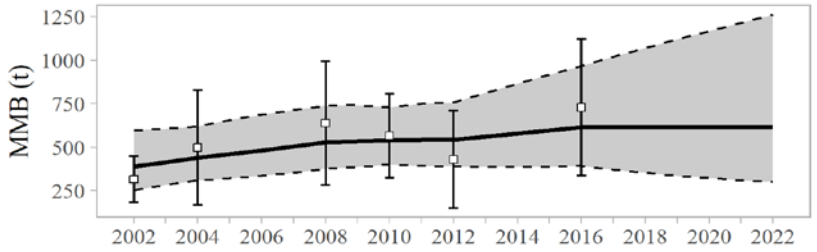


PIGKC : RE MODEL

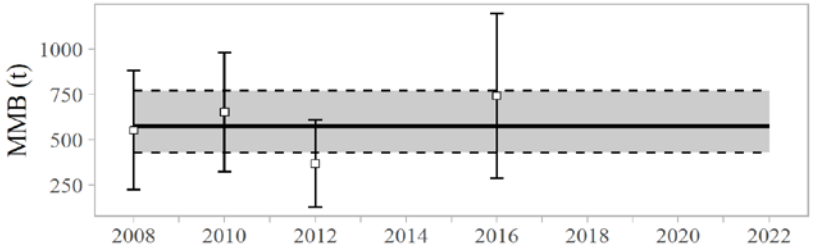
2020a



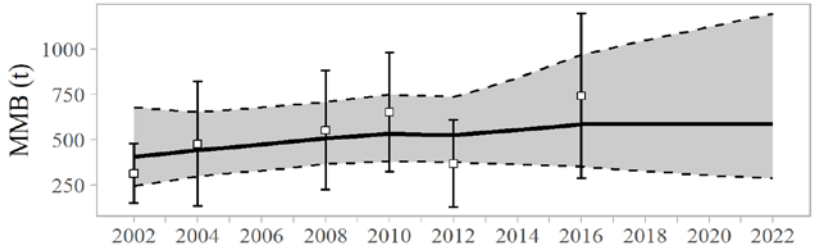
2020d



2020b



2020e



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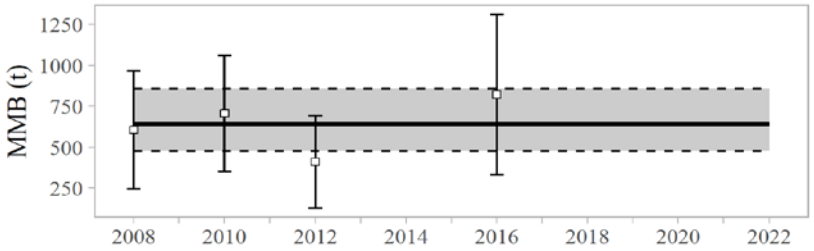

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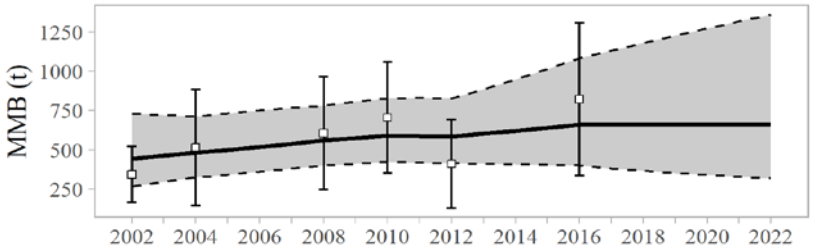


PIGKC: TIER 5 VS. TIER 4 AVERAGE CATCH VS. AVERAGE SURVEY MMB????

Tier 5

- Average retained catch 1993 – 1998
- Static
- Historic catch, may not characterize current population

Tier 4

- random effects model smoothing slope survey data (2002 – 2016)
- Limited data
- Uncertain when/if future data will be collected
- Captured during low fishery participation
- Uncertainty in 2002 and 2004 estimates
- Work needed on characterization of the RE model

PIGKC: RECOMMENDATIONS

- Tier 5 specifications
- Bring tier 4 model for work during the Jan 2021 modeling workshop, with a presentation at May 2021 meeting for possible adoption
- Tier 4 improvements:
  - Explore 2004 size comp data availability
  - Improve CV for 2002 and 2004 MMB estimates
  - Explore simple GMACS model

PIGKC: TIER 5 SPECIFICATIONS

Management Performance Table (values in t)

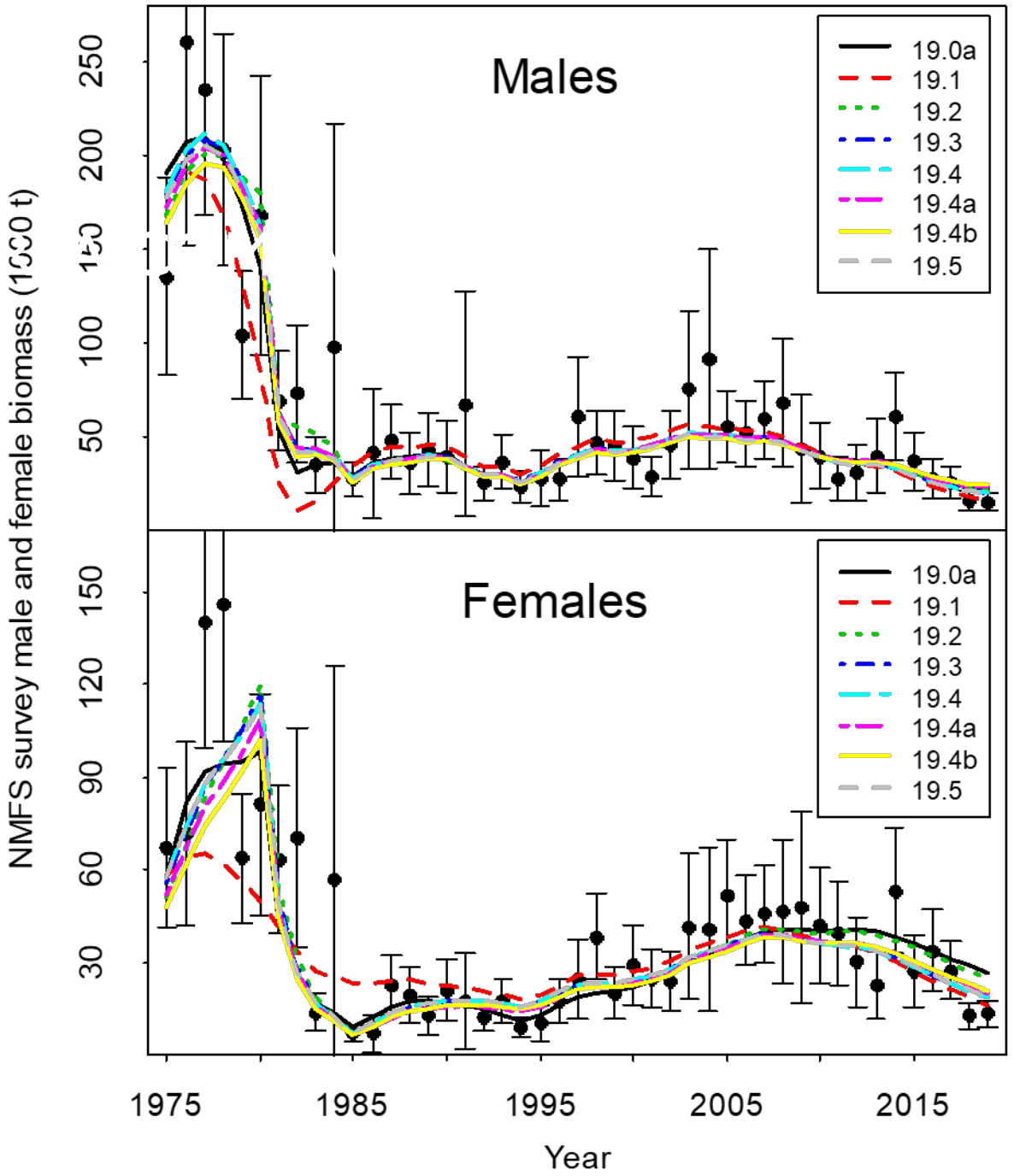
Calendar Year	MSST	Biomass (MMB)	GHL[a]	Retained Catch	Total Catch[b]	OFL	ABC
2016	N/A	N/A	59	0	0.24	91	68
2017	N/A	N/A	59	Conf.[c]	Conf.[c]	93	70
2018	N/A	N/A	59	Conf.[c]	Conf.[c]	93	70
2019	N/A	N/A	59	Conf.[c]	Conf.[c]	93	70
2020	N/A	N/A	59			93	70
2021	N/A	N/A				93	70
2022	N/A	N/A				93	70
2023	N/A	N/A				93	70

BRISTOL BAY RED KING CRAB (BBRKC) MODEL RUN OPTIONS

- Reviewed 8 model scenarios:
  - 19.0a – replace 19.0: uses a correct mean recruitment sex ratio for B35% estimation, structurally the same model
  - 19.1: constant M = 0.18 males
  - 19.2: 19.1 + constant M estimated 1980-1984, M = 0.18 during other years
  - 19.3: 19.2 + constant M males 1980-1984, M = 0.18 for males during other years. Estimated constant multiplier for females
  - 19.4: 19.3 + same selectivity for males and females for each survey
  - 19.4a: 19.4 with VAST
  - 19.4b: 19.4a + add CV for VAST trawl survey biomass
  - 19.5: 19.4 + separate catchabilities for males and females in NMFS trawl survey

BRISTOL BAY RED KING CRAB (BBRKC) MODEL RUN OPTIONS

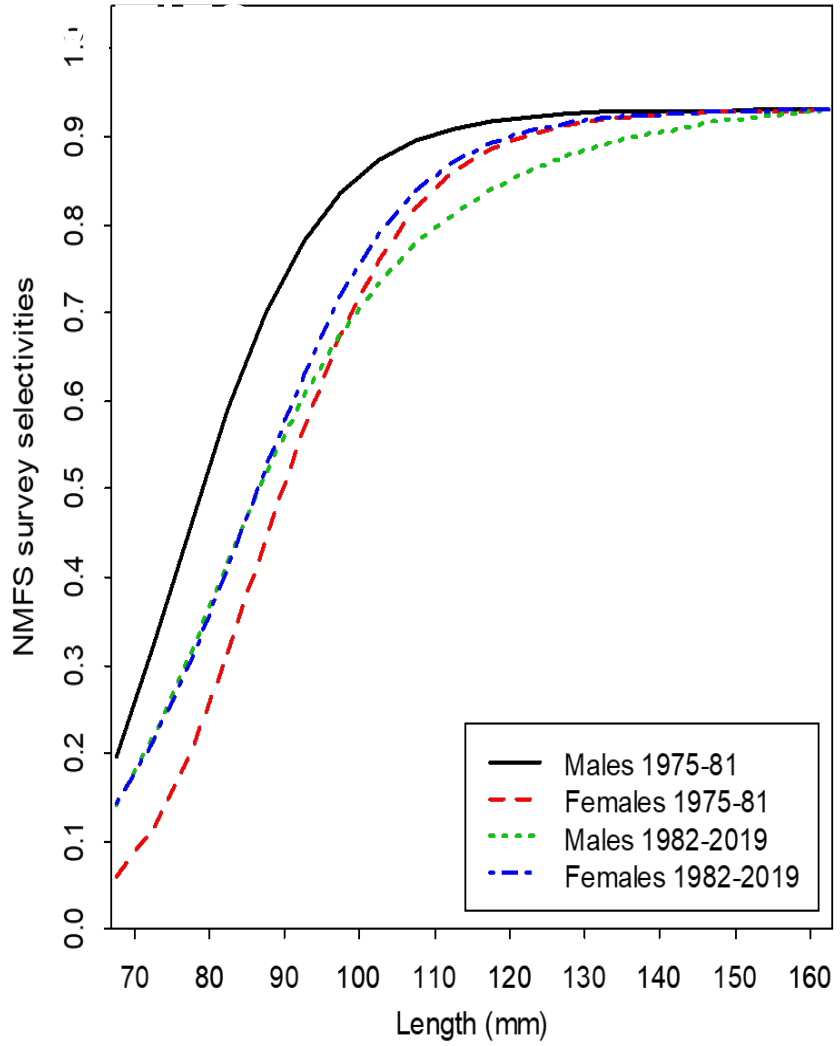
Model	Male M	Female M	Same survey sel. by sex	VAST	Extra CV for NMFS survey	Diff. Q by sex
19.0a	75-79 & 85-19: 0.18, 80-84: M1	75 & 94-19: 0.18, 80-84: M2, 76-79 & 85-93: M3	N	N	N	N
19.1	0.18	c*0.18	N	N	N	N
19.2	80-84: M1, others: 0.18	Same as male M	N	N	N	N
19.3	80-84: M1, others: 0.18	c*male M	N	N	N	N
19.4	80-84: M1, others: 0.18	c*male M	Y	N	N	N
19.4a	80-84: M1, others: 0.18	c*male M	Y	Y	N	N
19.4b	80-84: M1, others: 0.18	c*male M	Y	Y	Y	N
19.5	80-84: M1, others: 0.18	c*male M	Y	N	N	Y



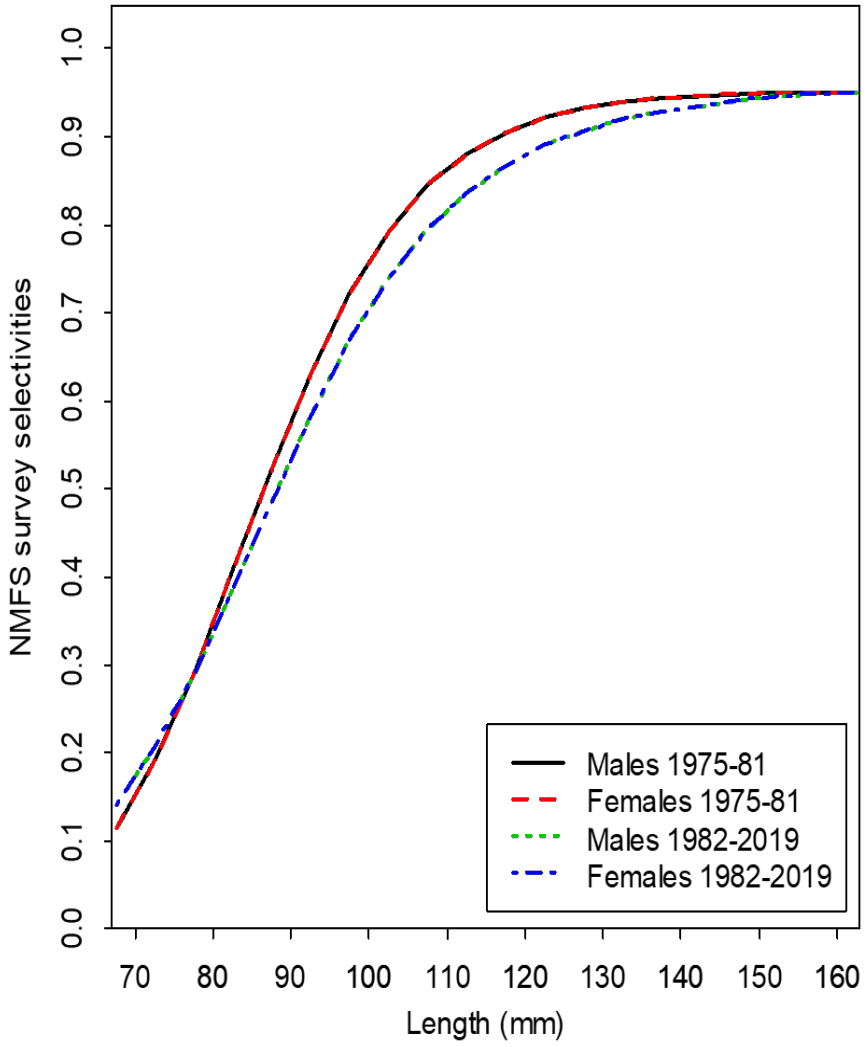
Comparisons of area-swept estimates of total NMFS survey biomass and model prediction for model estimates in 2019 under eight models. The error bars are plus and minus 2 standard deviations.

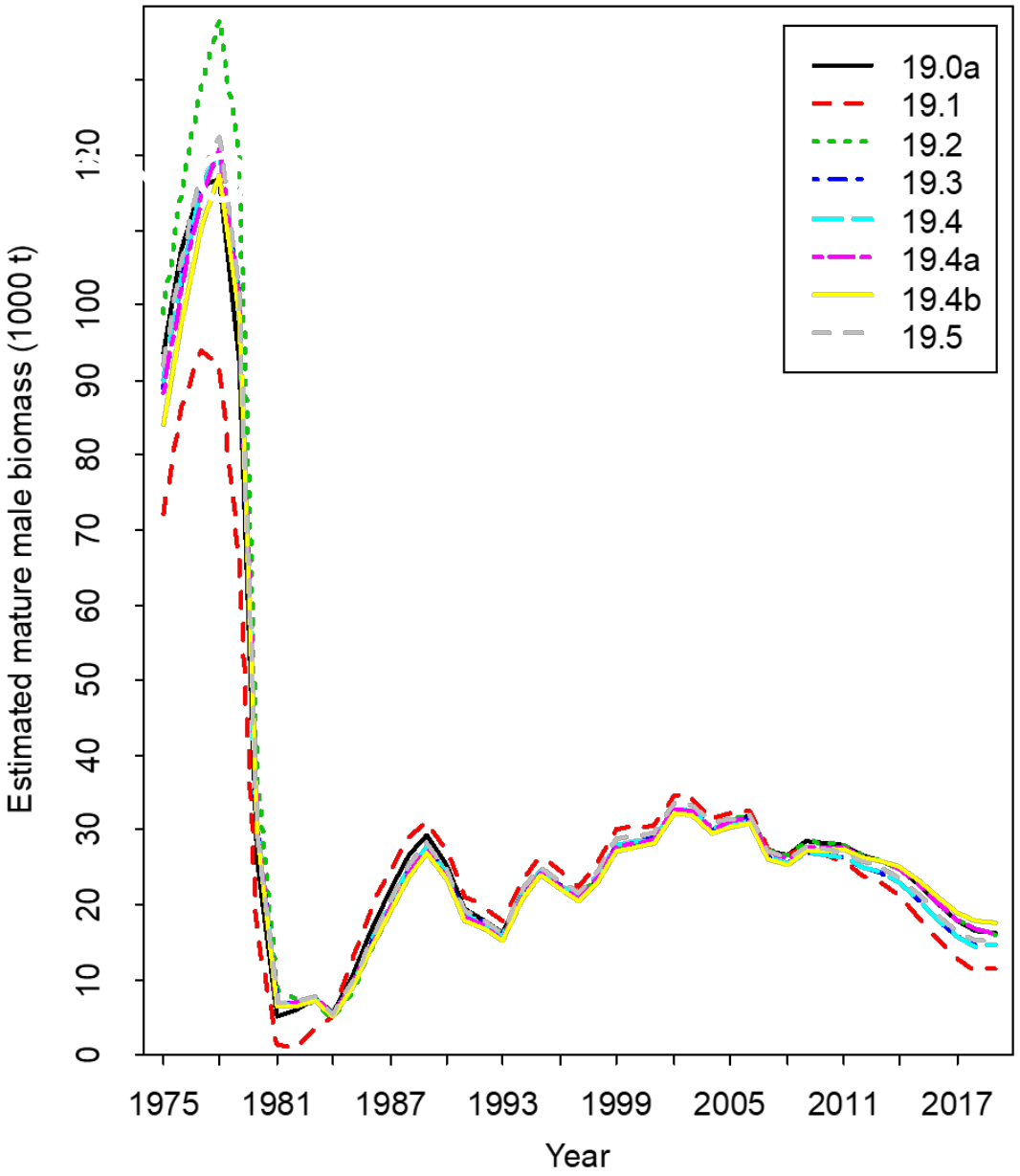
NMFS survey selectivities (including catchability)

19.0a



19.4





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

Estimated trawl survey catchabilities:

Model	Q
19.0a	0.930
19.1	0.972
19.2	0.915
19.3	0.950
19.4	0.951
19.4a	0.936
19.4b	0.920
19.5	0.92/0.94

BRISTOL BAY RED KING CRAB (BBRKC) MODEL RUN OPTIONS

- VAST models not considered until diagnostics improve
- 19.1 and 19.2 fit data poorly (removed)
- 19.4 was author preferred
- Recommendations:
  - Improved explanation of model specifications (see minutes)
  - 19.3 as preferred model
    - constant M males 1980-1984, M = 0.18 for males during other years
    - estimated constant multiplier for females
    - Survey selectivity separate by sexes, with single catchability (Q)
  - Additional model: prior on catchability is relaxed and estimated separately by sex

BOARD OF FISHERIES UPDATE DISCUSSION OF ACTION ON TANNER CRAB

- Ben Daly (ADF&G Kodiak) presented MSE that evaluated alternative State harvest strategies for Tanner crab
- Positive collaboration
  - ADF&G developed new harvest strategy options
  - Industry stakeholders provided feedback throughout
  - High value fishery, variable TAC, closures, complex harvest strategy
  - NOAA and UW conducted the analysis
  - 15 harvest strategies evaluated
  - Narrowed down to 1 strategy with 3 sub-options for BOF consideration
    - Alignment across collaborators, with some differences in final preference
- This was a strong collaborative effort

PROPOSAL 261 RECOMMENDED HARVEST STRATEGY FOR BERING SEA TANNER CRAB

Benjamin Daly[1], Madison Heller-Shipley[2], Mark Stichert[1], William Stockhausen[3], André Punt[2], Scott Goodman[4]

Alaska Board of Fisheries Meeting

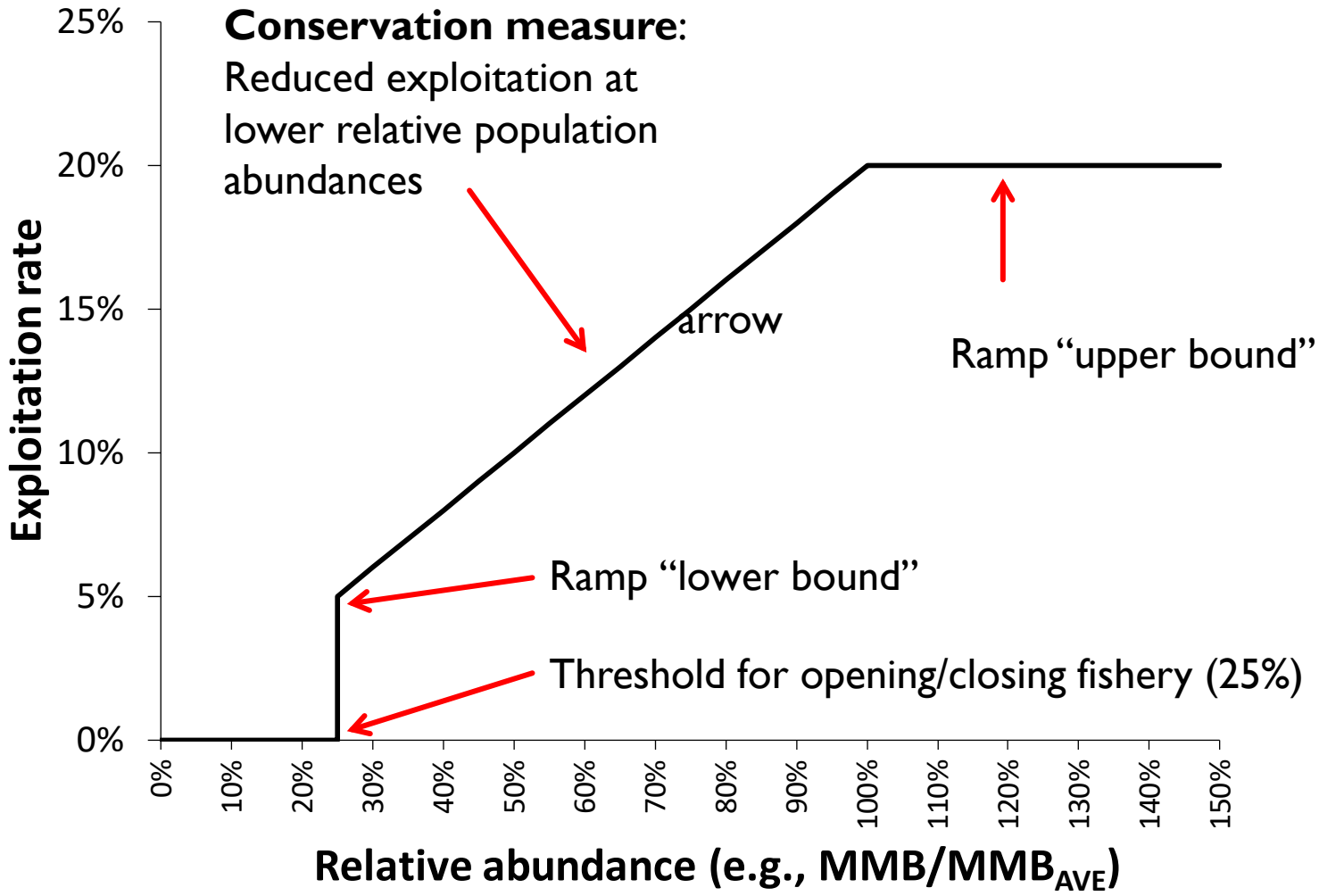
Anchorage, AK

March 8-11, 2020

[1] Alaska Department of Fish and Game, [2] University of Washington, [3] National Oceanic and Atmospheric Administration, [4] Natural Resources Consultants Inc.

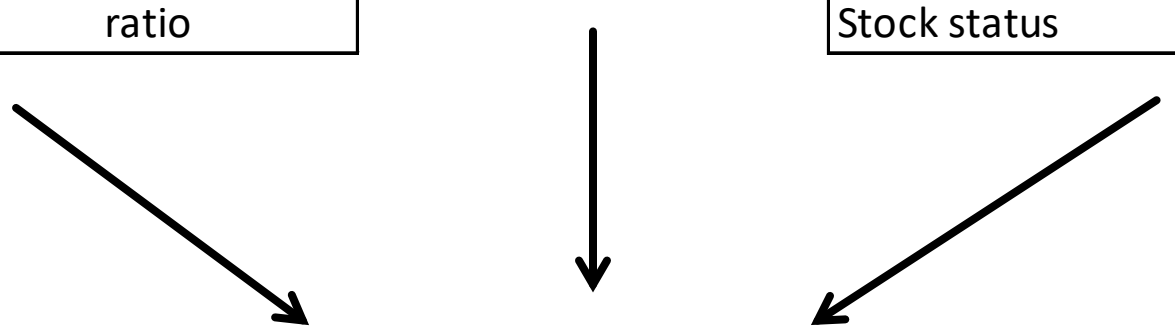
[3] The scientific results and conclusions, as well as any views or opinions expressed herein, are those of the author(s) and do not necessarily reflect those of NOAA or the Department of Commerce.

SLOPING CONTROL RULE

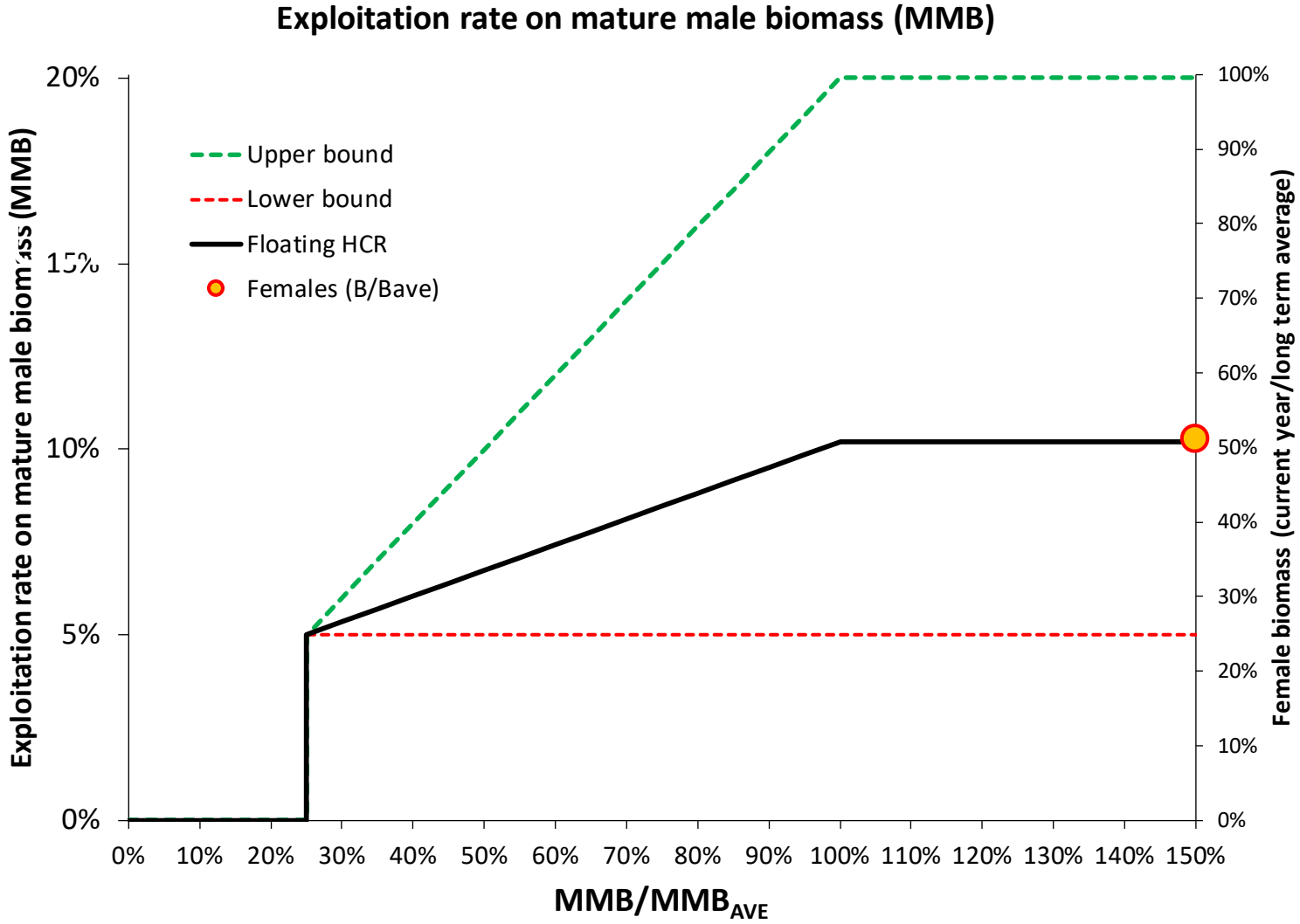


Evaluating harvest strategies

Conservation		Catch		Catch Stability	
Metric	Unit	Metric	Unit	Metric	Unit
Overfished	Probability	TAC	Mill lb	Fishery closures	Probability
Overfishing (OFL)	Probability			Annual TAC var	Proportion
Overfishing (ABC)	Probability			Relative TAC (1)	Probability
MMB	Mill lb			Relative TAC (2)	Probability
MMB/MMB_{AVE}	ratio			Stock status	Probability



Single harvest strategy



Female dimmer sub-options

Policy	Description	Fixed vs ramp	Ramp lower	Ramp upper	Max TAC
HCR4_1	Female dimmer 20%	Ramp	5%	20%	50% ELM
HCR4_2	Female dimmer 20%	Ramp	10%	20%	50% ELM
HCR4_3	Female dimmer 22.5%	Ramp	10%	22.5%	50% ELM
HCR4_4	Female dimmer 22.5%	Ramp	10%	22.5%	30% ELM

TANNER CRAB PROPOSED MODEL RUNS FOR SEPT

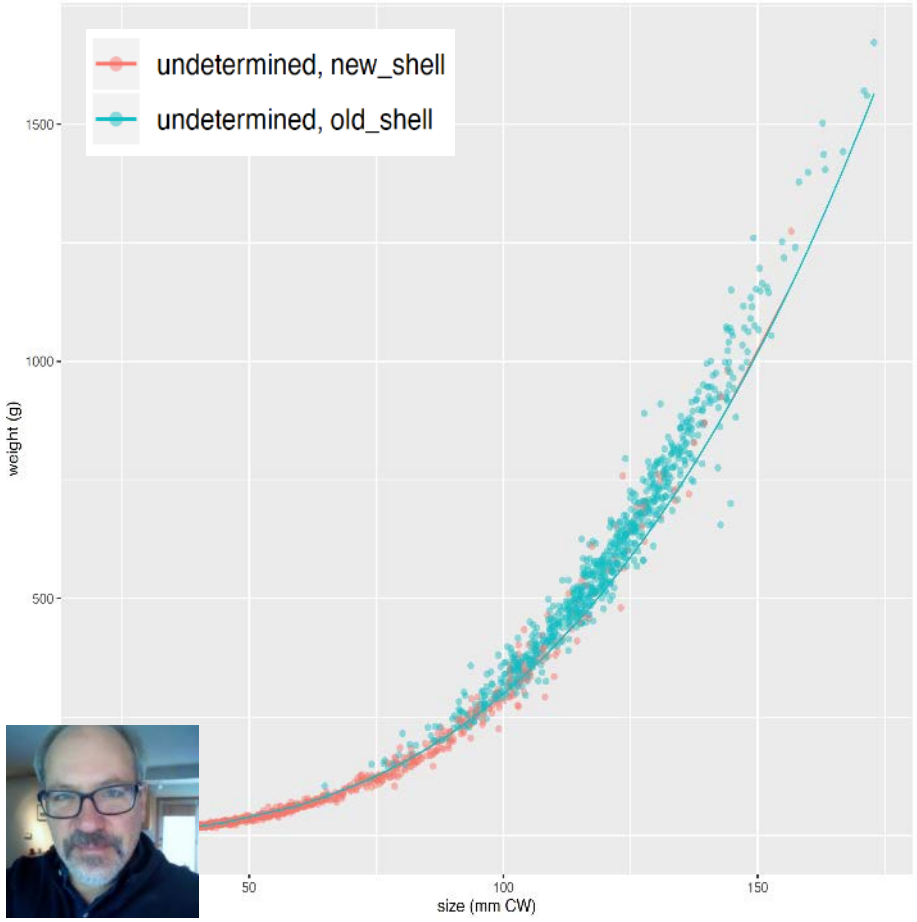
- Buck Stockhausen presented the draft Tanner crab assessment
- Analyses included:
  - Size-weight relationships
  - Empirical availability from side by side (SBS) studies
  - Empirical catchability from SBS studies
  - VAST estimates of survey biomass
- Nine model scenarios were presented

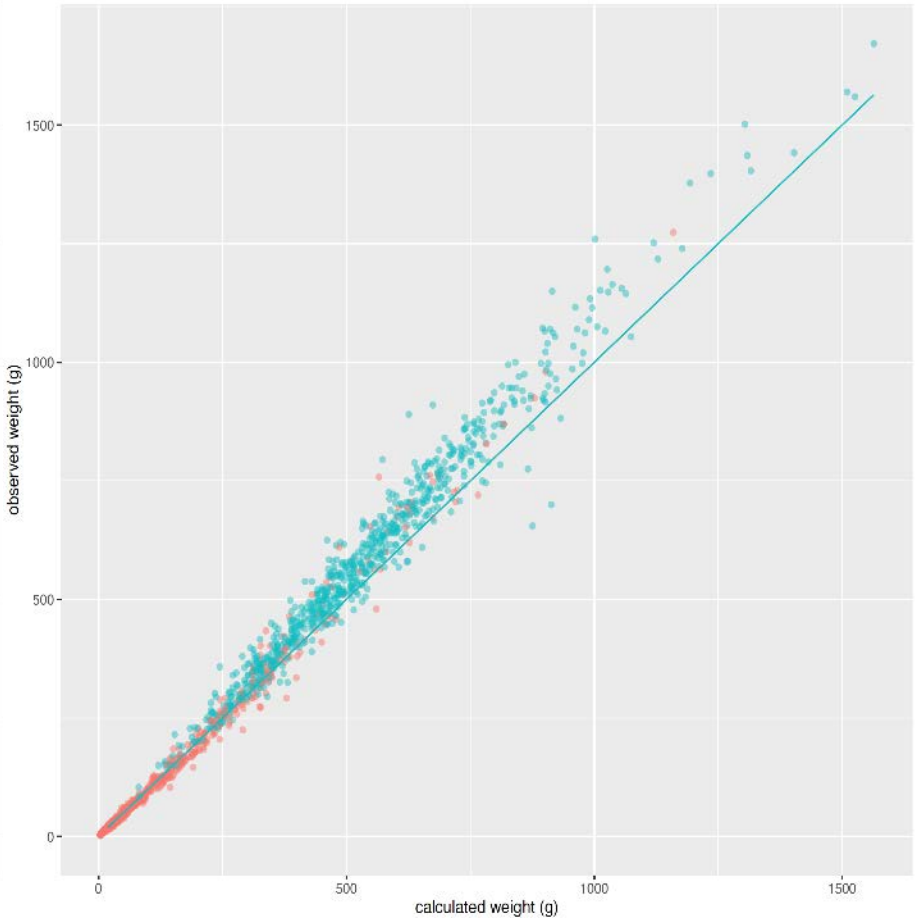
TANNER CRAB PROPOSED MODEL RUNS FOR SEPT

- Nine model scenario were presented:

Scenario	Parameters	Progression	Description
19.03	343	--	Accepted model for the 2019 Tanner crab assessment (identified as M19F03 in Stockhausen, 2019.)
20.01 (RecZCs)	345	19.03 +	Recruitment size distribution estimated
20.02 (TruncSrv)	339	20.01 +	NMFS surveys 1982-2019 only
20.03 (CbSpls)	359	19.03 +	NMFS survey selectvity estimated using cubic splines
20.04 (VAST)	343	19.03 +	VAST estimates for NMFS surrvey abundance and biomass
20.05 (VAST+XU)	347	20.04 +	Additional survey uncertainty estimated
20.06 (SBS)	610	20.01 +	SBS NMFS and BSFRF biomass time series (revised) and size comp.s
20.07 (SBS+FACs)	345	20.01 +	SBS BSFRF biomass time series (revised) and size comp.s, with availability fixed from SBS studies
20.08 (SBS+FCCs)	339	20.01 +	sex/size-specific EBS NMFS survey catchability fixed using selectivity from SBS studies

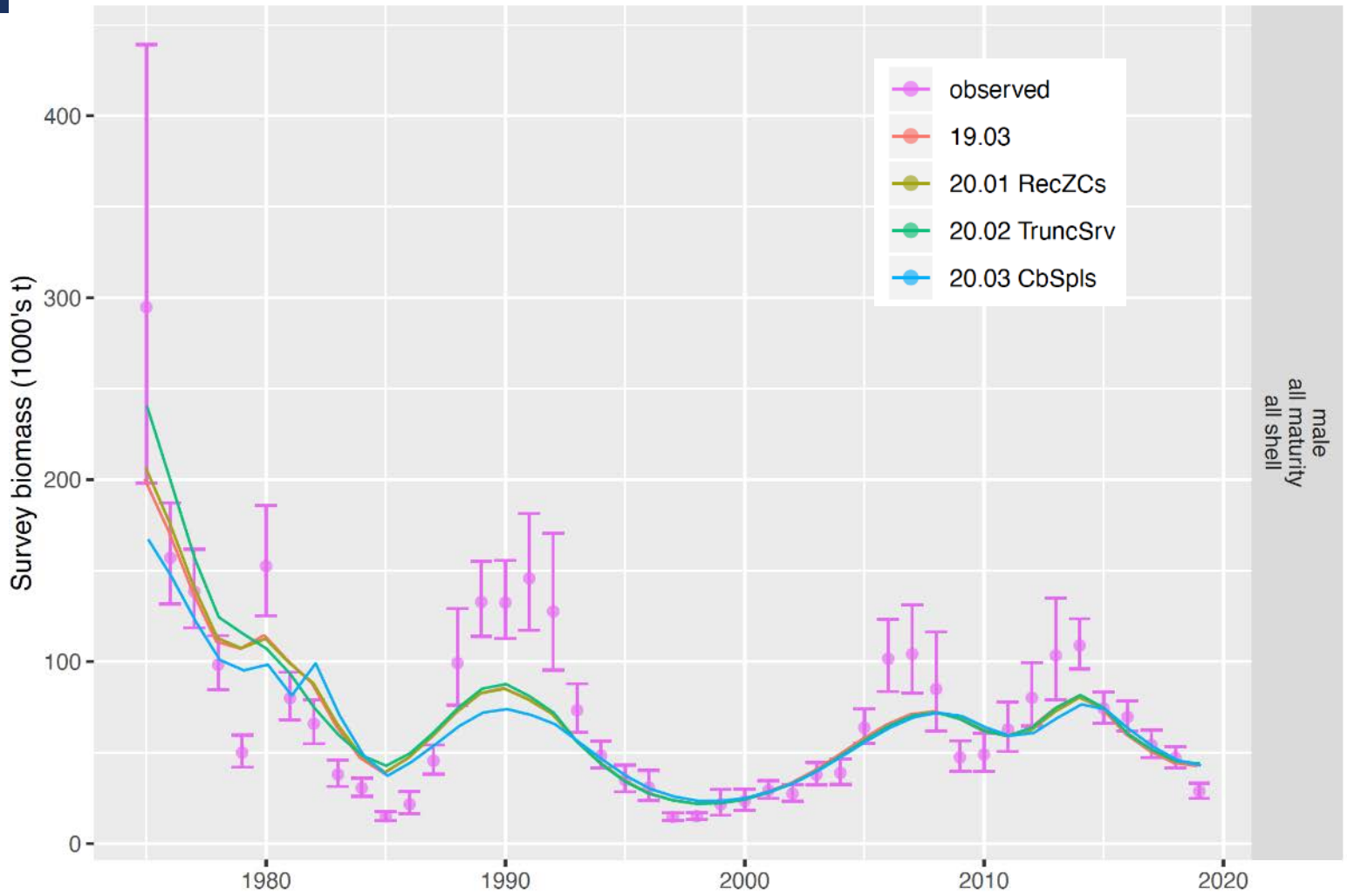
TANNER CRAB PROPOSED MODEL RUNS FOR SEPT



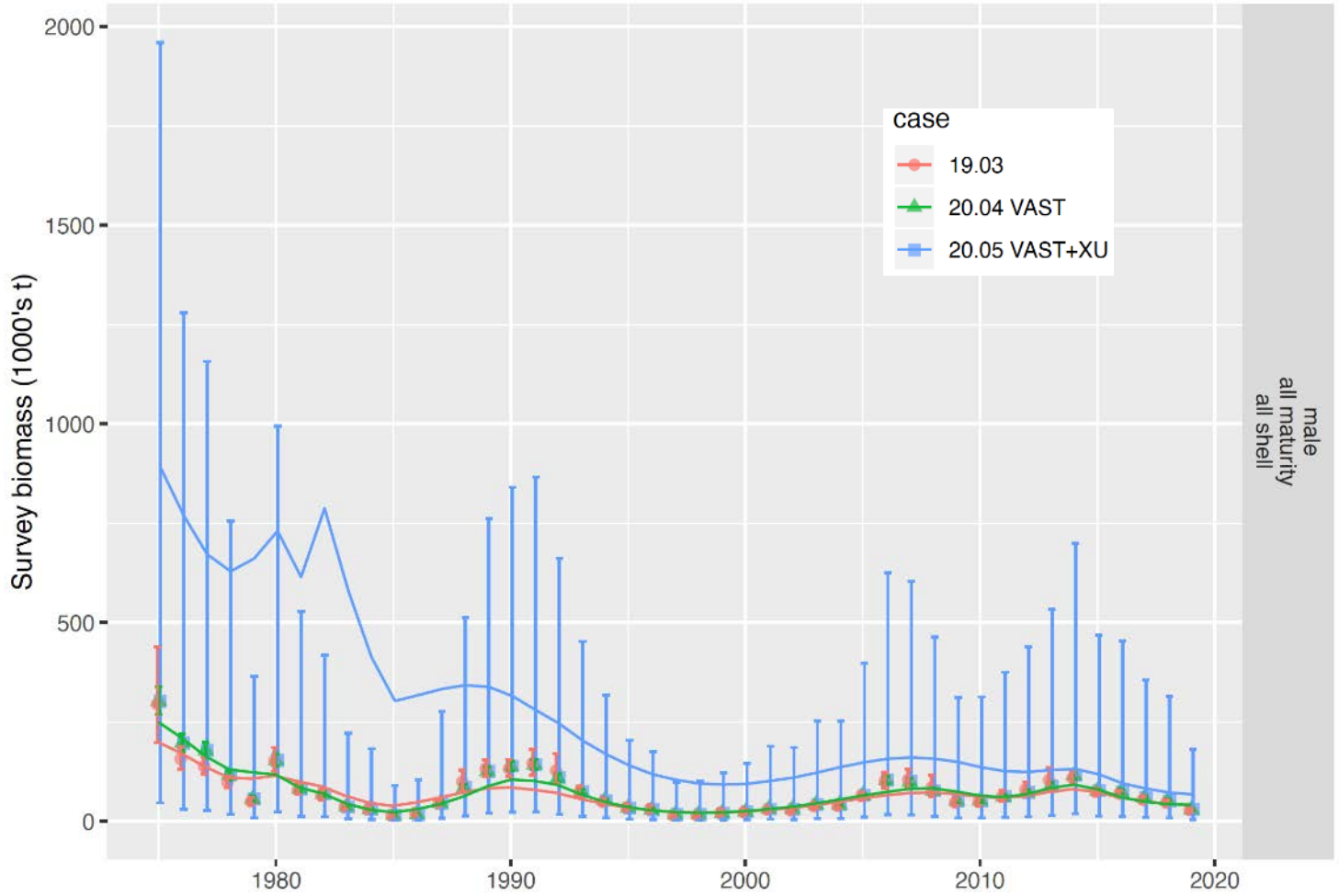


- Male size-weight relationships
- standardized weight vs. CW relationships for males under-predict weights at large sizes
- single regression for males

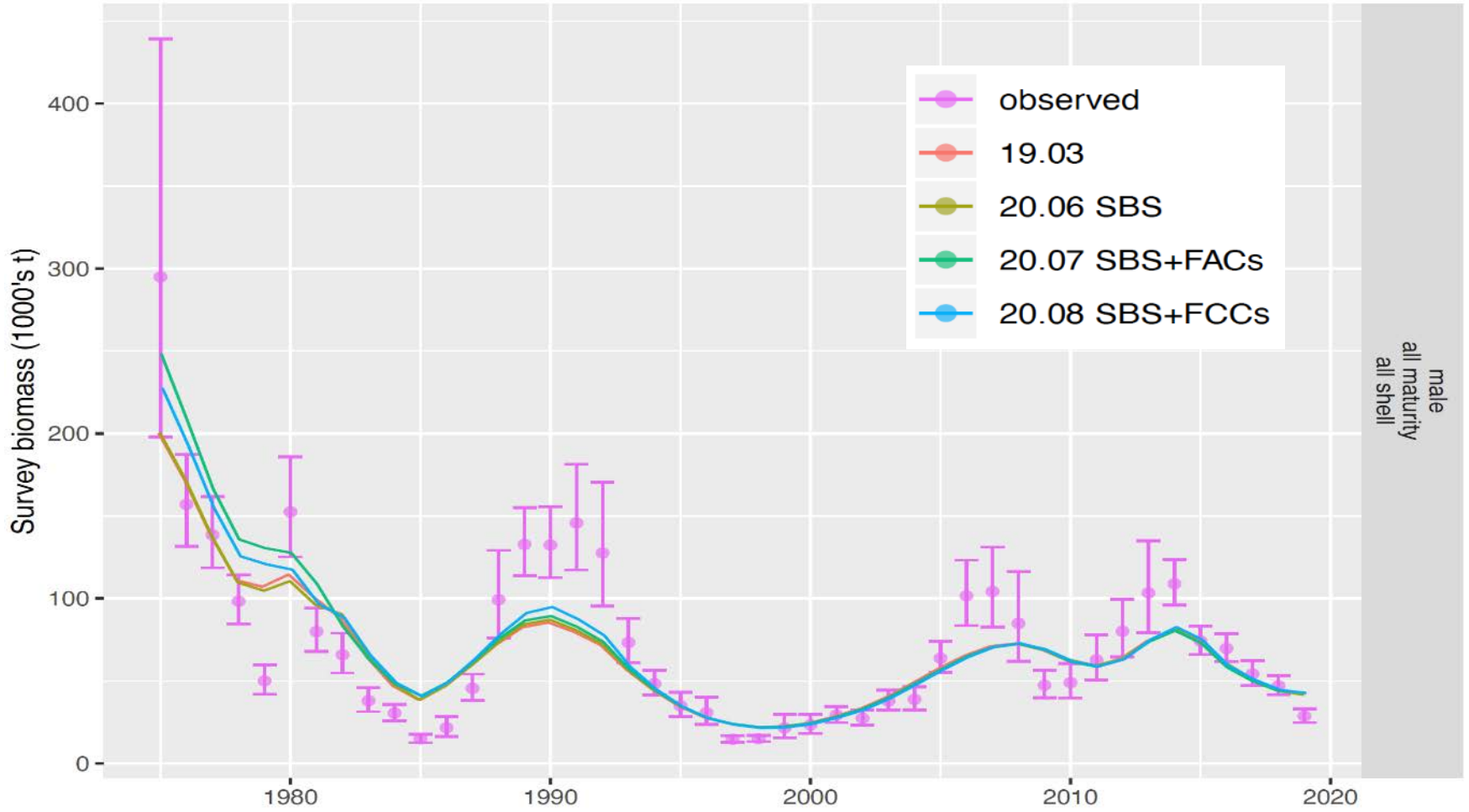
TANNER CRAB PROPOSED MODEL RUNS FOR SEPT



TANNER CRAB PROPOSED MODEL RUNS FOR SEPT



TANNER CRAB PROPOSED MODEL RUNS FOR SEPT



TANNER CRAB PROPOSED MODEL RUNS FOR SEPT

model scenario	N	objective function value	max gradient	current B (1000's t)	Fmsy	Bmsy (1000's t)	MSY (1000's t)	unfished B (1000's t)	average recruitment (millions)
19.03	343	3228.46	1.35E-04	82.6	1.18	41.6	19.5	119.0	393.8
20.01 (RecZCs)	345	3202.35	5.38E-03	84.1	1.24	42.1	19.8	120.4	473.3
20.02 (TruncSrv)	339	3227.47	9.96E-05	71.3	0.90	37.2	16.5	106.4	336.5
20.03 (CbSpls)	359	2975.18	2.59E-04	185.3	2.54	82.2	40.1	234.8	988.2
20.04 (VAST)	343	4069.76	9.62E-04	50.2	1.12	29.2	15.1	83.3	295.7
20.05 (VAST+XU)	347	2783.07	3.68E-04	67.2	1.42	47.2	19.1	134.7	407.4
20.06 (SBS)	610	3469.14	3.08E-04	58.9	1.03	35.1	15.8	100.2	326.4
20.07 (SBS+FACs)	345	3349.33	7.22E-04	68.7	0.96	36.8	16.8	105.0	366.3
20.08 (SBS+FCCs)	339	3229.69	1.22E-04	57.6	0.87	32.0	14.0	91.4	266.2

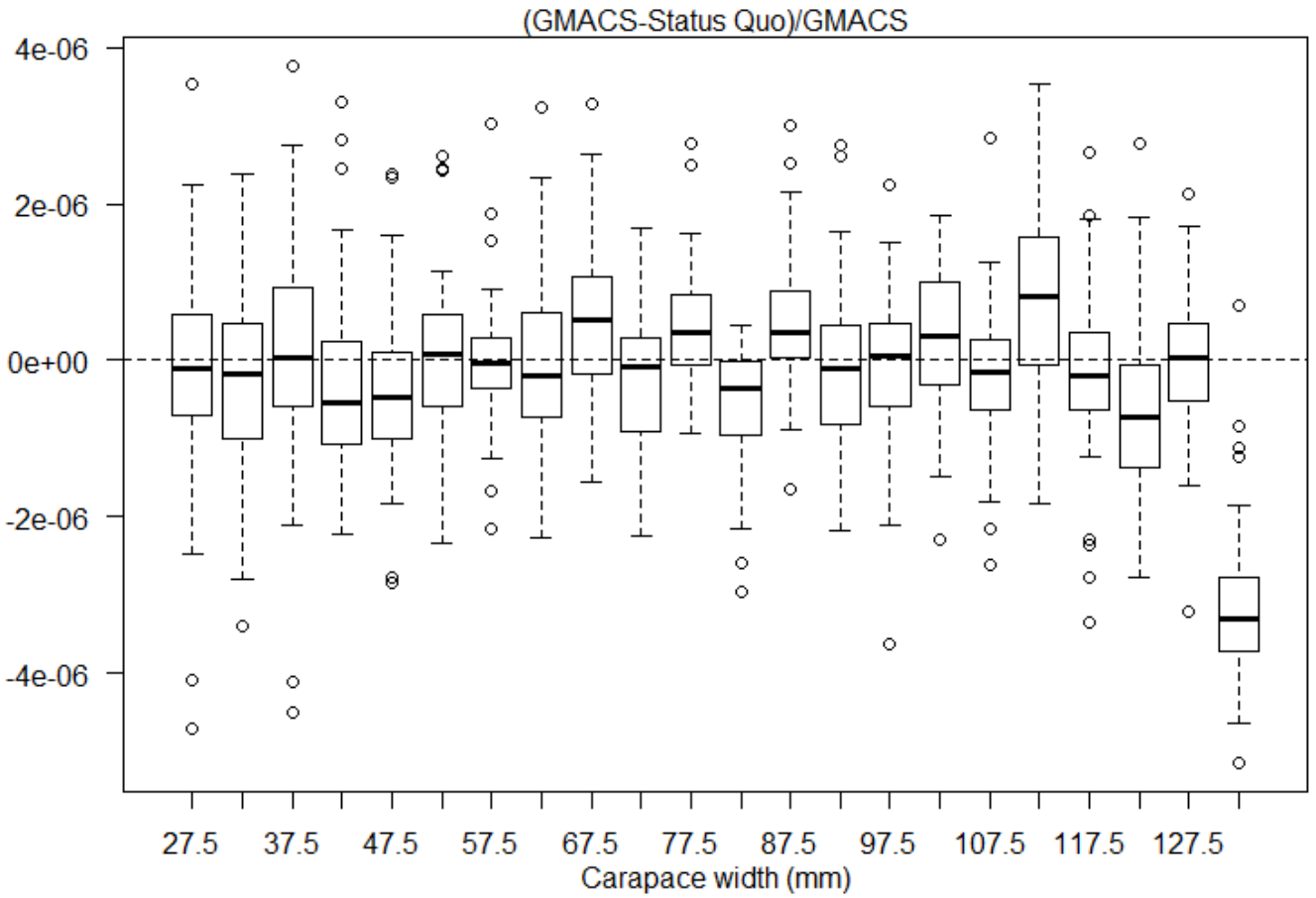
TANNER CRAB PROPOSED MODEL RUNS FOR SEPT

- Model 20.01 (estimating recruitment size distributions) seemed a clear improvement over the base model.
- Models 20.02 (truncated survey) and Model 20.03 (cubic spline) were considered exploratory and are not recommend for this cycle.
- Models 20.04 and 20.05 (VAST and VAST with additional variance) were not successful in that the extra variance parameter went to the limit.
- Model 20.07, in which empirical availabilities were input, was considered the most robust of the different ways to model the SBS data and was recommended by the CPT
- A proposed variant of Model 20.07, denoted Model 20.07b, would input the availability as data vector with uncertainty, was also recommend if it can be implemented for Sept.

SNOW CRAB PROPOSED MODEL RUNS FOR SEPT

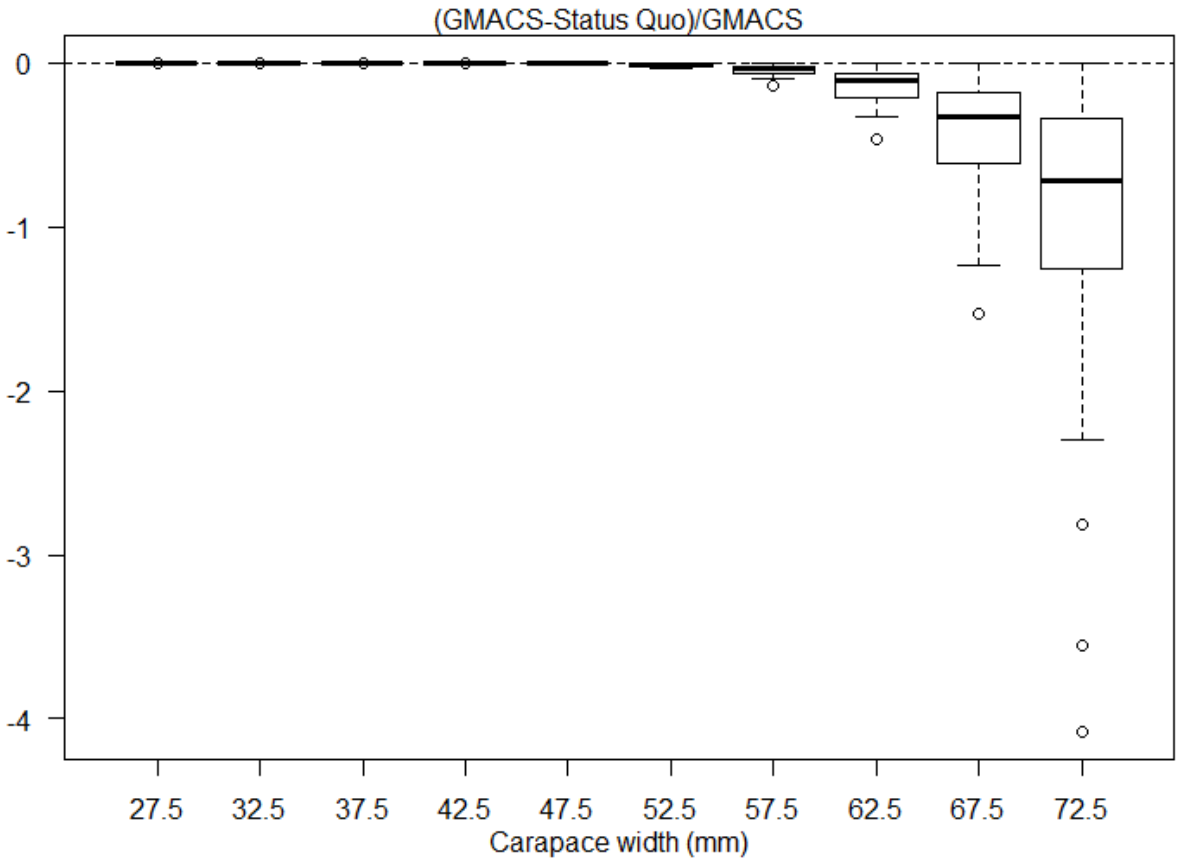
- Major focus on implementing a GMAC model for snow crab with a terminal molt.
- Comparison between GMACs and the status quo model under matching assumptions indicated good alignment for male crab.
- Alignment was not as good for females.
- CPT agreed that comparability had been adequately demonstrated.

SNOW CRAB PROPOSED MODEL RUNS FOR SEPT



- Males reproduced well: Mean absolute relative difference in numbers at size bin over year = 0.00001%
- GMACS can reproduce the male dynamics nearly perfectly rounded to the whole number

SNOW CRAB PROPOSED MODEL RUNS FOR SEPT



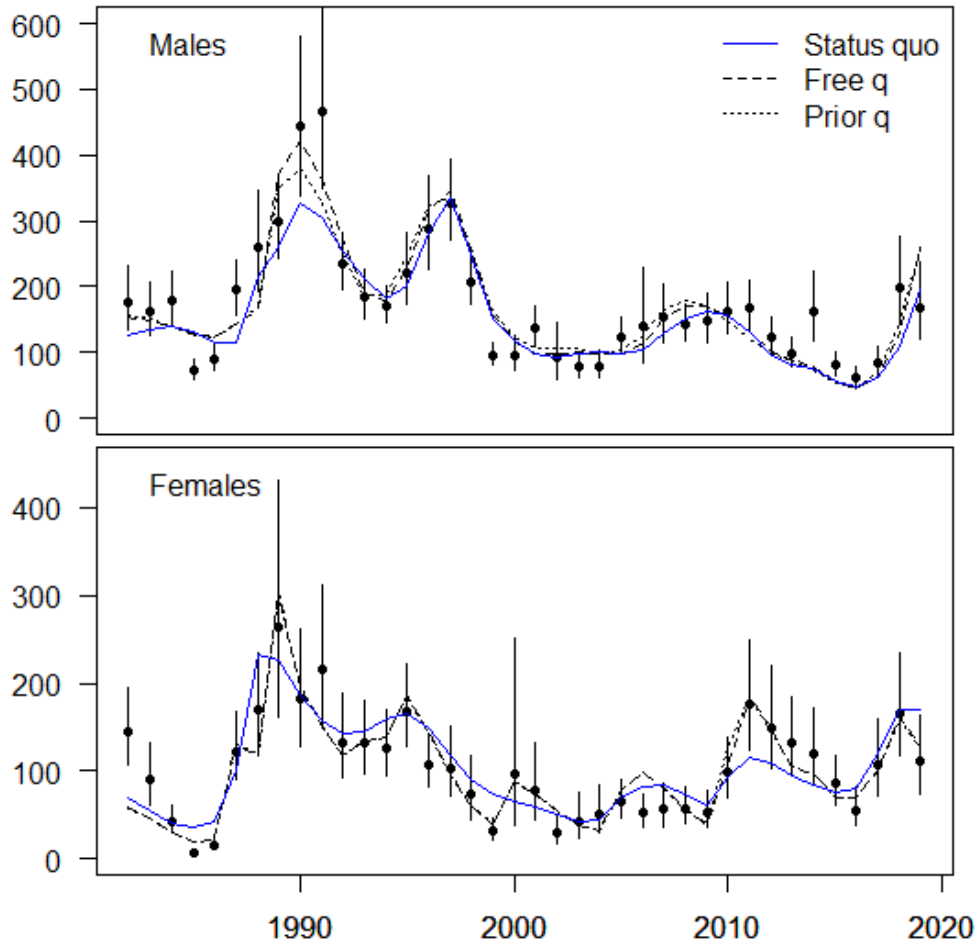
- Numbers at size for females are very well reproduced by GMACS until fishing mortality begins to influence the population (around 62.5mm carapace width)

SNOW CRAB PROPOSED MODEL RUNS FOR SEPT

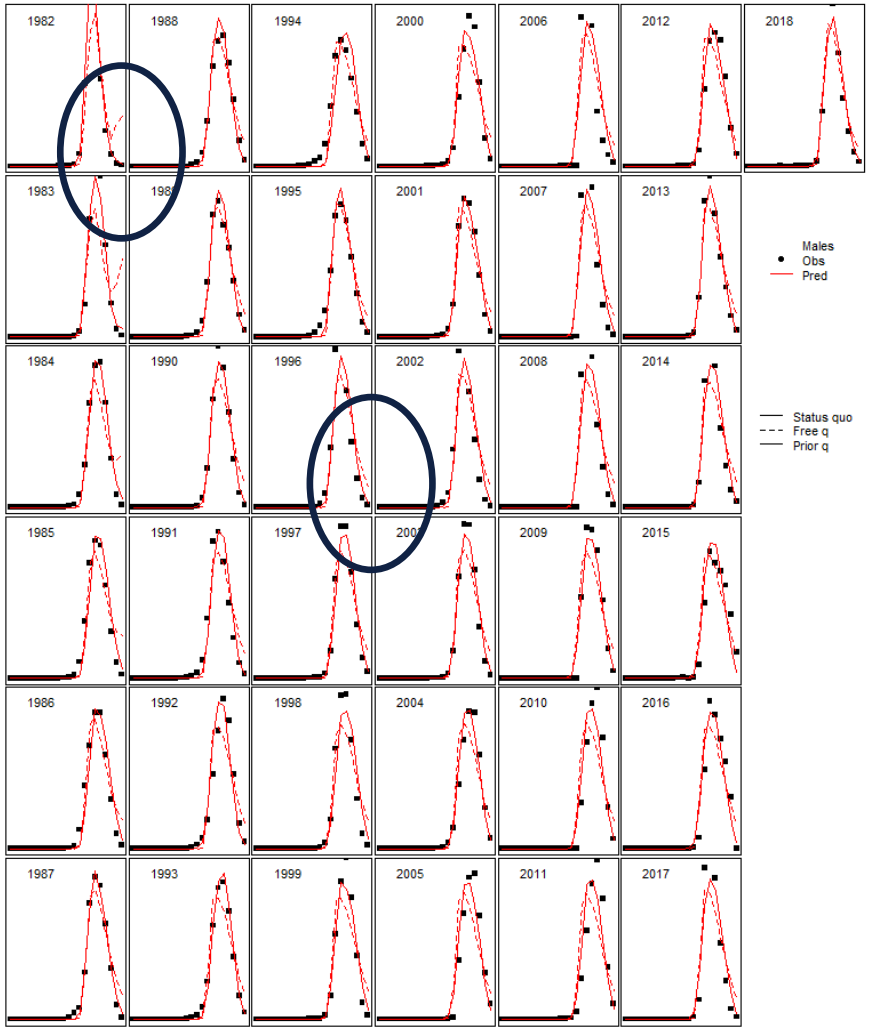
Changes made to GMACS to fit to snow crab data

- **Altering indexing and mirroring of selectivity**
- **Smoothness penalties added for free selectivity and free molting probability**
- **Priors on immature natural mortality** were added when estimated.
- **Calculation of the size composition data** was altered so it is now possible to fit to mature length compositions when a terminal molt is specified.
- **Calculation of indices of abundance/biomass** was altered so that maturity state was represented correctly under a terminal molt.
- **Calculation of spawning biomass** was amended to correctly capture maturity under a terminal molt.

SNOW CRAB PROPOSED MODEL RUNS FOR SEPT



SNOW CRAB PROPOSED MODEL RUNS FOR SEPT



- "Pigtails:"Model over-predicts large crab, particularly at the start of the time series

SNOW CRAB PROPOSED MODEL RUNS FOR SEPT

- CPT recommendations include the following:
- Identify the cause of the "pigtails" in the retained catch size compositions.
- Pending further diagnostic analysis and CPT consensus on the use of VAST for crab stocks, do not bring forward models that fit the VAST estimates of survey biomass.
- Implement reference point calculations in GMACS for status determination and OFL calculation.
- Bring forward the following alternative model scenarios for the September CPT Meeting:
  - Status quo model with updated data.
  - "Free q" GMACS model with updated data.
  - "Prior q" GMACS model with updated data.

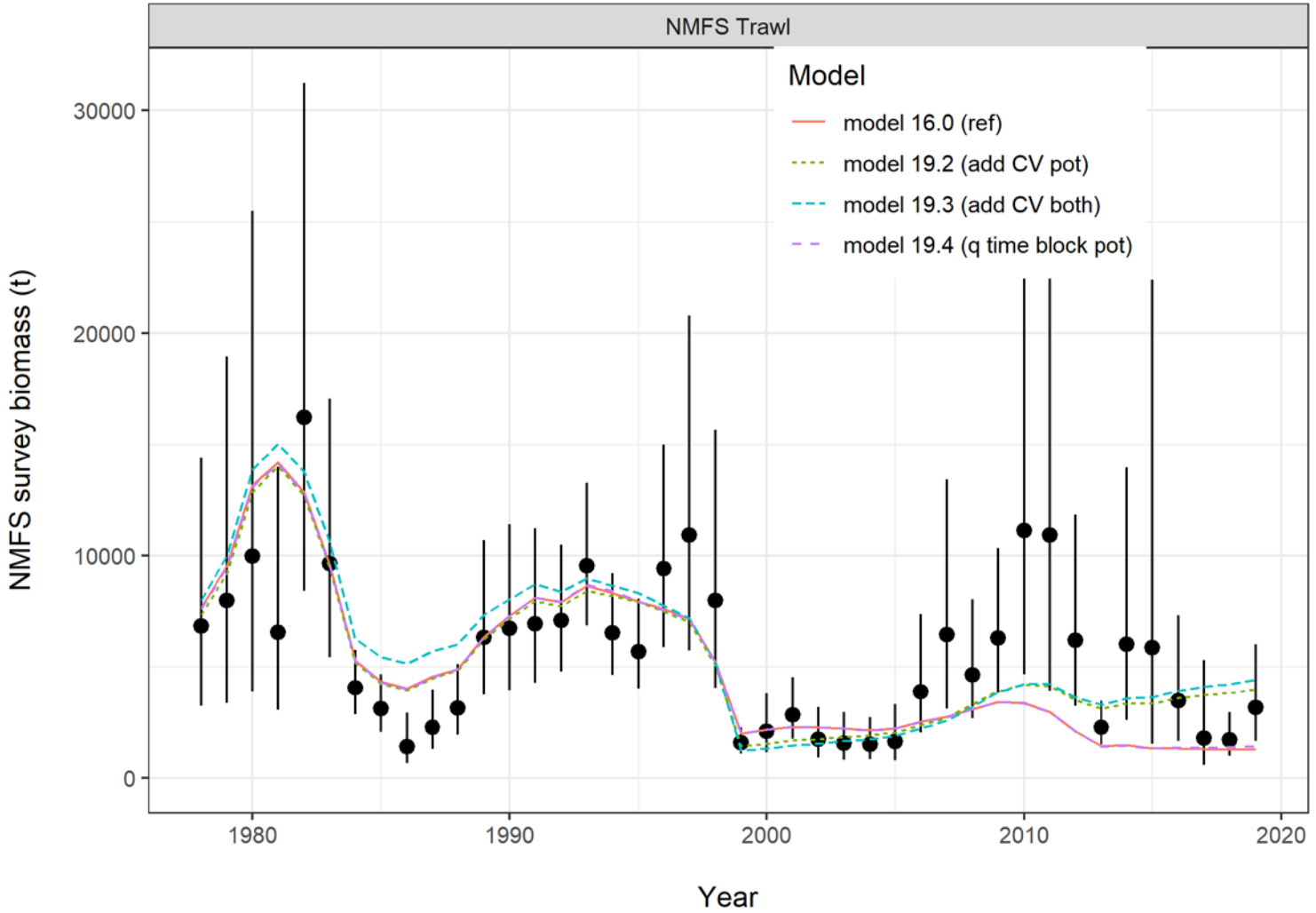
ST MATTHEW IS. BLUE KING CRAB PROPOSED MODEL RUNS FOR SEPT

- Three-stage, length-based, male-only model has been used to assess SMBKC since 2012.
- Modeling in GMACS since 2016.
- Model estimates abundance for 1978 to 2019
- Fits to commercial catch, groundfish trawl and fixed-gear bycatch, observer composition, trawl surveys, and pot surveys.
- Pot survey data were recently updated.
- Major modeling issues include:
  - Trend discrepancies between pot and trawl surveys,
  - Spatial hot spots in surveys (e.g., station R24), and
  - Poor model fits to surveys after 2009

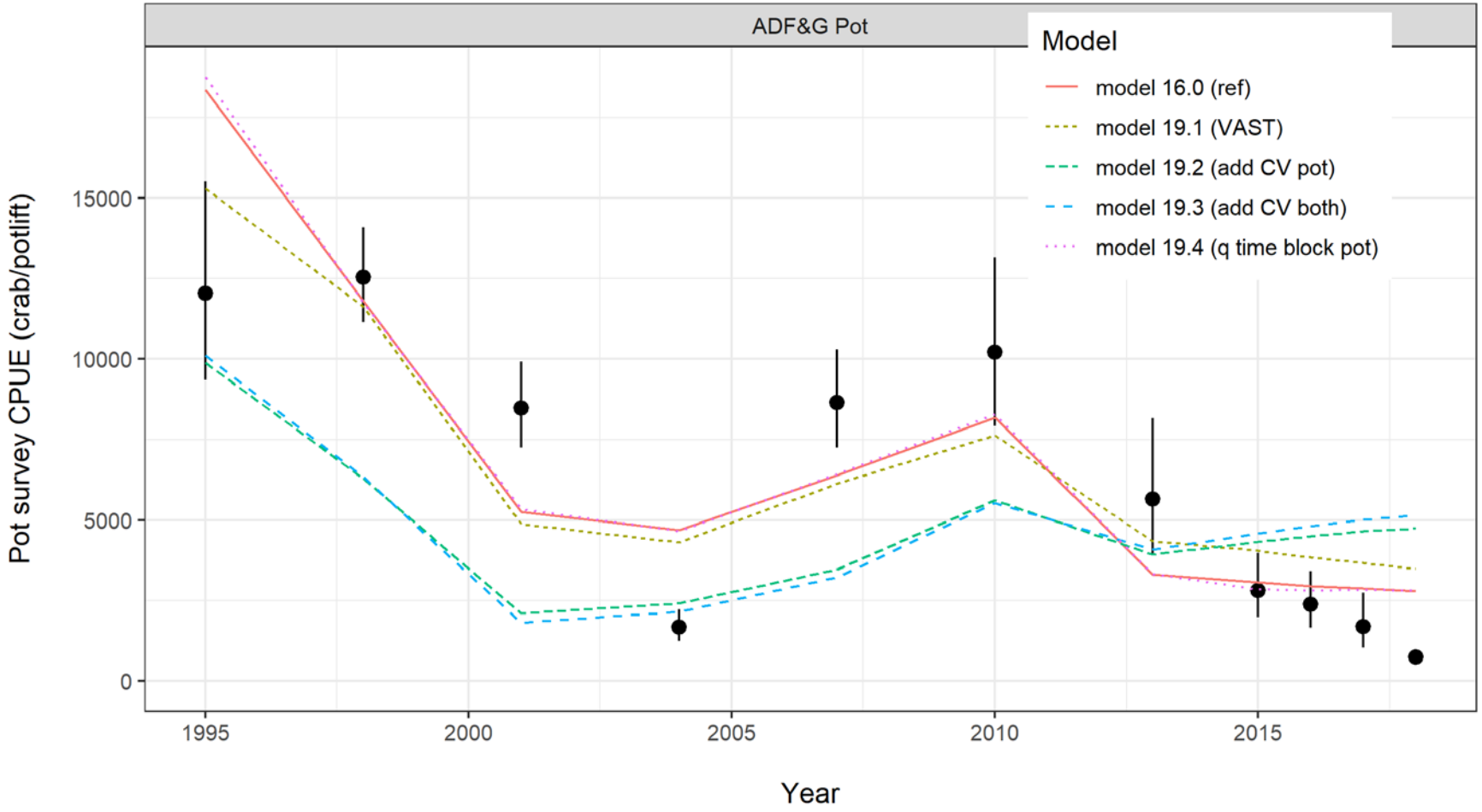
ST MATTHEW IS. BLUE KING CRAB PROPOSED MODEL RUNS FOR SEPT

- Five models were considered:
- Model 16.0 (2019 reference model): updated with Jan 2020 revisions to GMACS.
- Model 19.1 (VAST NMFS trawl data): model 16.0 with VAST data output for the NMFS trawl survey time series.
- Model 19.2 (add CV pot): Model 16.0 + an estimated additional CV on the ADF&G pot survey.
- Model 19.3 (add CV both): Model 16.0 + an estimated additional CV on the ADF&G pot survey and the NOAA trawl survey.
- Model 19.4 (time block pot): catchability for ADF&G pot survey estimated in two time blocks: 1995–2013 and 2015–2018.

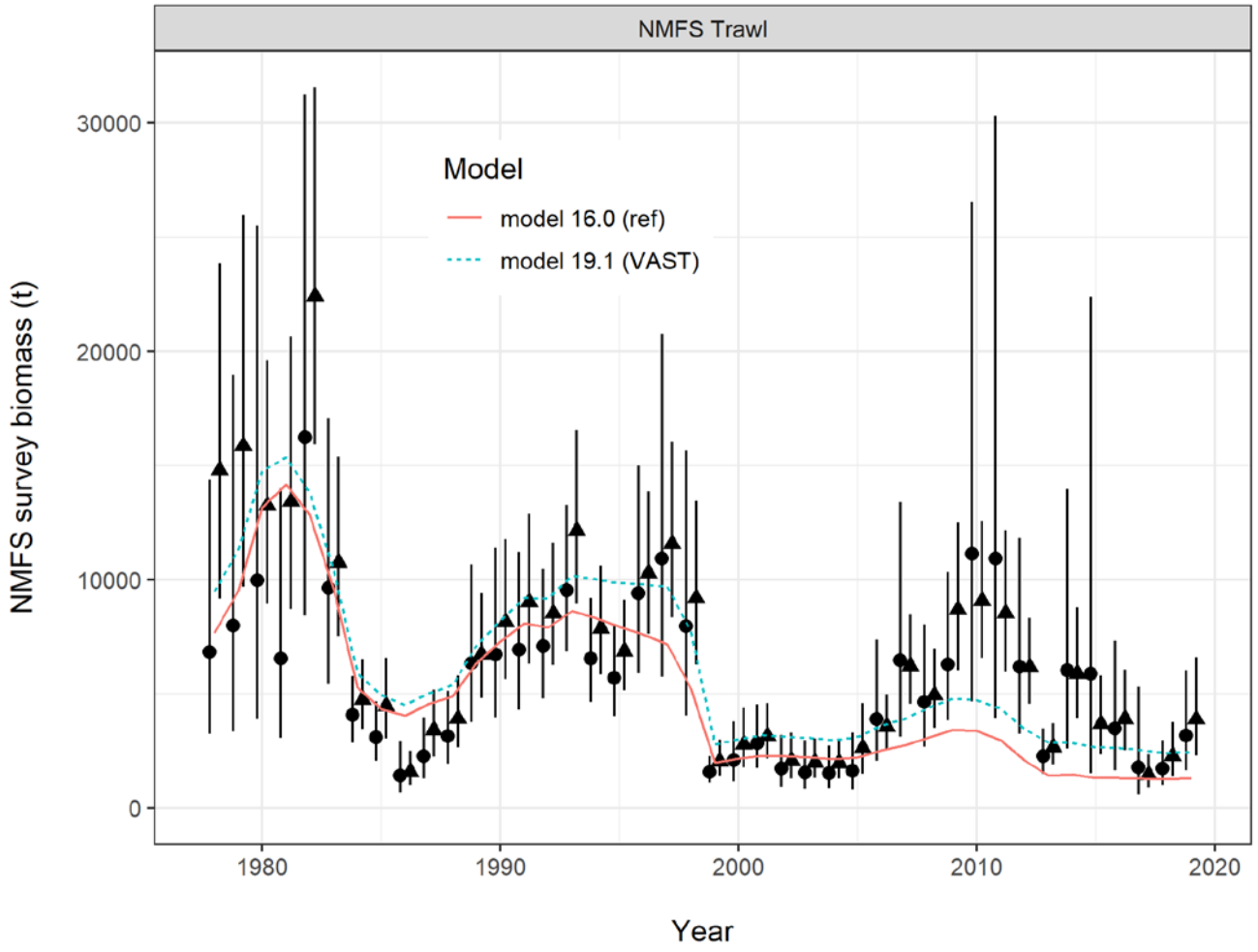
ST MATTHEW IS. BLUE KING CRAB PROPOSED MODEL RUNS FOR SEPT



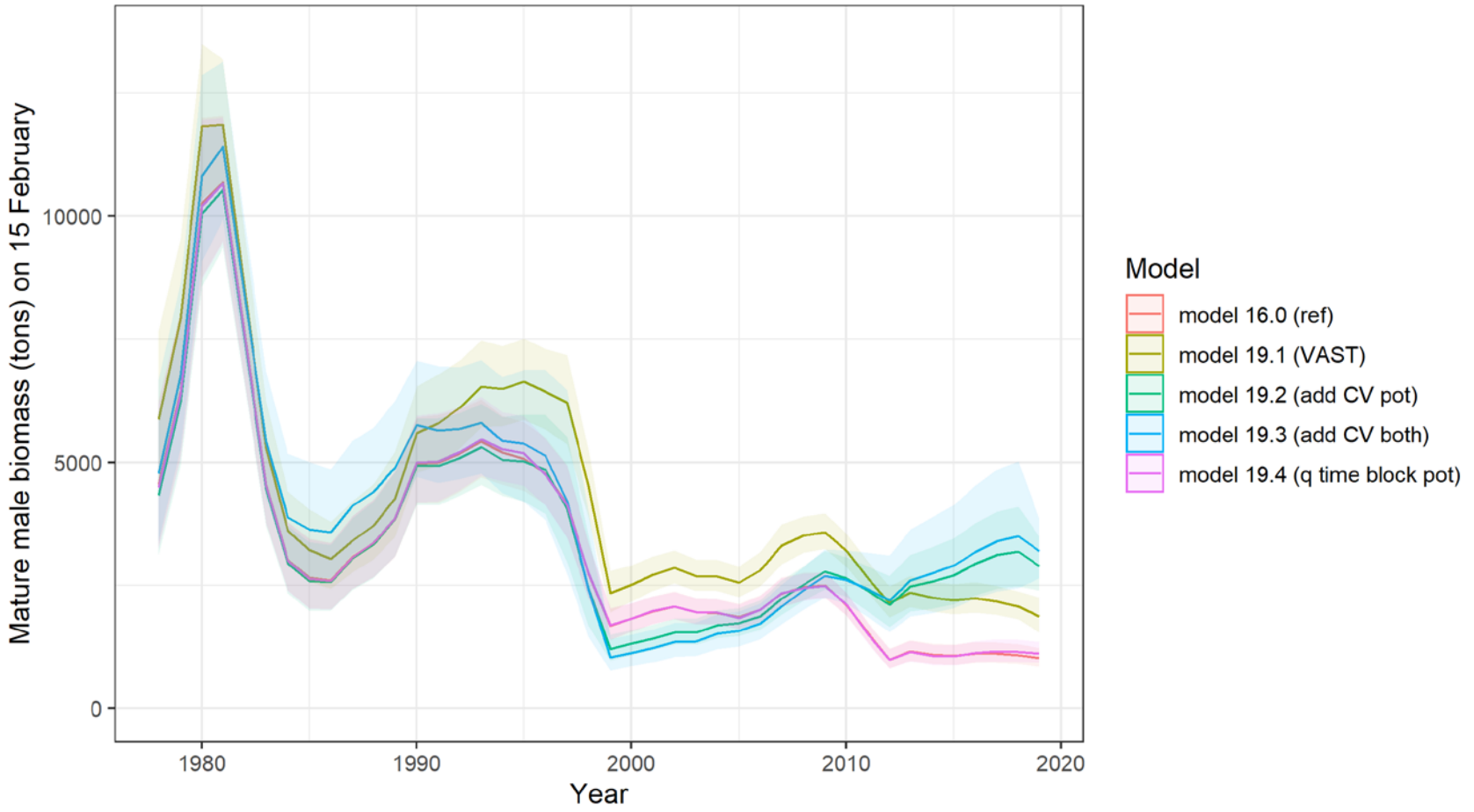
ST MATTHEW IS. BLUE KING CRAB PROPOSED MODEL RUNS FOR SEPT



ST MATTHEW IS. BLUE KING CRAB PROPOSED MODEL RUNS FOR SEPT



ST MATTHEW IS. BLUE KING CRAB PROPOSED MODEL RUNS FOR SEPT



ST MATTHEW IS. BLUE KING CRAB PROPOSED MODEL RUNS FOR SEPT

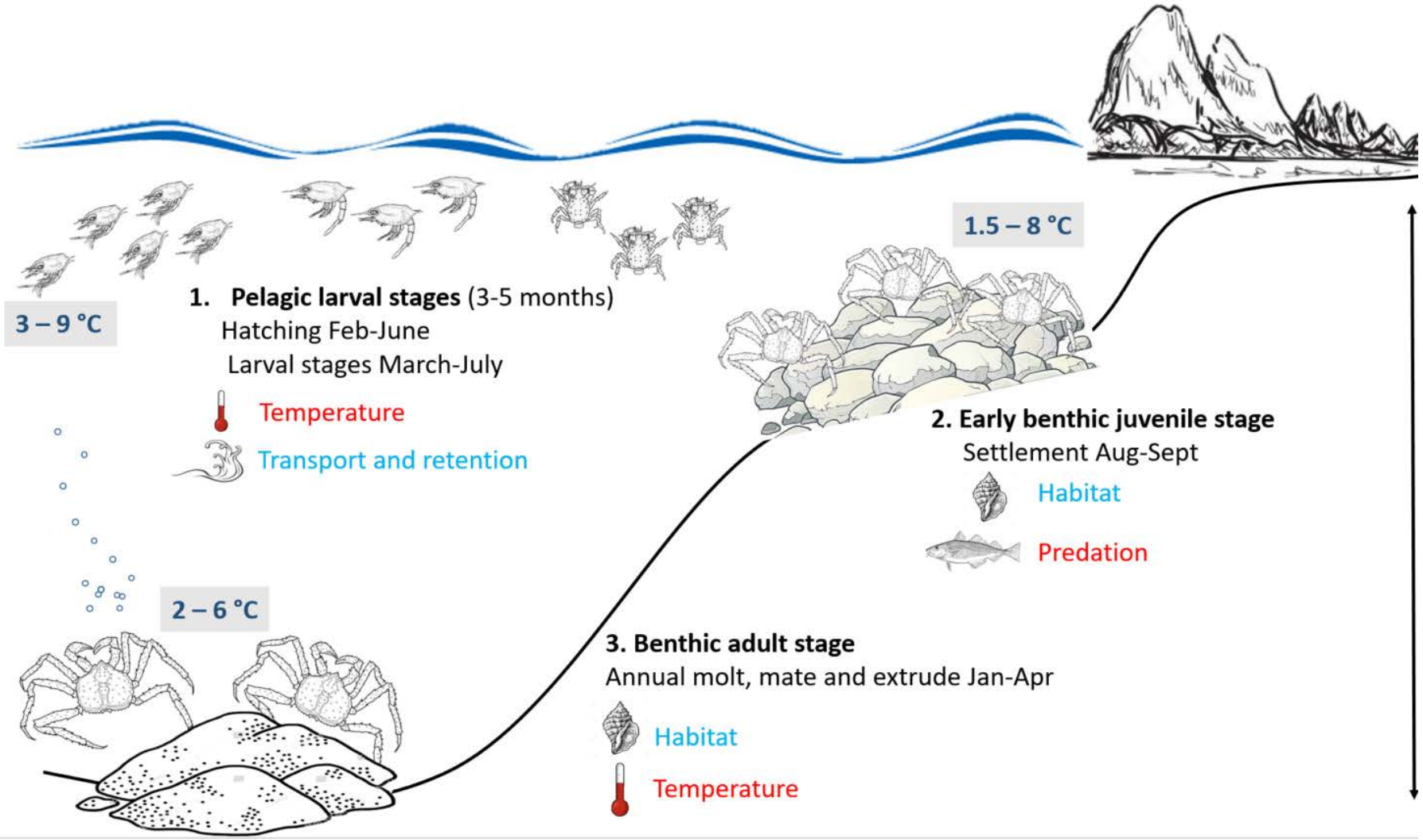
- CPT Recommendations:
- Provide results for the following four models for September 2020:
  - Model 16.0.
  - Model 19.1 (VAST).
  - A model with a random walk in pot survey catchability.
  - Model 16.0 without ADF&G pot survey data.

- Other recommendations
  - Conduct a retrospective analysis for the base model.
  - Initiate a spatial analysis of NMFS trawl and ADF&G pot survey

ECOSYSTEM AND SOCIOECONOMIC PROFILES (ESP) (ERIN FEDOWA & BRIAN GARBER-YONTS)

- Discussion of indicators/metrics for crab stocks
  - Metrics should identify vulnerability or resilience of stocks
  - Metrics should be measurable and responsive
  - Indicators spatially relevant as possible
- Work towards improving and adding to indicators and metrics in the future
  - Request to CPT and other members of crab research community or industry to participate in this process

BBRKC ECOSYSTEM PROCESSES



BBRKC ECOSYSTEM INDICATOR SUITE

Title	Description
Cold Pool Extent	Total number of EBS trawl survey stations in each year with a bottom temperature measurement < 2° C, multiplied by the area of a standard survey grid cell (401 nm²).
Summer Bottom Temperature	Average bottom temperature (° C) over all hauls within the BBRKC management boundary of the EBS trawl survey
Pacific Decadal Oscillation	Average of November – March PDO values
EBS Wind Stress	June ocean surface wind stress for the EBS region. Product of NOAA blended winds and MetOp ASCAP sensors from multiple satellites
EBS Chlorophyll-a	May chlorophyll-*a* blended product for the EBS region from MODIS Aqua, VIIRS, MERIS and SeaWiFS sensors
EBS juvenile salmon abundance	September juvenile Pacific salmon abundance (in metric tonnes) from the Bering Arctic Subarctic Integrated Surveys (BASIS). Includes Chinook, Chum, Pink and Sockeye salmon
Pacific cod biomass	Combined biomass (1,000t) of Pacific cod within the BBRKC management boundary on the EBS bottom trawl survey
Benthic invertebrate biomass	Combined biomass (1,000t) of benthic inverts within the BBRKC management boundary on the EBS trawl survey
BBRKC pre-recruit biomass	Biomass of male red king crab (110-134 mm CL) from the EBS bottom trawl survey that will likely enter the fishery the following year.
BBRKC male length weight residual	Residuals calculated from a predicted linear regression model fit of male BBRKC weight-at-carapace length as a proxy for condition
BBRKC Catch Area	Area of 1 standard deviational ellipses calculated using observer data from the autumn fishery (starting Oct. 15th) as a measure of population dispersion for mature male Bristol Bay red king crab
BBRKC Catch Distance from Shore	Mean distance (km) legal male Bristol Bay red king crab were caught from shore in the autumn fishery (starting Oct. 15th) using observer data.
BBRKC mature male area occupied	The minimum area containing 95% of the cumulative CPUE for BBRKC mature males
BBRKC mature female area occupied	The minimum area containing 95% of the cumulative CPUE for BBRKC mature females

BBRKC SOCIOECONOMIC INDICATORS (CANDIDATE SET)

Socioeconomic Indicator	Description
TAC Utilization	Percentage of the annual BBRKC TAC (GHL prior to 2005) that was harvested by active vessels, including deadloss discarded at landing
Local Quotient of BBR landed catch in Dutch Harbor/Unalaska	Ex-vessel value share of BBRKC landings to communities on St. Paul Island, as percentage of total value of commercial landings to St. Paul processors from all commercial Alaska fisheries, aggregate percentage over all landings during the respective year
Processors active in fishery	Total number of crab processors that purchased landings of BBRKC from delivering vessels during the calendar year
BBR ex-vessel revenue share	Ex-vessel revenue from BBRKC sales as percentage share of total calendar year ex-vessel revenue from all commercial landings in Alaska fisheries, mean value over all vessels active in BBRKC during the respective year
Ex-vessel price per pound	Commercial value per unit (pound) of BBRKC landings[1], measured as weighted average value over all ex-vessel sales reported
Total Potlifts	Fishing effort, as measured by estimated number of crab pots lifted by vessels during the BBR fishery
CPUE	Fishing effort efficiency, as measured by estimated mean number of retained crabs per potlift
Vessels active in fishery	Annual count of crab vessels that delivered commercial landings of BBRKC to processors[2]
BBR Male Bycatch in Groundfish Fishery	Incidental bycatch biomass estimates of male BBRKC (tons) in trawl and fixed gear fisheries

[1] As adjusted by CFEC to account for post-season adjustments to ex-vessel settlements; alternately, could use advance (pre-season) price, which is more current and may be more relevant in ESP context.
[2] Includes crab catcher/processors that harvested and processed SMBKC catch on-board.

ESP RECOMMENDATIONS

- CPT strongly supports ESP efforts completed and underway
- Update SMBKC ESP for fall
- Continue to put together stock "report cards" on ecosystem status for other stocks
- ESP for BBRKC included as an appendix in fall 2020

OTHER AGENDA ITEMS

- GMACS update
- Crab PSC
- Climate change and LT/TK for NSRKC
- New business

GMACS

- Ongoing work with GMACS since the Jan modeling workshop:
  - Additional selectivity options
  - Jittering
  - Implementing terminal molt
  - Restructuring the likelihood section, adding maturity partitions to the likelihoods
  - Changing how growth is treated
  - Implementing additional recruit sex ratio options
  - Improving the "gmr" package.

GMACS: UP NEXT

- Snow crab GMACS model for consideration in Sept
- NSRKC GMACs model to be reviewed in Sept for use in Jan
- AIGKC to be reviewed in Jan for use in May
- Merging the terminal molt model into the GMACS main branch
- Workshop in Jan

CRAB PSC

- Proposal to reduce PSC limits when crab fisheries are closed
- CPT provided input on bycatch impacts on assessments and ideas on unobserved bycatch mortality
- Recommendations:
  - Size comp and spatial patterns of bycatch evaluated, also look at non-trawl bycatch time series
  - Document rational behind current PSC approach and limits
  - Runs for BBRKC, Tanner, and snow with higher bycatch levels (increases of 50% and 100%) for sensitivity.

CLIMATE CHANGE AND LT/TK FOR NSRKC

- SSC has suggested that the Climate Change Taskforce (CCTF) and the LKTK TF use Norton Sound red king crab fishery as a case study
- SSC minutes Feb 2020: "This case combines the need for long-term, strategic recommendations on how to adapt to climate change with a need to involve a variety of local stakeholders."
- The CPT met with the co-chairs of the Local Knowledge, Traditional Knowledge, and Subsistence Taskforce (LK/TK TF) and Climate Change Taskforce

CLIMATE CHANGE AND LT/TK FOR NSRKC

- LKTK TF liked the idea of using Norton Sound red king crab fishery as a case study.
- Recommended to put on hold any further consideration of case studies until at least 2021 due to COVID-19 travel restrictions.
- Emphasized the need to develop a community-driven plan.
- The next LK/TK TF meeting is scheduled for Fall 2020.
- CC TK included NSRKC on the list of potential test cases but did not make a decision.

CLIMATE CHANGE AND LT/TK FOR NSRKC

- The CPT recommends:
- Formation of a local (Norton Sound) committee
  - Composed of local stakeholders, community members, and ADF&G representatives.
  - Would report back to the CPT.
  - Would informally request information to start the conversation and build relationships
- Request knowledge and data from local stakeholders, specifically NSCDC, to be presented at the September CPT to help inform the stock assessment modeling framework and again at the January meeting when OFL and ABC recommendations are developed.

NEW BUSINESS: SEPTEMBER 2020 CPT MEETING

- The meeting will be held in Seattle from September 14-18.
- Proposed agenda items include:
- Final 2020 SAFE chapters for BBRKC, SMBKC, Tanner and snow crab
- Update bycatch estimates for WAIRKC and PIGKC to determine final overfishing status
- Proposed model runs for January CPT meeting for NSRKC including GMACS
- LK/TK draft input for NSRKC
- Research reports on snow crab:
  - Spatial model
  - Individual-based model with incorporation of ROMS inputs
- Tanner crab MSE
- Final report for NPRB project on Pribilof Island blue king crab

NEW BUSINESS: JANUARY 2021 CPT MEETING

- The meeting will be held in Anchorage during the week of January 11-15.
- Final 2021 NSRKC assessment, which will include consideration of LK/TK input.
- Proposed model runs for AIGKC will be reviewed, including GMACS application.
- Review stock assessment terms of reference.
- Modeling workshop will be held after CPT meeting.
- Likely topics include GMACS and VAST diagnostics, but others may be added.

SURVEY CANCELATION & CRAB MODEL OPTIONS FOR FALL 2020

- 2020 model with same configuration as 2019 model with data inputs available (updated catch, size comps) **
- 2020 model with same configuration as 2019 model with either just catch or just size comps (evaluates sensitivity to new data)
- Include bogus 2020 survey data estimate with huge CV to get an expected value for 2020 survey, then put that back into the model assuming typical CV (this is a sensitivity run to evaluate the loss of survey data)
- CPT preferred model from May meeting, i.e., use GMACs for snow crab, new natural mortality patterns for BBRKC, etc.

- What does the SSC want like to see in Oct to support ABC/OFL recommendations?
- What diagnostics are needed for these type of runs?

** preferred by CPT

QUESTIONS?

Thanks to all CPT members and participants for a successful CPT meetings.

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