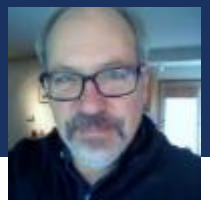
C1 BSAI CRAB STOCKS

KATIE PALOF & MARTIN DORN,

SEPTEMBER 28-29TH, 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

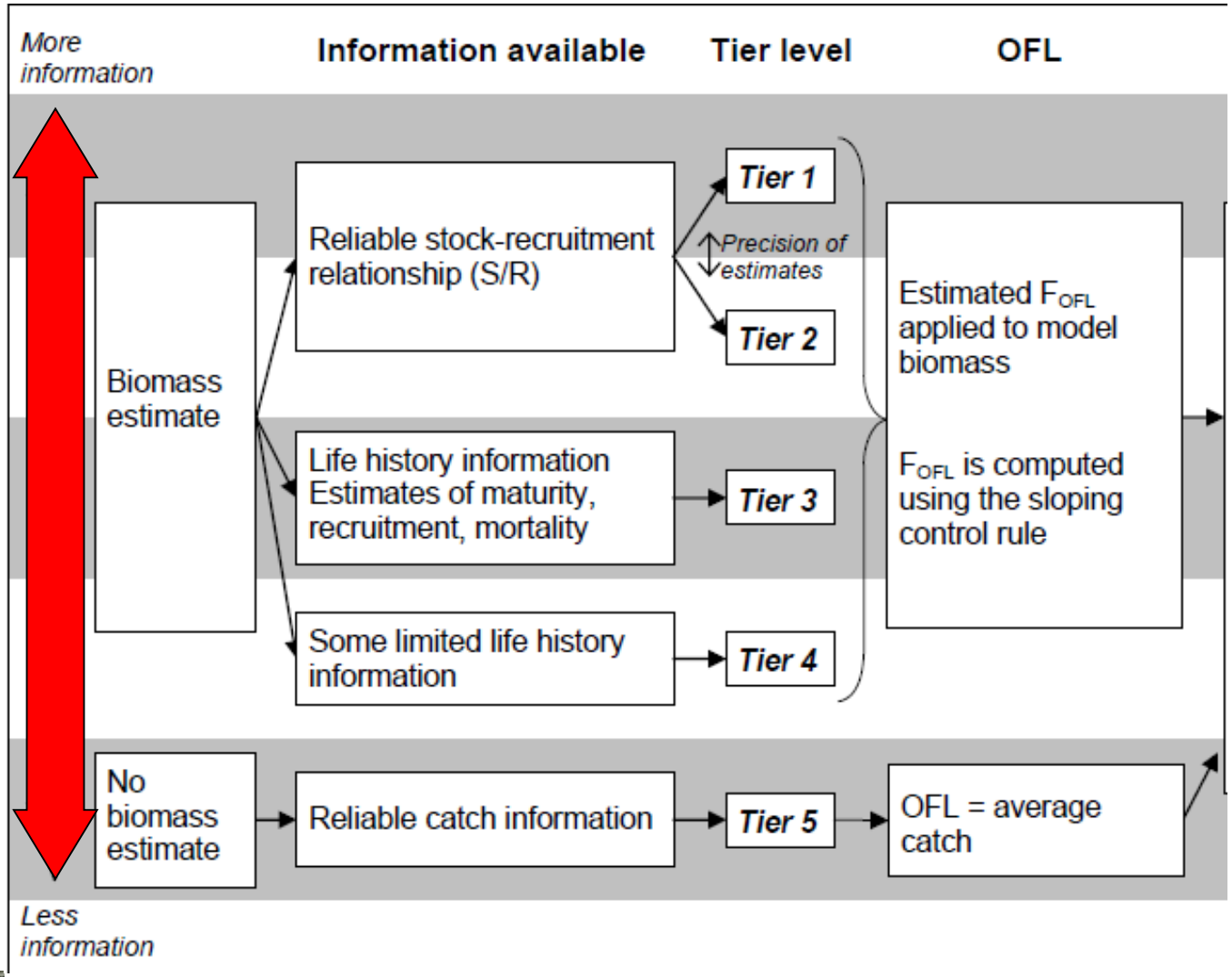
EBS snow crab
Bristol Bay red king crab
EBS Tanner crab
Pribilof Islands red king crab *
St. Matthew blue king crab

→ 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%

SEPT 2020 AGENDA

- Uncertainty due to 2020 survey cancellation
- **BBRKC final assessment, OFL and ABC,** fishery overview, ESP
- **Snow crab final assessment, OFL and ABC,** fishery overview
- **SMBKC final assessment, OFL and ABC,** ESP update
- **Tanner crab final assessment, OFL and ABC,** fishery overview
- WAIRKC, AIGKC, PIBKC, PIRKC, PIGKC overfishing updates
- Stock projections subgroup
- NSRKC model runs for Jan/Stock boundaries
- Trawl survey updates
- ESR
- Crab PSC
- PIBKC NPRB final project report

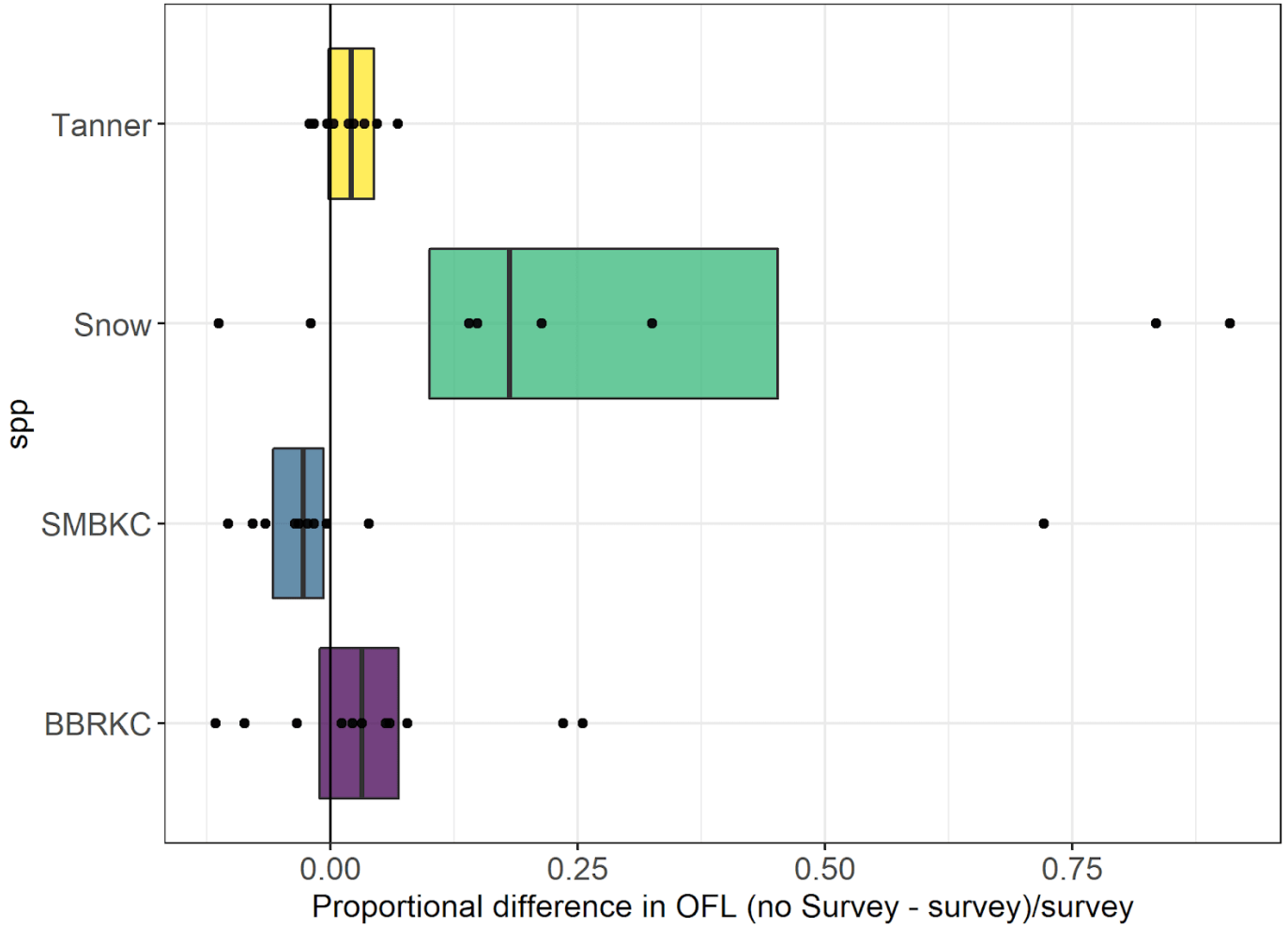
CPT APPROACH TO EVALUATING IMPACTS OF THE CANCELLATION OF THE 2020 SURVEY

- CPT and SSC co-chairs met over the summer and agreed on two analyses that would done for each affected assessment.
- Approach 1: Retrospective analysis with two sets of runs. The first set is the standard retrospective analysis. The second set of retrospective runs is like the first except that the survey data in the final year are also removed.
- Approach 3: Obtain the predicted survey value for the 2020 survey by putting in a trial survey value for 2020 with a very high CV. Multiply the predicted survey value by the 25th and 75th percentiles of the multiplicative residual for a high and a low survey observation for 2020. Assume a CV equal to the median and fit these values in two model runs to evaluate sensitivity to variation in the ending year survey.
  - Large changes in management quantities such as OFL and MMB indicate high sensitivity.
  - This sensitivity analysis evaluates the behavior of the assessment model in the current year, while the first analysis evaluates the historical performance of the assessment

CPT APPROACH TO EVALUATING IMPACTS OF THE CANCELLATION OF THE 2020 SURVEY

- At the start of the meeting the CPT discussed three possible approaches for dealing three possible approaches for dealing with the cancellation of the 2020 survey:
- No additional ABC buffers for any stock assessment to account for the cancellation of the 2020 survey.
- Add the same additional ABC buffer for all assessments affected by the cancellation of the survey (for example a 10% additional buffer).
- Take a species-by-species approach to decide on a buffer. An additional buffer should be considered only for stocks where assessment uncertainty increases appreciably.
- Based on Meaghan's analysis showing strongly differing impacts by stock, the CPT concluded that the third option was the best course of action.

SUMMARIZING APPROACH 1: RETROSPECTIVE WITH AND WITHOUT TERMINAL YEAR SURVEY



Approach 3 – Summarizing sensitivity to potential high and low 2020 survey data point

OFL_high – OFL_low / OFL_base

BBRKC 10.6%

Snow 26.5%

Tanner 4.4%

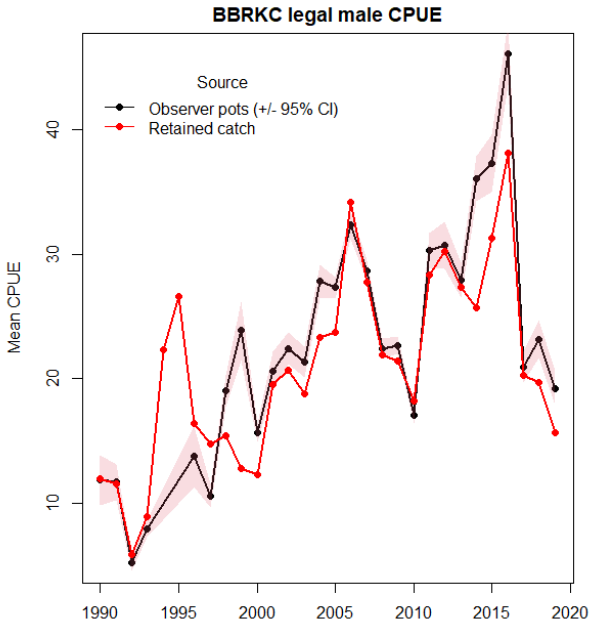
SMBKC 13.6%

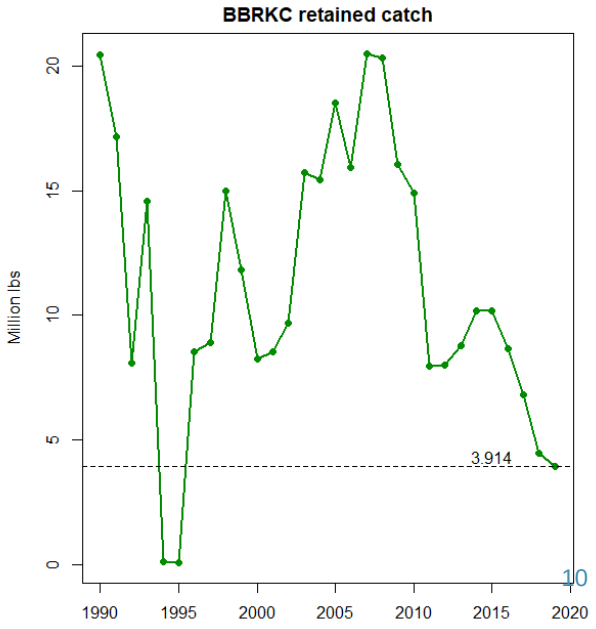
BBRKC

FINAL ASSESSMENT 2020

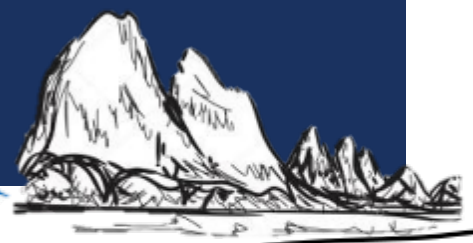
BBRKC FISHERY UPDATE

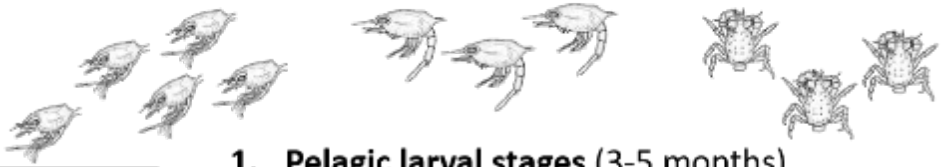
- Total catch for 2019/20 3.914, lowest catch in recent history
- Legal male CPUE declined over past 5 seasons
- Most of harvest in first two weeks of fishery
- Further west in Bristol Bay than past fisheries
- Higher discard mortality (likely sublegal & old shell crab)
- Increase in average weight of retained catch
- Groundfish bycatch – under 60-ft P.cod pot and yellowfin sole trawl





BBRKC METRICS ASSESSMENT AND ECOSYSTEM PROCESSES





5 – 10 °C

1. **Pelagic larval stages** (3-5 months)
   Peak hatch: February
   Larval stages: March-June

Synchrony with spring bloom

Offshore advection

2 – 12 °C

2. **Early benthic juvenile stage**
   Settlement: July-Aug

Habitat

Predation

Depth

2 – 4 °C

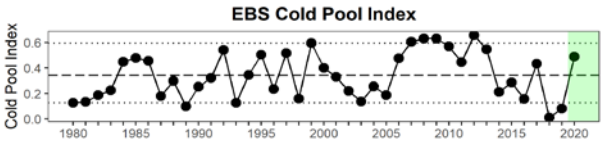
3. **Benthic adult stage**
   Annual molt, mate and extrude: Jan-June

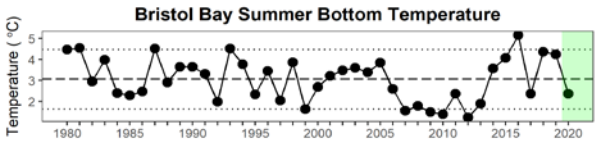
Predation

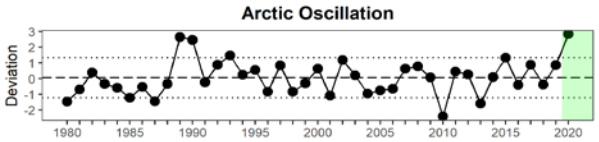
Temperature

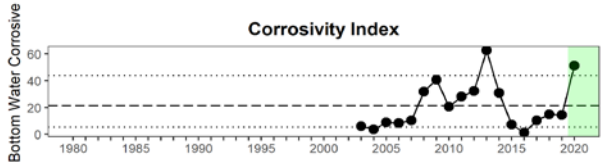
Identifying **vulnerability** or **resilience** of the stock to ecosystem or socioeconomic pressures

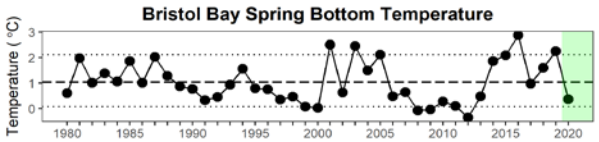
BBRKC ECOSYSTEM INDICATOR TIME SERIES

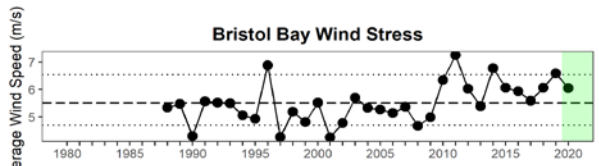


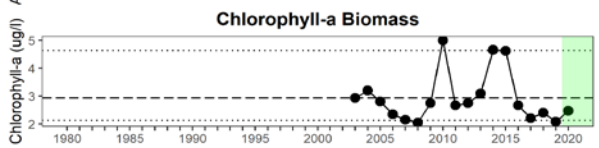


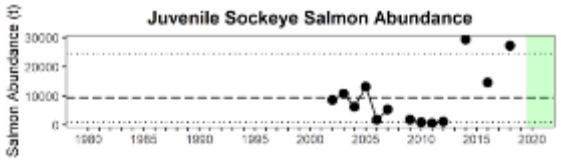


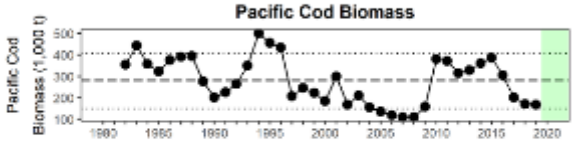


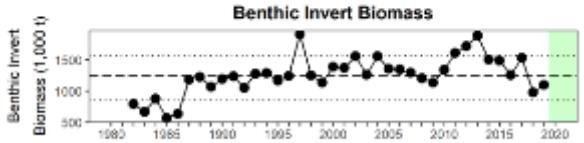


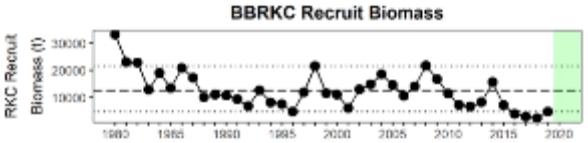


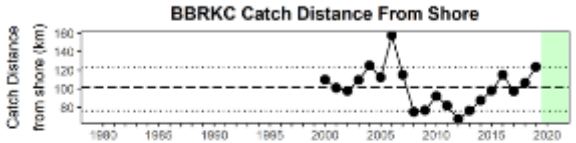


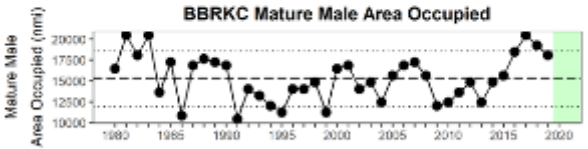


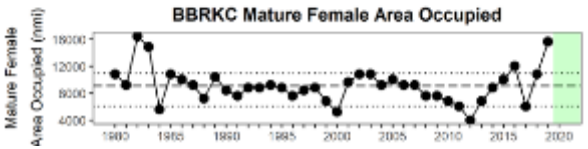












STAGE 1 INDICATOR ANALYSIS:
TRAFFIC LIGHT TEST FOR ECOSYSTEM INDICATORS

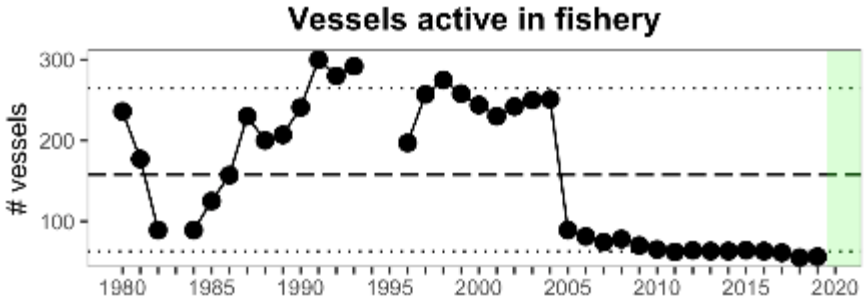
Title	Description	Recent
Cold Pool Index	Fraction of the EBS BT survey area with bottom water less than 2°C on 1 July of each year from Bering10K ROMS model output hindcasts	●
Summer Bottom Temperature	Average of June-July bottom temperatures (° C) within the BBRKC management boundary from the Bering 10K ROMS model output hindcasts	●
Arctic Oscillation	Average of Jan-March Arctic Oscillation Index estimates; constructed by projecting daily 1000mb height anomalies poleward of 20°N onto the loading pattern of the Arctic Oscillation	+
Corrosivity Index	Percent of the BBRKC management area containing an average bottom aragonite saturation state of < 1 from Feb-April	+
Spring Bottom Temperature	Average of Feb-March bottom temperatures (° C) within the BBRKC management boundary from the Bering 10K ROMS model output hindcasts	●
Wind Stress	June ocean surface wind stress within the BBRKC management boundary. Product of NOAA blended winds and MetOp ASCAP sensors from multiple satellites	●
Chlorophyll-a Biomass	April-June average chlorophyll-a biomass within the Southern Inner Shelf of the Bering Sea; calculated with 8-day composite data from MODIS satellites	●

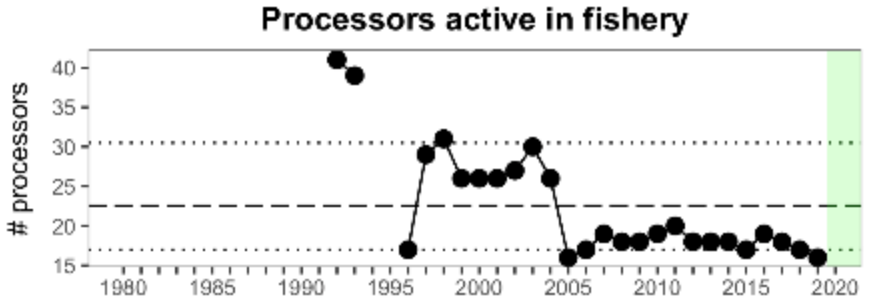
Title	Description	Recent
Juvenile sockeye salmon abundance	Estimated September juvenile sockeye salmon biomass from the Bering Arctic Subarctic Integrated Surveys in the EBS	+
Pacific cod biomass	Biomass (1,000t) of Pacific cod within the BBRKC management boundary on the EBS bottom trawl survey	-
Benthic invertebrate biomass	Combined biomass (1,000t) of benthic invertebrates within the BBRKC management boundary on the EBS bottom trawl survey	●
BBRKC 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 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 from the EBS bottom trawl survey	+
BBRKC mature female area occupied	The minimum area containing 95% of the cumulative CPUE for BBRKC mature females from the EBS bottom trawl survey	+

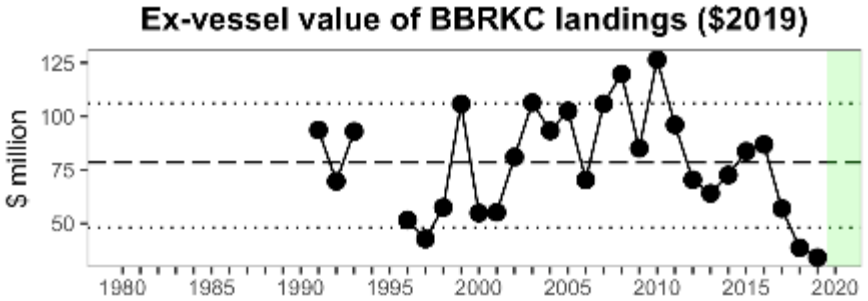
Ecosystem Considerations:

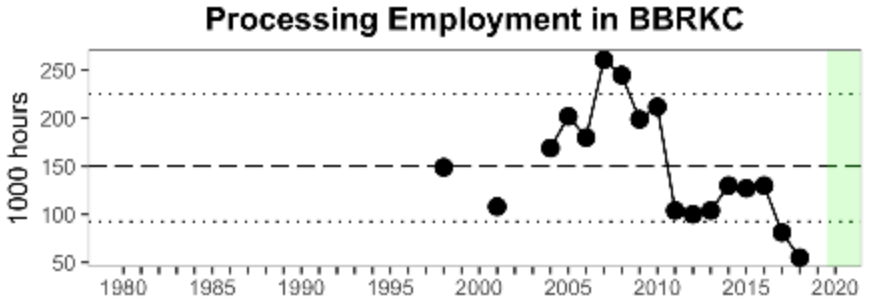
- Available physical indicators for 2020 show a return to near-average conditions in Bristol Bay
- A relatively high positive Arctic Oscillation index in winter 2020 may suggest favorable conditions for BBRKC productivity
- Current-year increases in corrosive bottom waters in Bristol Bay have the potential to impact shell formation, growth and survival of BBRKC

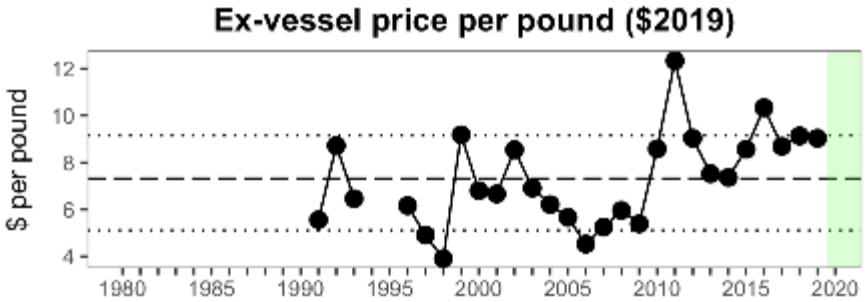
BBRKC SOCIOECONOMIC INDICATOR TIME SERIES

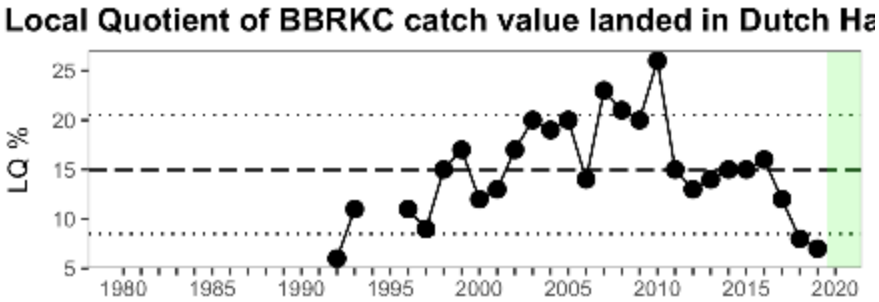


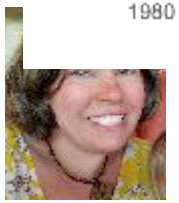












STAGE 1 INDICATOR ANALYSIS:
SOCIOECONOMIC INDICATORS

Title	Description	Recent
CPUE	Fishing effort efficiency, as measured by estimated mean number of retained BBRKC per potlift	●
Vessels active in fishery	Annual count of crab vessels that delivered commercial landings of BBRKC to processors[2]	–
Total Potlifts	Fishing effort, as measured by estimated number of crab pots lifted by vessels during the BBRKC fishery	●
BBRKC Male Bycatch in Groundfish Fishery	Incidental bycatch biomass estimates of male BBRKC (tons) in trawl and fixed gear fisheries	●
TAC Utilization	Percentage of the annual BBRKC TAC (GHL prior to 2005) that was harvested by active vessels, including deadloss discarded at landing.	●
Ex-vessel value of BBRKC landings	Aggregate ex-vessel value of BBRKC landings (as adjusted by CFEC to account for post-season adjustments to ex-vessel settlements), summed over all ex-vessel sales reported.	–
Ex-vessel price per pound	Commercial value per unit (pound) of BBRKC landings (as adjusted by CFEC to account for post-season adjustments to ex-vessel settlements), measured as weighted average value over all ex-vessel sales reported.	●
BBRKC ex-vessel revenue share	BBRKC ex-vessel revenue share as percentage 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.	–
Processors active in fishery	Total number of crab processors that purchased landings of BBRKC from delivering vessels during the calendar year.	–
Processing Employment in BBRKC	Crab processing employment generated in BBRKC fishery as measured by total paid hours of labor input by processing employees, summed over all shore-based plants that processed BBRKC landings.	–
Local Quotient of BBRKC landed catch in Dutch Harbor	Ex-vessel value share of BBRKC landings to Unalaska/Dutch Harbor, as percentage of total value of commercial landings to processors in the community from all commercial Alaska fisheries, as aggregate percentage over all landings during the respective year.	–

Socioeconomic Considerations:

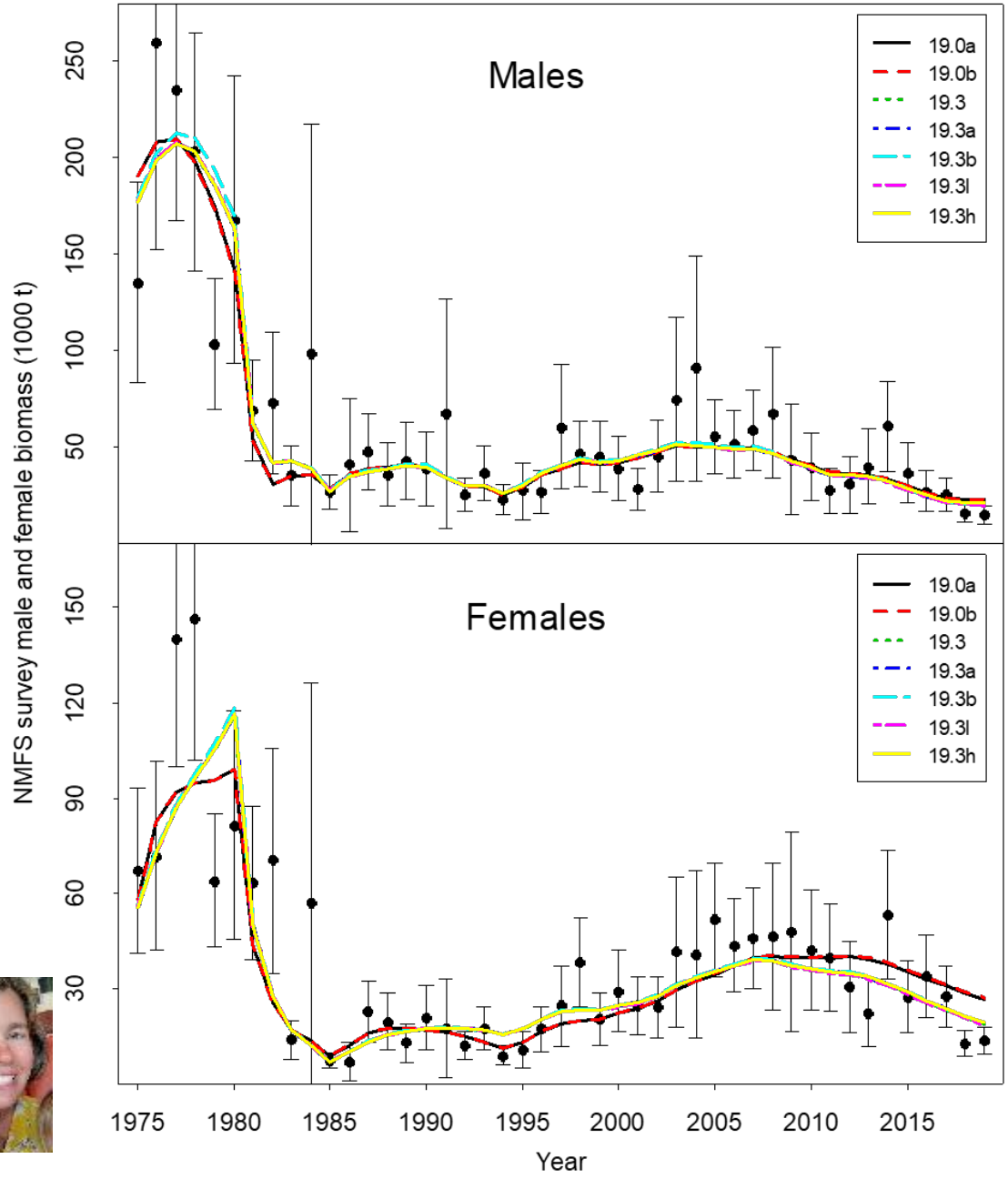
- Counts of active vessels and processors in declining trend since 2005; in 2018/19 and 2019/20 seasons, both dropped below long-term lower bound
- Ex-vessel price above the long-term average since 2010, partially mitigating some income effects of declining BBRKC production, but the reduced level of participation and employment suggest that reduced economic performance of the BBRKC fishery may have negative distributional effects.
- While aggregate BBRKC ex-vessel value was at a historical low in 2019, BBRKC ex-vessel revenue share on average for active vessels was only moderately below average during 2019. The local quotient for BBRKC catch value of landings to Dutch Harbor also declined to a historical low in 2019.

BBRKC FINAL ASSESSMENT 2020

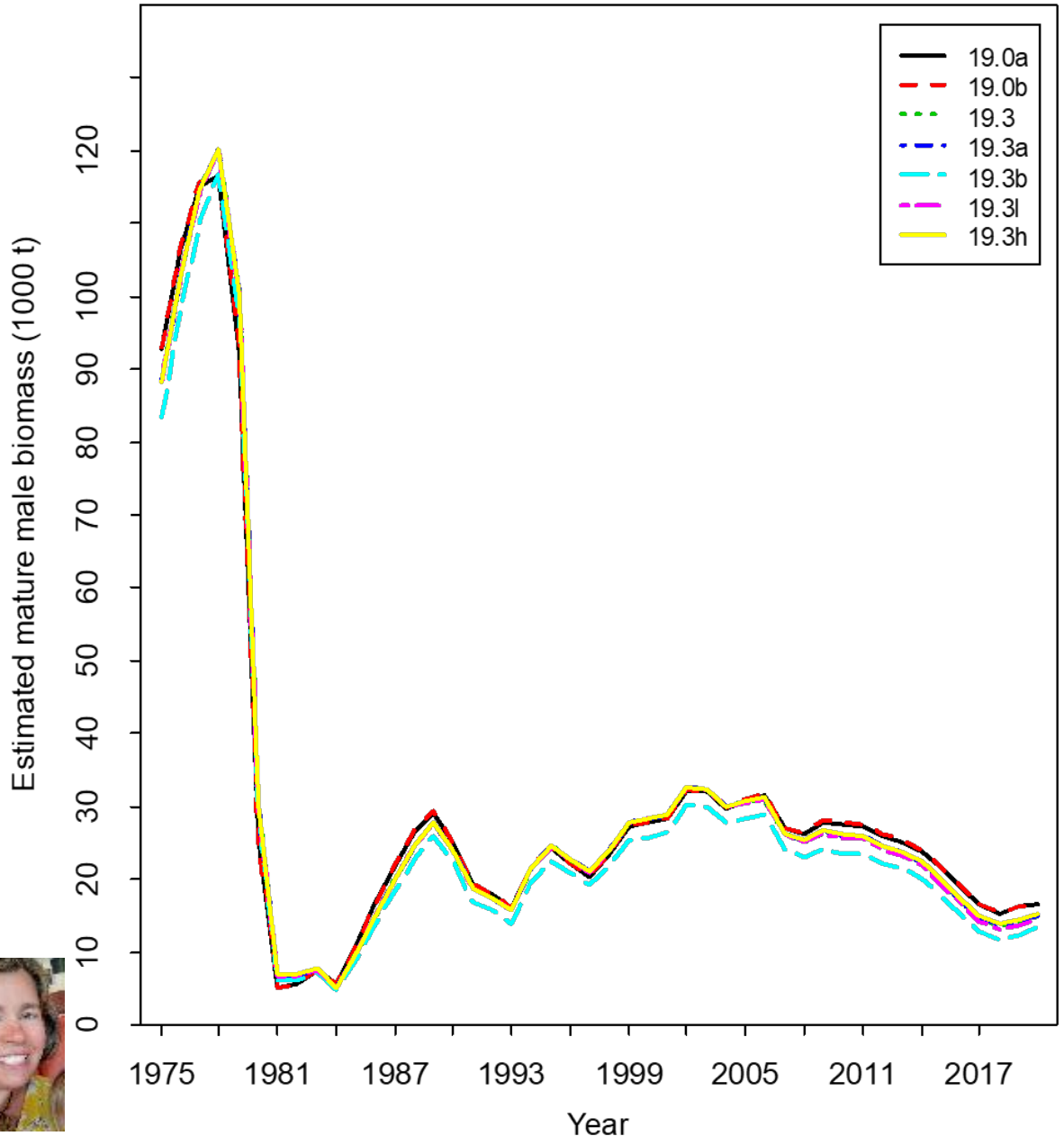
- Declining trend, survey biomass decreased ~50% in 2018, 2019
- New data: directed fishery data, groundfish bycatch (abundance and size comps)
- Model biased high compared to low 2018 and 2019 survey estimates
- Recruitment estimate in terminal year unrealistically high (not used for estimating $B_{35\%}$)
- Model 19.3 preferred by CPT in May 2020
  - Fits the data better with one less parameter than 19.0a
- Analyses indicate impact without terminal survey in 2020 may be small

BBRKC FINAL ASSESSMENT 2020

- **19.0a**: the model 19.0 in September 2019 except with mean recruitment sex ratio during the reference period to estimate $B_{35\%}$. Correction of previous GMACS version with the sex ratio only in the terminal year.
- **19.0b**: the same as model 19.0a except for fixing the recruitment in the terminal year to be the mean recruitment during the seven years prior to the terminal year.
- **19.3:** the same as model 19.0a except for a constant *M* being estimated for males during 1980-1984, a constant *M* of 0.18 for males during the other years, and an estimated constant multiplier being used to multiply male *M* to estimate *M* for females. That is, *M* for females is relative to *M* for males each year.
- **19.3a:** the same as model 19.3 except for fixing the recruitment in the terminal year to be the mean recruitment during the seven years prior to the terminal year.
- **19.3b:** the same as model 19.3 except for doubling the CV of the prior for trawl survey catchability.
- 19.3l and 19.3h – low and high hypothetical 2020 survey data point runs



Comparisons of area-swept estimates of total NMFS survey biomass and model prediction for model estimates in 2020 under seven models. The error bars are plus and minus 2 standard deviations.

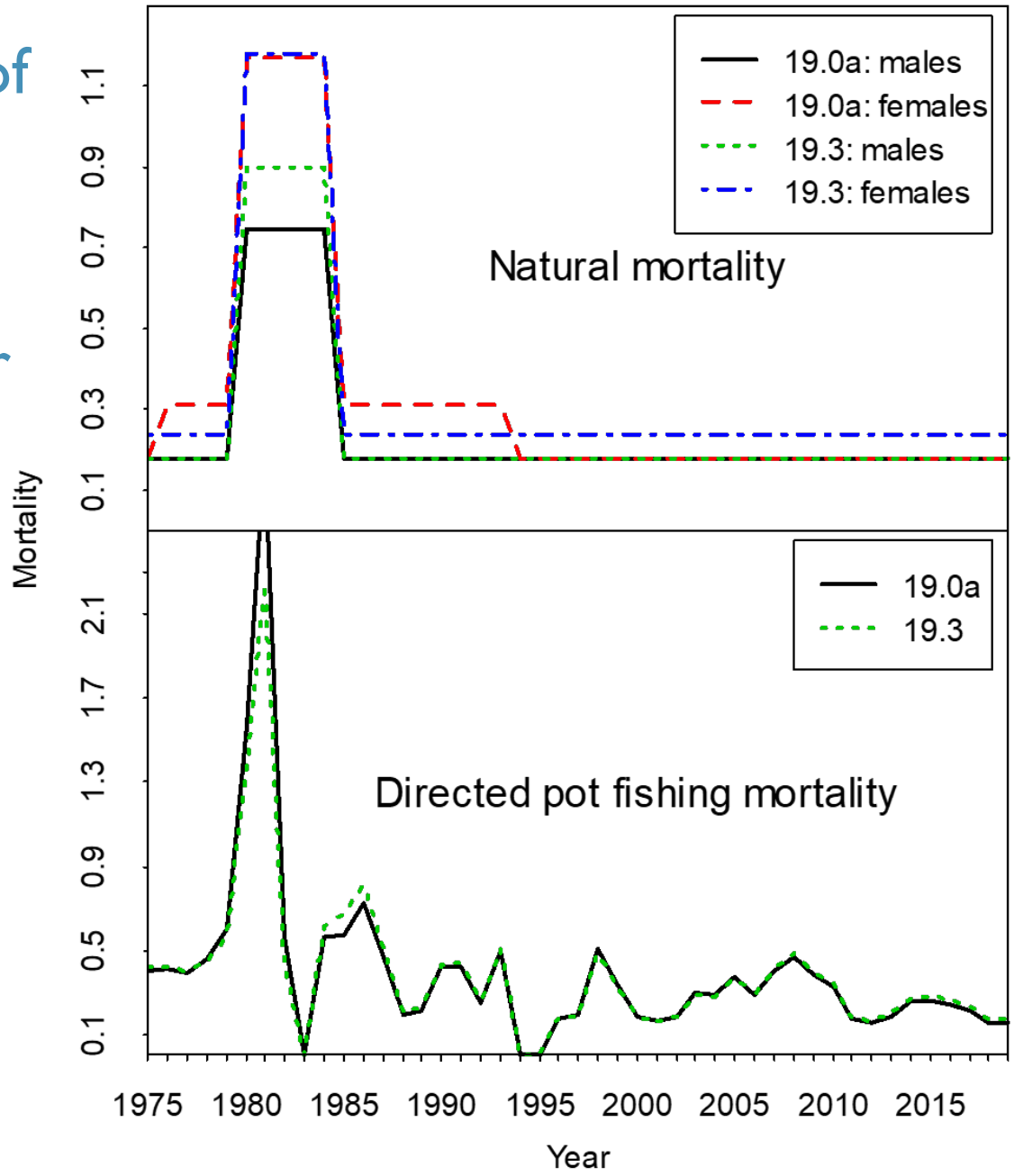


Comparisons of mature male biomass on Feb. 15 under seven models.

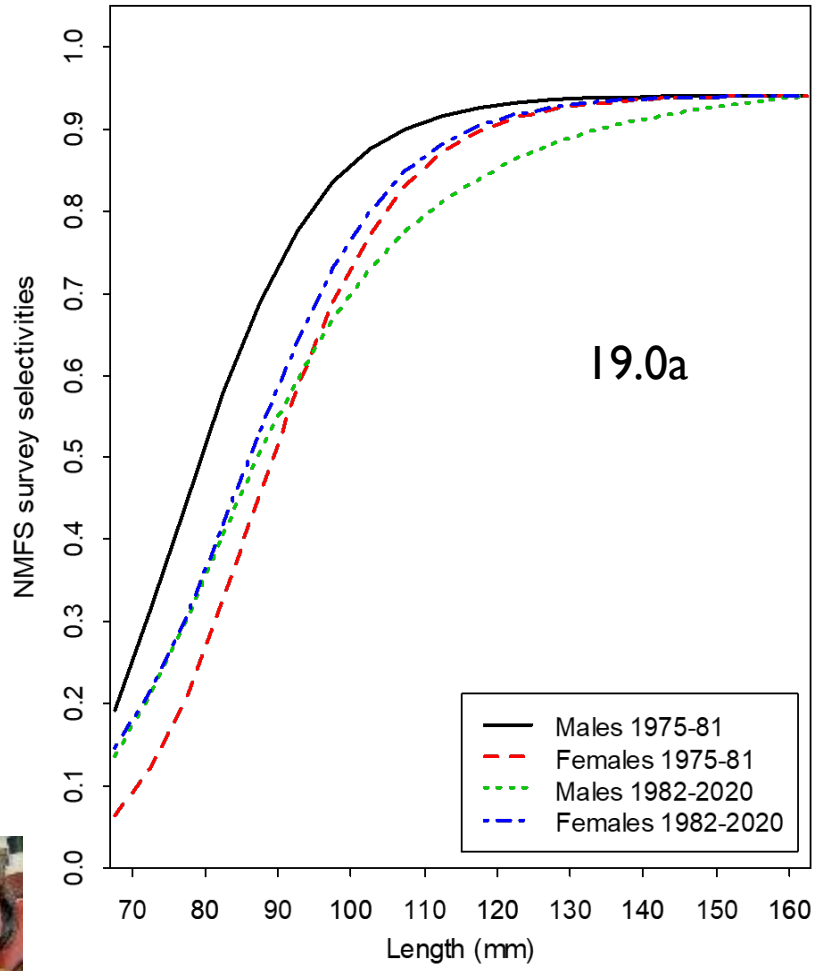
Estimated trawl survey catchabilities:

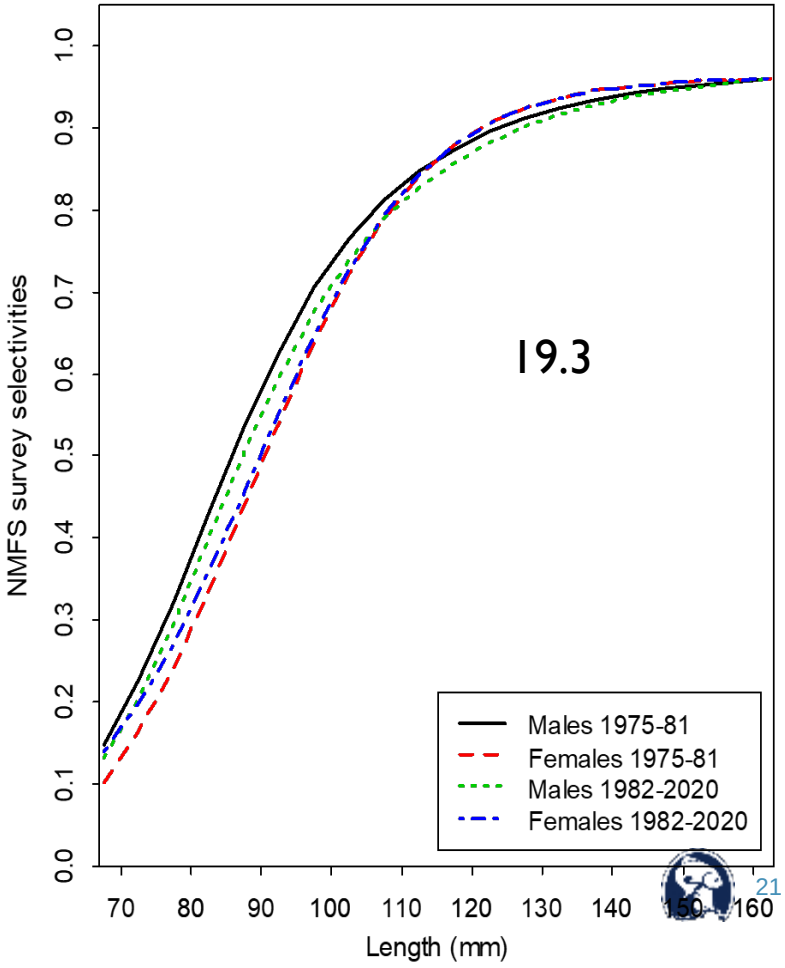
Model	Q
19.0a	0.940
19.0b	0.936
19.3	0.959
19.3a	0.958
19.3b	1.053
19.3l	0.960
19.3h	0.959

Comparison of estimated M and directed pot fishing mortality over time

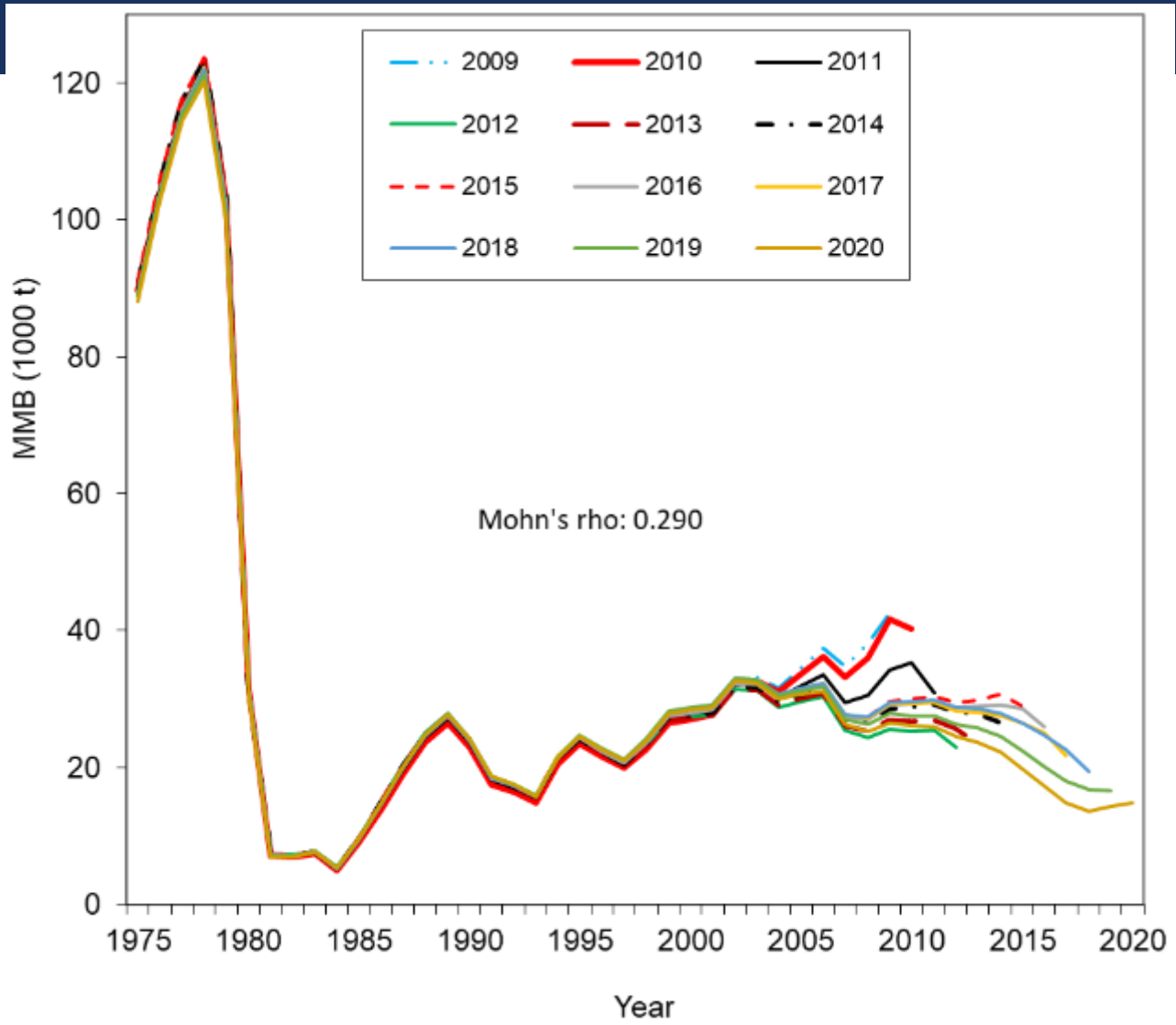


NMFS SURVEY SELECTIVITIES (INCLUDING CATCHABILITY)





Comparison of hindcast estimates of MMB for model 19.3 from 1975 to 2020 made with terminal years 2009-2020.



Status and catch specifications (1,000 t) (model 19.3):

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2016/17	12.53[A]	25.81[A]	3.84	3.92	4.37	6.64	5.97
2017/18	12.74[B]	24.86[B]	2.99	3.09	3.60	5.60	5.04
2018/19	10.62[C]	16.92[C]	1.95	2.03	2.65	5.34	4.27
2019/20	12.72[D]	14.24[D]	1.72	1.78	2.22	3.40	2.72
2020/21		14.93[D]				2.14	1.61

Basis for the OFL: Values in 1,000 t (model 19.3):

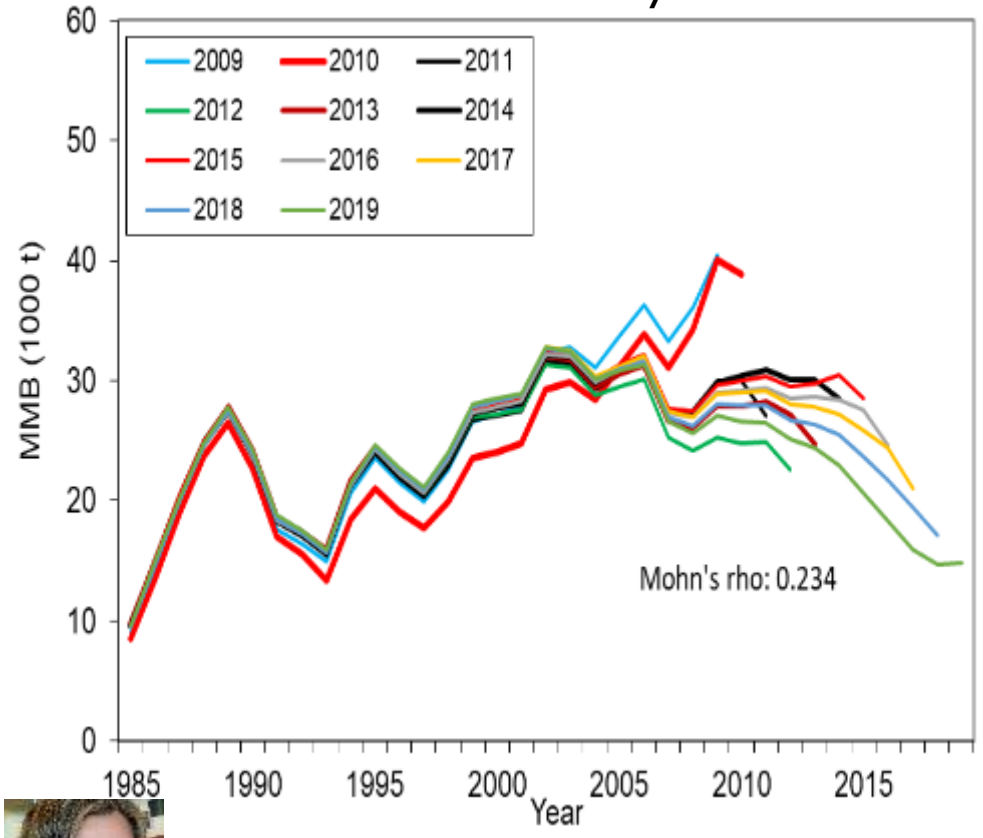
Year	Tier	B_{MSY}	Current MMB	B/B_{MSY} (MMB)	F_{OFL}	Years to define B_{MSY}	Natural Mortality
2016/17	3b	25.8	24.0	0.93	0.27	1984-2016	0.18
2017/18	3b	25.1	21.3	0.85	0.24	1984-2017	0.18
2018/19	3b	25.5	20.8	0.82	0.25	1984-2017	0.18
2019/20	3b	21.2	16.0	0.75	0.22	1984-2018	0.18
2020/21	3b	25.4	14.9	0.59	0.16	1984-2019	0.18

Model 19.3, base ABC buffer 20% (same as 2019)

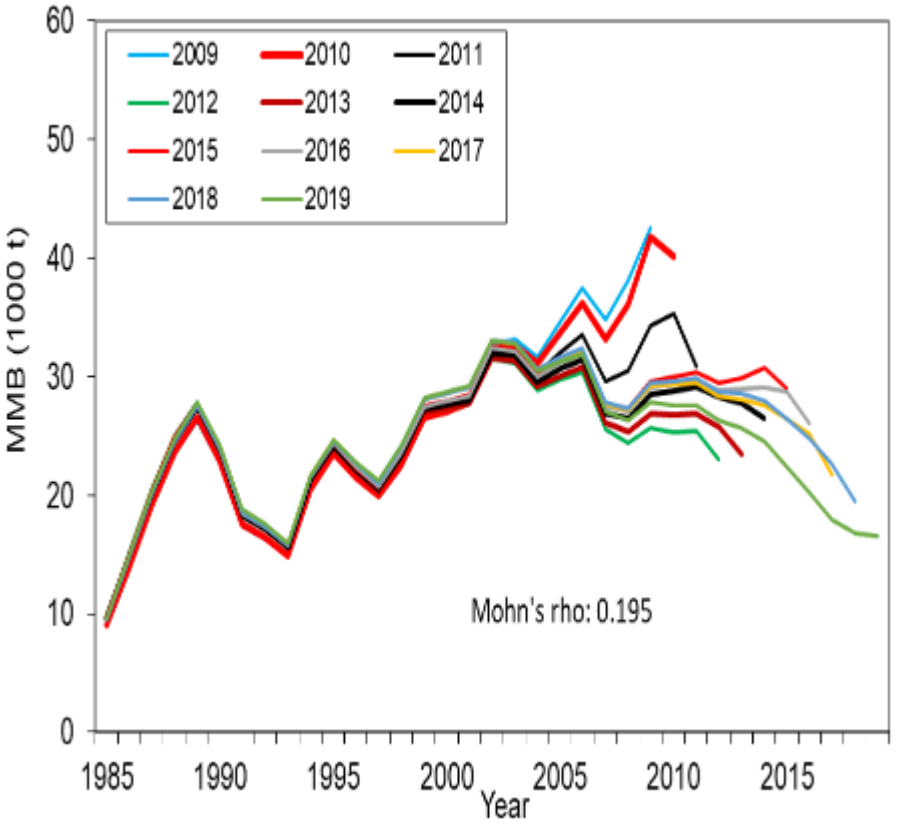
App D. Uncertainty cancelled 2020 survey

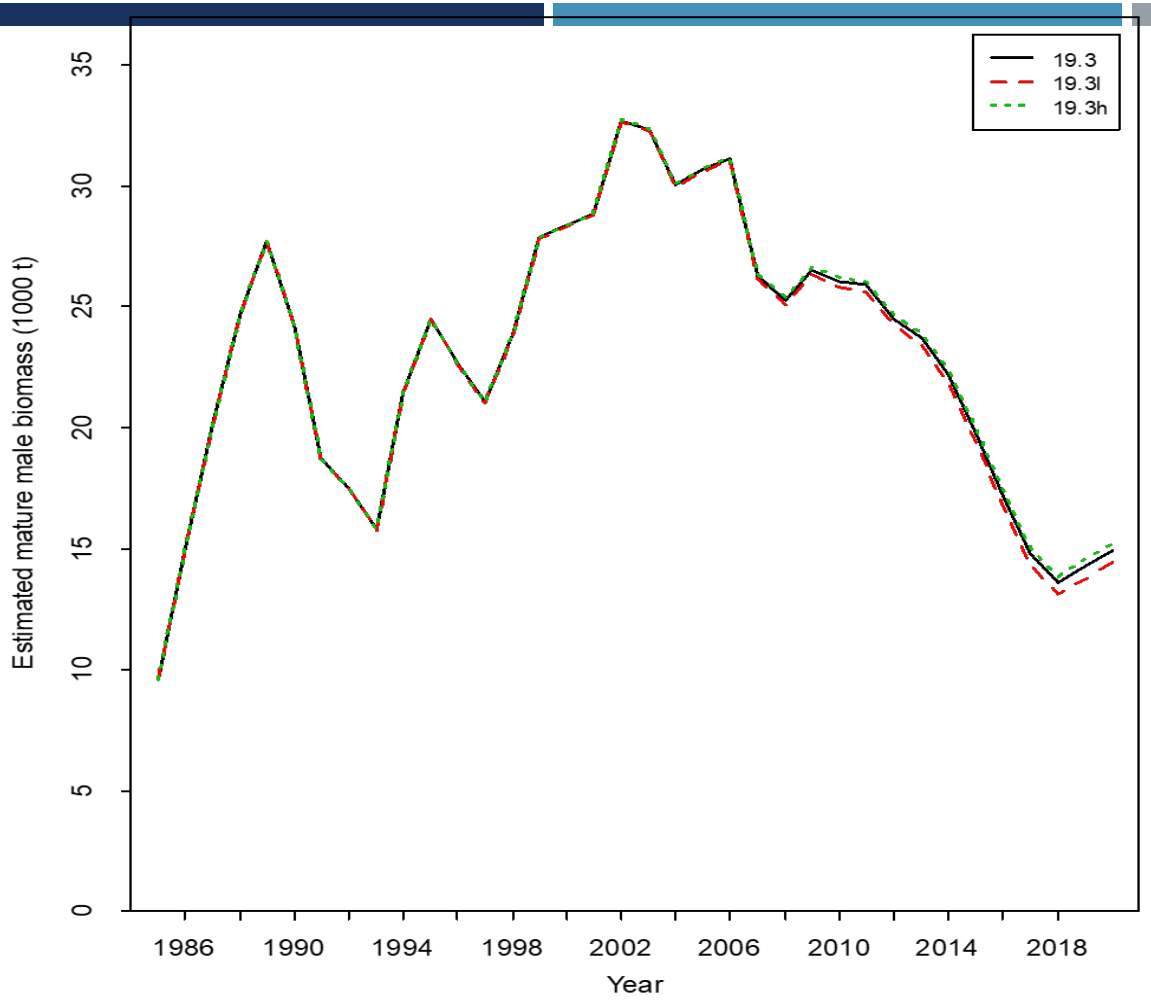
Approaches 1 & 2: Retrospective analysis with two sets of runs: with & without survey in the terminal years.

With survey



Without survey





	19.3l	19.3	19.3h	(19.3h-19.3l)/19.3
B35%	25.324	25.445	25.523	0.78%
MMB-terminal	14.422	14.928	15.220	5.34%
F35%	0.290	0.291	0.291	0.17%
Fofl	0.152	0.157	0.160	5.66%
OFL	1.997	2.141	2.224	10.58%
MMB/B35%	0.570	0.587	0.596	4.57%

Approach 3: Sensitivity analysis with high and low proxy surveys:

Adding 25th (model 19.3l) and 75th (model 19.3h) model-expected percentile survey biomass to the terminal year (2020).

Summary:

1. Overall, differences of results from these three approaches are very small.
2. Retrospective results are better without terminal survey than with terminal survey, maybe due to unexpected survey biomass in 2014, 2018 and 2019.

CPT DISCUSSION ON ABC BUFFERS FOR BBKRC

- ABC base buffer 20%
  - 2019 buffer was 20%
  - Similar uncertainties exist
    - Model's lack of fit to 2018 and 2019 NMFS EBS trawl survey data
    - Retrospective patterns
    - Recent environmental conditions
    - Lack of recent recruitment
- Uncertainty due to cancelled 2020 survey
  - Additional positive retrospective bias in OFL ~5%
  - Missing critical information on if this stock is approaching an overfished status
  - King crab in Alaska do not rebuild easily, therefore important to avoid overfished status
  - Recommend an additional 5% buffer
- Total 2020 buffer of 25%

SMBKC

FINAL ASSESSMENT 2020

SAINT MATTHEW BLUE KING CRAB FINAL 2020 SAFE

- ESP update for SMBKC
- Stock assessment
- CPT discussion of ABC buffers for SMBKC

Title	Description
Cold Pool Index	Fraction of the EBS BT survey area with bottom water less than 2°C on 1 July of each year from Bering10K ROMS model output hindcasts
Summer Bottom Temperature	Average of June-July bottom temperatures (° C) within the SMBKC management boundary from the Bering 10K ROMS model output hindcasts
Corrosivity Index	Percent of the SMBKC management area containing an average bottom aragonite saturation state of < 1 from Feb-April
Spring Bottom Temperature	Average of Feb-March bottom temperatures (° C) within the SMBKC management boundary from the Bering 10K ROMS model output hindcasts
Wind Stress	June ocean surface wind stress within the SMBKC management boundary. Product of NOAA blended winds and MetOp ASCAP sensors from multiple satellites
Chlorophyll-a Biomass	April-June average chlorophyll-a biomass within the St. Matthew region; calculated with 8-day composite data from MODIS satellites
Pacific cod biomass	Biomass (1,000t) of Pacific cod within the SMBKC management boundary on the EBS bottom trawl survey
Benthic invertebrate biomass	Combined biomass (1,000t) of benthic invertebrates within the SMBKC management boundary on the EBS bottom trawl survey
SMBKC Pre-recruit Biomass	Model estimates for SMBKC recruitment. Includes male crab (90-104 mm CL) that will likely enter the fishery the following year.

SMBKC ESP: CHANGES IN ASSESSMENT INPUTS

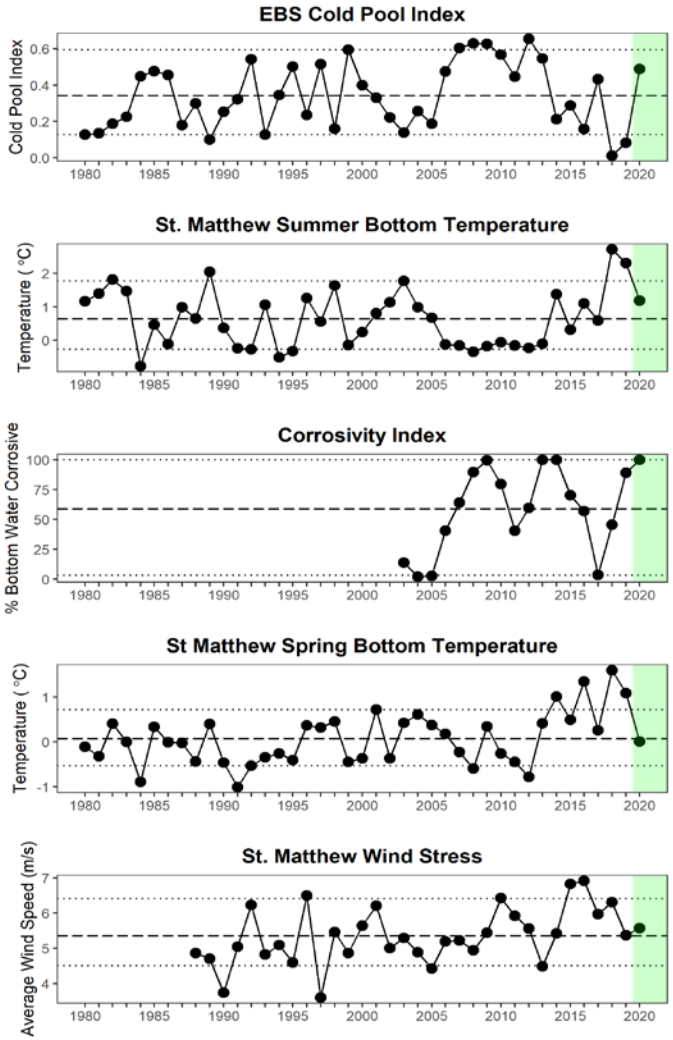
Changes in the Metric or Indicator Data

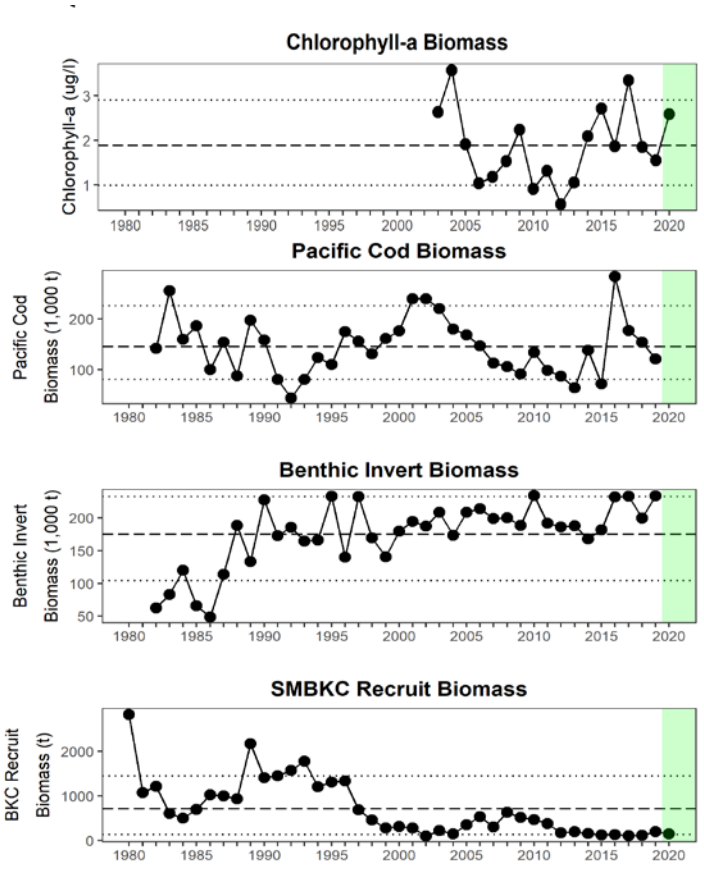
The 2020 SMBKC ESP update includes a suite of new ecosystem indicators. The suite of socioeconomic indicators for SMBKC remain unchanged due to the continued closure of the fishery while the stock rebuilds.

Changes in the Indicator Analysis

We have included the addition of a Stage 2 Importance Test in the Indicator Analysis section

SMBKC ECOSYSTEM INDICATOR TIME SERIES





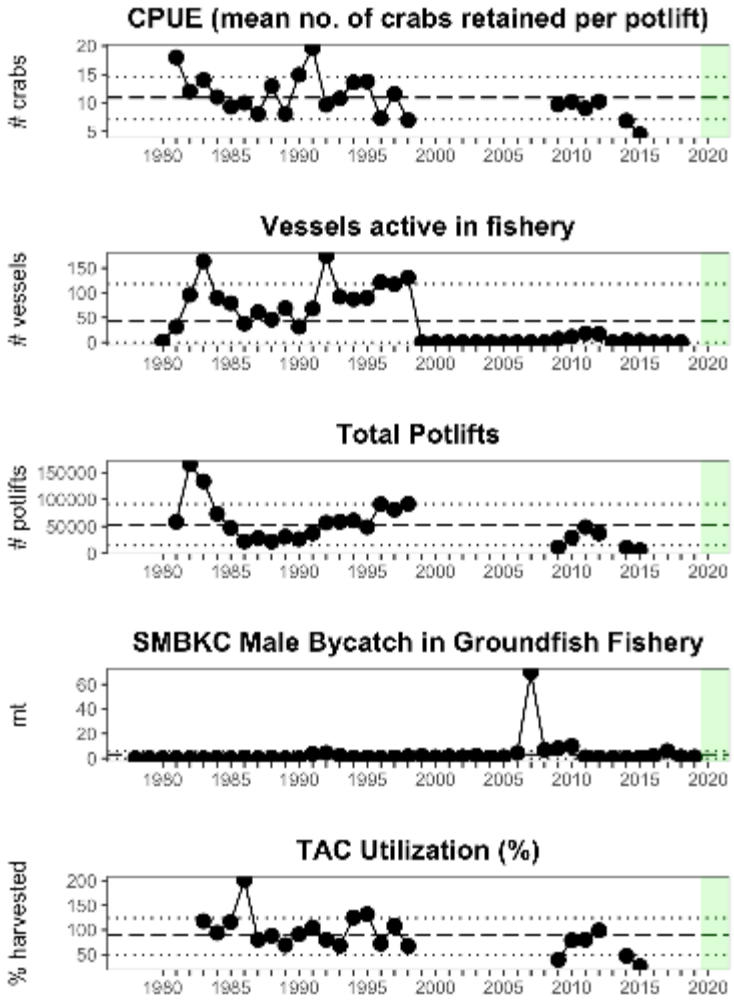
STAGE 1 INDICATOR ANALYSIS: TRAFFIC LIGHT TEST FOR ECOSYSTEM INDICATORS

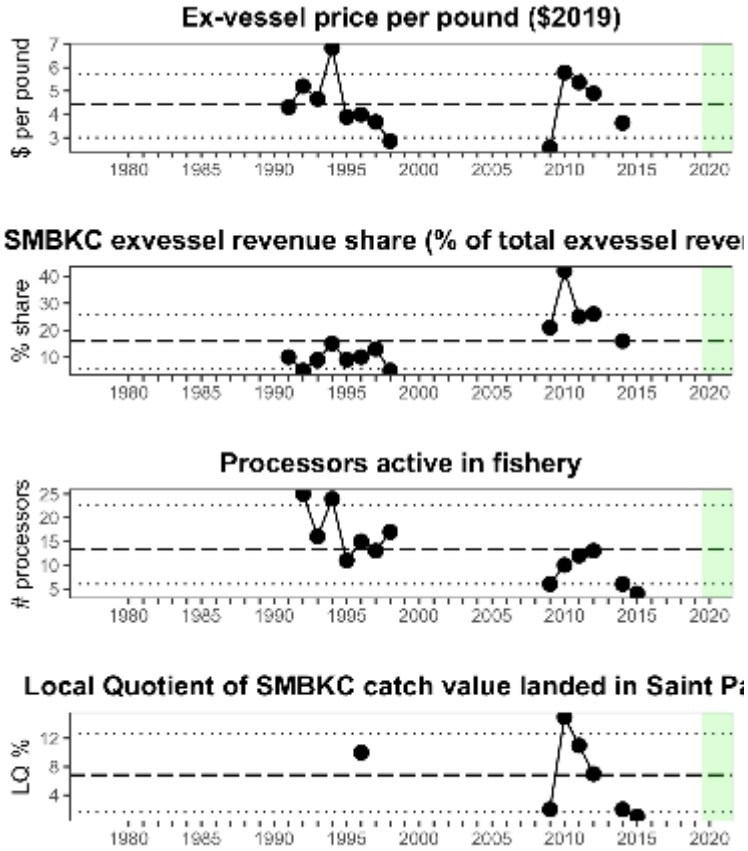
Title	Description	Recent
Cold Pool Index	Fraction of the EBS BT survey area with bottom water less than 2°C on 1 July of each year from Bering10K ROMS model output hindcasts	●
Summer Bottom Temperature	Average of June-July bottom temperatures (° C) within the SMBKC management boundary from the Bering 10K ROMS model output hindcasts	●
Corrosivity Index	Percent of the SMBKC management area containing an average bottom aragonite saturation state of < 1 from Feb-April	+
Spring Bottom Temperature	Average of Feb-March bottom temperatures (° C) within the SMBKC management boundary from the Bering 10K ROMS model output hindcasts	●
Wind Stress	June ocean surface wind stress within the SMBKC management boundary. Product of NOAA blended winds and MetOp ASCAP sensors from multiple satellites	●
Chlorophyll-a Biomass	April-June average chlorophyll-a biomass within the St. Matthew region; calculated with 8-day composite data from MODIS satellites	●
Pacific cod biomass	Biomass (1,000t) of Pacific cod within the SMBKC management boundary on the EBS bottom trawl survey	●
Benthic invertebrate biomass	Combined biomass (1,000t) of benthic invertebrates within the SMBKC management boundary on the EBS bottom trawl survey	+
SMBKC Pre-recruit Biomass	Model estimates for SMBKC recruitment. Includes male crab (90-104 mm CL) that will likely enter the fishery the following year.	●

Ecosystem Considerations:

- Trend modeling for SMBKC ecosystem indicators revealed near-average conditions for SMBKC in 2020
- Persistent, corrosive bottom waters surrounding St. Matthew Island suggest potential impacts on shell formation, growth and survival of BKC

SMBKC SOCIOECONOMIC INDICATOR TIME SERIES





Title	Description	Recent
Vessels active in fishery	Annual count of crab vessels that delivered commercial landings of SMBKC to processors[1]	●
TAC Utilization	Percentage of the annual SMBKC TAC (GHL prior to 2005) that was harvested by active vessels, including deadloss discarded at landing.	●
Total Potlifts	Fishing effort, as measured by estimated number of crab pots lifted by vessels during the SMBKC fishery	+
CPUE	Fishing effort efficiency, as measured by estimated mean number of retained SMBKC per potlift	●
Ex-vessel price per pound	Commercial value per unit (pound) of SMBKC landings (as adjusted by CFEC to account for post-season adjustments to ex-vessel settlements), measured as weighted average value over all ex-vessel sales reported.	●
SMBKC ex-vessel revenue share	SMBKC ex-vessel revenue share as percentage of total calendar year ex-vessel revenue from all commercial landings in Alaska fisheries, mean value over all vessels active in SMBKC during the respective year.	●
Processors active in fishery	Total number of crab processors that purchased landings of SMBKC from delivering vessels during the calendar year.	-
Local Quotient of SMBKC landed catch in St. Paul	Ex-vessel value share of SMBKC 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.	●
SMBKC Male Bycatch in Groundfish Fishery	Incidental bycatch biomass estimates of male SMBKC (tons) in trawl and fixed gear fisheries	●

STAGE 1 INDICATOR ANALYSIS: TRAFFIC LIGHT TEST FOR SOCIOECONOMIC INDICATORS

Socioeconomic Considerations:

- In the most recent open seasons, the active fleet has been reduced to 3-4 vessels, with TAC utilization also declining to 26% during the 2015/16 season.

- Ex-vessel revenue share and the Local Quotient for Saint Paul both reached high values during 2010, concurrent with a peak in ex-vessel price; large declines in both metrics over the subsequent open seasons, despite relatively high ex-vessel prices during the next four open SMBKC seasons indicate that both vessels and processors active during those years have shifted into other fisheries.

NEW ESP DEVELOPMENTS: INDICATOR ANALYSIS STAGE 1

- Traffic Light Score
  - Evaluate for the current year
  - Use +1, -1, 0 to count G/P/S then / by total indicators
  - Evaluate for all categories and provide total ecosystem and socioeconomic score
- Potential Use of Score
  - Evaluate ESP considerations section, risk table, SSC

Category	Good	Poor	Stable	Score
Physical	3		1	0.75
Zooplankton			1	0
Larval & YOY	1			1
Juvenile	1	1	1	0
Adult	2	1	3	0.17
Total (8 NA)	7	2	6	0.33

SMBKC MODEL APPROACH

- Assessment has used GMACS since 2016
- Male only assessment
- Three size bins
- Fit to NMFS bottom trawl survey and ADF&G pot survey

MODEL EVALUATIONS

16.0 – 2019 Reference Model

16.0 – 2020 Reference Model

- 2019 accepted model updated with 2010 – 2019 groundfish bycatch

16.0a – 2020 Reference Model with fixed terminal year recruitment

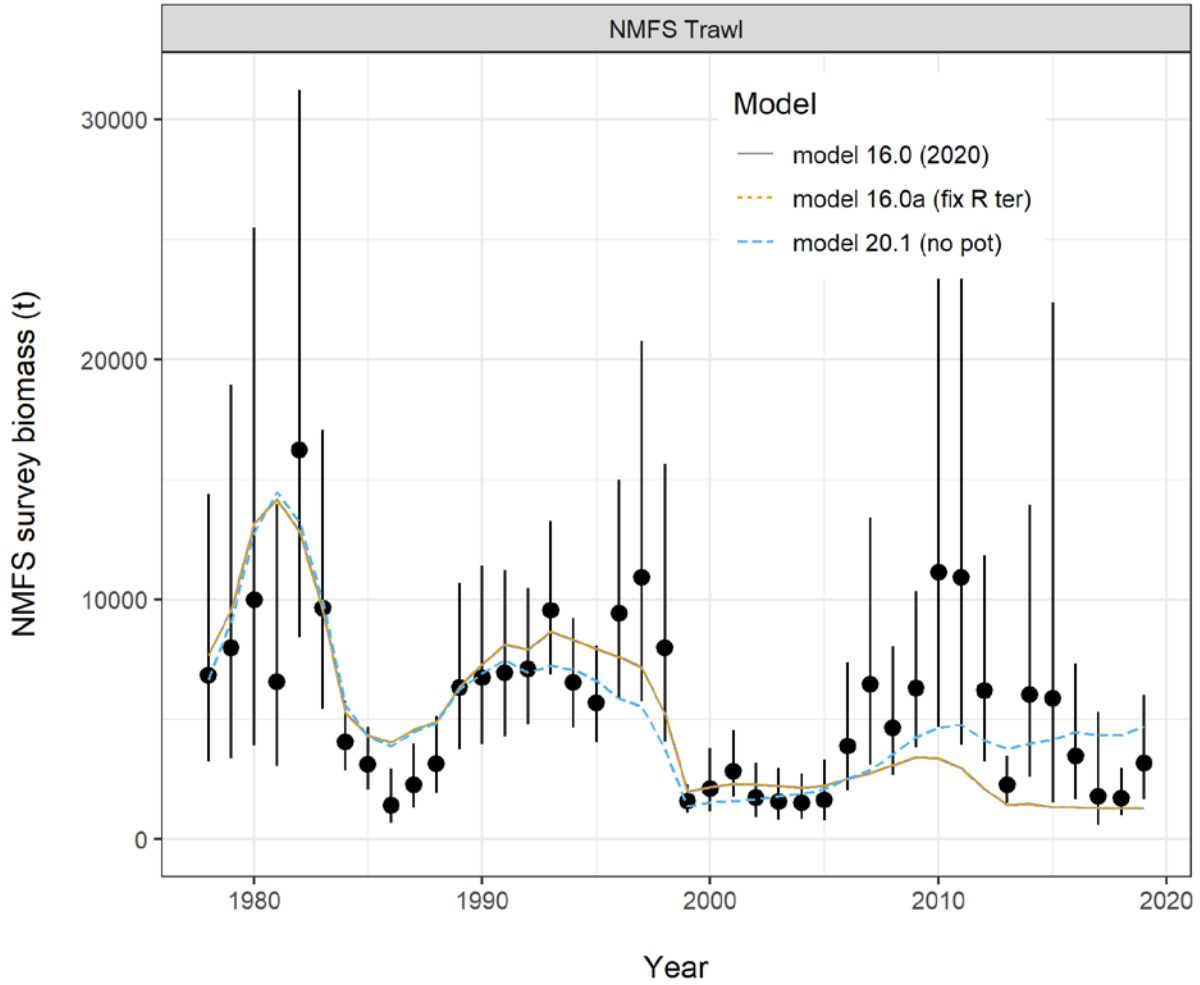
- model 16.0 with terminal year recruitment fixed as the average of the last seven years

20.1 – no ADF&G pot survey data

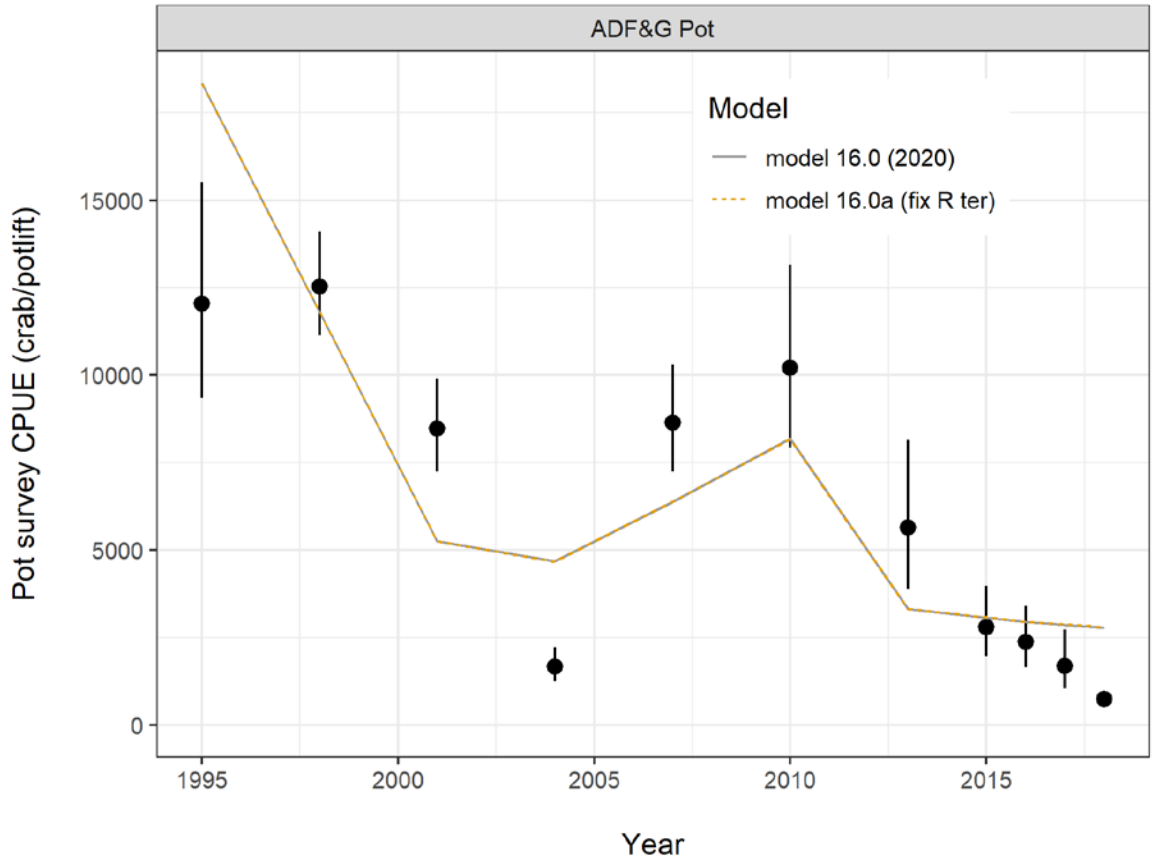
- model 16.0 – excludes ADF&G pot survey data – abundance and length comps

CPT agreed with the assessment author's recommendation of 16.0 as the preferred model

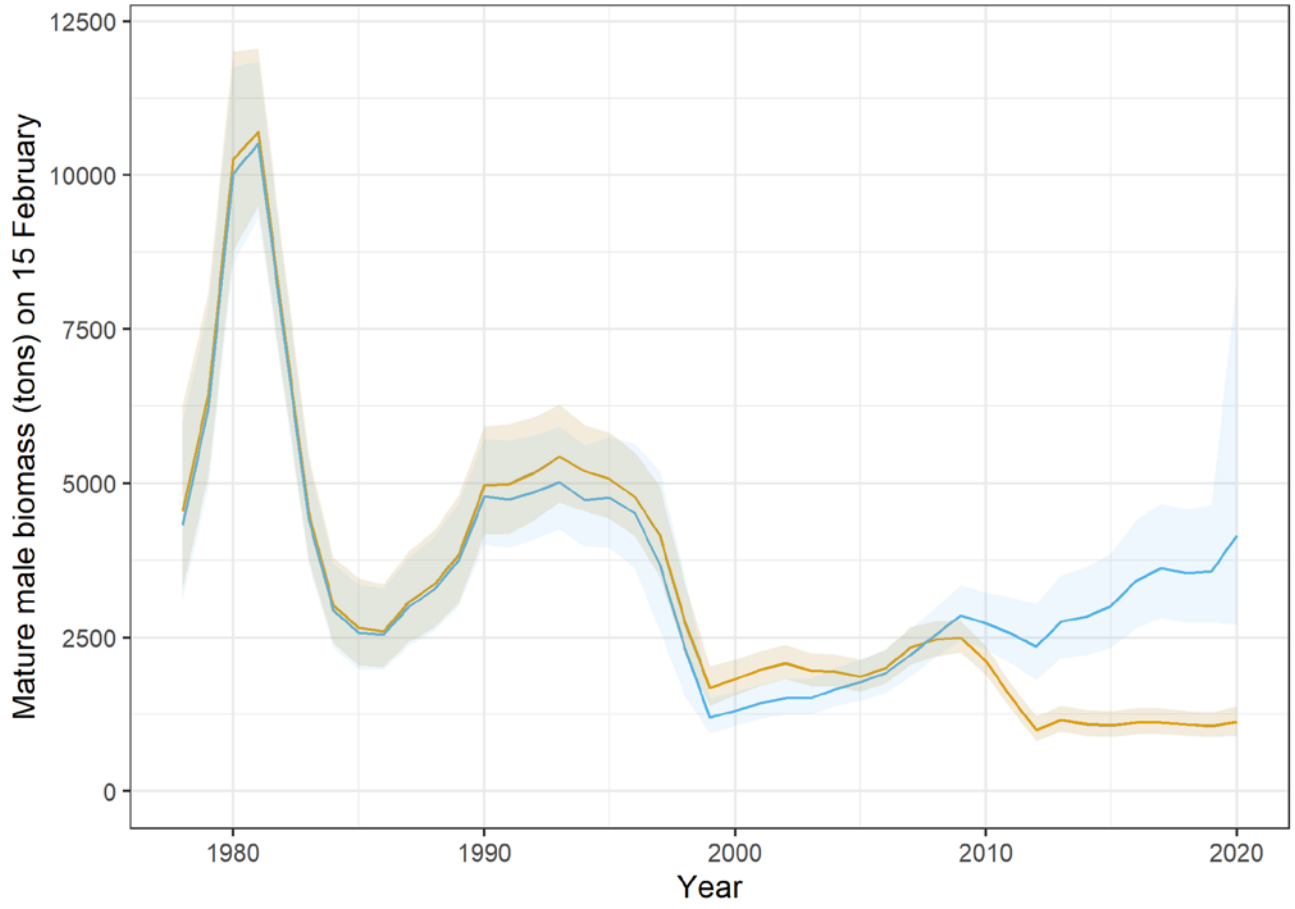
FIT TO NMFS BOTTOM TRAWL SURVEY



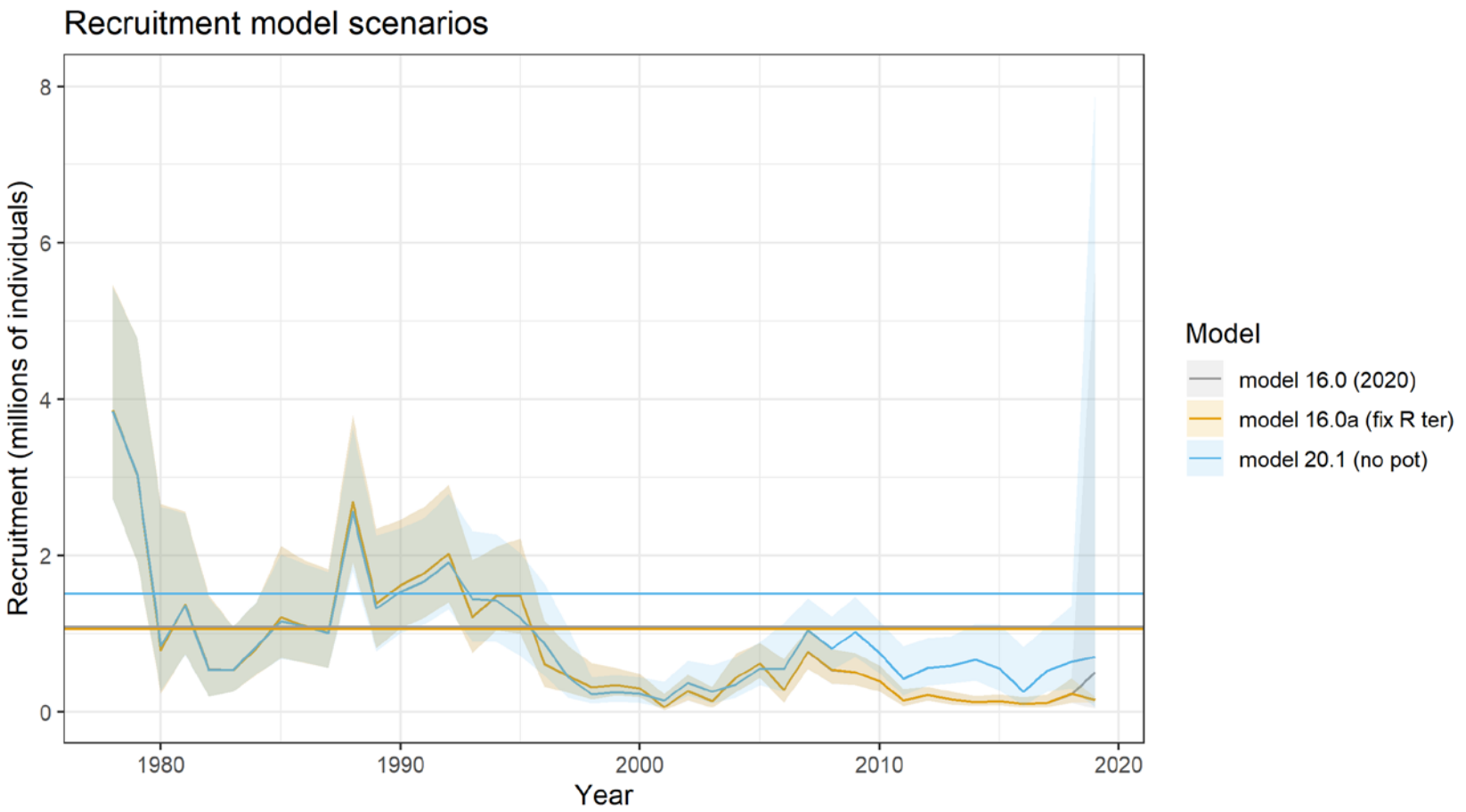
FIT TO ADF&G POT SURVEY



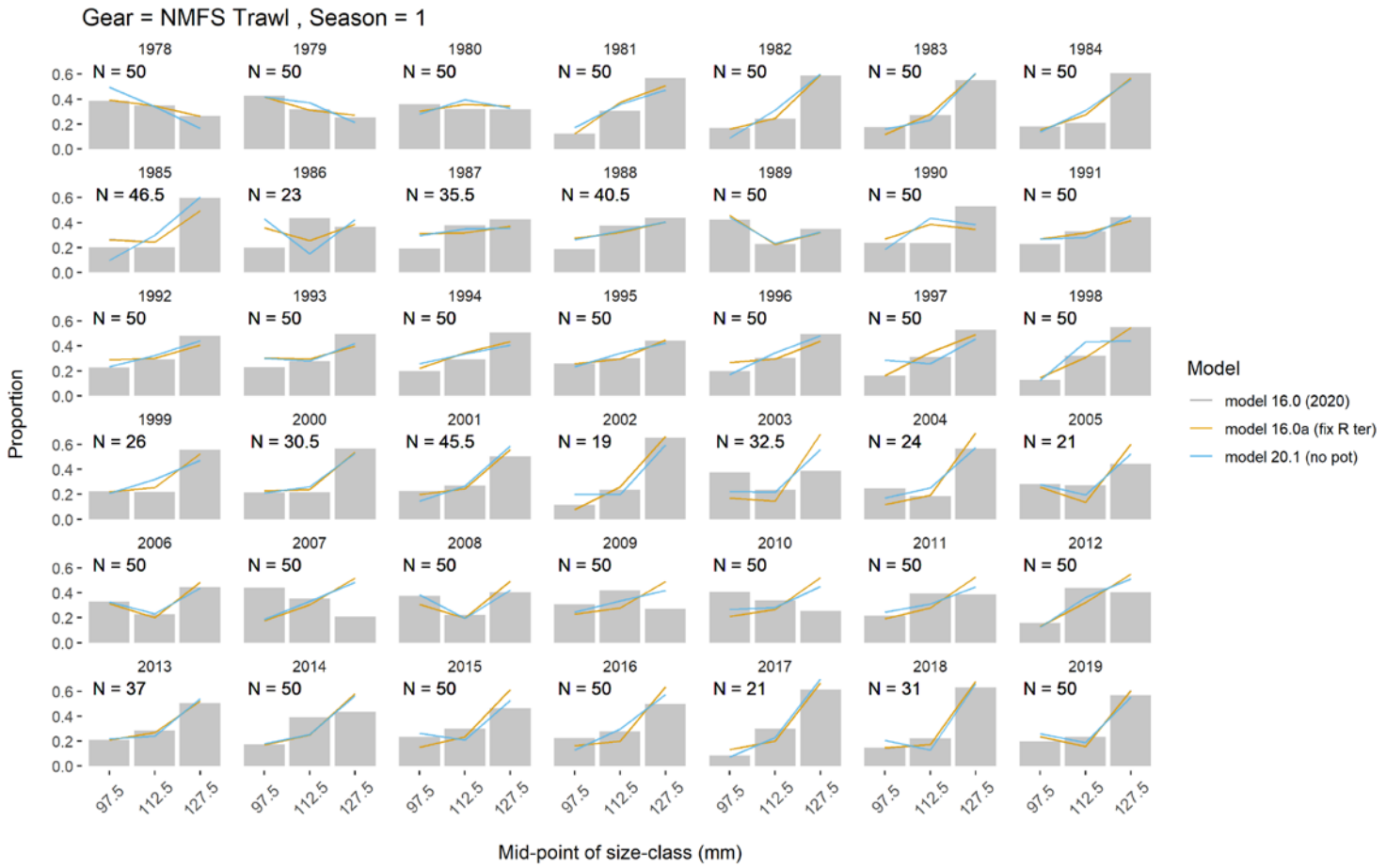
MATURE MALE BIOMASS



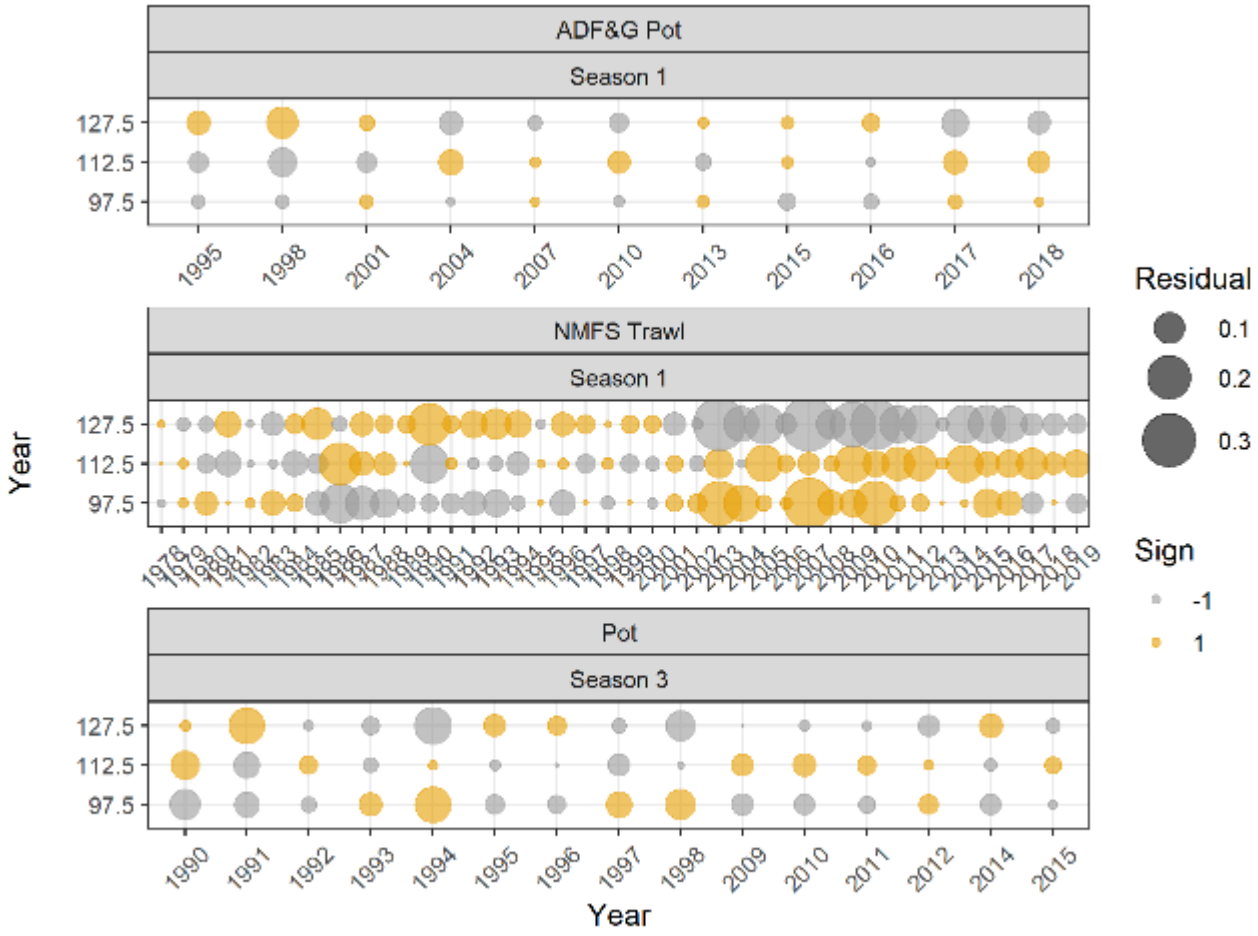
RECRUITMENT



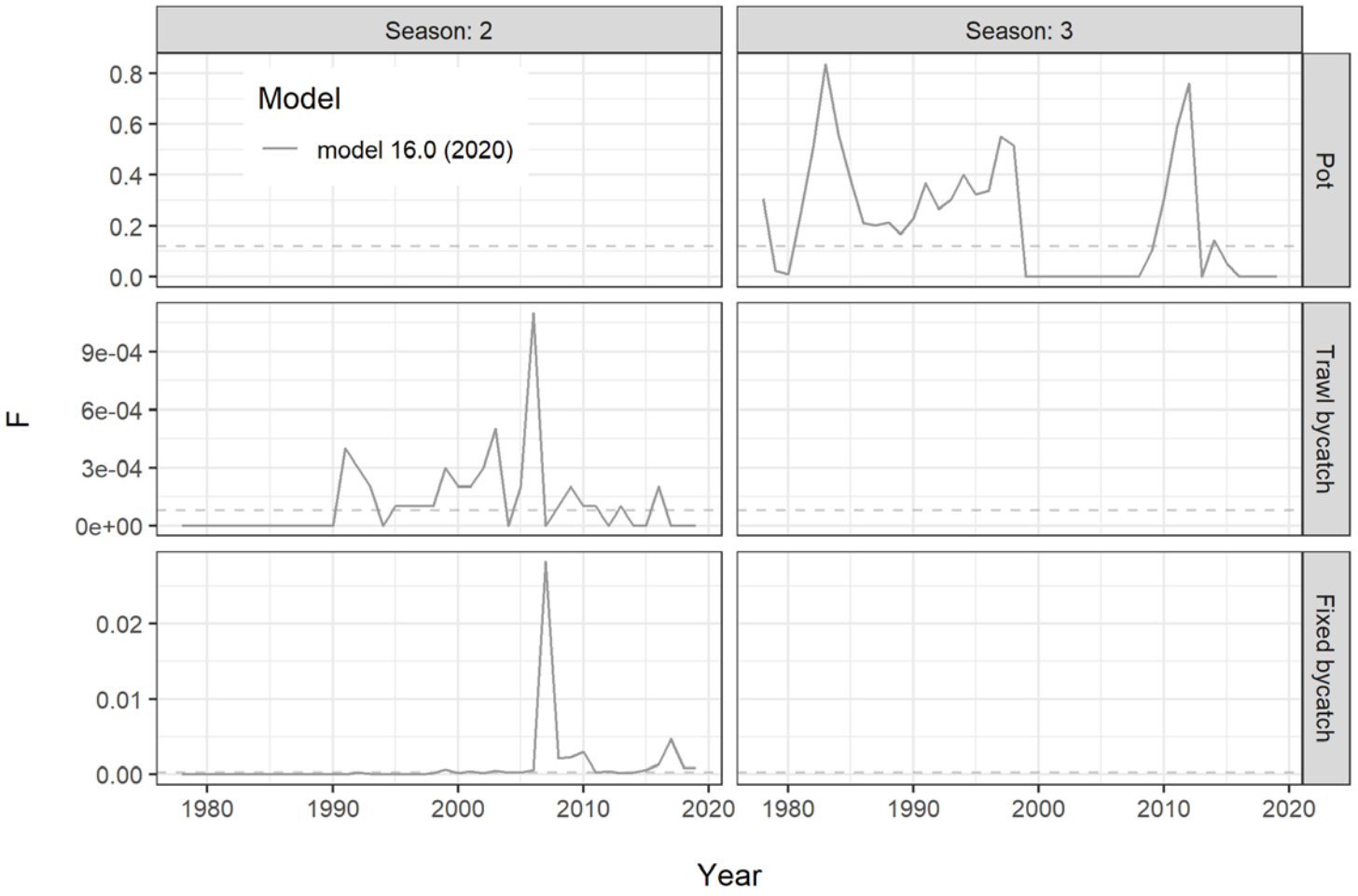
NMFS TRAWL SURVEY SIZE COMP FITS



REFERENCE 16.0
SIZE COMP RESIDUALS



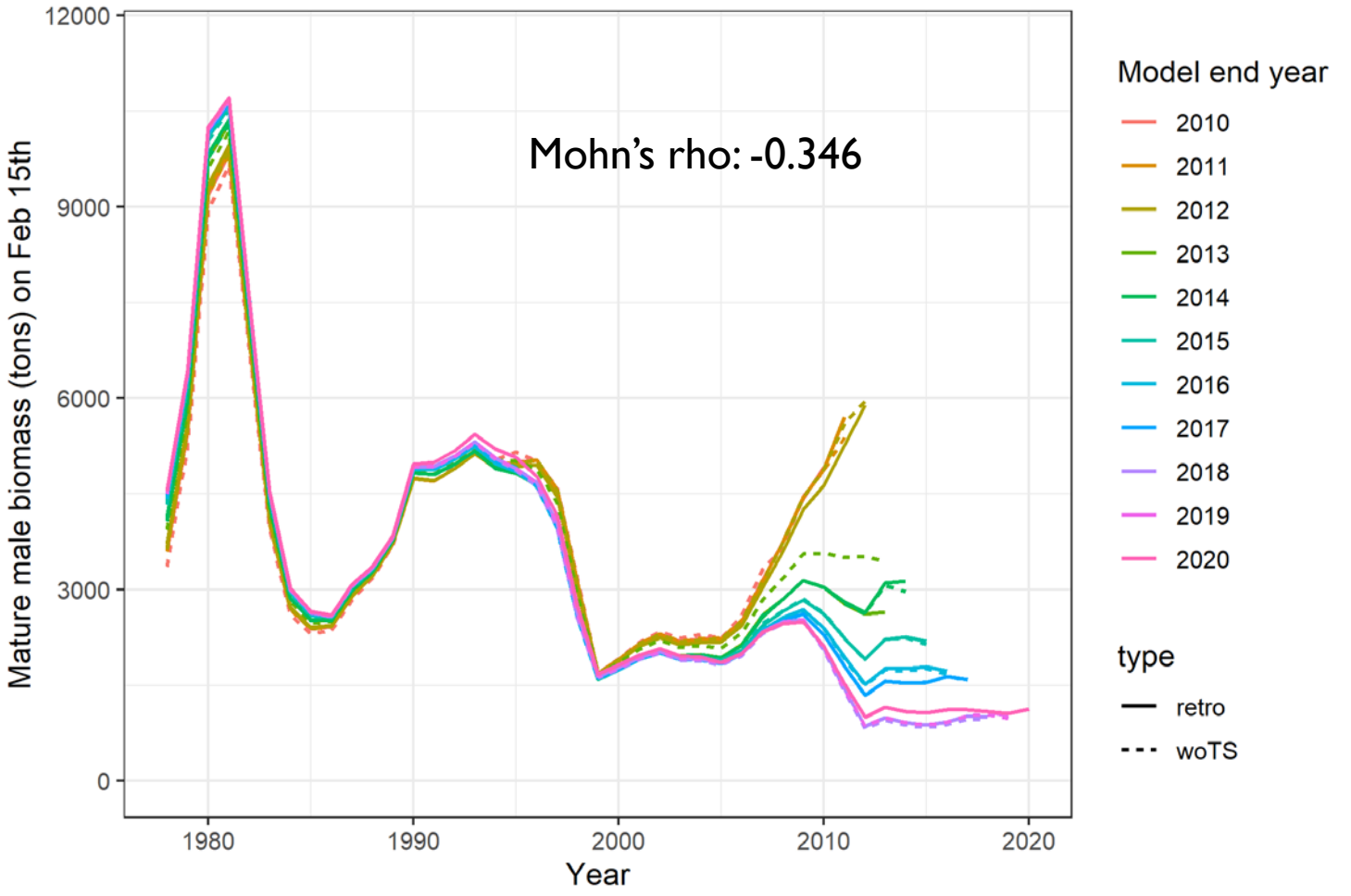
FISHING MORTALITY



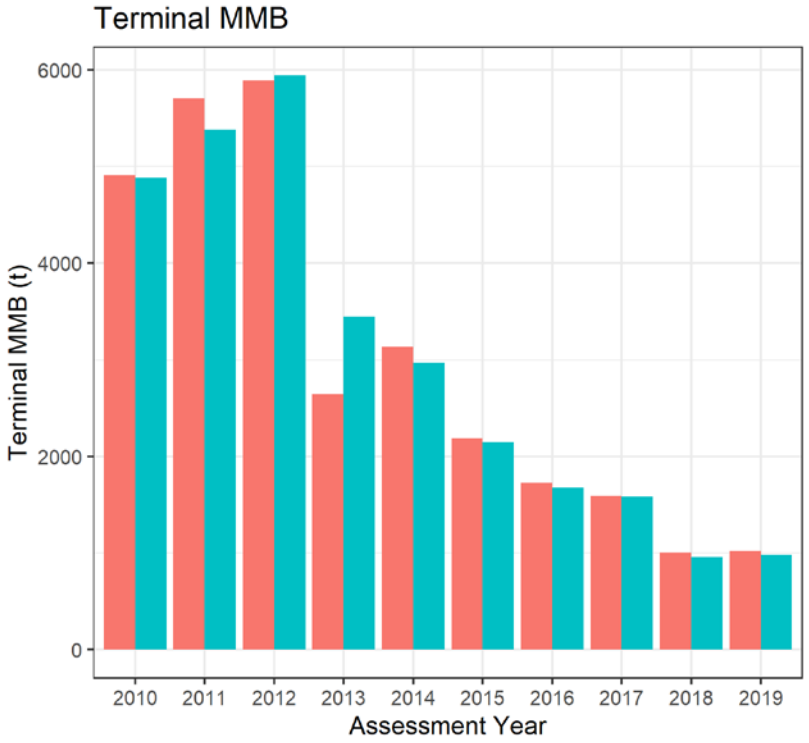
APPENDIX C – EVALUATING UNCERTAINTY DUE TO LACK OF 2020 SURVEY DATA

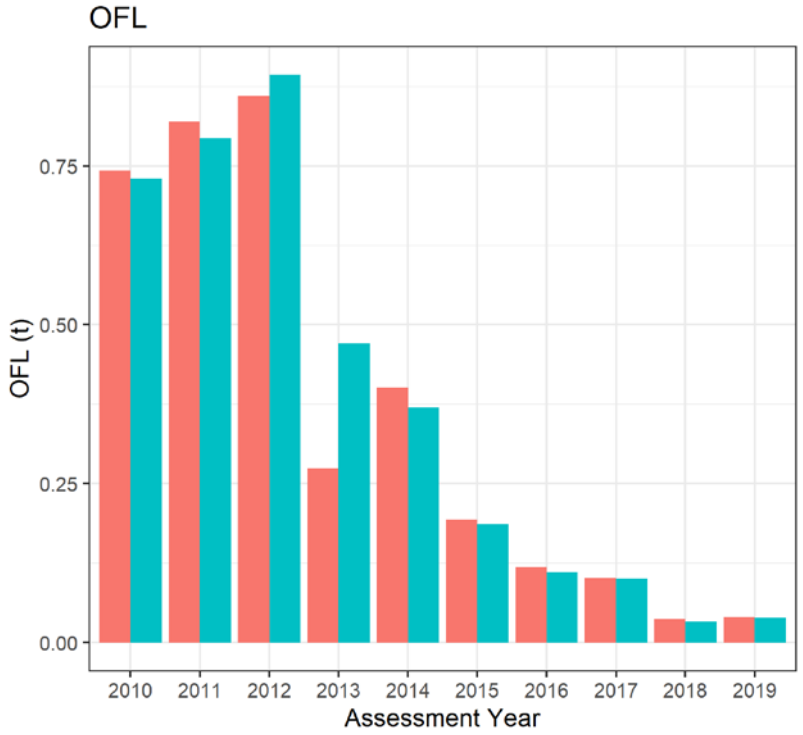
- Retrospective analysis with and without terminal year of survey data (abundance and size comps)
- Runs to determine sensitivity to hypothetical 2020 data – high and low values based on current variability of survey data (Approach 3)

RETROSPECTIVE (MMB)- WITH & WITHOUT TERMINAL YEAR OF SURVEY DATA



RETROSPECTIVE (MMB)- WITH & WITHOUT TERMINAL YEAR OF SURVEY DATA



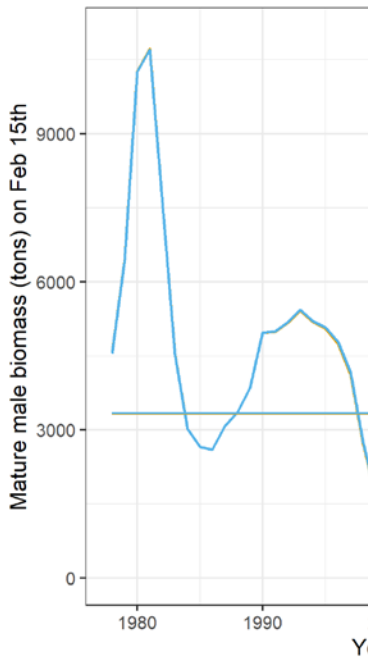


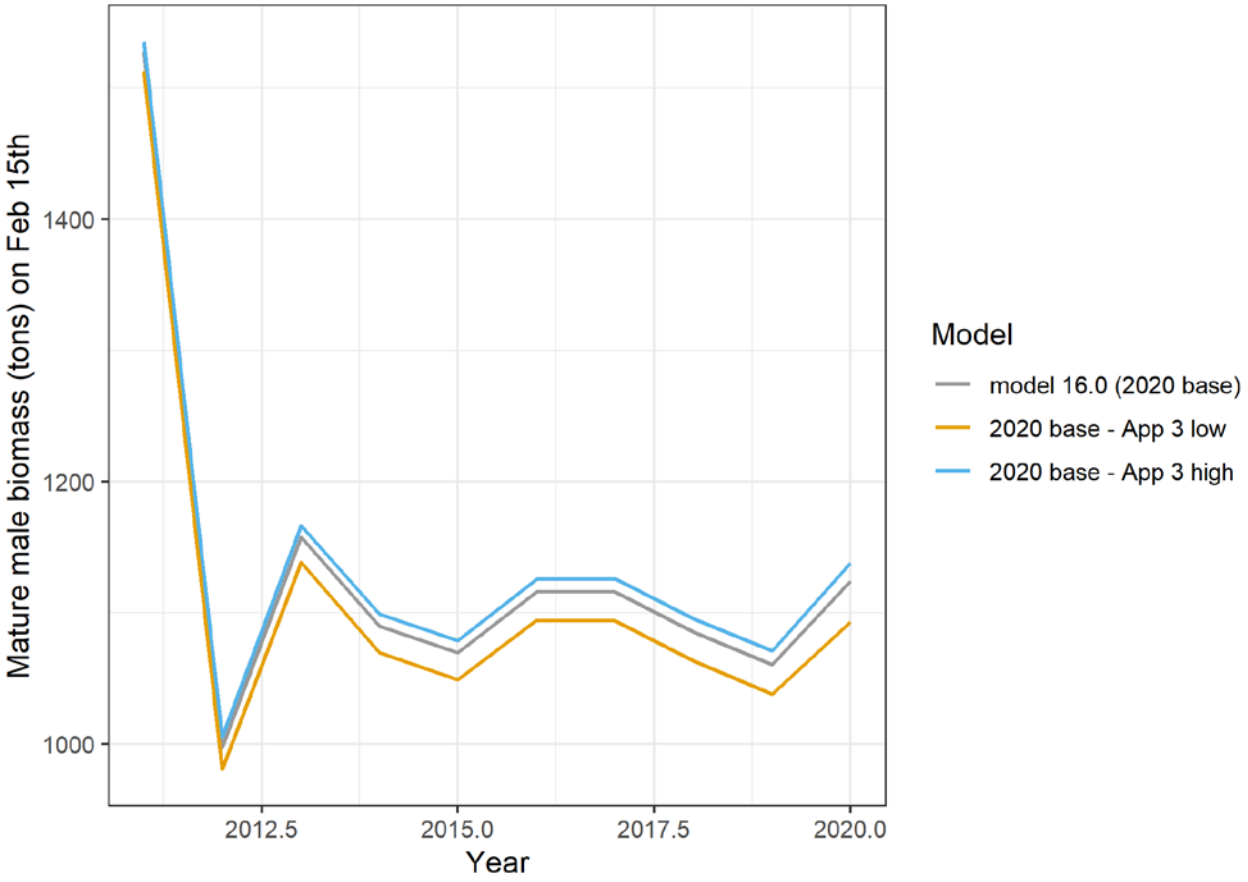
Type

Retrospective

MissingSurvey

APPROACH 3 – HIGH AND LOW 2020 SURVEY VALUES





BASED ON MODEL 16.0 (REFERENCE MODEL)

Table 1: Status and catch specifications (1000 t) for the reference model.

Year	MSST	Biomass (MMB_{mating})	TAC	Retained catch	Total male catch	OFL	ABC
2016/17	1.97	2.23	0.00	0.00	0.001	0.14	0.11
2017/18	1.85	2.05	0.00	0.00	0.003	0.12	0.10
2018/19	1.74	1.15	0.00	0.00	0.001	0.04	0.03
2019/20	1.67	1.06	0.00	0.00	0.001	0.04	0.03
2020/21		1.12				0.05	0.04

Table 2: Status and catch specifications (million pounds) for the reference model.

Year	MSST	Biomass (MMB_{mating})	TAC	Retained catch	Total male catch	OFL	ABC
2016/17	4.3	4.91	0.000	0.000	0.002	0.31	0.25
2017/18	4.1	2.85	0.000	0.000	0.007	0.27	0.22
2018/19	3.84	2.54	0.000	0.000	0.002	0.08	0.07
2019/20	3.68	2.34	0.000	0.000	0.002	0.096	0.08
2020/21		2.48				0.112	0.08

CPT DISCUSSION ON ABC BUFFERS FOR SMBKC

- SSC increased the buffer to 25% in 2017 to reflect concerns about the assessment and the fact that SMBKC is a data-limited assessment.
- Last year the buffer was mistakenly set at 20%.
- The assessment has a strong retrospective pattern, but it does not seem to be made much worse when a terminal year survey is missing
- The high/low 2020 survey sensitivity analysis indicated low to moderate sensitivity.
- The CPT recommends that the SSC continue to use a buffer of 25% to deal with assessment uncertainties. No additional buffer is recommended deal with the cancellation of the 2020 survey.

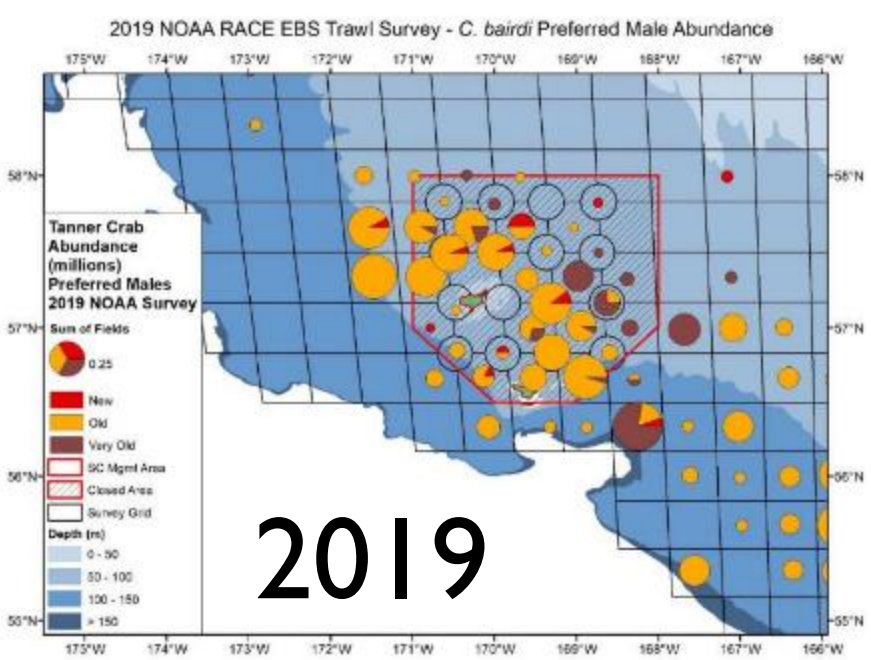
TANNER CRAB

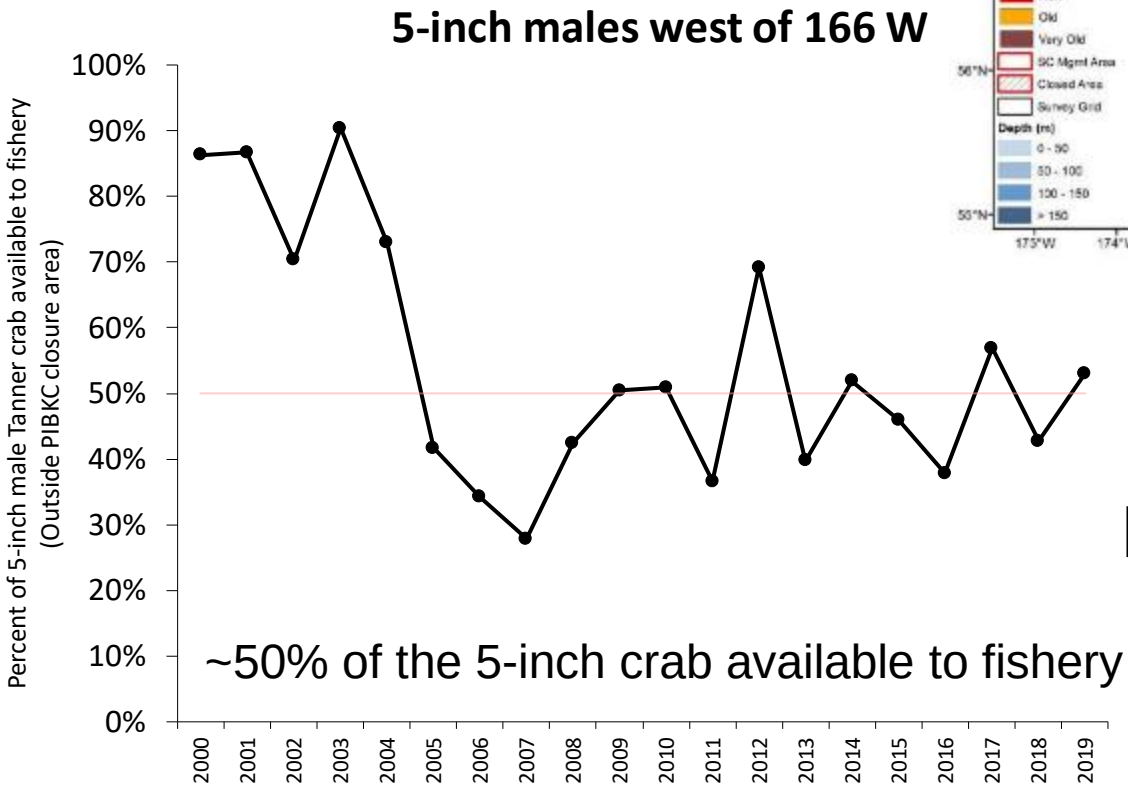
FINAL ASSESSMENT 2020

TANNER CRAB FINAL 2020 SAFE

- Fishery summary (no directed fishery in 2019/20)
- Stock assessment
- CPT discussion on ABC buffers for Tanner crab

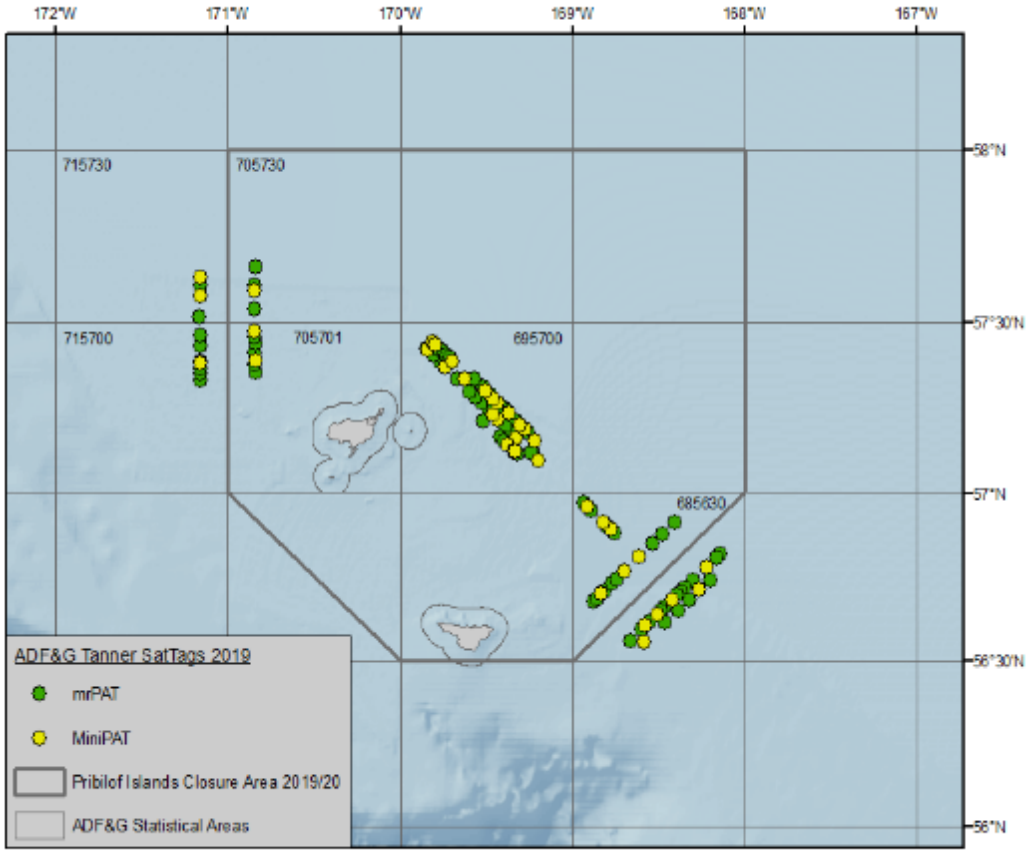
PRIBILOF ISLANDS CLOSURE AREA



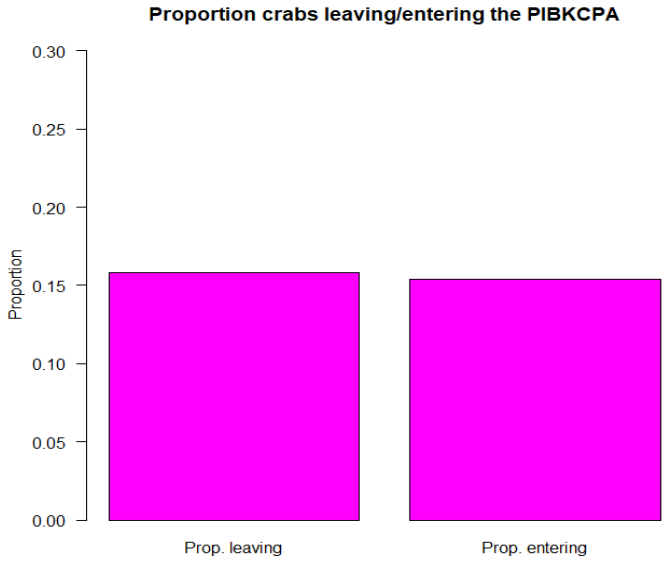


NMFS Survey Data

2019 TANNER SATELLITE TAG PROJECT

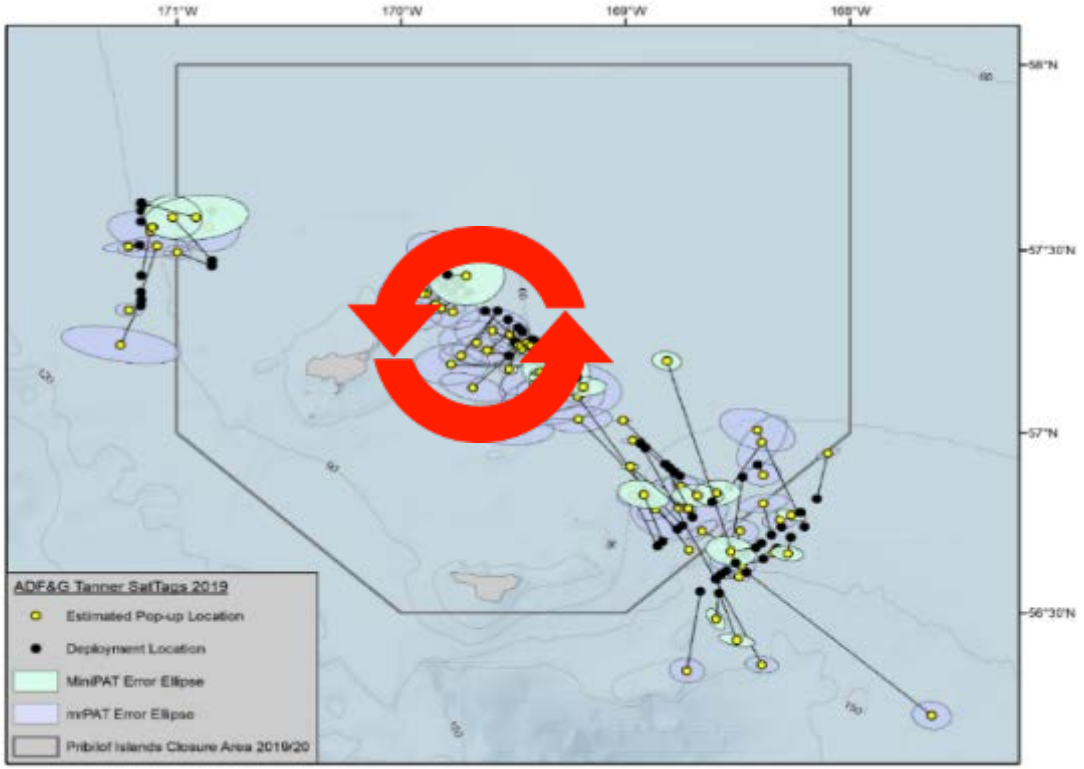


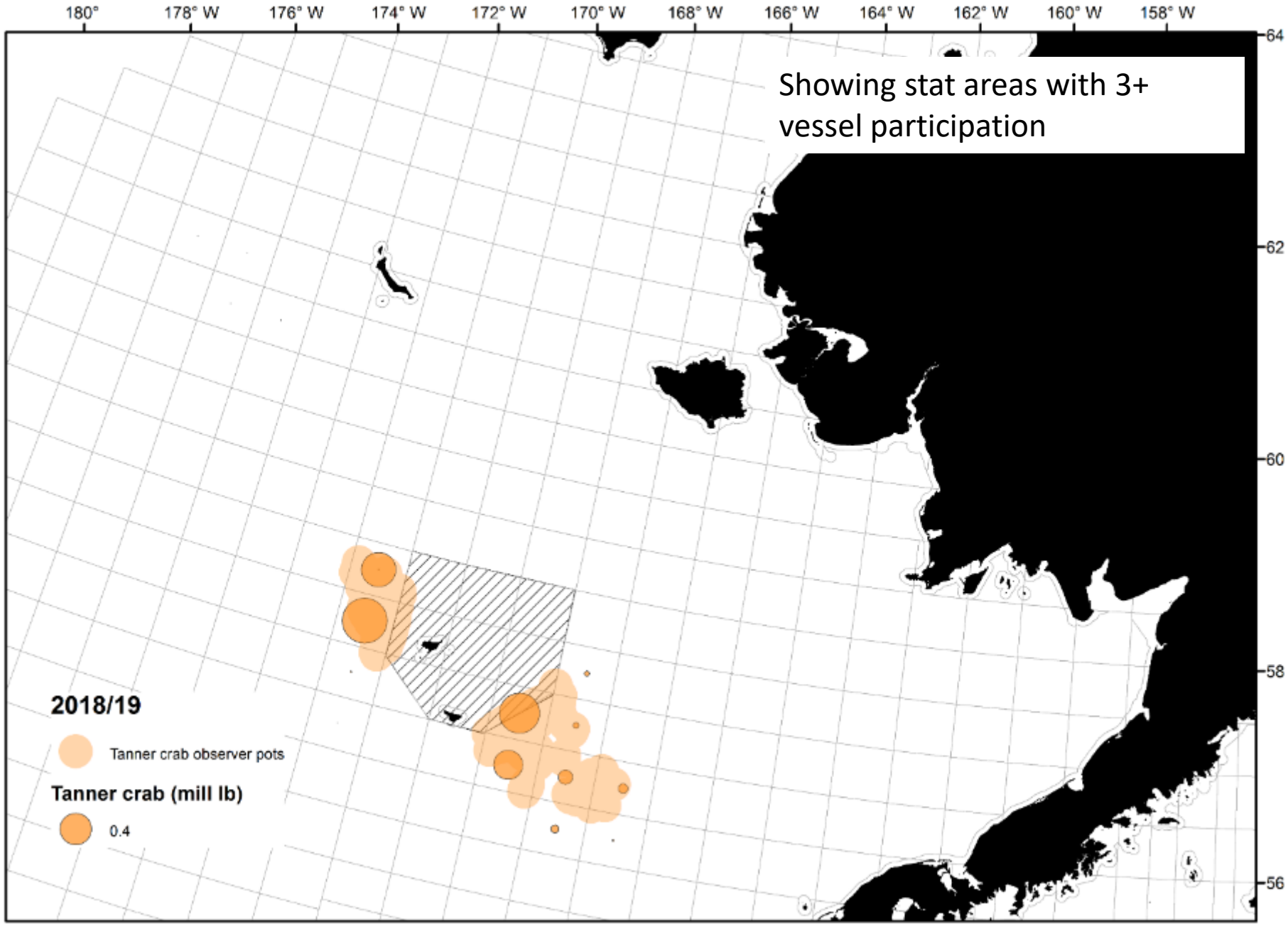
- 140 satellite tags (2 types)
- Immigration/emigration rates across area closure boundaries between survey and fishery
- Some lab work on behavioral effects of sat tags

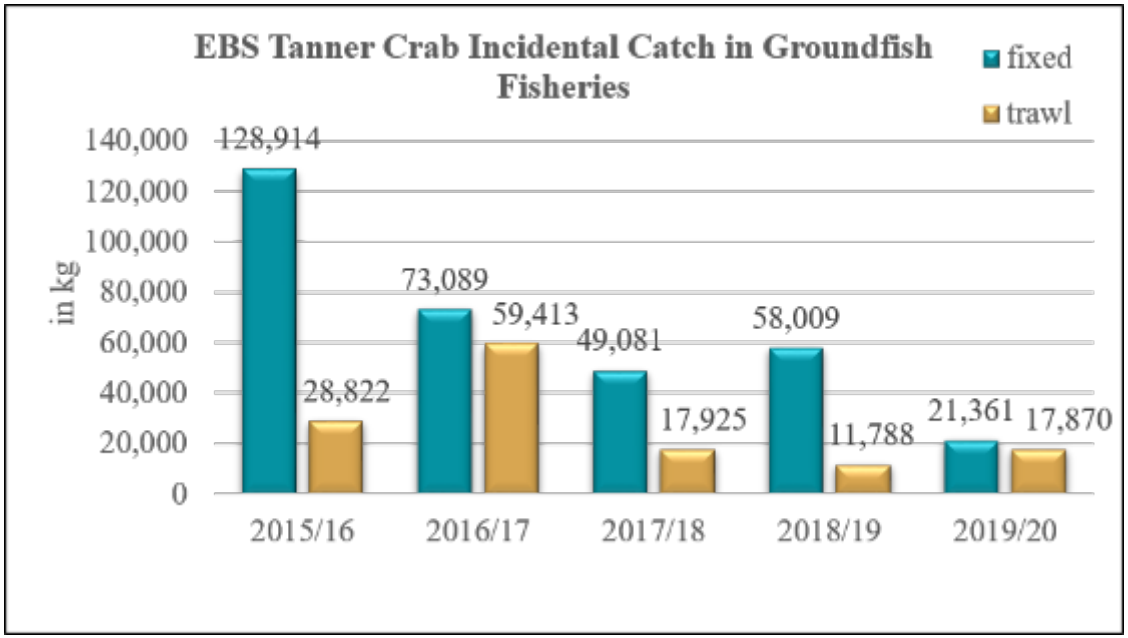


2019 TANNER SATELLITE TAG RESULTS

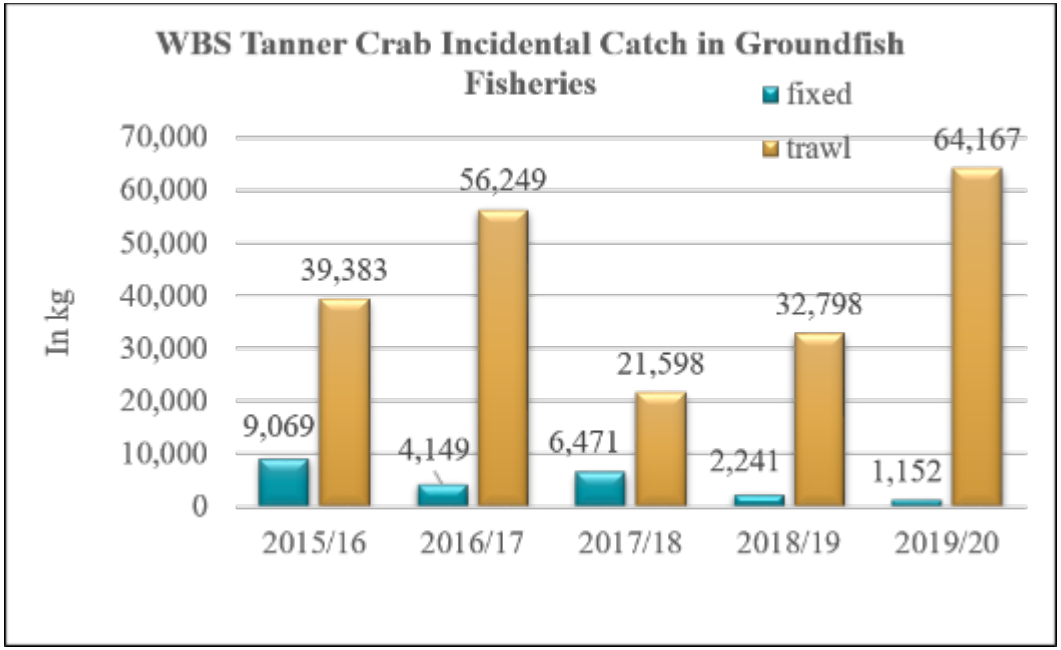
- Along boundary, similar proportion crab entering/leaving closure area
- Summer survey spatial distribution reasonable representation of the population at the time of the fishery




180°
178° W
176° W
174° W
172° W
170° W
168° W
166° W
164° W
162° W
160° W
158° W
64
62
60
58
56
Showing stat areas with 3+ vessel participation
2018/19
Tanner crab observer pots
Tanner crab (mill lb)
0.4



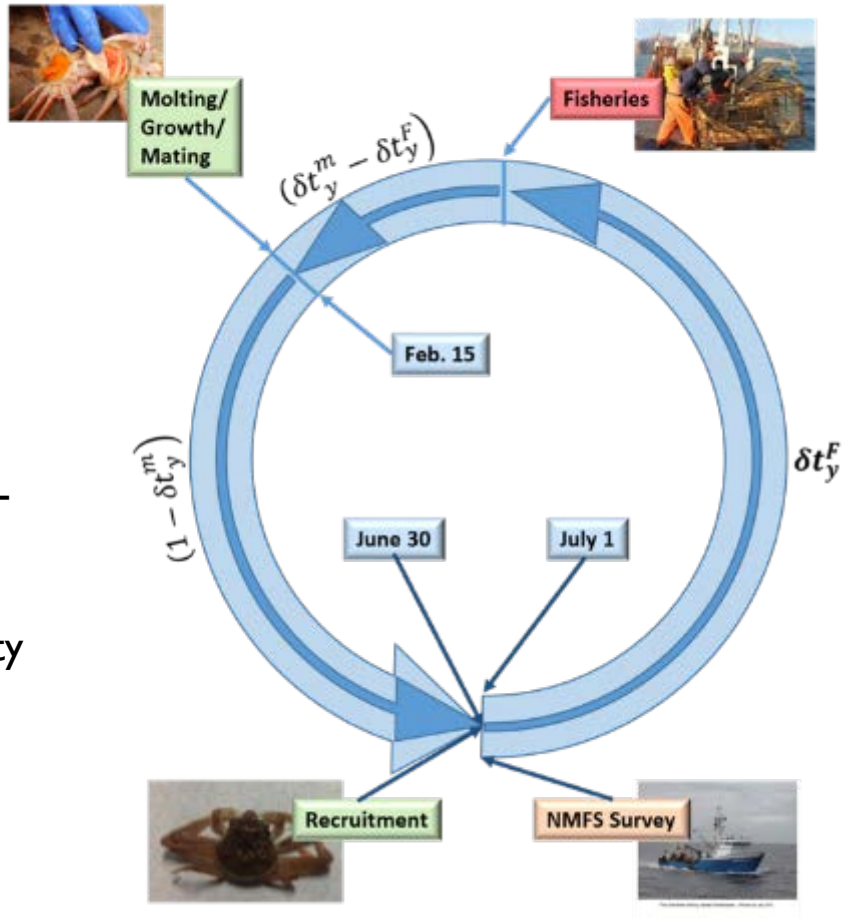
Eastern Bering Sea (EBS) Tanner crab is East of 166° W



Western Bering Sea (WBS) Tanner crab is West of 166° W

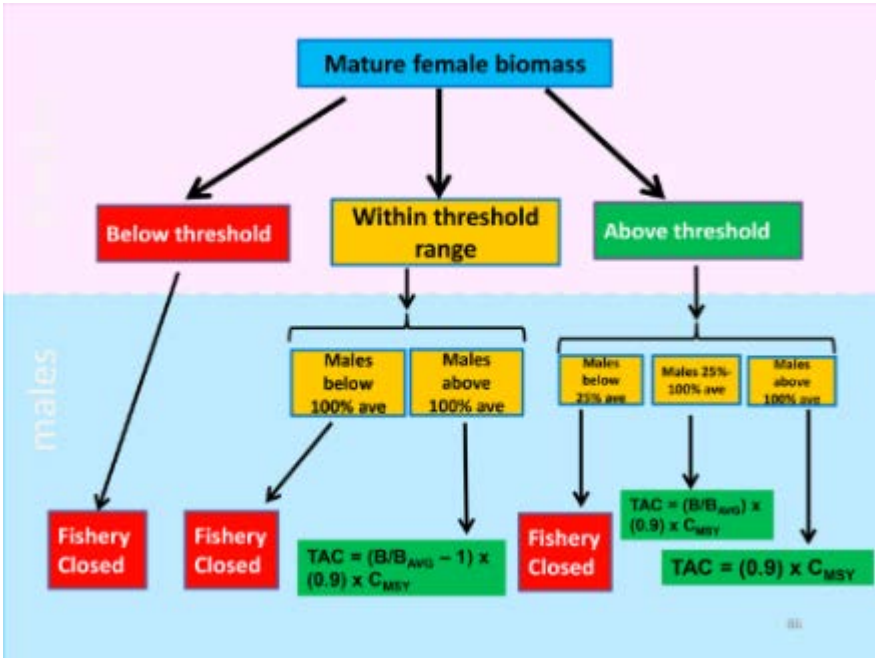
TANNER CRAB STOCK ASSESSMENT MODEL

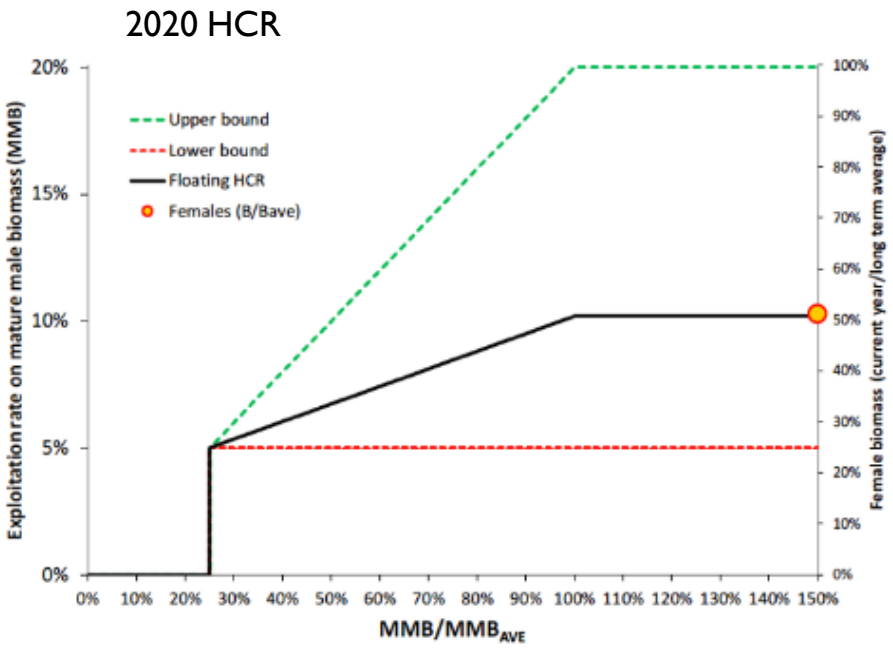
- TCSAM02 was endorsed by the SSC in 2017
- Model is structured by size, sex, shell condition, maturity state
- Model includes priors on natural mortality, smoothing penalties on recruitment and the proportion maturing
- sex-specific growth & maturity (after fisheries) pre-molt/post-molt size transition matrix
- size-specific probability of terminal molt to maturity



STATE MANAGEMENT: NEW HARVEST CONTROL RULE

- Based on
  - BSFRF, ADFG, UW, AFSC cooperative research
  - Madi Shipley MS Thesis (successfully defended 9/11/20!!)
  - Daly et al., 2020





MODEL SCENARIOS

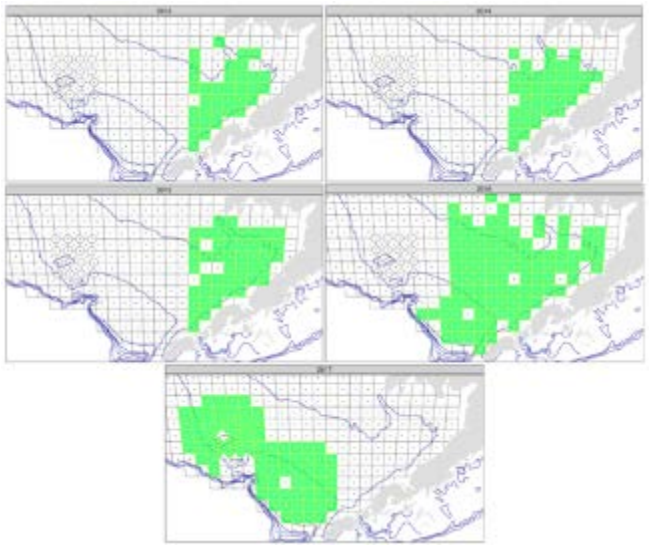
Assessment

- 3 scenarios evaluated for 2020 assessment
- 19.03(2020): updated 2019 assessment model
  - Bycatch data added for 2019/20
- New models use BSFRF-NMFS SBS data
  - 20.07:
    - availability curves for SBS data determined outside model
    - fits BSFRF SBS data
  - 20.10:
    - NMFS survey catchability determined outside model
    - fits to NMFS data only

Other model explorations

- Reduced complexity scenarios
  - male only
  - directed fishery (TCF) only
  - TCF + snow crab fishery only
- Alternative parameterizations
  - lognormal fits to fishery catch data
  - half-normal selectivity functions
  - fixed M
- Goal: eliminate parameters at bounds
  - some success, not complete

Empirical Availability: Females

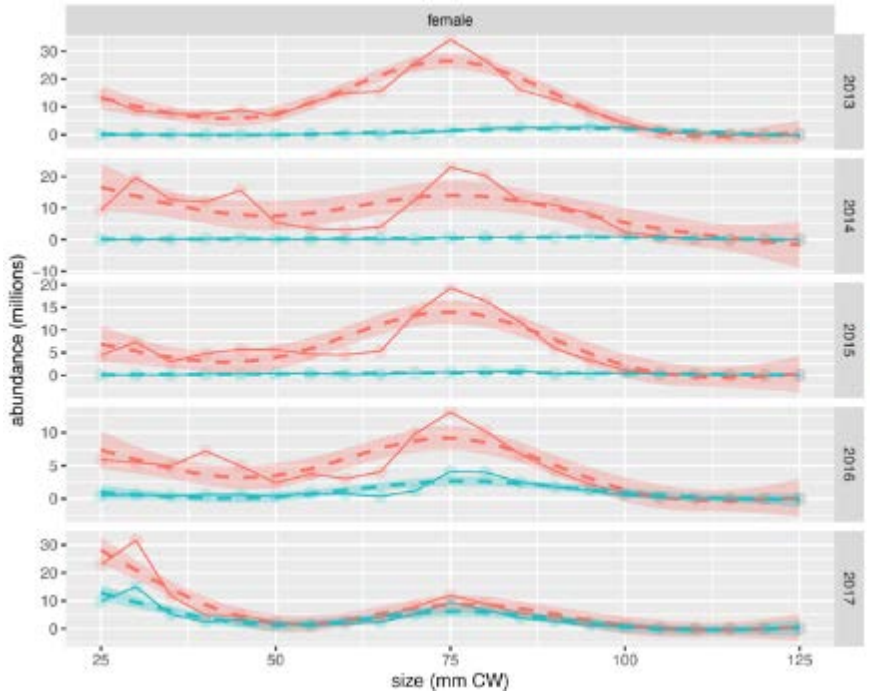


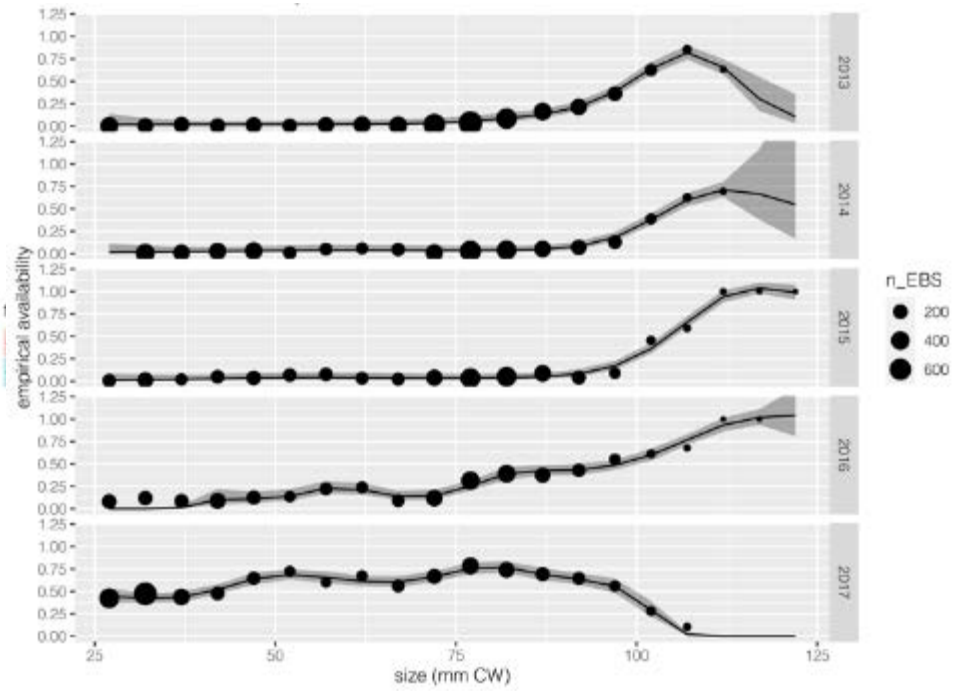
$$A_z^{SBS} = \frac{N_z^{NMFS\ SBS}}{N_z^{NMFS\ EBS}} \cdot e^{\varepsilon_z}$$

- Found best fitting cubic spline GAM by year to

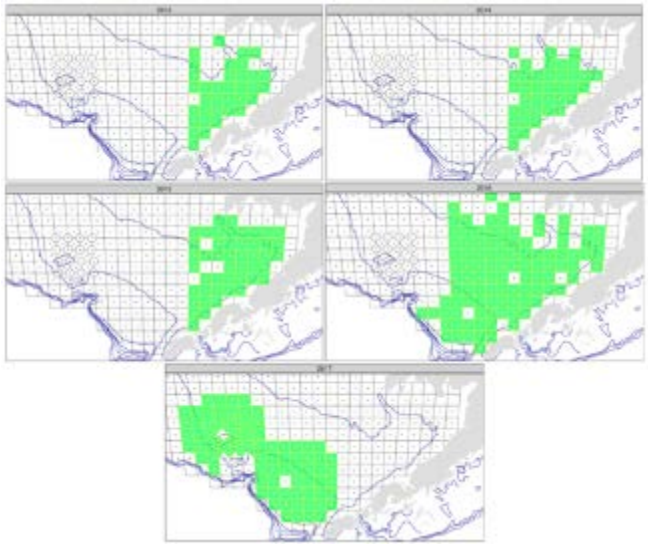
$$ln(A_z^{SBS}) \sim N(cs(z), \sigma_z^2)$$

- using gcv to determine optimal dof's





Empirical Availability: Males

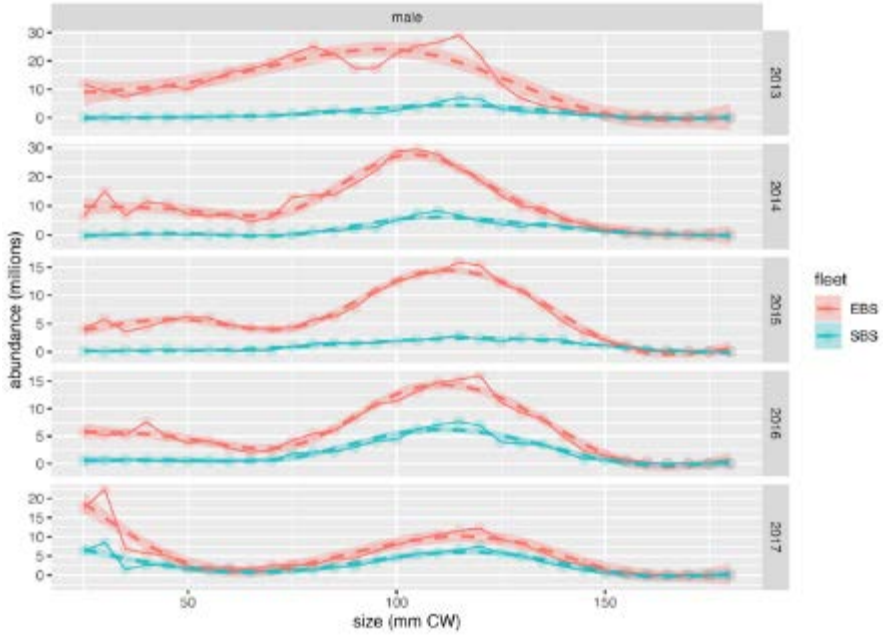


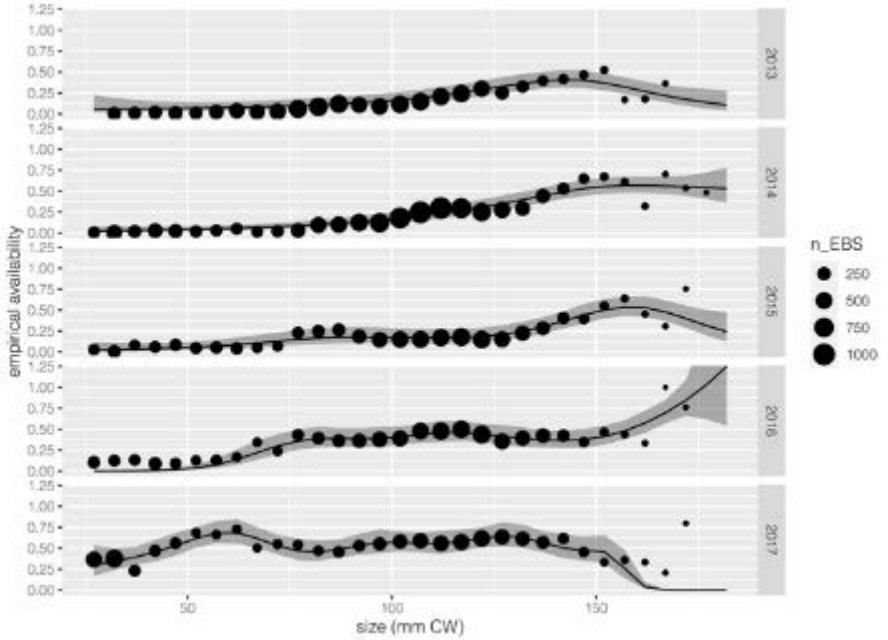
$$A_z^{SBS} = \frac{N_z^{NMFS\ SBS}}{N_z^{NMFS\ EBS}} \cdot e^{\varepsilon_z}$$

- Found best fitting cubic spline GAM by year to

$$ln(A_z^{SBS}) \sim N(cs(z), \sigma_z^2)$$

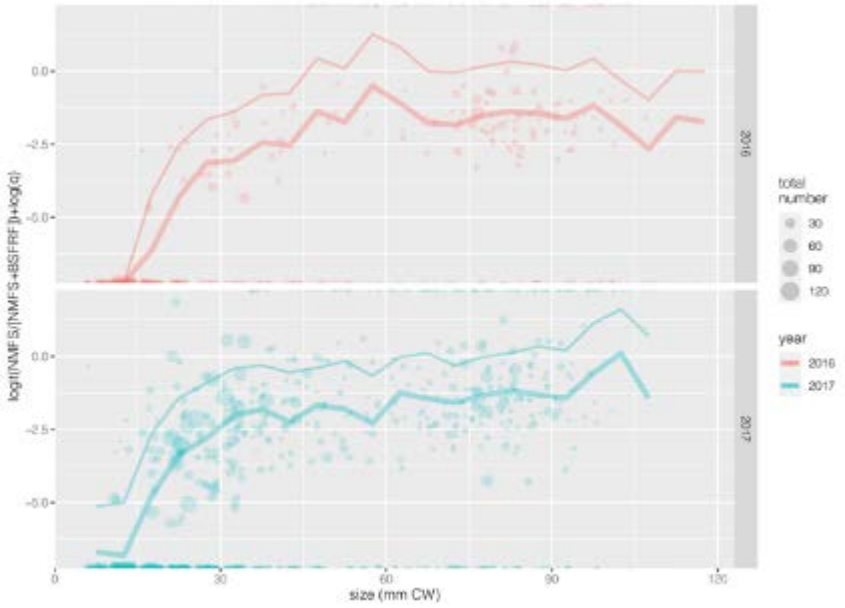
using gcv to determine optimal dof's



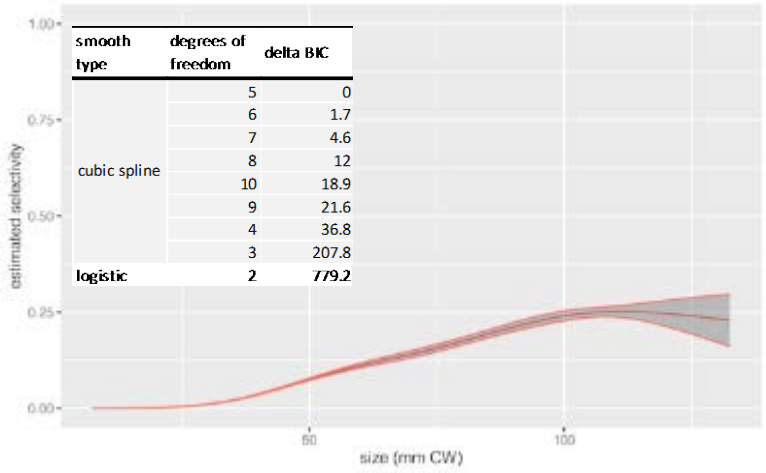


Empirical Catchability

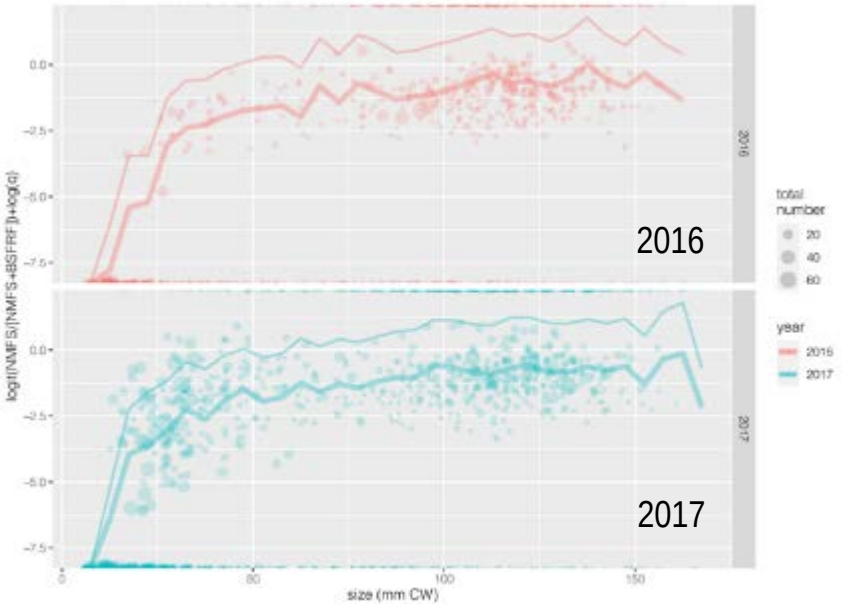
females



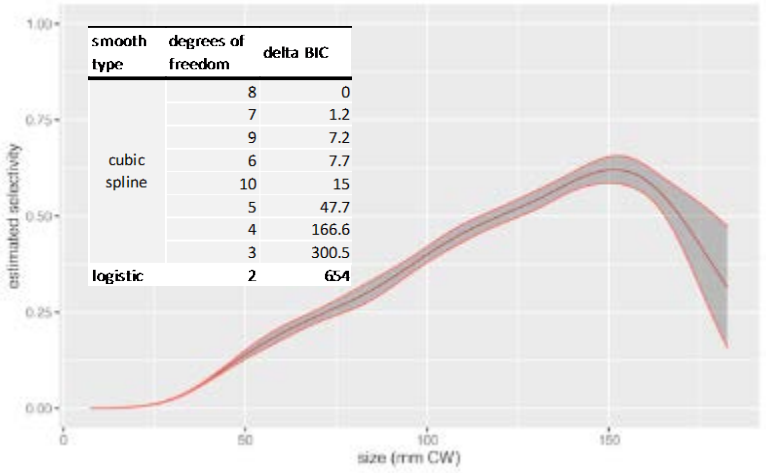
smooth type	degrees of freedom	delta BIC
cubic spline	5	0
	6	1.7
	7	4.6
	8	12
	10	18.9
	9	21.6
	4	36.8
	3	207.8
logistic	2	779.2



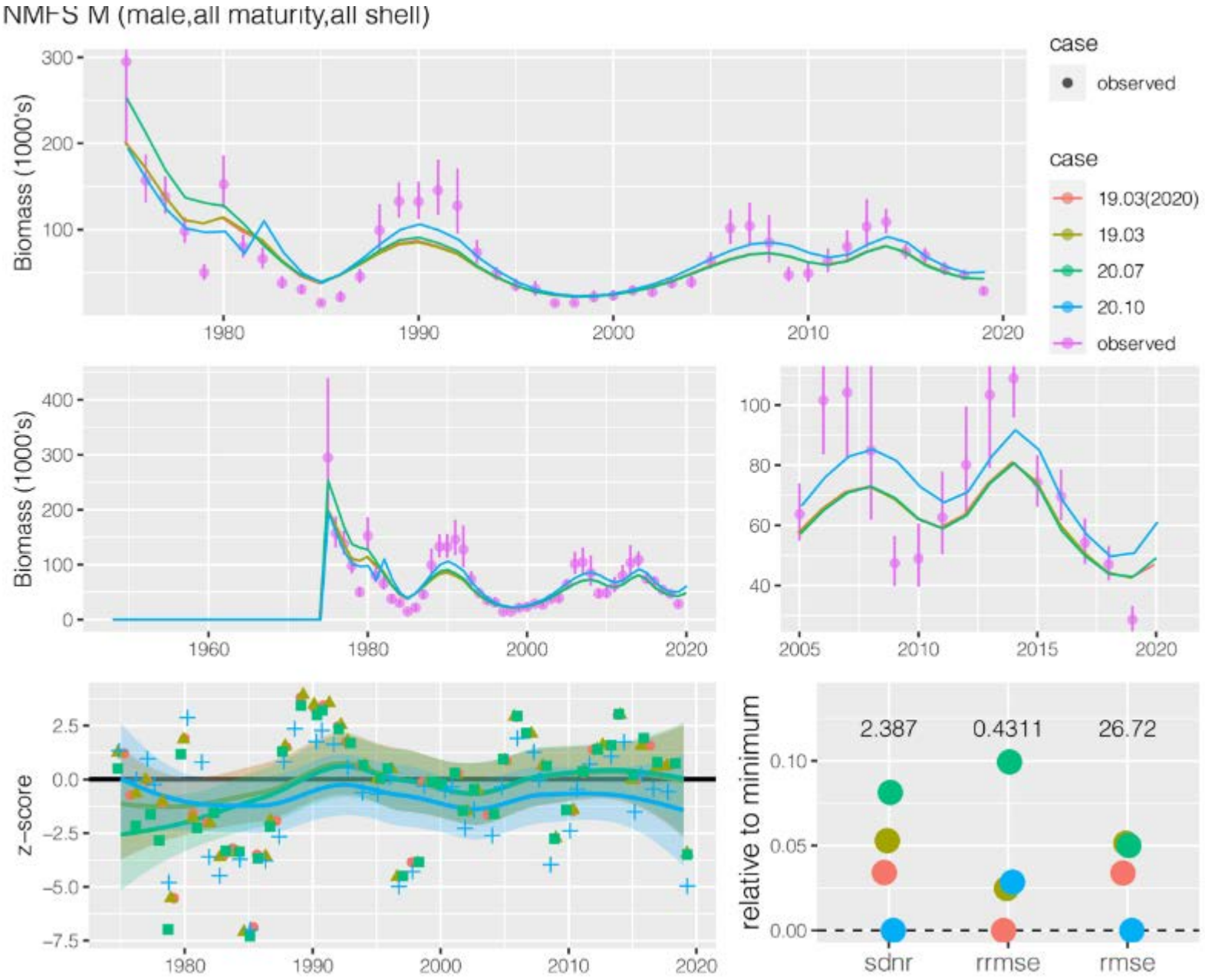
males



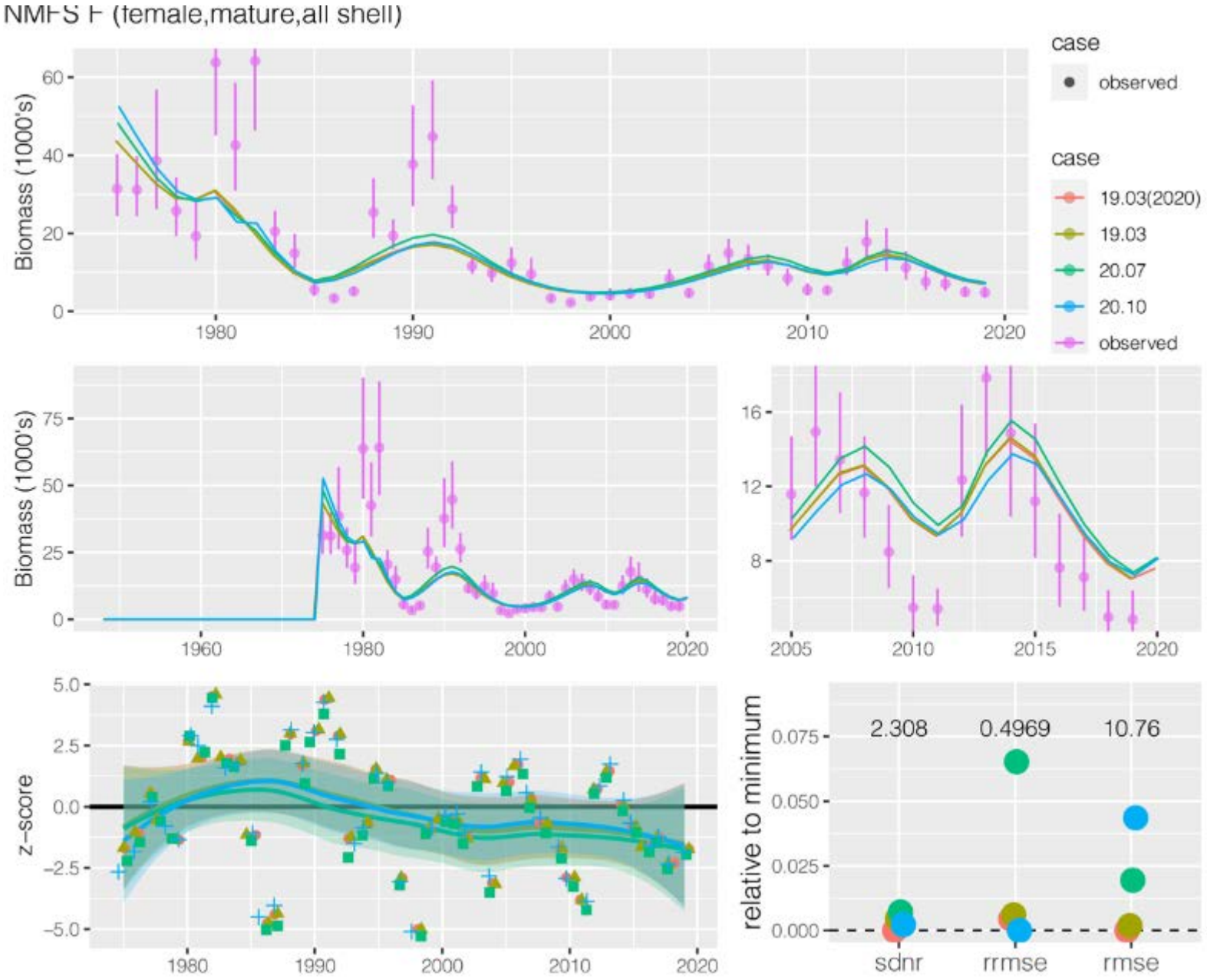
smooth type	degrees of freedom	delta BIC
cubic spline	8	0
	7	1.2
	9	7.2
	6	7.7
	10	15
	5	47.7
	4	166.6
	3	300.5
logistic	2	654



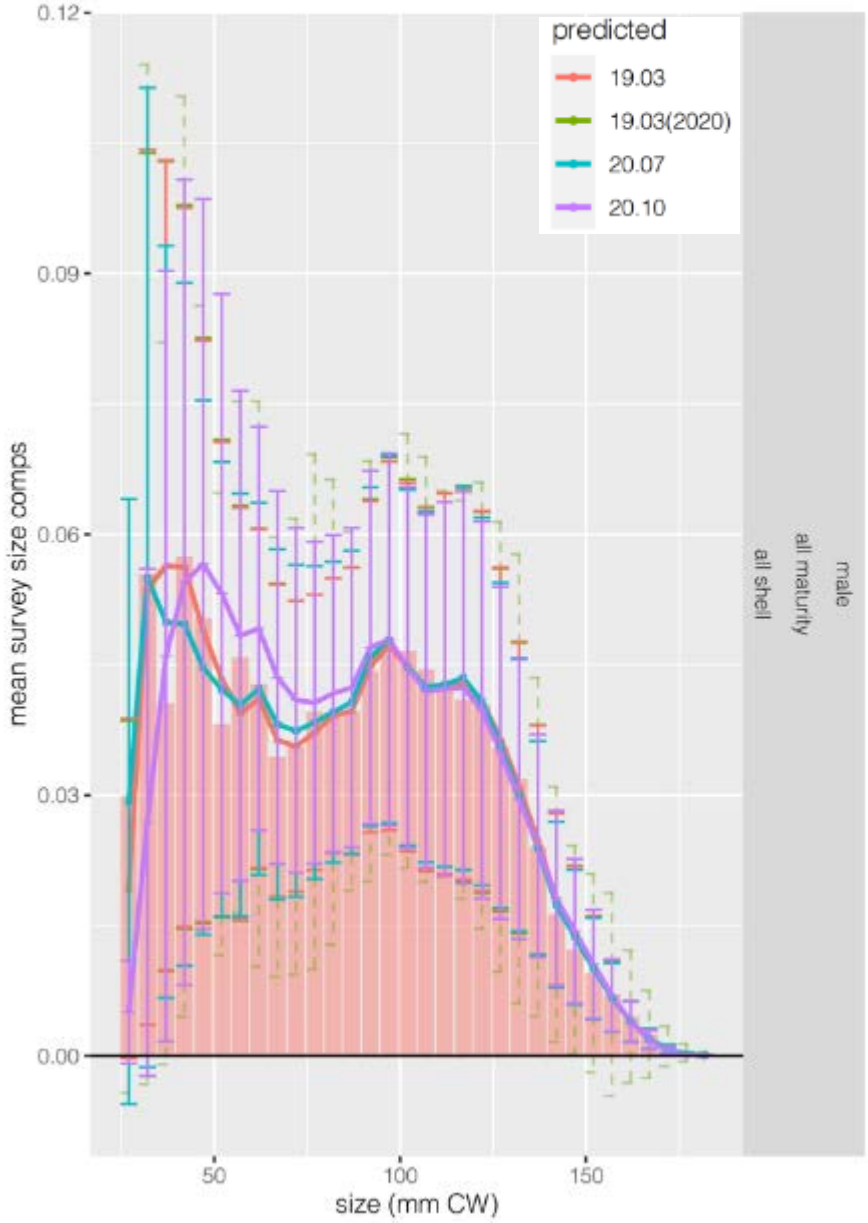
Model Evaluation: Fits to NMFS Survey Biomass

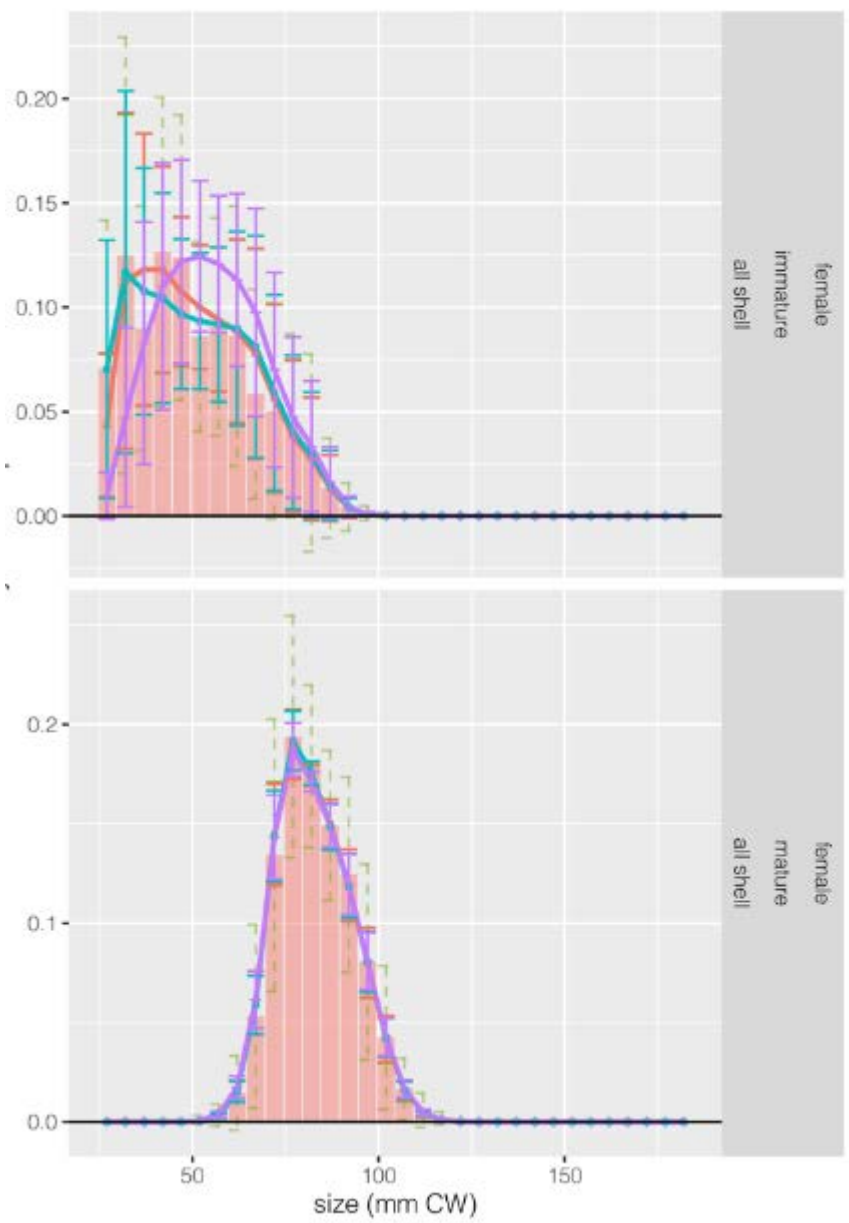


Model Evaluation: Fits to NMFS Survey Biomass

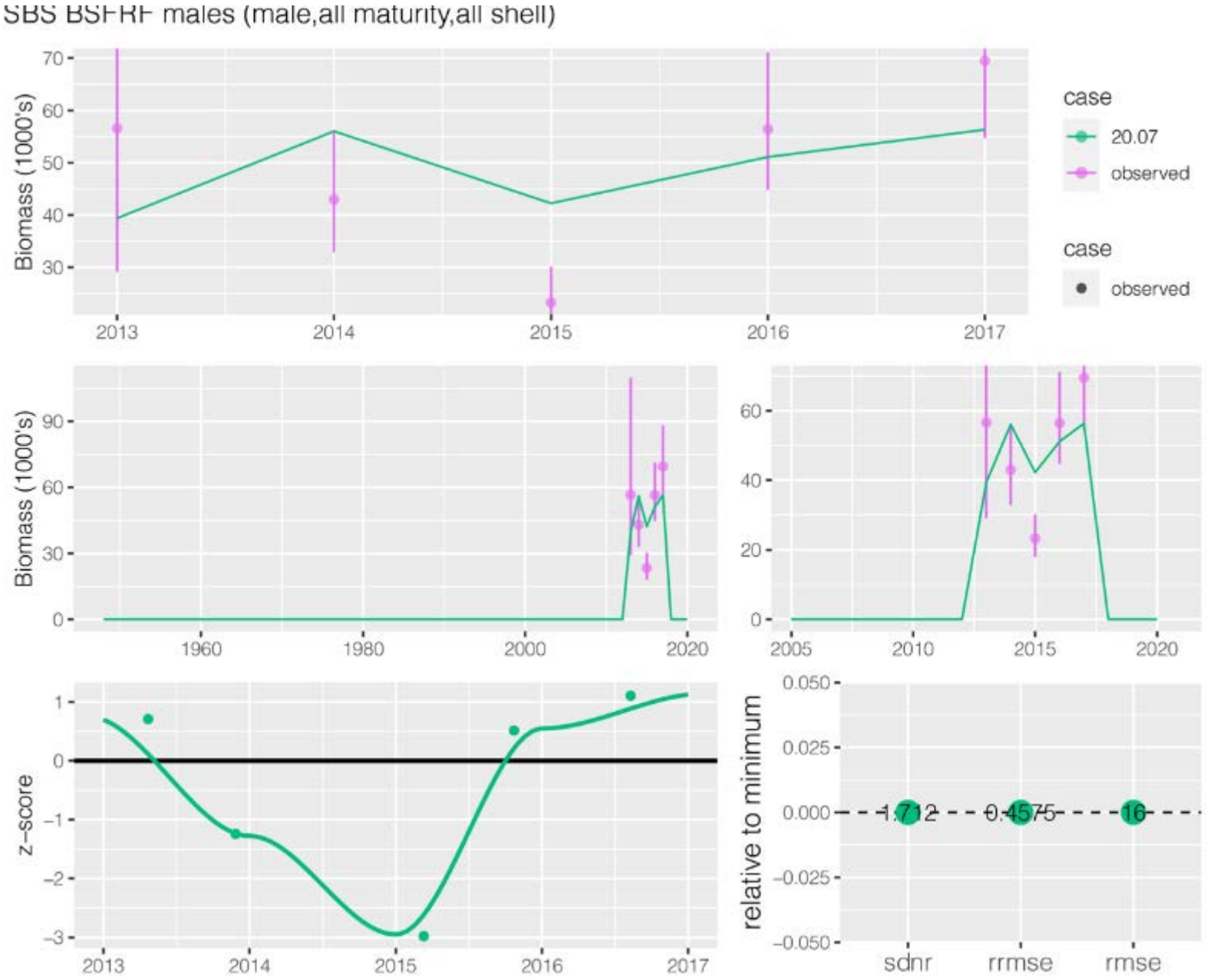


Model Evaluation: Fits to NMFS Survey Size Comps

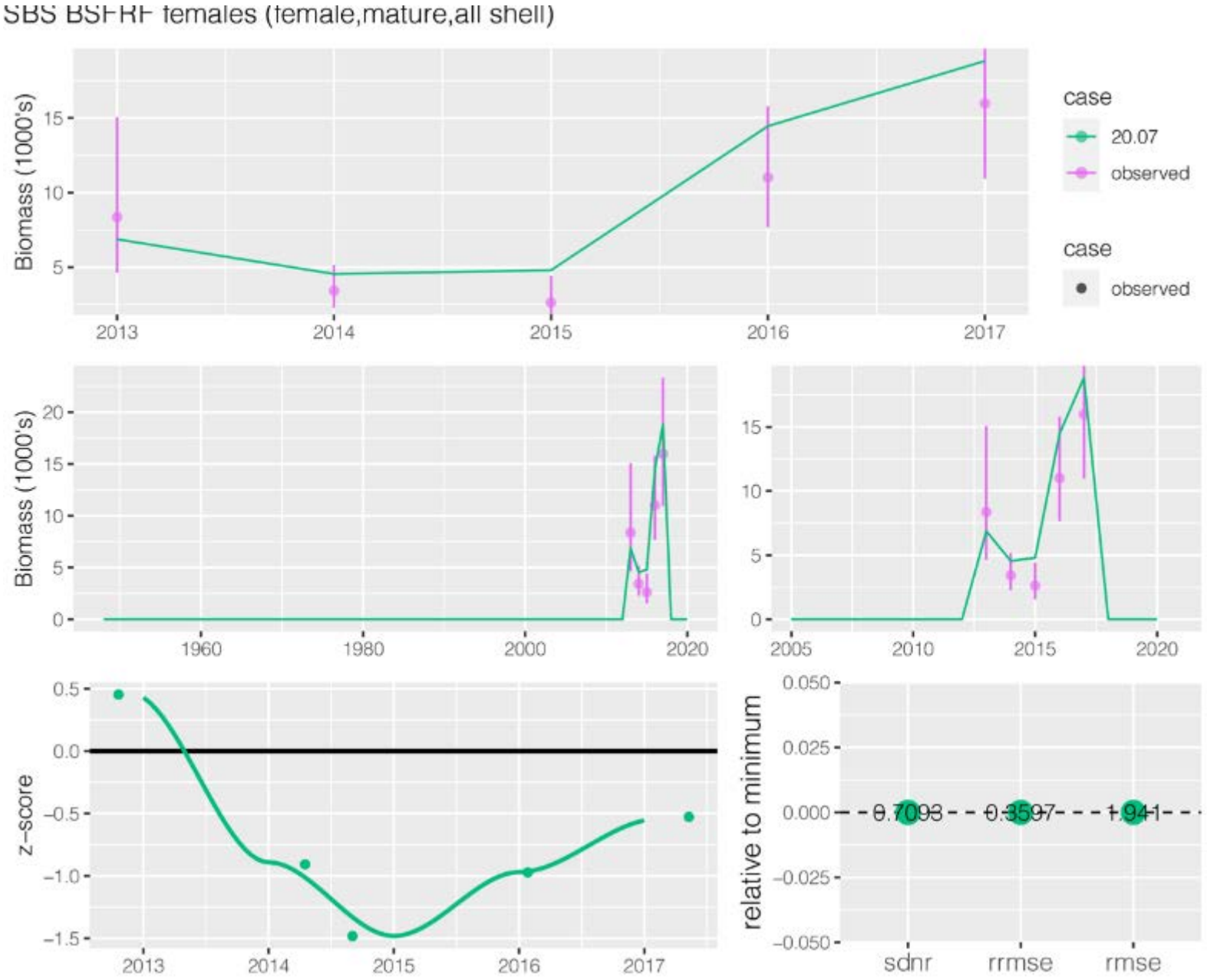




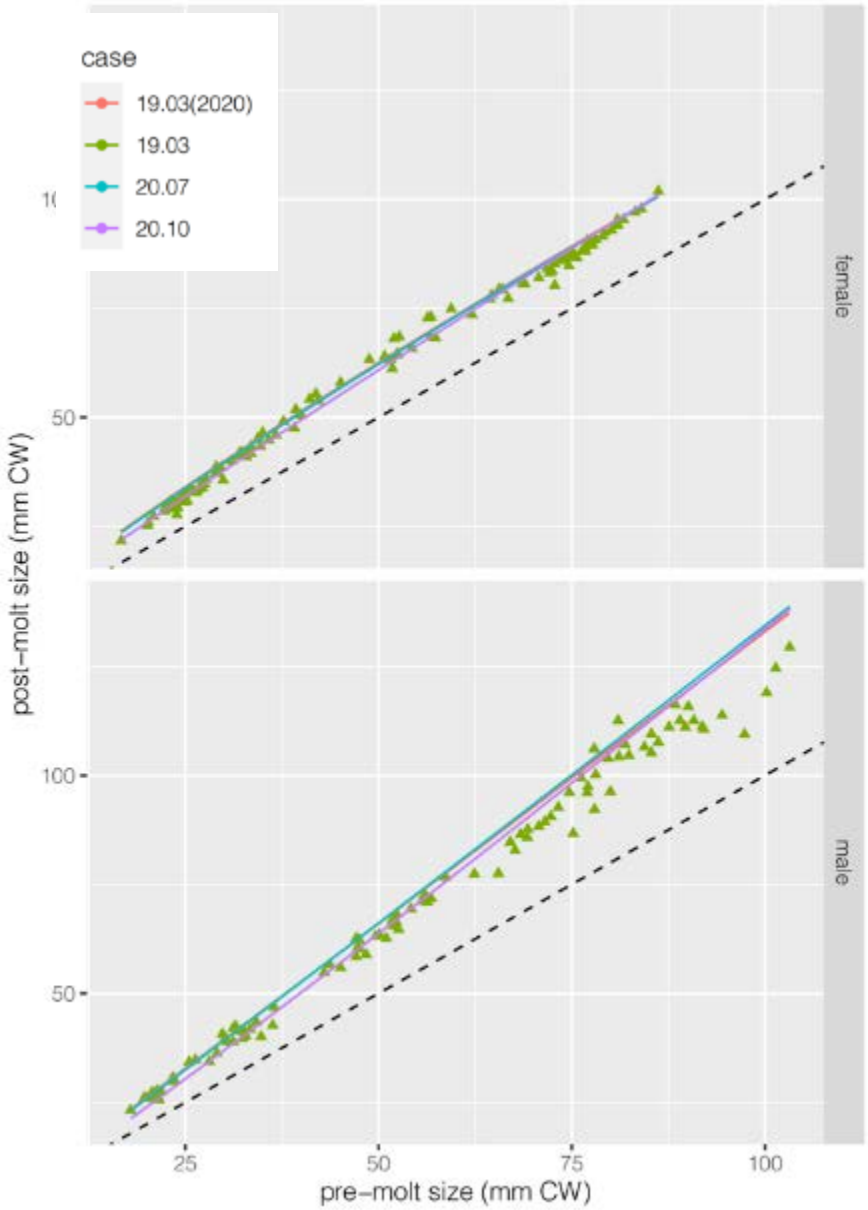
Model Evaluation: Fits to BSFRF SBS Survey Biomass

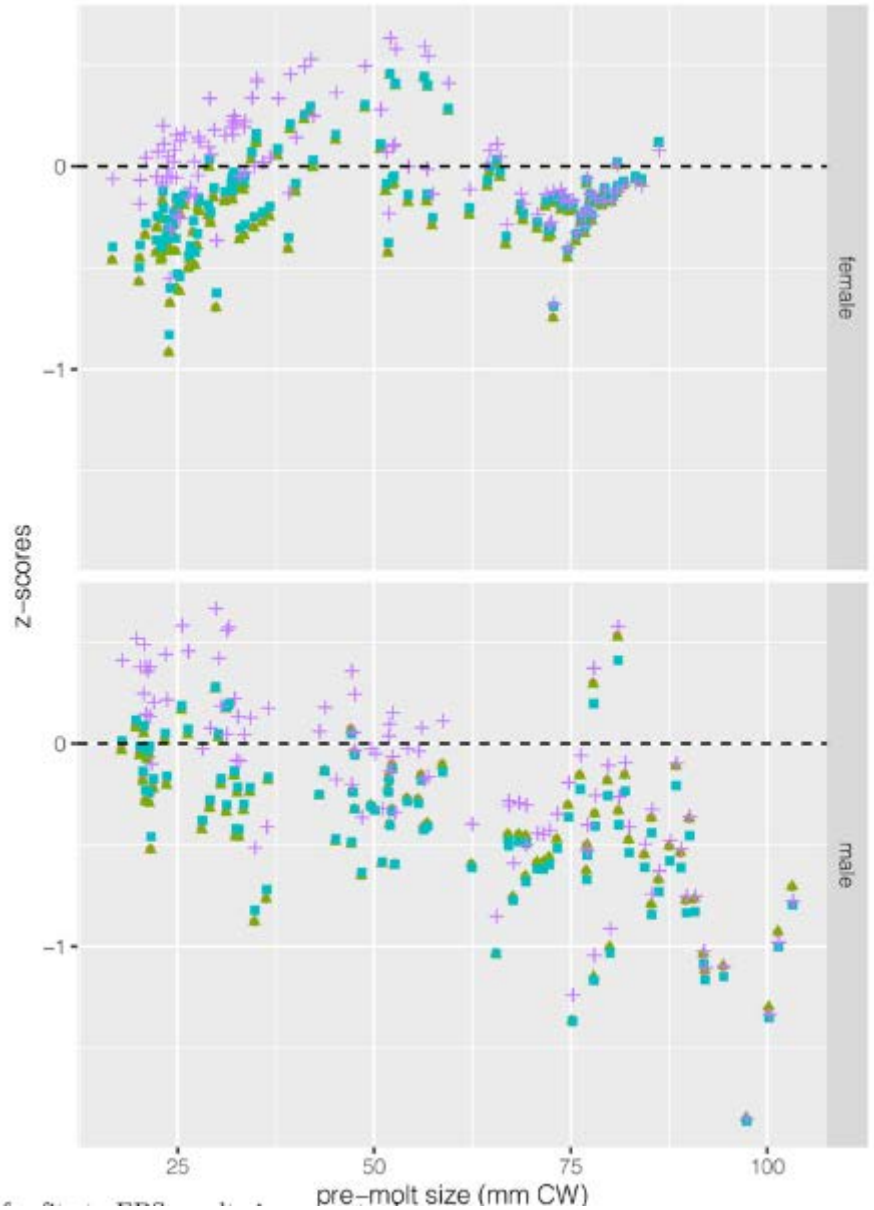


Model Evaluation: Fits to BSFRF SBS Survey Biomass

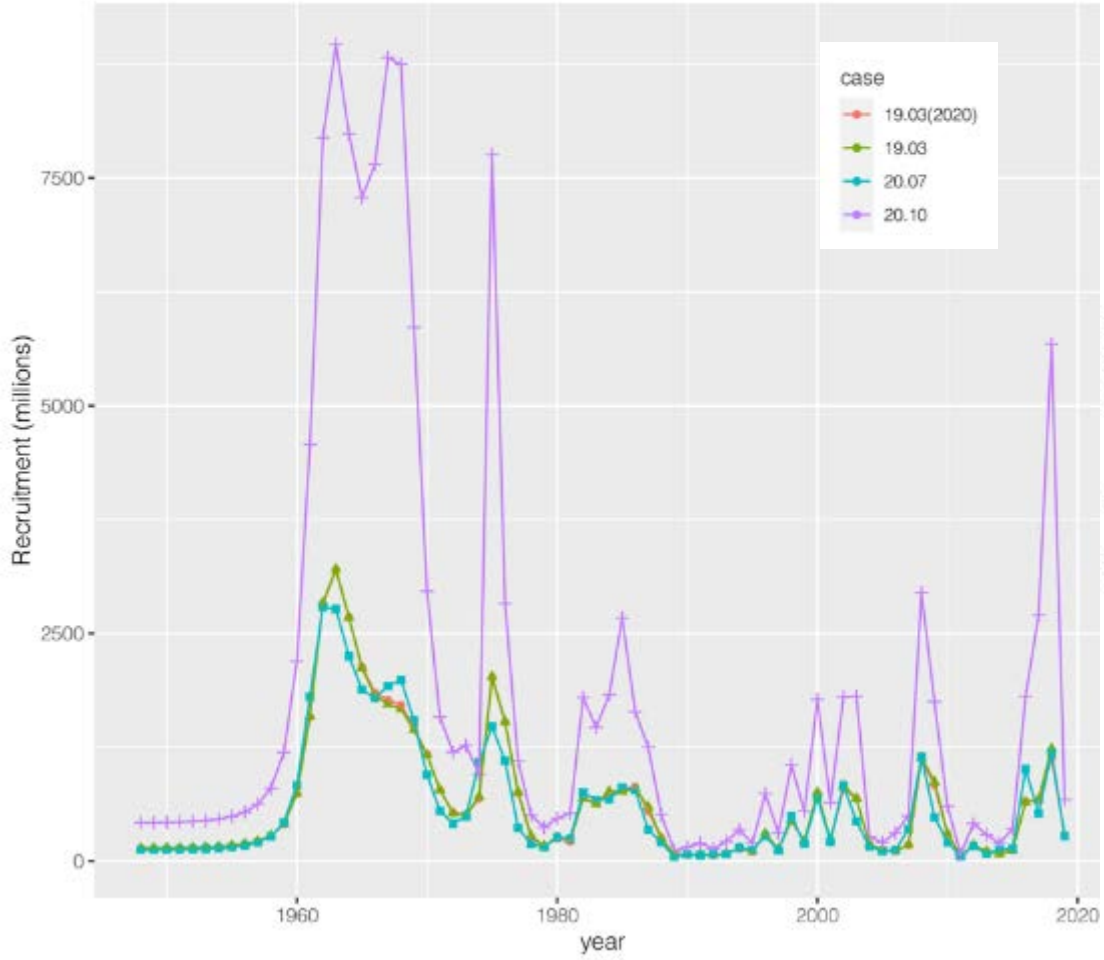


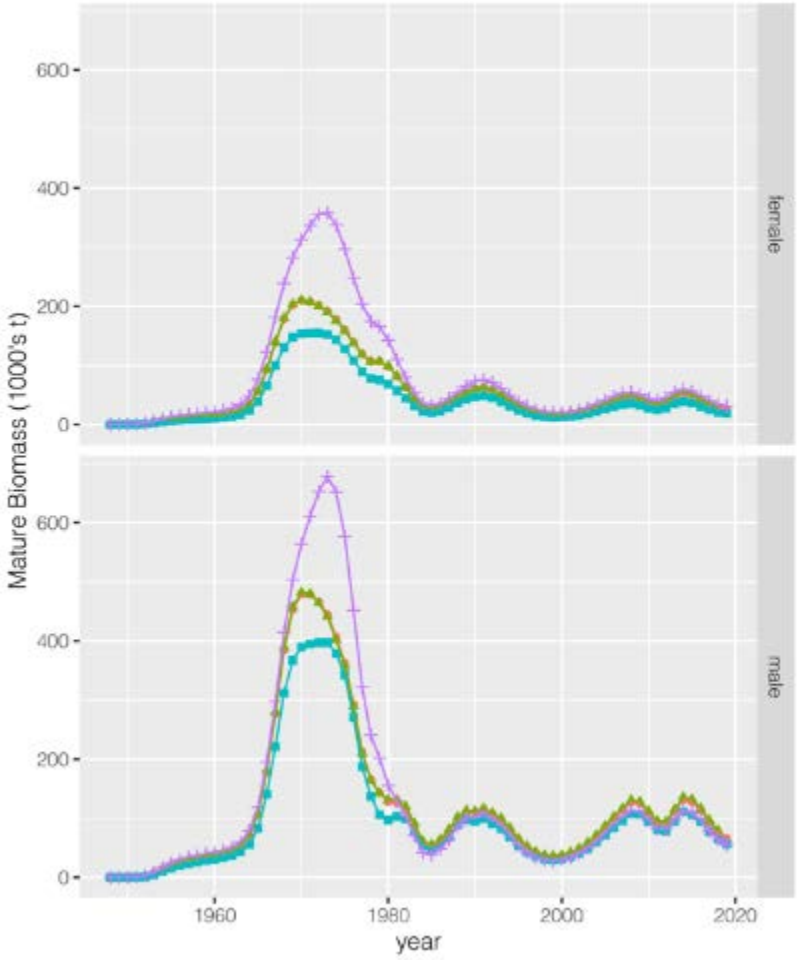
Model Evaluation: Fits to Growth Data





Model Evaluation: Trends in Recruitment and Mature Biomass





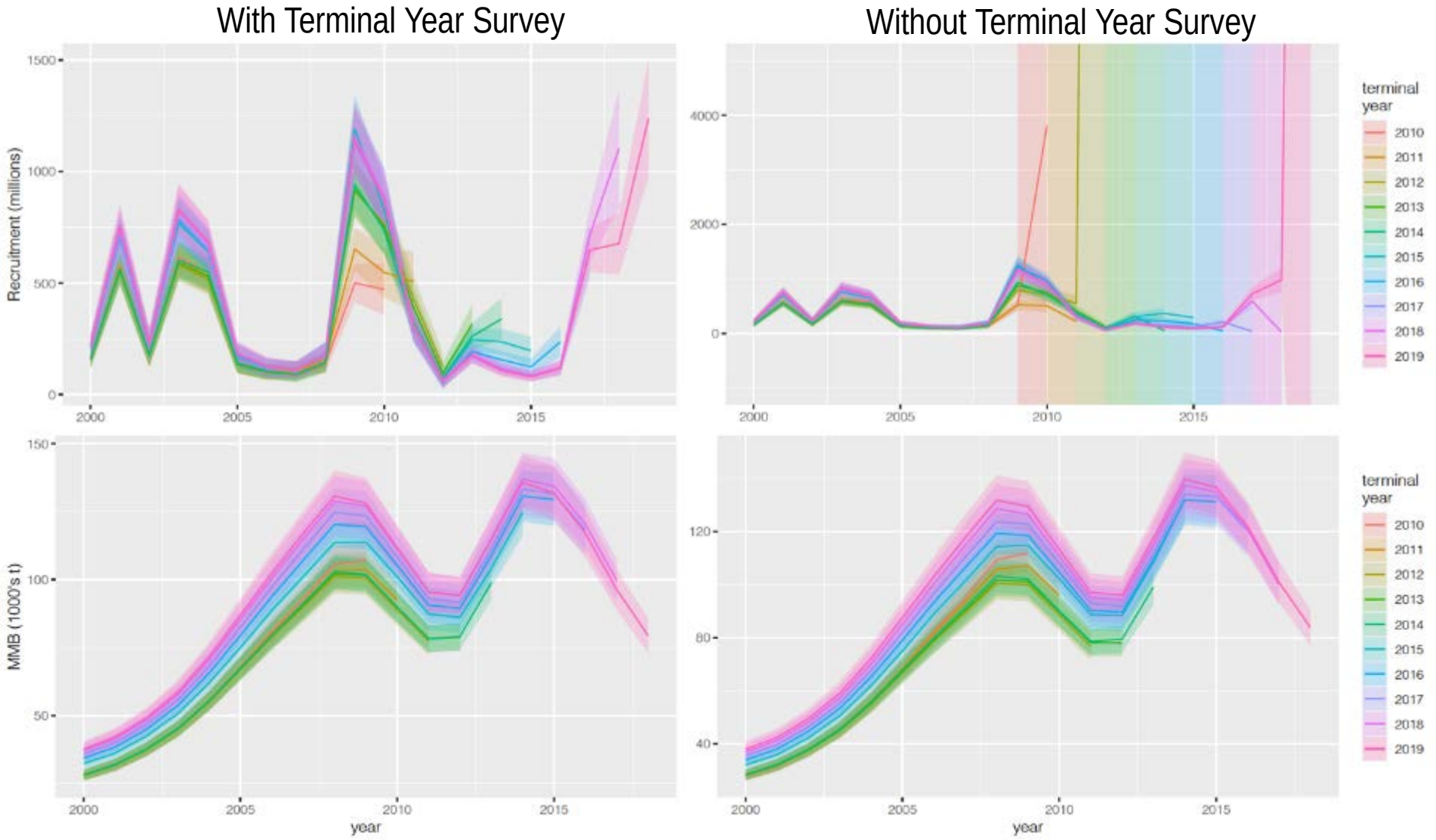
Model Evaluation: Author's Preferred Scenario

Author's preferred scenario: 20.07

- Pro's:
  - Includes BSFRF SBS data to set scale
  - Fits to data similar to base model
  - Slightly better retrospective patterns
  - MCMC results better (but still inadequate mixing)
  - Fewer problematic parameter estimates

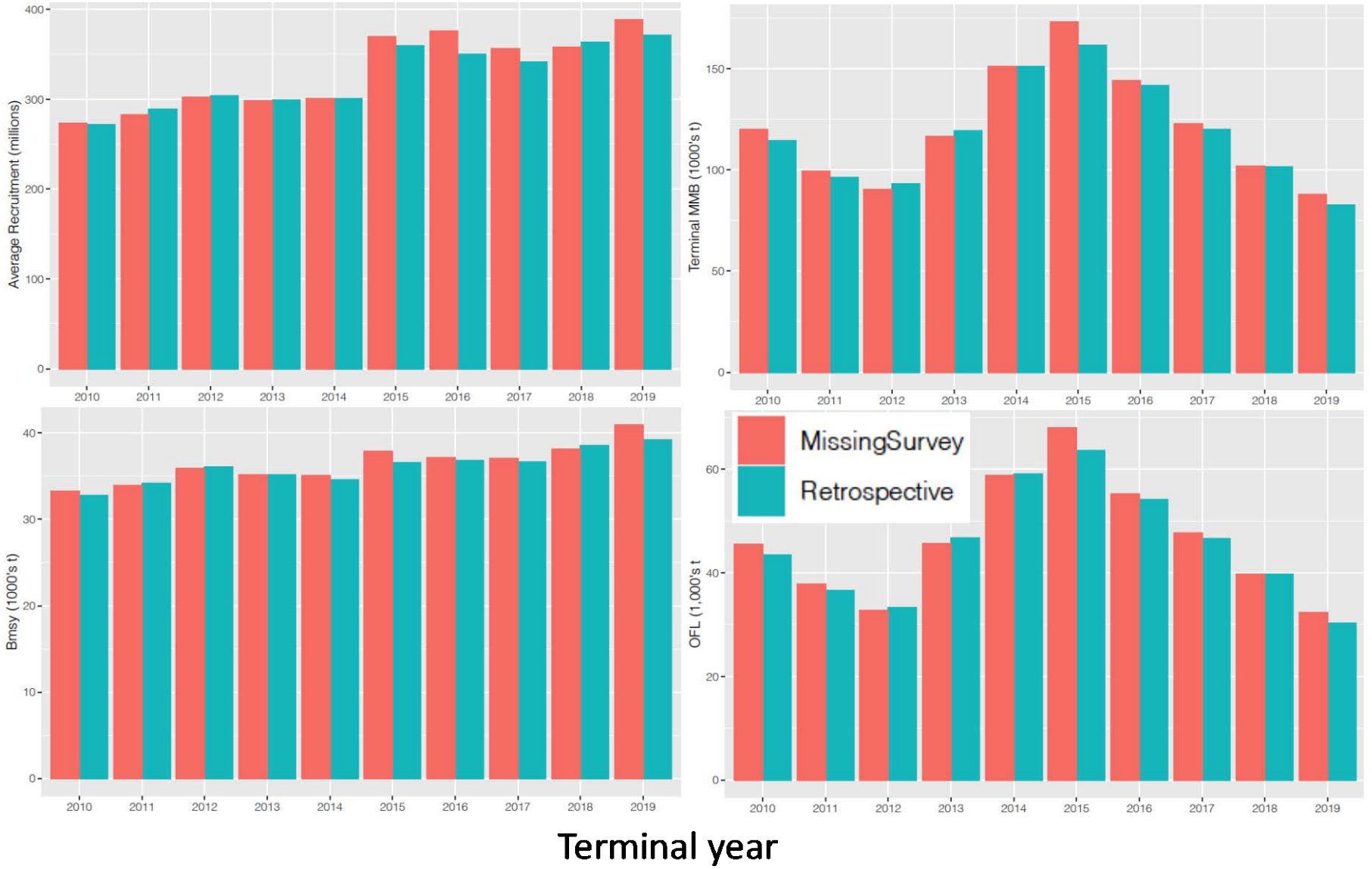
- Con's:
  - Doesn't fit most datasets quite as well as base model (not surprising given extra fits to BSFRF data)
- The CPT agreed with the author, and identified scenario 20.7 as the preferred model. Recommended using MLE estimates rather than the MCMC draws for harvest specification table.

Missing Survey Uncertainty: 19.03 Retrospective Analysis

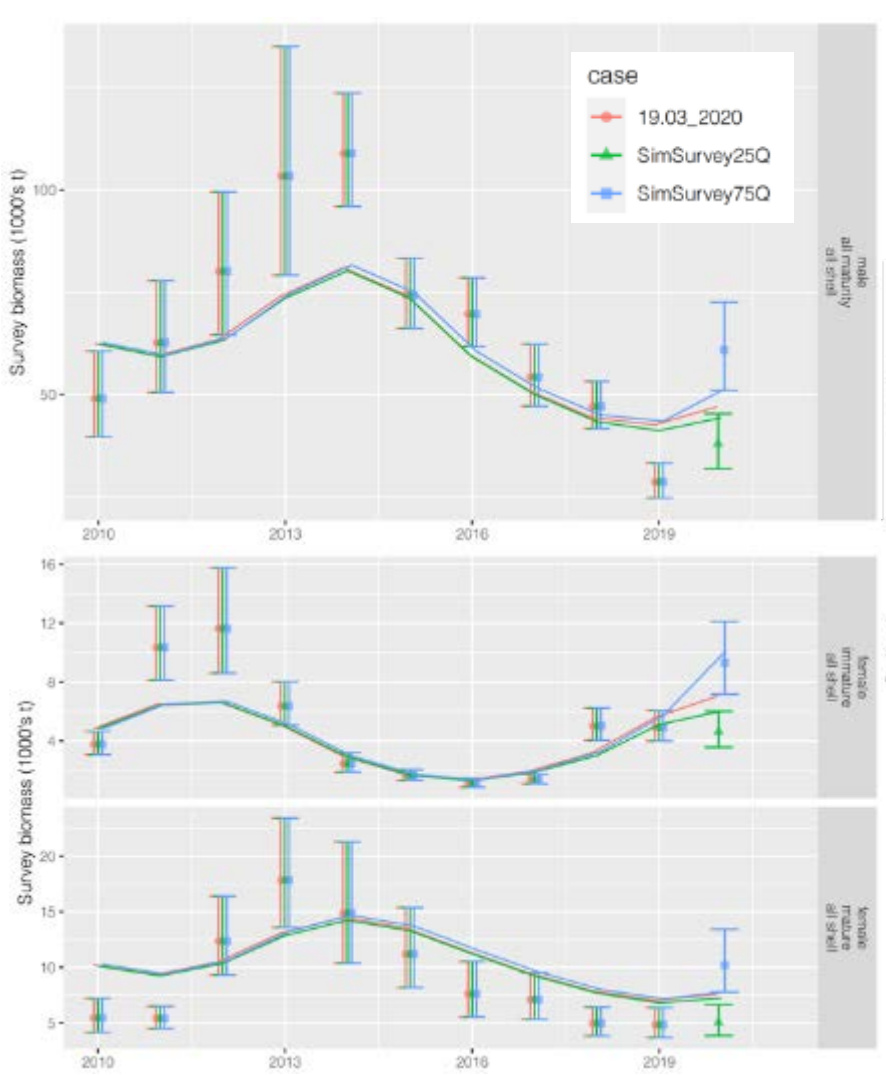


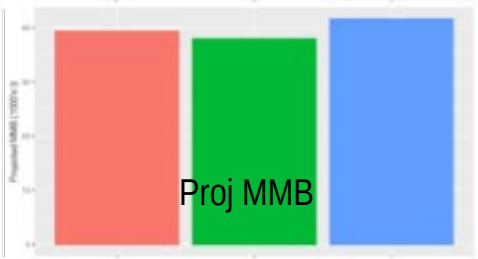
Missing Survey Uncertainty: Retrospective Without Terminal Year Survey

Recruitment averaging: 1982 – (terminal year-1)



Characterizing missing survey uncertainty: simulated 2020 survey





STATUS AND CATCH TABLE

- Author preferred scenario: 20.07
- Period for average recruitment: 1982-2019

20.07: MLE

units: 1000's t

2016/17	14.58	77.96	0.00	0.00	1.14	25.61	20.49
2017/18	15.15	64.09	1.13	1.13	2.37	25.42	20.33
2018/19	20.54	82.61	1.11	1.11	1.90	20.87	16.70
2019/20	18.38	56.15	0.00	0.00	0.54	28.86	23.09
2020/21		35.33				21.13	16.90

CPT DISCUSSION ON ABC BUFFERS FOR TANNER CRAB

- In 2019 the SSC identified poor model performance, such as parameters being hitting bounds and poor convergence properties, as the rationale for recommending that a 20% buffer continue to be used for Tanner crab.
- Although there have been some improvements to the model to address these issues, they are still present in current assessment.
- The CPT noted that retrospective patterns for Tanner crab were minimal and did not increase substantially when the terminal year survey was removed.
- An exception was the estimates of recruitment in the terminal year, which could fluctuate wildly when survey data were not available. This variation did not have management implications since recruiting crab are neither mature nor legal sized.
- The sensitivity analysis with a high and a low hypothetical 2020 survey did not indicate high sensitivity in estimates of the OFL and mature male biomass.
- The CPT recommends that the SSC continue to use a buffer of 20% to deal with assessment uncertainties. No additional buffer is recommended to deal with the cancellation of the 2020 survey.

Summary of CPT recommendations on the 2020 survey cancellation

Stock	2019/20 ABC buffer	2020/21 proposed ABC buffer	Rationale	Status/ Trend in MMB	Uncertainty analysis results	Proposed additional 2020 buffer
BBRKC	20%	20%	- Overpredicting recent survey (18,19) - Cold pool distribution shifts - Align with other crab stocks - Long-term declining trend	0.59 / Down	Medium. Reduced ability to determine stock status; stock is close to overfished threshold	5%
Snow	20%	25%	- Model structure uncertainties (unexpected change in recent recruitment, i.e. 2015) - Retrospective patterns - Uncertainty around M - Discrepancy between 2018 and 2019 survey data - Specification of recruitment penalty	2.43 / Up	Strong positive retrospective bias, without survey overestimating OFL. Very sensitive to the terminal survey estimate	25%
SMBKC	20%	25%	- Overfished - Poor model fit to survey data - Data poor stock - Unfavorable environment	0.34 / Flat	Minimal. Recent years underestimate OFL without survey	none
Tanner	20%	20%	- Parameters hitting bounds - Poor convergence	0.96 / Stable (down slightly)	Minimal.	none

BALANCE OF CPT REPORT

SUBGROUP REPORT: STOCK PROJECTIONS FOR CRAB ASSESSMENTS

- A subgroup of CPT met Aug 12 to discuss methods of stock projections.
- This was in response to SSC request for longer-term projections under realistic exploitation scenarios
- The subgroup recommends:
  - Projections should extend 5 years.
  - Projections should be based on average 5-year fishing mortality.
  - Recruitment bootstrapped from historical recruitments
  - Use either MLEs or MCMC draws for the starting conditions
  - Each crab assessment is unique and other approaches may be used as needed.
  - Examples: reductions in average recruitment, trends in fishing mortality, ranging fishing mortalities when management uncertainty is high.

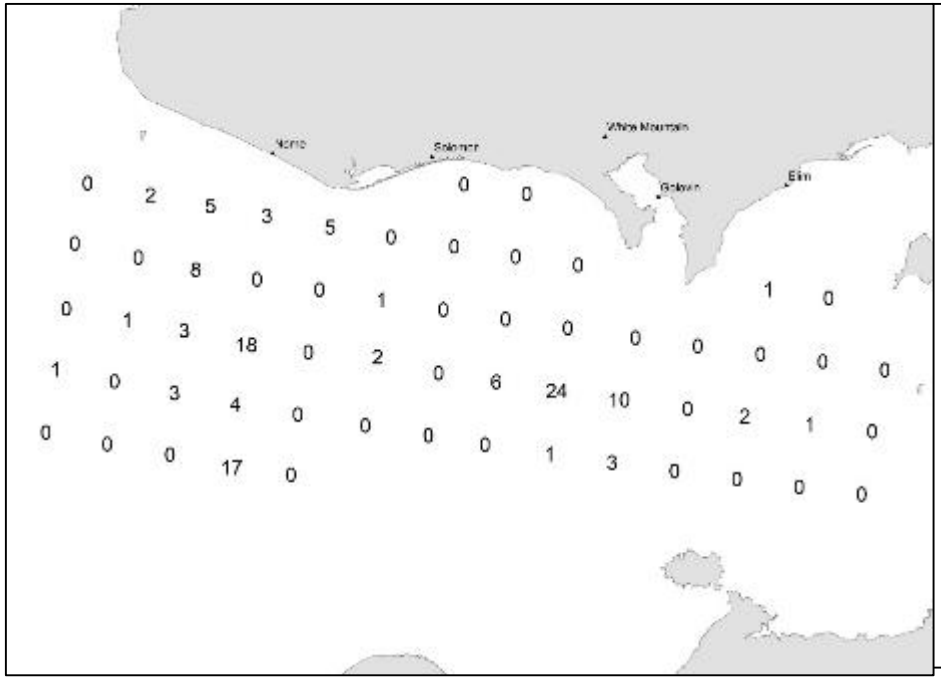
OVERFISHING STATUS UPDATES (OUT OF CYCLE STOCKS)

- WAIRKC (May 2020), PIBKC, PIRKC – closed to direct fishing
  - Total catch below ABC/OFL therefore NO OVERFISHING
- AIGKC (May 2020)
  - Fishery was not complete at May meeting so overfishing evaluated now
  - Total catch below ABC/OFL :: NO OVERFISHING
- PIGKC (May 2020)
  - Directed fishery confidential
  - Total catch below ABC/OFL:: NO OVERFISHING

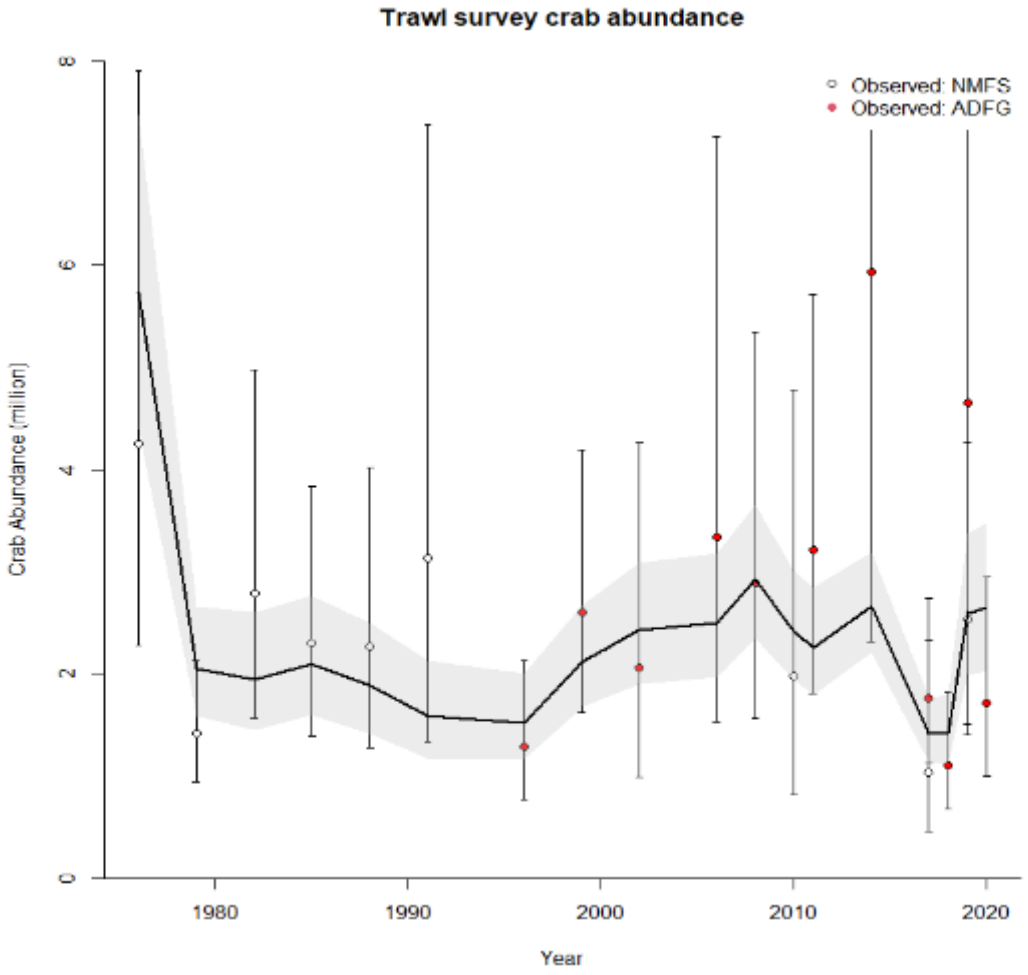
NSRKC PROPOSED MODEL RUNS FOR JAN

- Models for Jan: status quo model (base 19.0) with new data for 2020 preliminary GMACS model
  - Still much work needed to have a viable GMACS model for Jan 2021
- New 2020 data: ADF&G survey (abundance & size comps), small subsistence catch, winter commercial harvest (confidential)
- 2020 Fisheries
  - NSEDC halted purchase of crab (winter and summer)
  - BOF action : E 164 closed for summer 2020 fishery
- CPT/SSC comments addressed:
  - Collecting data on lost pot gear from winter fishery
  - Exploring changing discard mortality
  - Work on VAST exploration
  - Barren females – data collection issues and biological unknowns – in progress
  - GMACS model – in progress

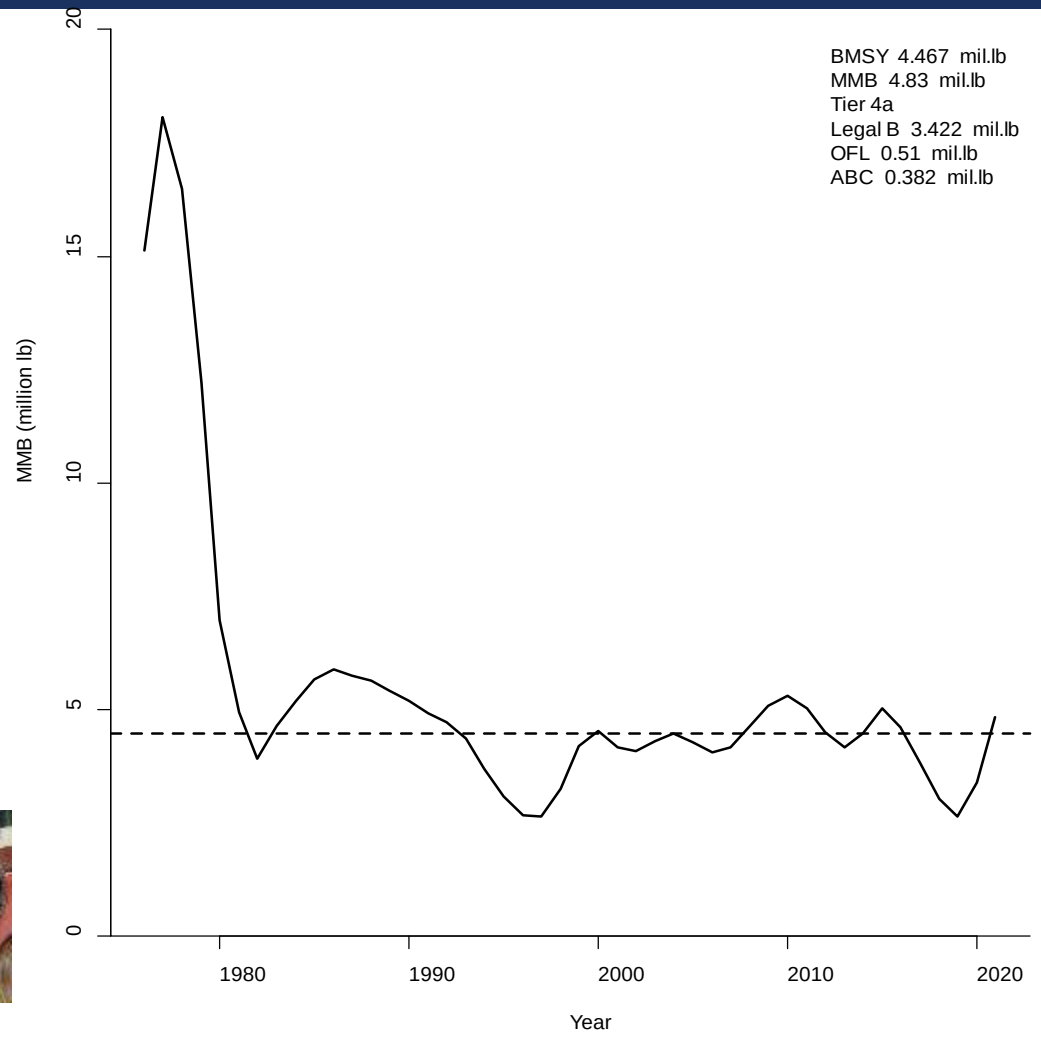
2020 NSRKC Trawl Survey catch: Male


Nome
Solomon
White Mountain
Golovin
Elim
0 2 5 3 5 0 0 0

NSRKC: CRAB SURVEY ABUNDANCE

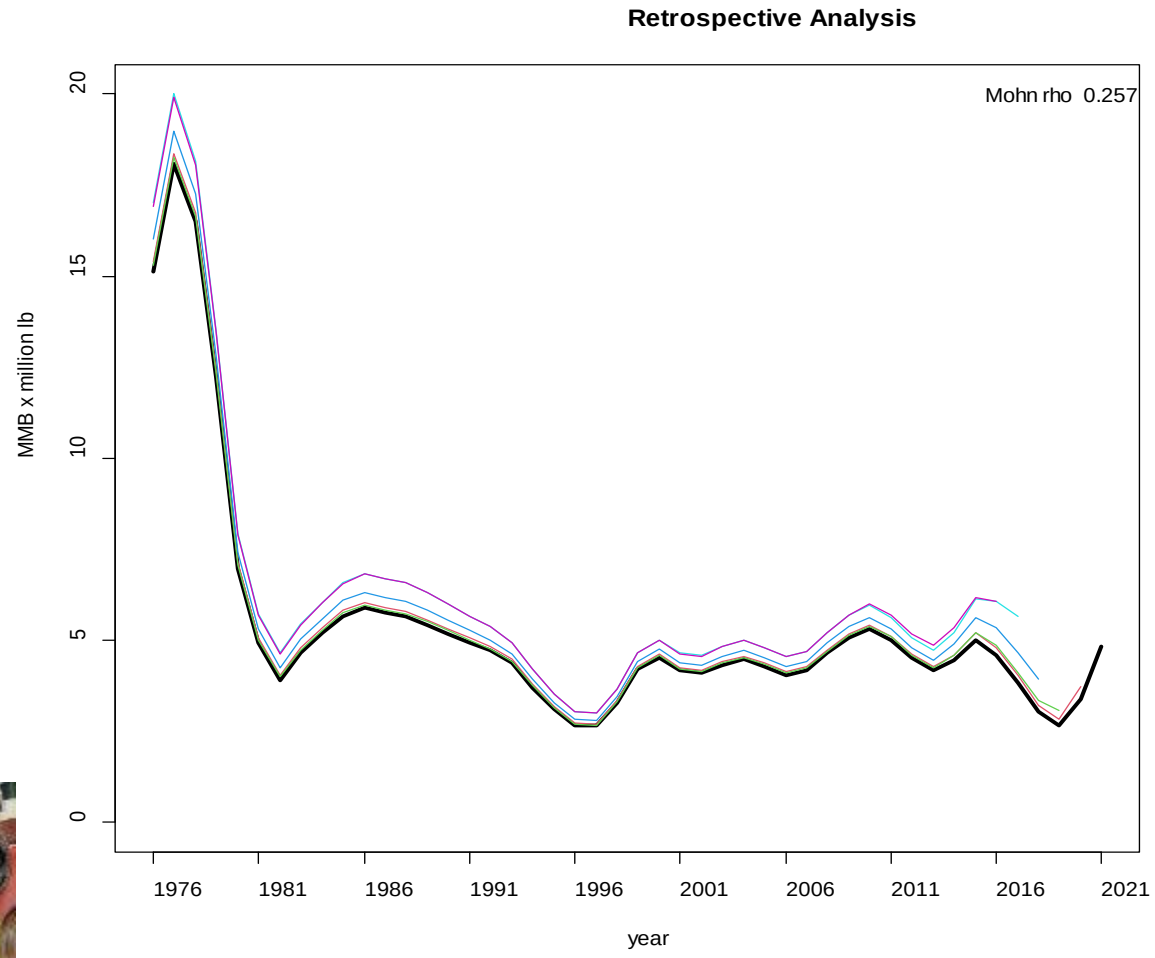


NSRKC: MMB



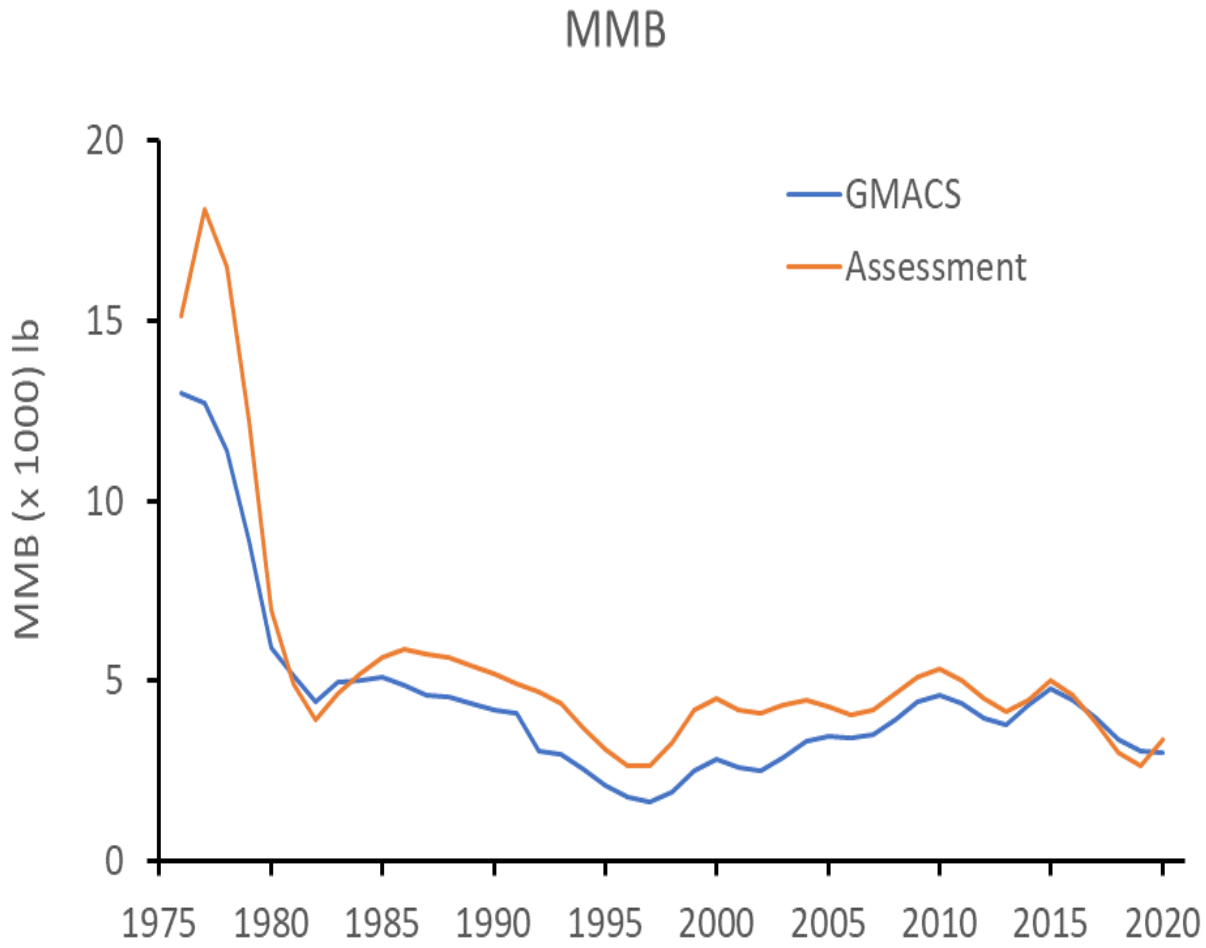
- 2021 MMB larger than 2019 model
- Concerns:
  - Model survey estimate biased high in 2020
  - Recent surveys (2018-2020) primarily caught juvenile crab (lack of mature males in survey)

NSRKC: RETROSPECTIVE MMB



Mohn'rho = 0.26. Cause for concern if NSRKC is considered longer life-history but marginal if it is considered shorter life-history (Hurtado-Ferro et al. 2015).

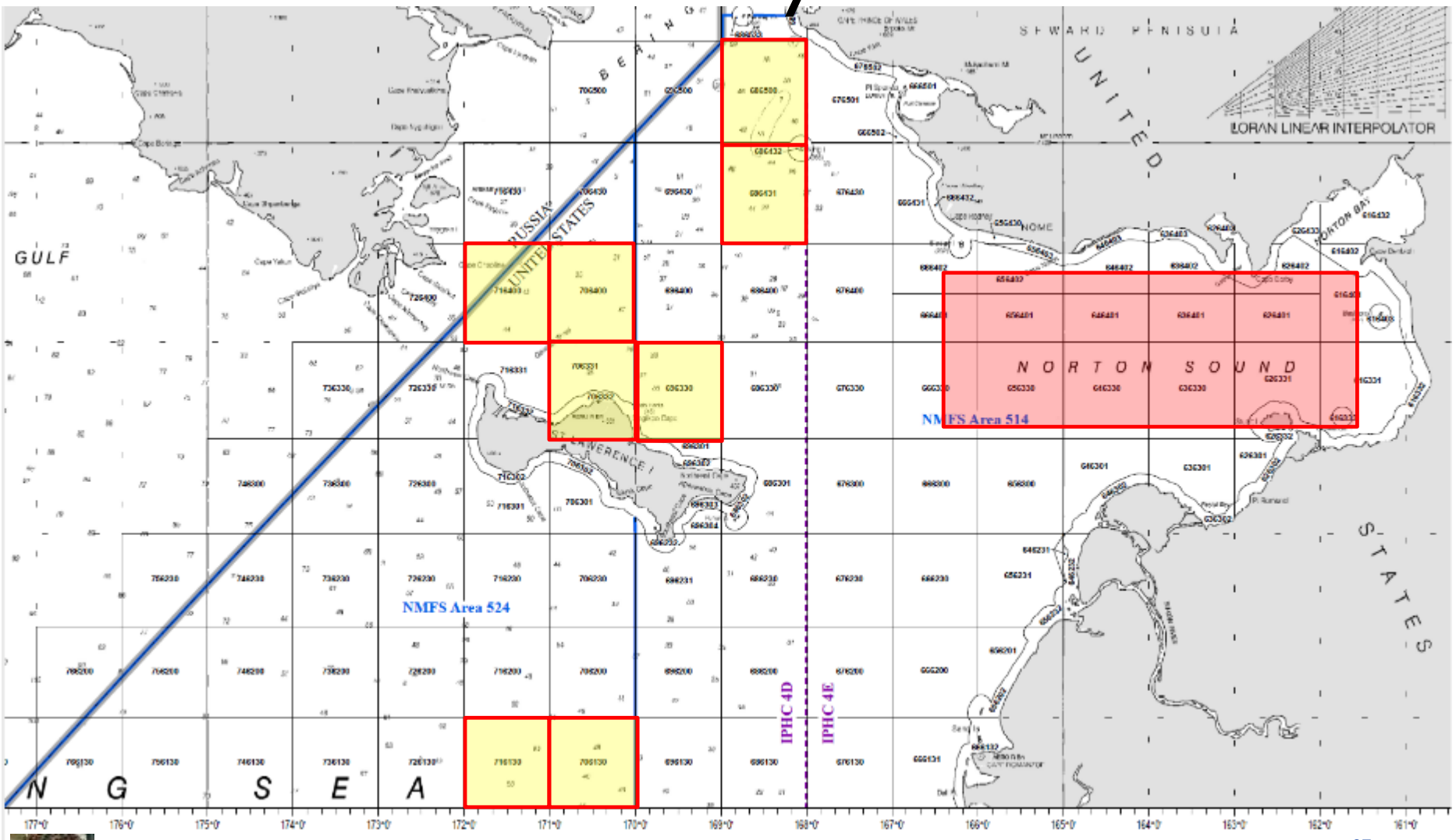
NSRKC GMACS: IN PROGRESS: GMACS IS NOT THE SAME AS ASSESSMENT MODEL



NSRKC RECOMMENDATIONS

- Review growth matrix to determine if growth is being overestimated in model (re: high 2020 estimate of MMB versus low mature males caught in survey)
- Work towards GMACS model (subgroup of GMACS users formed)
- Jan 2021:
  - Model 19.0 (base with new data)
    - Compared estimate growth in model with tagging data outside of model
  - Model 20.0 (GMACS model)
    - Detailed comparison with 19.0
- Improve data weighting
- Update VAST estimates and diagnostics
- Detailed data on female egg conditions and clutch fullness
- Report annual lost pot data

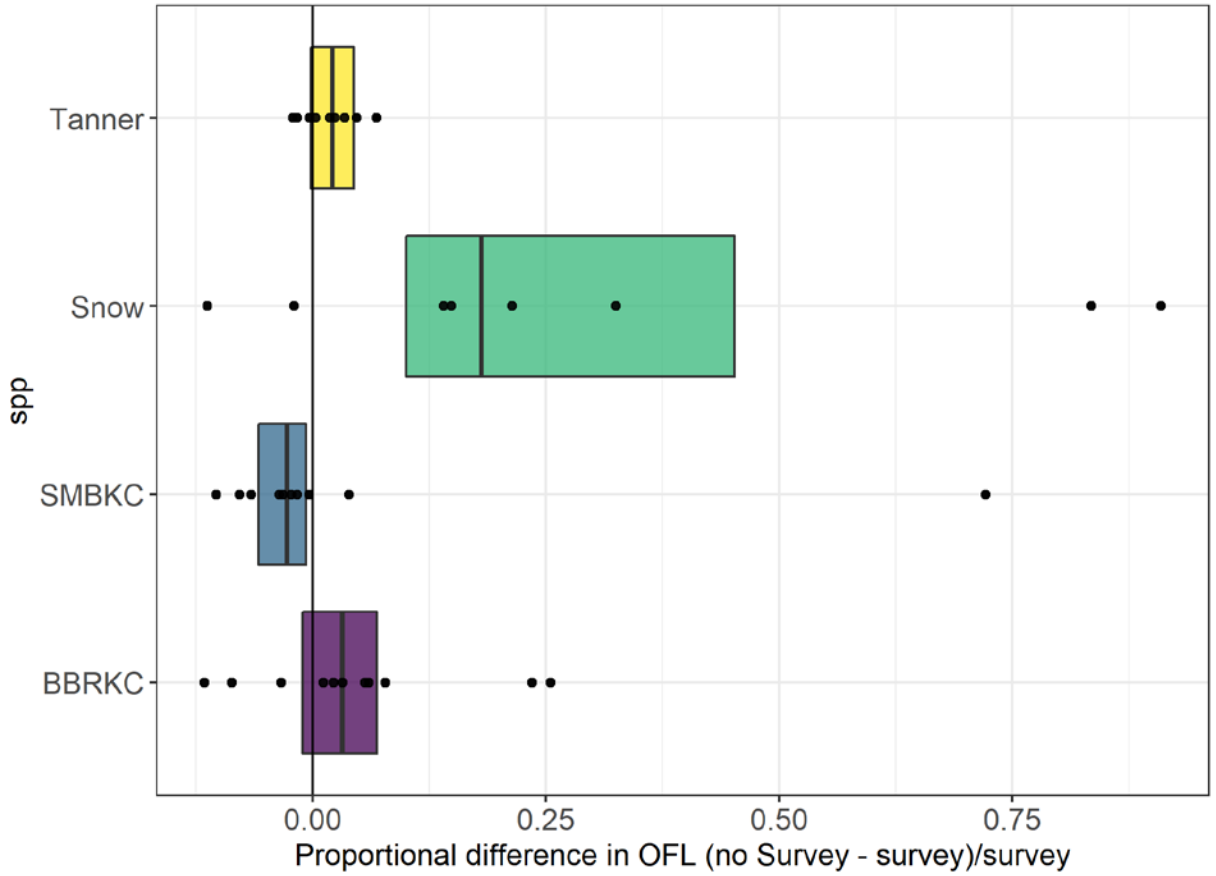
NSRKC Bycatch?



QUESTIONS?

Martin Dorn, Co-Chair (AFSC)
Katie Palof, Co-Chair (ADF&G)
Jim Armstrong (NPFMC)
Bill Bechtol (UAF)
Ben Daly, (ADF&G)
Ginny Eckert (UAF)
Erin Fedewa (AFSC)
Brian Garber-Yonts (AFSC)
Krista Milani (NMFS)
Andre Punt (UW)
Shareef Siddeek (ADF&G)
William Stockhausen (AFSC)
Cody Szuwalski (AFSC)
Miranda Westphal (ADF&G)
Jie Zheng (ADF&G)

- THANKS TO ALL CPT MEMBERS AND CPT ATTENDEES



APPROACH 1:

RETROSPECTIVE WITH AND WITHOUT TERMINAL YEAR OF SURVEY DATA EFFECT ON OFL

Stock	2019/20 ABC buffer	2020/21 proposed ABC buffer	Rationale	Status/ Trend in MMB	Uncertainty analysis results	Proposed additional 2020 buffer
BBRKC	20%	20%	- Overpredicting recent survey (18,19) - Cold pool distribution shifts - Align with other crab stocks - Long-term declining trend	0.59 / Down	Medium. Reduced ability to determine stock status; stock is close to overfished threshold	5%
Snow	20%	25%	- Model structure uncertainties (unexpected change in recent recruitment, i.e. 2015) - Retrospective patterns - Uncertainty around M - Discrepancy between 2018 and 2019 survey data - Specification of recruitment penalty	2.43 / Up	Strong positive retrospective bias, without survey overestimating OFL. Very sensitive to the terminal survey estimate	25%
SMBKC	20%	25%	- Overfished - Poor model fit to survey data - Data poor stock - Unfavorable environment	0.34 / Flat	Minimal. Recent years underestimate OFL without survey	none
Tanner	20%	20%	- Parameters hitting bounds - Poor convergence	0.96 / Stable (down slightly)	Minimal.	none