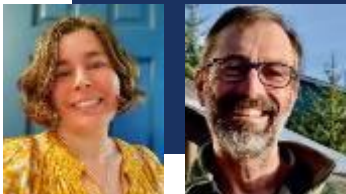


C1 BSAI CRAB STOCKS

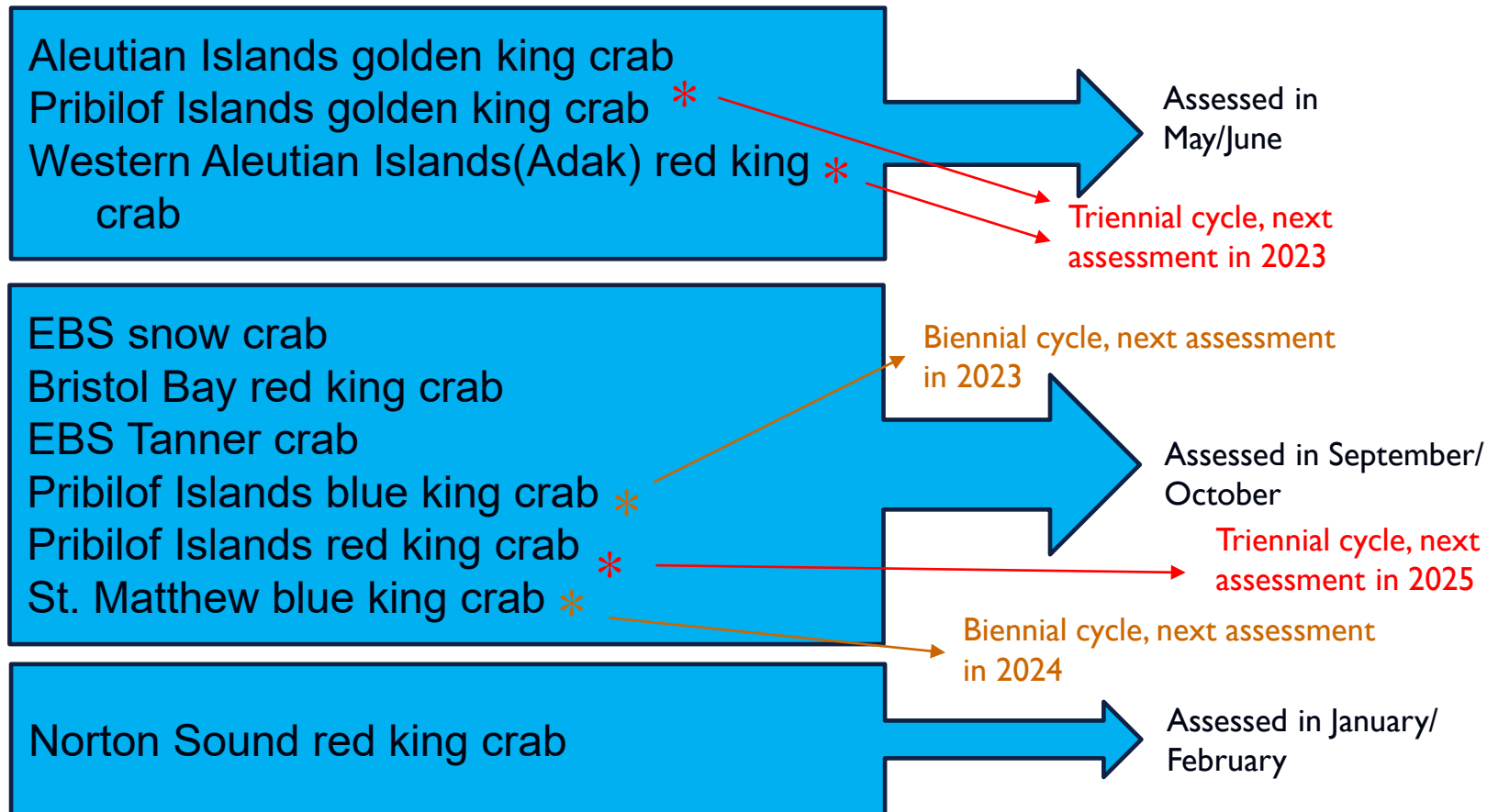
KATIE PALOF & MIKE LITZOW (CPT CO-CHAIRS)

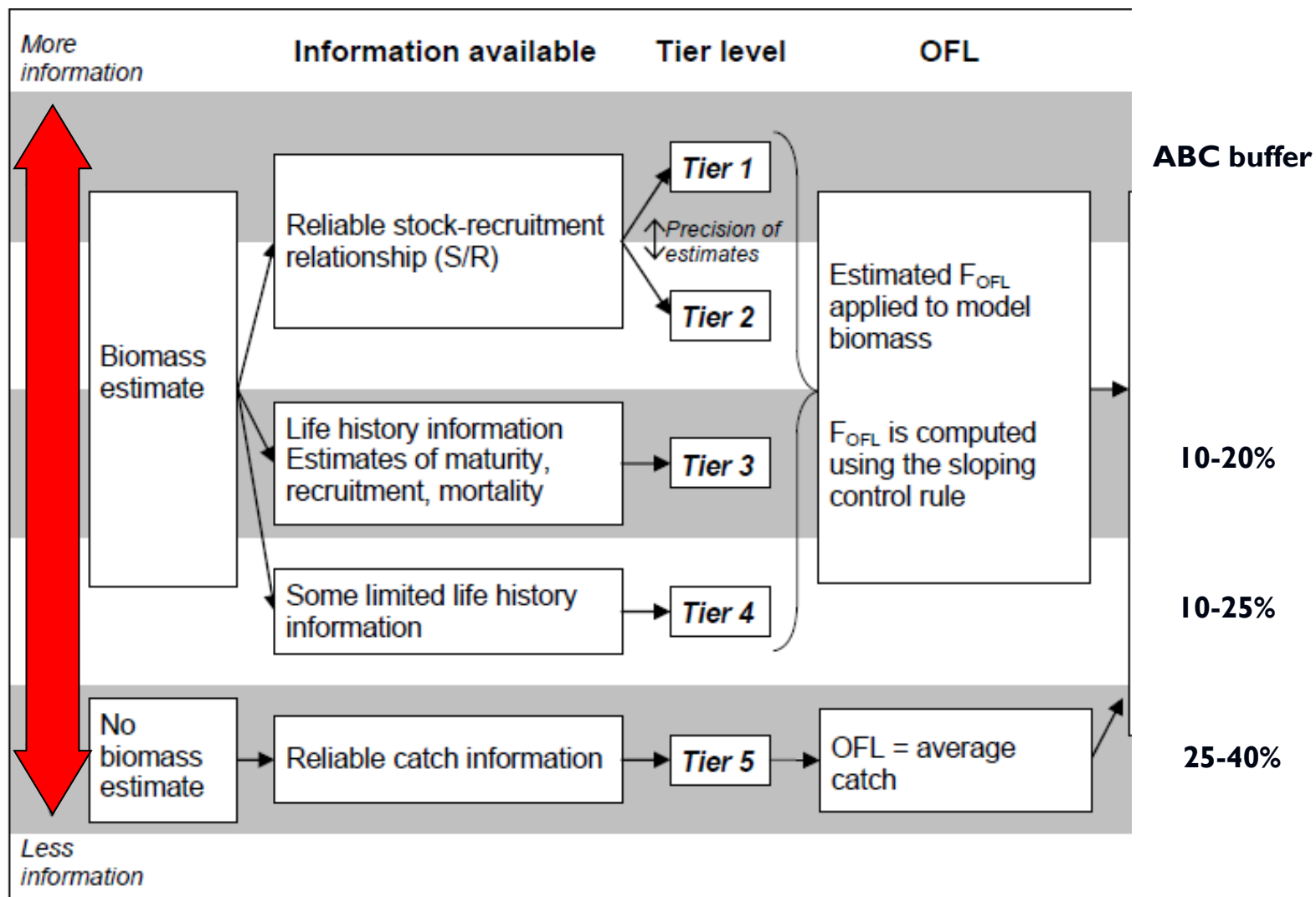
OCTOBER 2023 NPFMC MEETING

CPT MEETING MINUTES – SEPT. 12TH – 14TH, SEATTLE, WA



BSAI CRAB STOCKS MANAGEMENT TIMING





SEPTEMBER 2023 AGENDA

- ✓ Summer trawl survey results
- ✓ 2022/23 fishery season summary
- ✓ **BBRKC final assessment, OFL and ABC**
- ✓ **Tanner crab final assessment, OFL and ABC**
- ✓ **Snow crab final assessment, OFL and ABC**
- ✓ **PIBKC final assessment, OFL and ABC**
- ✓ Proposed model runs: NSRKC
- ✓ Bering Sea red king crab stock structure template
- ✓ Overfishing updates on non-assessed stocks
- ✓ BSFRF research updates and spring BBRKC sampling (informational)
- ✓ Ecosystem status report (crab update)
- ✓ Economic status of the crab fisheries
- ✓ Research priority planning (Dec / Jan meeting)
- ✓ Survey modernization (informational)
- ✓ New business / Jan modeling workshop planning / Member vacancies



2023 BERING SEA BOTTOM TRAWL SURVEY UPDATE



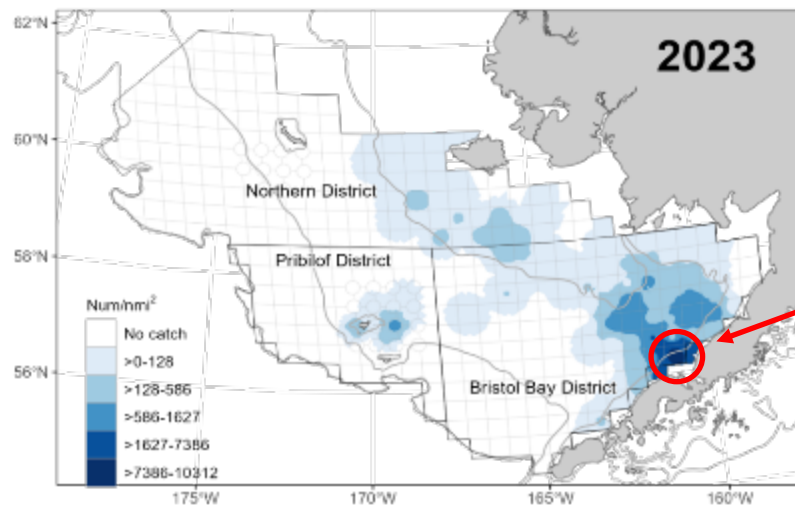
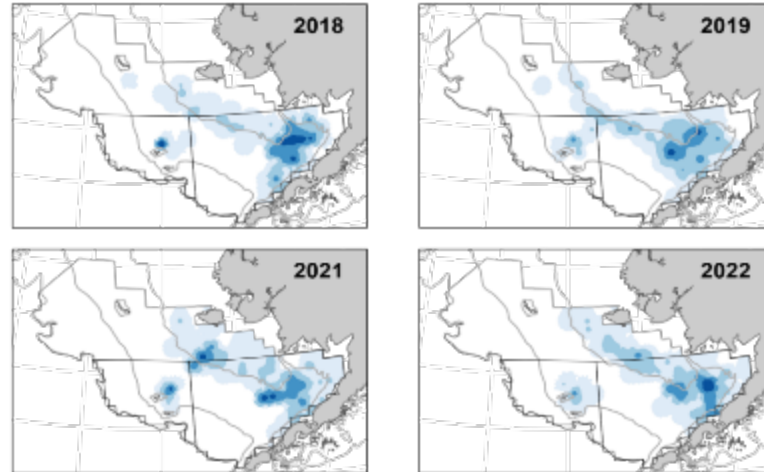
2023 SURVEY: TAKE-HOME RESULTS

- Bristol Bay red king crab mature female abundance *up*
- Snow crab mature female and commercial-size male abundance at *all-time low*
- Largest Tanner crab recruitment event in time series history



BBRKC MATURE FEMALE ABUNDANCE

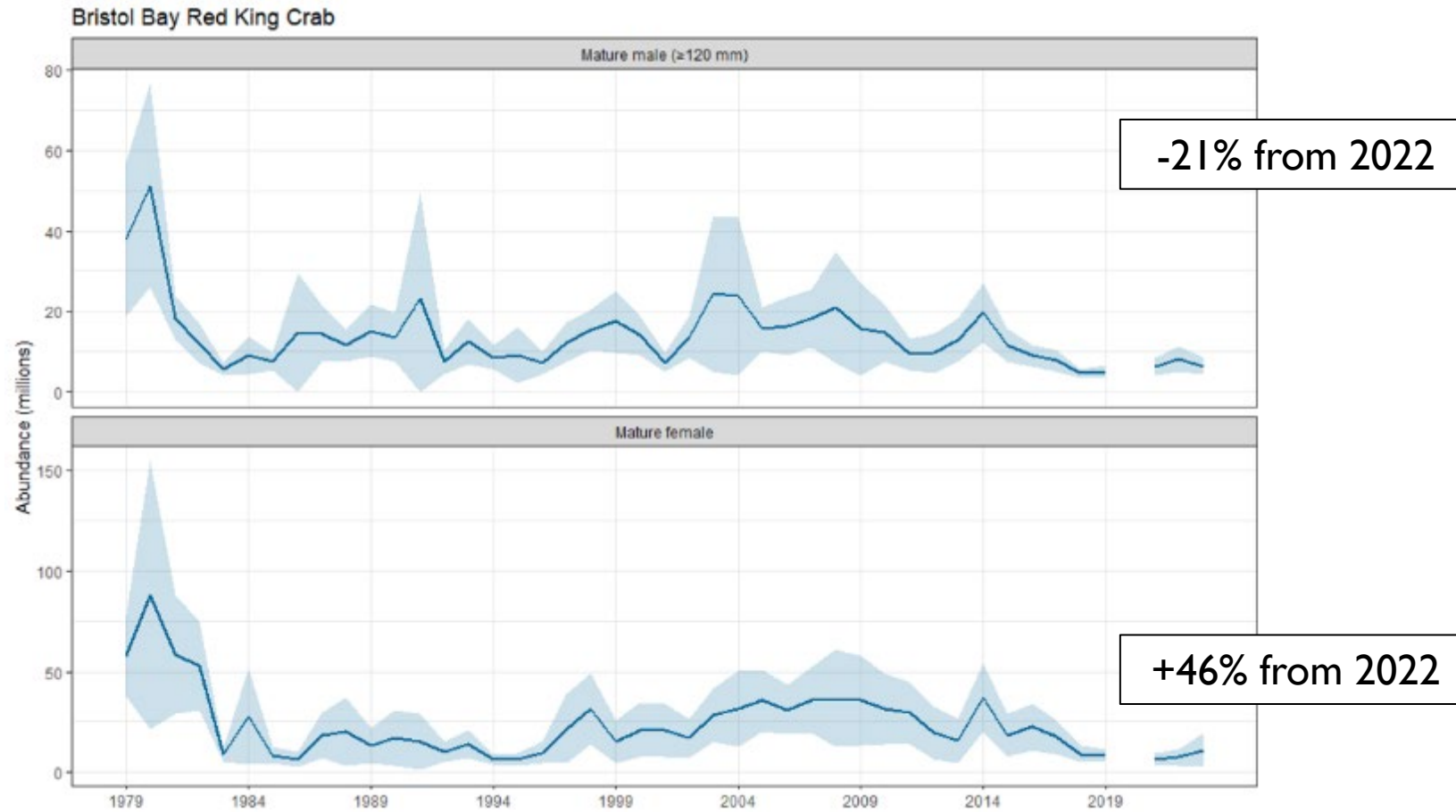
Red King Crab Mature Female



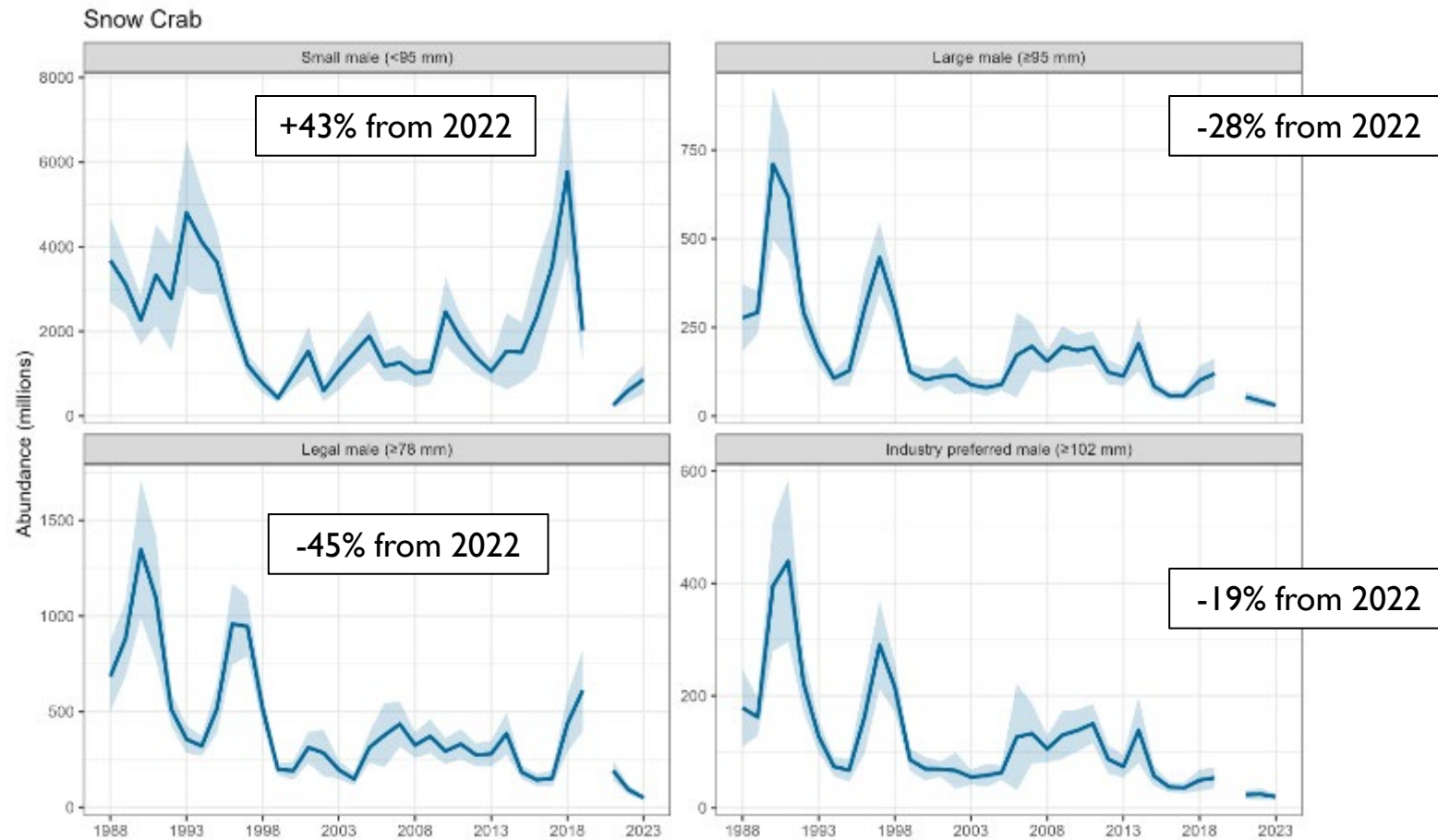
2023: 37% of BBRKC mature females caught at one station



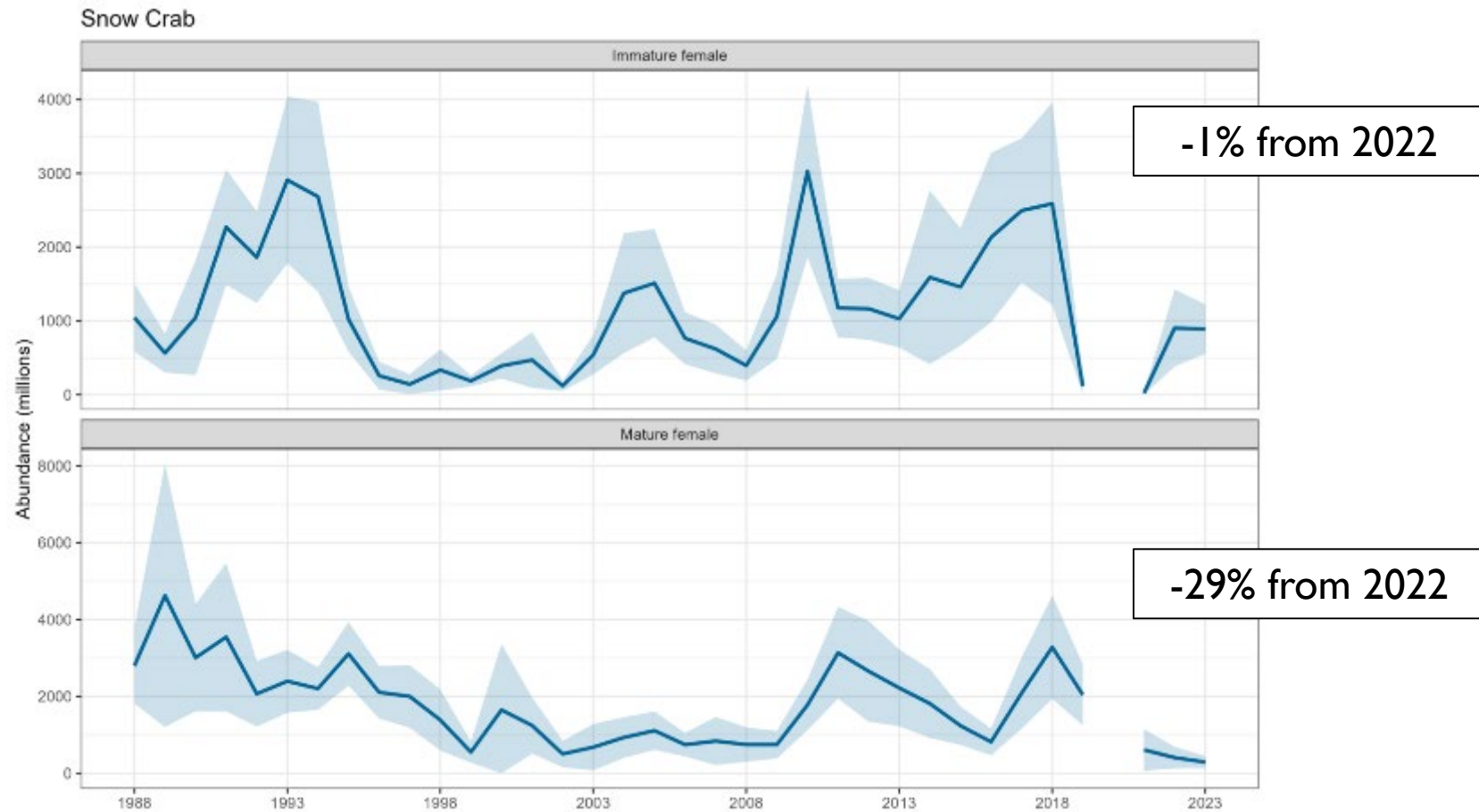
BBRKC LEGAL MALE / MATURE FEMALE ABUNDANCE



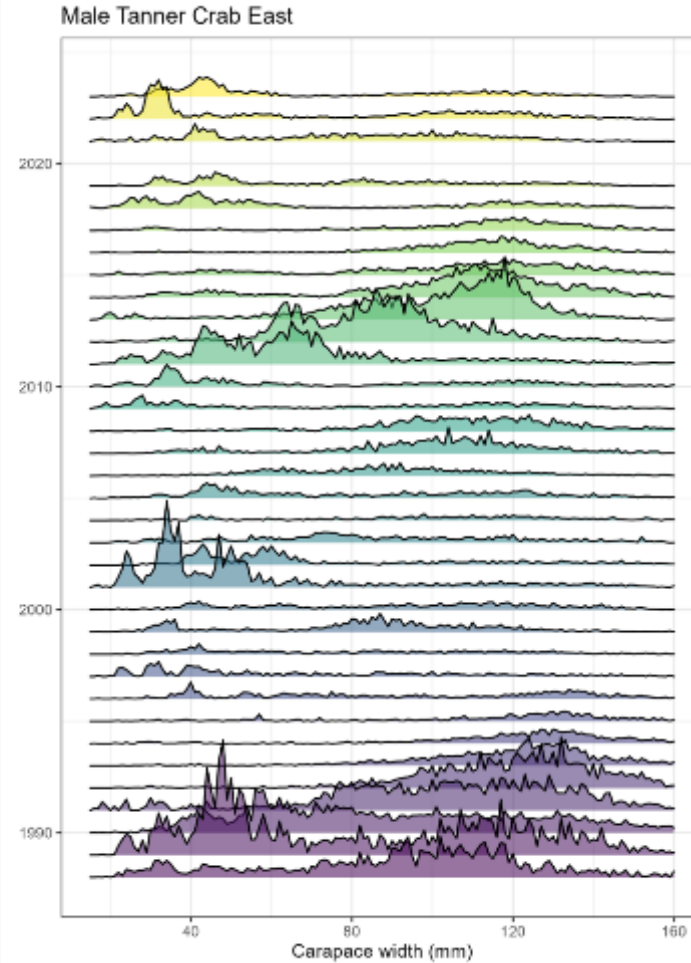
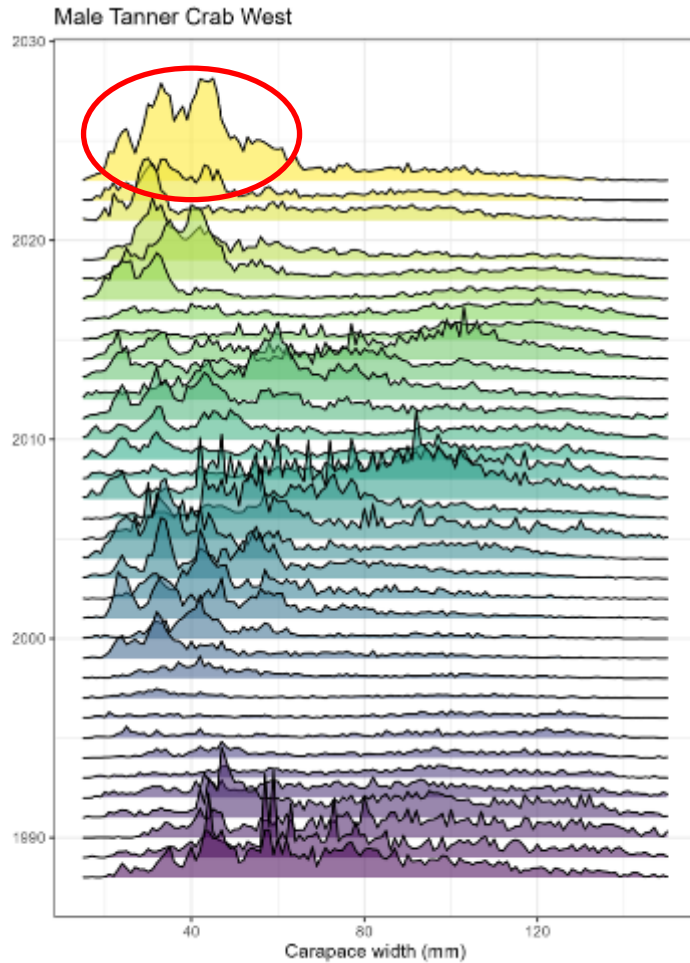
MALE SNOW CRAB ABUNDANCE



FEMALE SNOW CRAB ABUNDANCE

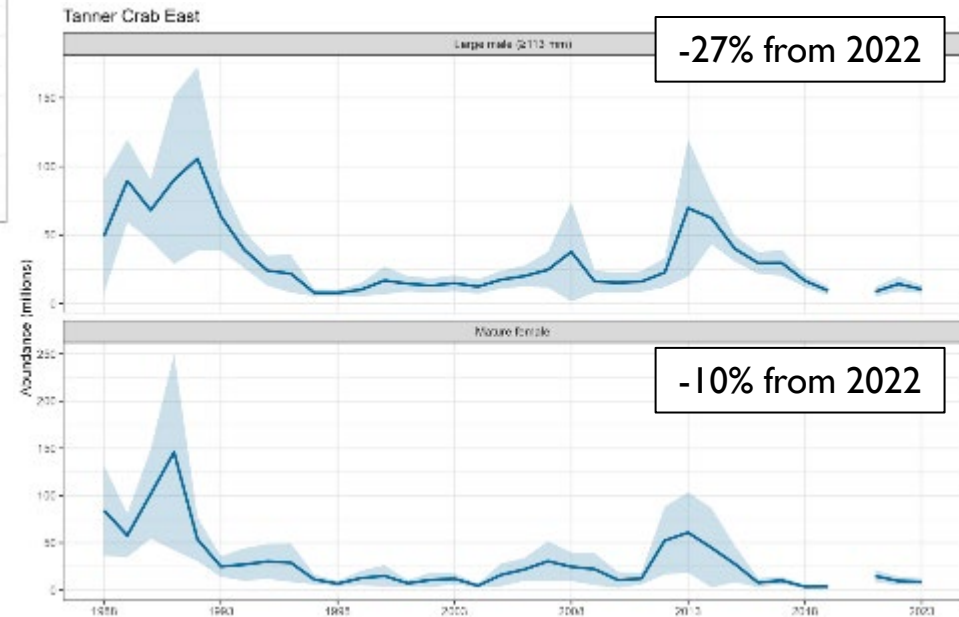
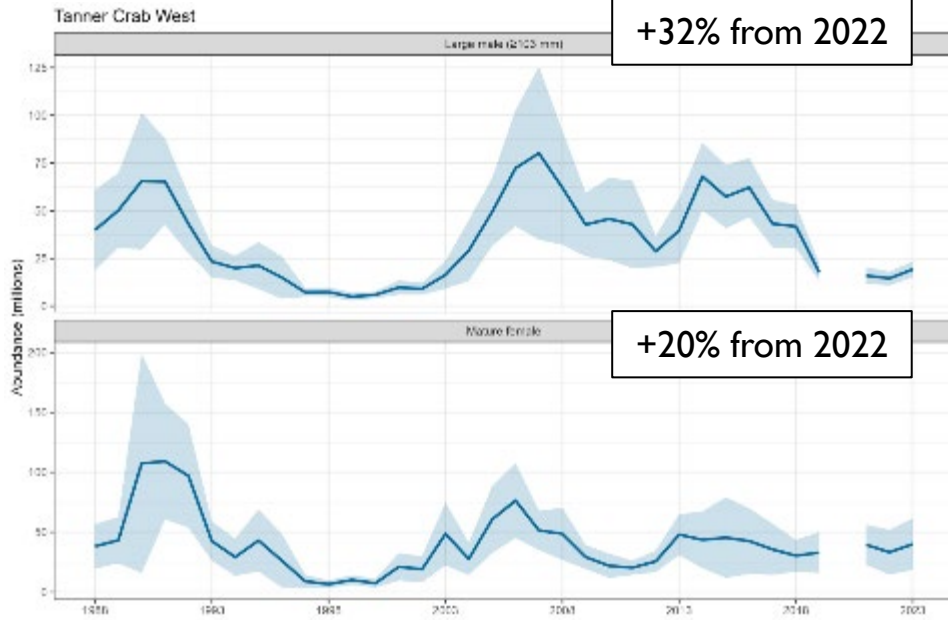


MALE TANNER CRAB ABUNDANCE AT SIZE



2023: Largest recruitment pulse in time series

TANNER CRAB ABUNDANCE: *UP IN THE WEST, DOWN IN THE EAST*



2022 FISHERY SUMMARY: DIRECTED AND BYCATCH



BRISTOL BAY RED KING CRAB

- Directed fishery closed
- BBRKC Savings Sub-Area closed to non-pelagic trawl
- Cost recovery fishery: 24 t
- Minimal bycatch in Tanner crab fishery
- Trawl bycatch lowest in 10 years
- Zero bycatch in pot cod fishery



SNOW CRAB

- Directed fishery closed
- Very low bycatch in Tanner crab fishery
- Total bycatch in groundfish fisheries low (43 t)



TANNER CRAB

- Total retained catch in eastern and western fisheries 2.013 million lbs (913 t)
- Very low bycatch in other crab fisheries (snow & BBRKC closed)
- Low bycatch in groundfish fisheries for eastern Tanner (22 t)
- Relatively high bycatch in groundfish fisheries for western Tanner (73 t), mostly yellowfin sole trawl fishery



ALEUTIAN ISLANDS GOLDEN KING CRAB

- Retained catch in western Aleutians lowest since 1998 due to low abundance estimates
- Retained catch in eastern Aleutians close to 10-year mean
- Groundfish bycatch in west and east very low (< 7 t in each area)



WESTERN ALEUTIAN ISLANDS RED KING CRAB

- Directed fishery closed
- Bycatch in AIGKC fishery low
- Bycatch in groundfish fisheries (trawl and fixed gear) low



BRISTOL BAY RED KING CRAB (BBRKC)

FINAL ASSESSMENT 2023



ESP REPORT CARD:

Ecosystem considerations 2023:

- Bottom temperatures and the spatial extent of the cold pool remained near-average in Bristol Bay. Summer bottom temperatures were well-within the thermal range of juvenile and adult red king crab.
- Red king crab have experienced a steady decline in bottom water pH in the past two decades, reaching 7.91 in 2023. Threshold pH levels of 7.8 could negatively affect juvenile red king crab growth, shell hardening and survival
- Sockeye salmon abundance in the eastern Bering Sea continues to remain well above average, and may represent increased predation on larval BBRKC. Anomalously low levels of chlorophyll-a in 2023 indicate a less pronounced spring bloom and poor feeding conditions for larval BBRKC
- Mature female spatial extent has remained above-average since 2019. The relatively large spatial footprint of mature females in recent years can be attributed to an increased use of habitats in central Bristol Bay that have historically been avoided in years when $<1^{\circ}\text{C}$ waters extended into Bristol Bay

Socioeconomic considerations:

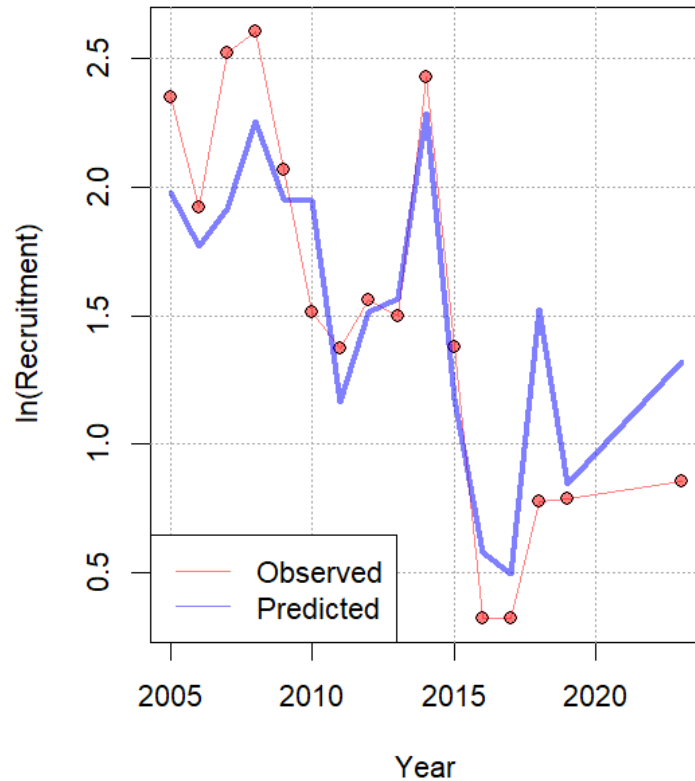
- Fishery closed – difficult to assess indicators without the fishery data (Is there a better way to incorporate the closure?)
- Incidental catch at near-average levels



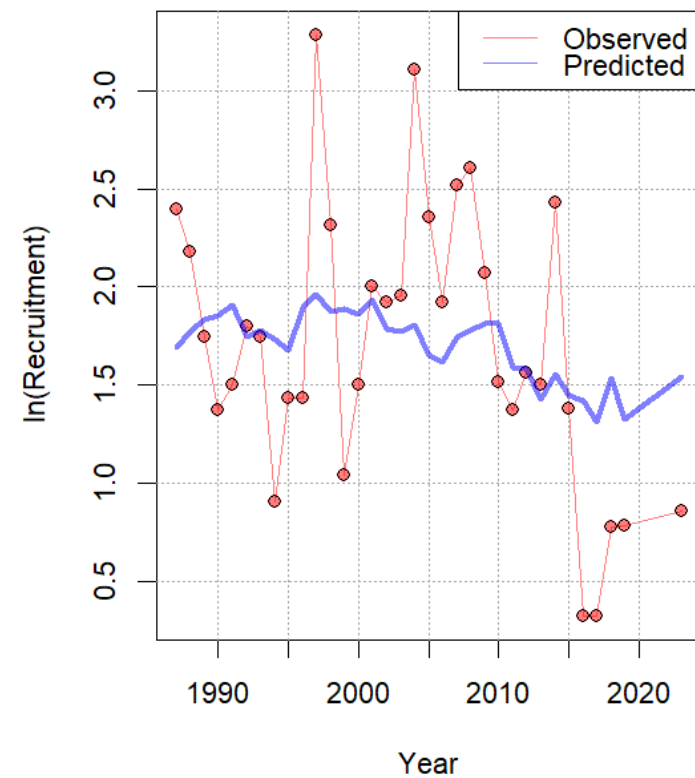
INDICATOR MONITORING ANALYSIS: IMPORTANCE TEST

Bayesian adaptive sampling model runs incorporating the longest time series (1988 – 2022) resulted in very poor fits to observed BBRKC recruitment. Evidence for non-stationarity?

2005 – 2022 recruitment model run



1988 – 2022 recruitment model run



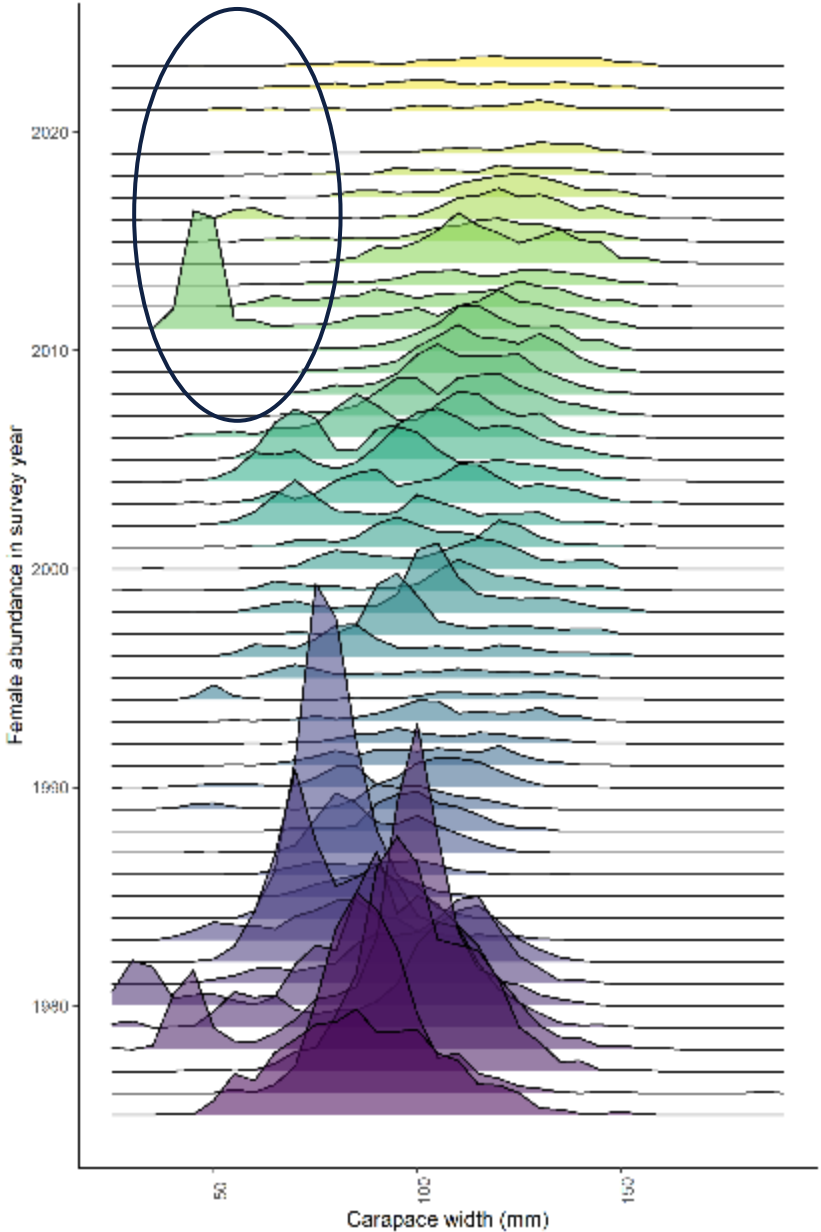
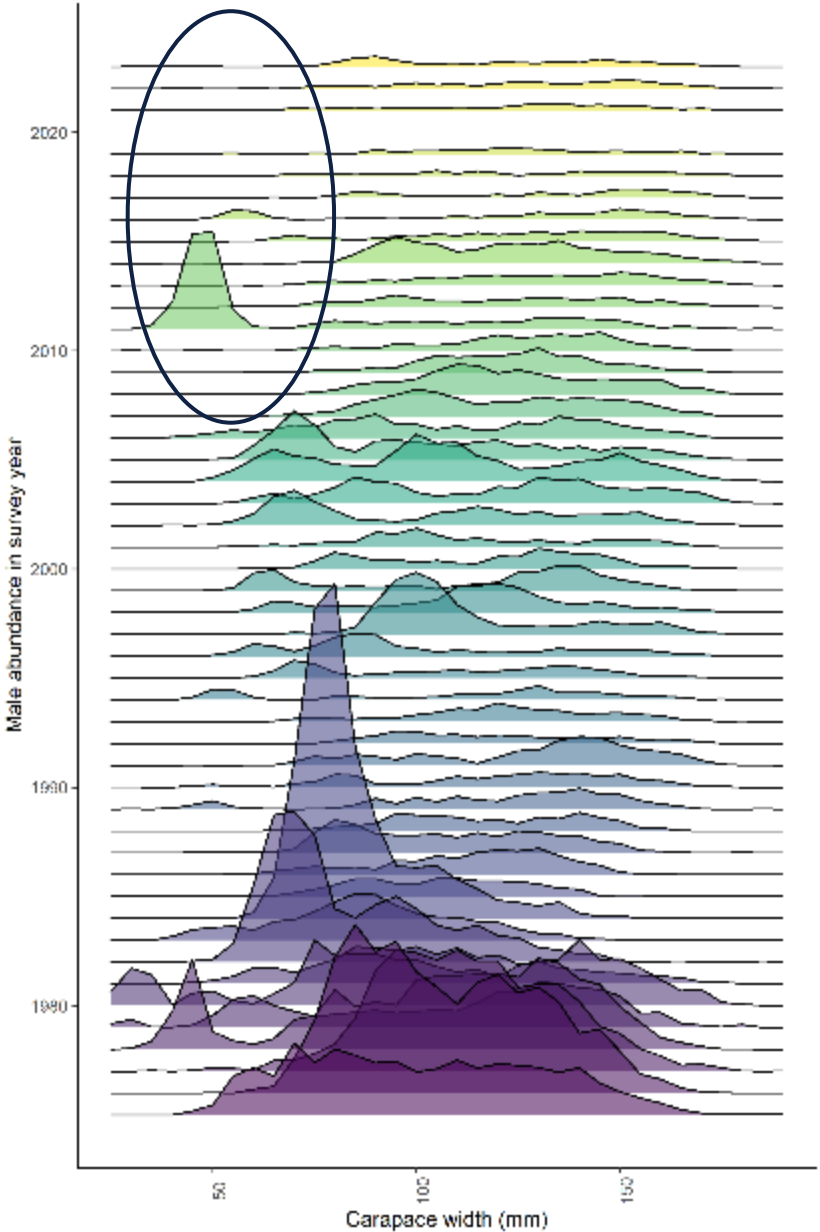
- Future work
 - Additional indicator importance work
 - Additional indicators
 - How to deal with fishery closures in socioeconomic data

BBRKC OVERVIEW

- **Tier 3 annual stock assessment, GMACS assessment** framework since 2018
- Mature male biomass decreased from 2022, still low compared to long term average
- Directed fishery was closed in 2021/22 and 2022/23 seasons due to low mature female abundance.
- Estimated mature female biomass up from recent years but still lower than it's been since the mid-90s
- 2023 area-swept and State of Alaska LBA model estimates of mature female abundance are above the State Harvest strategy thresholds (8.4 million) this year.
 - ADF&G will complete the process of determining an appropriate TAC, if applicable, after the CPT and Council process.
- Low recruitment in recent years (last 8-12 years), projected decline in biomass without a large recruitment event



LENGTH COMPOSITION FROM NMFS SURVEY



BBRKC CONT.

CPT /SSC COMMENTS:

- No new comments addressed this cycle
- Many addressed in May 2023, work will be continued for 2024 proposed model work
 - Growth
 - Q
 - BSFRF data used as a prior on Q

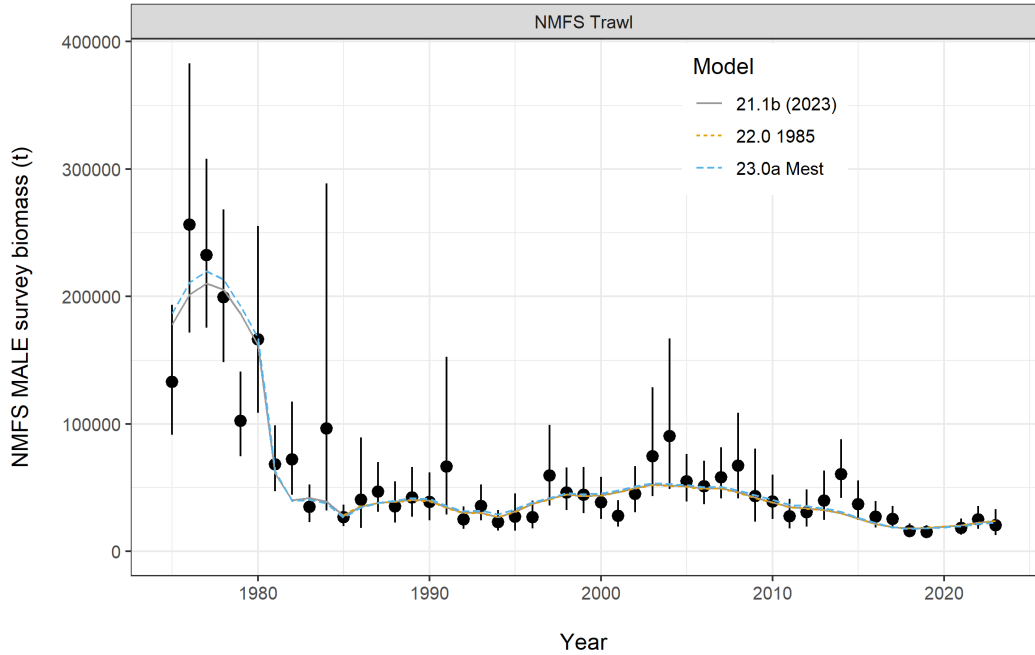
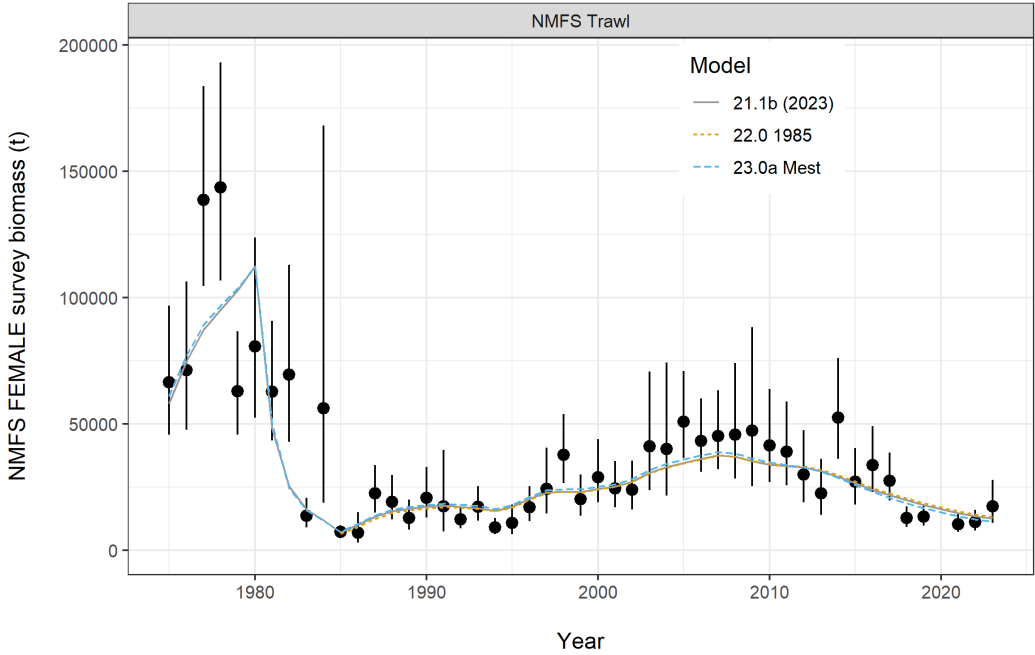
Model options:

21.1b: model 21.1 (2021 accepted model – base M for males fixed at 0.18, mortality event in 80s)
+ **GMACS updated version** (version 2.01.M.01, 2023-03-13)
+ **new 2022/23** data (fishery, bycatch, survey, etc.).

22.0: model 21.1b + starting in 1985.

23.0a: model 21.1b + *estimating* a constant M for males.

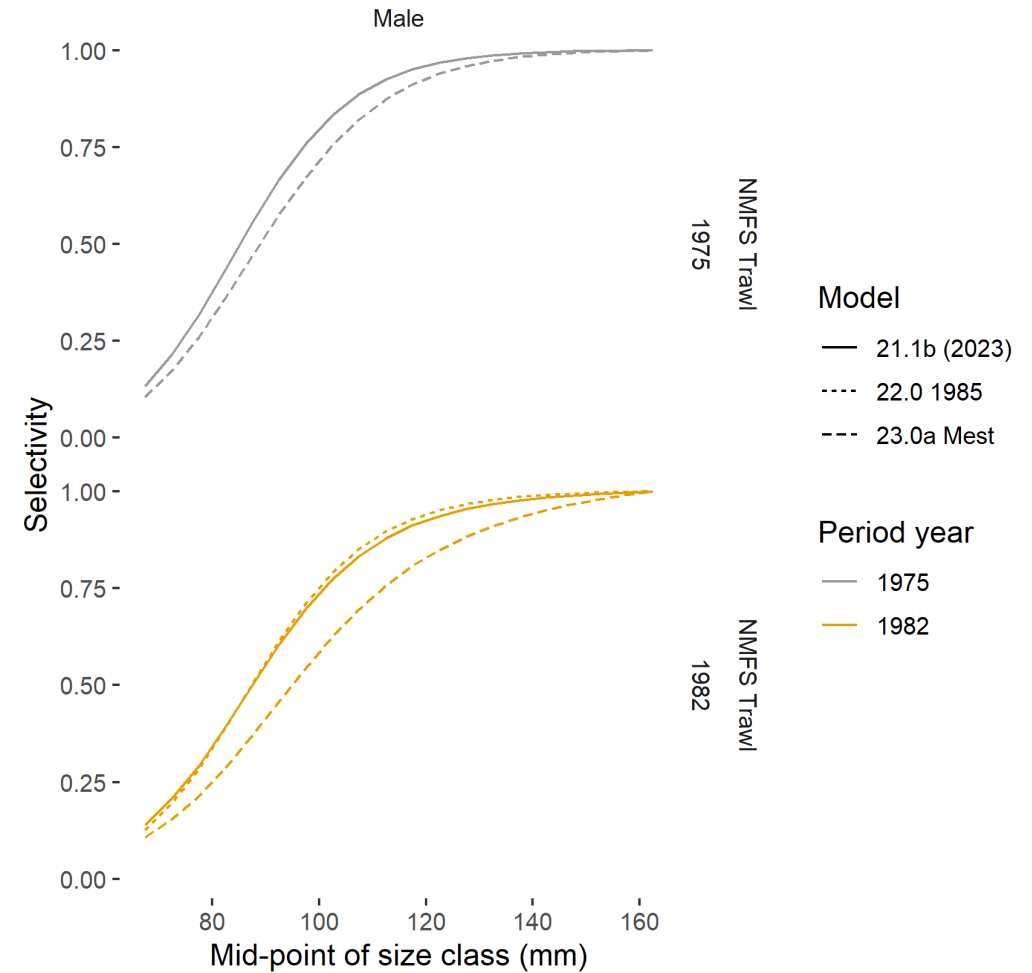
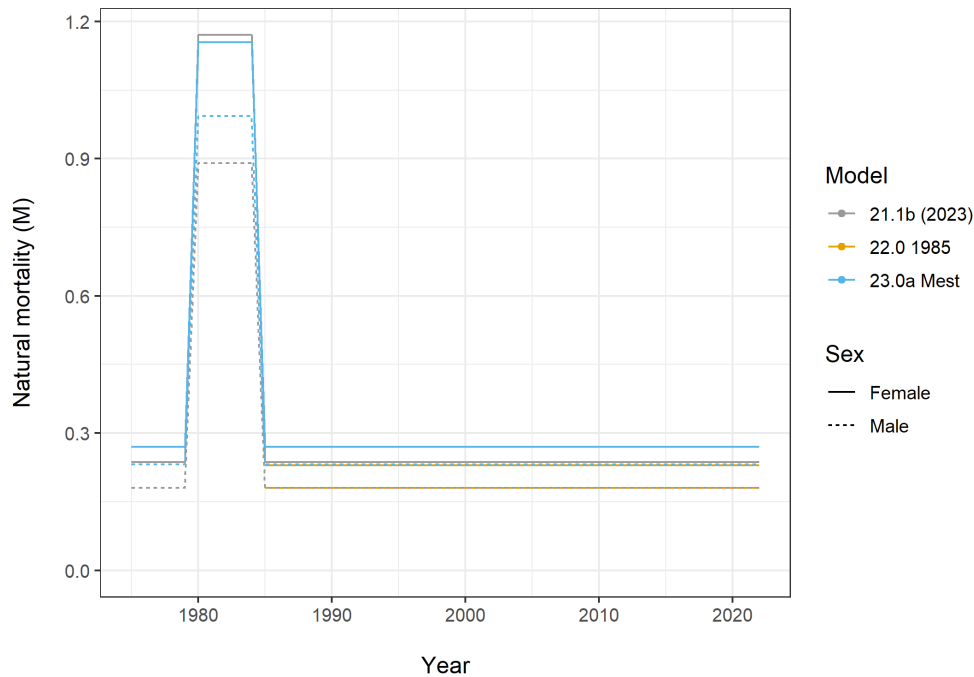




- ✓ Model fits to survey data are similar in all 3 models.
- ✓ Mature females still declining in modeled survey estimate (top), despite survey increase
- ✓ Mature males small increase in modeled survey (bottom)

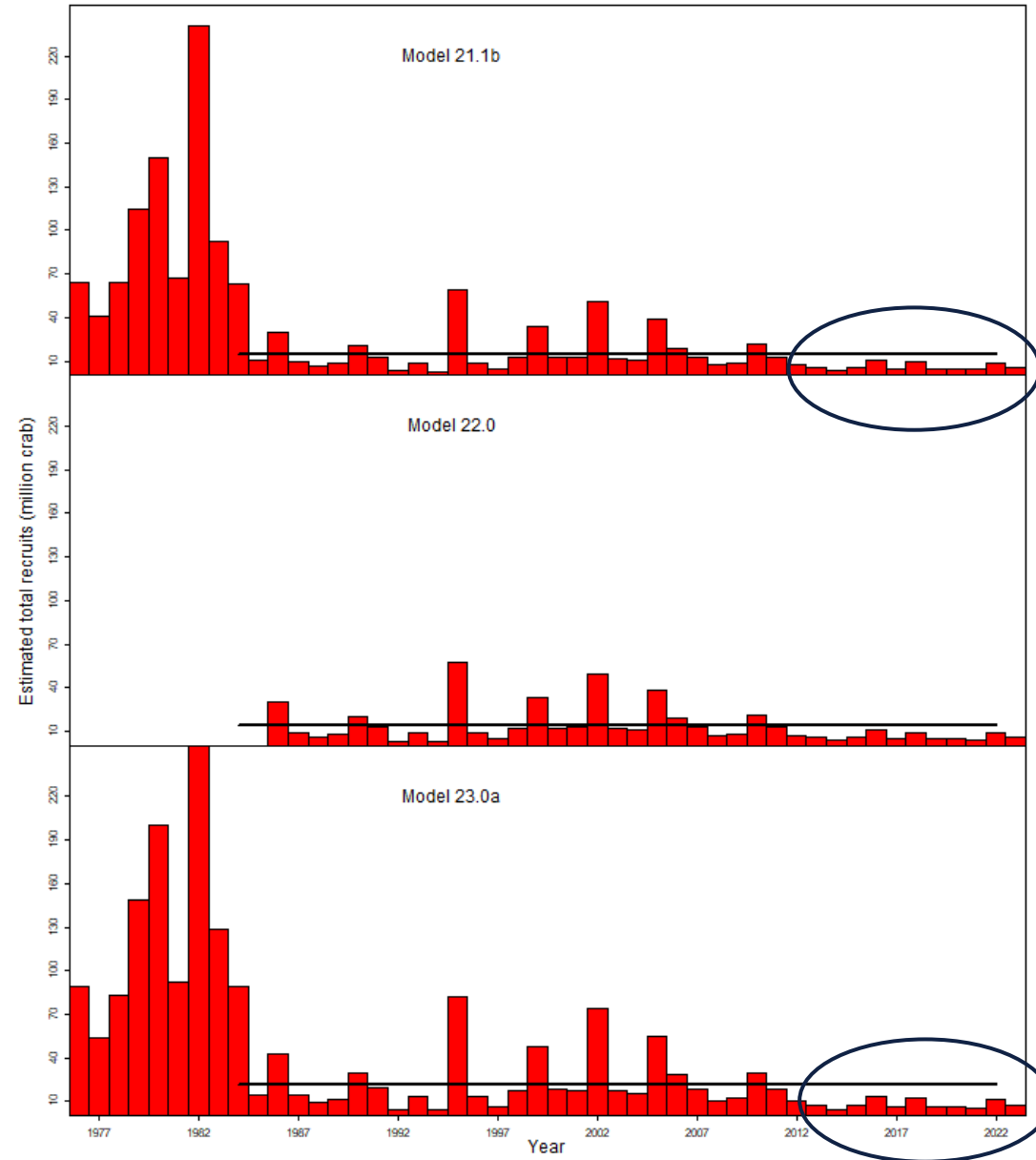
Table 14. Natural mortality estimates for three model scenarios during different year blocks.

Model	Sex	1975-1979,		
		1985-2022	1980-1984	1985-2022
21.1b	Females	0.24	1.17	
	Males	0.18	0.89	
22.0	Females			0.23
	Males			0.18
23.0a	Females	0.27	1.15	
	Males	0.23	0.99	

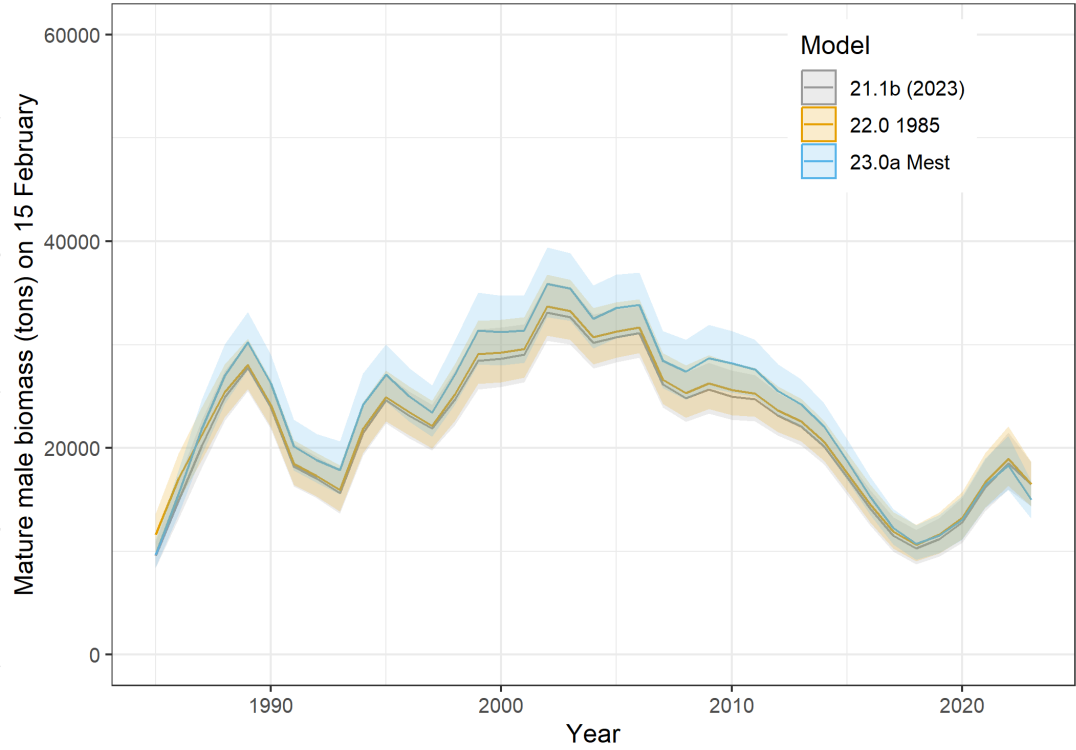
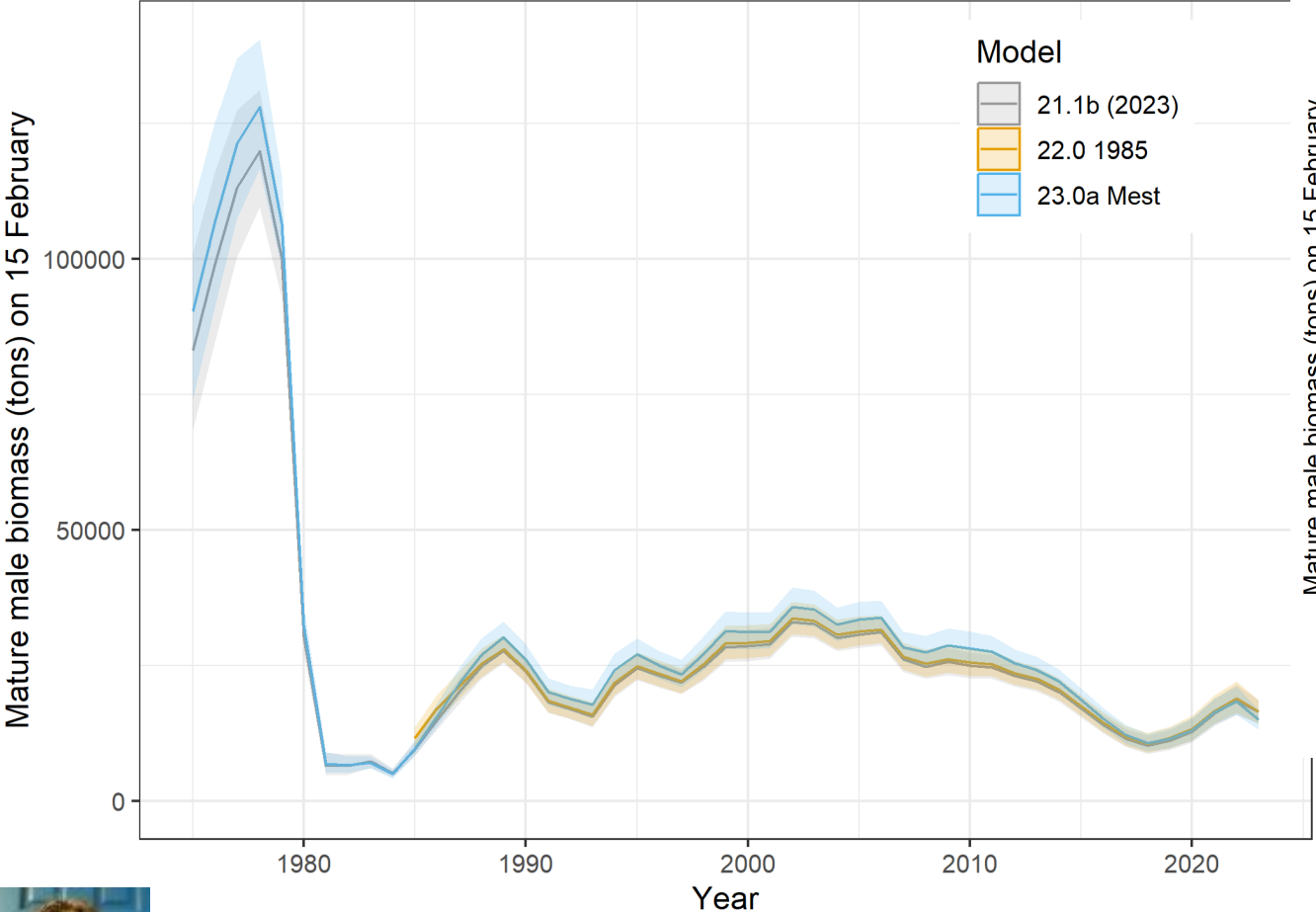


RECRUITMENT

- ✓ Model recruitment estimates similar in all 3 models.
- ✓ Low recruitment in past ~10 years

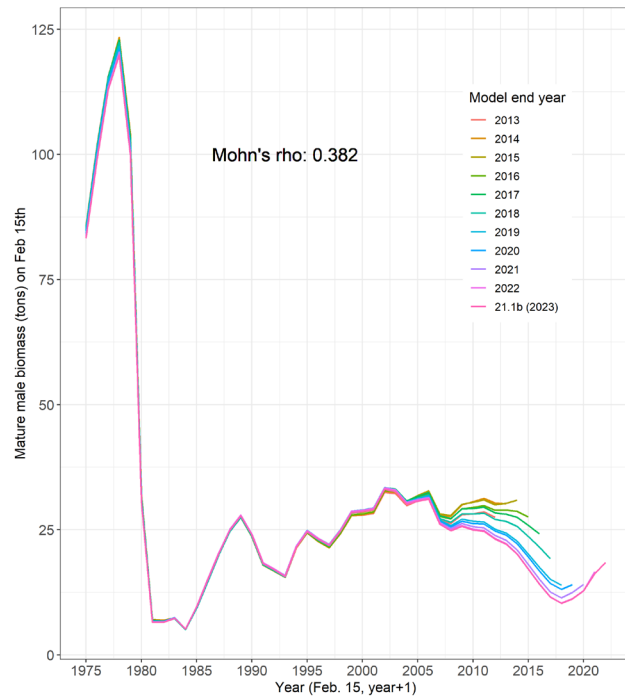


MATURE MALE BIOMASS – FEB 15TH

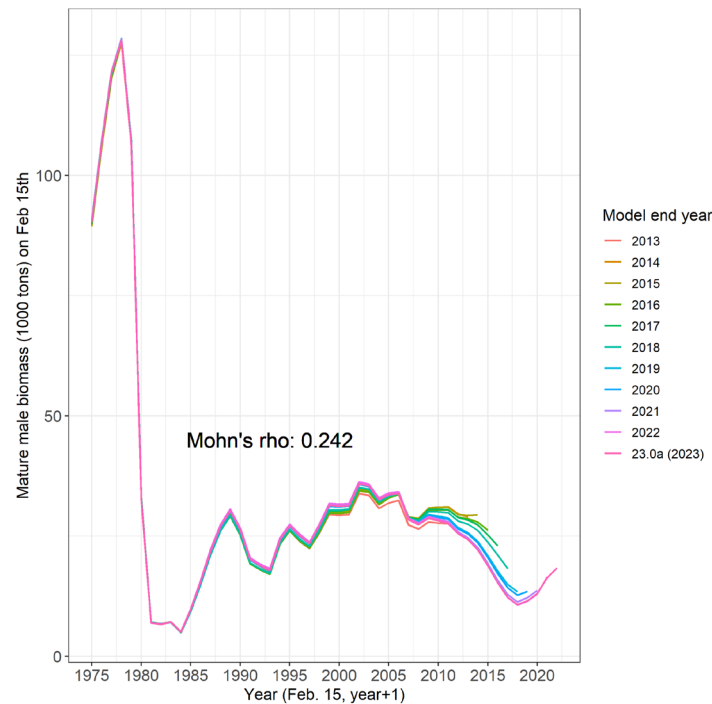


RETROSPECTIVE PATTERNS

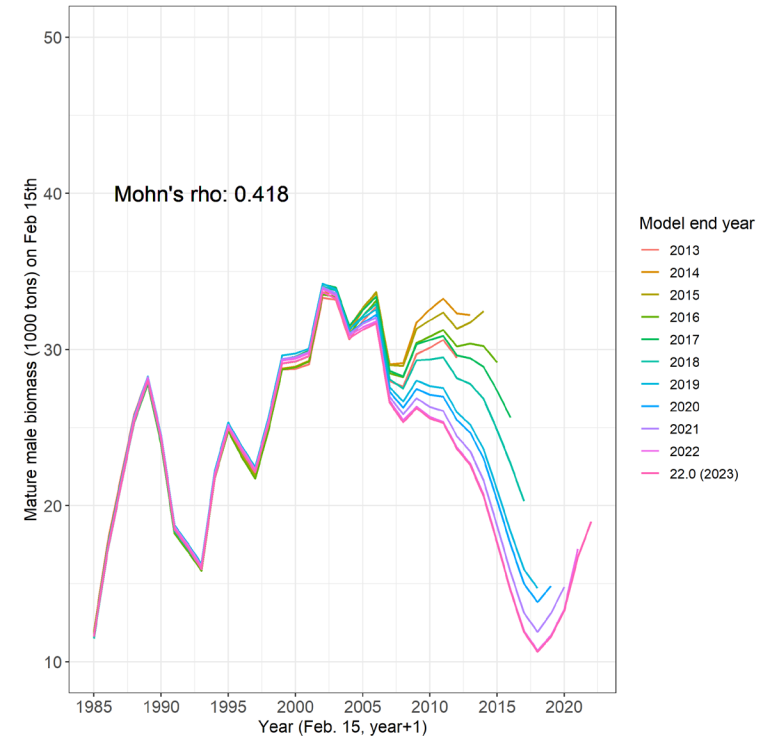
Model 21.1b



Model 23.0a



Model 22.0



- ✓ Retrospective pattern in MMB
- ✓ 1985 start date does NOT reduce retrospective pattern (note scale of y-axis is different in models 22.0)



Table 1: Status and catch specifications (1000 t) for the CPT recommended model (23.0a).

Year	MSST	Biomass (MMB_{mating})	TAC	Retained Catch	Total Catch	OFL	ABC
2019/20	12.72	14.24	1.72	1.78	2.22	3.40	2.72
2020/21	12.12	13.96	1.20	1.26	1.57	2.14	1.61
2021/22	12.01	16.64	0	0.02	0.10	2.23	1.78
2022/23	9.68	18.34	0	0.02	0.07	3.04	2.43
2023/24		14.98				4.42	3.54

Table 3: Basis for the OFL (1000 t) from the CPT recommended model (23.0a).

Year	Tier	B_{MSY}	Biomass (MMB_{mating})	B/B_{MSY}	F_{OFL}	Basis for B_{MSY}	Natural mortality
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
2021/22	3b	24.2	14.9	0.62	0.17	1984-2020	0.18
2022/23	3b	24.03	17.0	0.71	0.20	1984-2021	0.18
2023/24	3b	19.36	14.98	0.77	0.302	1984-2022	0.18

CPT recommendation: Model 23.0a, base ABC buffer 20%
 Author recommended model 21.1b or 23.0a



CPT RECOMMENDATIONS

Recommended Model 23.0a

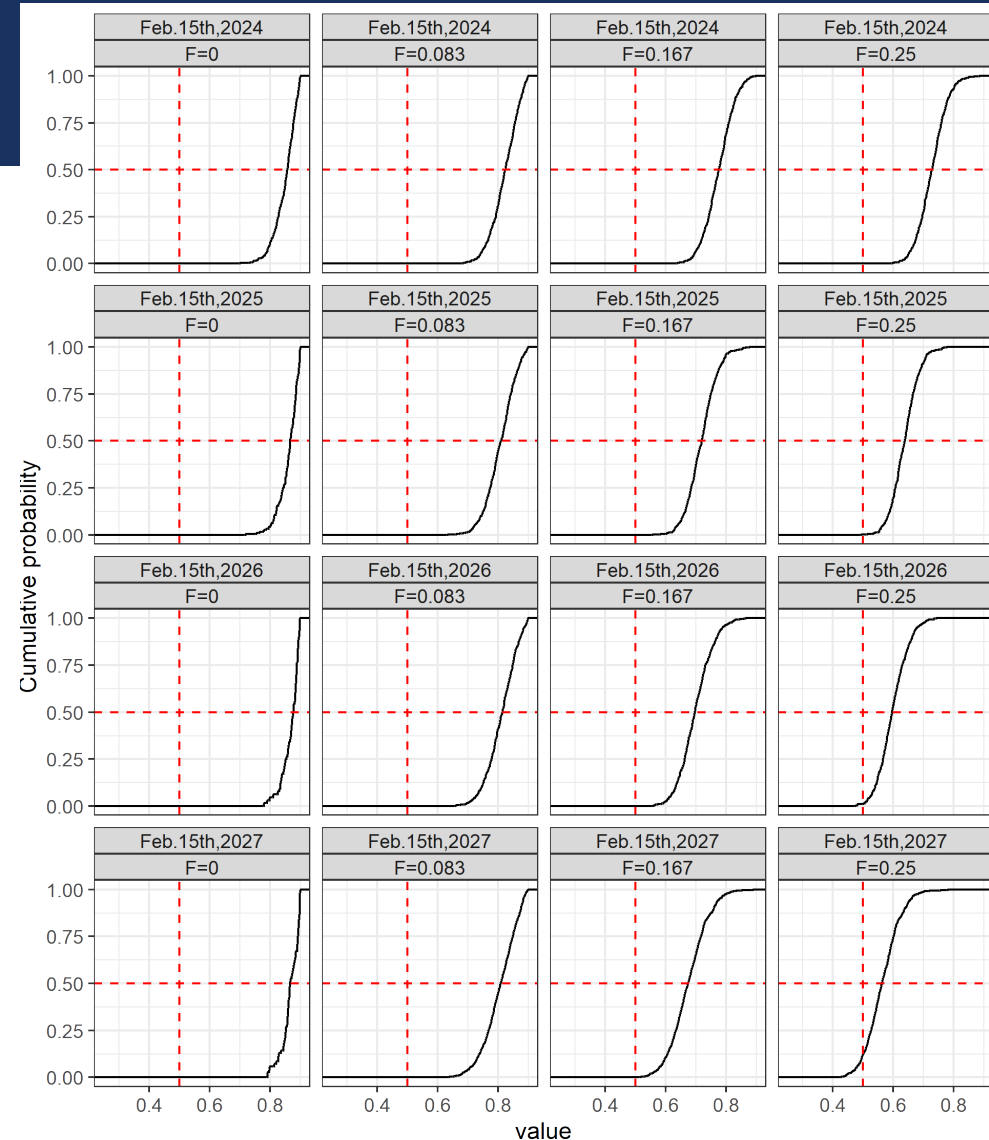
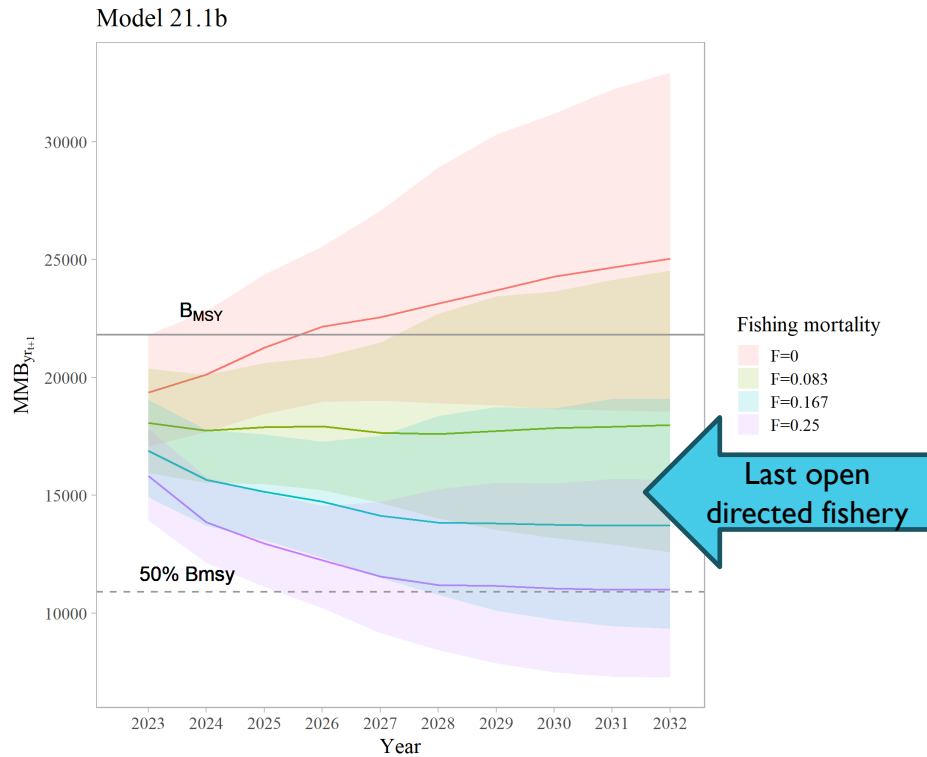
20 % ABC Buffer

- Similar uncertainties exist as previously for this assessment:
 - Cold pool distributional shifts
 - Declining trends (females) or low levels (males) in mature biomass
 - Lack of recruitment events in the last ~10 years
 - Retrospective patterns
 - Poor recent environmental conditions
- Future work
 - Work on retrospective pattern differences between models
 - Simpler modeling workshop recommendations – Q and BSFRF data
 - Investigate molting probability and tagging data differences



PROJECTIONS FOR FUTURE STATUS (21.1B MCMC OUTPUT)

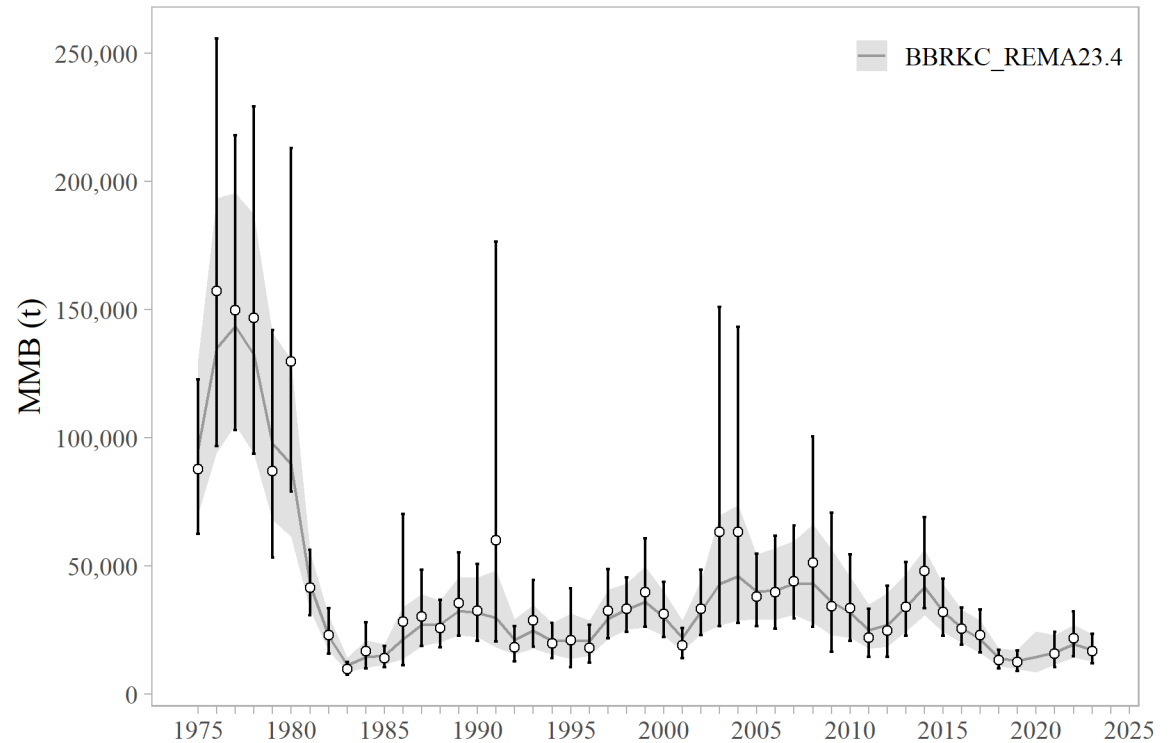
[2023 = PROJECTED MMB FEB 15TH, 2024]



Model 21.1b
Not approaching overfished condition during 2022-2025

BBRKC TIER 4 SIMPLE MODELING WORKGROUP OPTION

- Based on the simpler modeling working group discussions
- Mature male biomass (legal size + one growth increment below = mature for BBRKC)
- Average B – calculated using MMB from 1984 to 2022 (matches current Tier 3 assessment $B_{35\%}$ calcs)
- Assume 20% buffer – likely this would be different if we went with a Tier 4 option.

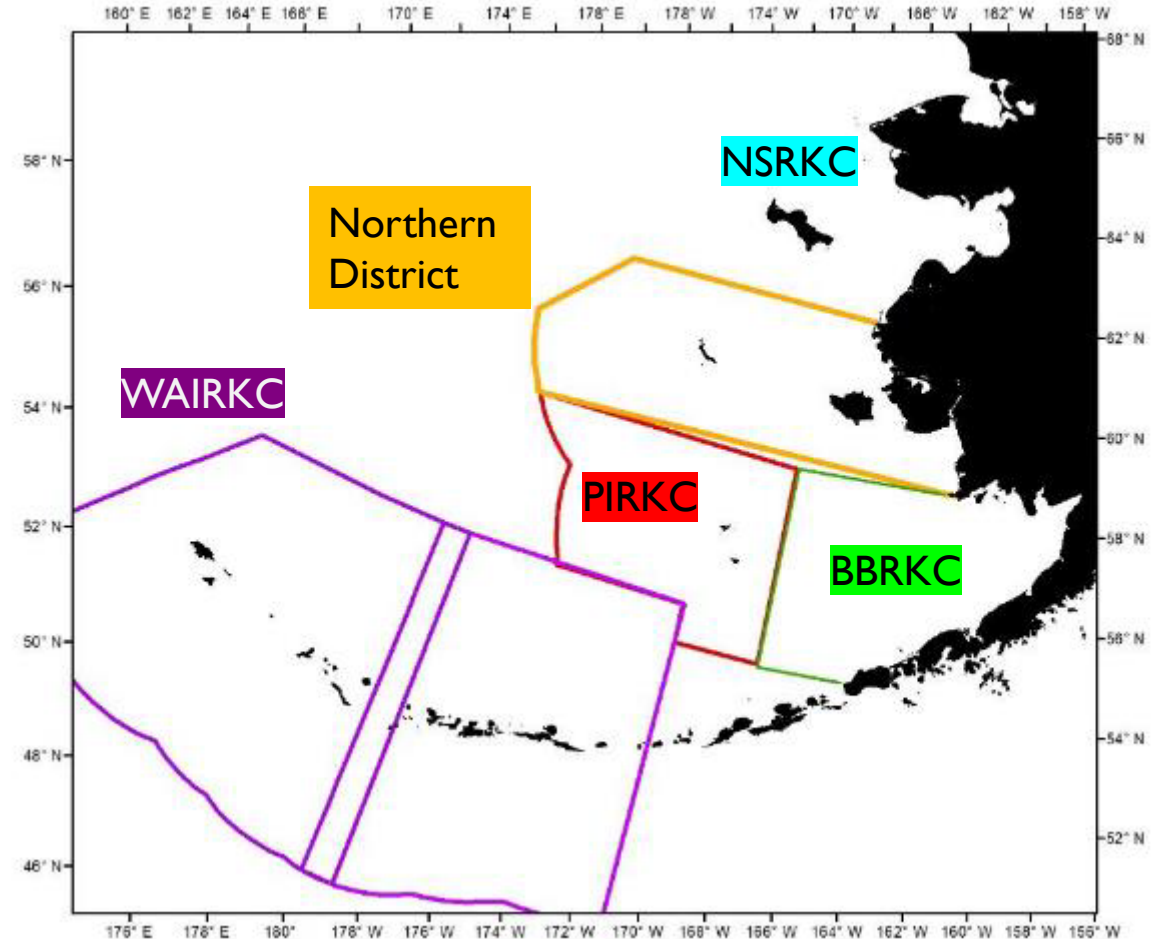
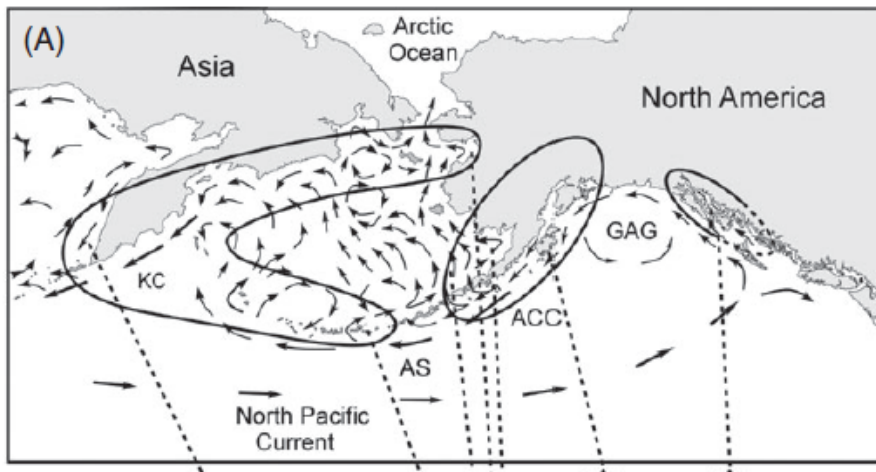


avgB (t)	Current B	MMB/ B_{msy}	M	F_{OFL}	OFL	ABC
28191.68	17377.32	0.61	0.18	0.10	1785.67	1428.54

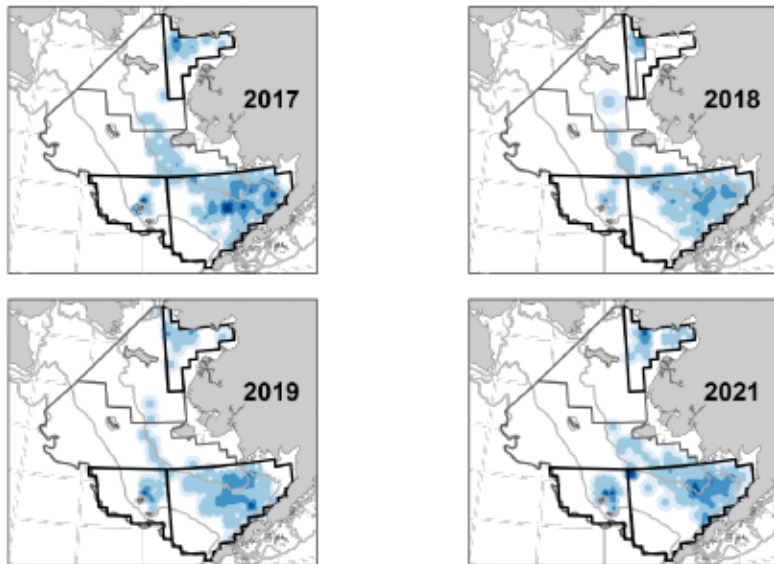


BERING SEA RED KING CRAB: STOCK STRUCTURE TEMPLATE

- Bering Sea red king crab –
 - Bristol Bay, PIRKC, WAIRKC, Northern district, NSRKC
 - WAIRKC and NSRKC genetically distinct from other three stocks
 - No genetic information on Northern district
 - Tagging studies on going – some movement within BB and Northern area



Red King Crab Mature Male



2022 Tech Memo
NOAA trawl
surveys

Red King Crab Mature Female

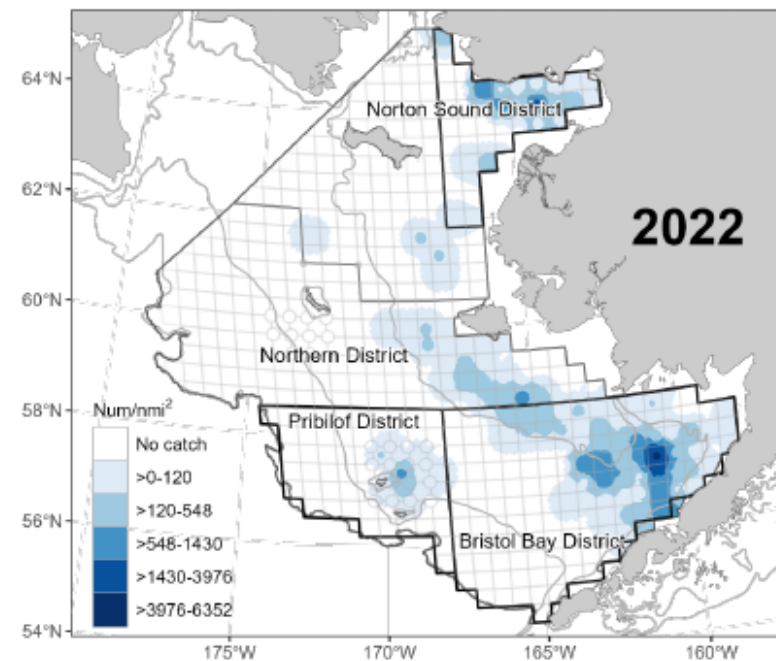
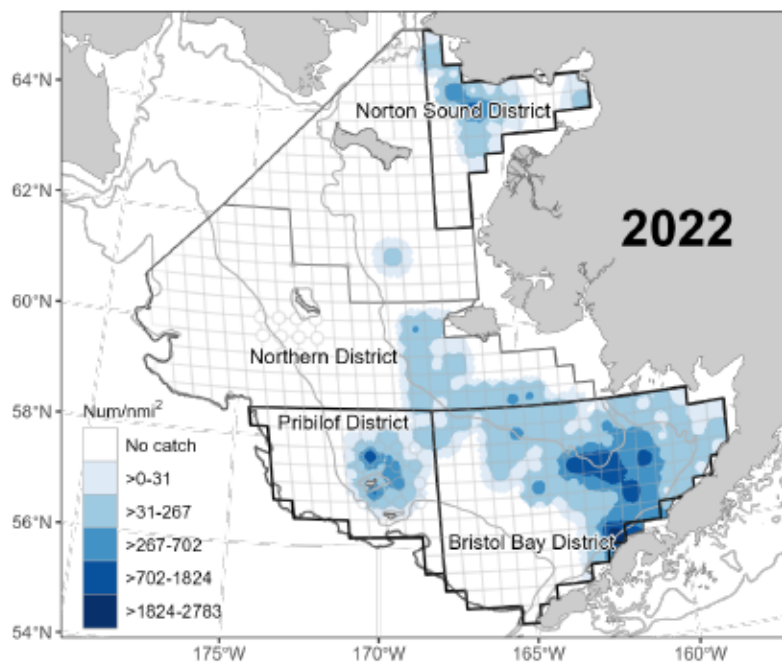
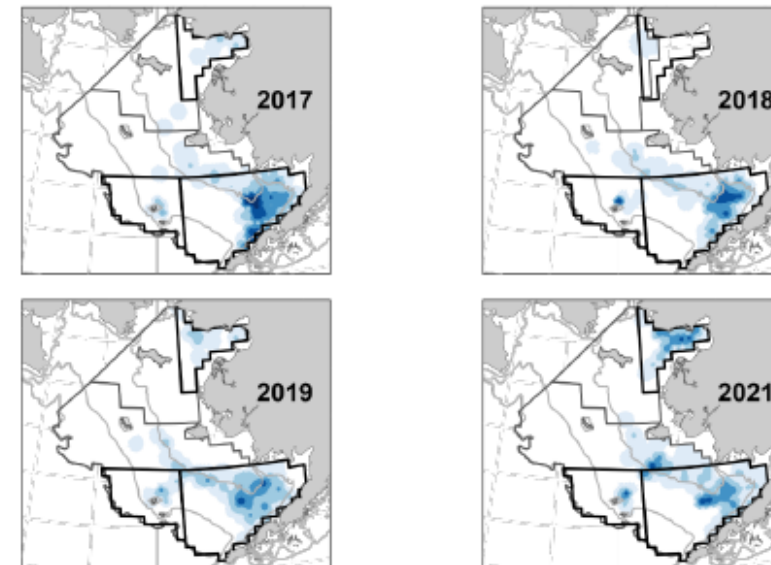


Figure 28. -- Estimated total density of mature-sized (≥ 120 mm carapace length in EBS and ≥ 94 mm in NBS) male red king crab (*Paralithodes camtschaticus*) for the past five survey years. Outlined areas depict management districts.

Figure 30. -- Estimated total density of mature female red king crab (*Paralithodes camtschaticus*) for the past five survey years. Outlined areas depict management districts. In years when a subset of stations were resampled, the resample stations replace data from the original stations.

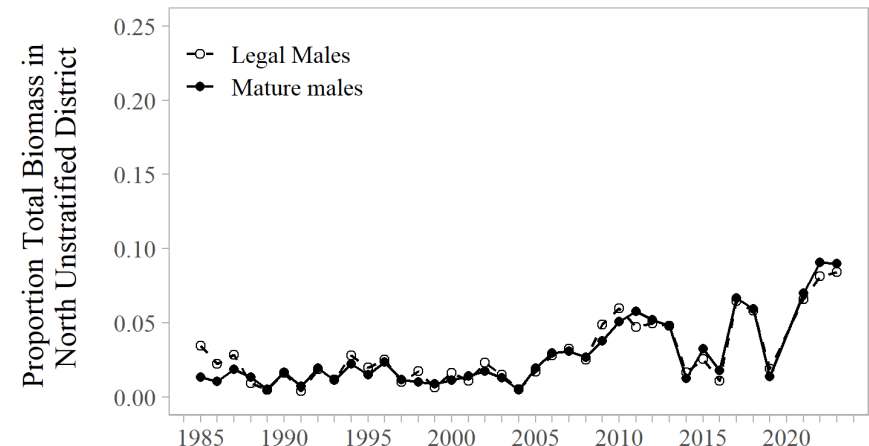
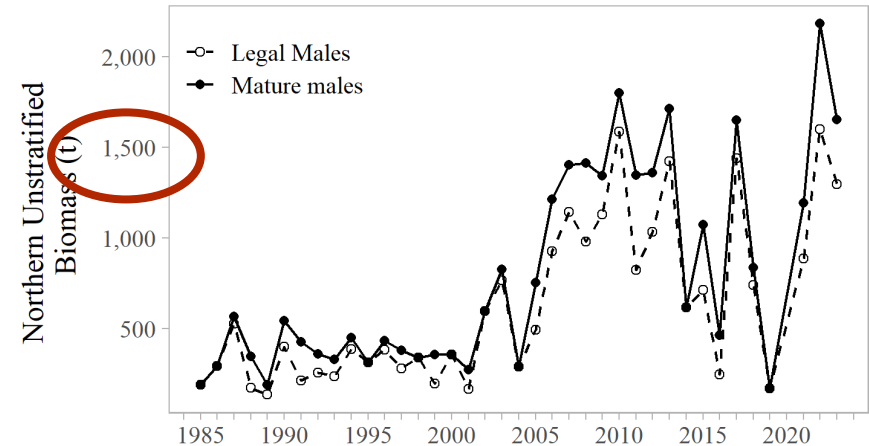
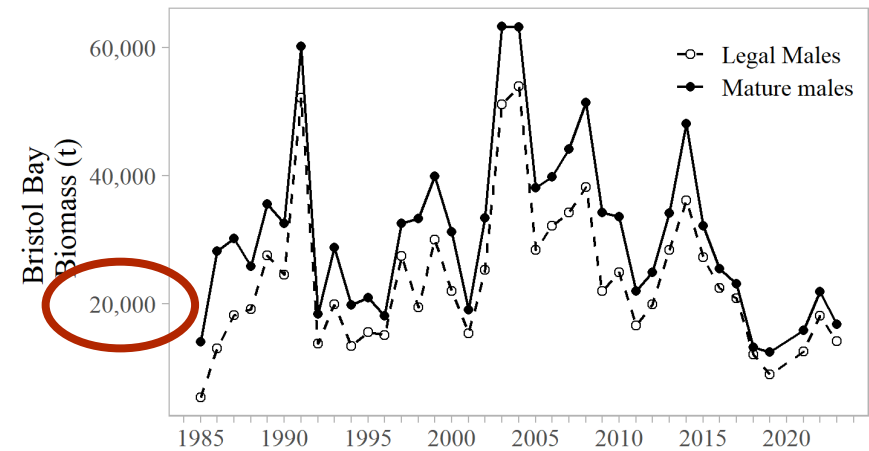
RKC STOCK STRUCTURE FUTURE WORK / NEXT STEPS

- Genetic results update
 - WIP on genomic sequencing suggests clear stock structure between PIRKC and BBRKC (Jan CPT presentation pending)
 - Need to obtain genetic samples for Northern district crab (discussions underway as part of summer trawl survey or BBRKC non-summer survey work)
- Non-genetic information
 - Size compositions, growth, recruitment pulses – low samples sizes (Northern district) or unknown
 - Physical or oceanographic barriers – in BB or Northern area depend on larval release and timing (Daly et al. 2020 simulations, recently funding NPRB work Weems et al.)
- Historic management units
 - Based on historic fishing to distribute effort and landmark boundaries, still DO represent majority of RKC stock centers in Bering Sea
- Future work
 - Objective of determining if Northern district red crab are part of the functional BBRKC stock?
 - For a yes, evidence for genetic linkage needed AND movement data to suggest these crab are part of mating aggregations OR indication of larvae exchange
 - For a no, evidence of genetic differences AND movement data to suggest they do NOT move into Bristol Bay
 - Increased genetic sampling around Bristol Bay
 - Oceanographic information and potential larval flow?



Northern area legal and mature male crab relative to Bristol Bay

- Northern area biomass 10x smaller than Bristol Bay in large years
- Last 15 years some changes in Northern vs BB proportion (panel 3)
 - Trend of increase with some fluctuation to low levels in the North
 - Highest level still only 10% of mature males in Northern area



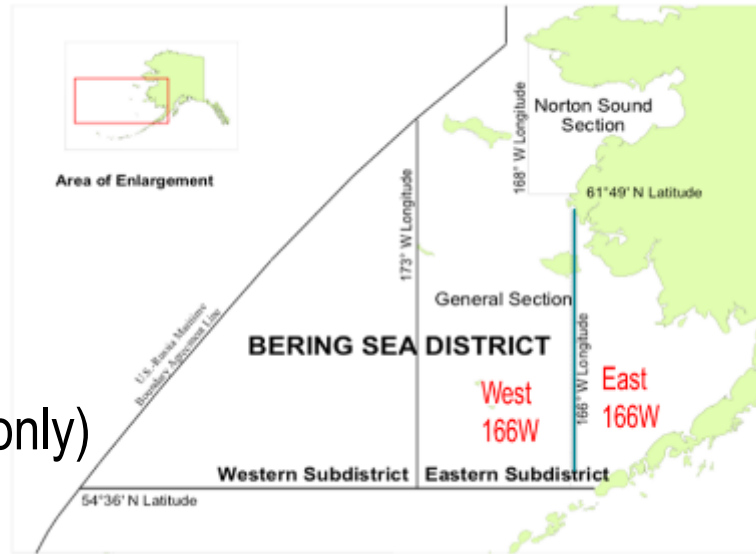
TANNER CRAB

FINAL ASSESSMENT 2023

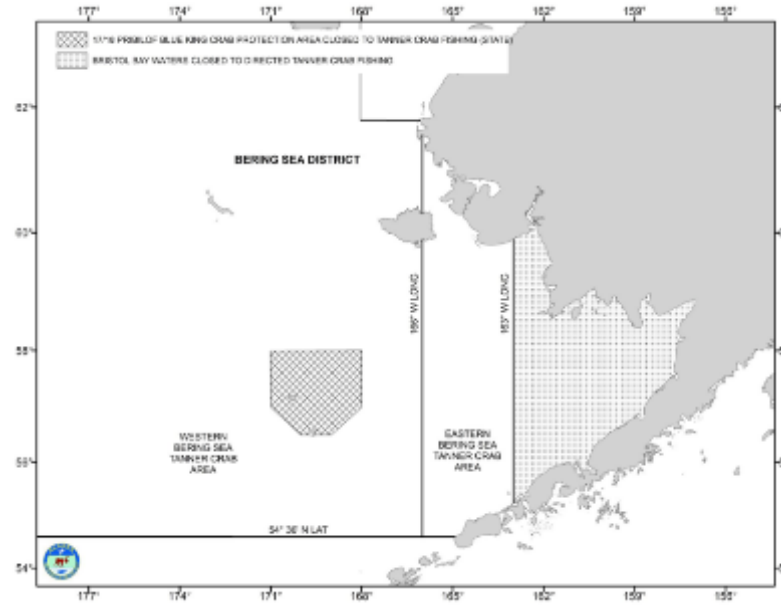


Overview

- ADFG manages fishery in two areas
 - **fishery open in both areas**
 - East: TAC: 528 t. RC: 528 t
 - West: TAC: 386 t. RC: 384 t
 - Last year: TAC: 499 t. RC: 494 t (W only)
- 2023 NMFS EBS Shelf Survey Biomass
 - male biomass: 35kt (-E,+W,+T)
 - IP male biomass: 6kt (-E,+W,~T)
 - female biomass: 17kt (+E,+W,+T)
 - **large recruitment event in W area**
- 2022/23 OFL: 32,810 t
 - Total catch mortality: 1,187 t
 - overfishing not occurring
- 2023 assessment
 - Tier 3a ($B > B_{MSY}$; not overfished)
 - OFL: 36,200 t, ABC: 27,150 t



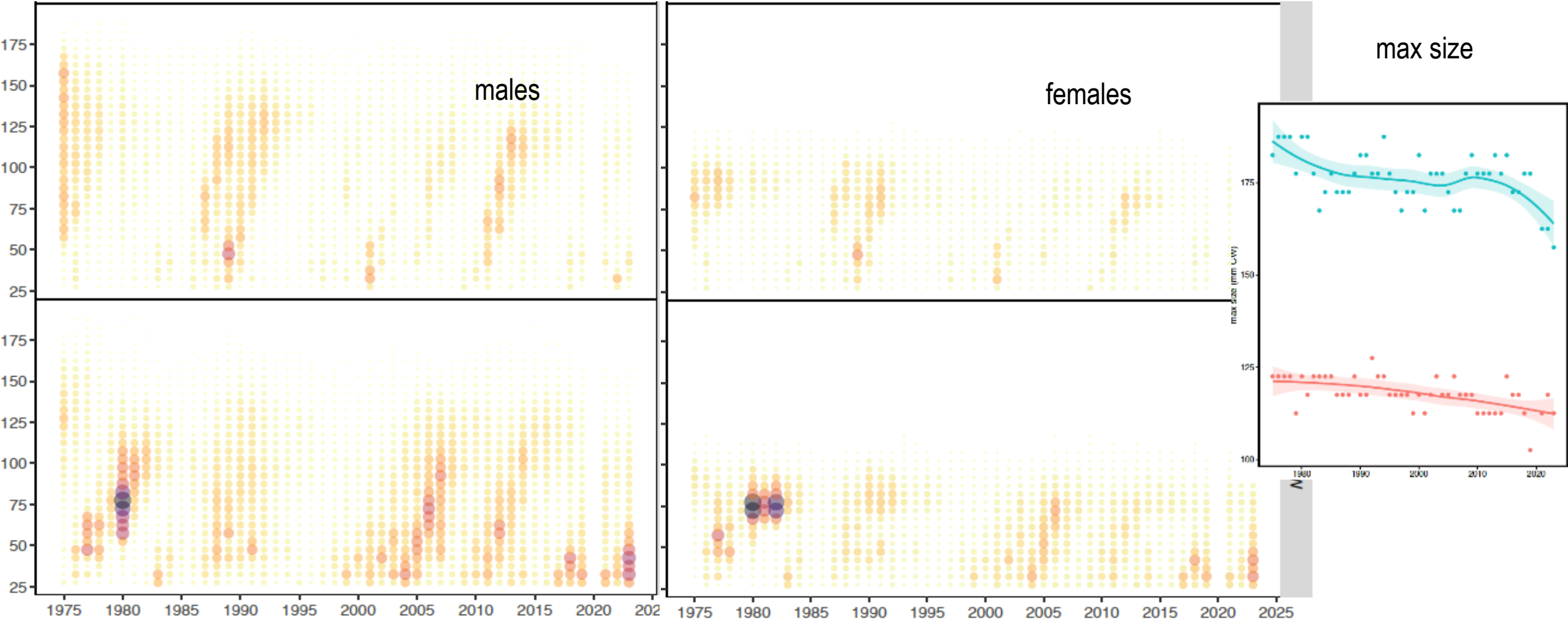
Tanner final assessment 2023



Concerns

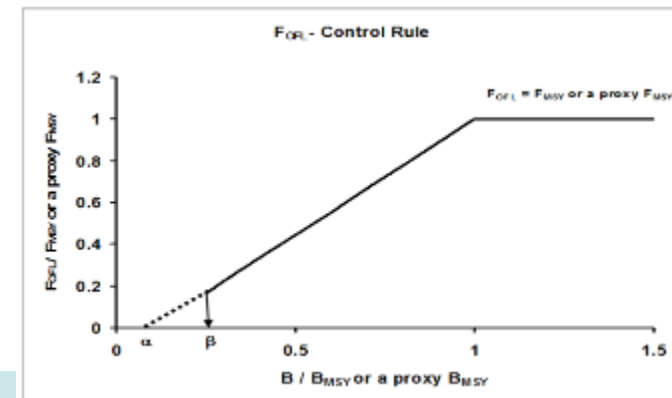
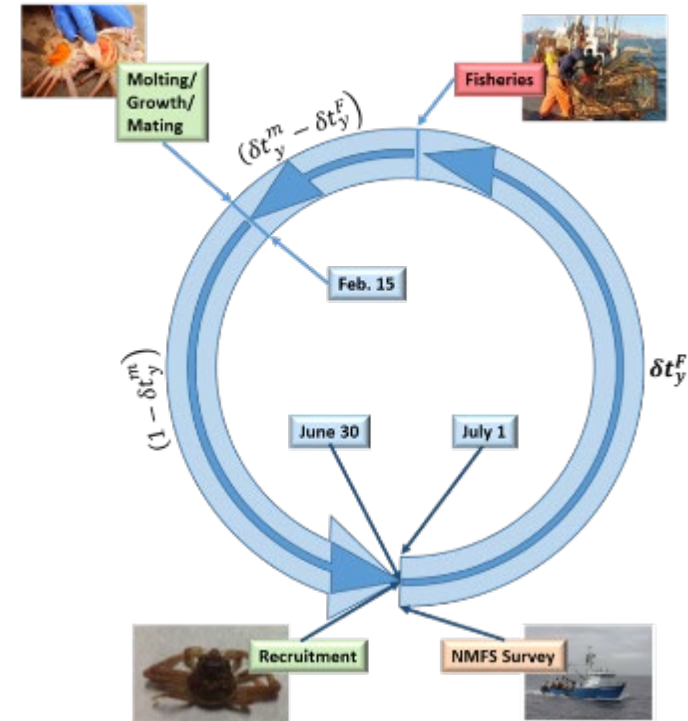
- recent recruitment **does not** move into larger size classes
- assessment model **overly-optimistic**

Survey Size Comps

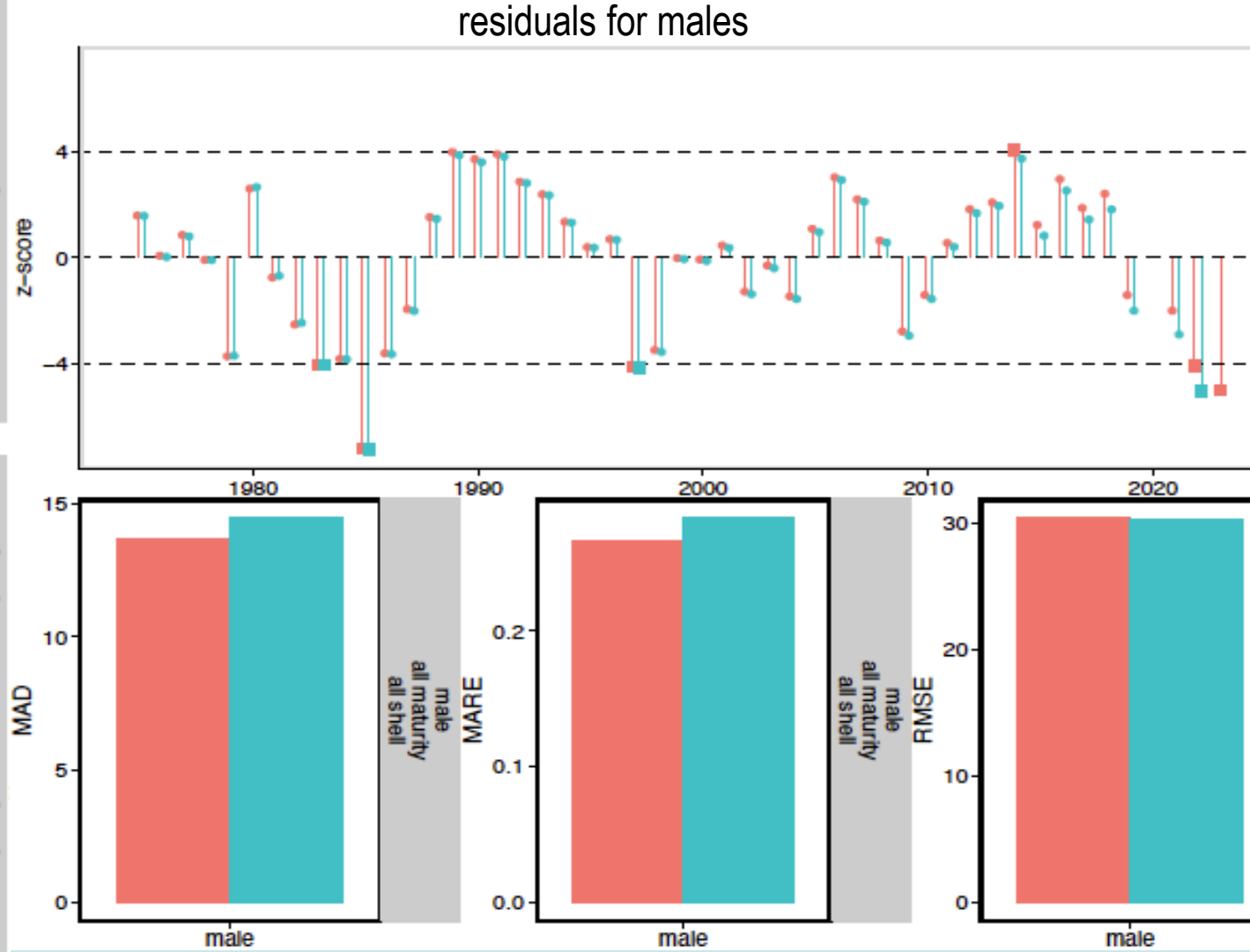
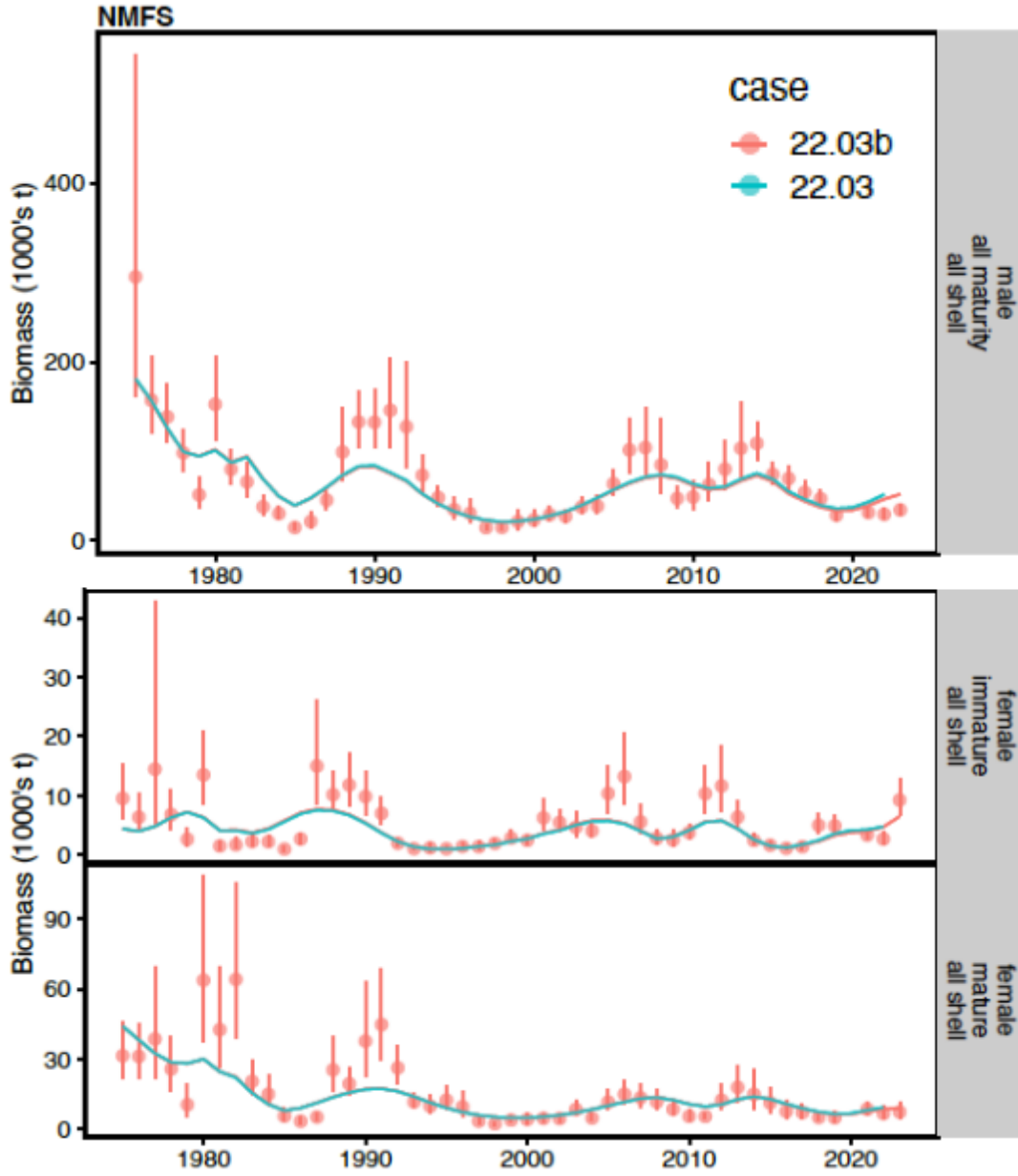


Assessment

- Tier 3 size-structured model
 - Survey data
 - NMFS EBS shelf survey: 1975-present
 - BSFRF side-by-side haul studies
 - Fishery data
 - directed fishery (areas combined)
 - retained catch
 - total catch
 - bycatch in
 - snow crab fishery
 - BBRKC fishery
 - groundfish fisheries
 - Estimates:
 - Annual recruitment
 - Annual numbers-at-size (M,F)
 - mature biomass (MMB, MFB)
 - Determines:
 - F_{msy} , B_{msy} , F_{OFL} , OFL , ABC

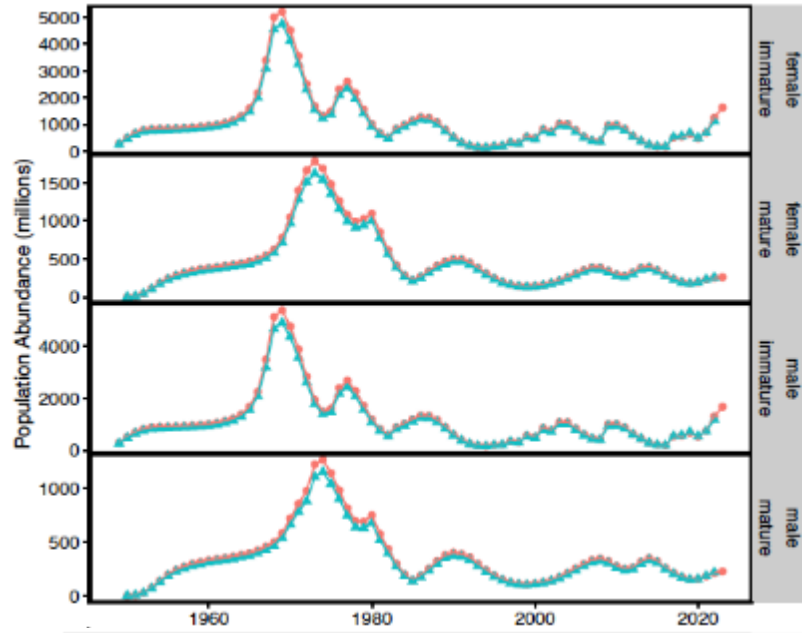


Fits to NMFS Survey Biomass

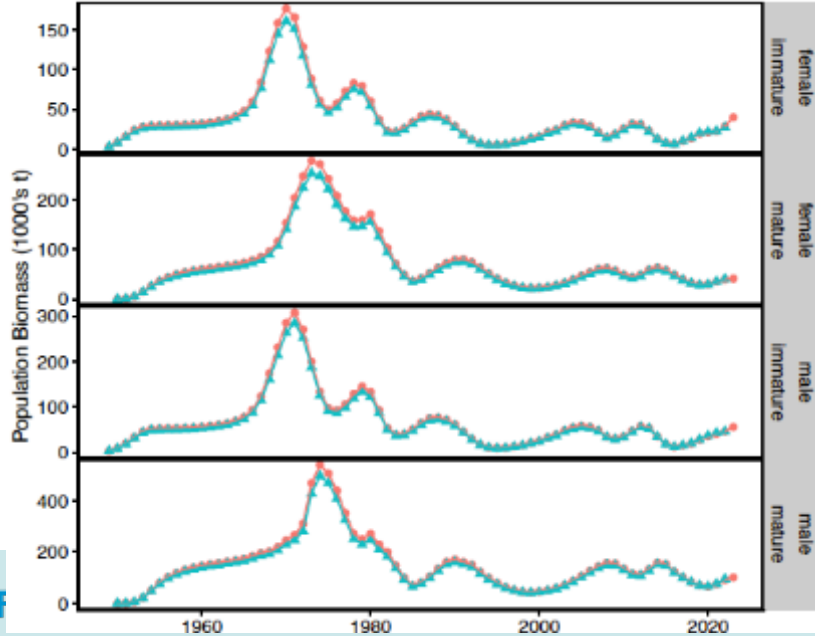


Estimated Population Quantities

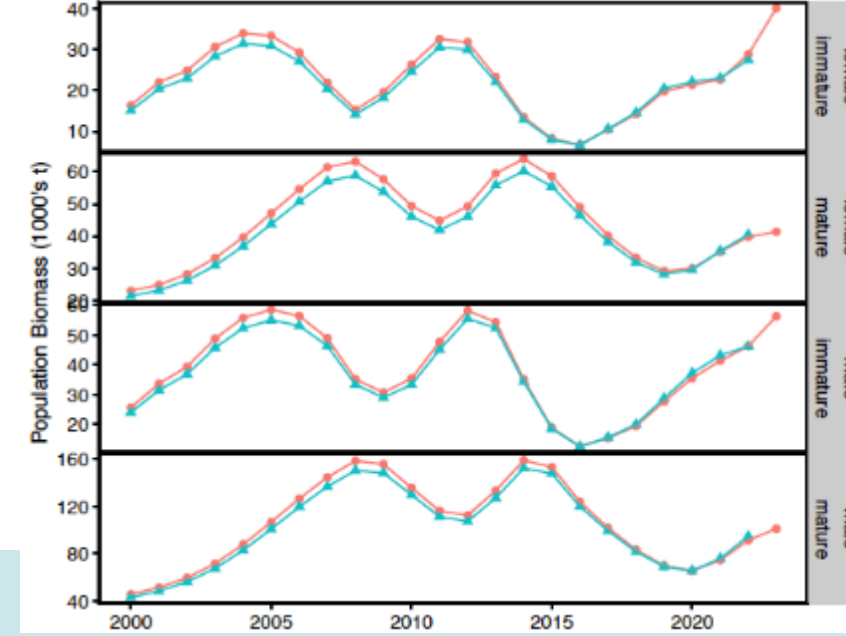
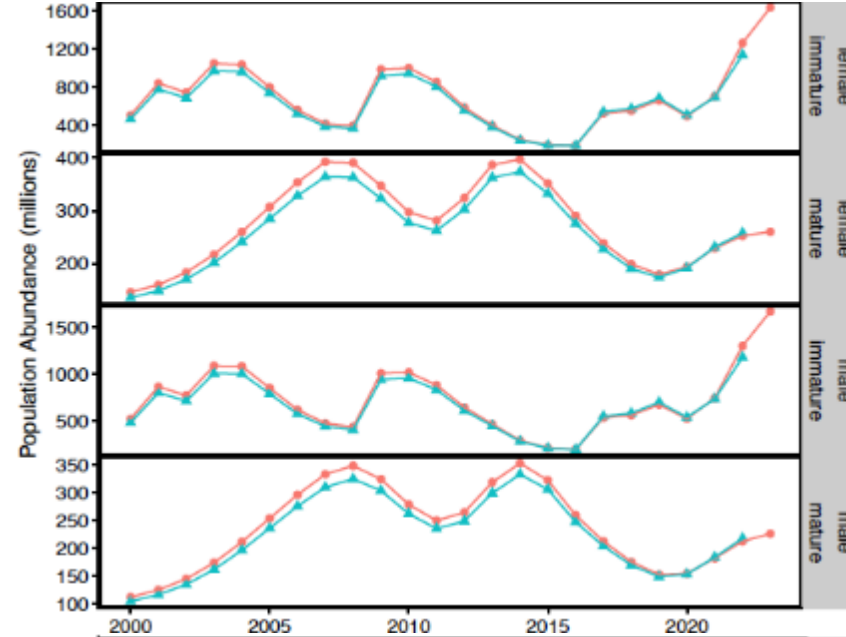
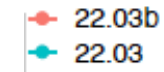
abundance



biomass

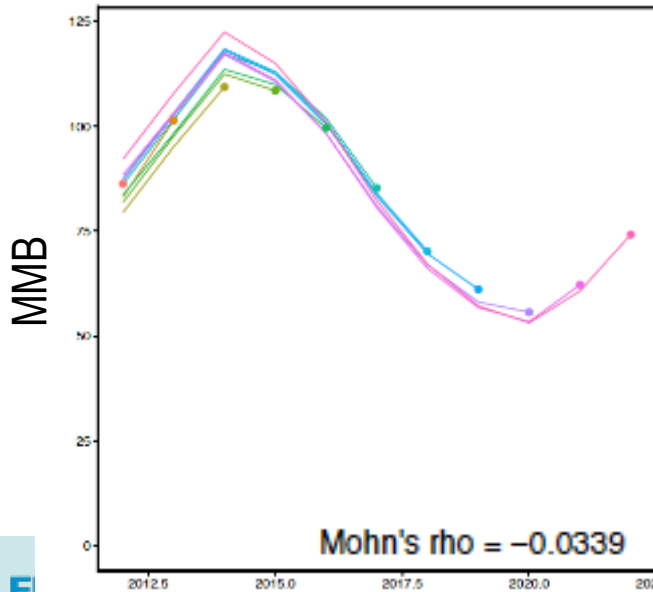
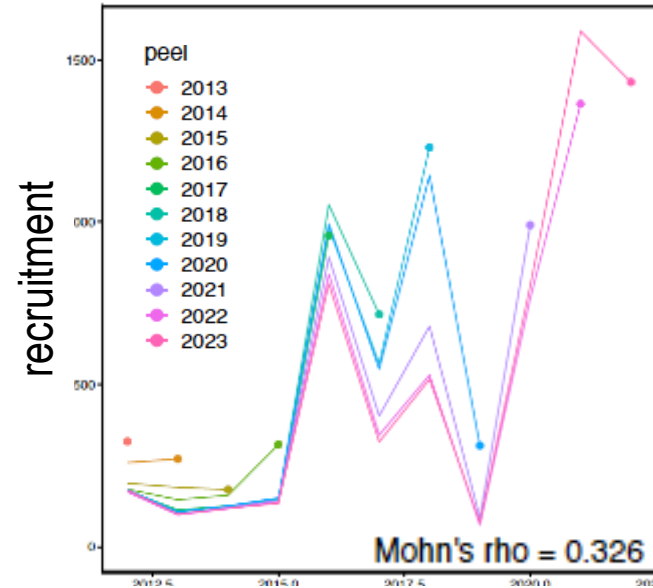


Case

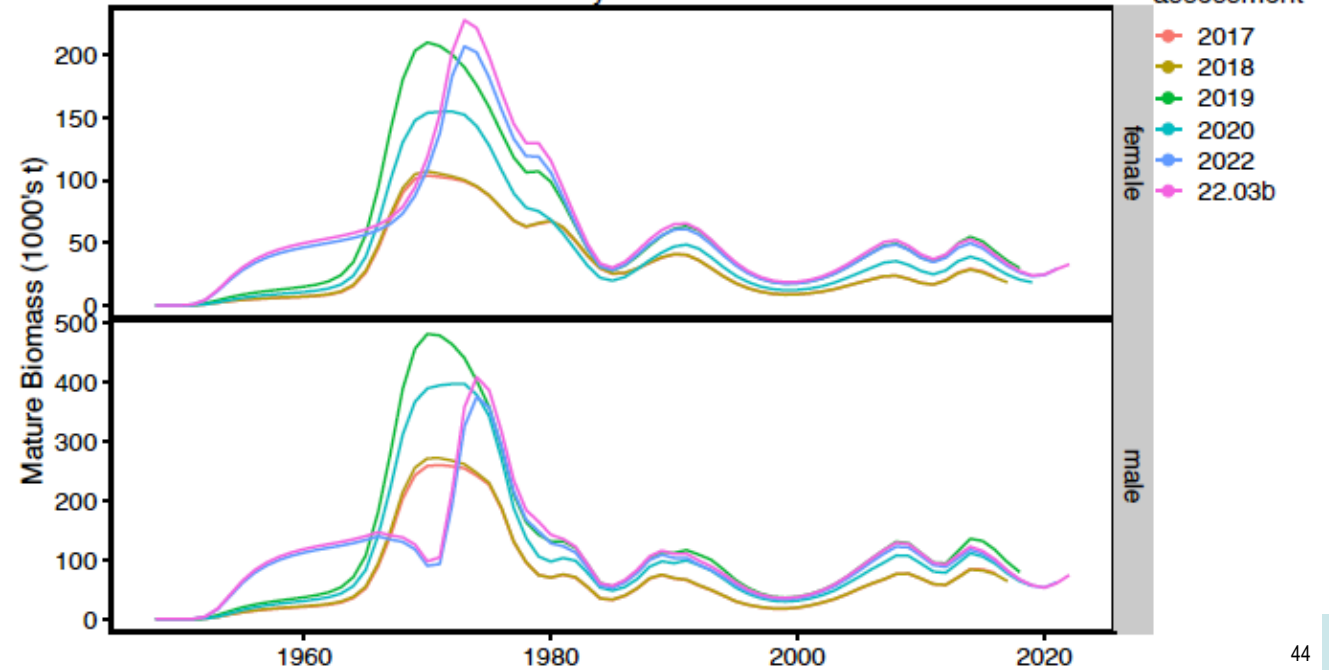
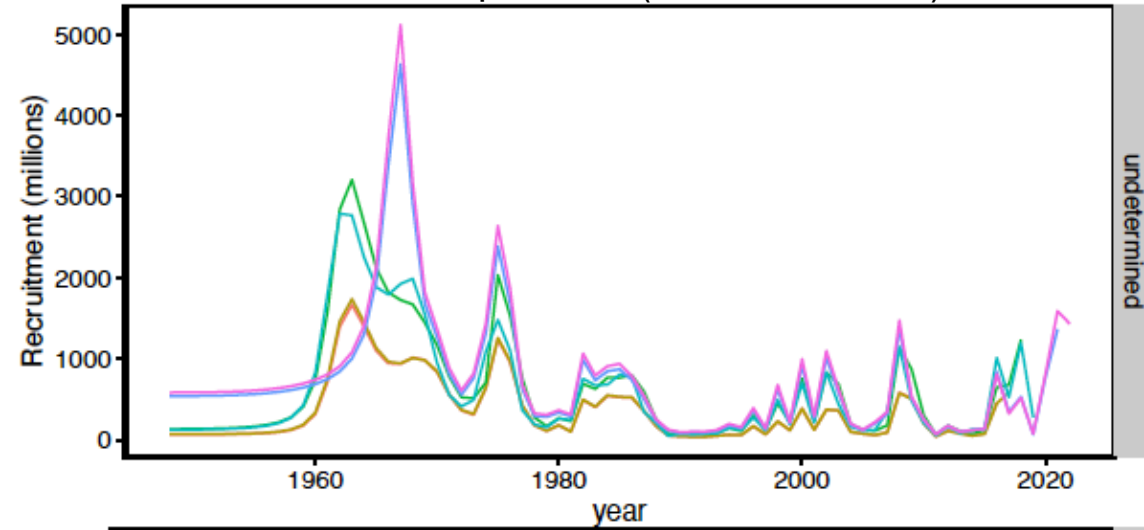


Retrospective patterns

retrospective comparisons



historical comparisons (different models)



TANNER 2023 FINAL SAFE RECOMMENDATIONS

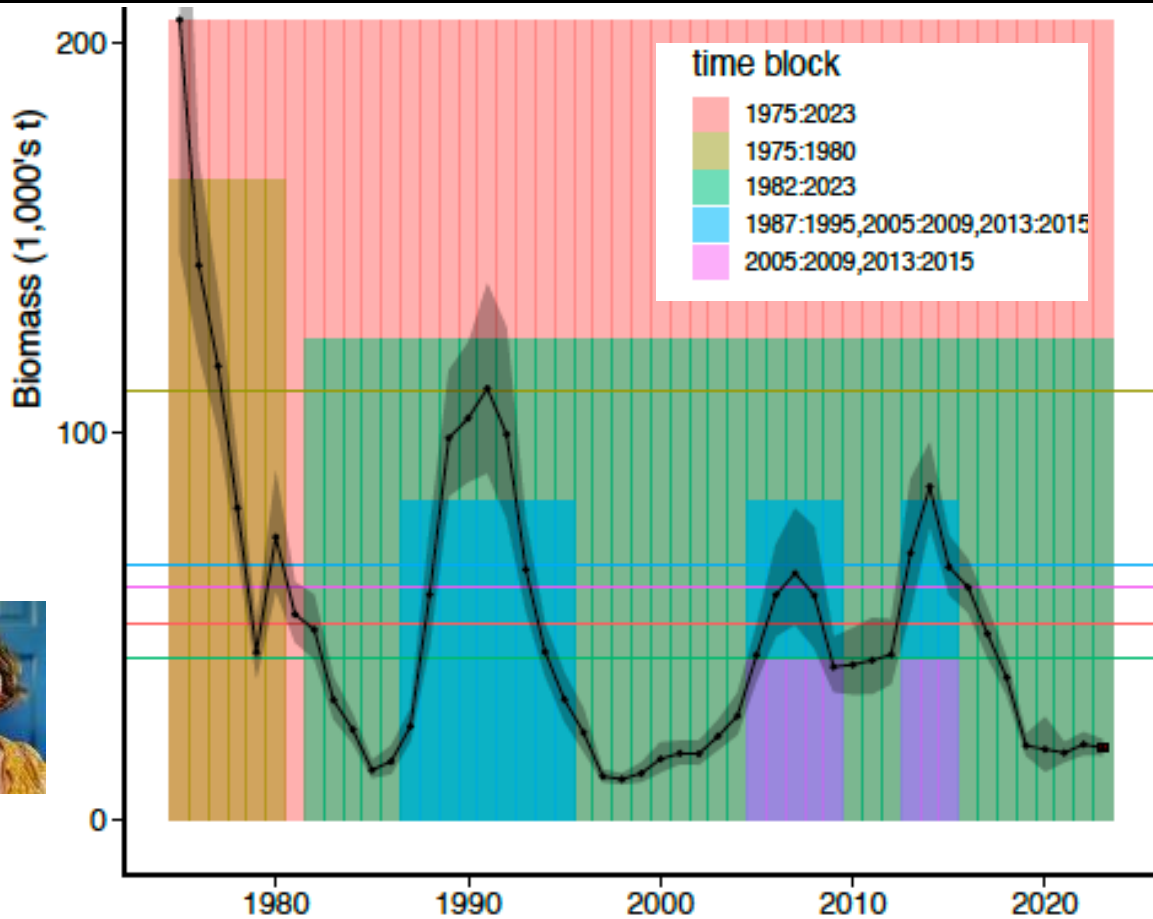
- Tier 3a Model 22.03b
 - Based on previously-adopted assessment model
 - jitter analysis successful in identifying MLE
 - small max gradient at MLE
 - no parameter-at-bounds
 - all results similar to 2022 assessment
 - but not much improvement on previous assessment
 - abundance of large crab overestimated
 - terminal year recruitment consistently overestimated
- ABC buffer: 25% (same as rec'd last year; SSC adopted 20% last year)
 - continuing concern over model inadequacies
 - continuing concern over F35%, B35% as metrics for a sustainable fishery
 - concern over lack of recruitment pulses into larger sizes



Tier 4 “Fallback”

time block	M	B	Bmsy	status	Fofl	OFL
1975:2023	0.23	18.68	50.63	0.37	0.07	1.24
1975:1980	0.23	18.68	110.42	0.17	NA	NA
1982:2023	0.23	18.68	42.03	0.44	0.09	1.57
1987:1995,2005:2009,2013:2015	0.23	18.68	65.64	0.28	0.05	0.86
2005:2009,2013:2015	0.23	18.68	60.21	0.31	0.05	0.98

← fishery closed



ABC buffer

- recommend using cv on model-estimated terminal biomass (8.9%) as basis
- Author recommended 8.9%
- CPT recommended 10% if use Tier 4 fallback

SNOW CRAB

FINAL ASSESSMENT 2023



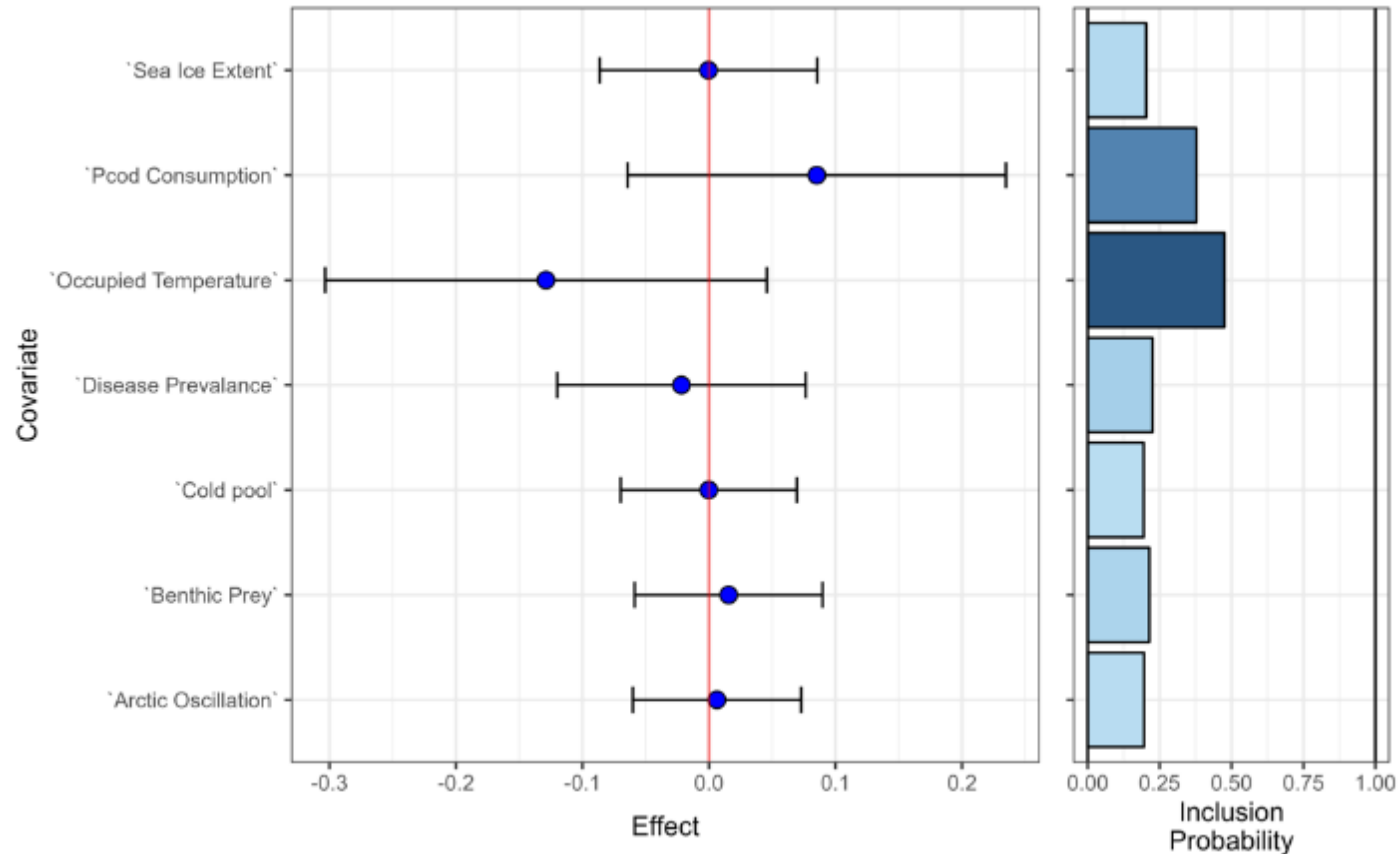
SNOW CRAB ECOSYSTEM CONSIDERATIONS

- Summer bottom temperatures and the spatial extent of the cold pool remained near-average
- Average juvenile snow crab temperature of occupancy: -0.3°C , optimal cold-water habitat for predator refuge
- Anomalously low levels of chlorophyll-a in 2023 suggest a less pronounced spring bloom and poor feeding conditions for larval snow crab
- Bitter crab syndrome prevalence near-average.
- Pacific cod consumption of snow crab near-average in 2021 and 2022
- Mature male center of abundance more northerly than average
- Juvenile snow crab were in very poor body condition in 2019 (beginning of collapse); 2021-2023 condition near-average
- Socioeconomic considerations: Fishery closed in 2022/23, many indicators missing, reflecting severe economic impacts on harvesters, processors, communities



SNOW CRAB ECOSYSTEM CONSIDERATIONS

Stage 2 analysis: Indicator relationship to survey 50-65mm male abundance



Poor predictive performance, not as advanced as BBRKC ESP

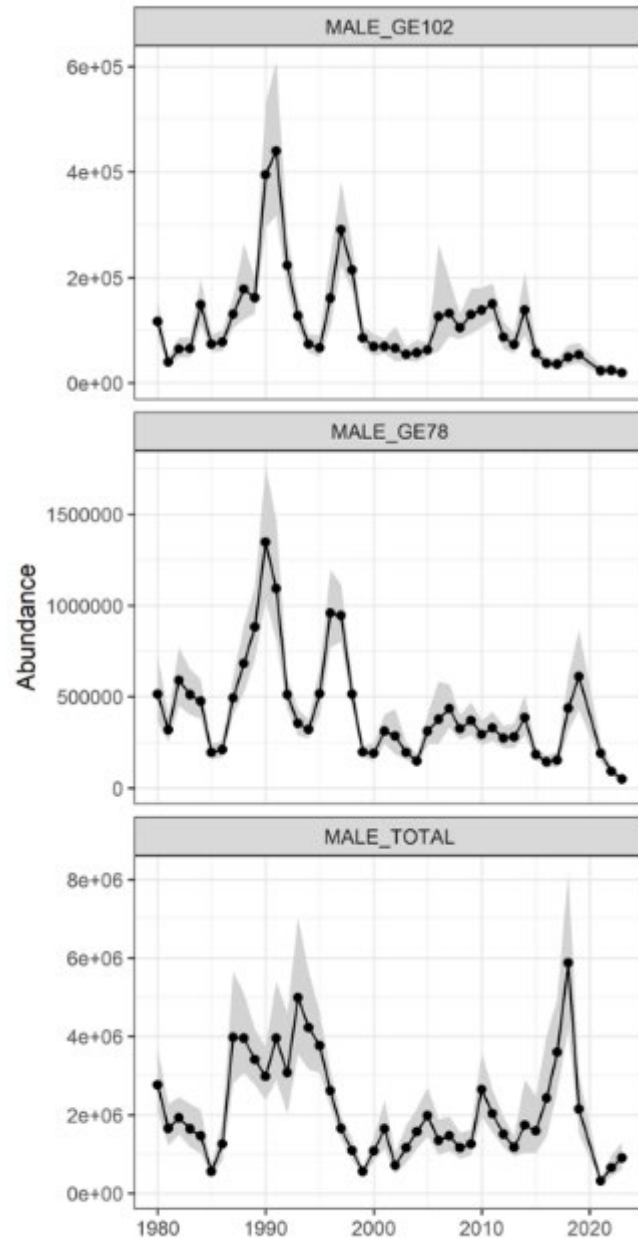


SNOW CRAB ASSESSMENT OVERVIEW

- **Tier 3 annual stock assessment, GMACS modeling framework**
- Declared overfished in 2021
- Fishery closed in 2022/23
- **Two decisions:**
 - Model choices
 - Biological assumptions (terminal molt to maturity)
 - Treatment of data (BSFRF survey data)
 - Management choices
 - Currency of management (mature male biomass)
 - Tier placement



Snow crab final assessment 2023



- Commercially preferred males (≥ 102 mm) and legal males (≥ 78 mm) at historical lows
- Slight uptick in total males, dominated by small crab
- Four or more years until fishable size



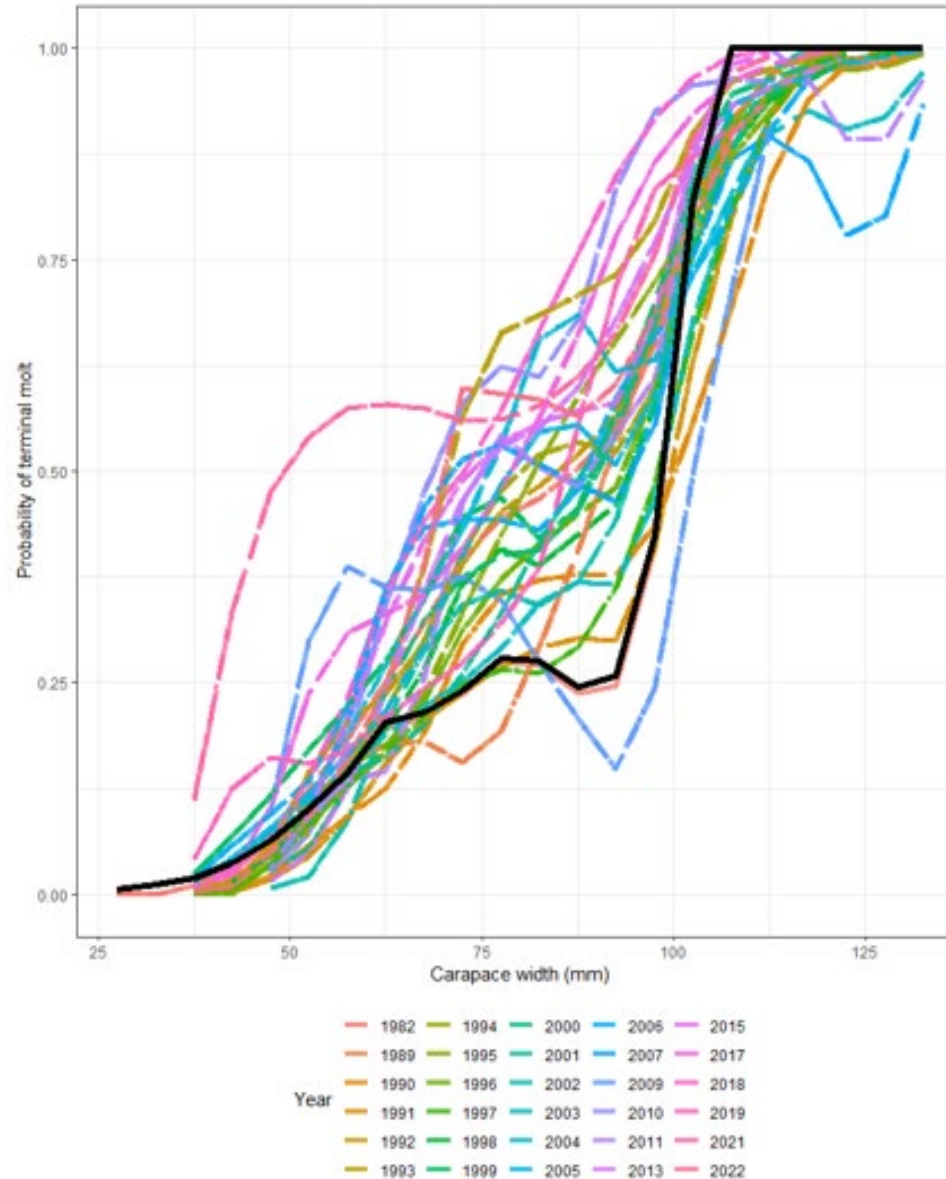
22.1	Last year's accepted model
23.1	Last year's model fit to this year's data
23.2	23.1 + specifying the probability of having undergone terminal molt based on survey data
23.3	23.2 + specifying survey selectivity based on the BSFRF data
23.3a	23.3 + estimating survey selectivity with the BSFRF data as priors
23.3b	23.3a + loosening the prior on natural mortality



Snow crab final assessment 2023: Key model differences

Process	23.1	23.2	23.3	23.3a	23.3b
Sex	Both	Both	Both	Both	Both
Maturity	Single estimated ogive	Input	Input	Input	Input
BSFRF	Survey	Survey	Prior	Prior	Prior
Survey	Estimated logistic by sex and era	Estimated logistic by sex and era	Specified non-parametric	Estimated non-parametric	Estimated non-parametric
Growth	Linear estimated	Linear estimated	Linear estimated	Linear estimated	Linear estimated
Natural.M	By sex and maturity + 2018/19	By sex and maturity + 2018/19	By sex and maturity + 2018/19	By sex and maturity + 2018/19	By sex and maturity + 2018/19 + looser prior
Fishery	Logistic	Logistic	Logistic	Logistic	Logistic





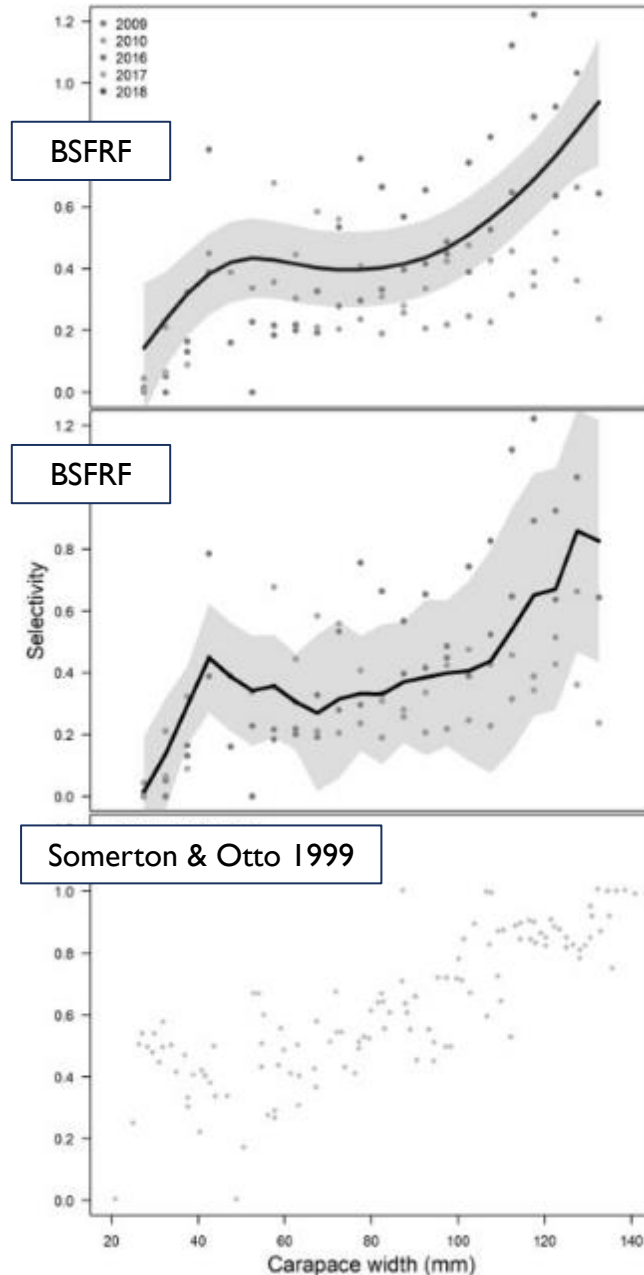
Inputting the observed probability of having undergone terminal molt

- Growth stops after a molt to maturity
- What size this happens at has large effects on reference points
- Observations are made in the survey and used to split the data into 'mature' and 'immature'



Size-dependent probability of maturity: survey data (colors) and status-quo model estimate (black)



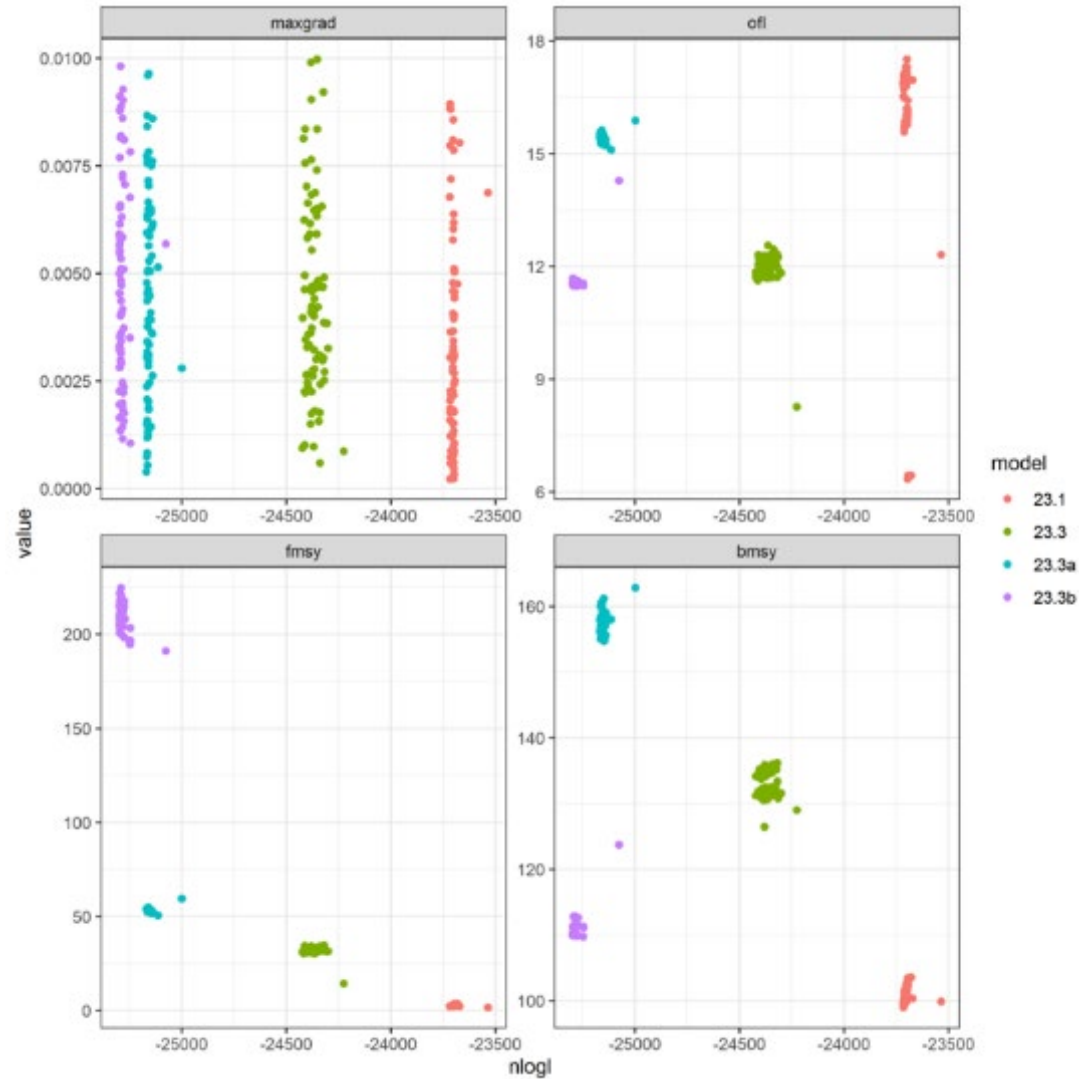


BSFRF data as priors

- Previously input as additional survey, but the fitting process has a lot of flexibility
- Previously assumed to be logistic, but now two studies suggest this isn't the case



Snow crab final assessment 2023: Model convergence

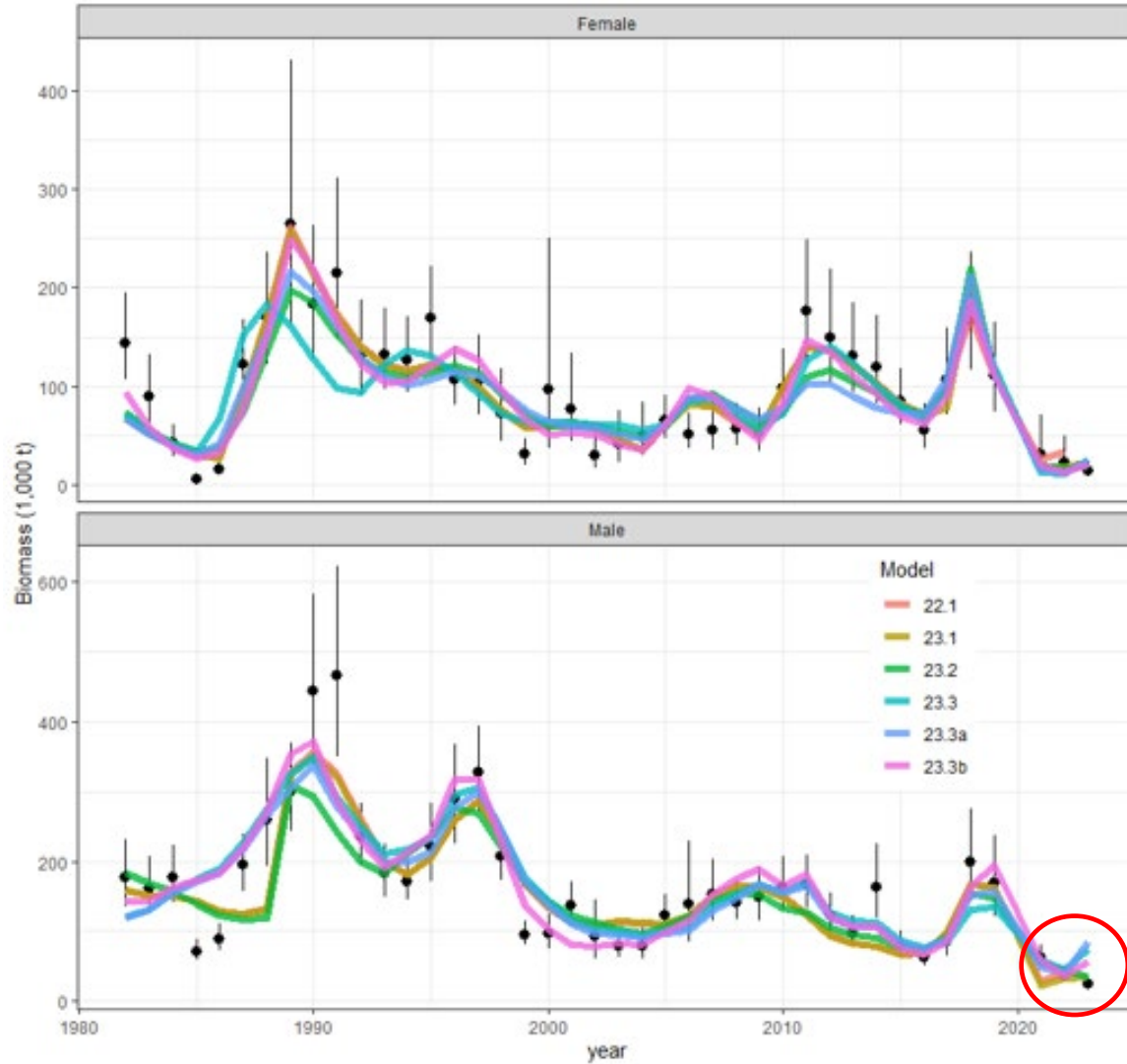


- All models produce invertible Hessian matrices
- Retrospective patterns acceptable
- Bimodality was reduced in the 23.3 series of models
- The OFL was bimodal for the status quo model with updated data.

Management quantities from jittered models



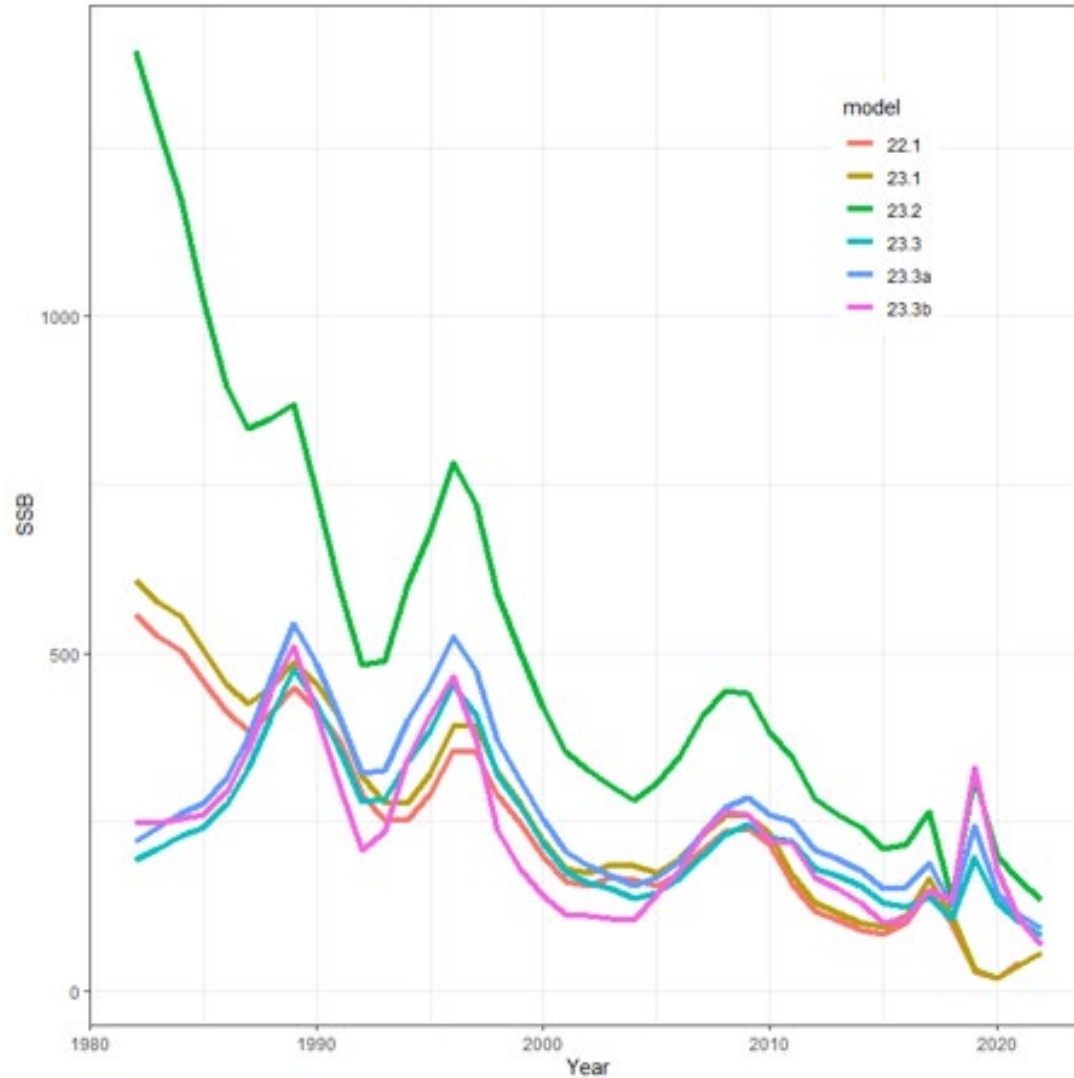
Snow crab final assessment 2023: Model fits



- Model 23.3 series had sharp uptick in final year of MMB data
- Growth data were similarly fit
- Catch data were similarly fit
- Fishery size comps all similarly fit
- Survey size comps were more variable

Model fits to survey biomass

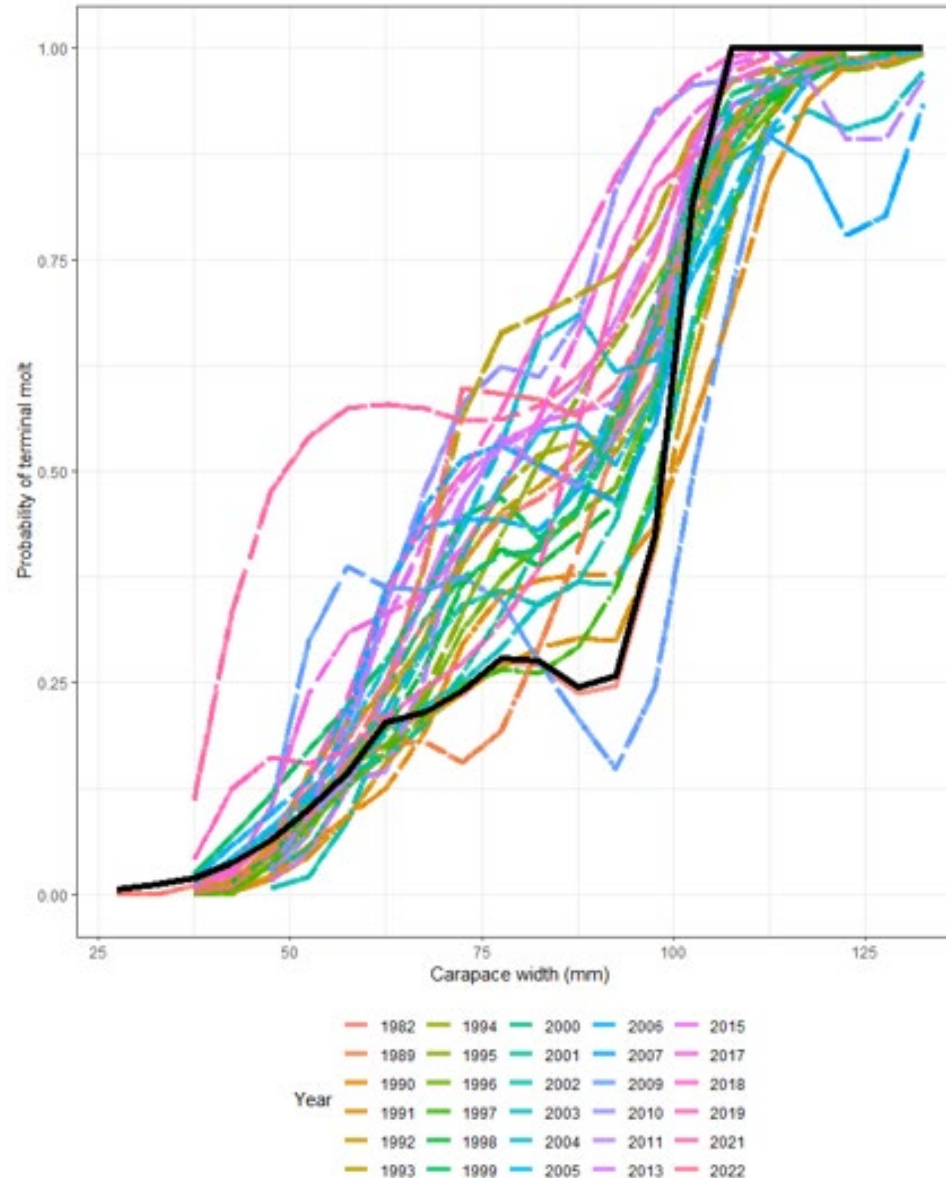




- Incorporation of terminal molt data changes interpretation of stock dynamics around the collapse
- Not concurrently including non-parametric selectivity results in larger stock sizes

Model predicted mature biomass at mating time in 1,000 tonnes.





Why does the status quo model get terminal molt so wrong?

- The model 'needs' animals to continue growing because logistic selectivity that has the same catchability for medium sized animals as large animals need the medium sized animals to grow to large sizes.
- Given growth and M are based on informative data or priors, the way for this to happen is by reducing the probability that growth ceases.



Size-dependent probability of maturity: survey data (colors) and status-quo model estimate (black)



SNOW CRAB: MODEL RECOMMENDATIONS

CPT supports author-recommended model (23.3a)

- Important to fix issues around terminal molt and logistic selectivity simultaneously - Model 23.2 is an unsatisfactory half-fix.
- Model 23.3 series incorporate the best available science on the biology of the stock in the most defensible ways.
- Model 23.3a and b are preferable over 23.3 because they propagate uncertainty in survey selectivity.
- Model 23.3a is preferable to 23.3b because loosening the prior on M results in a higher M than has historically been assumed and has important effects on stock dynamics.



SNOW CRAB: MANAGEMENT CHOICES

- Realistic modeling of terminal molt, combined with morphometrically mature male biomass as the currency of management, creates unacceptably high F values for commercially-preferred males
 - Most males mature below commercial size and never grow again, thus are protected from interaction with the fishery
 - Applying F to only a subset of the currency of management ignores any size-based differences in functional maturity
- Best fix is to reassess the currency of management (longer-term project)
- Simpler modeling working group suggested using Tier 4 specs as a temporary bridge while management choices (i.e., currency) catch up to modeling improvements



Strategies considered for setting management reference points.

Strategy	Fishing mortality target	Biomass target	Biomass currency
Tier 3	F35%	B35%	Morphometrically mature males (model)
Tier 4_ssc	Natural mortality	B35%	Morphometrically mature males (model)
Tier 4_specs	Natural mortality	Average from 1982-2022	Morphometrically mature males (model)
Tier 4_survey	Natural mortality	Average from 1982-2022	>101 mm carapace width (survey)



MANAGEMENT CHOICES: CPT DISCUSSION

- Tier 3
 - Spawner-per-recruit methods are well-studied / well-established
 - Does not provide appropriate management advice: B_{35} can only be reached by removing all large males, ignores evidence that large and small males are not reproductively equivalent
- Tier 4_ssc
 - Creates a logical disconnect: F_{OFL} proxy (M) cannot reach B_{MSY} proxy (B_{35})
 - Places stock above MSST, which is inconsistent with our understanding of status
 - B_{35} does not appear to be an appropriate biomass target under current conditions
- Tier 4_survey
 - Model 23.3a does a good job of describing population dynamics, no reason to move to survey-estimate MMB
- Tier 4_specs (**CPT recommendation**)
 - Maintains consistency with FMP by moving from Tier 3 to Tier 4 for both F_{OFL} and B_{MSY} proxies
 - Estimated stock status (34% of B_{MSY}) consistent with CPT understanding of current status of the stock
- Buffer: CPT recommends 20% (change from 25% last year)
 - Reduced uncertainty over model convergence and bimodality
 - Change to Tier 4 harvest control rules



MANAGEMENT CHOICES

Tier	MMB	BMSY	FMSY	FOFL	OFL	M	avg_rec	Status
Tier 3	92.39	155.91	53.25	14.96	15.44	0.29	141.66	0.59
Tier 4_ssc	92.39	155.91	0.29	0.11	0.63	0.29	141.66	0.59
Tier 4_spec	92.39	273.83	0.29	0.05	0.31	0.29	141.66	0.34
Tier 4_srv	9.99	59.64	0.29	0.00	0.00	0.27	141.66	0.17

- Tier 4_spec recommended OFL = 0.31 kt, recommended ABC = 0.25 kt



PRIBILOF ISLANDS BLUE KING CRAB (PIBKCR)

FINAL ASSESSMENT 2023

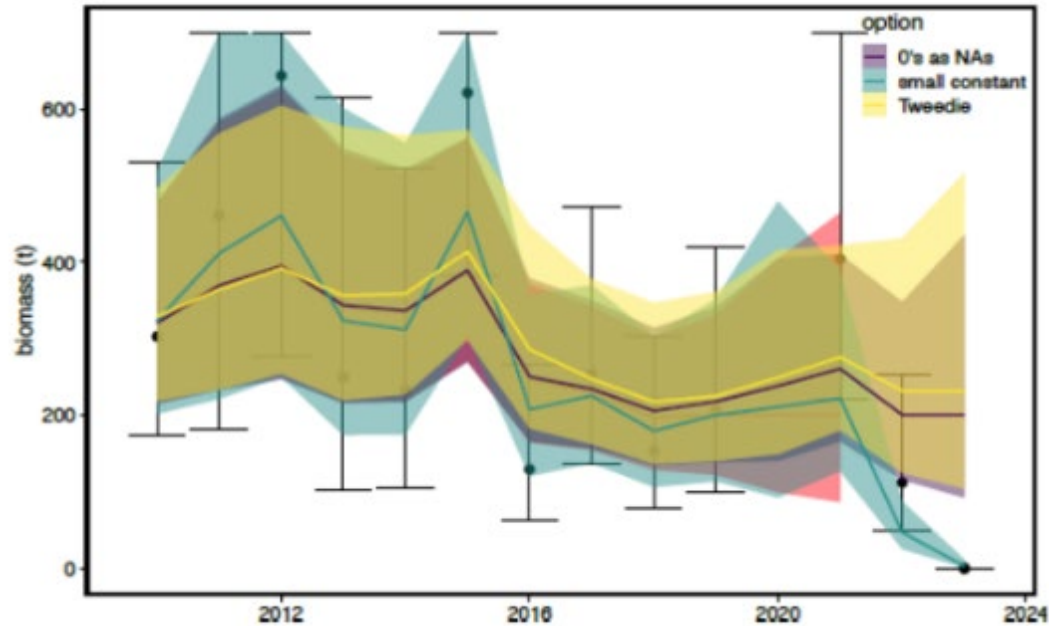


PIBKC OVERVIEW

- Tier 4 stock, biennial assessment
- In overfished status since 2002, directed fishery closed since 1999
- 2022/23 total removals = 0.26 t, 2022/23 OFL = 1.16 t, overfishing did not occur
- State-space / random-effects random walk model fit to bottom trawl survey MMB estimates with R package *rema*
- 2023 survey caught 0 mature males, 2 immature males, 7 females, continuing a declining trend



PIBKC: CHOICES FOR SURVEY MMB = 0



Three approaches:

- Set 0 values to NA (GPT approach)
- Add small constant to 0 values
- Use Tweedie distribution
- CPT and author recommend setting 0 to NA
- Likely temporary, reassess Tweedie as progress with *rema* model continues



PIBKC SUMMARY

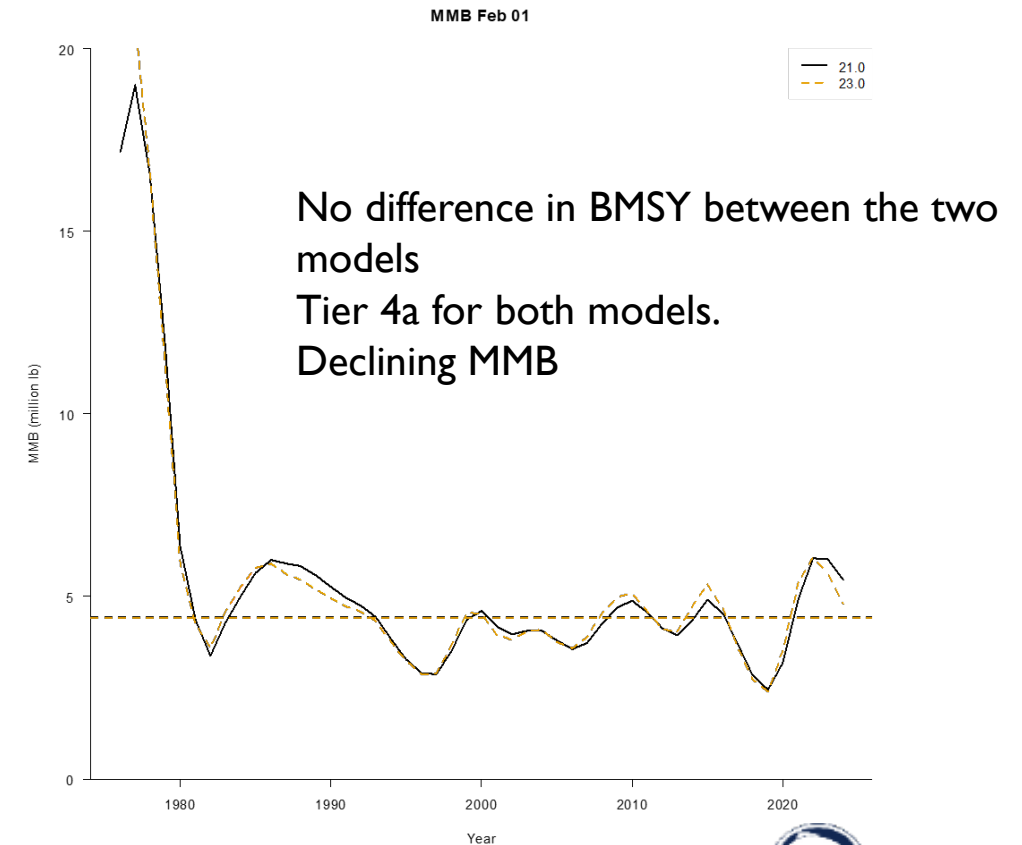
Chapter	Stock	Tier	FOFL	BMSY or BMSYproxy	BMSY basis years	2023/2024 MMB	2023/24 MMB / MMBBMSY	Natural Mortality (M)	2023/24 OFL
4	Pribilof Is. blue king crab	4c	0	4.20	1980/81-1984/85; 1990/91-1997/98	0.18	0.04	0.18	0.00116

- Random walk model estimates MMB = 181 t, status = 4.3% of B_{MSY} , stock remains overfished
- **OFL = 1.16 t**, set with Tier 5 approach using 1999/2000 - 2005/06 reference period, approach established in rebuilding plan
- Plan team recommends continuation of 25% buffer, reflecting continued uncertainty around low recruitment; **ABC = 0.87 t**
- Rebuilding progress:
 - Revised rebuilding plan does not include a target rebuilding date
 - Low recruitment may be related to environmental drivers (e.g. temperature)
 - April 2022, Regional Administrator determined that stock was “not making inadequate progress” towards rebuilding



NSRKC: PROPOSED MODEL RUNS 2023

- Two models presented:
 - 21.0 – status quo model (length dependent M – $0.18 < 124\text{mm CL}$, and estimates M for crab $> 124\text{mm CL}$)
 - 23.0 – estimates single M (~ 0.41)
 - Likelihood profile suggest $M \sim 0.4116$
- Review of work on recent SSC/CPT comments
 - Limited funding focused on ADF&G trawl survey (observer program logistics and bias reduce priority of this data collection)
 - Standardized CPUE work – CPUE has little affect on model performance and projection (SAFE 2018)
 - GMACS – in progress. Model is running working on bridging



NSRKC: CPT RECOMMENDATIONS

- Bring forwards both models in Jan 2024
- ADF&G survey
 - Review of sampling procedures in place
 - Review of area surveyed in each year and how that has varied
- Continued support for VAST for this stock
- Eliminate shell condition in fits for size compositions (not used for other king crab stocks)
- Maturity and growth research ongoing – incorporate sensitivities to reflect these
- Natural mortality
 - Literature review – using tagging data for estimated maximum age, use informed prior for M





BALANCE OF CPT REPORT



OVERFISHING STATUS UPDATES

- 2022/23 total catch:
 - WAIRKC = 1.2 t
 - PIRKC = 4 t
 - AIGKC = 2.57 kt
 - SMBKC = 2 t
 - PIGKC catch is confidential
 - Catch for all stocks below OFL; overfishing did not occur
- Stock status:
 - PIRKC & AIGKC: $MMB > MSST$, stocks are not overfished
 - SMBKC: $MMB < MSST$, stock is overfished
 - WAIRKC & PIGKC: Tier 5, status determination not possible because biomass cannot be estimated



CPT VACANCIES

- Current vacancies:
 - Management expert (tentatively ADF&G Dutch Harbor)
 - Stock assessment expert
- Additional need: Social sciences
 - Currently CPT has social sciences expertise only in fisheries economics
 - Increasing to two social sciences seats would improve CPT ability to respond to stakeholder / SSC requests for improved social sciences information, and would aid CPT ability to review social sciences information



BSFRF UPDATE / SURVEY AND RESEARCH UPDATES

- Update on current/ proposed research (next slide)
 - Results of CPSI (spring pot sampling) summarized in talk to CPT, draft write up expected Jan 2024
- Directly influenced by CPT / SSC / Council process research priorities
- Importance of research priorities to guide crab research now and upcoming
 - Influx of congressional money to BSFRF
 - Influx of research allocation from disaster relief funds (BBRKC, snow, tanner)



➤ Focused Research Areas

BSFRF focused research areas (sept 2023)

HABITAT & RECRUITMENT RESEARCH – understanding of specific areas of crab habitat is lacking context with recent ecosystem and climate changes, and current fishing activities. Surveys, tagging, and new research may reflect important breeding, nursery, and/or juvenile areas. This research will help to fill huge gaps in knowledge about important recruitment areas. **Focus species: BBRKC, snow crab, Tanner crab, other king crab stocks**

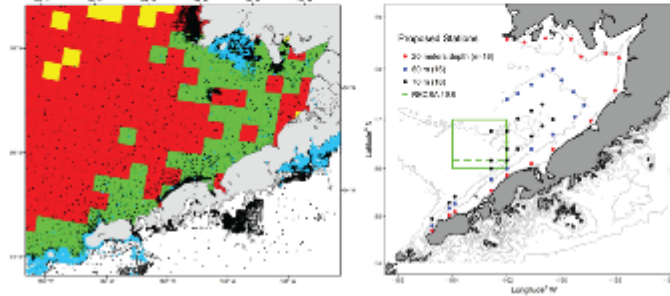
Research is a blend of current plans on tagging/movement/survey work, and focused NPRB projects that are pending (start in early 2024)

BYCATCH RESEARCH – there are estimates of handling and discard mortality for crabs in target and non-target fisheries. Given poor stock status, further focus on bycatch and fishing impacts would provide more precision. **Focus species: all BSAI crab stocks**

Unobserved Fishing Mortality – UFM research
BREP/Similar Projects – specific gear research
Camera/Sensors - gear performance/some working ideas
Collaborative approaches with other sectors



HABITAT & RECRUITMENT RESEARCH
Research is a blend of current plans on tagging/movement/survey work, and focused NPRB projects that are pending (start in early 2024)



BSFRF charters are part of this project plan...

CRAB PREDATION – understanding is limited for how much crab are eaten by groundfish (cod). Major gaps in time and space requires a focus on molting periods, when crab are most vulnerable, nearshore areas with young crab that have not been studied - this is particularly critical now given changing conditions that are affecting the overlap of groundfish predators with crab. **Focus species: all BSAI crab stocks – parts of this are connected to Madi's research**



QUESTIONS?

- Thanks to all CPT members and crab assessment authors.
- Thanks to Miranda Westphal for her contributions as a CPT member

