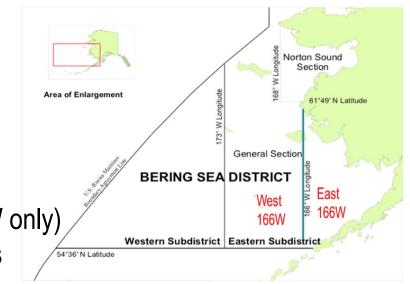
## 2023 Tanner Crab Stock Assessment

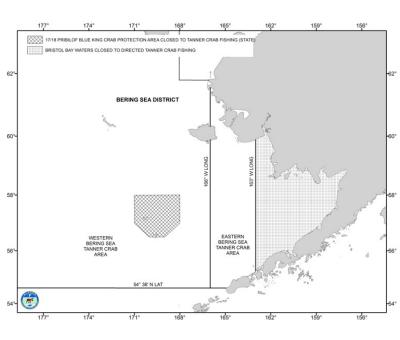
William Stockhausen
AFSC/NMFS/NOAA
Sept 14, 2023



#### **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<sub>MSY</sub>; not overfished)
  - OFL: 36,200 t, ABC: 27,150 t





#### **Concerns**

- recent recruitment does not move into larger size classes
- assessment model overlyoptimistic



#### **SSC Comments**

Comment: The SSC highlights that the estimation of unrealistically high instantaneous fishing mortality rates appears to be an emergent property of several crab assessments...These estimates result in ABC recommendations that would remove virtually all legal sized crab from the population.

Response: The root cause of *OFL* recommendations that would remove all legal-sized crab is the combination of an industry-preferred size larger than the average size at maturity, and an SPR-based harvest control rule.

Comment: The SSC reiterates its support for transitioning this model, or a simplified version thereof, into the standardized GMACS platform. The SSC feels that transitioning this assessment into GMACS is a higher priority at this point than continued exploration of model alternatives...

Response: Transitioning the assessment to GMACS is the top priority for development in the fall.



#### **SSC Comments**

Comment: The SSC recommends that when "fallback" Tier 4 alternatives are provided, as recommended by the crab Simpler Modelling Workshop, plots that compare the OFLs predicted by the existing status quo Tier 3 model against the OFLs recommended by Tier 4 models for previous years be included.

Response: The Tier 4 model does not estimate OFLs for "previous years", which would require developing a retrospective analysis capability. If this is a priority, it could be addressed in the future.

Comment: In addition, when estimating biomass for Tier 4 models, the SSC recommends that the authors base these on the whole time series or develop justification for a better time block that represents current fishing potential for the stock.

Response: Results for  $B_{MSY}$  calculated using several alternative time blocks are presented.

Comment: The SSC also recommends that, for "fallback" Tier 4 models, the authors and CPT recommend an appropriate ABC buffer.

Response: The author recommends using the cv for terminal year survey biomass from the random walk model as a basis for the ABC buffer.



#### **CPT Comments**

Comment: Show plots for jitter analyses that could demonstrate (or rule out) bimodality in management quantities...

Response: Plots for jitter diagnostics are presented.

Comment: Provide a plot of the fits to male and female components separately when they are fit in an aggregated fashion (as in 22.03). Are the fits to either sex substantially degraded?

Response: Although this is a reasonable idea, it is currently not possible to provide such a plot.

Comment: Provide some discussion as to why there was an exceptionally small retrospective pattern in spite of the issues with recruitments that appear and then do not propagate through the population.

Response: The small retrospective pattern was with respect to MMB, while the pattern for recruitment was much larger. The larger retrospective pattern for recruitment occurs exactly as a result of the apparent recruitment events disappearing (new data reduces the estimated size of recruitment in any particular year).

Comment: Continue to explore ways to eliminate the overestimates of large crab (the interplay between growth estimates and non-parametric selectivity might be a useful avenue to explore)

Response: This suggestion will be explored as part of building a GMACS Tanner crab model.



#### **Recent model explorations**

- 1-mm size bins
- fixed growth
- fixed NMFS survey selectivity
- estimated BSFRF survey availability
- annually-varying M
- 1982 model start

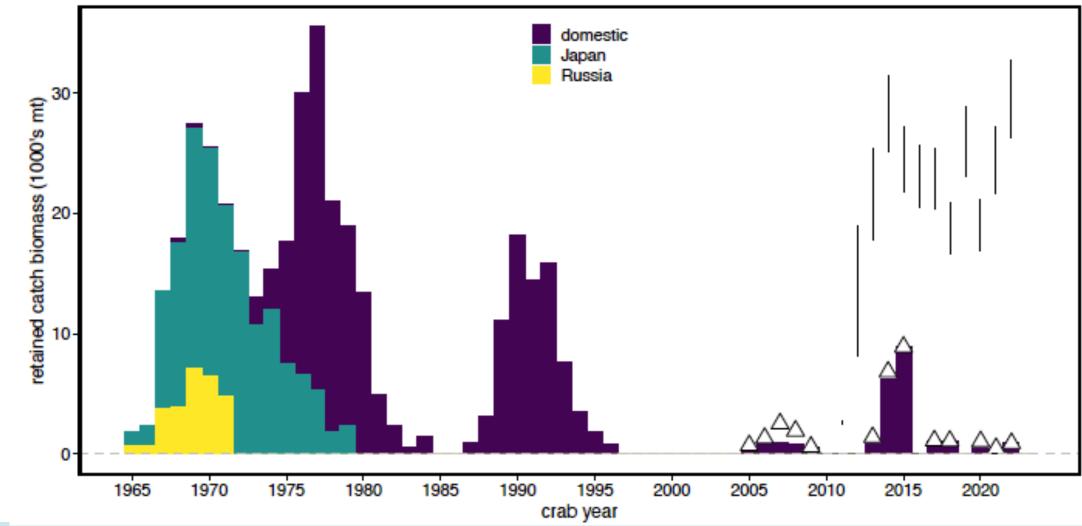
- fit VAST time series
- fit aggregated total catch data
- bootstrapped effective sample sizes as input sample sizes for NMFS survey size comps
- compress size composition tails
- Dirichlet-multinomial likelihood used to estimate effective size comp sample sizes

#### Fleets-as-areas models

- ADFG two-area management
- Bycatch by groundfish gear type

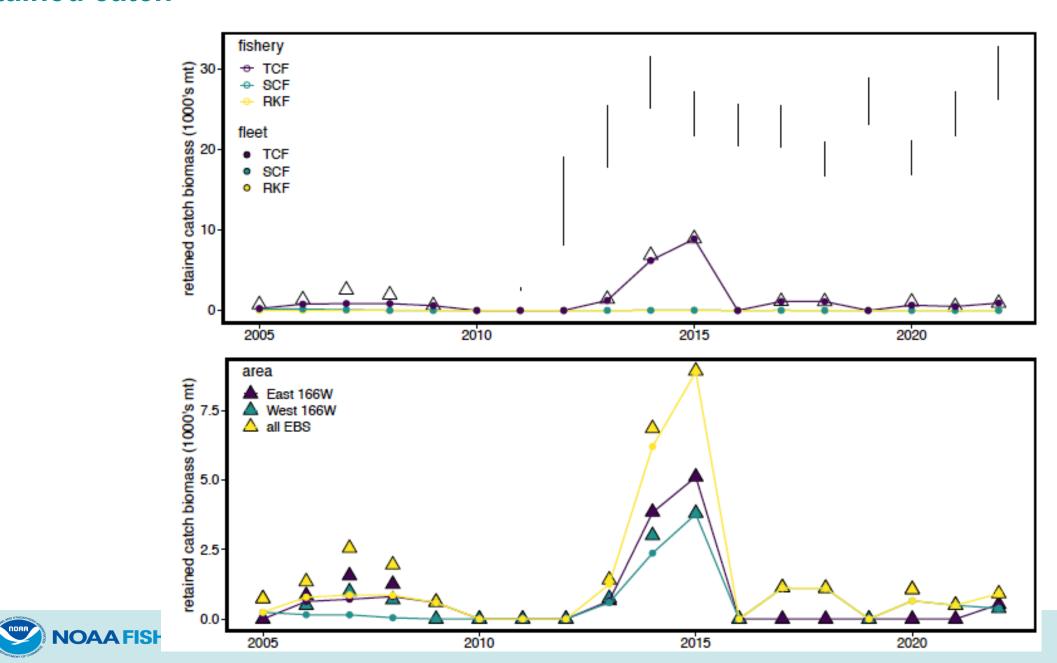


#### **Retained catch**

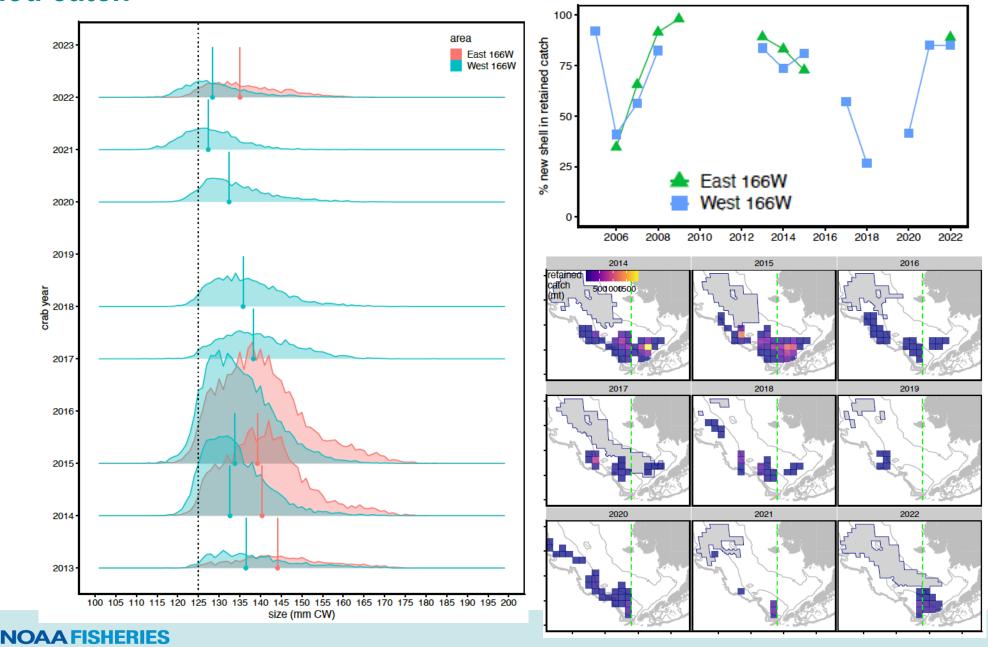




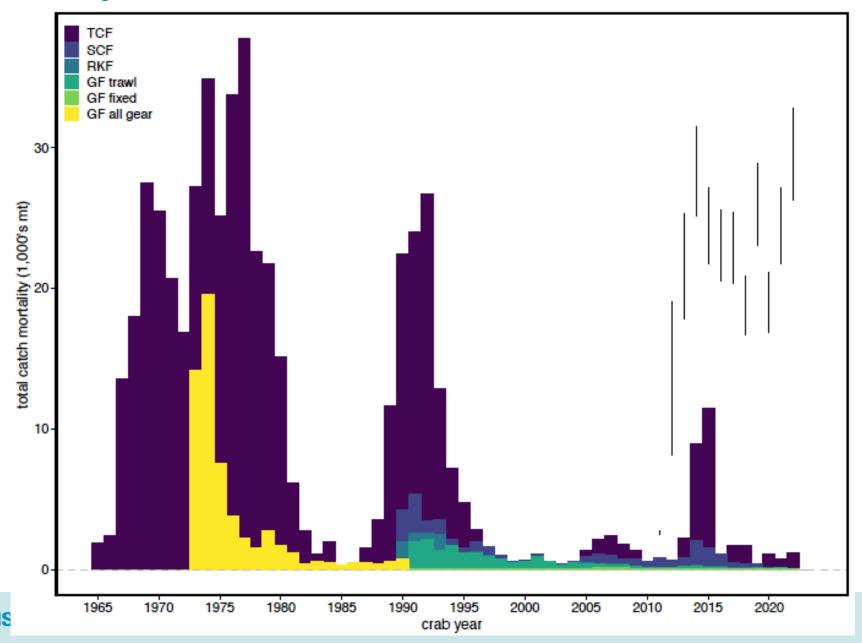
#### **Retained catch**



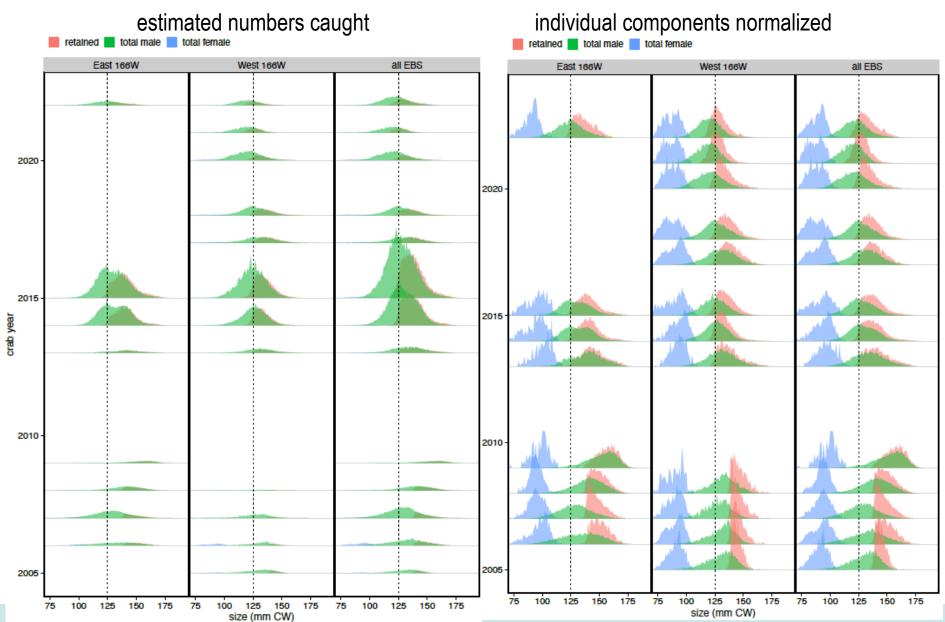
#### **Retained catch**



## **Total catch mortality**



#### Total catch mortality in the directed fishery

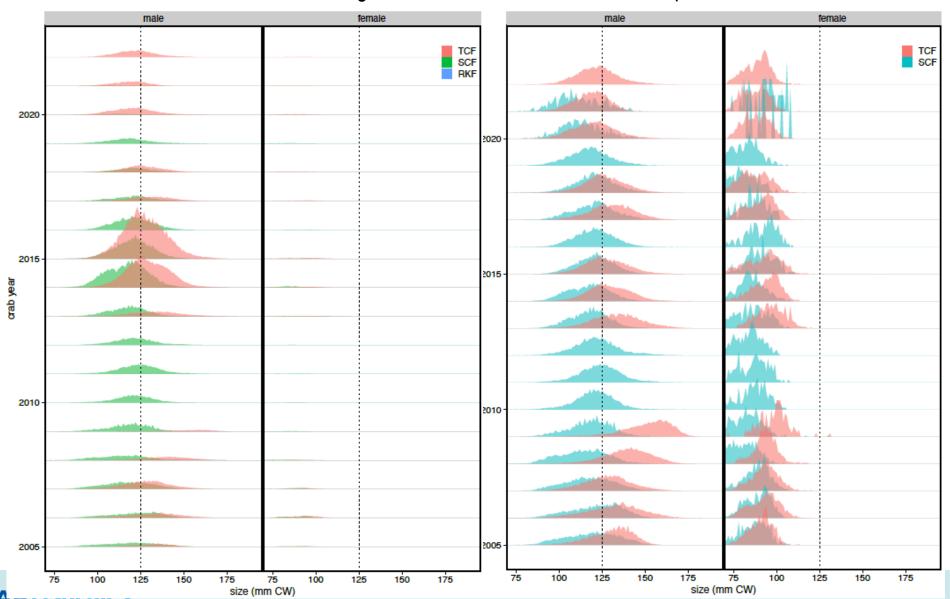




## Total catch comparisons: bycatch in snow crab fishery



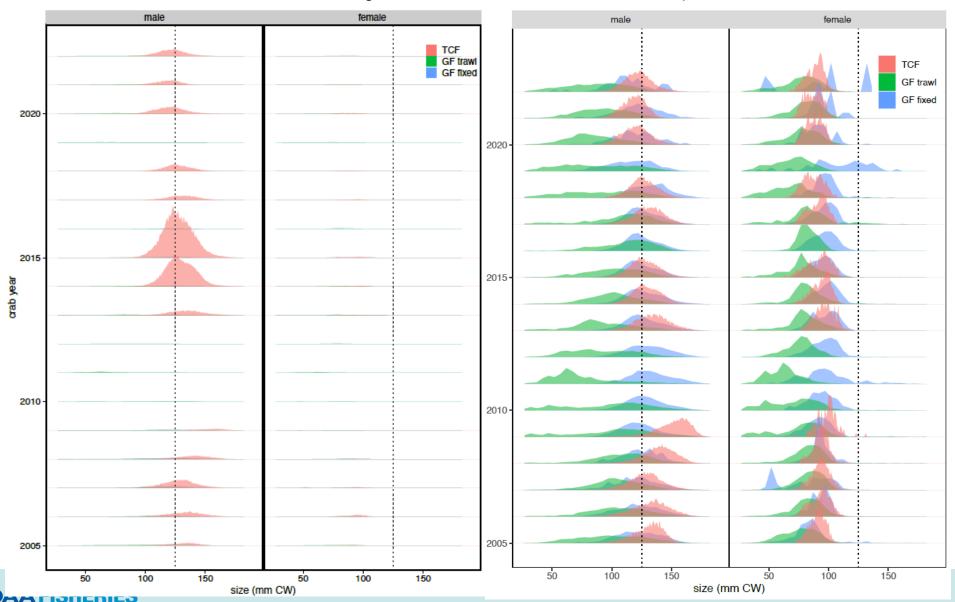
#### individual components normalized



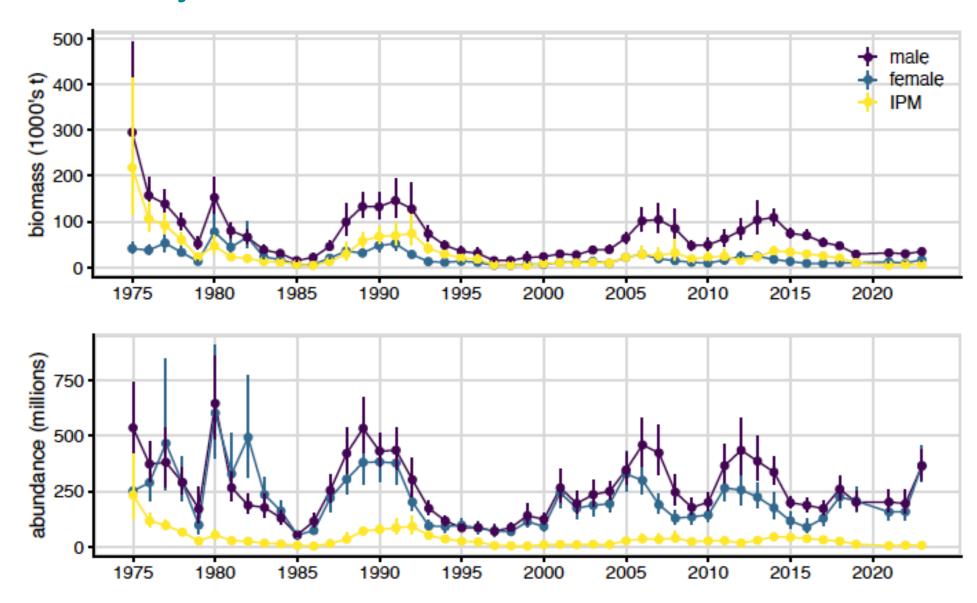
## Total catch comparisons: bycatch in groundfish fisheries



#### individual components normalized

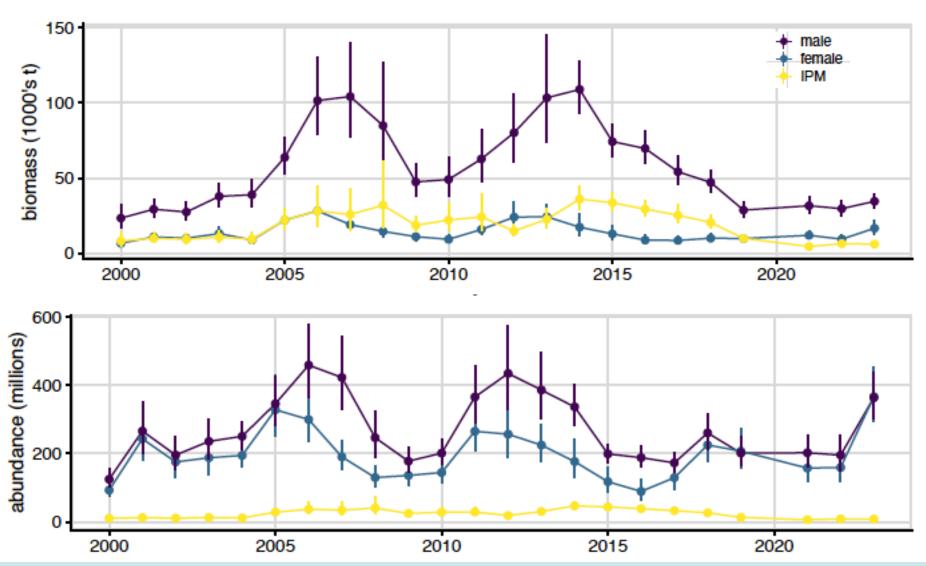


#### **NMFS EBS Survey Data**



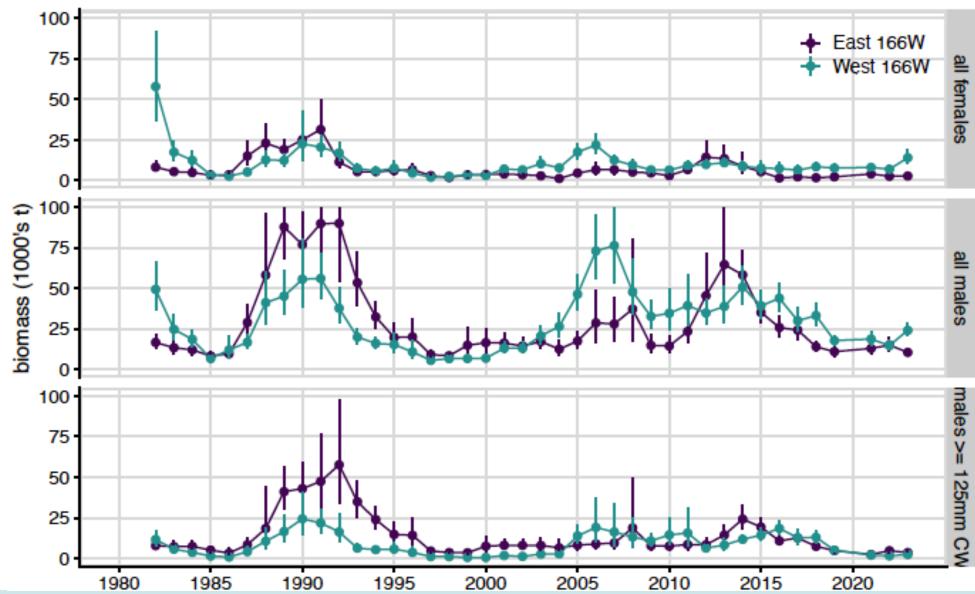


## **NMFS EBS Survey Data**



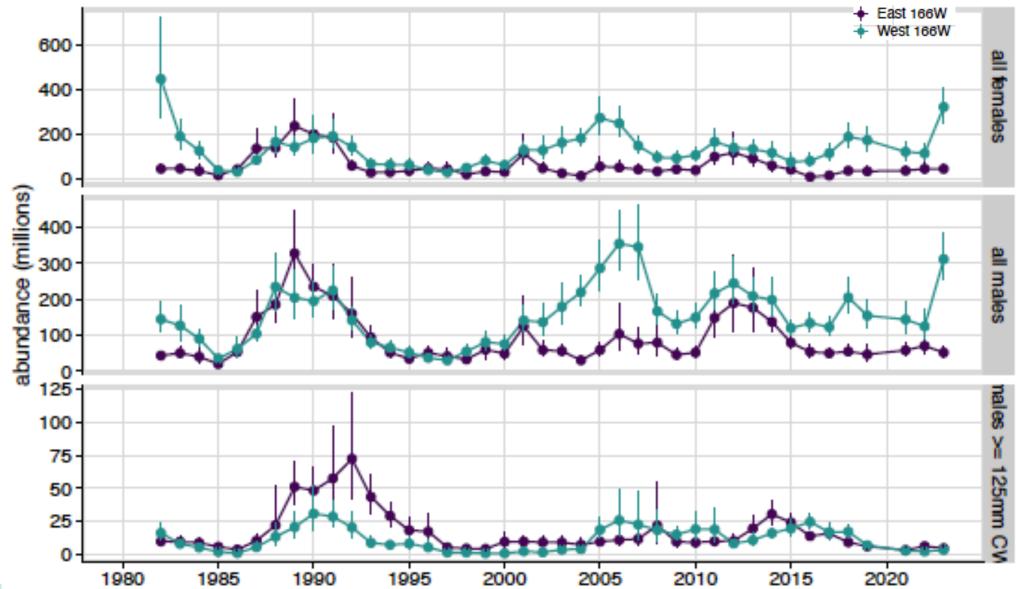


#### **Survey Data By Management Region**



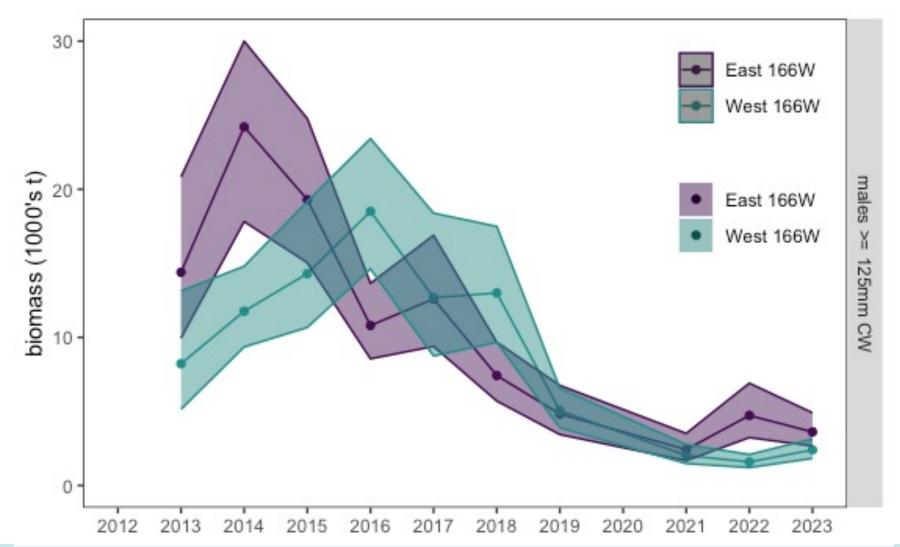


## **Survey Data By Management Region**



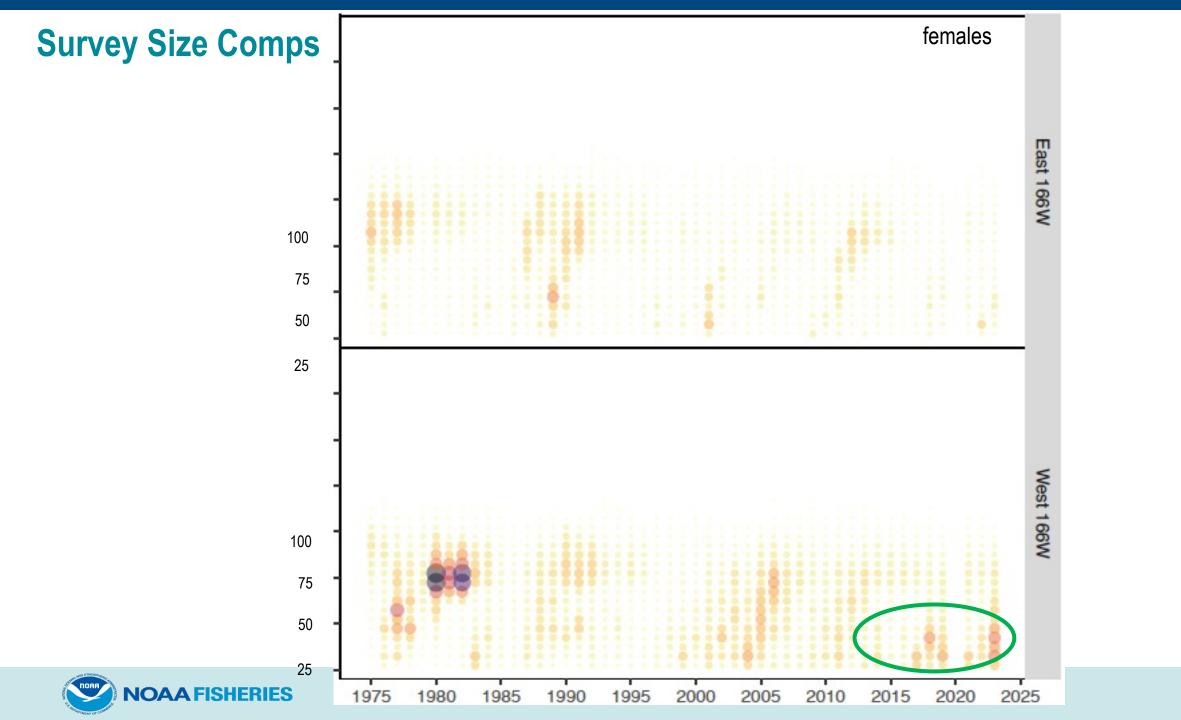


#### **NMFS EBS Survey Data: Industry-preferred males**

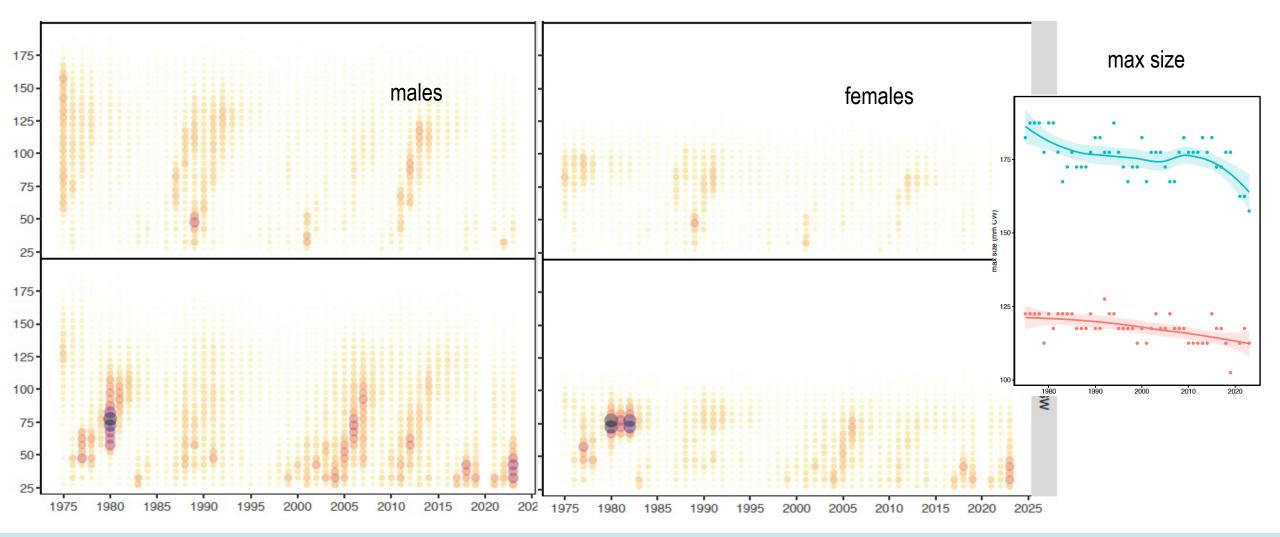




**Survey Size Comps** males 175-150-125-East 166W 75-175-150-West 166W 

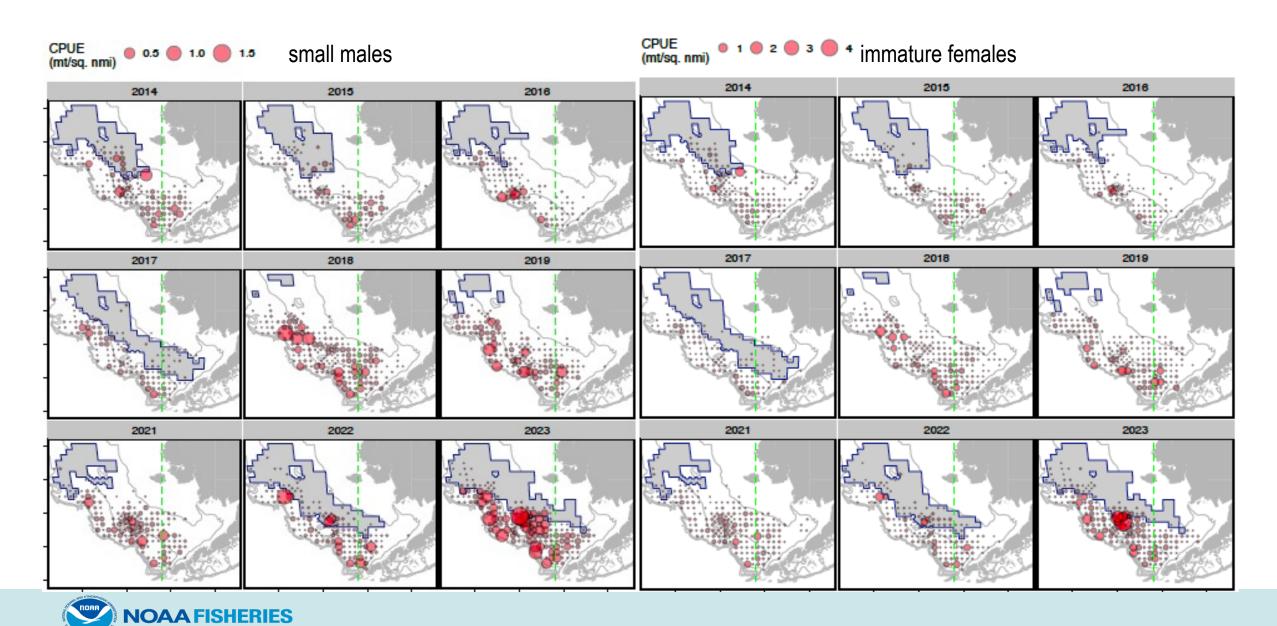


## **Survey Size Comps**

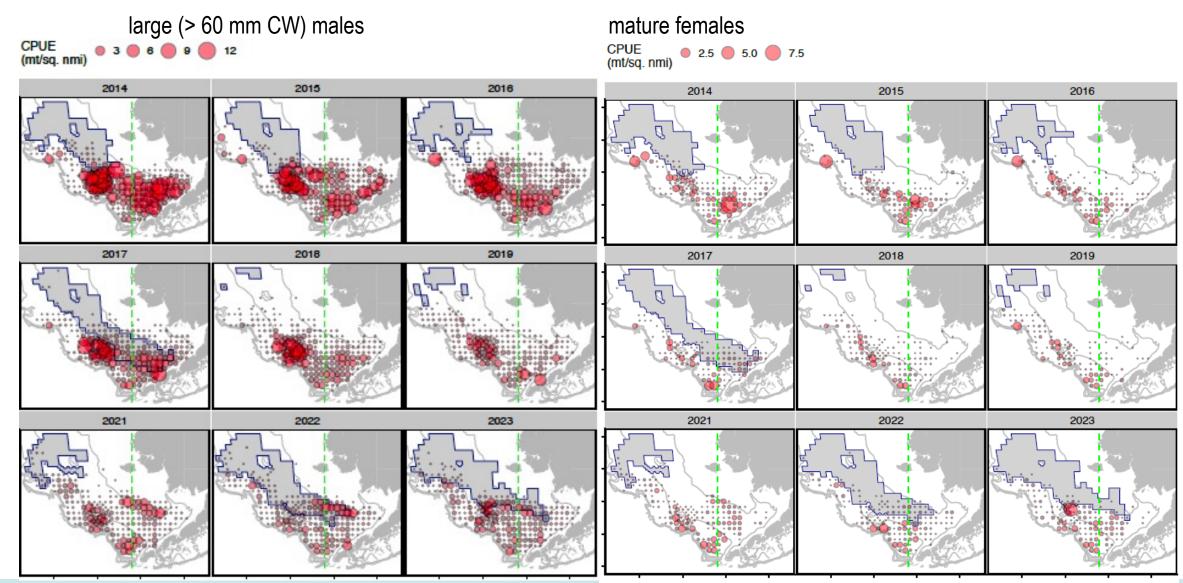




## **Survey spatial patterns**

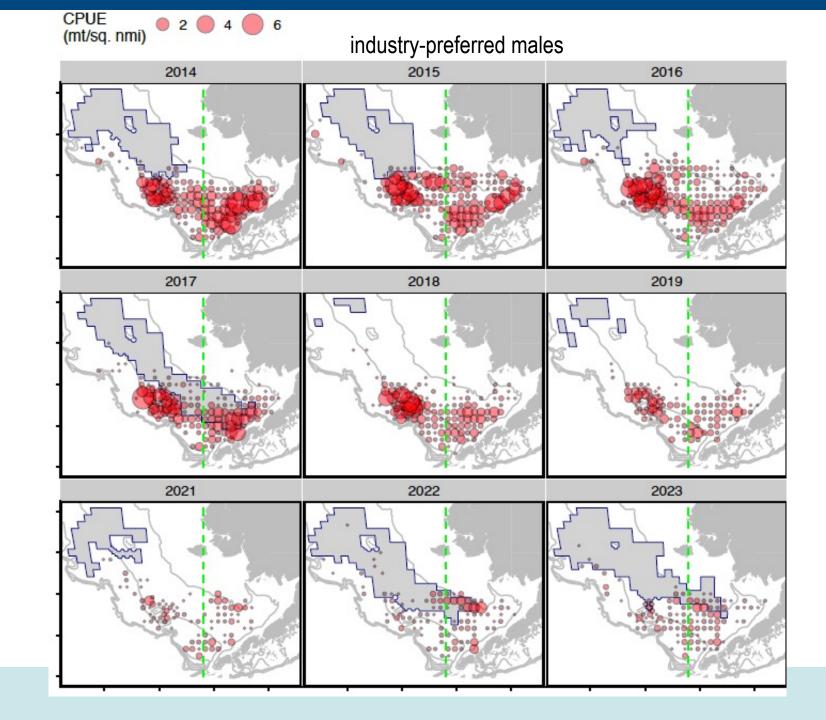


#### **Survey spatial patterns**



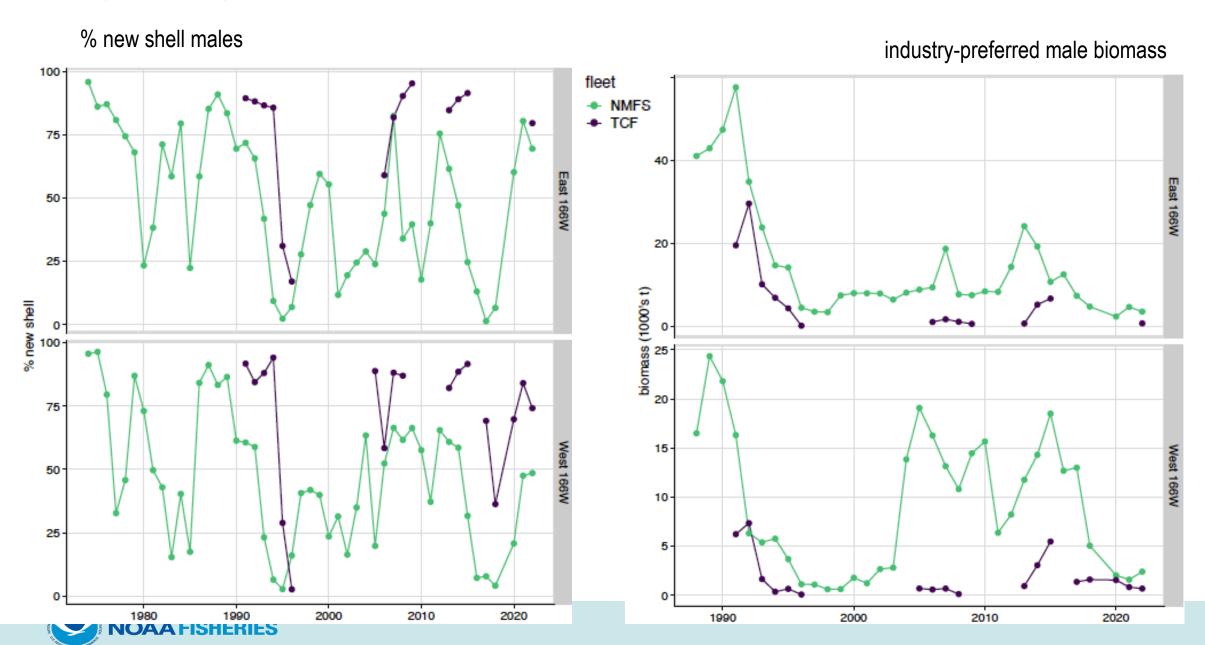


## **Survey spatial patterns**



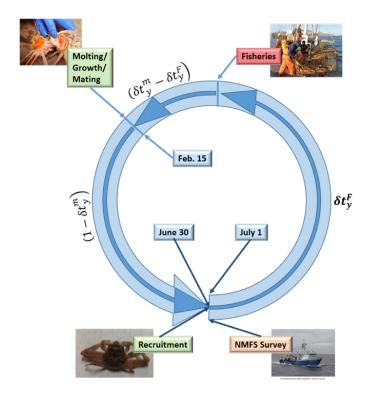


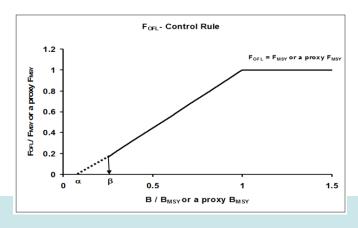
## **Survey-Fishery Comparisons**



#### **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<sub>msy</sub>, B<sub>msy</sub>, F<sub>OFL</sub>, OFL, ABC





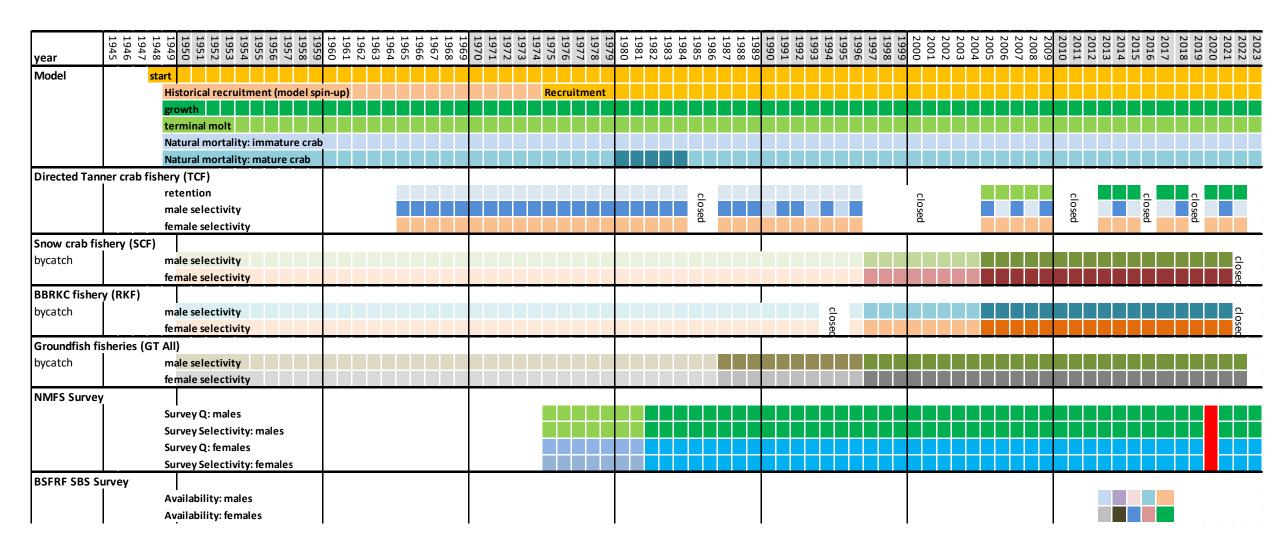


#### **Assessment time frames: data**

Model    Historical recruitment (model spin-up)   Recruitment   1982+for mean recruitment		1958 1957 1957 1956 1953 1953 1953 1951 1951 1950 1949 1949	196 196 196 196 196 196 196 196	197 197 197 197 197 197 197 197 197	1989 1988 1987 1986 1986 1984 1983 1982 1981	1999 1998 1997 1996 1995 1994 1993 1992 1991	2009 2008 2007 2006 2005 2004 2004 2003 2002 2001	2023 2022 2021 2020 2019 2018 2017 2016 2015 2015 2015 2015 2015 2017
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Directed Tanner crab fishery (TCF) retained catch numbers, biomass size compositions effot (potlifts) total numbers, biomass catch size compositions  Snow crab fishery (SCF) bycatch numbers, biomass size compositions effot (potlifts)  BBRKC fishery (RKF) bycatch numbers, biomass size compositions effot (potlifts)  Groundfish fisheries (GT AII) bycatch biomass (combined sexes) size compositions effot potlifts)  Groundfish fisheries (GT AII) bycatch biomass (combined sexes) size compositions size weight relationships male maturity ogives (chela height data) growth data  BSFRF SBS Survey		Historical recruitment (model sp	in-up)	Recruitment				
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size compositions size compositions								



#### **Assessment time frames: model processes**





## **Objective Function Values**

category	fleet	catch type	data type	sex	22.03	22.03b
				female	-	_
			abundance	male	-	-
	NIMEC M			female	-	-
	NMFS M		biomass	male	70.699	79.289
			n.at.z	male	411.493	415.477
				female	-	-
			abundance	male	-	-
	NMFS F			female	163.916	165.612
	NMFSF		biomass	male	-	-
			n.at.z	female	298.183	299.199
				female	-	-
surveys	SBS BSFRF M	index catch	abundance	male	_	_
data			biomass	female	_	_
				male	-1.151	-0.814
			n.at.z	male	290.992	290.592
	SBS BSFRF F	_		female	-	_
			abundance	male	_	_
			_	female	-1.622	-0.185
			biomass	male	_	-

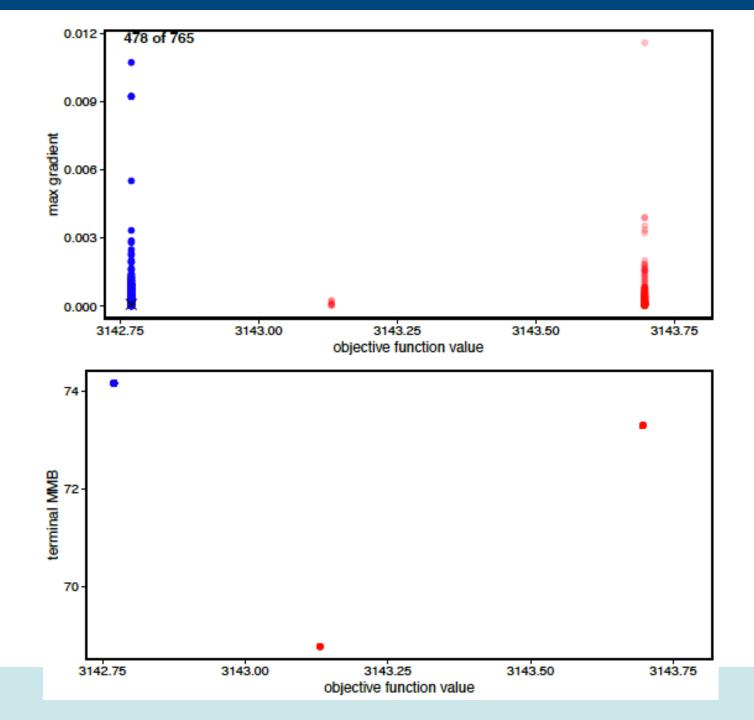
fleet	catch type	data type	sex	22.03	22.03b	
SBS BSFRF F	index catch	n.at.z	female	231.943	232.897	
			female	-	_	•
		abundance	male	-	-	i
	retained	_	female	_	_	•
	catch	biomass	male	-143.049	-147.653	_
		n.at.z	male	64.684	66.936	
TCF		abundance	all sexes	-	-	i
		biomass	all sexes	6.586	4.793	•
			female	89.435	91.380	
		n.at.z	male	83.283	93.482	•
	_	abundance	all sexes	-	-	
		biomass	all sexes	-52.237	-52.247	•
SCF			female	52.316	52.392	i
		n.at.z	male	80.186	80.300	
	total catch	abundance	all sexes	-37.835	-39.433	i
		biomass	all sexes	-68.910	-70.213	•
GF All			female	224.001	224.620	i
		n.at.z	male	291.464	307.289	_
RKF	_	abundance	all sexes	-	-	
	SBS BSFRF F  TCF  SCF  GF All	SBS index catch  retained catch  TCF  SCF  total catch	SBS index catch n.at.z  BSFRF F  retained catch biomass n.at.z abundance biomass n.at.z abundance biomass  SCF  total catch abundance biomass  GF All n.at.z	SBS	SBS   Index catch   SFRFF   SBSFRFF   SBSFRFF   SBSFRFFF   SBSFRFFF   SBSFRFFF   SBSFRFFF   SBSFRFFF   SBSFRFFF   SBSFRFFF   SBSFRFFFF   SBSFRFFFF   SBSFRFFFF   SBSFRFFFF   SBSFRFFFF   SBSFRFFFF   SBSFRFFFFF   SBSFRFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF	SBS   index catch   n.at.z   female   231.943   232.897

category	fleet	catch type	data type	sex	22.03	22.03b
			biomass	all sexes	-37.093	-37.077
fisheries	RKF	total catch		female	6.904	6.876
data			n.at.z	male	31.646	31.474
			EBS molt	female	246.735	246.159
growth data			increment data	male	279.870	279.997
maturity ogive data	NMFS M	_	EBS mature male ratios	male	211.641	255.629



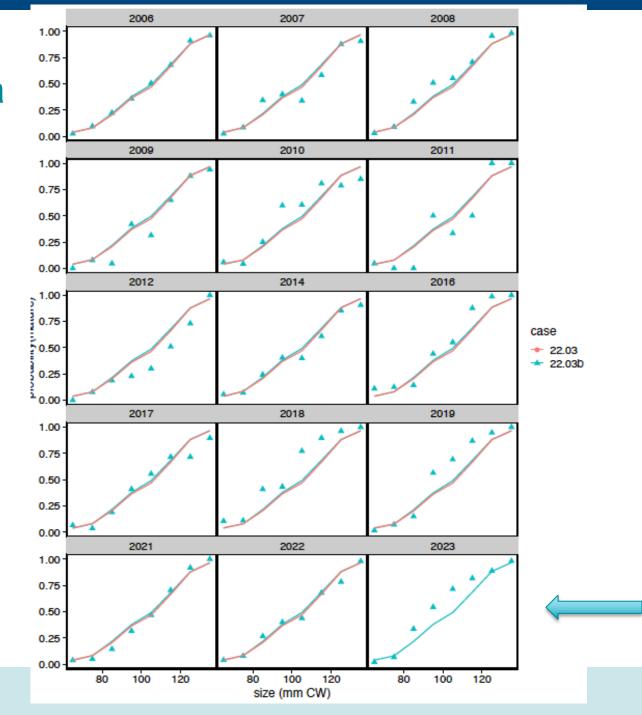
#### **Model Convergence**

- 476 out of 800 jitter runs converged to MLE
- max. gradient at MLE: 8 x 10<sup>-5</sup>
- no parameters at bounds



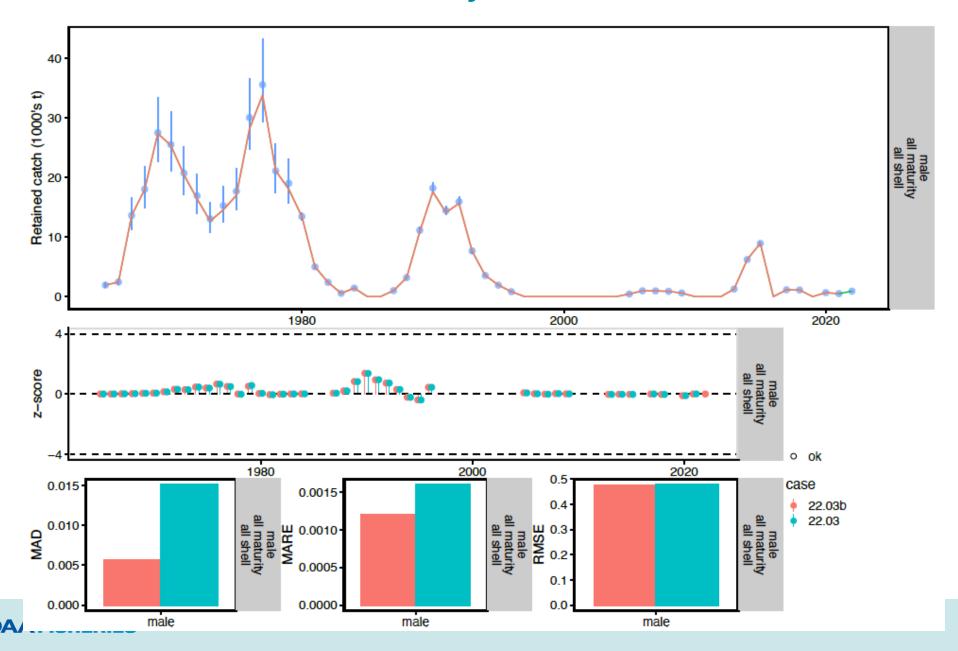


# Fits to Male Maturity Ogive Data

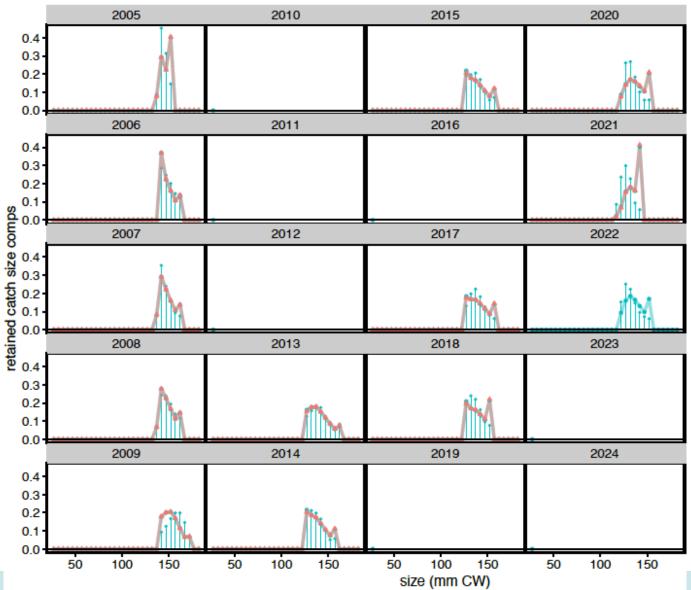




## **Fits to Retained Catch in Directed Fishery**

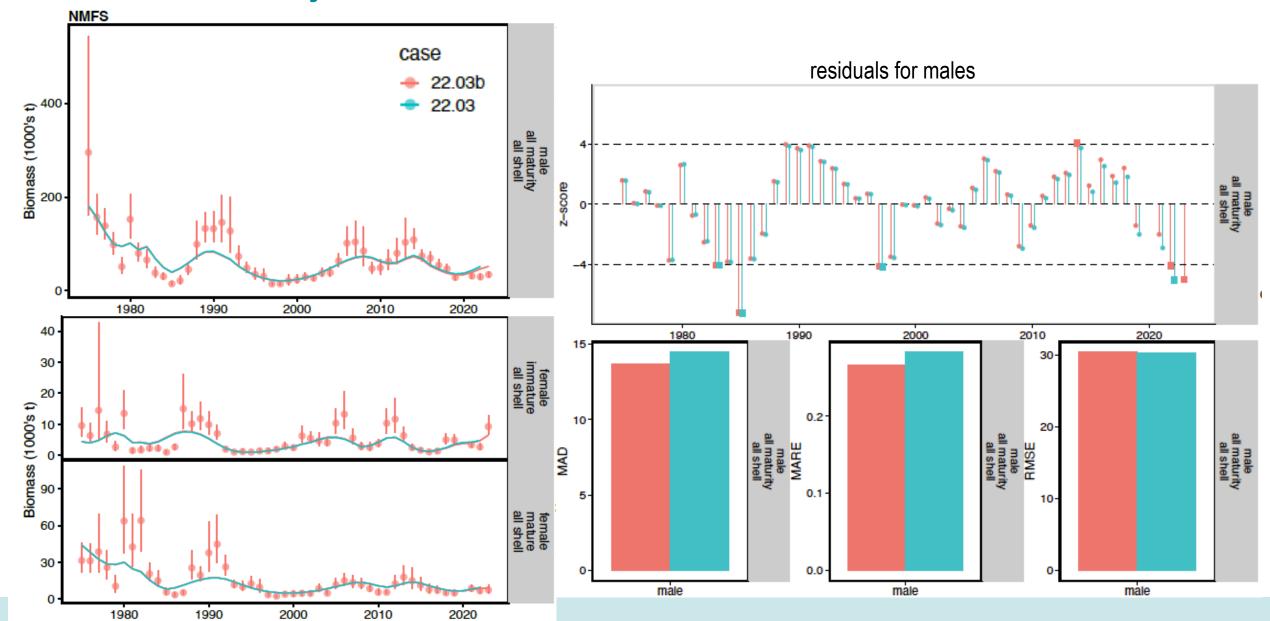


## **Fits to Retained Catch in Directed Fishery**

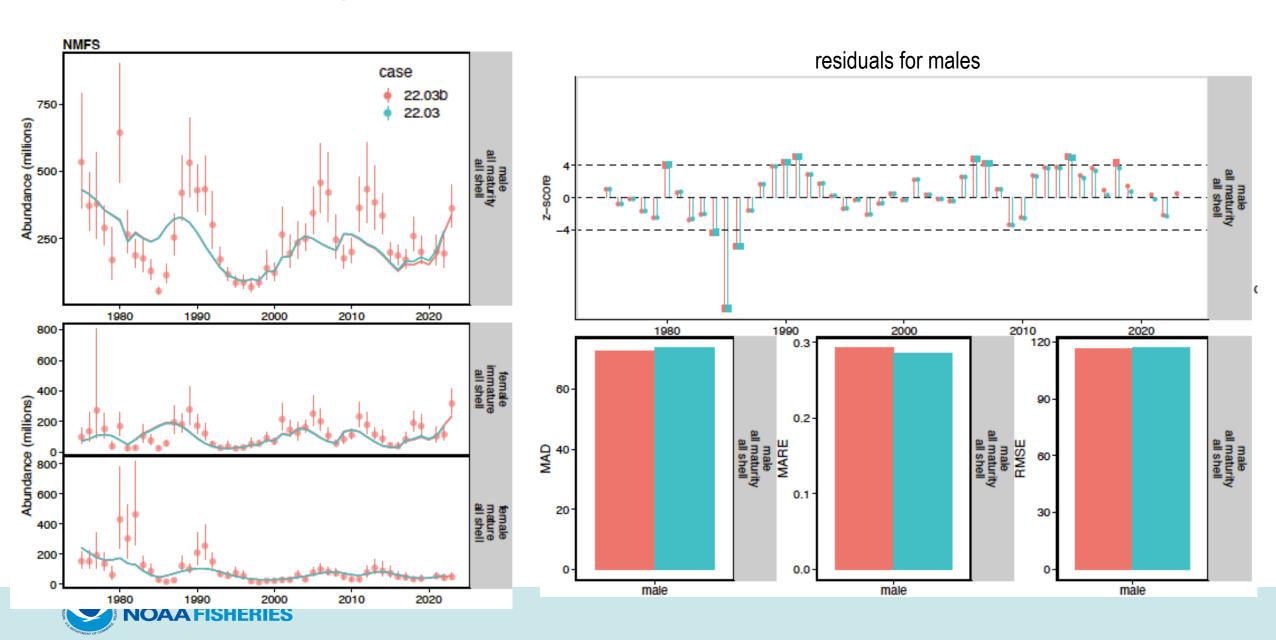




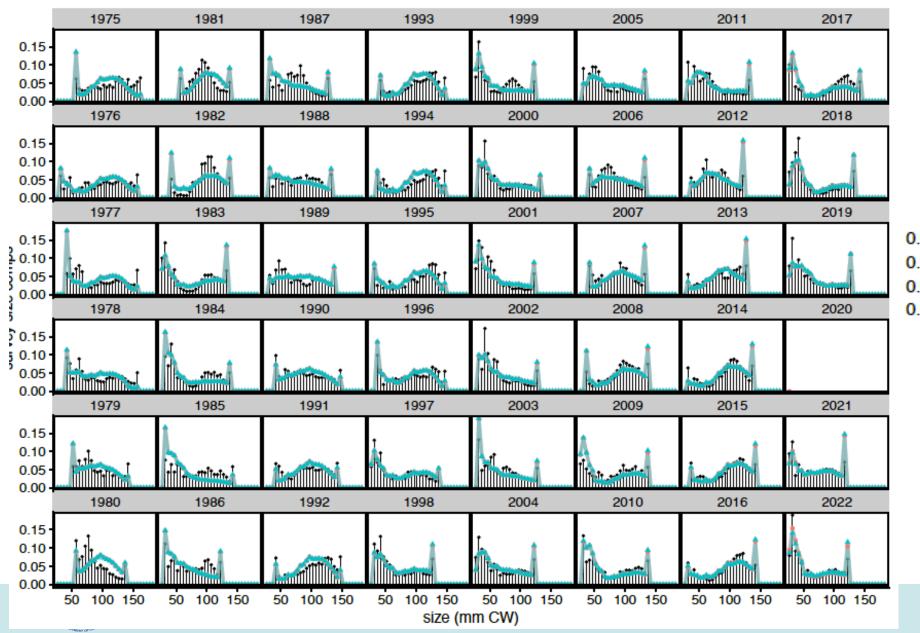
#### **Fits to NMFS Survey Biomass**



## "Fits" to NMFS Survey Abundance



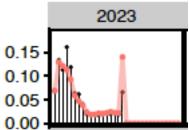
#### Fits to NMFS Survey Size Comps (males)



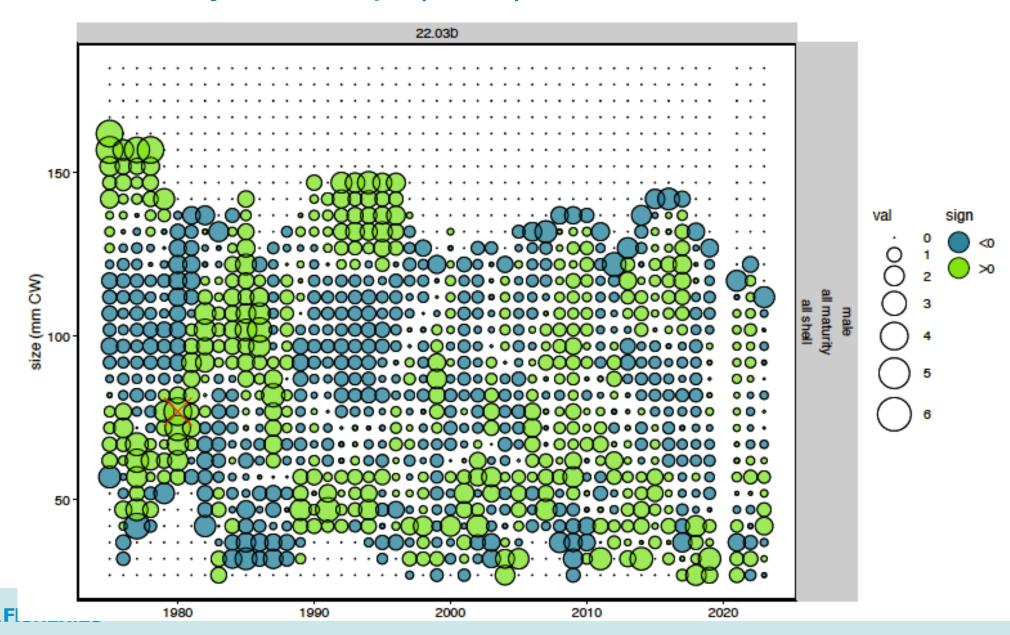
#### predicted



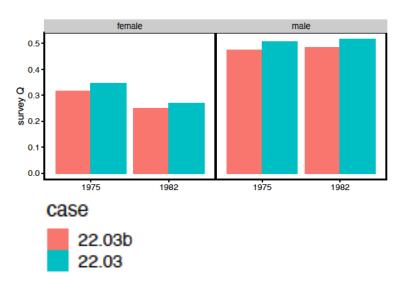




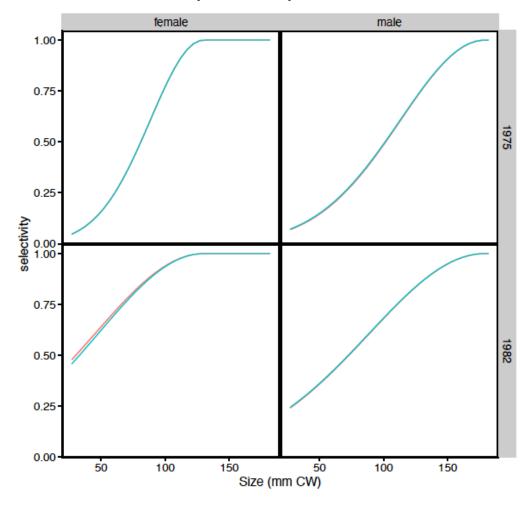
# Residuals to NMFS Survey Size Comps (males)



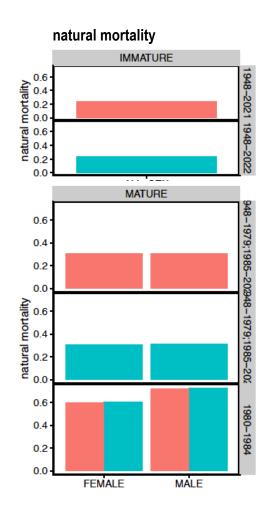
#### NMFS survey Q

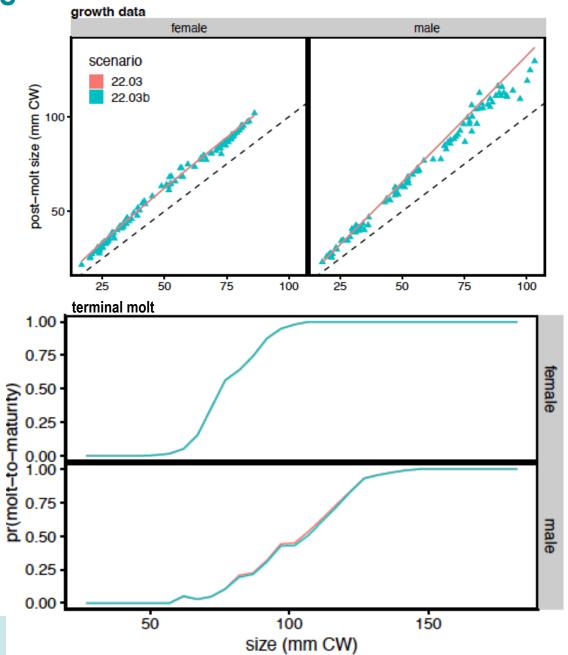


#### NMFS survey selectivity

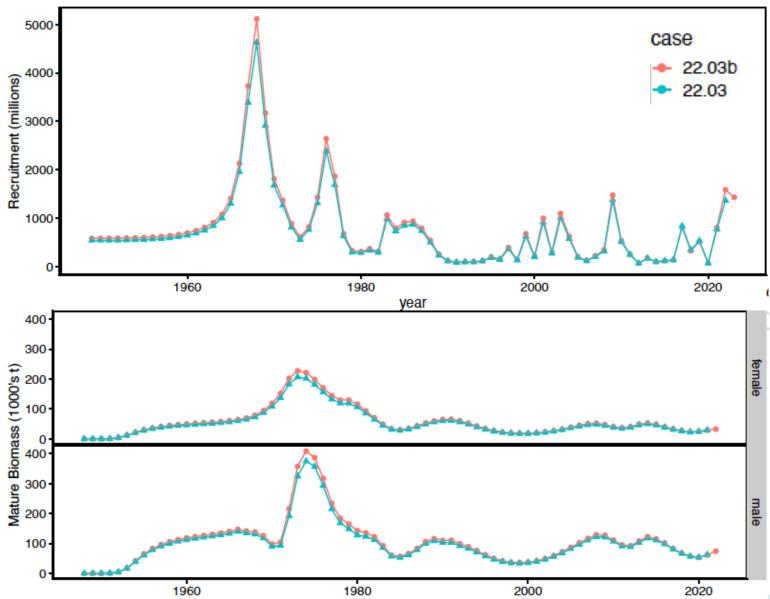








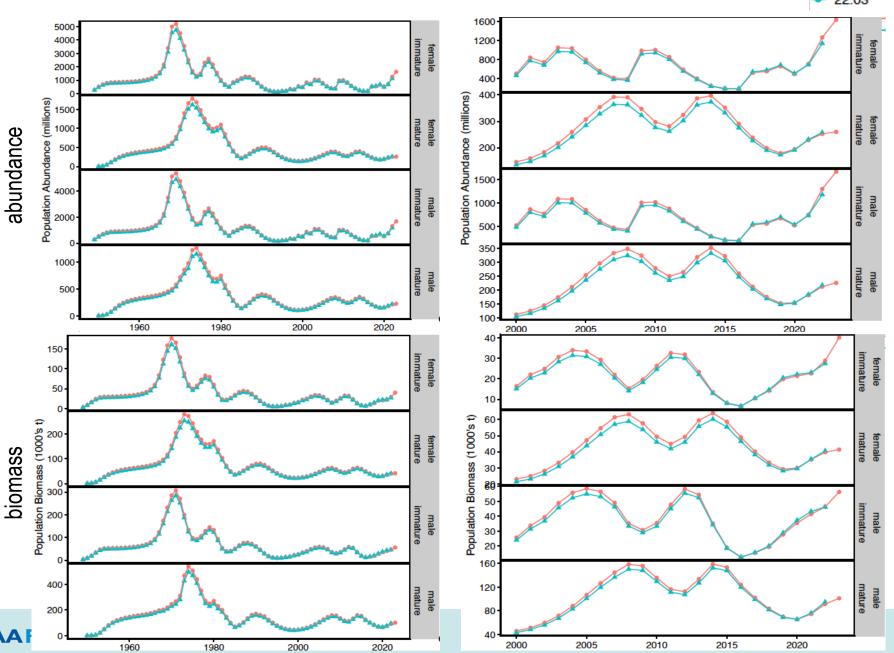




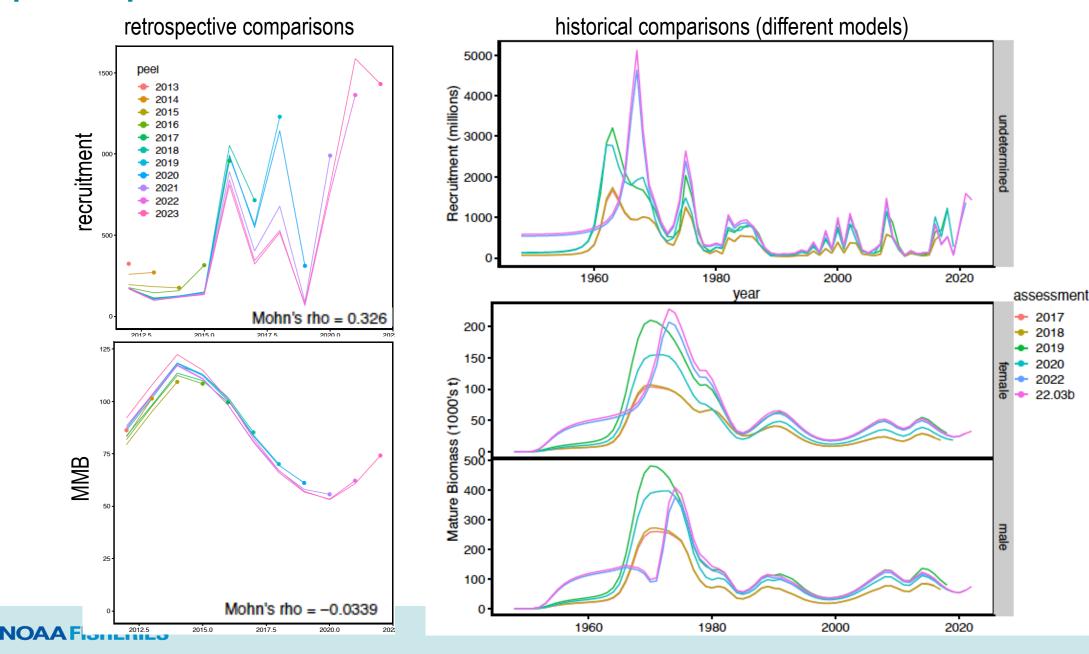




case



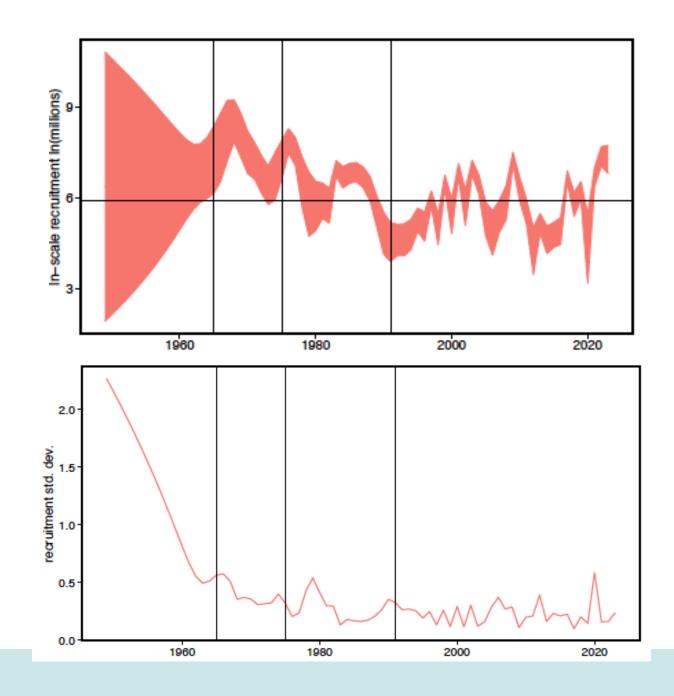
# **Retrospective patterns**



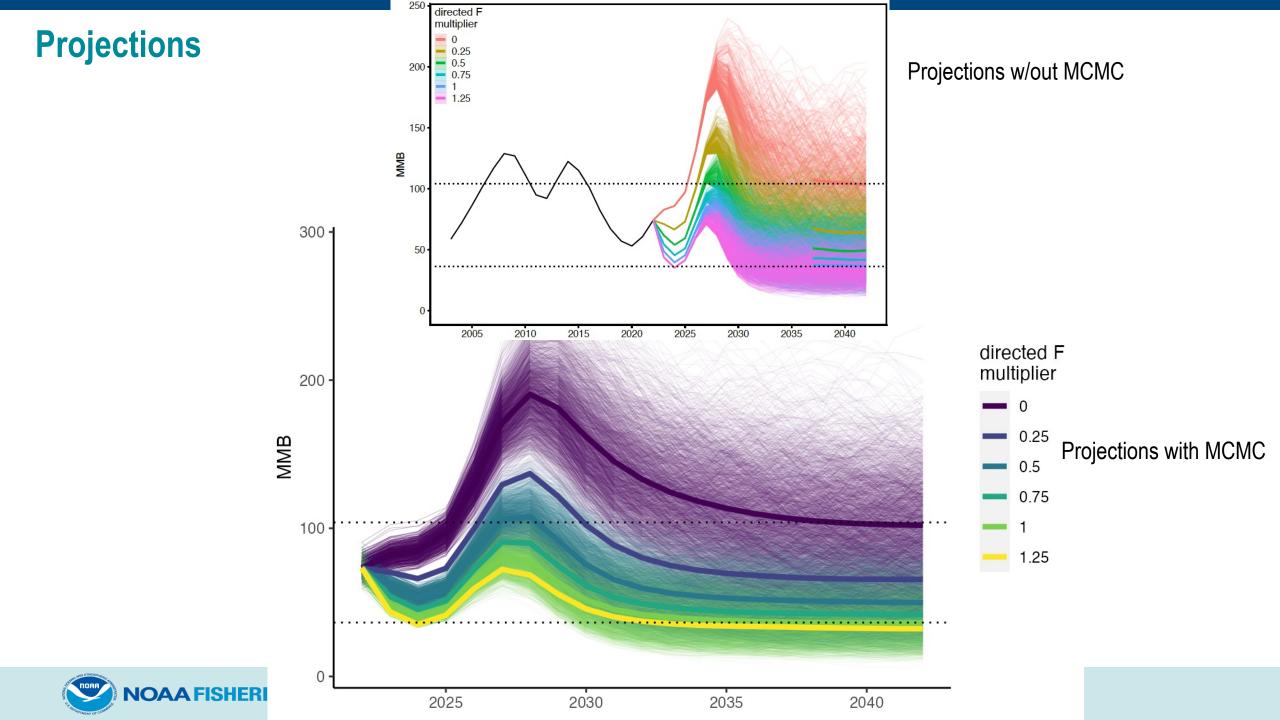
# Average recruitment time period

#### Author's recommendation

- Drop terminal year estimate
  - larger uncertainty
  - retro. pattern suggests estimate will decrease with time
  - consistent with other assessments
  - consistent with last year
- time period: 1982-2022 (year of entry into population)







#### **Stock Status: Tier 3a** p<sup>star</sup> ABC OFL directed F multiplier 25% Buffer **-** 0 0.25 **0.5** 0.75 1.25 150 -Catch Biomass (1000's t) MMB Fully-selected fishing mortality rate (per year) • 1990's 100 • 2000's PR (2005) **1**991 **1**993 ■990 50 1994 ◀996◀995 100 2005 2010 2015 2020 2025 2030 2035 2040 MMB (1,000's t) Year Biomass (MMB) TAC Retained Catch Total Catch ABC MSST OFL2019/2018.3156.150.000.000.5428.8623.09 2020/2117.97 56.341.07 0.660.9621.1316.90 2021/2217.3762.050.500.490.7827.1721.742022/2318.1974.170.910.911.19 32.8126.252023/2448.7736.2027.15

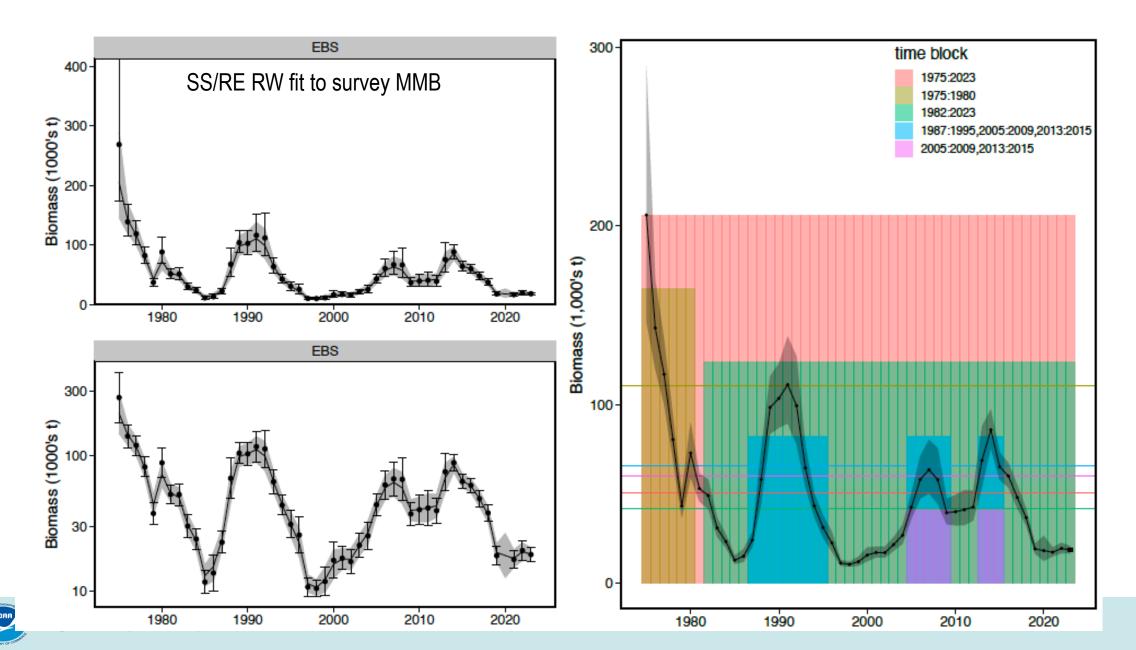


#### Recommendations

- 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 F<sub>35%</sub>, B<sub>35%</sub> as metrics for a sustainable fishery



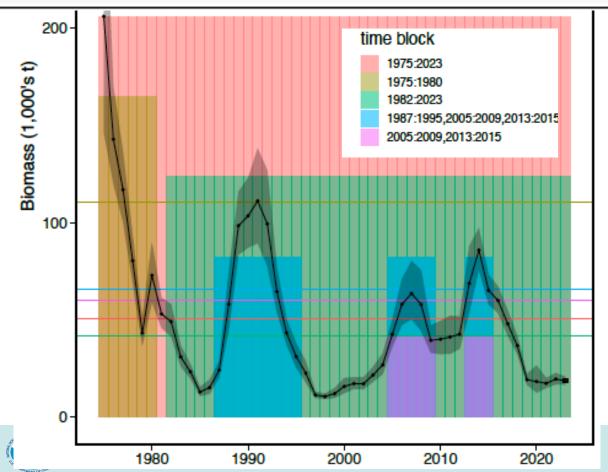
#### Tier 4 "Fallback"



Tier 4 "Fallback"

time block	M	В	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





#### ABC buffer

- recommend using cv on modelestimated terminal biomass (8.9%) as basis
- buffer = 91.9%

## **Future work (top priority)**

- Complete GMACS model for Tanner crab
  - start simple, build complexity
- Complete BSFRF/NMFS selectivity analysis
  - 2018 BSFRF Tanner crab data provided last week

