

# 2021 Tanner Crab Stock Assessment

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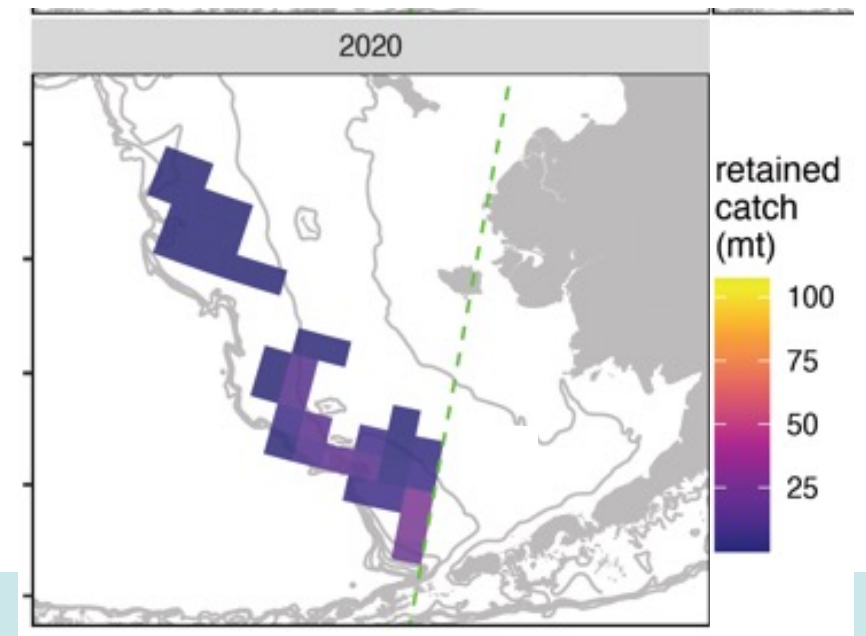
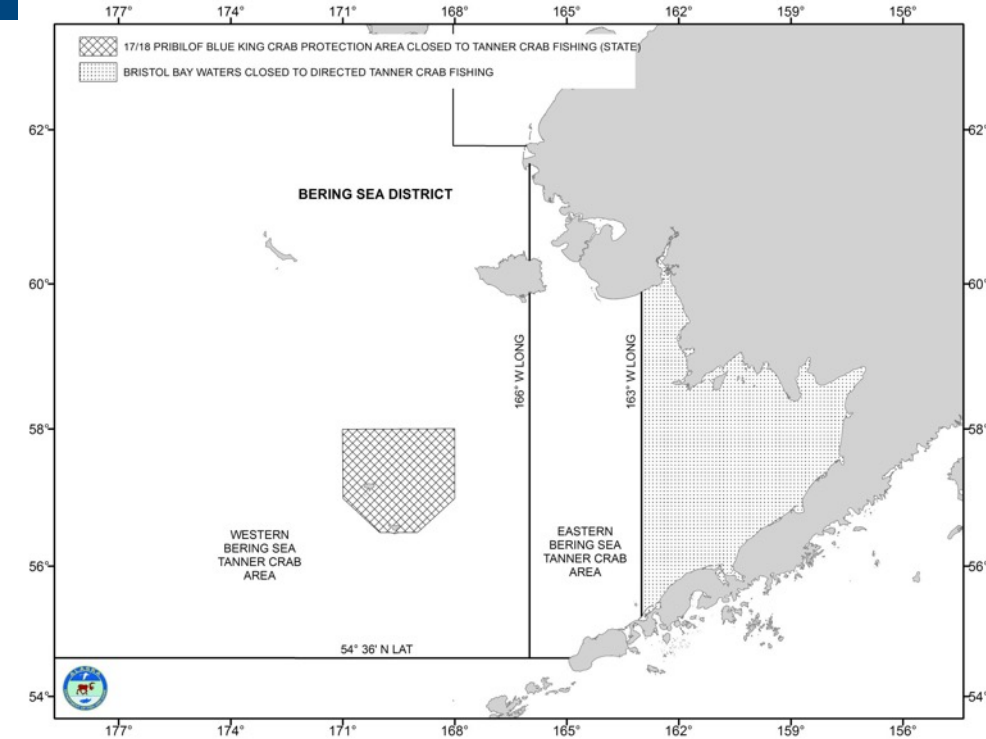
AFSC/NMFS/NOAA

Sept 14, 2021



# Overview:

- 2020/21 Federal management
  - OFL: 21,130 t
  - ABC: 16,900 t
  - Total catch mortality: 960 t
    - mostly taken in directed fishery
- ADFG management
  - Eastern Area closed
    - MMB failed to meet threshold
  - Western Area
    - TAC: 1,070 t
    - Retained catch: 660 t
    - 41 vessels participated
    - CPUE: 21



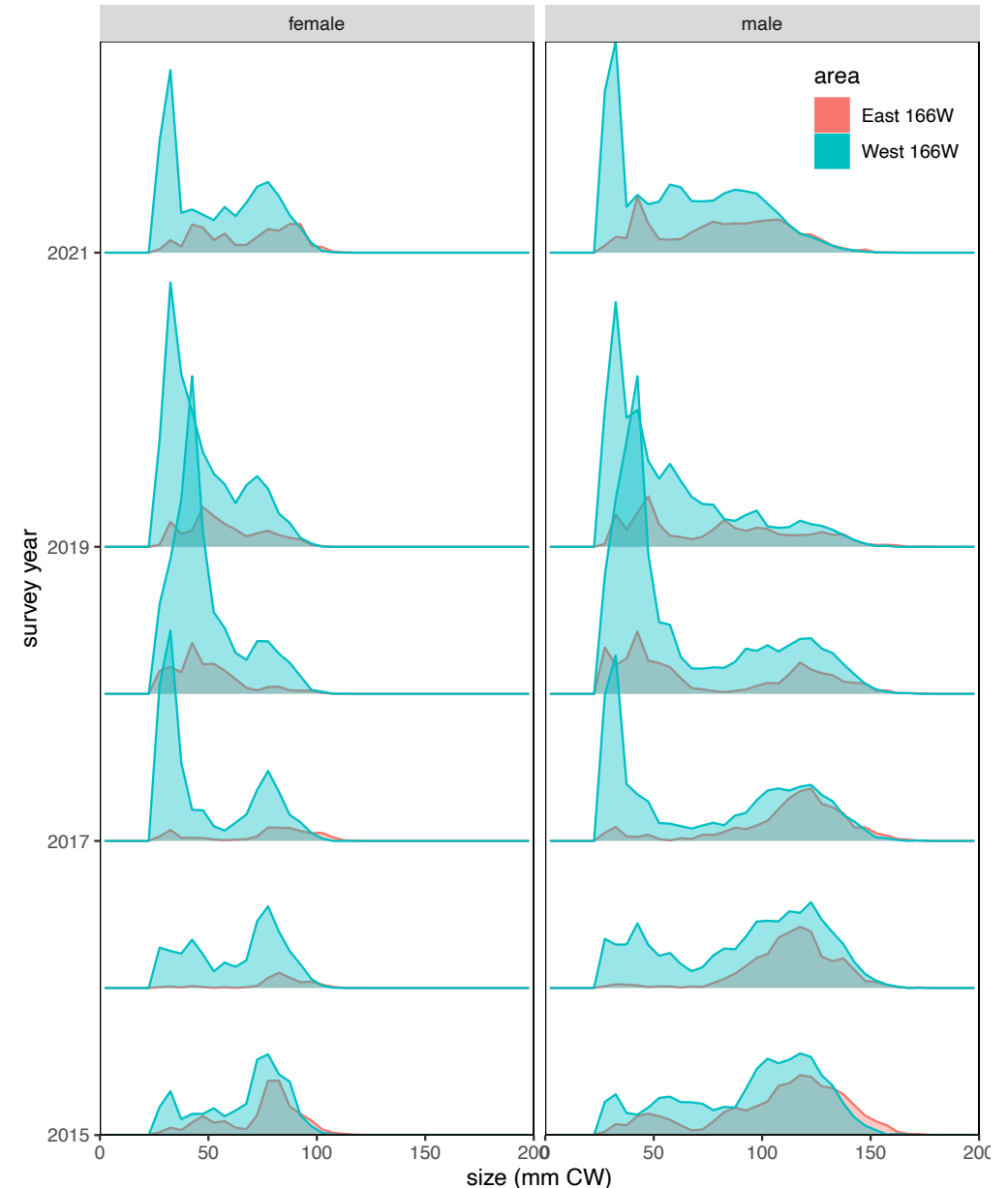
# Overview:

## Surveys

- 2021 NMFS EBS Shelf Survey Biomass
  - 31,138 t male biomass (+10%)
  - 4,409 t industry-preferred males (-55%)
  - 8,420 t mature female biomass (+77%)
- Concern:
- lots of recent recruitment
- not moving into larger size classes

## 2021/22 Management

- Based on preferred model (21.22a)
  - Tier 3a ( $B > B_{MSY}$ ; not overfished)
  - OFL: 27,170 t, ABC: 21,740 t



# Outline

- SSC & CPT Comments
- Recent Fishery & Survey Trends
- Model Description & Scenarios
- Model Evaluation
- Status Determination & OFL Calculation
- Final Remarks



# SSC & CPT Comments

*Comment: The SSC supports the CPT recommended models for September 2021: ...Model 20.07, ...Model 21.22, ... Model 21.22 + pre-specification of growth increments per molt based on external estimates.*

Response: The models evaluated in this assessment are 20.07, 21.22, 21.24 (21.22 + pre-specification), and 21.22a (21.22 modified to have no parameters at bounds)

*Comment: The data may not support so many selectivity parameters. A reduction in the number of selectivity parameters may be needed.*

Response: Agreed. The preferred model reduces the number of estimated selectivity parameters by 12.

*Comment: Evaluate the use of half-normal curves for selectivity rather than logistic functions.*

Response: Half-normal curves have been adopted in the preferred model to describe selectivity for both sexes in the NMFS EBS Shelf Survey and BBRKC fishery bycatch.

*Comment: A small percentage of models converge and it is not clear if the model is converging on a global minimum. Efforts should strive to reduce the number of parameters and minimize the number of parameters hitting bounds.*

Response: With fewer (or no) parameters at bounds, a much larger percentage of “jittered” runs converged to the MLE in the models considered here.



# SSC & CPT Comments

*Comment: support for fixing Dirichlet-Multinomial weighting must be rechecked for every new alternative model considered in future assessments to ensure data weighting remains consistent with model fit.*

Response: This was done for all models employing D-M likelihoods to fit size composition data. The D-M weighting parameter was estimated at an upper bound for all data sources except the BSFRF SBS data. Rather than fixing the relevant D-M parameters, the associated likelihoods were changed to multinomials with no re-weighting.

*Comment: Include a rationale if MCMC is used to recommend management advice.*

Response: Evaluating the max ABC (defined as the p-star ABC) requires information on the uncertainty in the estimated OFL. Using the “delta” approximation to estimate uncertainty in a complex model can result in biased estimates. MCMC, used in this assessment, can provide a better characterization of model uncertainty (but places a large demand on time and processing resources). Using the delta approximation to determine the p-star ABC is not possible with the Tanner crab model code (the OFL calculations do not use “AD” variables).

*Comment: The SSC supports continued exploration of VAST indices within this assessment and research to evaluate optimal methods for addressing changes in index uncertainty in the context of data weighting*

Response: Optimal methods for weighting VAST indices for this assessment have not been yet been developed. No VAST-based models are considered here.



# SSC & CPT Comments

*Comment: Create a standard approach for creating priors on selectivity and catchability from the BSFRF/NMFS side-by-side trawl data for use in the respective assessments.*

Response: In progress. A substantial amount of work has been done to develop a standard approach, using Tanner crab as a test case. Results were presented at the May 2021 CPT Meeting.

*Comment: Modifications to the assessment should be considered to the extent practicable that bridge state-federal disconnects (two-area management, one-area assessment) and facilitate application of the stock assessment to the State's harvest strategy for fishery management.*

Response: The author supports the ideas for future research outlined in this comment.

*Comment: Develop a standard approach for projecting the upcoming year's biomass that does not include removing the entire OFL for stocks where recent mortality has been substantially below the OFL.*

Response: This capability has not yet been implemented in the Tanner crab assessment code.



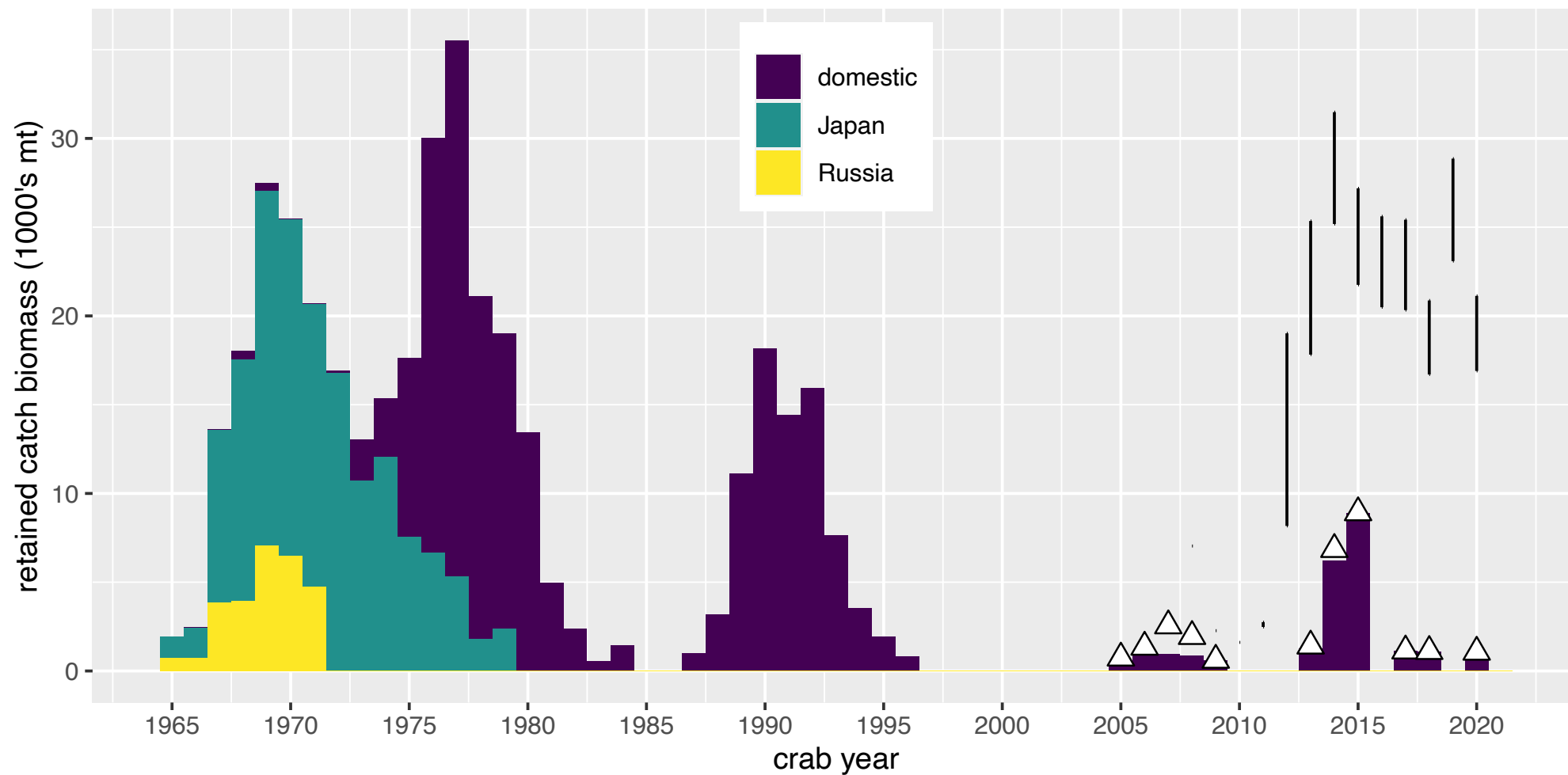
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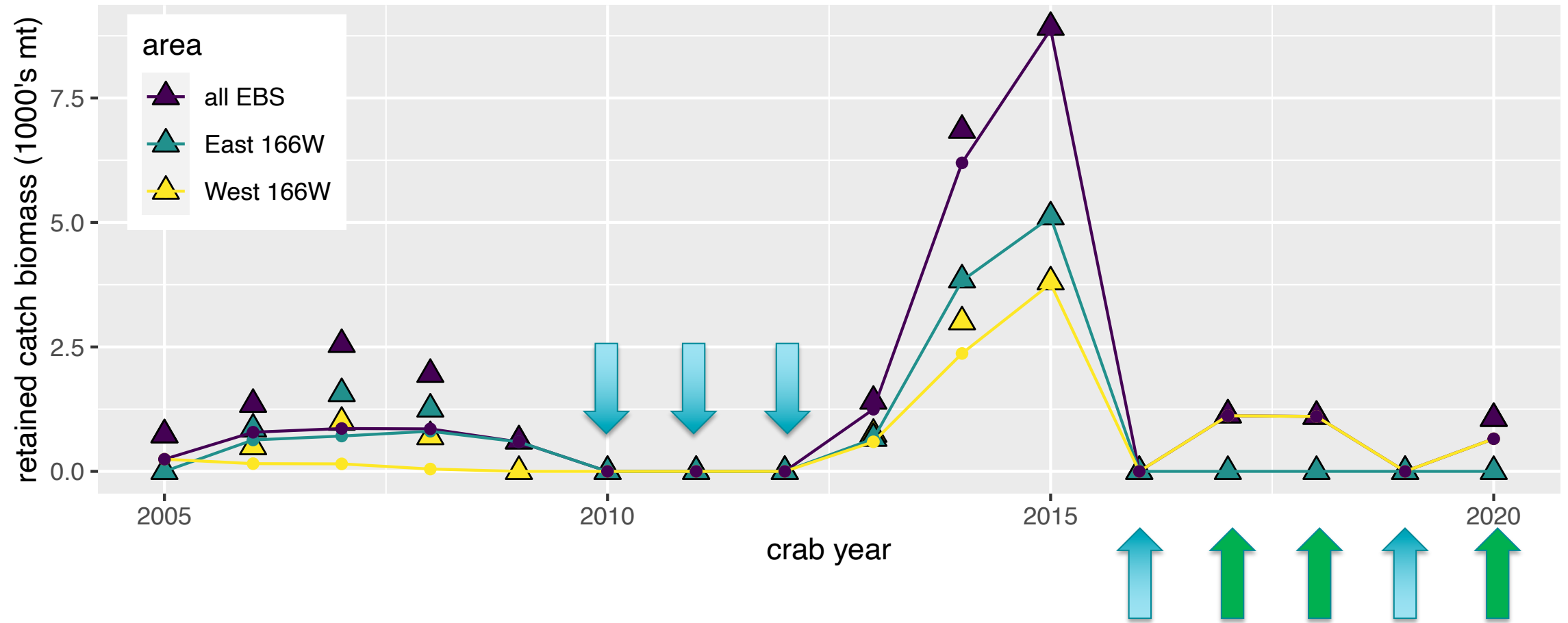




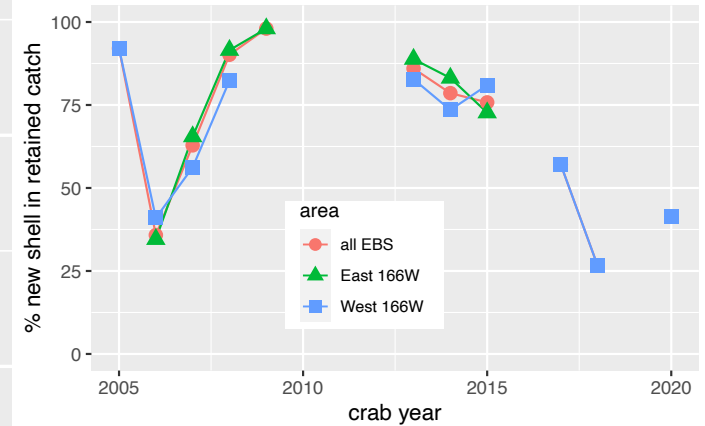
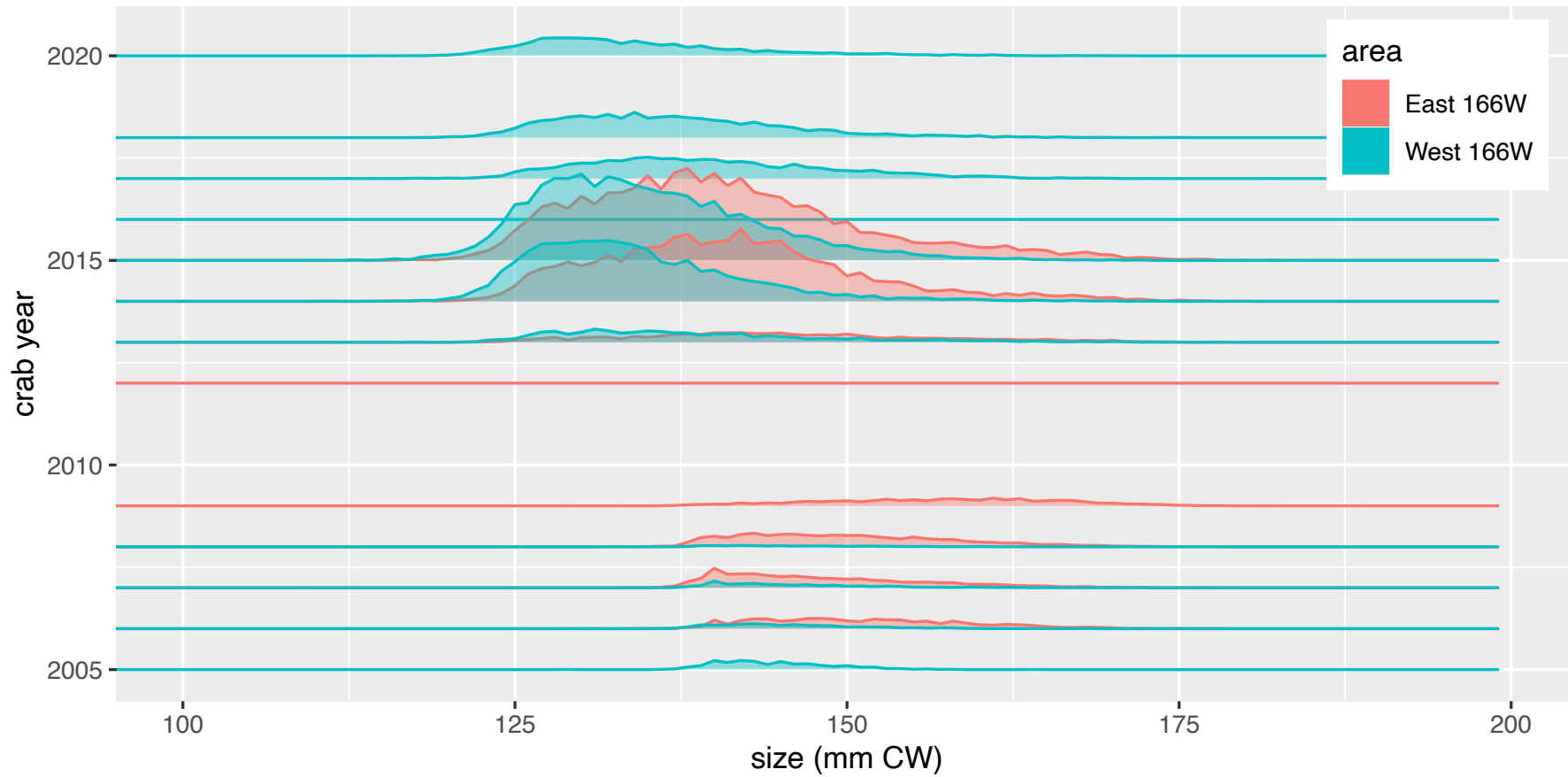
# Retained catch

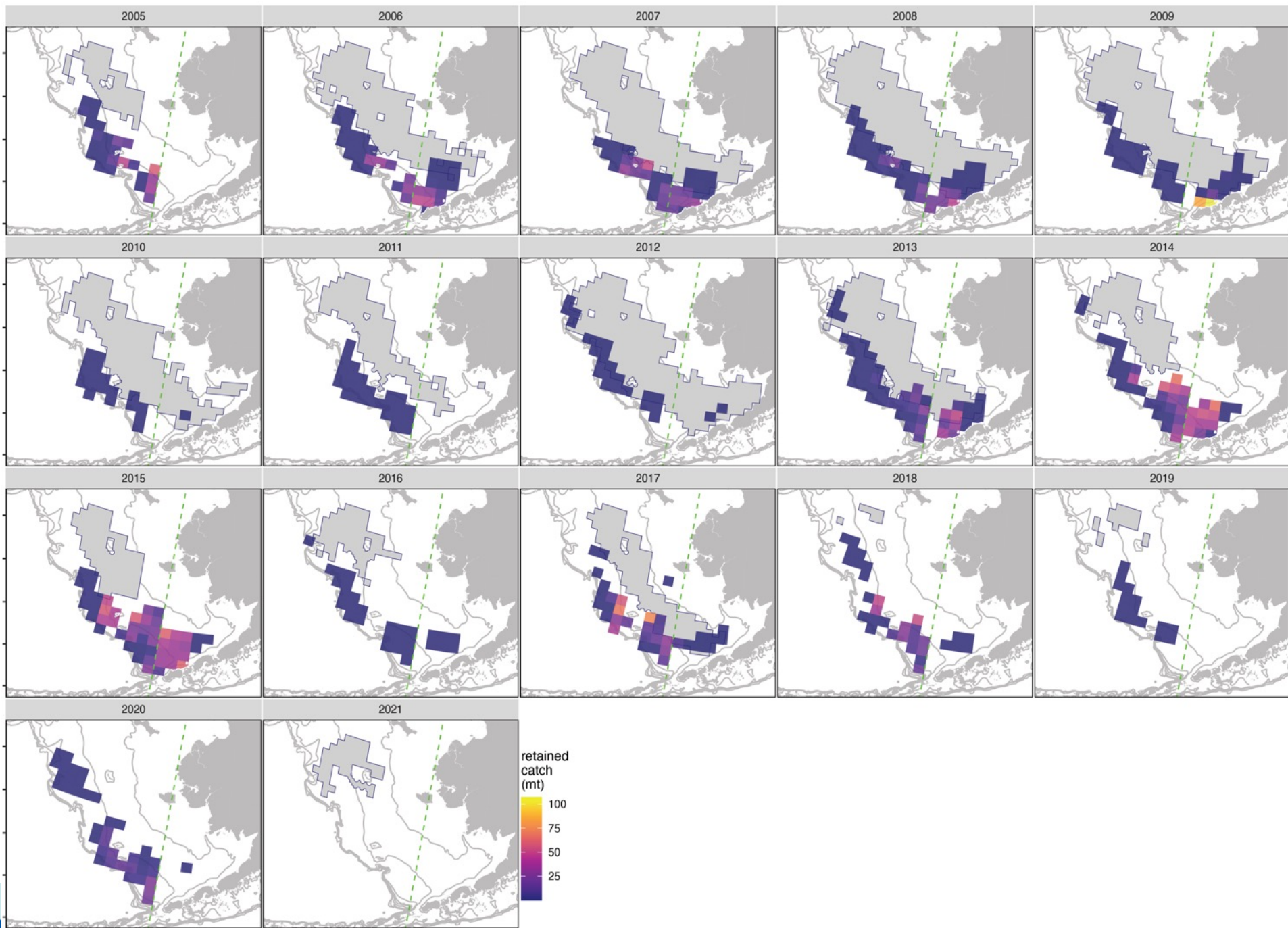


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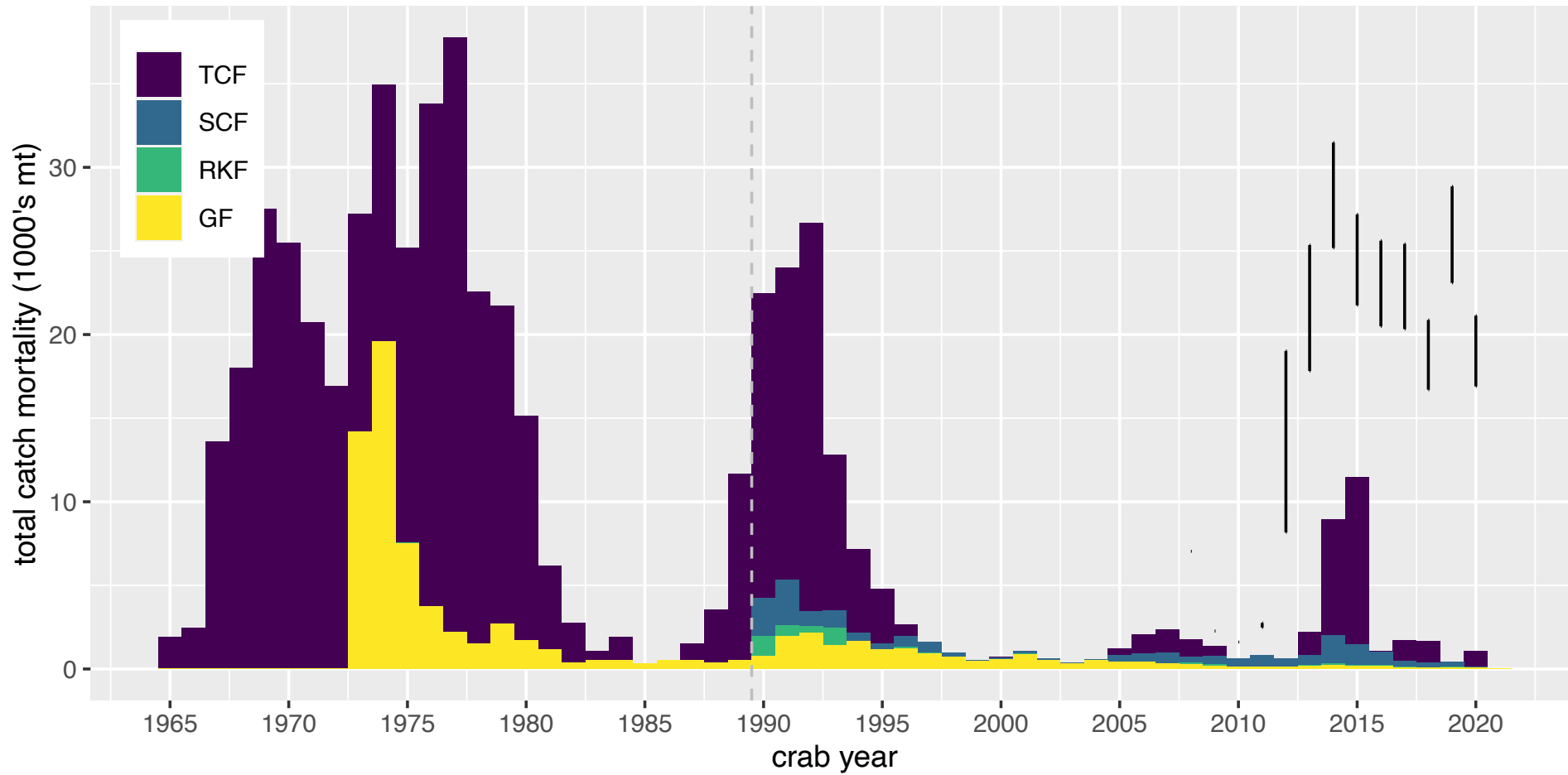


# Retained catch

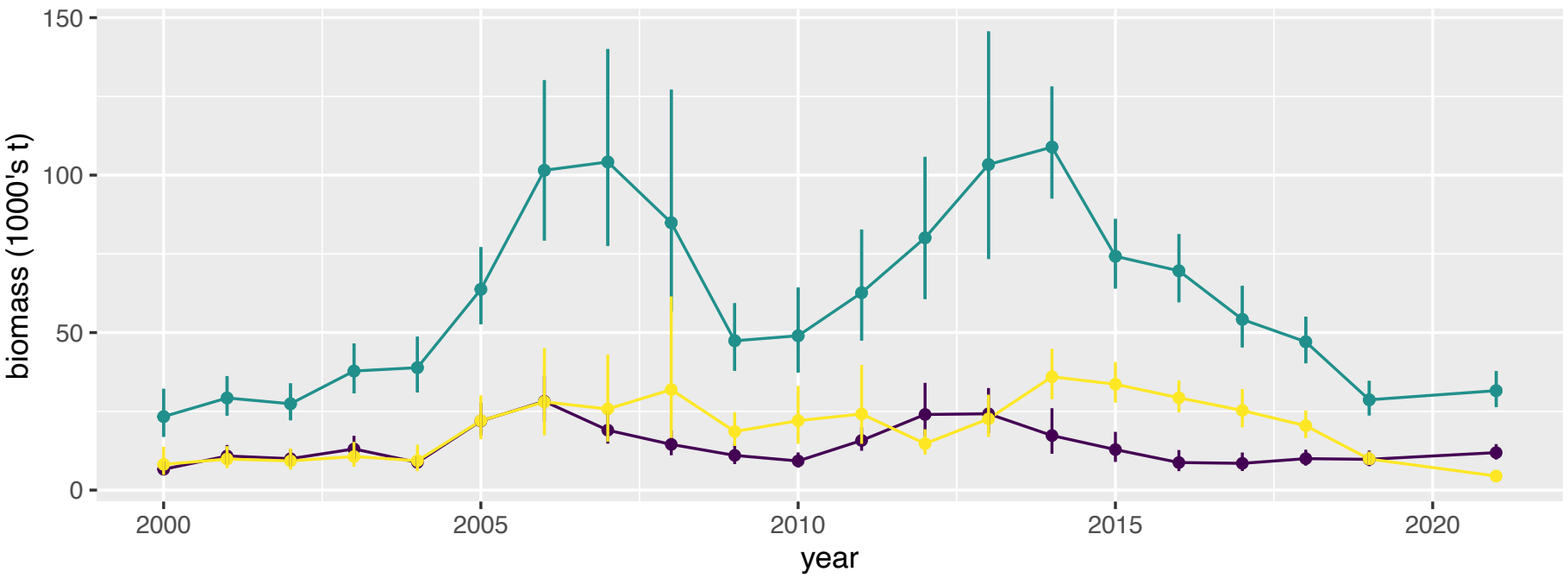
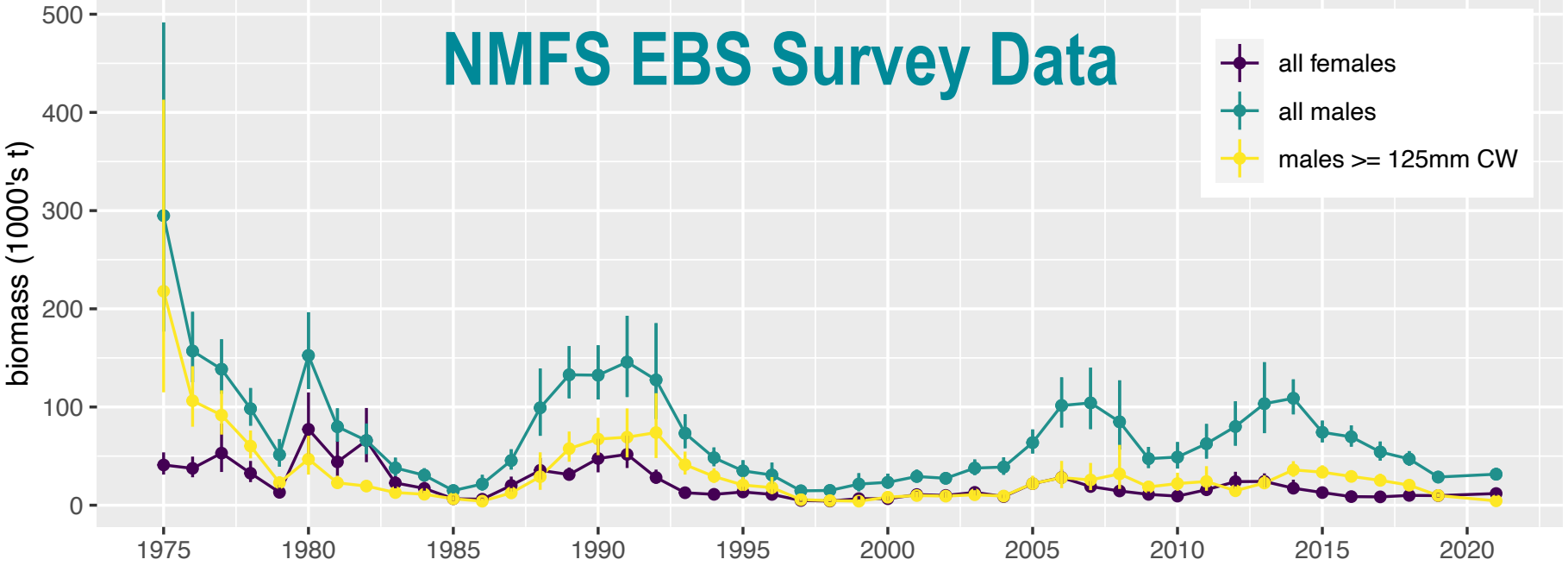




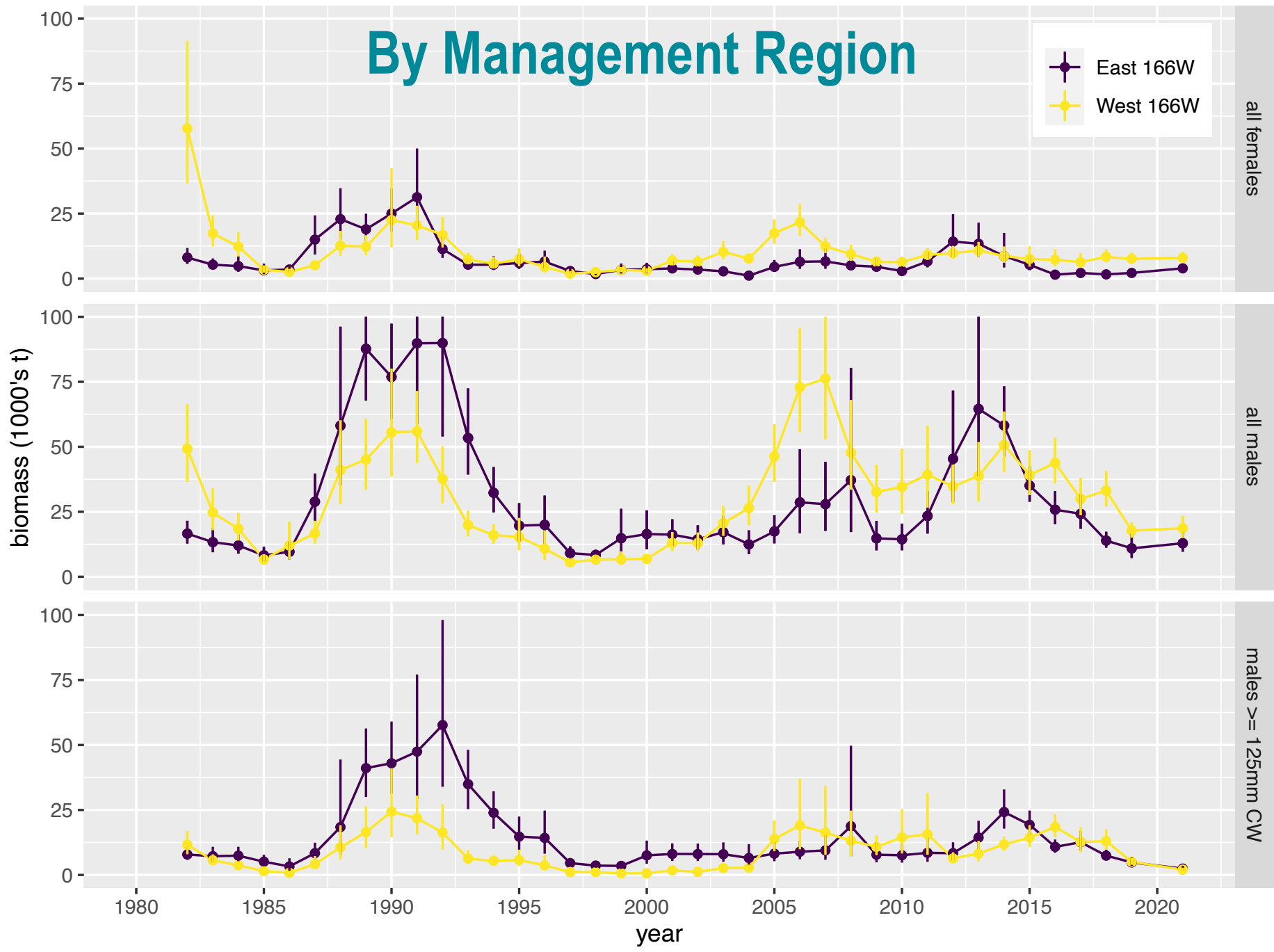
# Total catch mortality



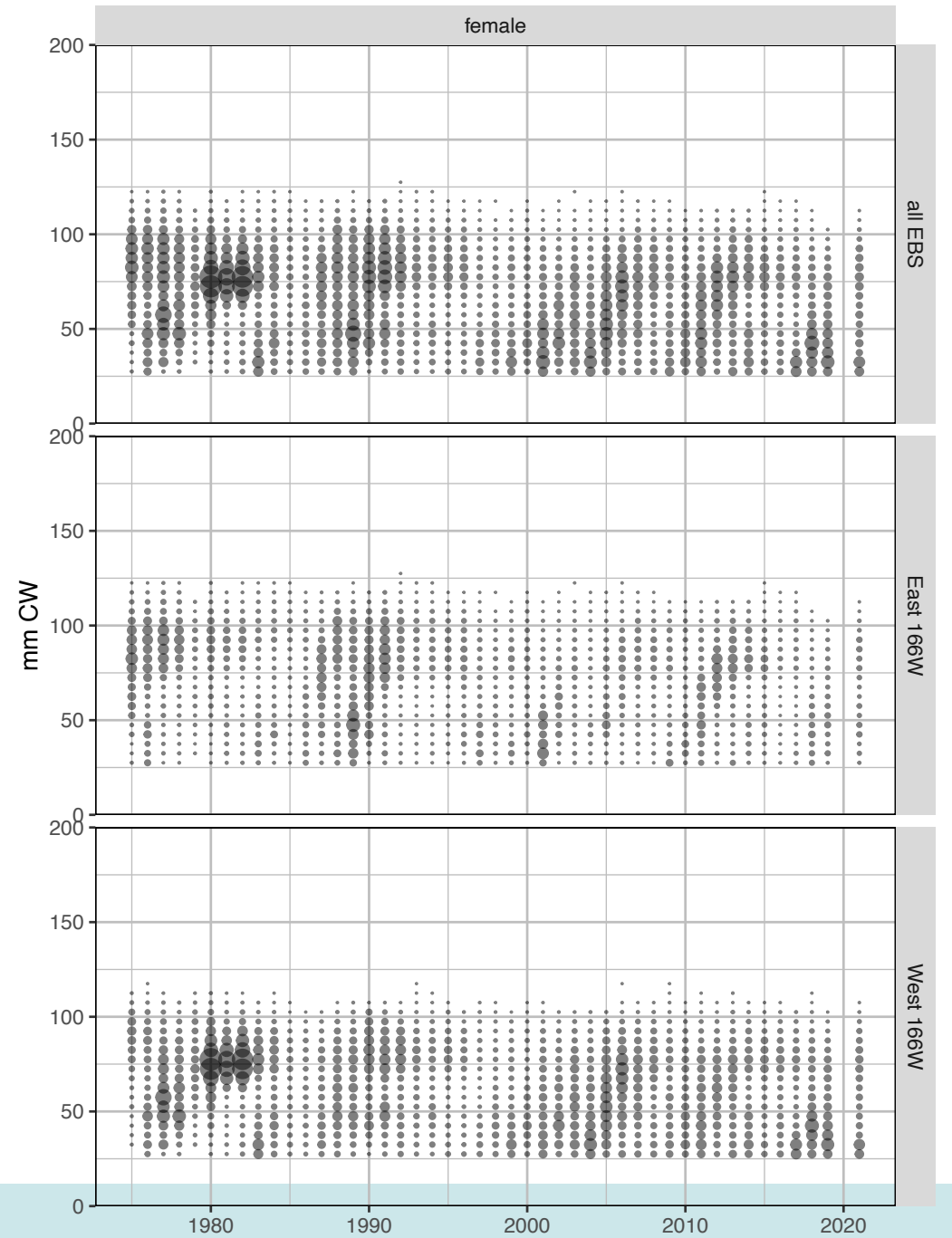
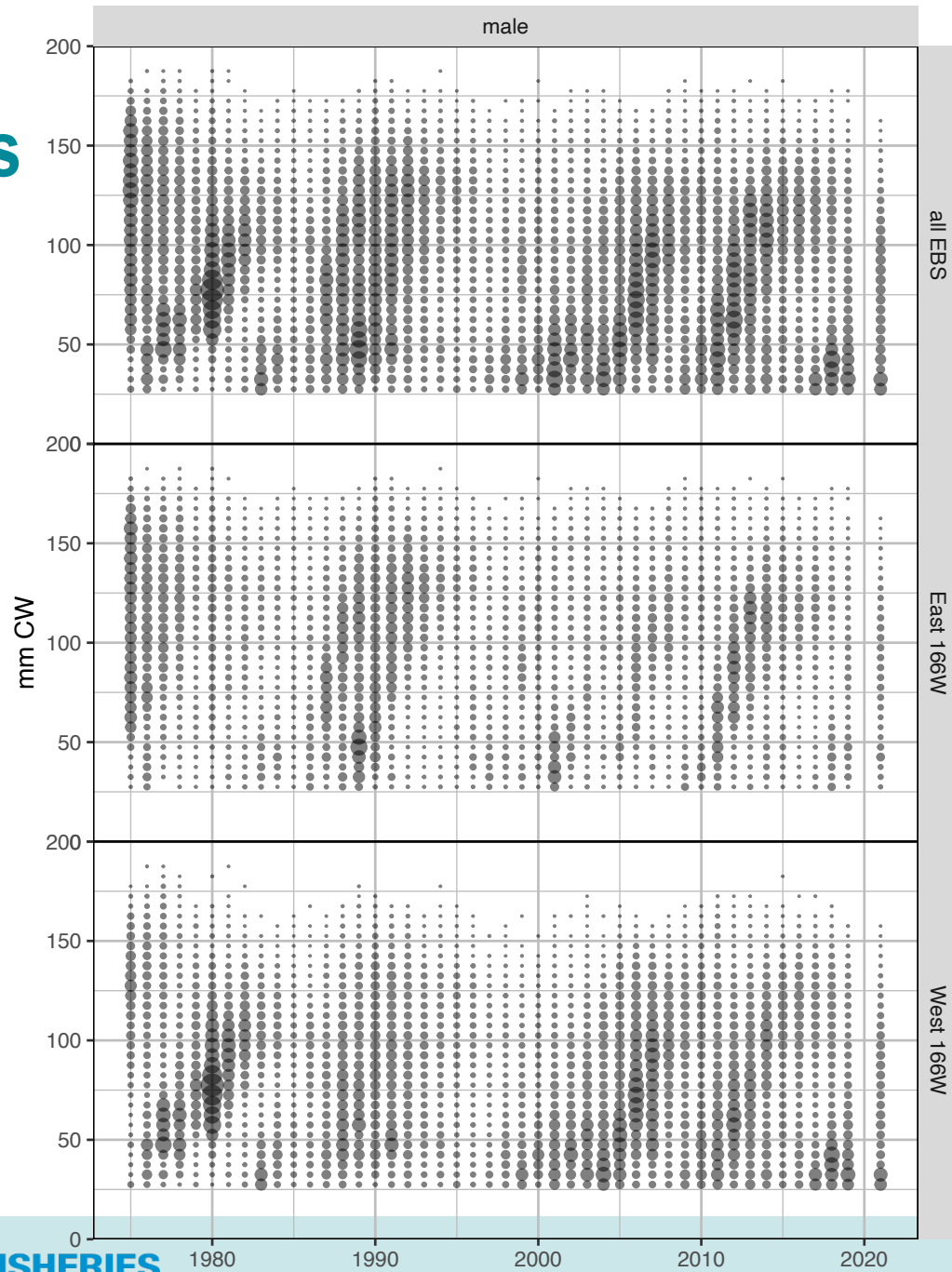
# NMFS EBS Survey Data



# By Management Region



# Survey Size Comps





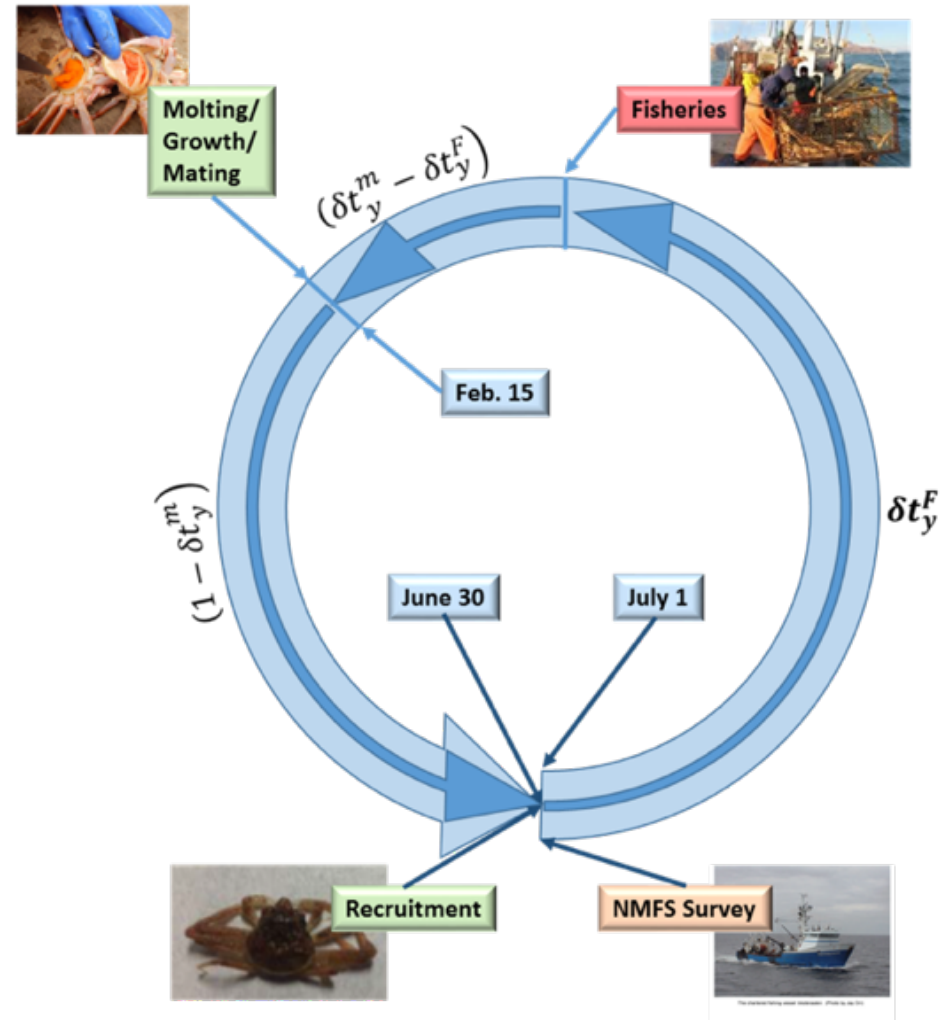
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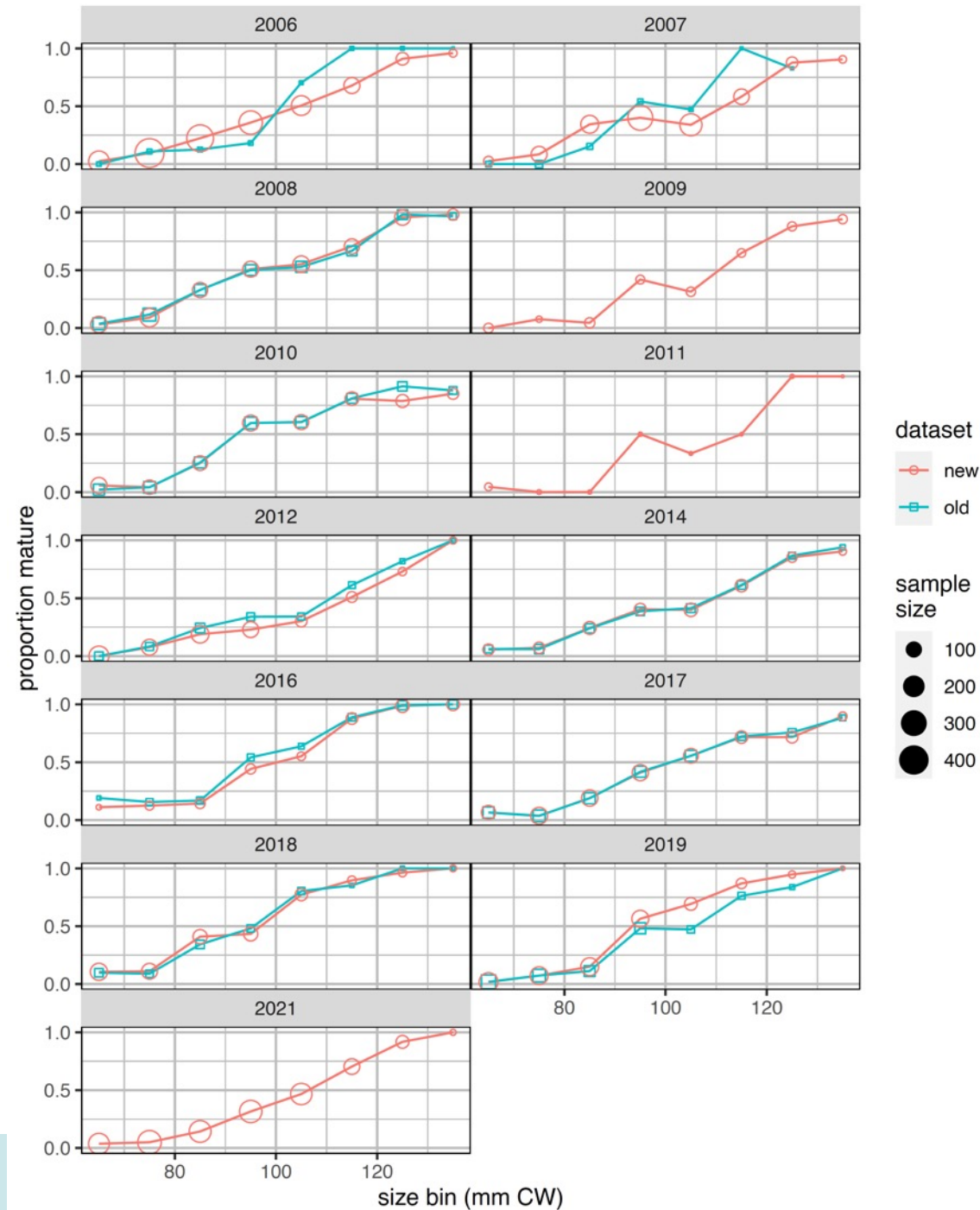
# Assessment

- 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:
    - $F_{msy}$ ,  $B_{msy}$ ,  $F_{OFL}$ ,  $OFL$ ,  $ABC$





# Changes to Data: Male Maturity Data



- couple of new years
- additional observations

# New: Lognormal Fits to Fishery Catch Data

- 20.07: normal likelihood assumes standard deviation is 500 t

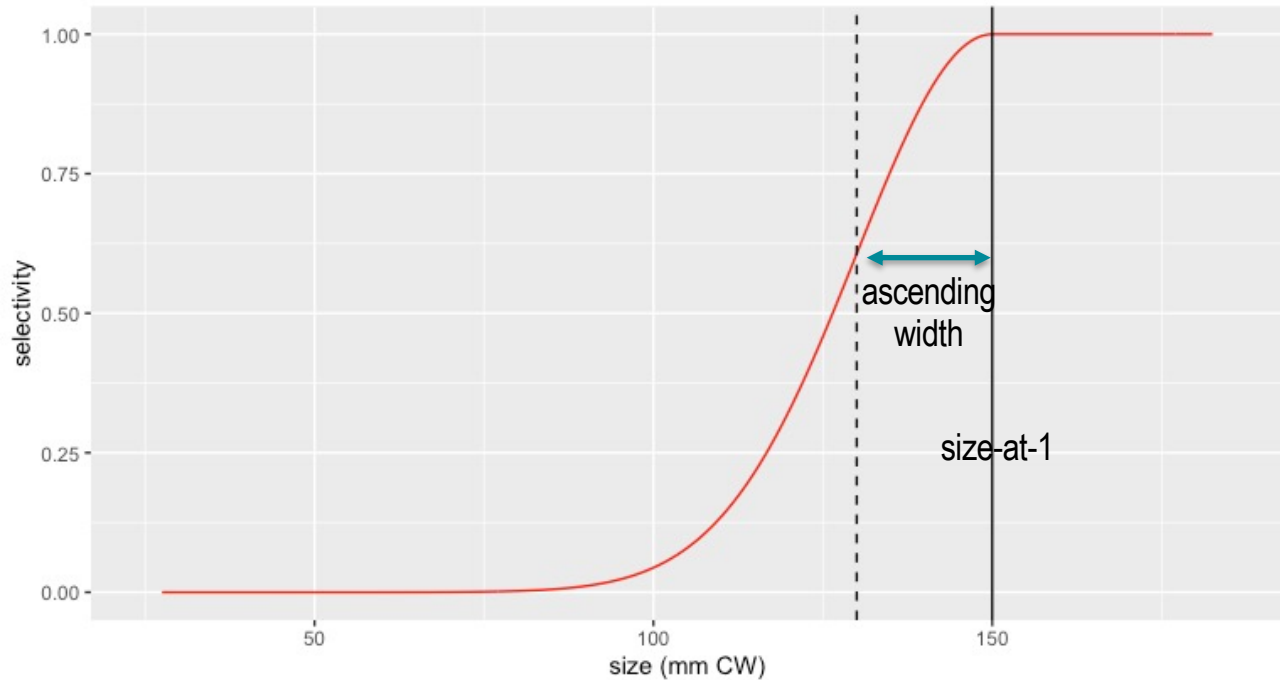
fishery	catch type	time period	CV
		1965-1979	10%
directed fishery	retained	1980	3%
		1996+	1%
		total	1990+
snow crab	total	1990+	20%
BBRKC	total	1990+	20%
groundfish	total	1973	20%

- minimum assumed error: 10 t

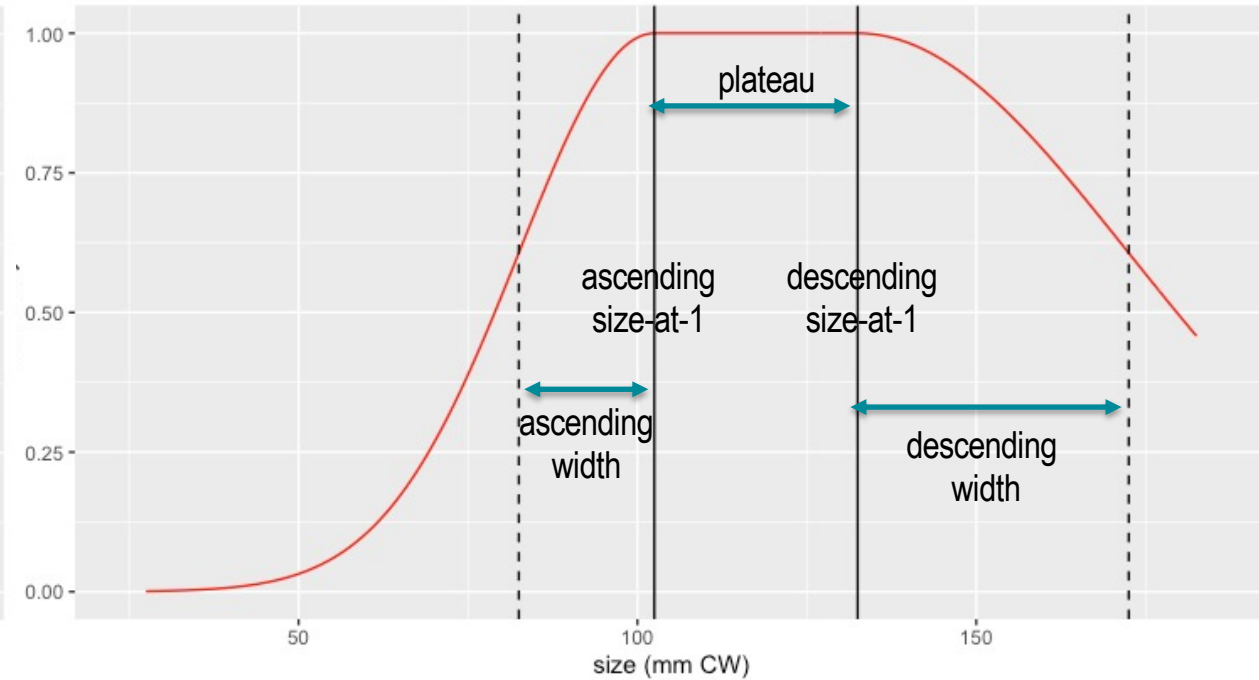


# New: Normal-based Selectivity Functions

ascending half-normal



double normal

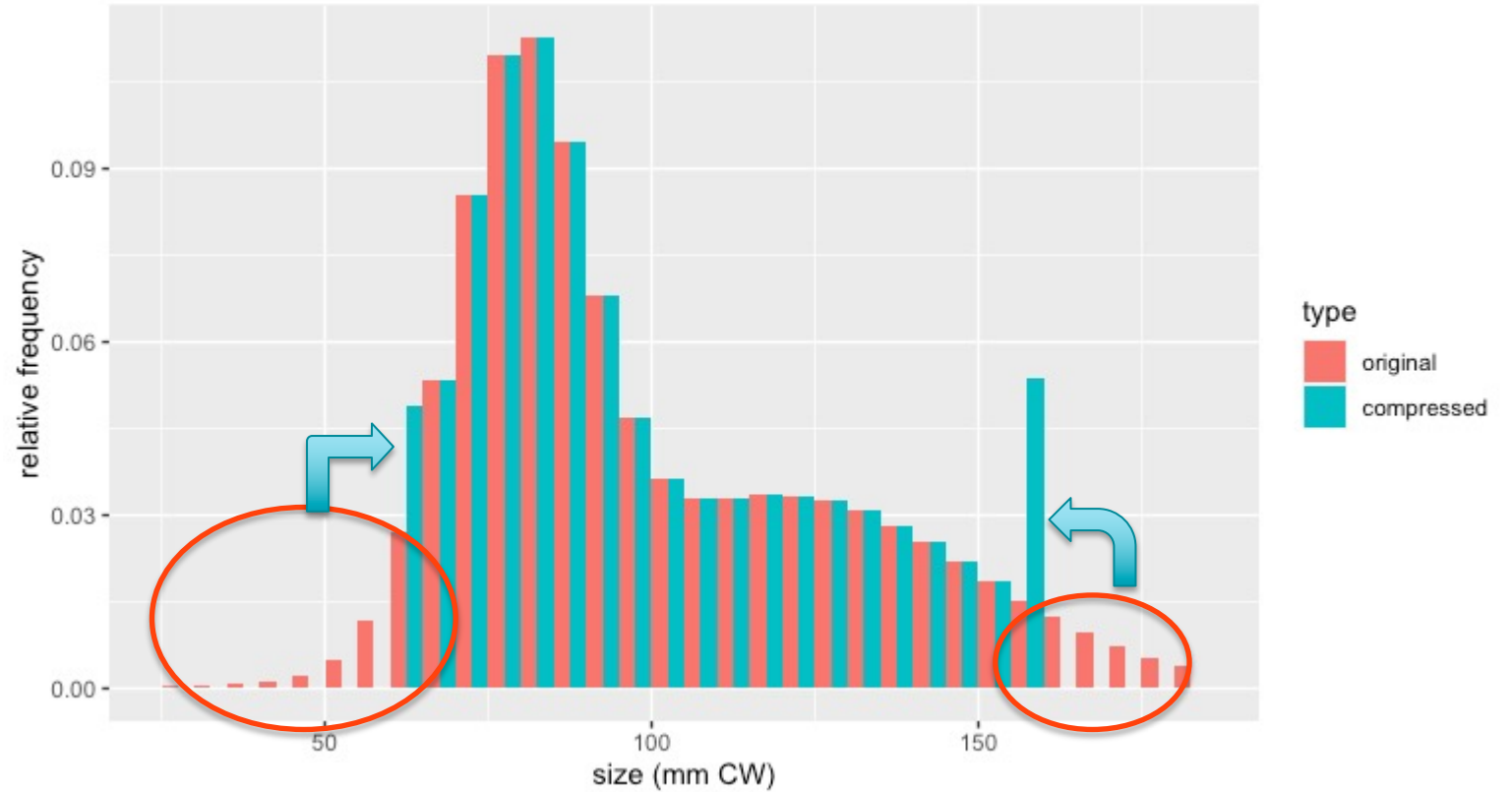


- advantage over logistic functions:
  - always reaches 1
  - intrinsically normalized



# New: Tail Compression

can improve statistical stability  
fitting to size comps with long tails



# New: Dirichlet-multinomial likelihood

- Fits to size composition data based on multinomial likelihood frequently exhibit overdispersion
- D-M uses mixed-effects modeling to replace McAllister-lanelli-type tuning

$$\begin{aligned}\mathcal{L}(\tilde{\pi}_t; \pi_t, \theta, n_t) &= \int \text{Multinomial}(n_t \tilde{\pi}_t | \pi_t^*, n_t) \text{Dirichlet}(\pi_t^* | \pi_t, \theta) d\pi_t^* \\ &= \frac{\Gamma(n_t + 1)}{\prod_{i=1}^{n_i} \Gamma(n_t \tilde{\pi}_{a,t} + 1)} \frac{\Gamma(\theta n_t)}{\Gamma(n_t + \theta n_t)} \prod_{a=1}^{n_a} \frac{\Gamma(n_t \pi_{a,t} + \theta n_t \pi_{a,t})}{\Gamma(\theta n_t \pi_{a,t})} \\ n_{\text{effective}} &= \frac{1}{1 + \theta} + n_t \frac{\theta}{1 + \theta}\end{aligned}$$

- scaling factor for effective sample size
  - hit upper bound for all size composition data except BSFRF survey data
  - results imply input sample sizes adequate for most data sources



# Model Scenarios

- 20.07u: 2020 assessment model, with updated data for 2020/21
- 21.22: CPT/SSC recommended scenario from May Meeting
  - no parameters at bounds in May
  - 5 parameters at bounds with 2020/21 data
- 21.24: CPT/SSC recommended scenario from May Meeting
  - 21.22 + mean growth determined outside model
- 21.22a: Author's preferred model
  - 21.22 + changes necessary to obtain model with no parameters at bounds



# Model Processes

process	time blocks	20.07 description	21.22 description
Population rates and quantities			
Population built from annual recruitment			
Recruitment	1949-1974	ln-scale mean + annual devs constrained as AR1 process	no change
	1975+	ln-scale mean + annual devs	no change
Growth	1949+	sigma-R fixed	estimated
	1949+	sex-specific	no change
		mean post-molt size: power function of pre-molt size	no change
Maturity	1949+	post-molt size: gamma distribution conditioned on pre-molt size	no change
		sex-specific	no change
		size-specific probability of terminal molt	no change
Natural mortality	1949-1979,	logit-scale parameterization	no change
		estimated sex/maturity state-specific multipliers on base rate	no change
	1985+	priors on multipliers based on uncertainty in max age	no change
	1980-1984	estimated "enhanced mortality" period multipliers	no change

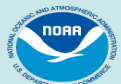
# Fisheries

Fishery/process	time blocks	20.07 description	21.22 description
TCF	directed Tanner crab fishery		
capture rates	pre-1965	male nominal rate	no change
	1965+	male ln-scale mean + annual devs	no change
	1949+	ln-scale female offset	no change
male selectivity	1949-1990	ascending logistic	no change
	1991-1996	annually-varying ascending logistic	no change
	2005+	annually-varying ascending logistic	no change
female selectivity	1949+	ascending logistic	no change
male retention	1949-1990, 1991-1996, 2005-2009, 2013-2015, 2017, 2018	ascending logistic	no change
	pre-1988	100%	no change
	1991-1996	estimated	fixed at 100%
	2005-2009	estimated	fixed at 100%
% retained	2013+	estimated	fixed at 100%
	SCF	bycatch in snow crab fishery	
	capture rates	pre-1978	nominal rate on males
1979-1991		extrapolated from effort	no change
1992+		male ln-scale mean + annual devs	no change
1949+		ln-scale female offset	no change
male selectivity	1949-1996	dome-shaped (double logistic)	dome-shaped (double normal)
	1997-2004	dome-shaped (double logistic)	dome-shaped (double normal)
	2005+	dome-shaped (double logistic)	dome-shaped (double normal)
female selectivity	1949-1996	ascending logistic	no change
	1997-2004	ascending logistic	no change
	2005+	ascending logistic	no change



# Fisheries

Fishery/process	time blocks	20.07 description	21.22 description
RKF		bycatch in BBRKC fishery	
capture rates	pre-1952	nominal rate on males	no change
	1953-1991	extrapolated from effort	no change
	1992+	male ln-scale mean + annual devs	no change
	1949+	ln-scale female offset	no change
male selectivity	1949-1996	ascending logistic	ascending normal, asymptote fixed
	1997-2004	ascending logistic	ascending normal, asymptote fixed
	2005+	ascending logistic	ascending normal, asymptote fixed
female selectivity	1949-1996	ascending logistic	ascending normal
	1997-2004	ascending logistic	ascending normal
	2005+	ascending logistic	ascending normal
GTF		bycatch in groundfish fisheries	
capture rates	pre-1973	male ln-scale mean from 1973+	no change
	1973+	male ln-scale mean + annual devs	no change
	1973+	ln-scale female offset	no change
male selectivity	1949-1986	ascending logistic	no change
	1987-1996	ascending logistic	no change
	1997+	ascending logistic	no change
female selectivity	1949-1986	ascending logistic	no change
	1987-1996	ascending logistic	no change
	1997+	ascending logistic	no change



# Surveys

process	time blocks	20.07description	21.22 description
Surveys			
NMFS EBS trawl survey			
male survey q	1975-1981	ln-scale	no change
	1982+	ln-scale w/ prior based on Somerton's underbag experiment	no change
female survey q	1975-1981	ln-scale	no change
	1982+	ln-scale w/ prior based on Somerton's underbag experiment	no change
male selectivity	1975-1981	ascending logistic	no change
	1982+	ascending logistic	no change
female selectivity	1975-1981	ascending logistic	ascending normal, fixed asymptote
	1982+	ascending logistic	ascending normal, fixed asymptote
BSFRF SBS trawl surveys			
male catchability	2016-2017	fixed at 1 for all sizes	no change
male availability	2016-2017	empirically-determined outside the model	no change
female catchability	2016-2017	fixed at 1 for all sizes	no change
female availability	2016-2017	empirically-determined outside the model	no change



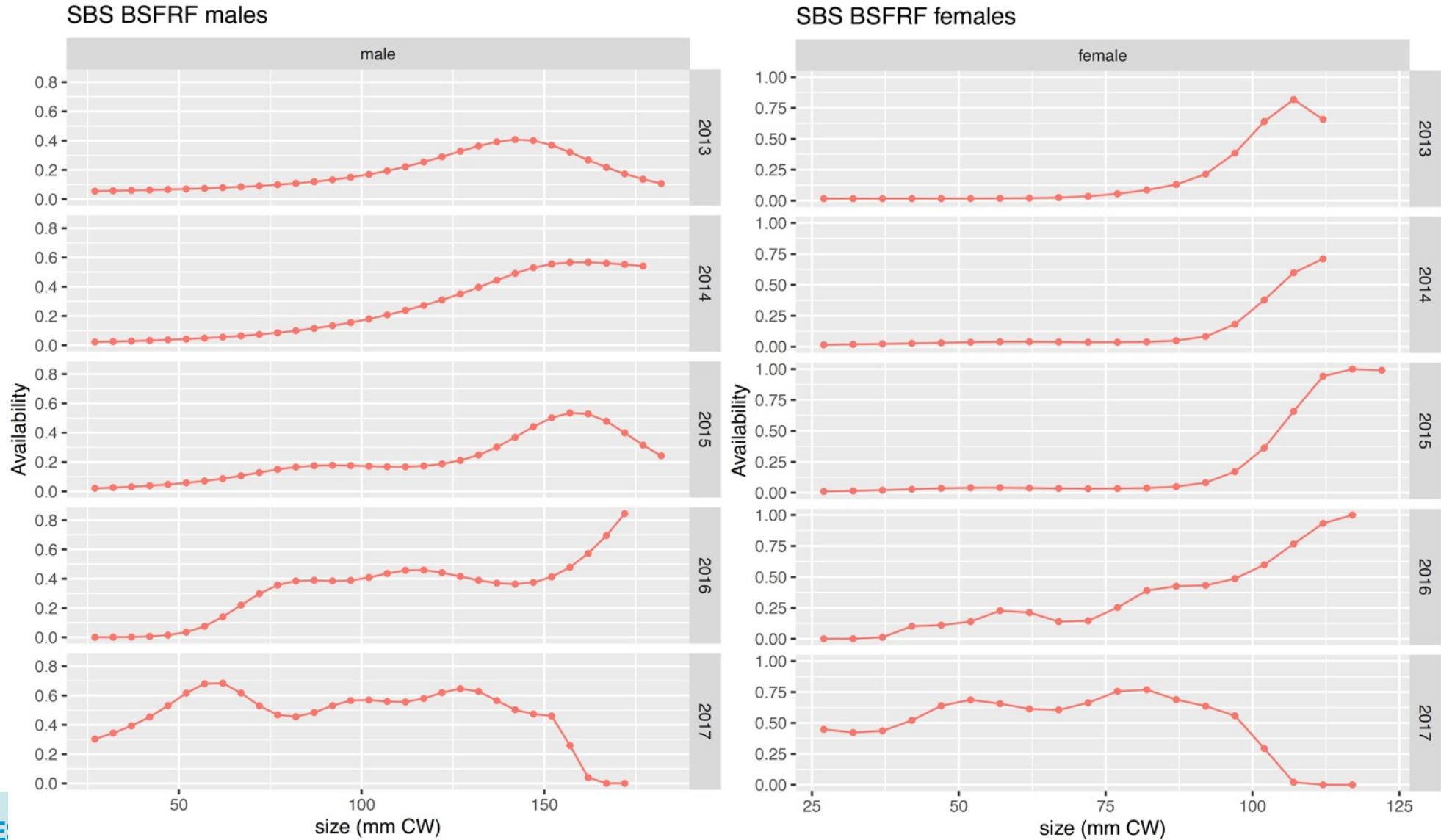
# Likelihoods

Component	Type	included in optimization	Likelihood	20.07 distribution	21.22 distribution
TCF: retained catch	biomass	yes	males only	norm2	lognormal
	size comp.s	yes	males only	multinomial	no change
TCF: total catch	biomass	yes	by sex	norm2	lognormal
	size comp.s	yes	by sex	multinomial	no change
SCF: total catch	biomass	yes	by sex	norm2	lognormal
	size comp.s	yes	by sex	multinomial	no change
RKF: total catch	biomass	yes	by sex	norm2	lognormal
	size comp.s	yes	by sex	multinomial	no change
GF All: total catch	abundance	yes	by sex	norm2	lognormal
	biomass	yes	by sex	norm2	lognormal
	size comp.s	yes	by sex	multinomial	no change
NMFS "M" survey (males only, no maturity)	biomass	yes	all males	lognormal	lognormal
	size comp.s	yes	all males	multinomial	no change
NMFS "F" survey (females only, w/ maturity)	biomass	yes	by maturity classification	lognormal	no change
	size comp.s	yes	by maturity classification	multinomial	no change
BSFRF "M" survey (males only, no maturity)	biomass	yes	all males	lognormal	no change
	size comp.s	yes	all males	multinomial	D-M
BSFRF "F" survey (females only, w/ maturity)	biomass	yes	by maturity classification	lognormal	no change
	size comp.s	yes	by maturity classification	multinomial	D-M
growth data	EBS only	yes	by sex	gamma	no change
male maturity ogive data	EBS only	yes	males only	binomial	no change



# Empirical availability

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



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# Model Evaluation

model scenario	number of parameters	objective function value	max gradient	Jitter runs	# runs converged to MLE	scenario description	Number of parameters at bounds
20.07	349	3,429.39	0.0003	400	47	2020 assessment model	11
20.07u	355	3,619.43	0.0001	139	51	2020 asesment model with updated 2020/21 data	12
21.22	353	2,939.77	0.0011	347	313	CPT/SSC recommended alternative	5
21.22a	346	3,132.07	0.0001	--	--	21.22 updated to eliminate parameters at bounds	0
21.24	349	3,014.12	0.0006	360	8	CPT/SSC recommended alternative: 21.22 with growth estimated outside model	10



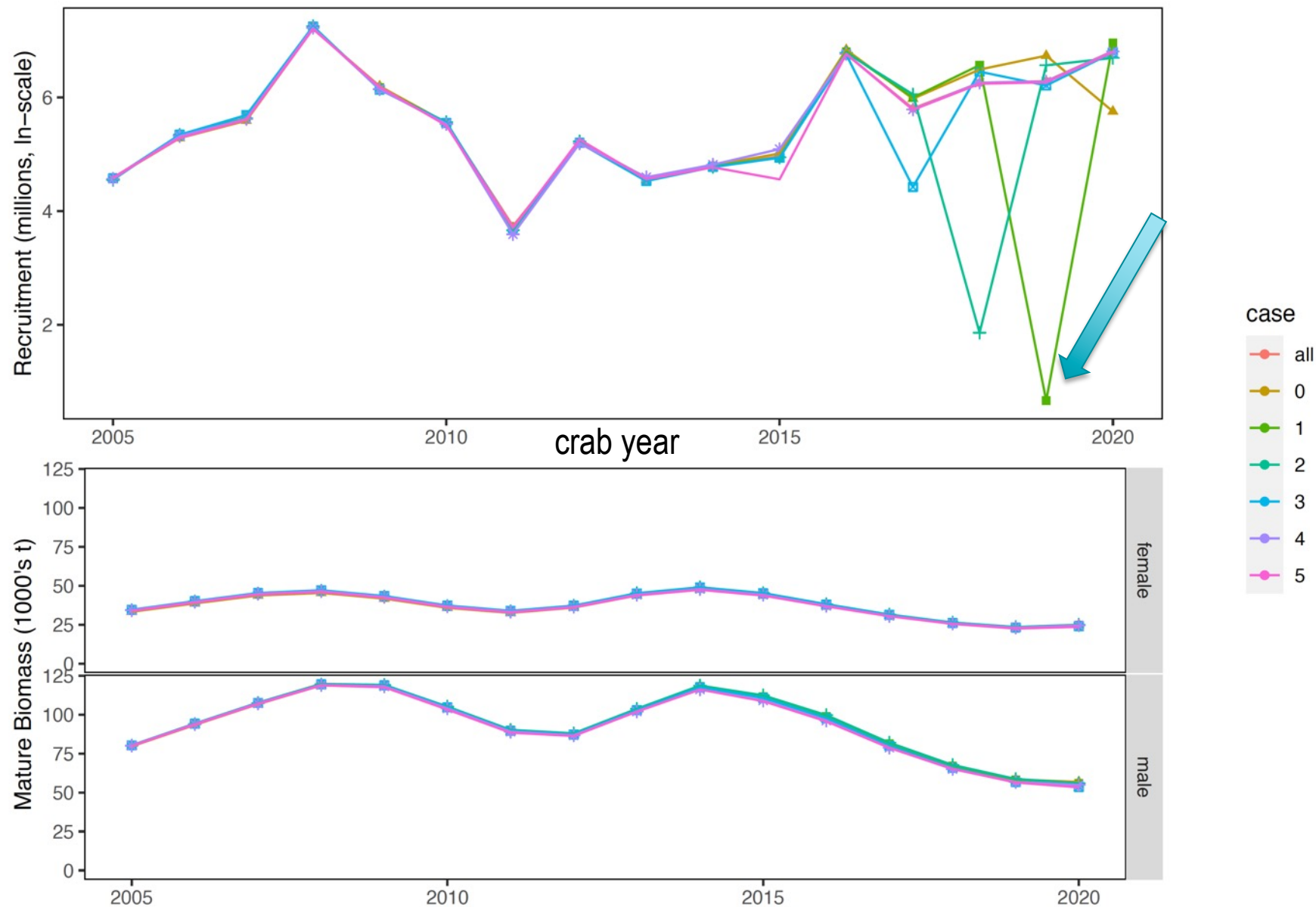
# Overview

category	process	name	label	20.07	20.07u	21.22	21.24	21.22a
fisheries	fisheries	pLgtRet[1]	TCF: logit-scale max retention (pre-1997)	1	1	-	-	-
population processes	growth	pGrBeta[1]	both sexes	1	-	-	-1	-
	recruitment	pDevsLnR	current recruitment period	-	-1	-1	-1	-
selectivity	selectivity	pS1[1]	z50 for NMFS survey selectivity (males, pre-1982)	-	1	-	-	-
		pS1[17]	z50 for GF.AllGear selectivity (males, 1987-1996)	-	-	-	1	-
		pS1[2]	z50 for NMFS survey selectivity (males, 1982+)	-	-	-	1	-
		pS1[23]	z95 for RKF selectivity (males, 1997-2004)	1	1	-	-	-
		pS1[24]	z95 for RKF selectivity (males, 2005+)	1	1	-	-	-
		pS1[25]	size at 1 for RKF selectivity (females, pre-1997)	-	-	1	1	-
		pS1[27]	z95 for RKF selectivity (females, 2005+)	1	1	-	-	-
		pS1[3]	size at 1 for NMFS survey selectivity (females, pre-1982)	-	-	-	1	-
		pS1[4]	z50 for NMFS survey selectivity (females, 1982+)	1	1	-	-	-
		pS2[10]	ascending slope for SCF selectivity (males, pre-1997)	-1	-1	-	-	-
		pS2[2]	z95-z50 for NMFS survey selectivity (males, 1982+)	-	1	1	1	-
		pS2[4]	z95-z50 for NMFS survey selectivity (females, 1982+)	1	1	-	-	-
		pS2[6]	slope for TCF retention (1997+)	-	-	-	1	-
		pS3[1]	scaled increment for descending z-at-1 for SCF selectivity (males, pre-1997)	-	-	-1	-1	-
		pS4[1]	descending slope for SCF selectivity (males, pre-1997)	-1	-1	-	-	-
surveys	surveys	pQ[1]	NMFS trawl survey: males, 1975-1981	-1	-1	-	-	-
		pQ[3]	NMFS trawl survey: females, 1975-1981	-1	-	-	-	-



# Model Evaluation: Missing Survey

- Faked the 2020 survey
- Ran 21.22a with “all” data
- Dropped single survey year sequentially going back to 2016
- “1” represents the true dataset (no 2020 survey)



# Model 21.22a: 21.22 adjusted so no parameters at bounds

1. Increased prior on ln-scale rec devs
2. fixed the following 7 parameters:
  - the ln-scale parameter determining the recruitment variance
  - BBRKC fishery female bycatch selectivity size-at-full selection in the half-normal function (pre-1997 time block, set to the same value, 140 mm CW, as other time blocks)
  - Parameters for snow crab fishery male bycatch double-normal selectivity function (pre-1997 time block):
    - the plateau parameter to 0 (no plateau; same as the other time blocks)
    - the parameter controlling the width of the descending limb (to 1 mm CW)
  - NMFS female survey selectivity size-at-full selection to 130 mm CW in both selectivity time periods (1975-1981, 1982+),
  - NMFS male survey selectivity size-at-full selection to 180 mm CW (1982+)



# Model Evaluation

## Incomparable likelihoods:

- 20.07 and all others
- size comps between 20.XX, 21.XX
- fishery catch biomass between 20.XX, 21.XX

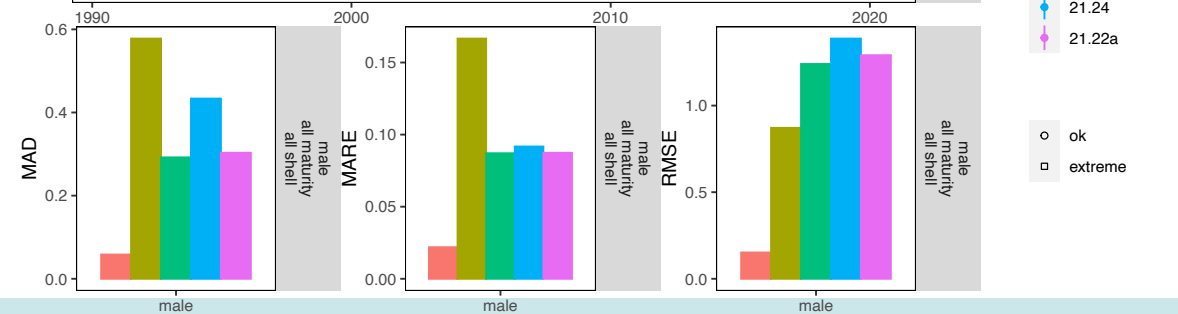
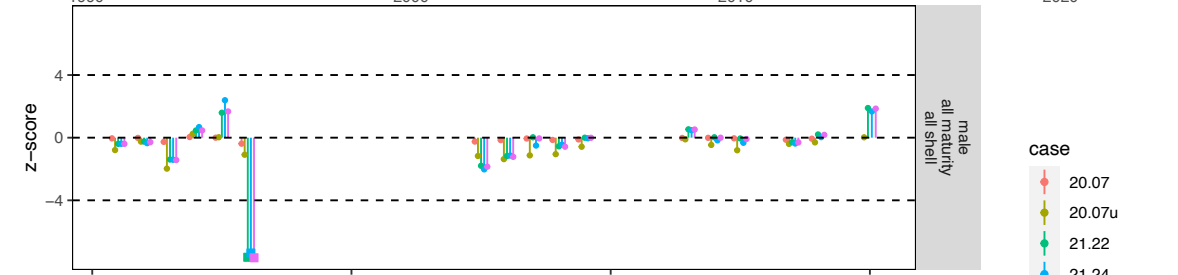
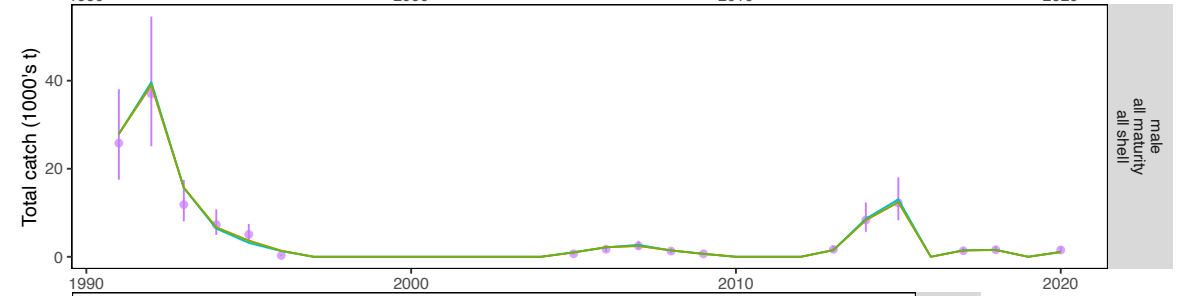
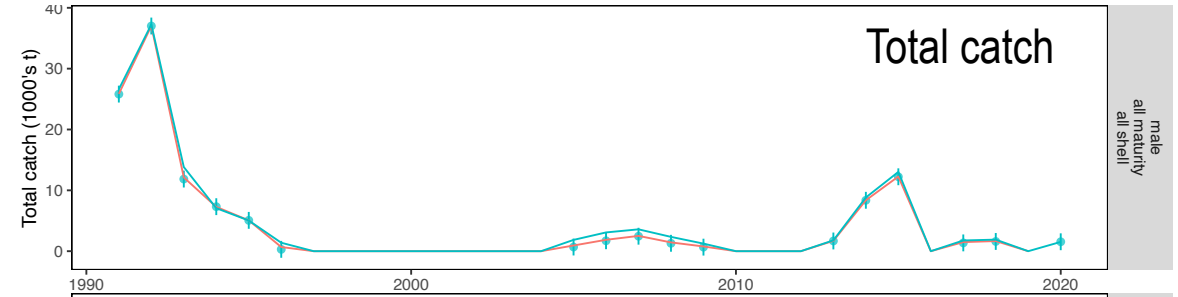
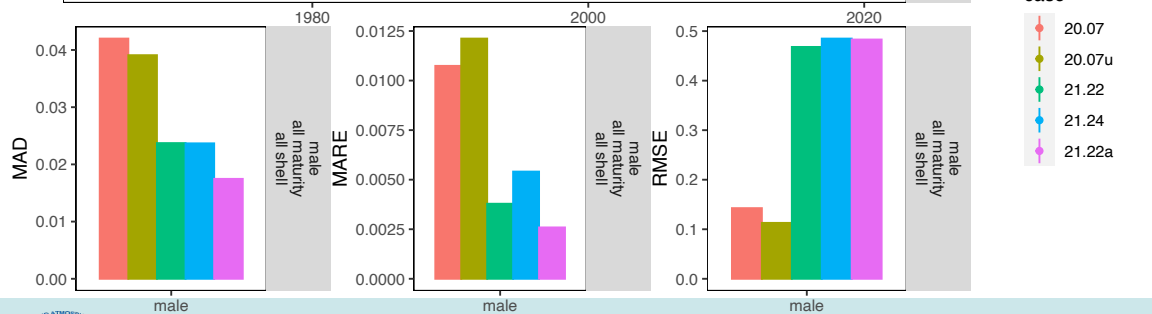
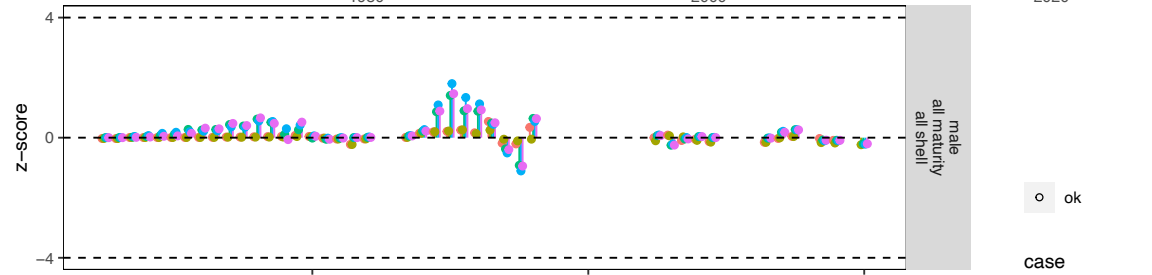
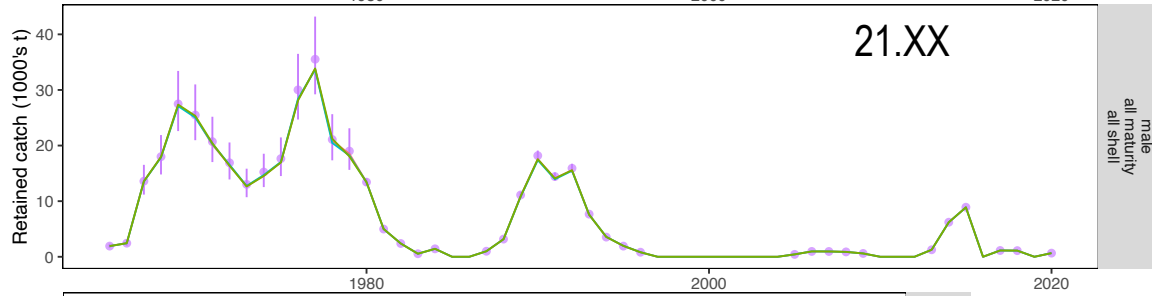
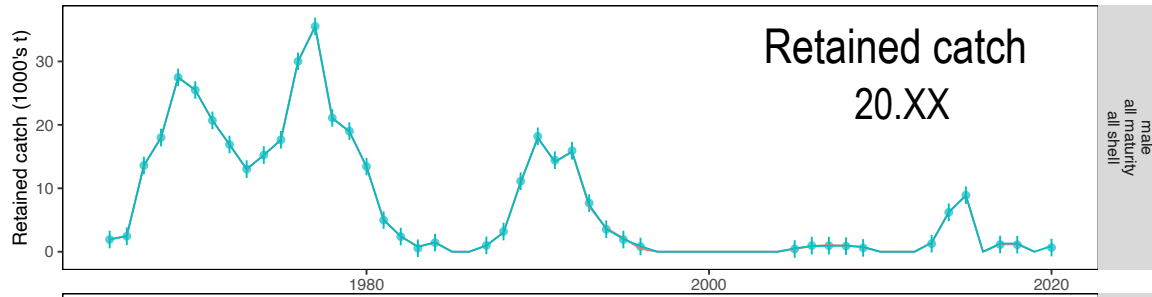
## Comparable likelihoods:

- NMFS survey biomass
- BSFRF survey biomass
- Growth data
- Maturity data

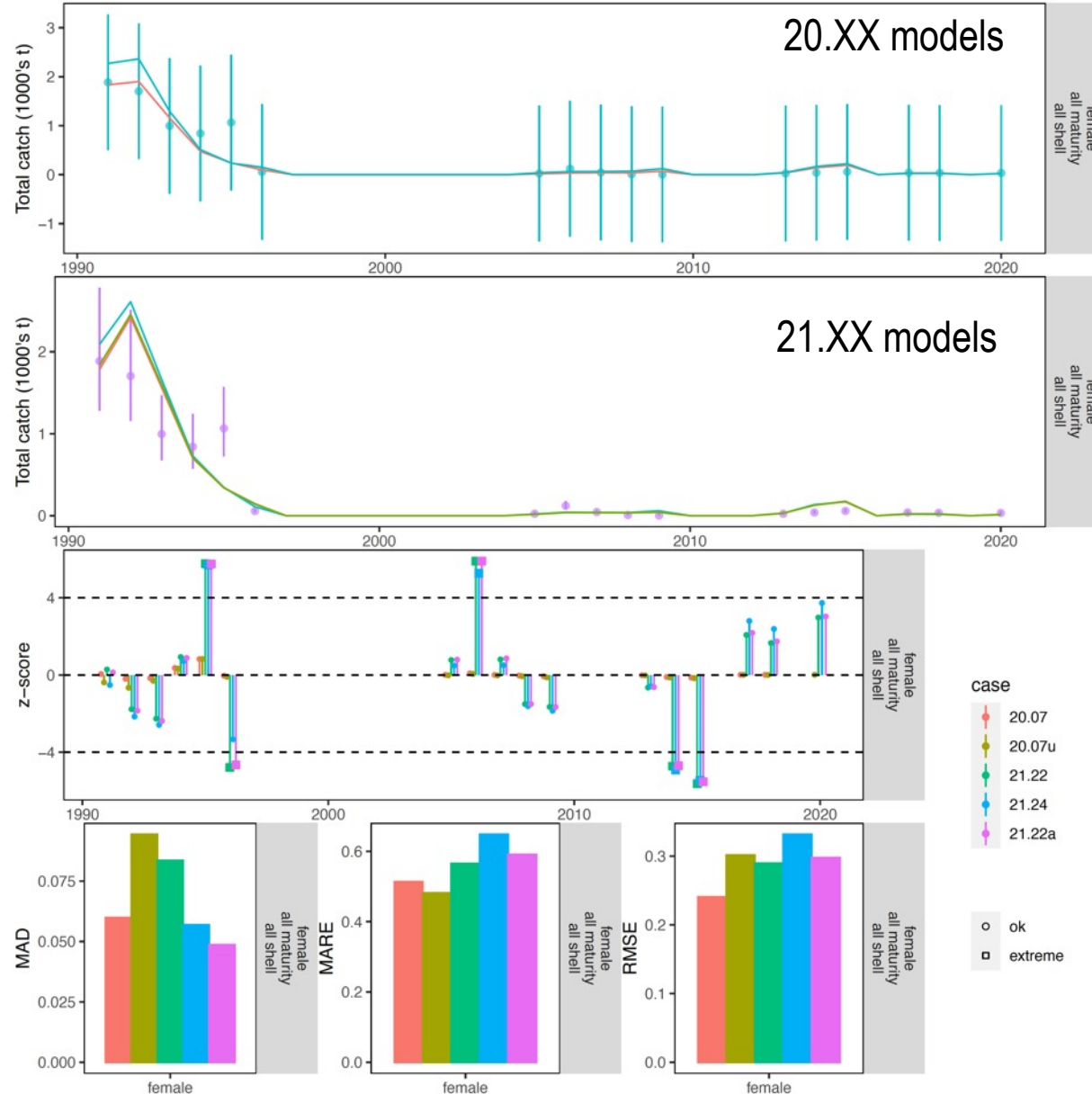
category	fleet	data type	sex	Model Scenarios				
				20.07	20.07u	21.22	21.24	21.22a
surveys data	NMFS	biomass	male	65.33	57.84	65.66	115.06	61.36
		n.at.z		411.35	455.95	385.70	400.42	405.87
		biomass	female	139.92	155.00	162.41	200.27	164.70
		n.at.z		330.88	338.09	293.72	289.69	293.16
	SBS BSFRF	biomass	male	-1.02	-0.90	-1.05	4.40	-1.12
		n.at.z		153.24	152.04	289.49	284.50	290.32
		biomass	female	-6.64	-4.13	-3.62	13.58	-1.92
		n.at.z		146.29	150.17	229.71	227.63	231.46
fisheries data	TCF (RC)	biomass	male	8.13	5.22	-137.72	-135.94	-137.37
		n.at.z	male	55.13	56.43	52.71	47.15	54.91
	TCF (TC)	biomass	female	9.28	0.77	67.49	64.86	66.93
			male	3.69	6.46	8.52	8.36	9.07
		n.at.z	female	13.74	15.25	12.75	12.68	12.67
			male	89.33	92.67	79.82	57.76	76.77
	SCF	biomass	female	1.91	1.92	10.94	10.92	11.01
			male	16.44	16.69	-21.62	-20.71	-21.47
		n.at.z	female	14.57	14.47	17.53	16.79	17.51
			male	119.65	118.19	86.34	85.64	86.14
	RKF	biomass	female	0.06	0.06	17.31	17.88	17.23
			male	25.79	25.18	-40.25	-39.78	-40.18
n.at.z		female	2.91	2.96	2.23	2.25	2.24	
		male	70.64	70.35	33.45	35.86	33.86	
GF All	abundance	all sexes	3.45	3.39	-36.00	-36.26	-36.18	
	biomass	all sexes	32.03	34.07	-67.43	-66.86	-67.54	
	n.at.z	female	262.14	260.23	226.18	236.93	222.84	
		male	276.68	294.87	284.14	328.70	287.35	
growth data	--	molt	female	252.78	243.36	252.01	225.63	246.95
	--	increment	male	296.49	281.47	287.80	234.09	282.48
maturity ogive data	--	male maturity ogives	male	107.27	221.22	209.82	297.17	206.49



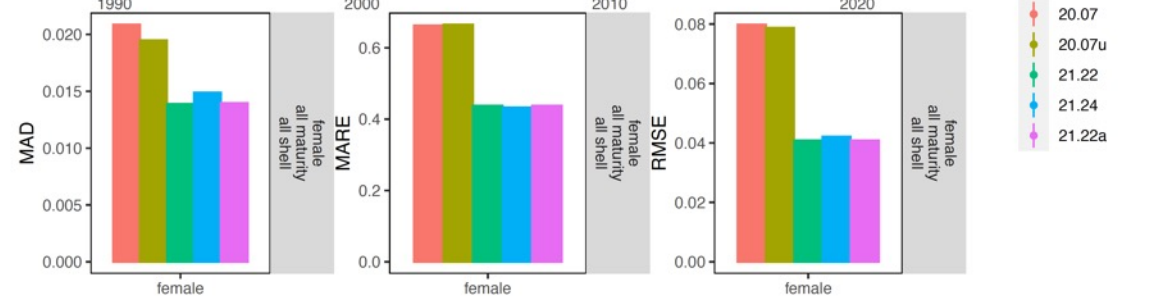
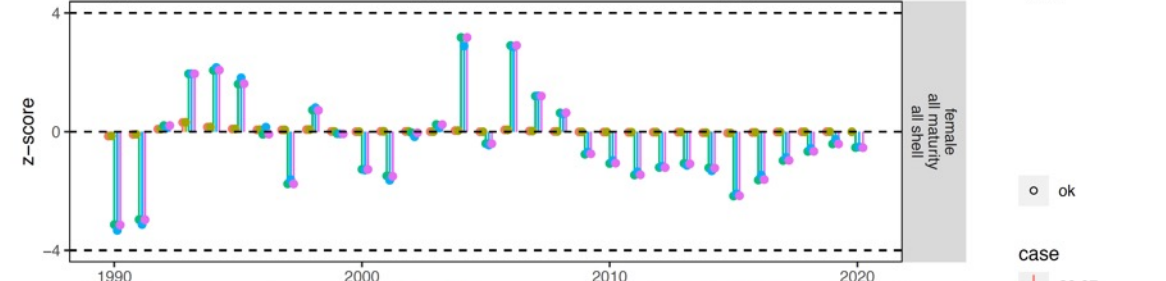
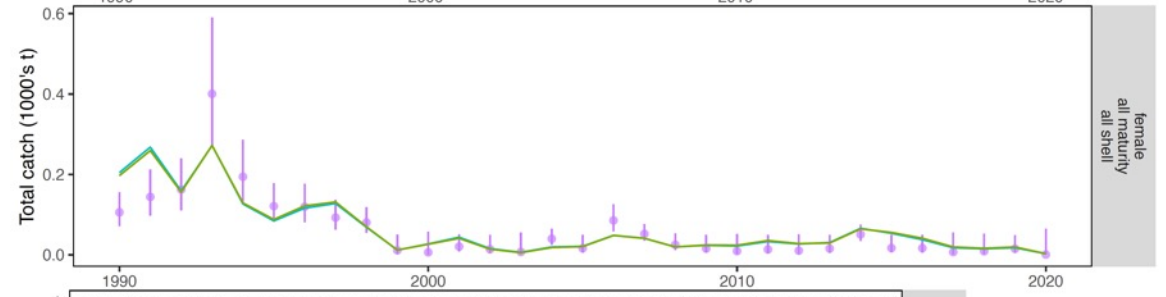
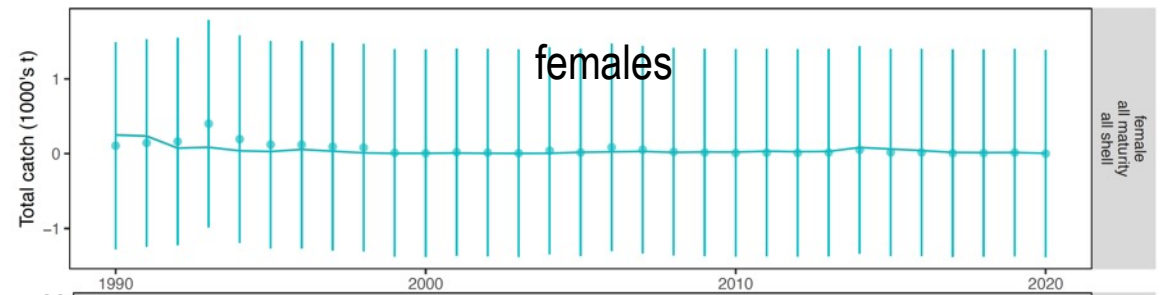
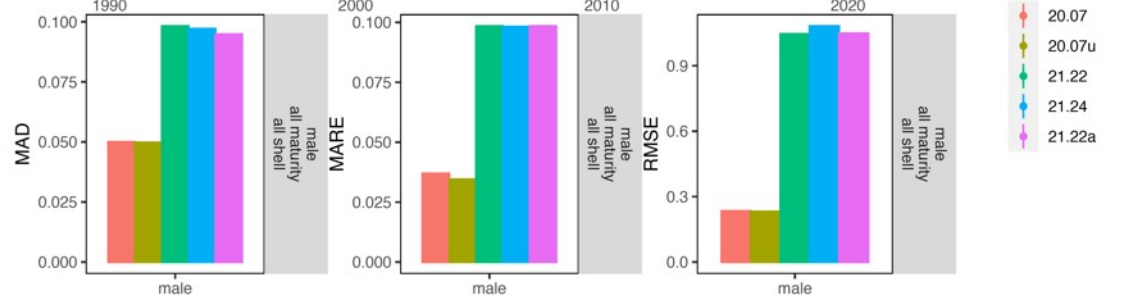
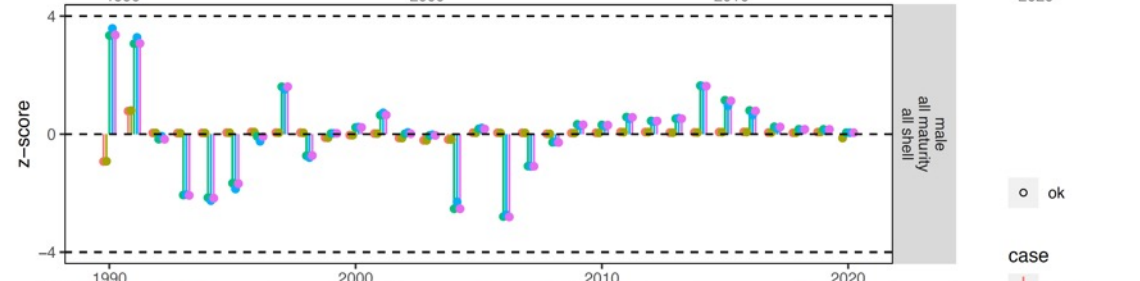
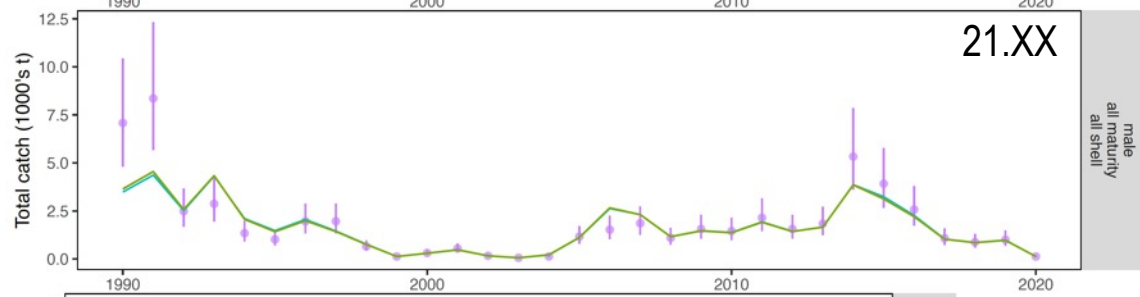
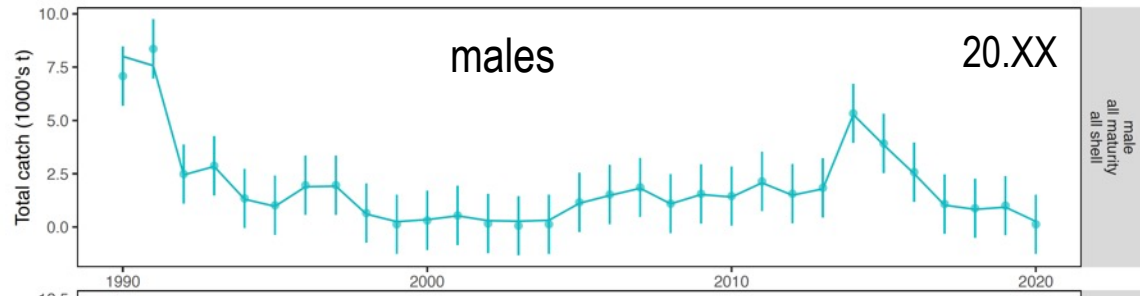
# Fits to Data: Males in Directed Fishery



# Fits to Data: Females in Directed Fishery

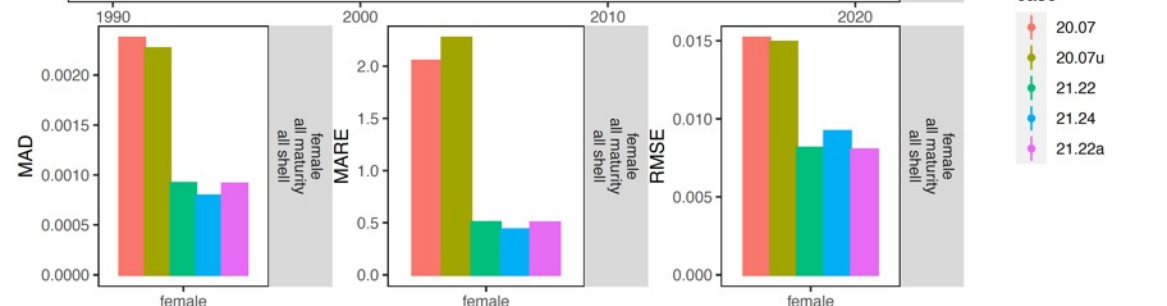
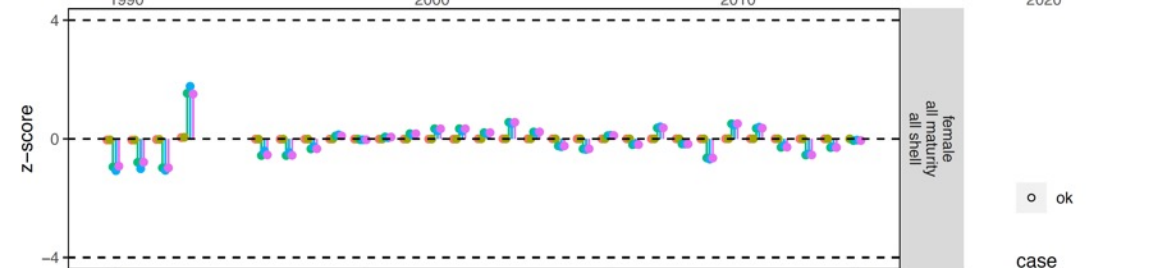
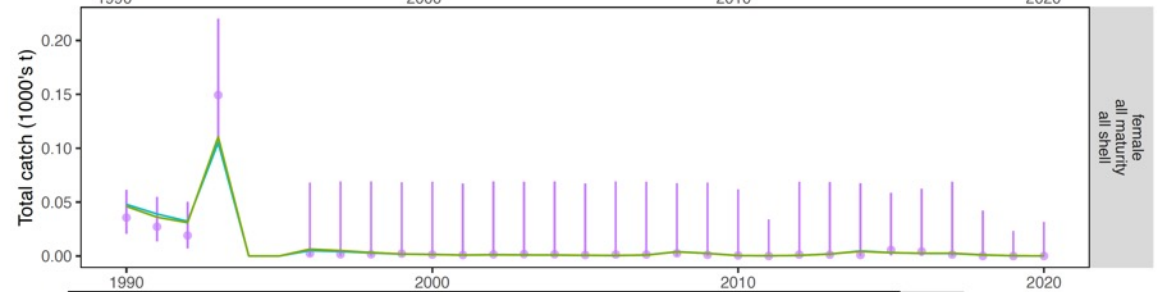
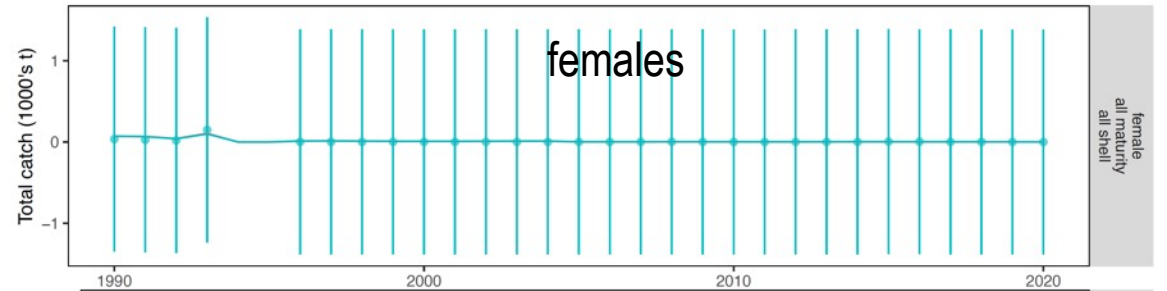
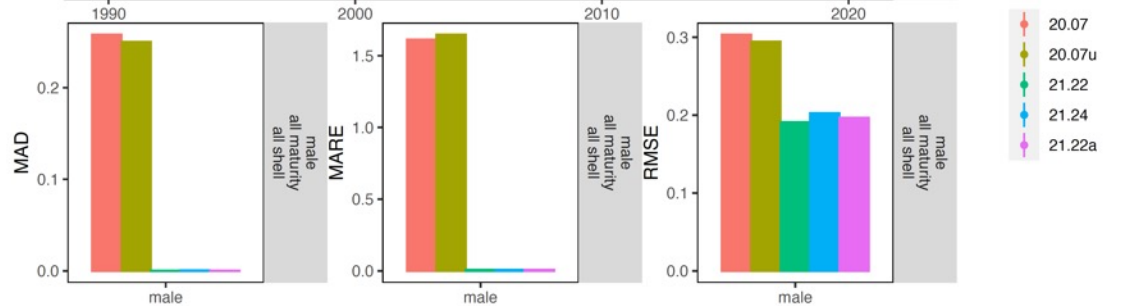
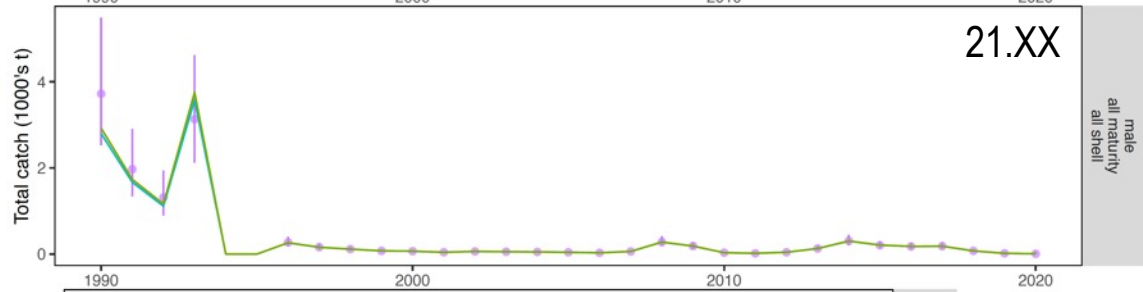
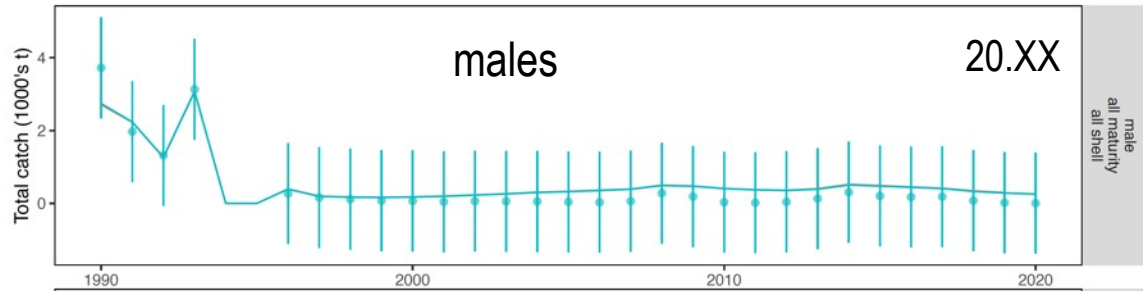


# Fits to Data: Bycatch in Snow Crab Fishery

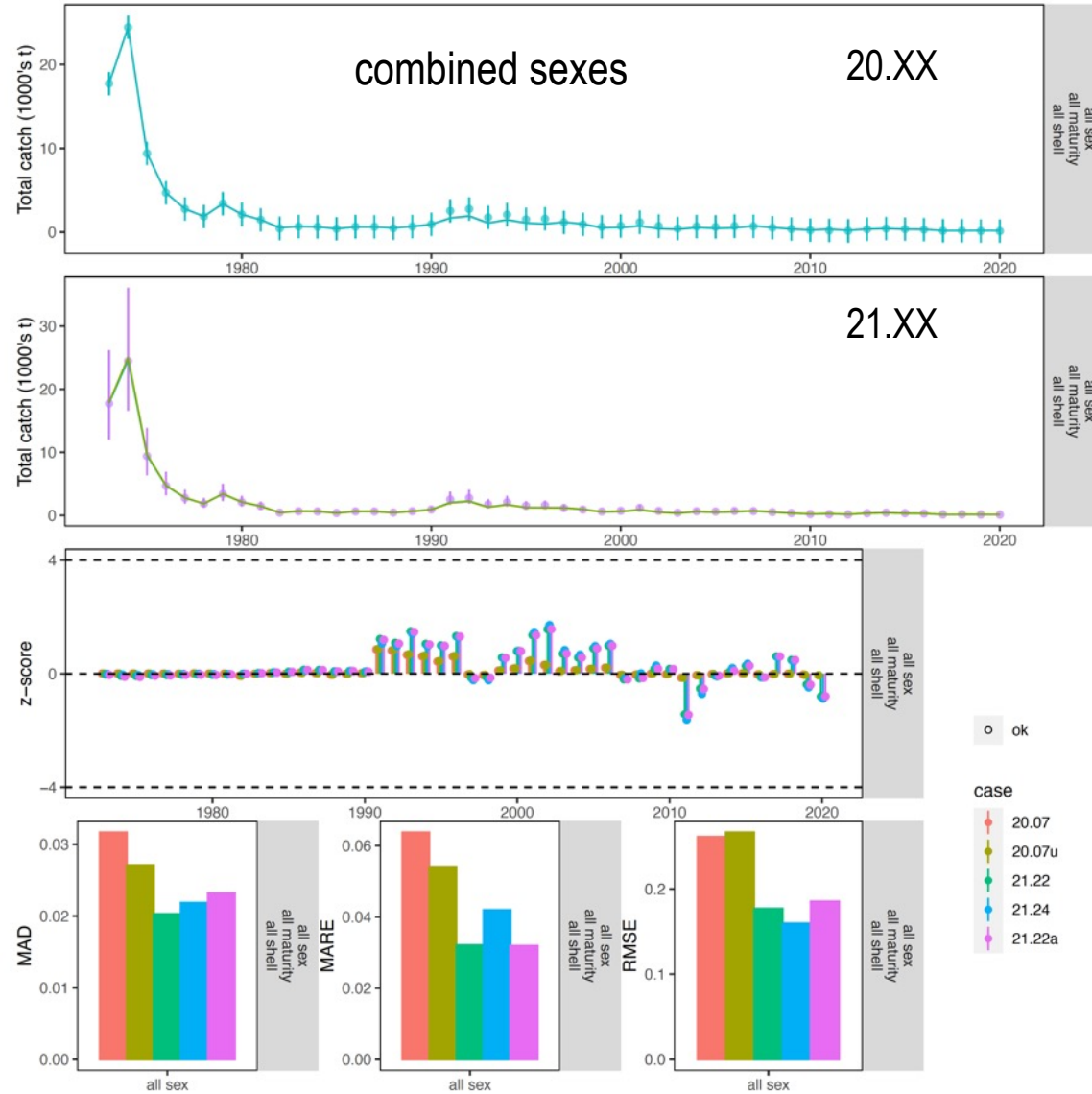




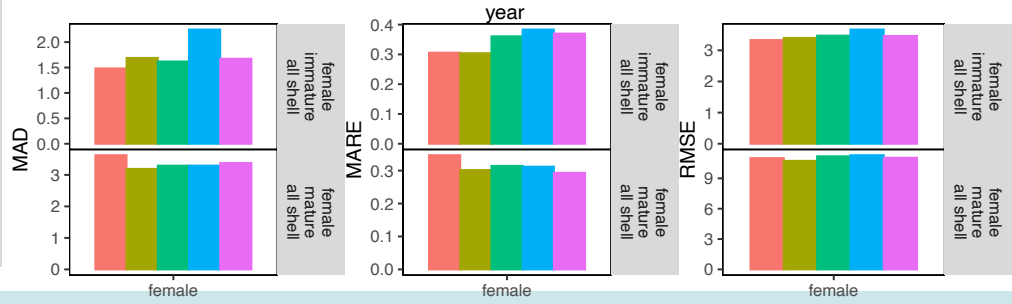
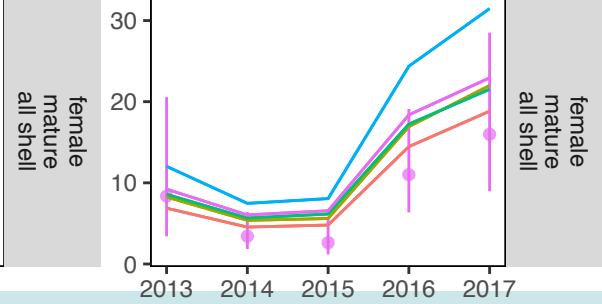
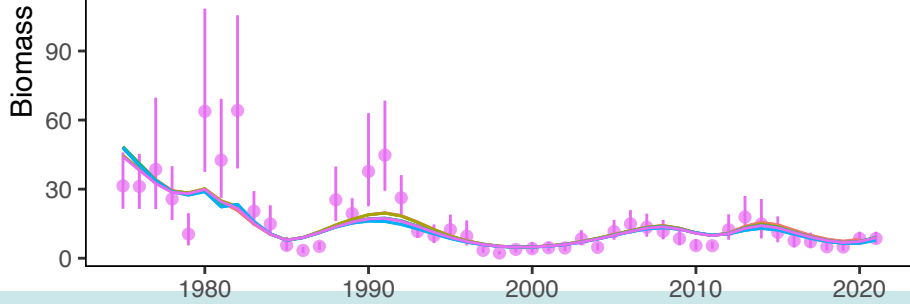
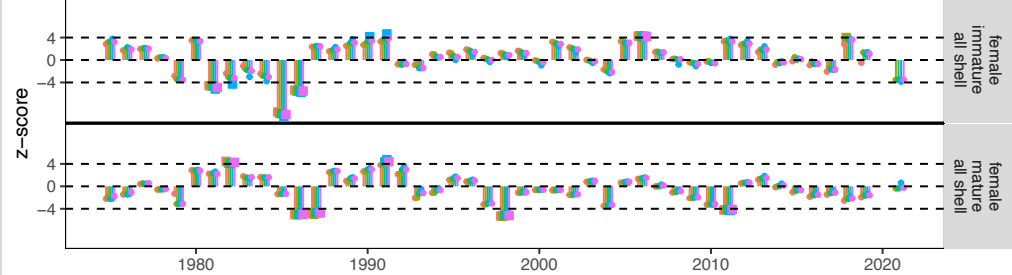
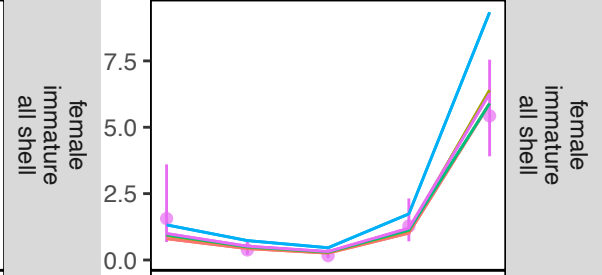
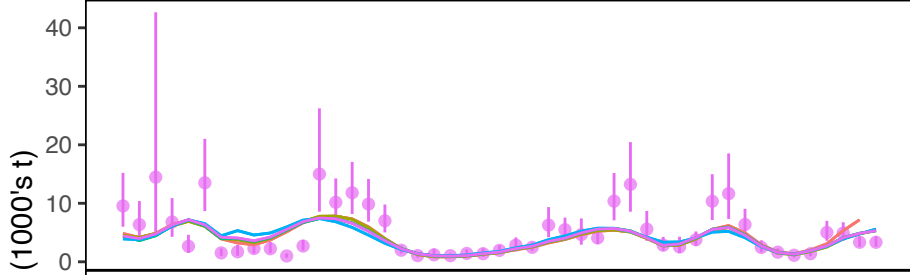
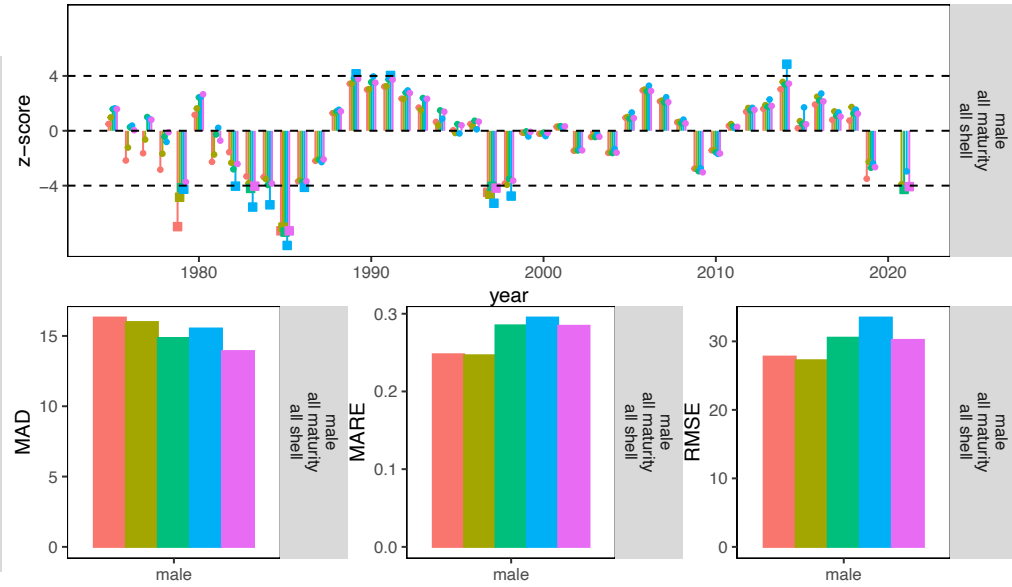
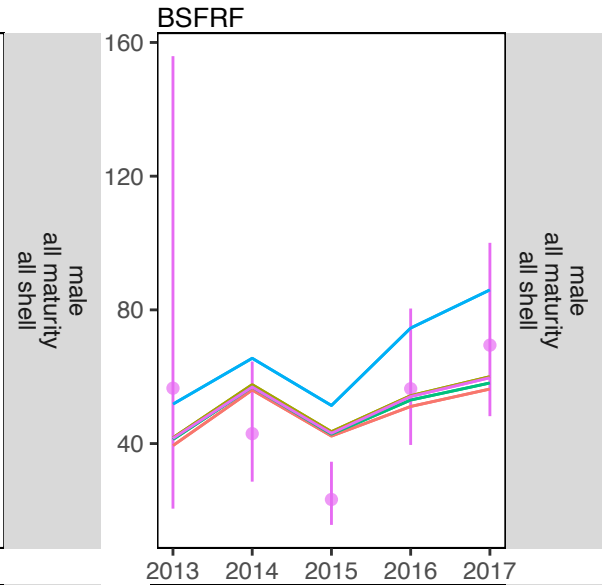
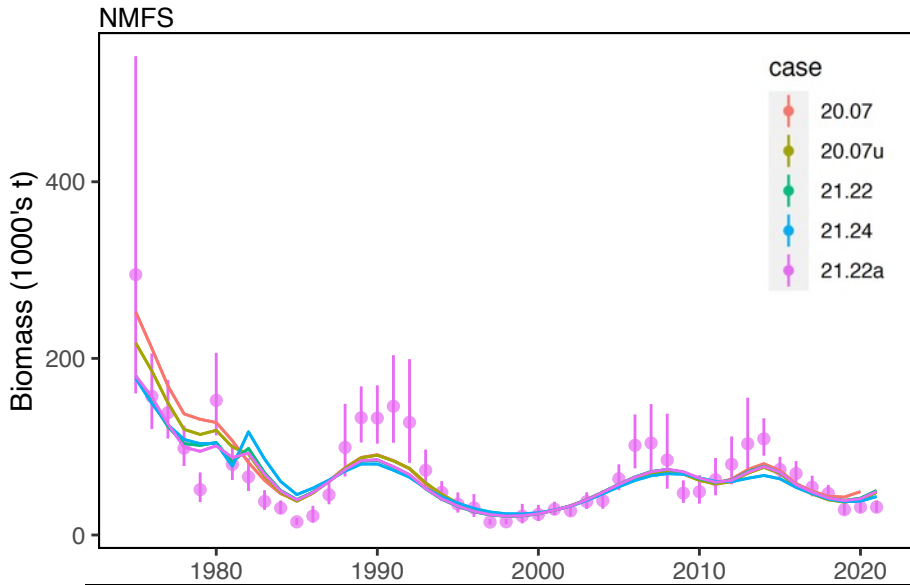
# Fits to Data: Bycatch in BBRKC Fishery



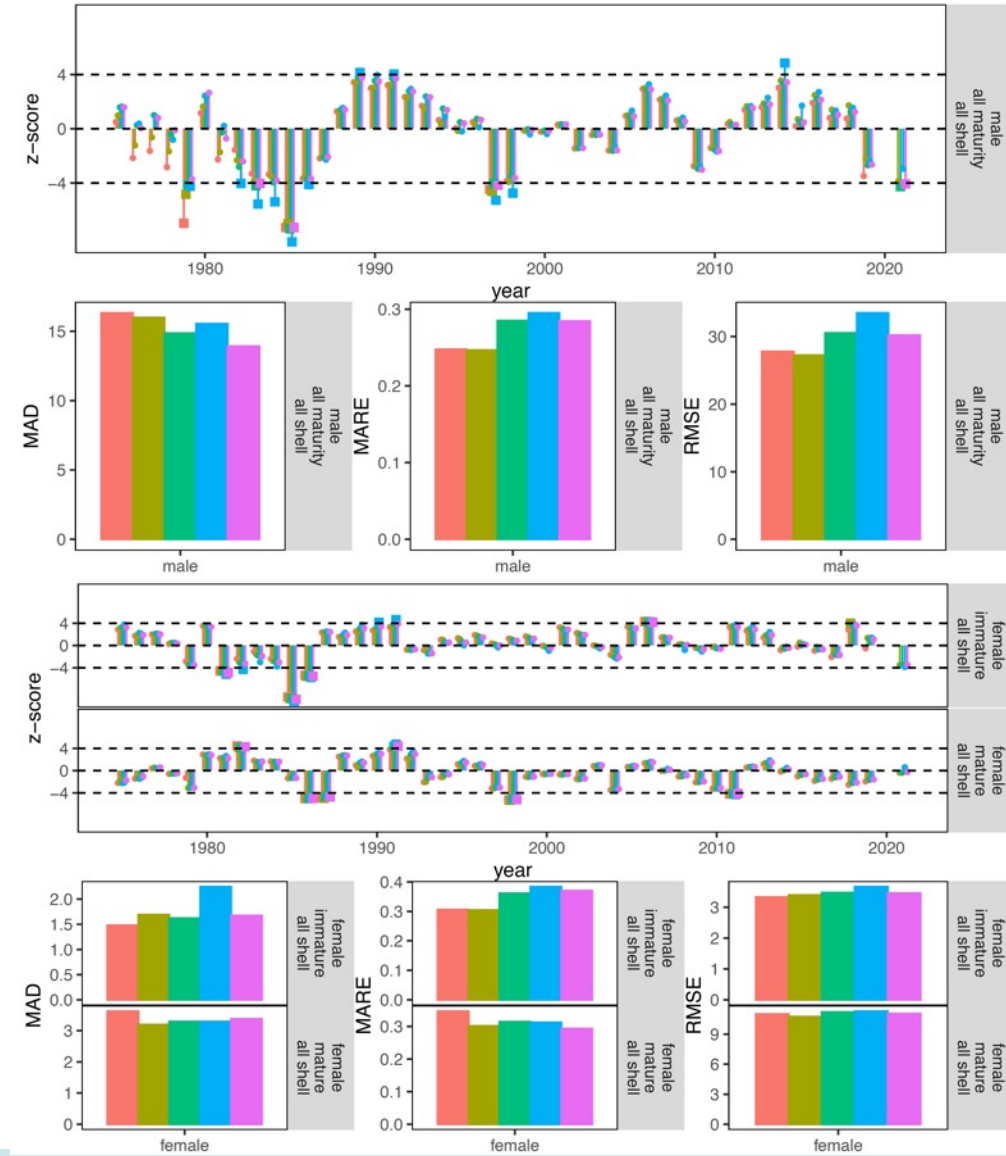
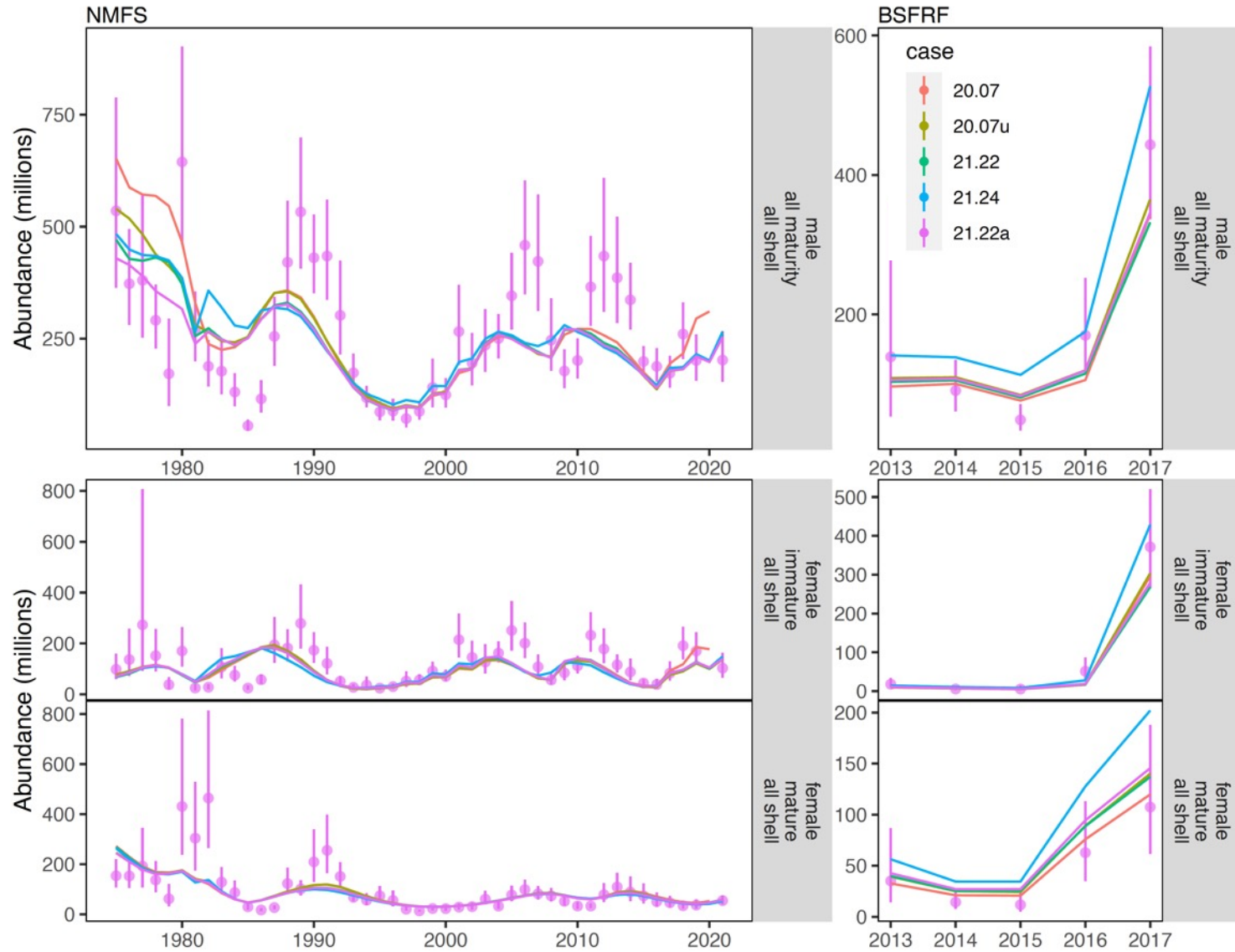
# Fits to Data: Bycatch in Groundfish Fisheries



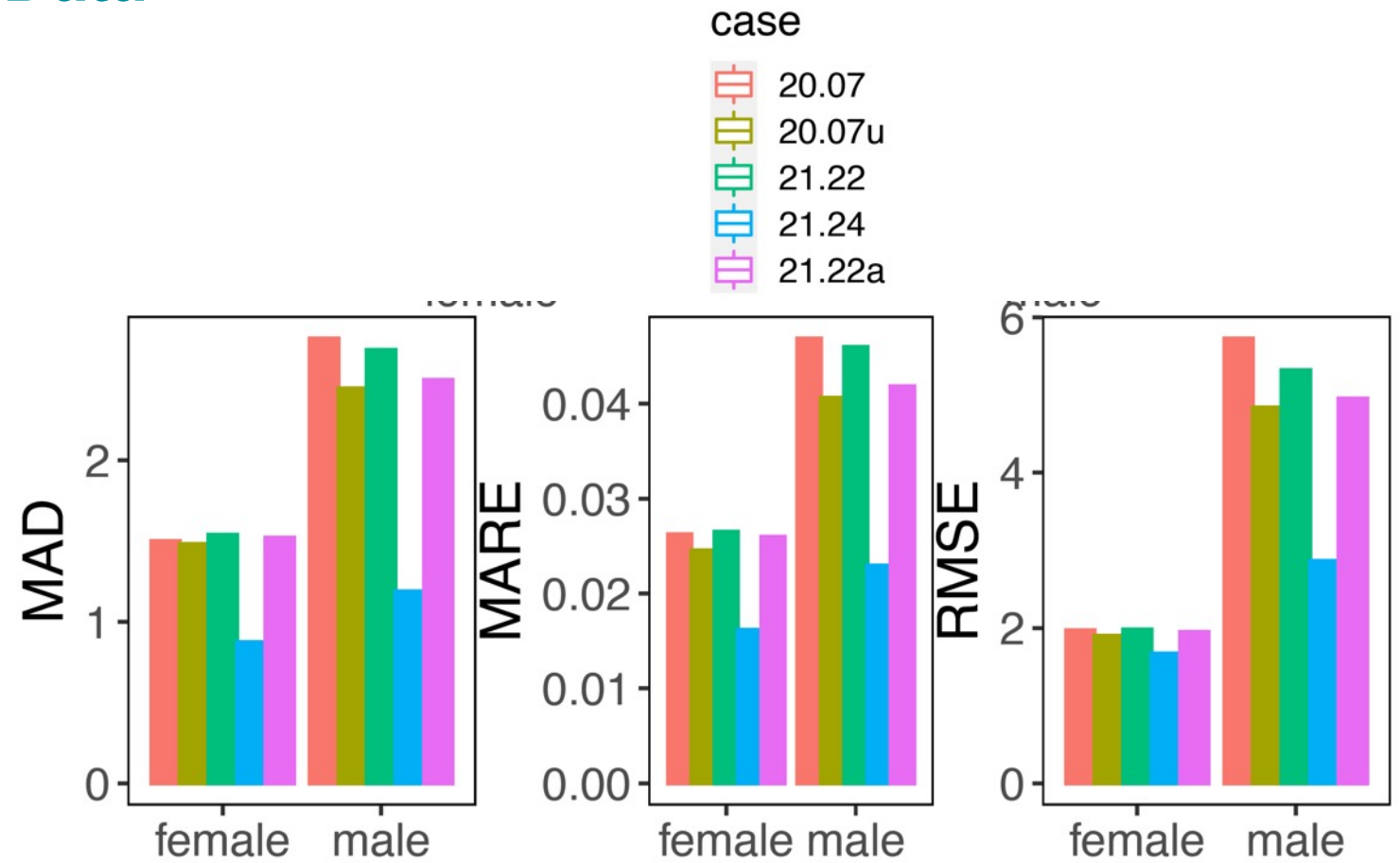
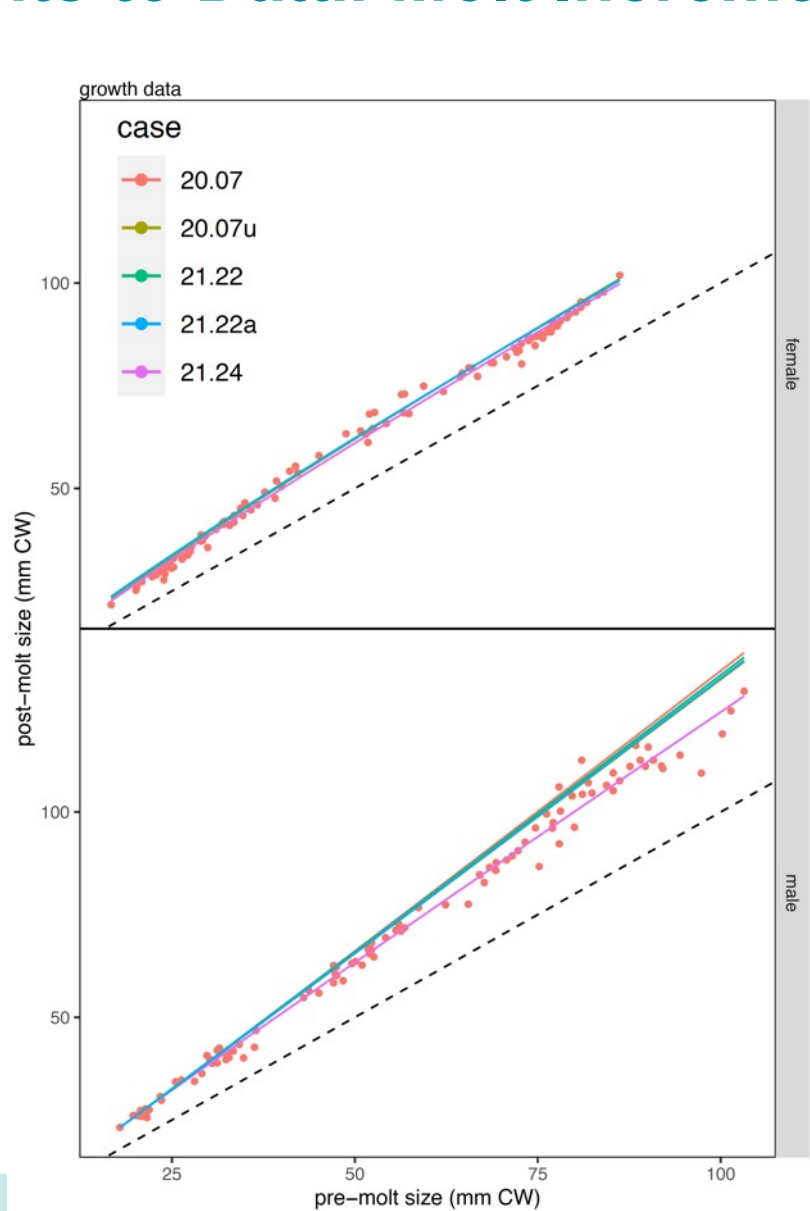
# Fits to Data: NMFS Survey Biomass



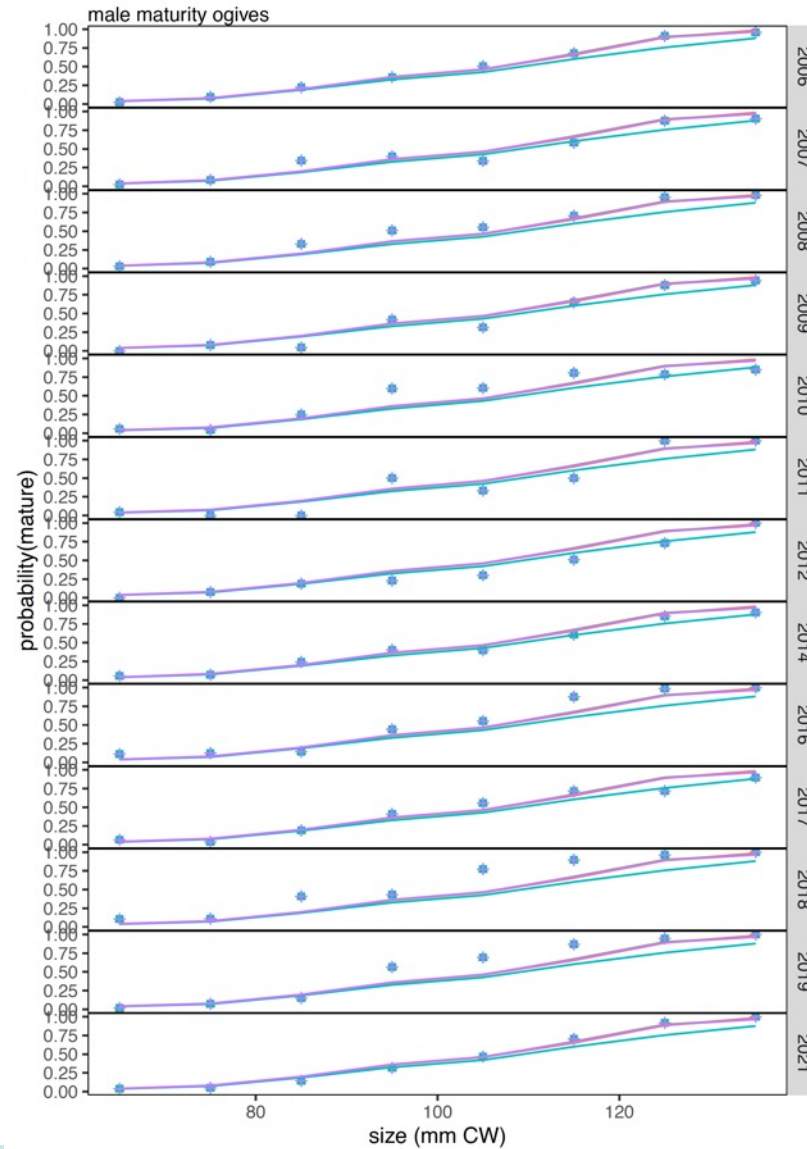
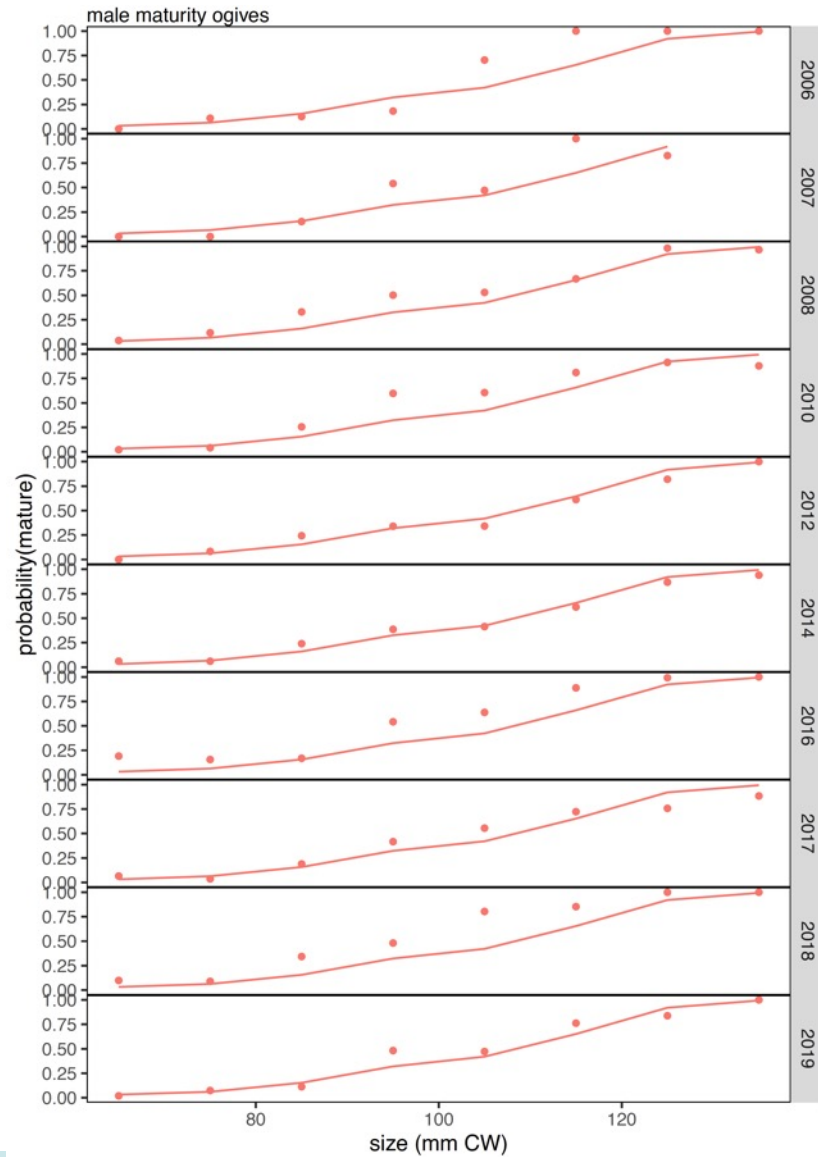
# Diagnostic fits to NMFS Survey Abundance



# Fits to Data: Molt Increment Data



# Fits to Data: Male Maturity Ogive Data



## Likelihoods

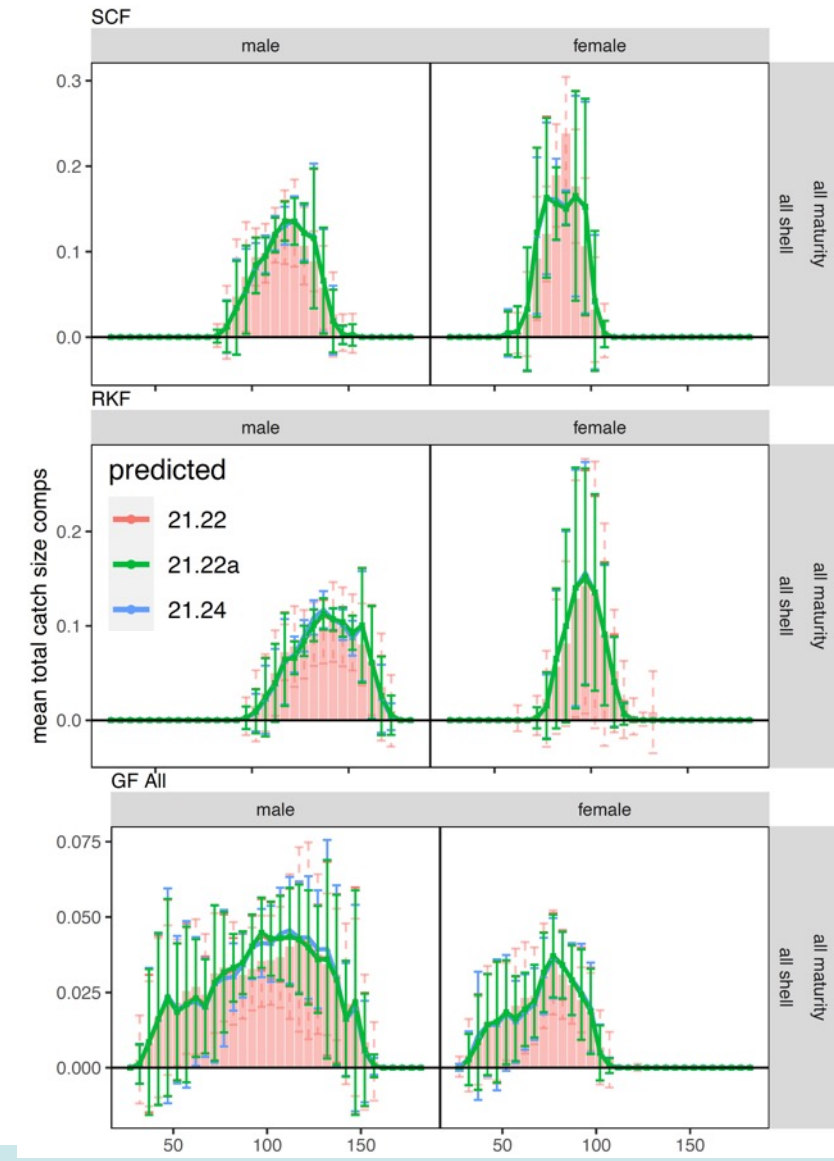
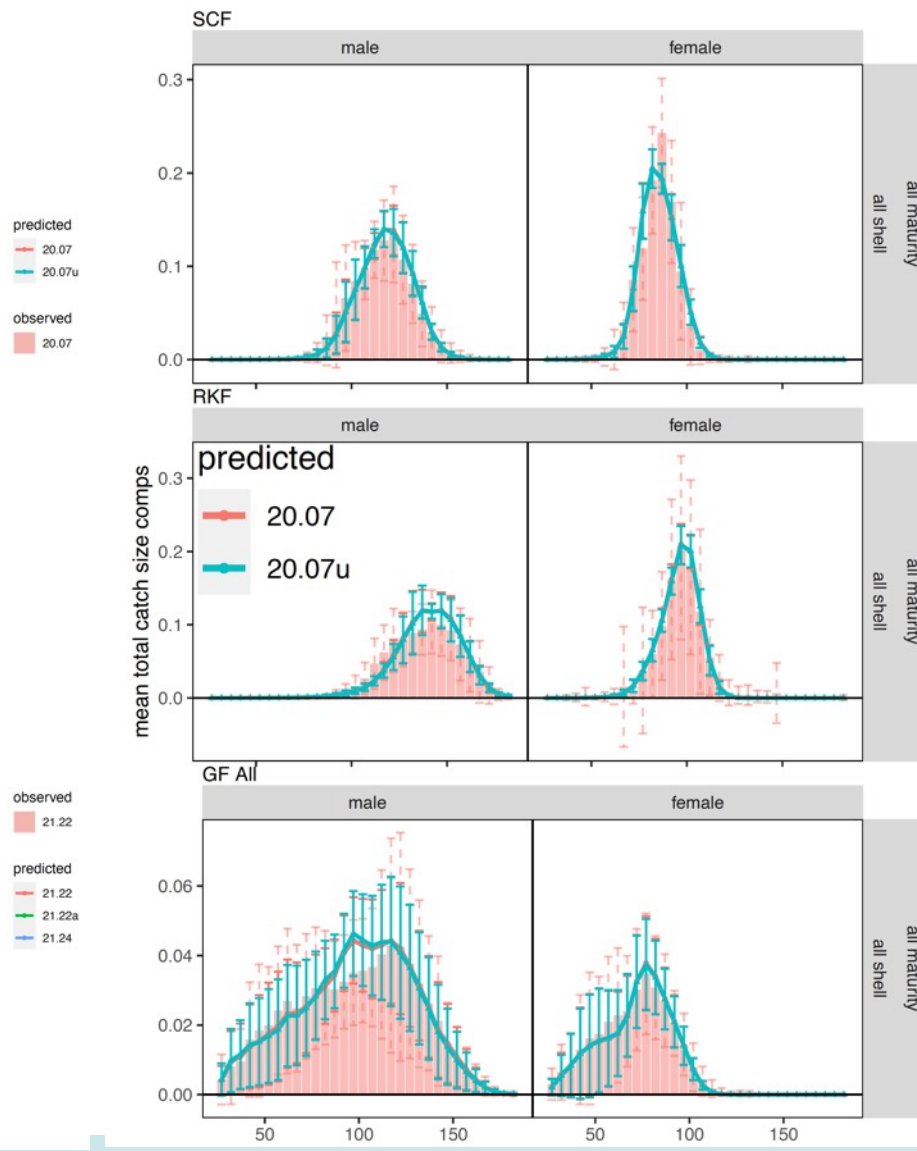
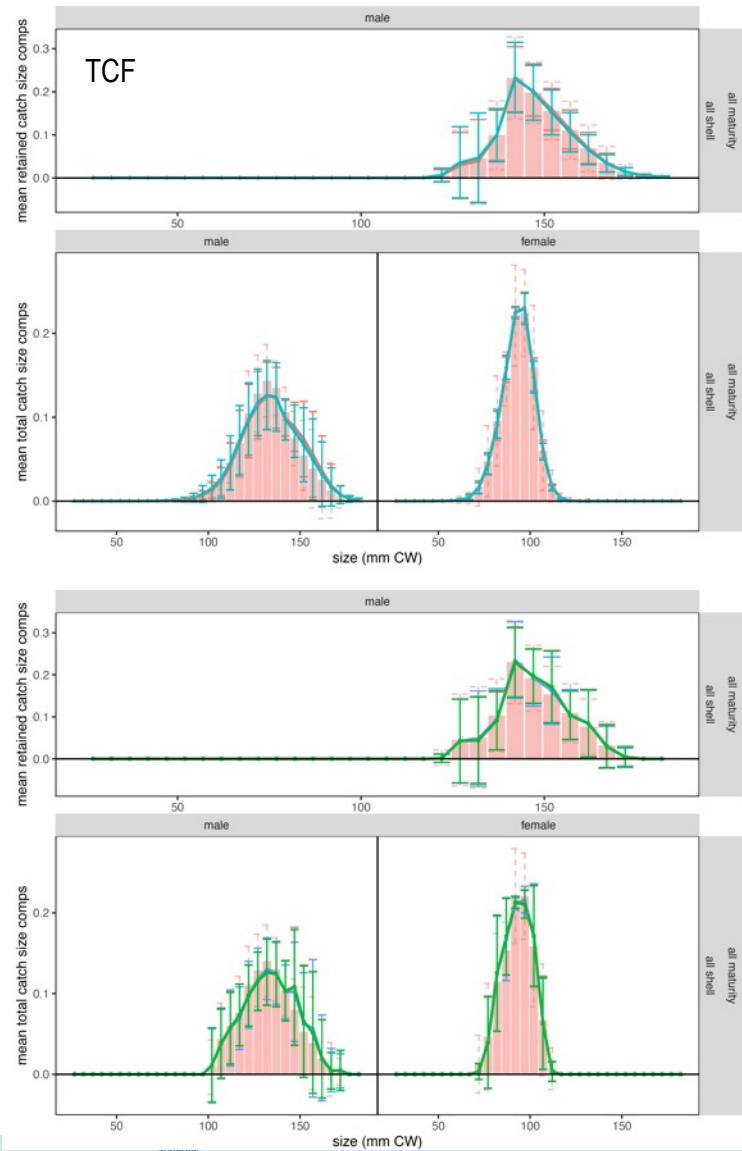
- 20.07: 107.27
- 20.07u: 221.22
- 21.22: 209.82
- 21.24: 297.17
- 21.22a: 206.49

case

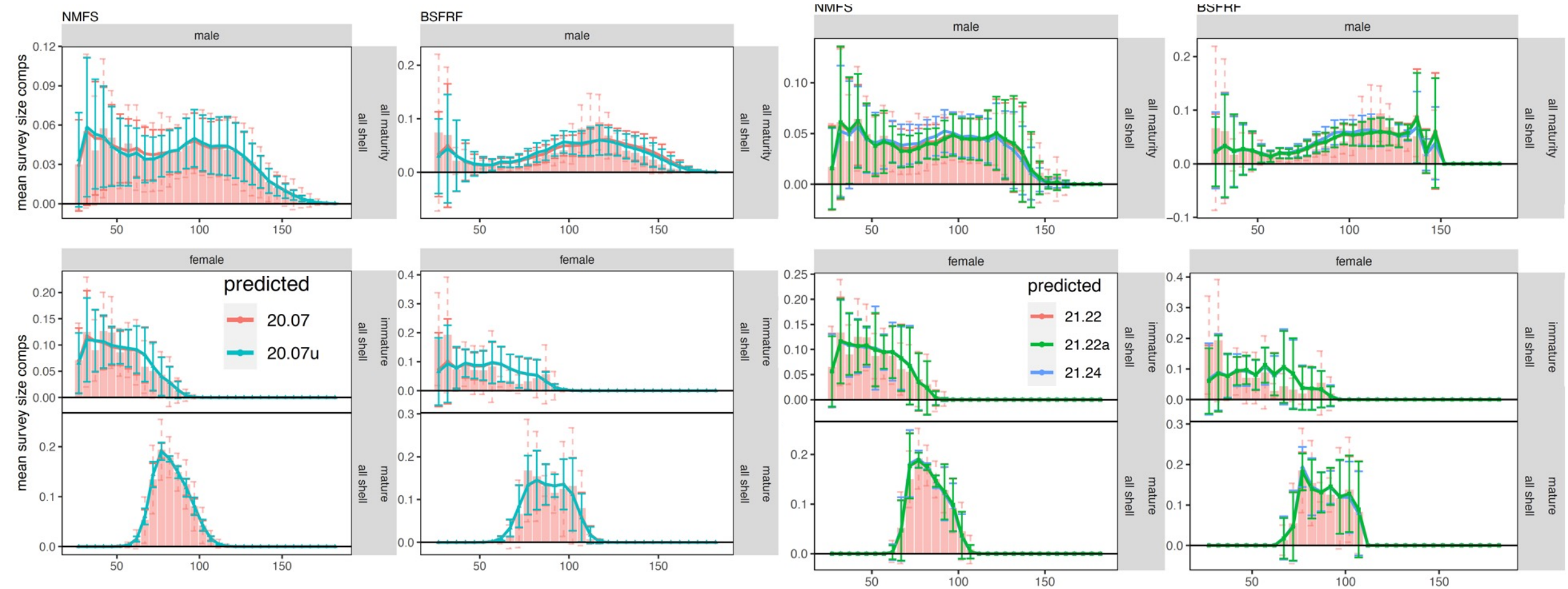
- 20.07u
- 21.22
- 21.24
- 21.22a



# Fits to Data: Mean Fishery Catch Size Comps



# Fits to Data: Mean Survey Size Comps

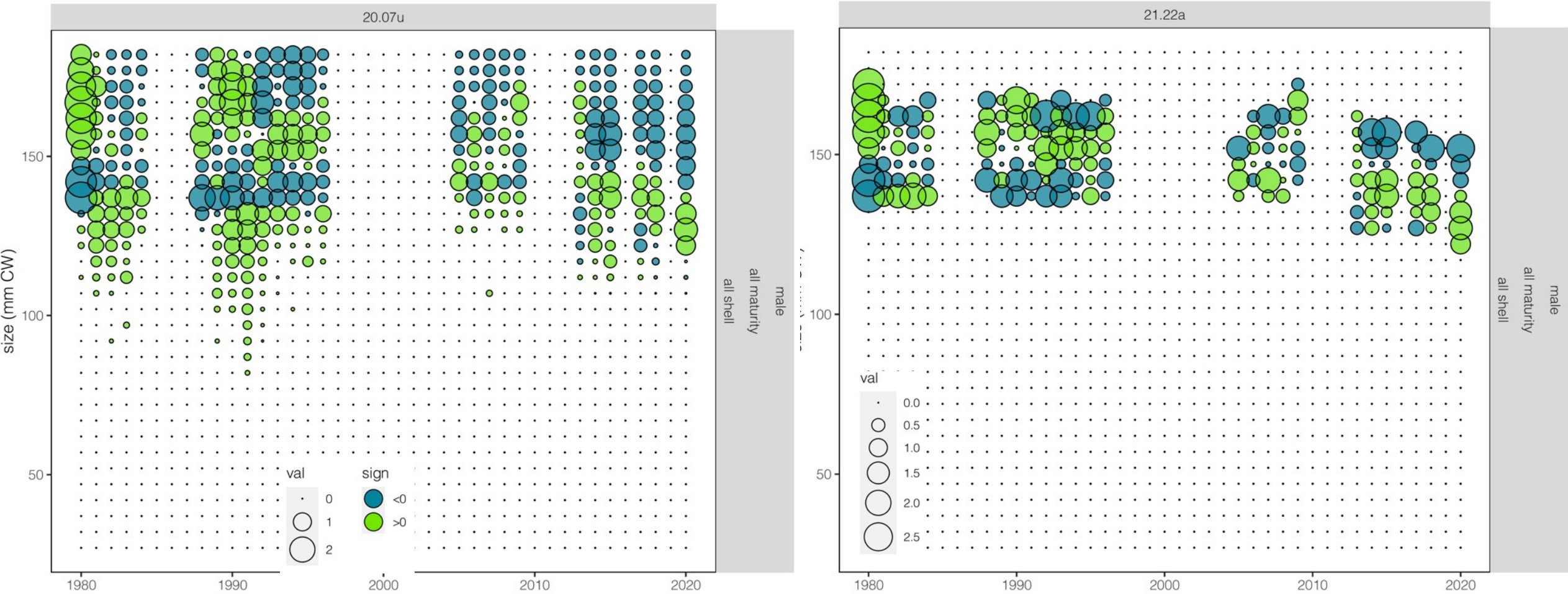




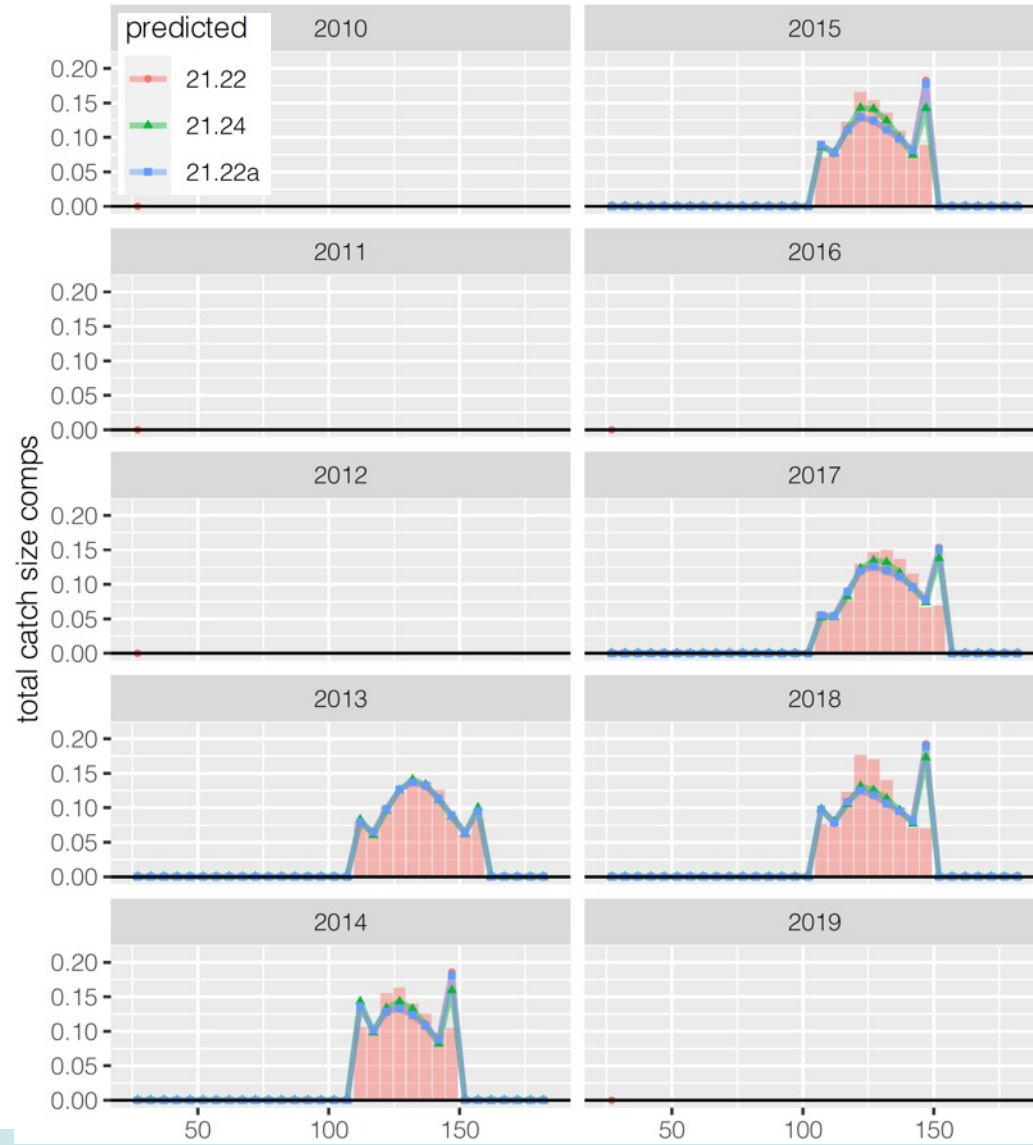
# Fits to Data: Retained catch



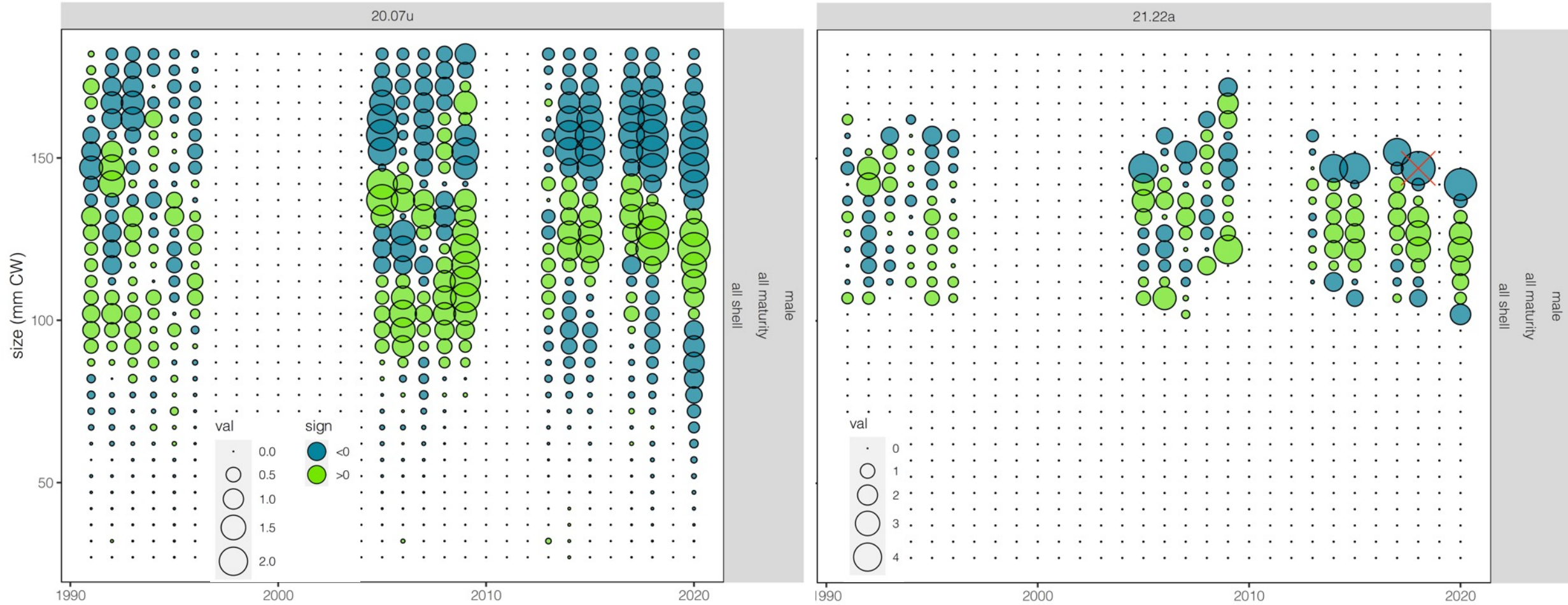
# Fits to Data: Retained catch size comps



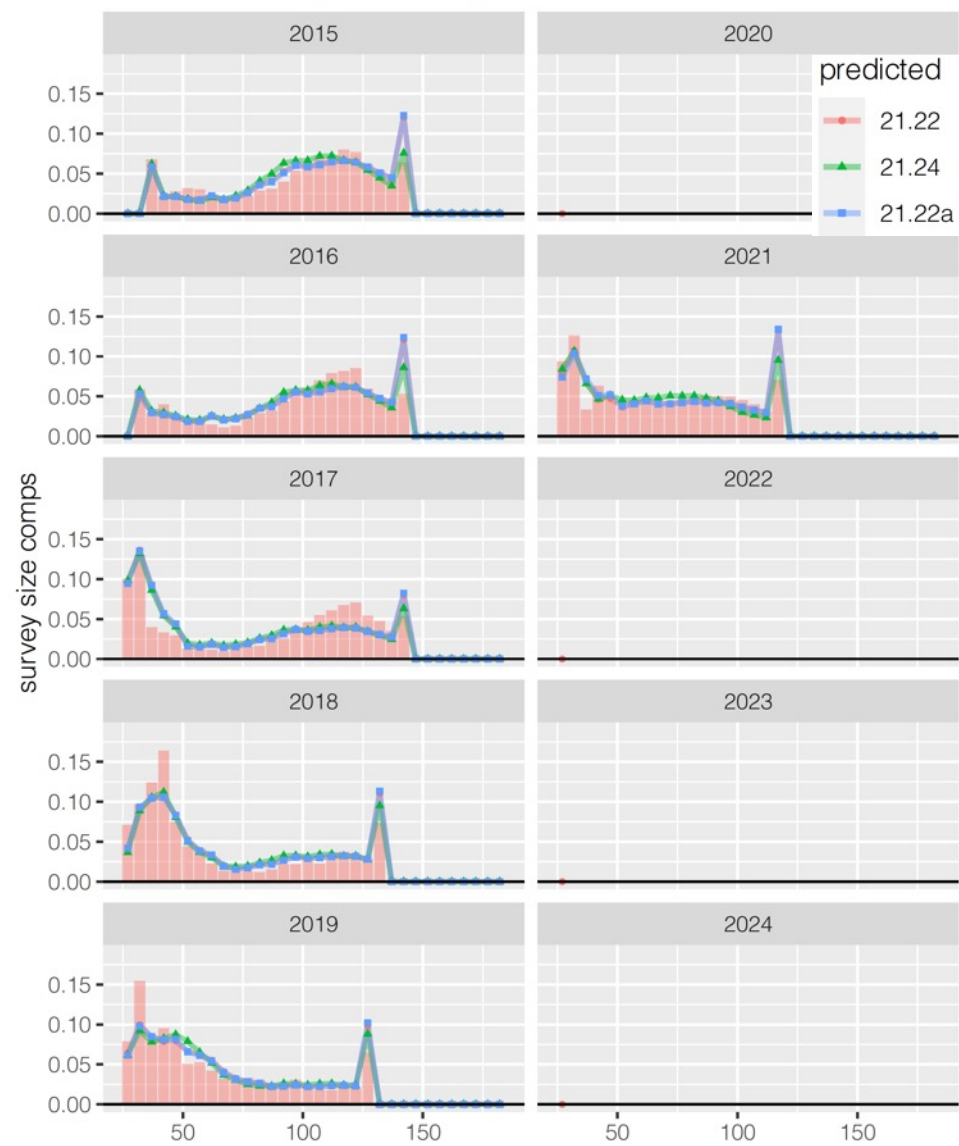
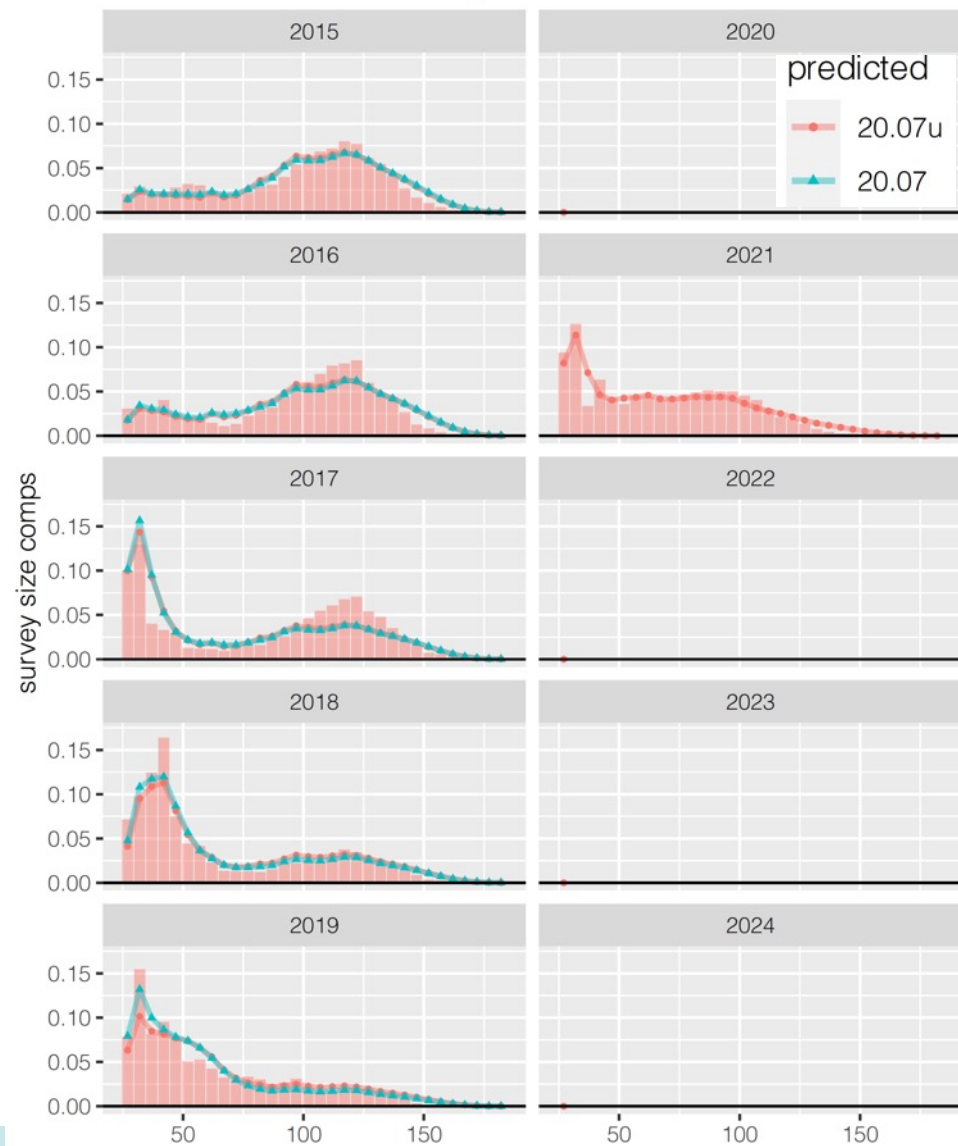
# Fits to Data: Total catch in Directed Fishery



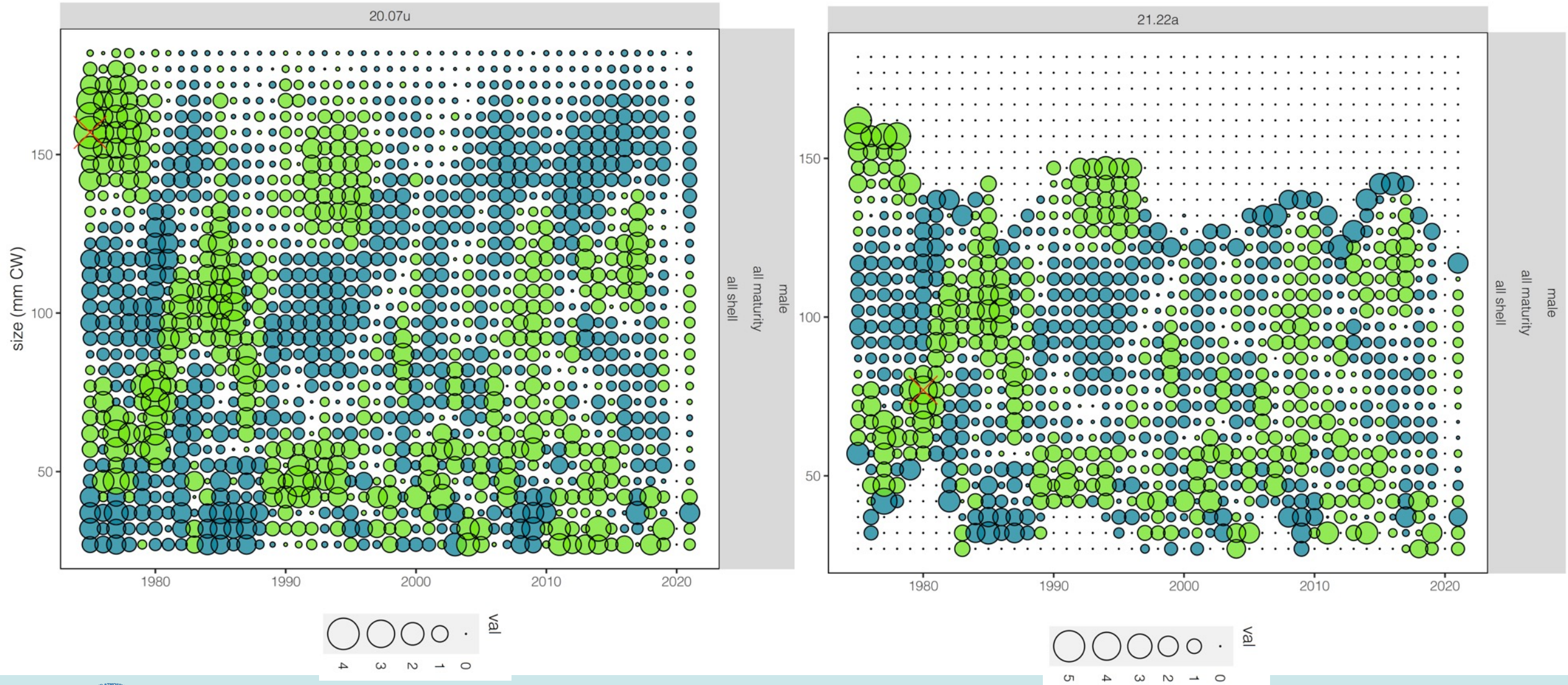
# Fits to Data: Total catch in Directed Fishery



# Fits to Data: NMFS Survey Male Size Comps



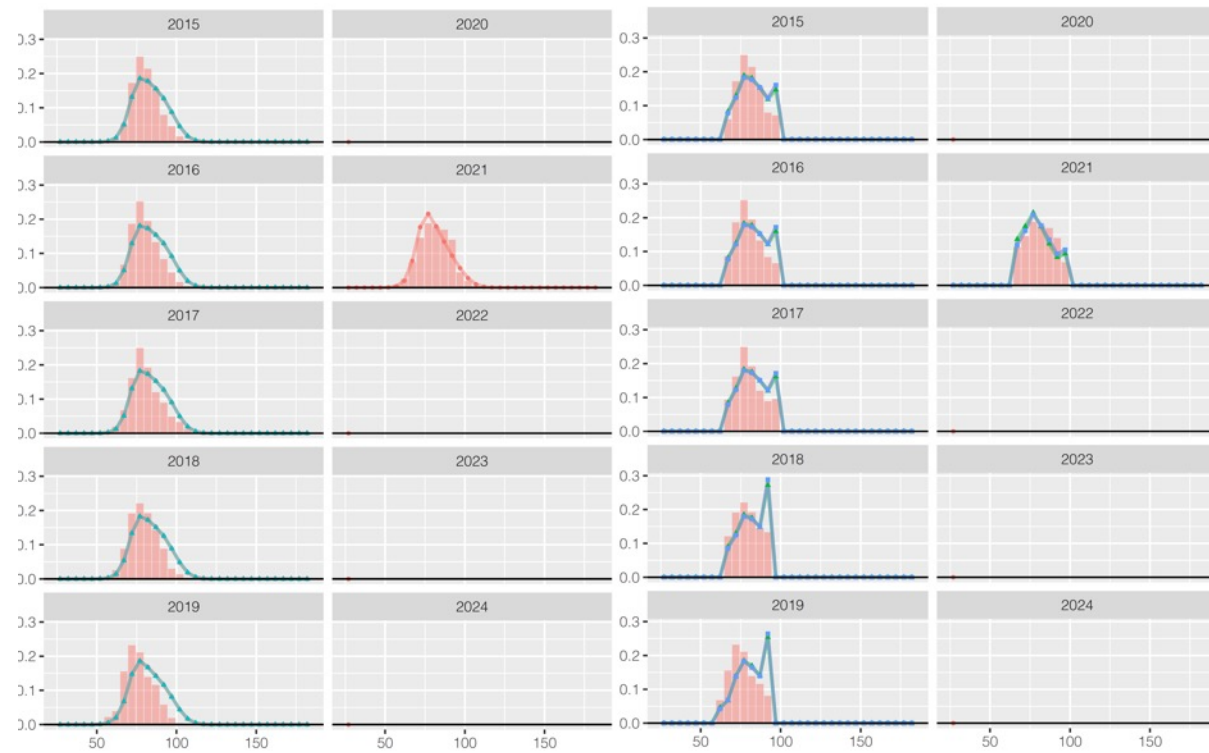
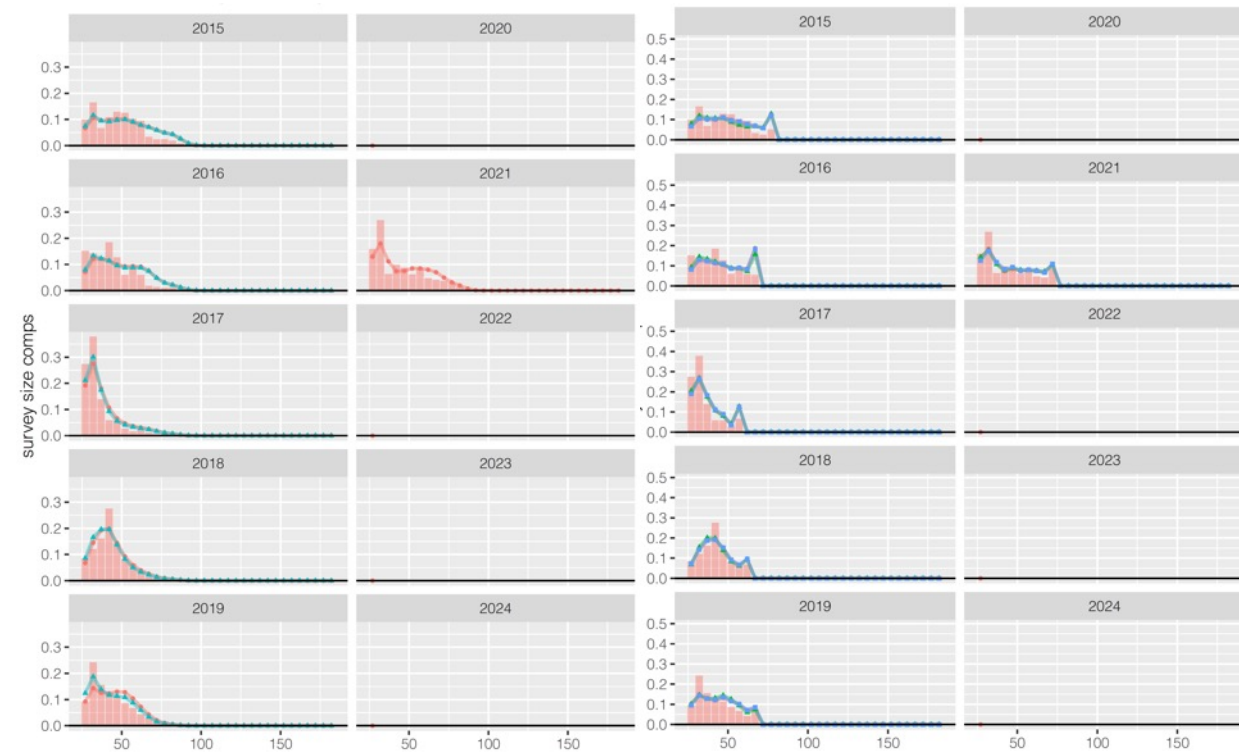
# Fits to Data: NMFS Survey Male Size Comps



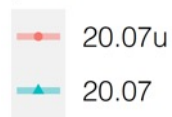
# Fits to Data: NMFS Survey Female Size Comps

immature females

mature females



predicted



predicted



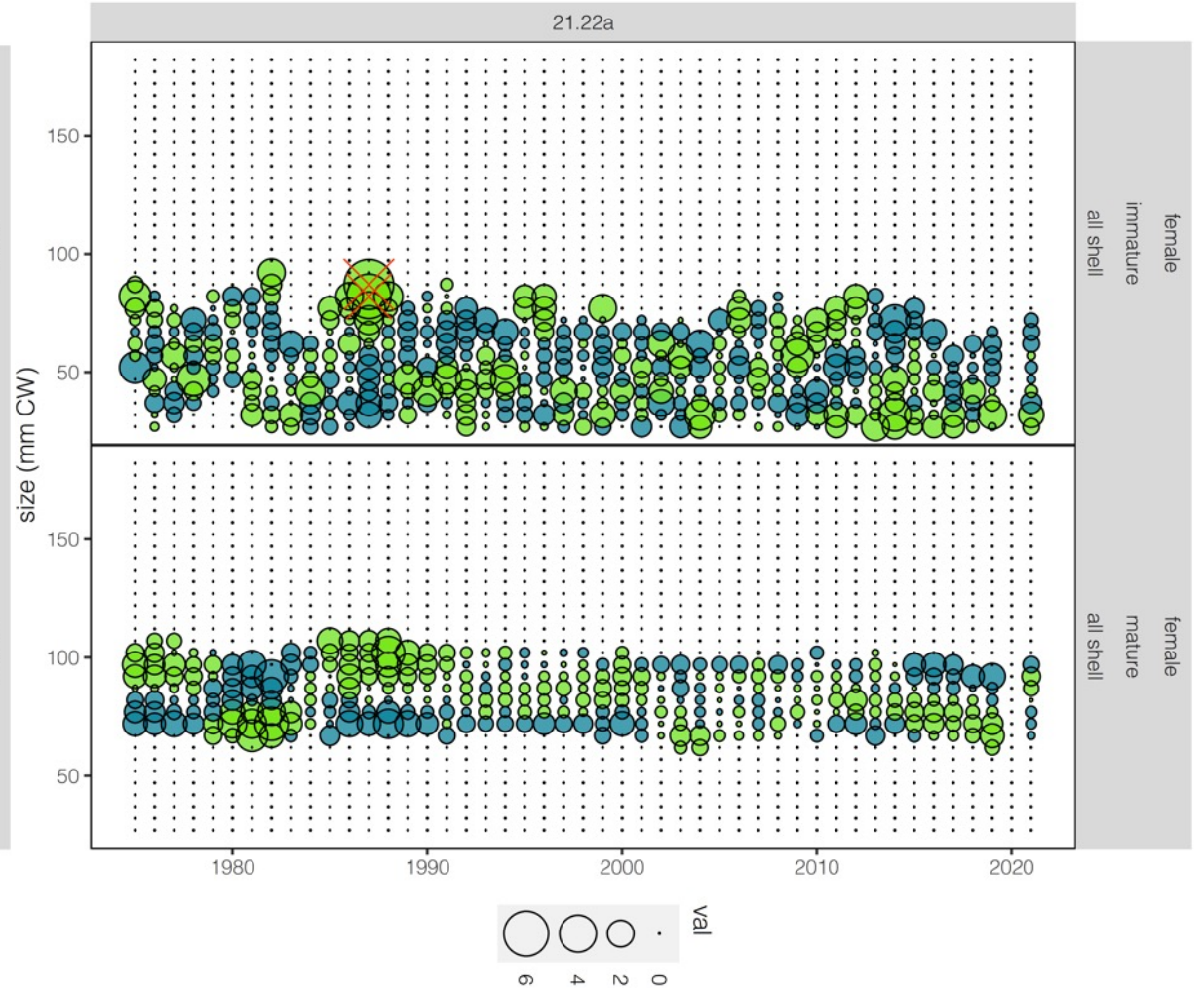
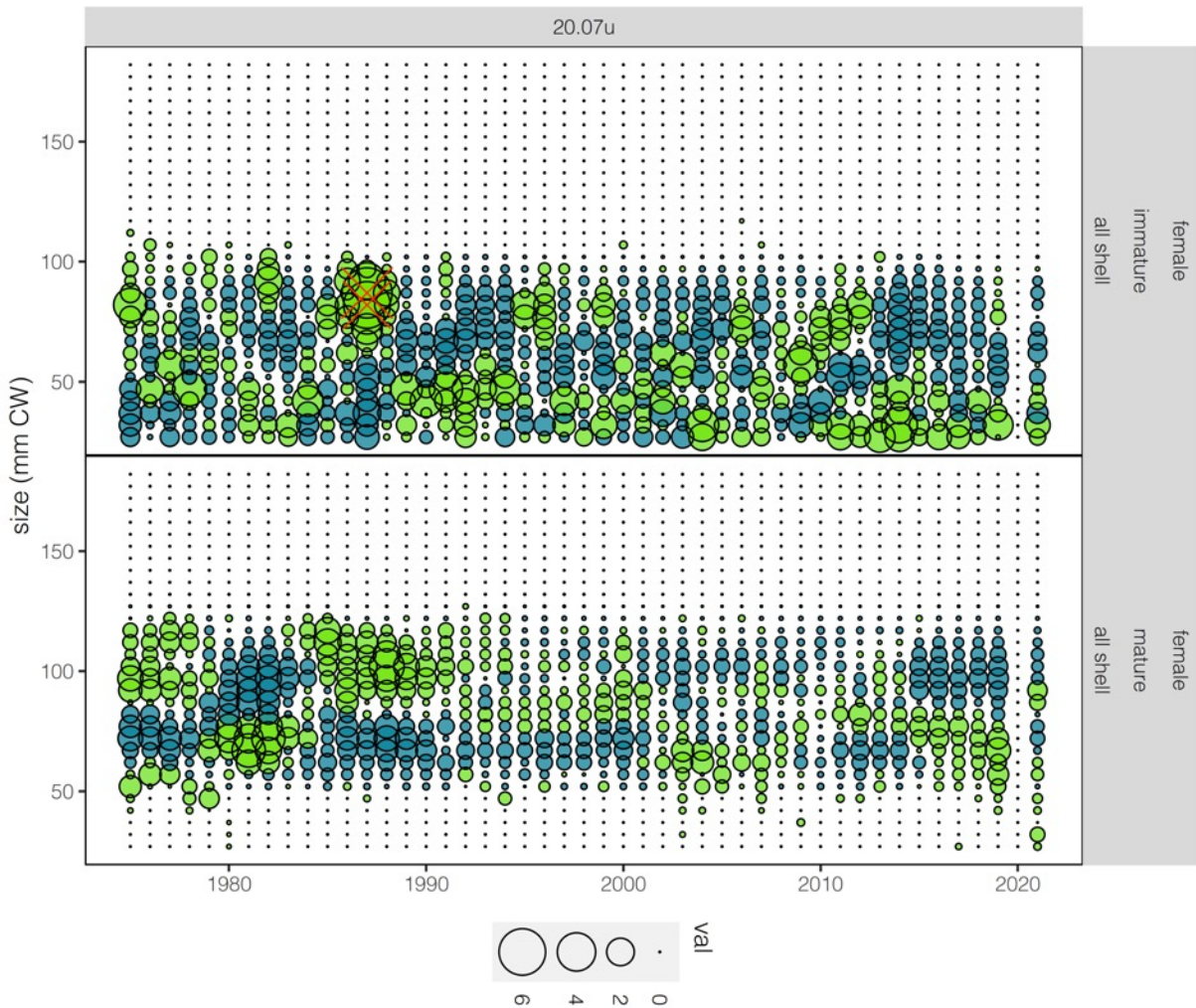
predicted



predicted

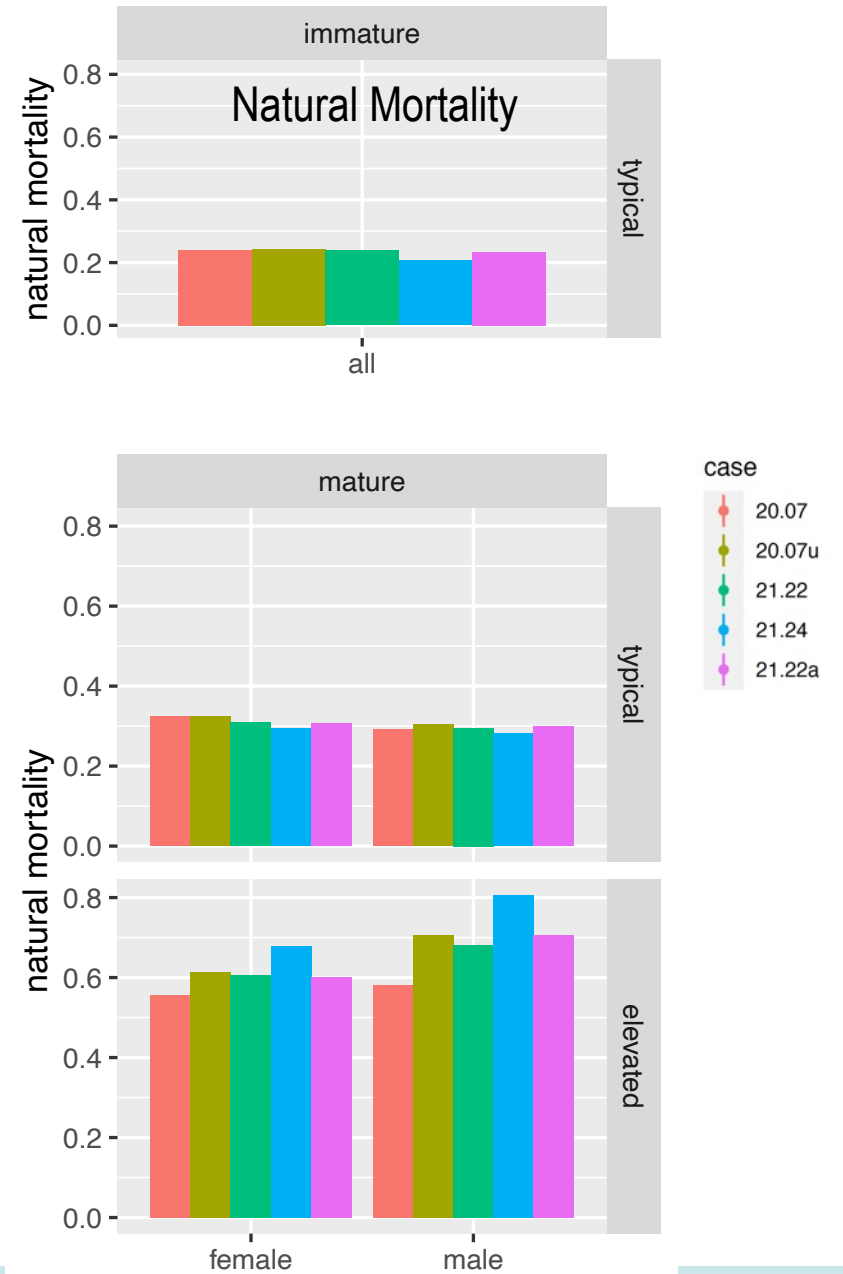
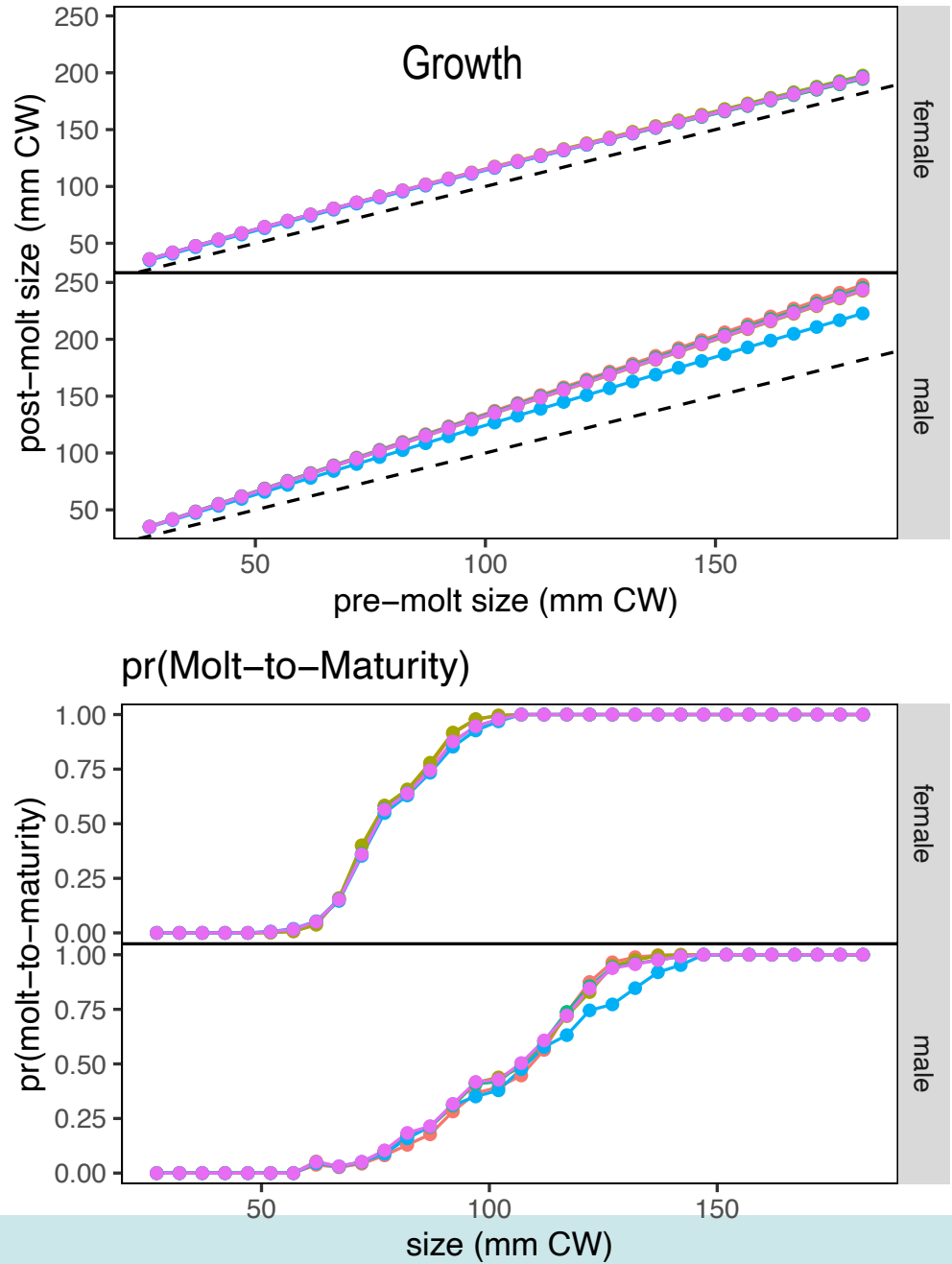


# Fits to Data: NMFS Survey Female Size Comps

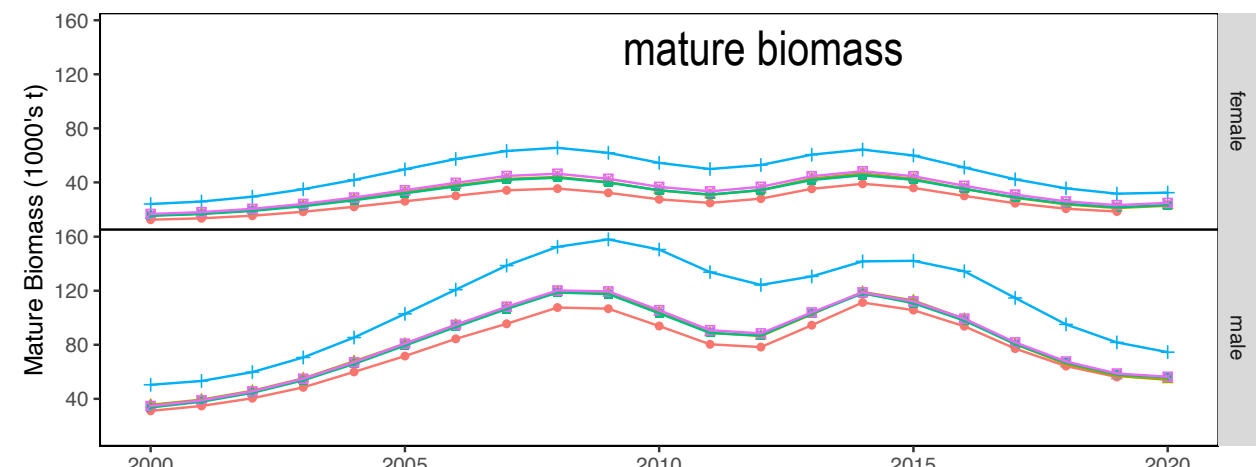
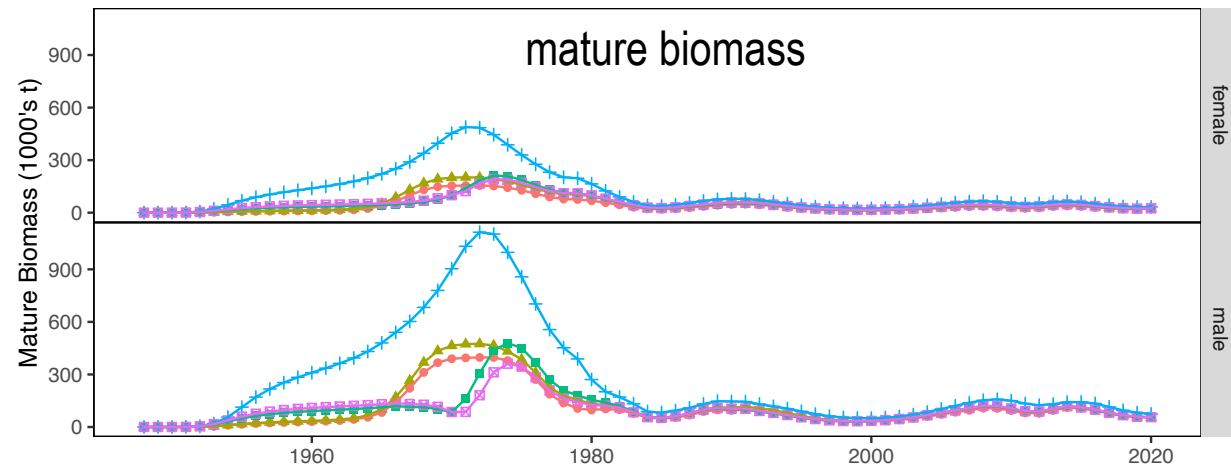
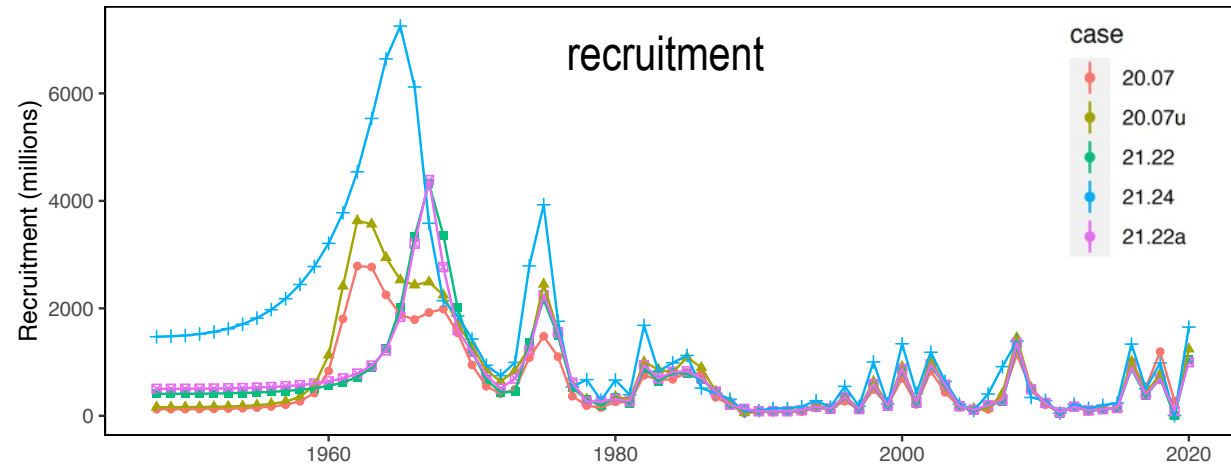




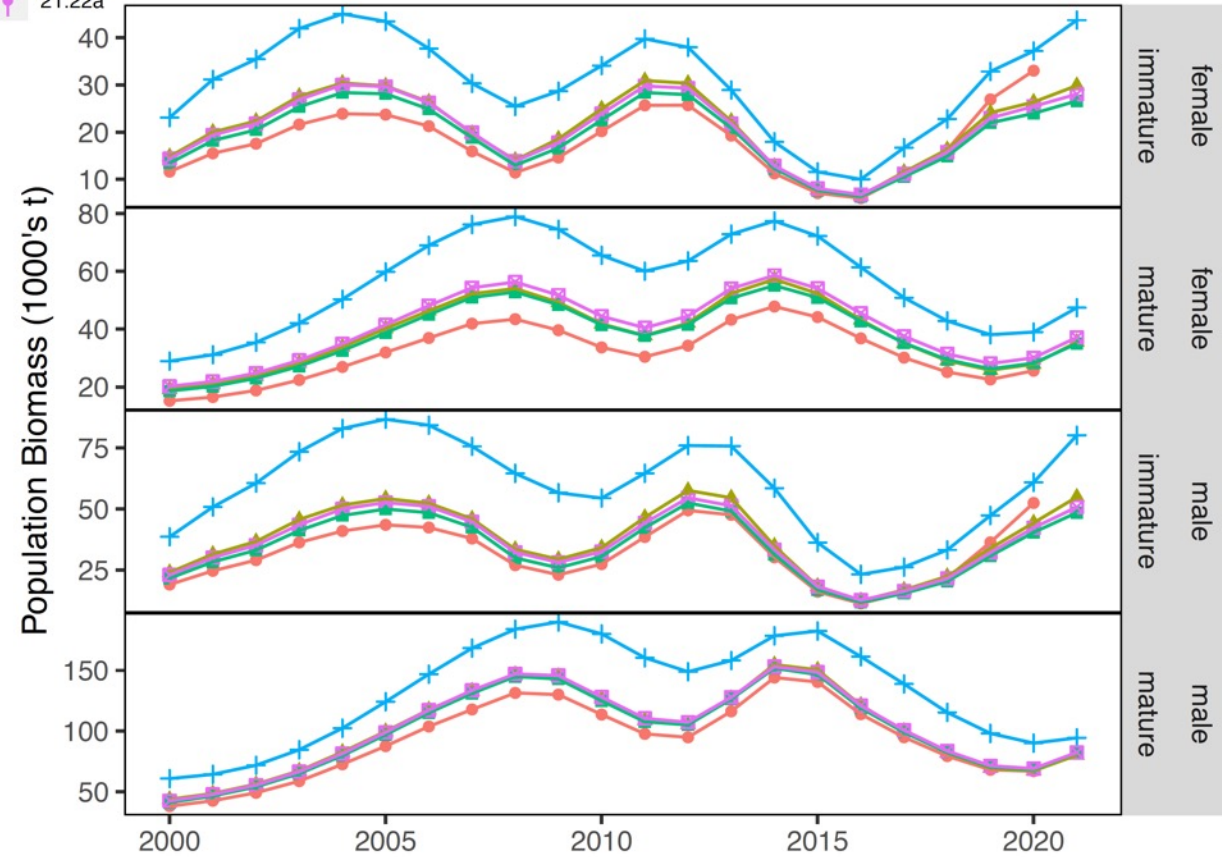
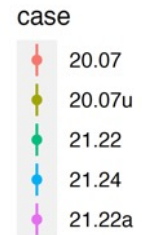
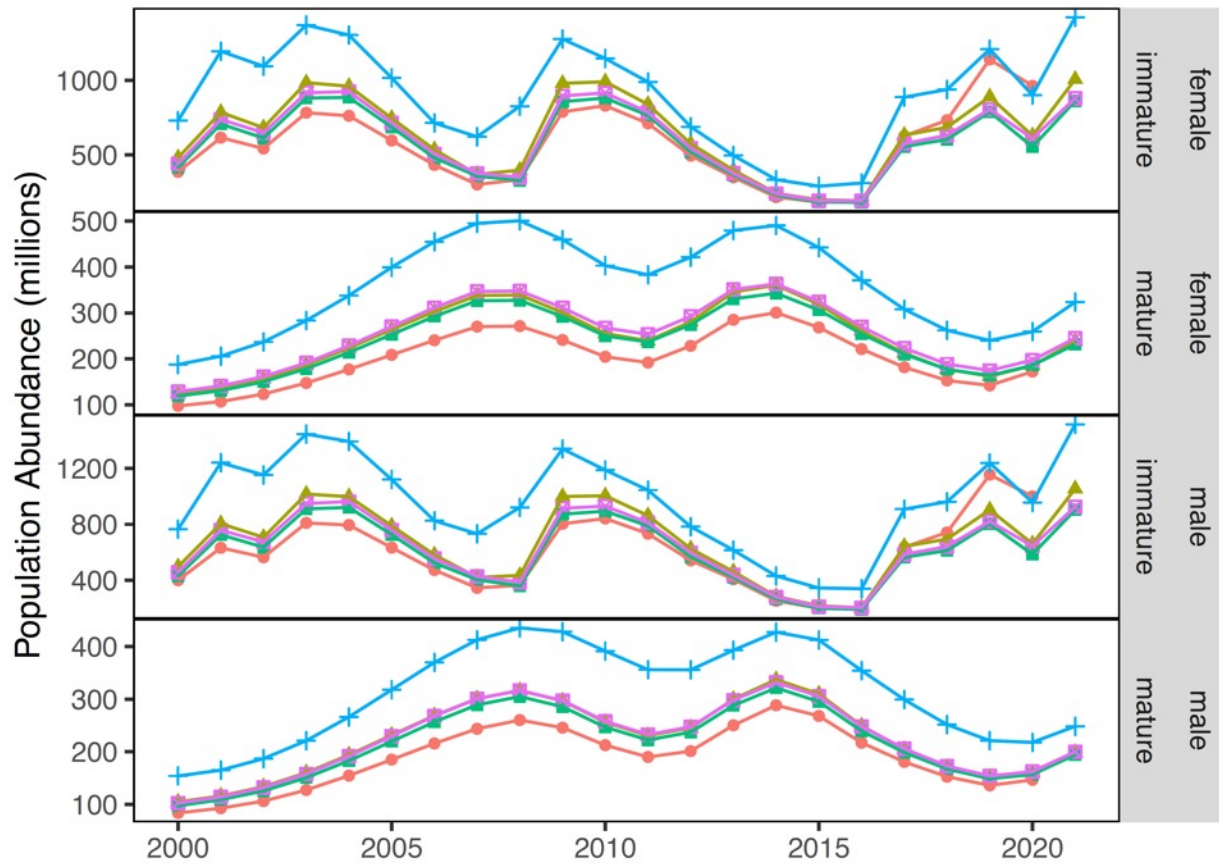
# Population Results



# Population Results

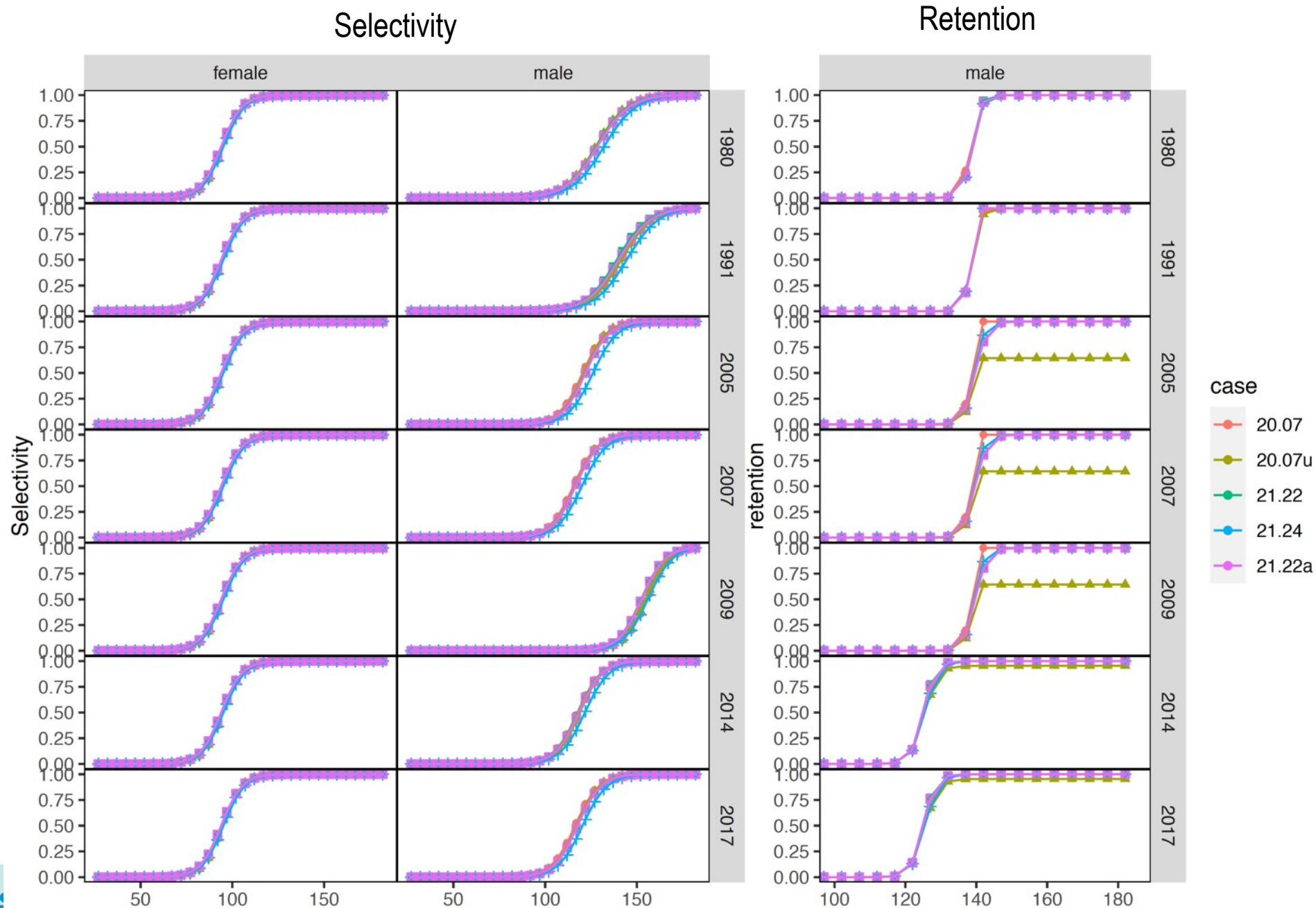


# Population Results

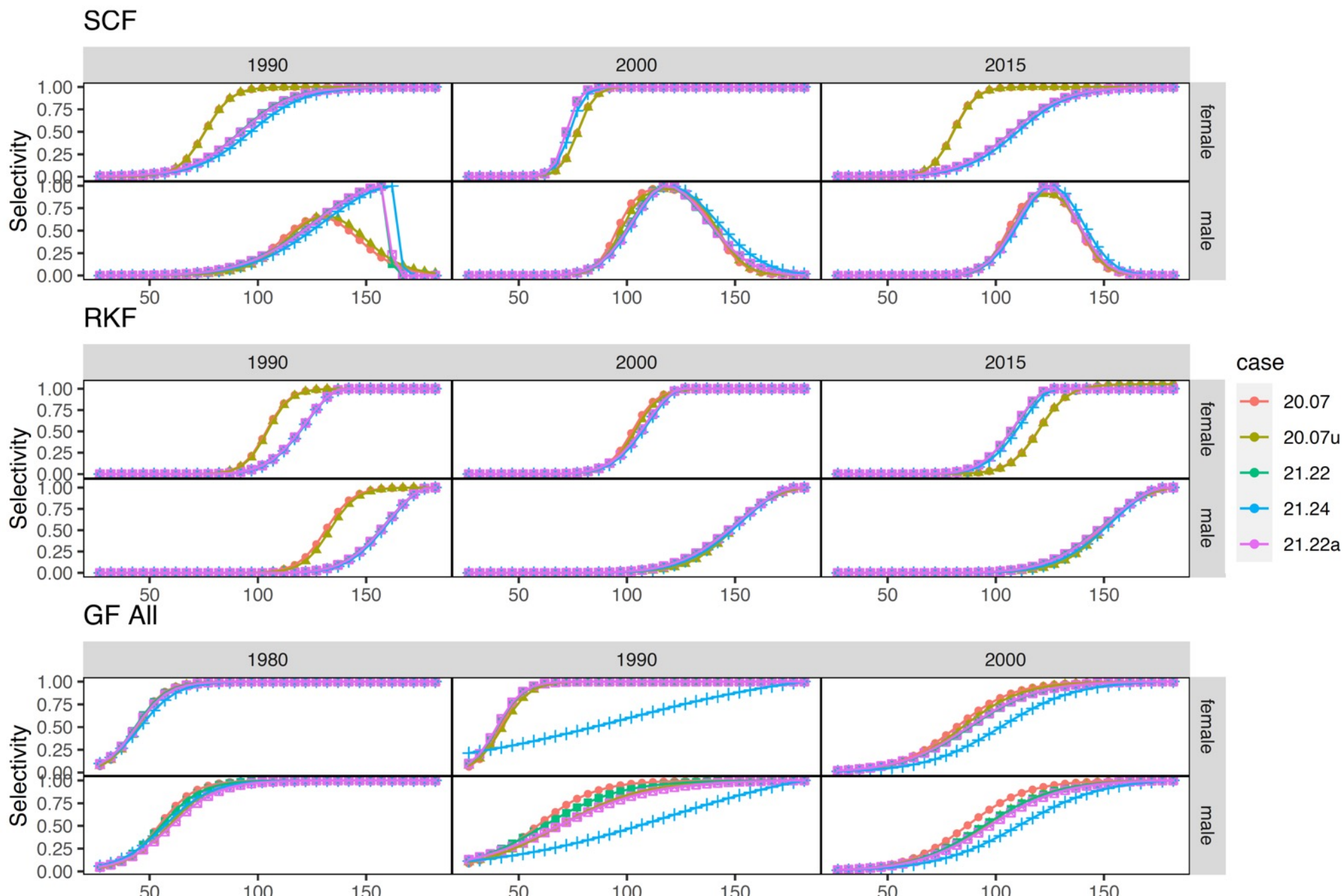


# Fishery Estimates

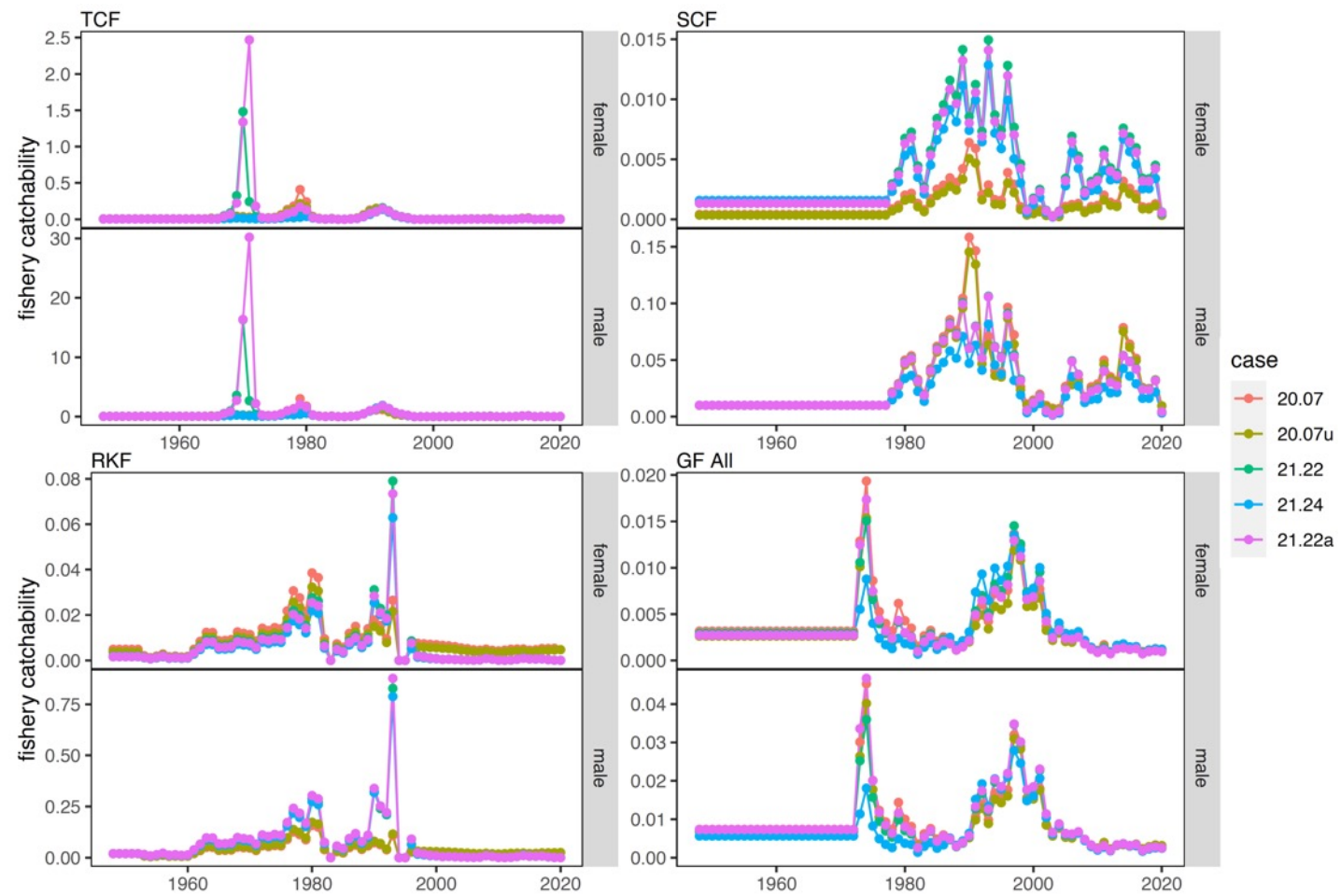
Directed Fishery



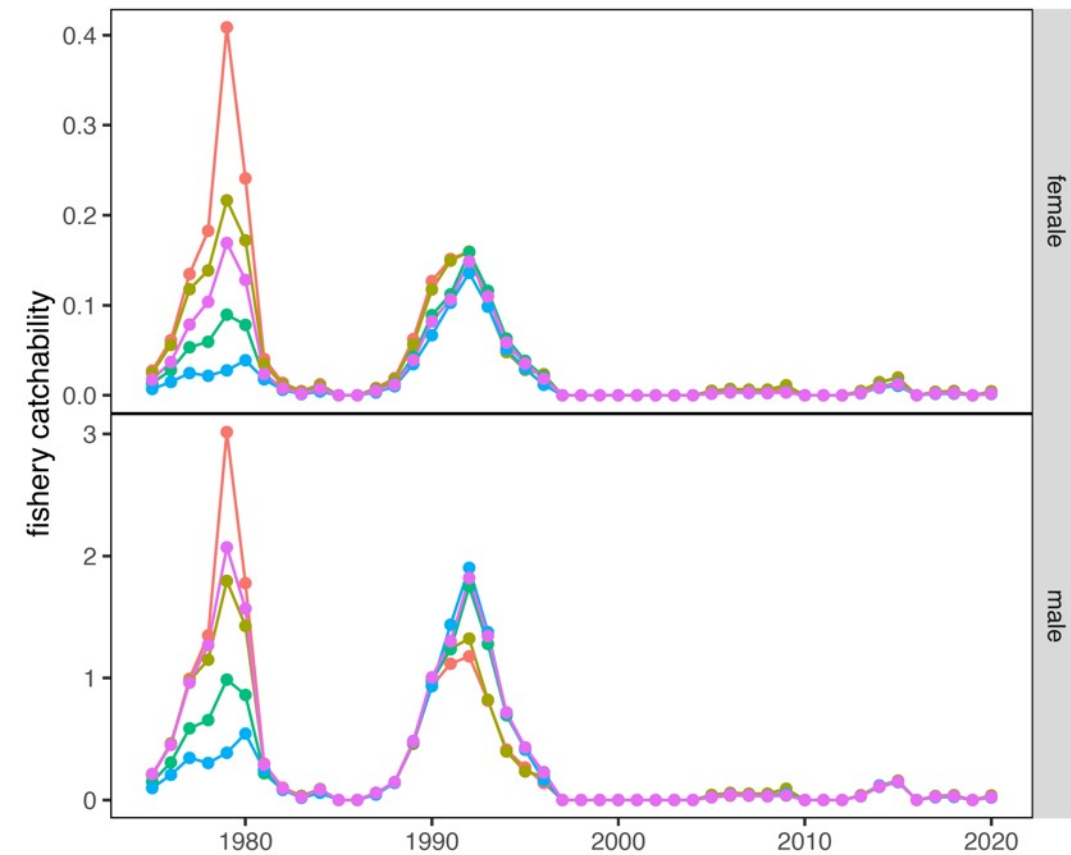
# Fishery Estimates



# Fishery Estimates

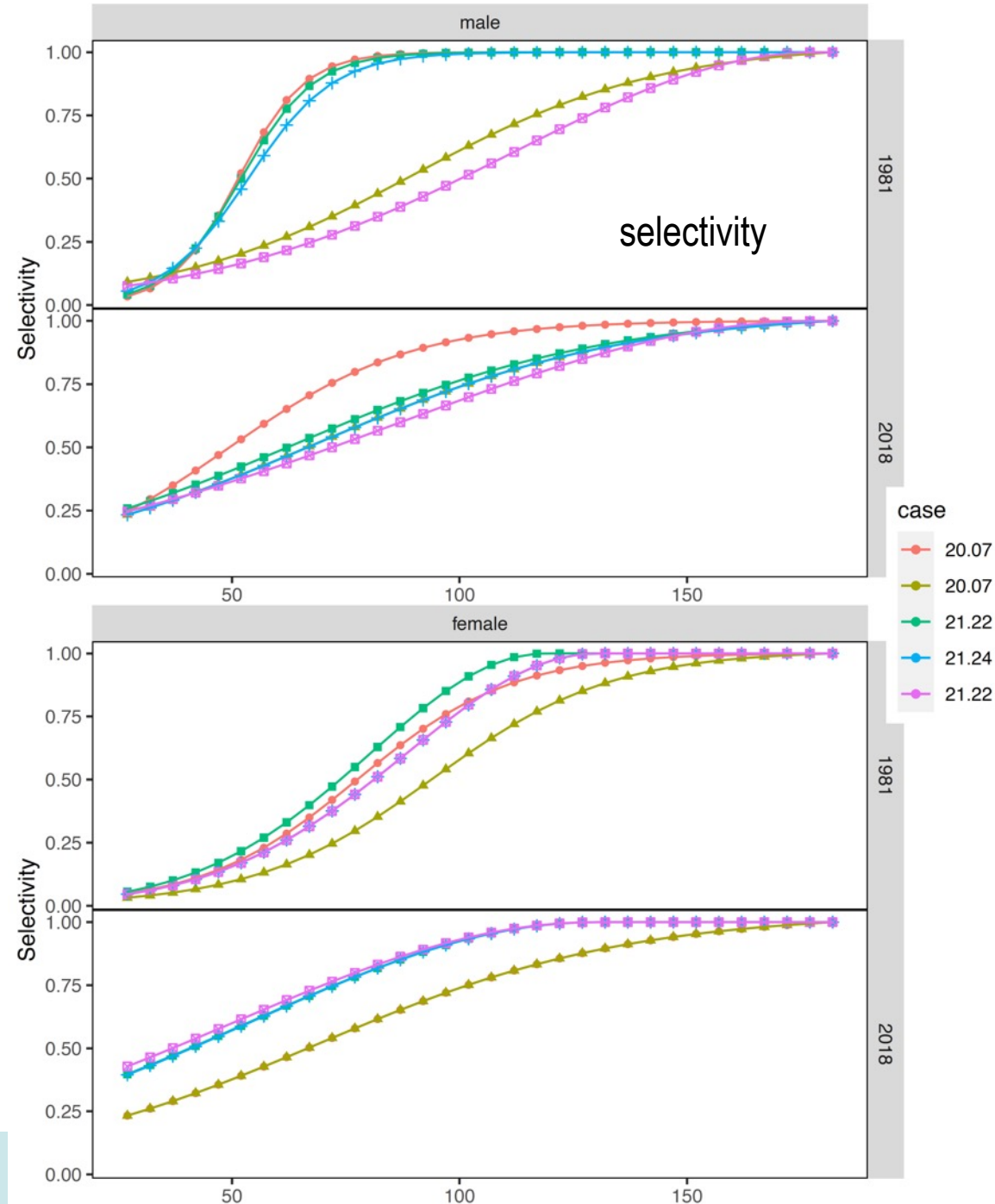
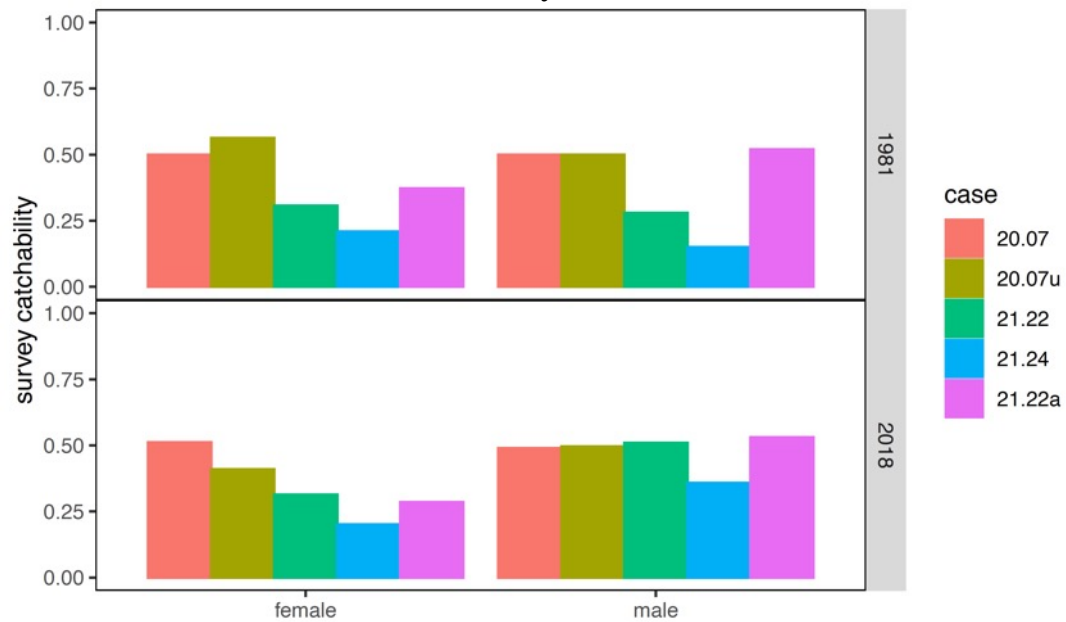


## Directed Fishery (TCF)

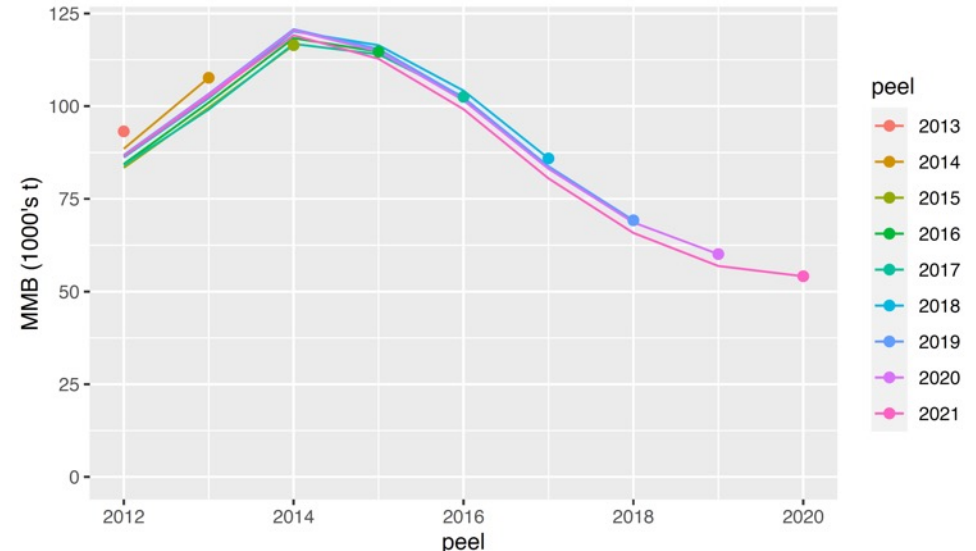
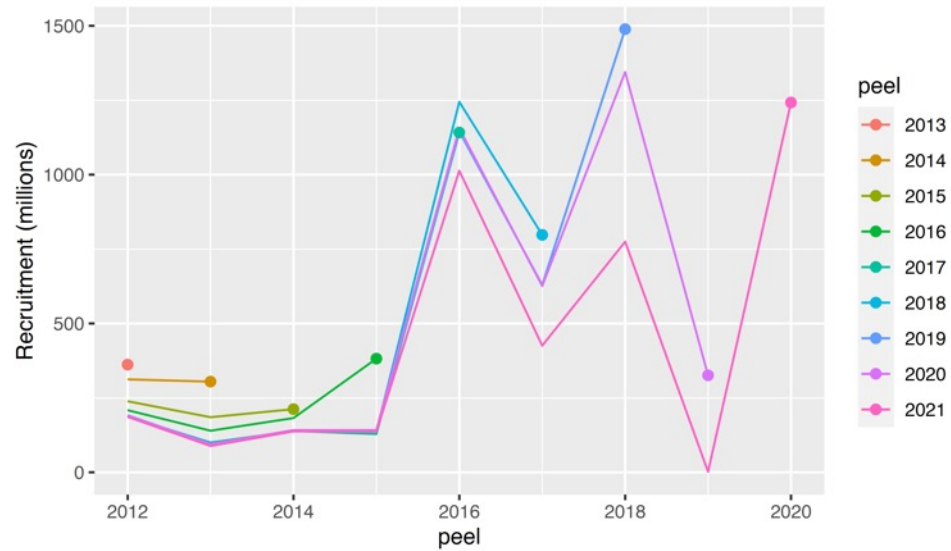
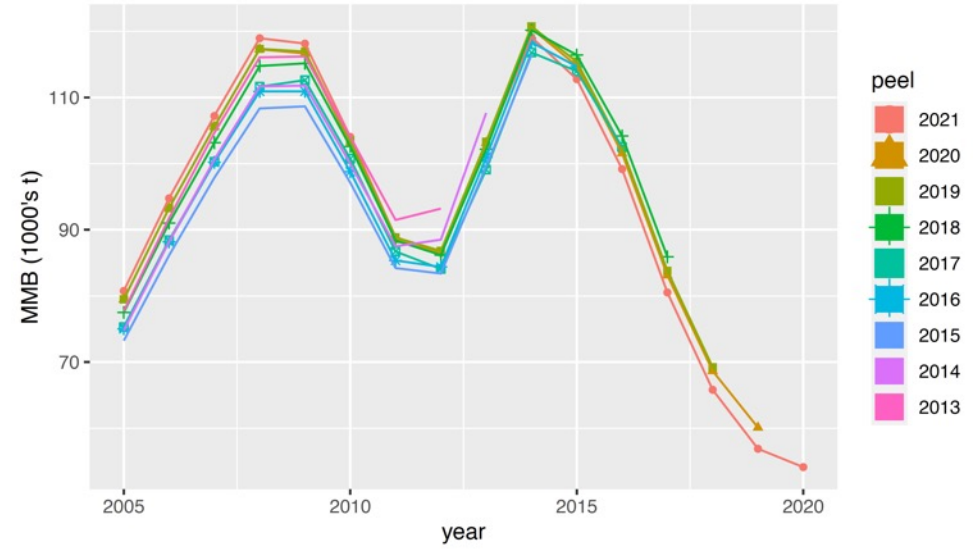
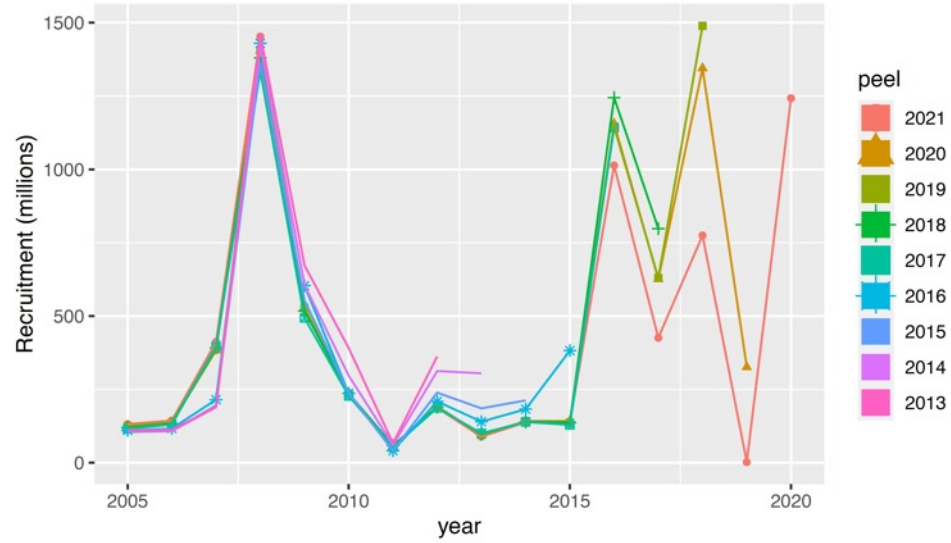


# Survey Estimates

## catchability



# Retrospective Analysis: 21.22a



Mohn's rho = 4.73

Mohn's rho = 0.0142





# Evaluation

consideration			20.07u	21.22	21.24	21.22a	
convergence			+	+	~	+	
parameters			---	---	---	+	
model fits	biomass	retained catch	++	++	++	++	
		total catch	++	+	+	+	
		surveys	-	-	--	-	
	size comps	retained catch	+	+	+	+	
		total catch	-	-	-	-	
		surveys	-	-	-	-	
	growth data		--	--	+	--	
	maturity data		-	+	--	+	
	retrospective patterns	recruitment					---
		MMB					+

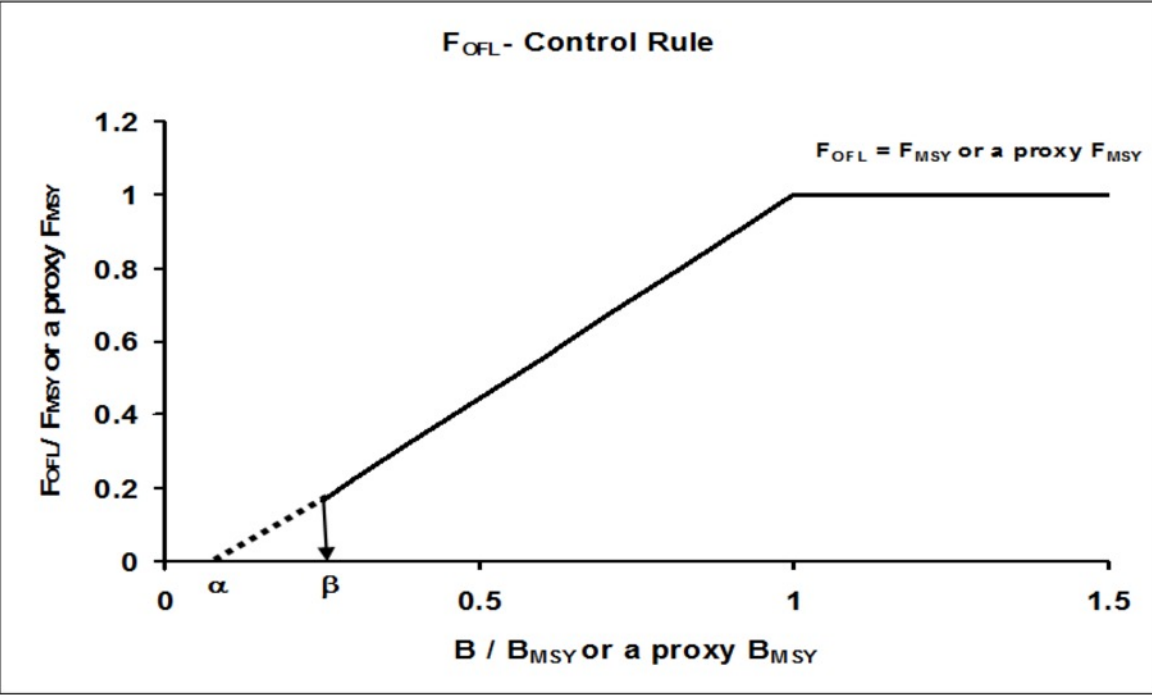


# Outline

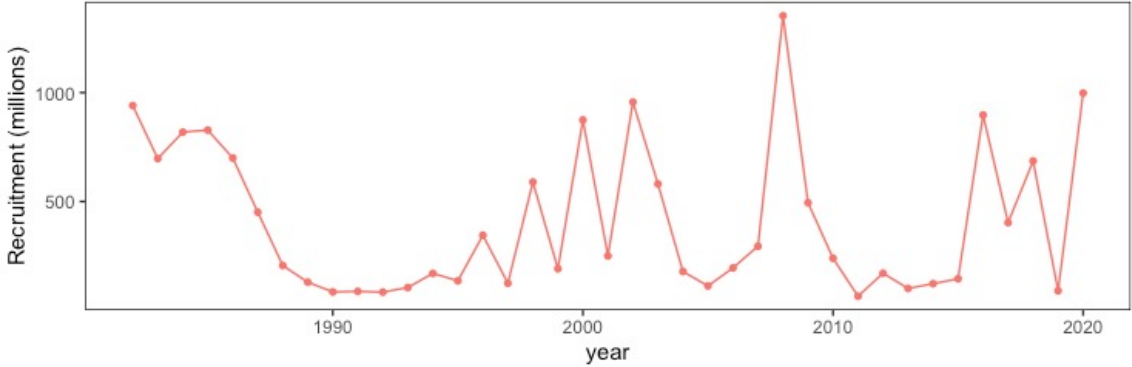
- SSC & CPT Comments
- Recent Fishery & Survey Trends
- Model Description & Scenarios
- Model Evaluation
- Status Determination & OFL Calculation
- Final Remarks



# OFL Calculation



Average Recruitment Time Frame

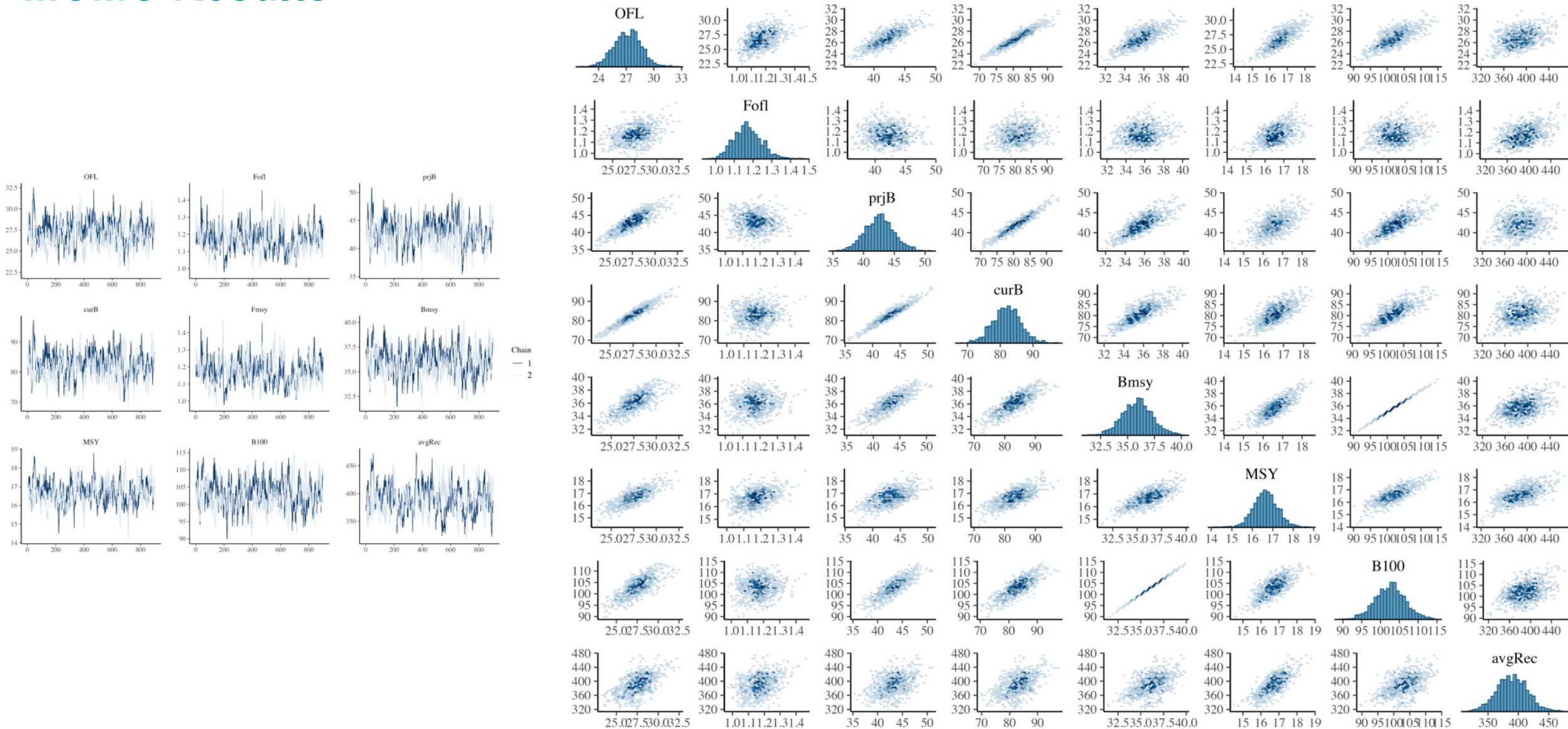


- 1982-2019 (terminal year-1)
- same as last year
- 2019 recruitment very low, but fairly consistent with 2021 survey size compositions

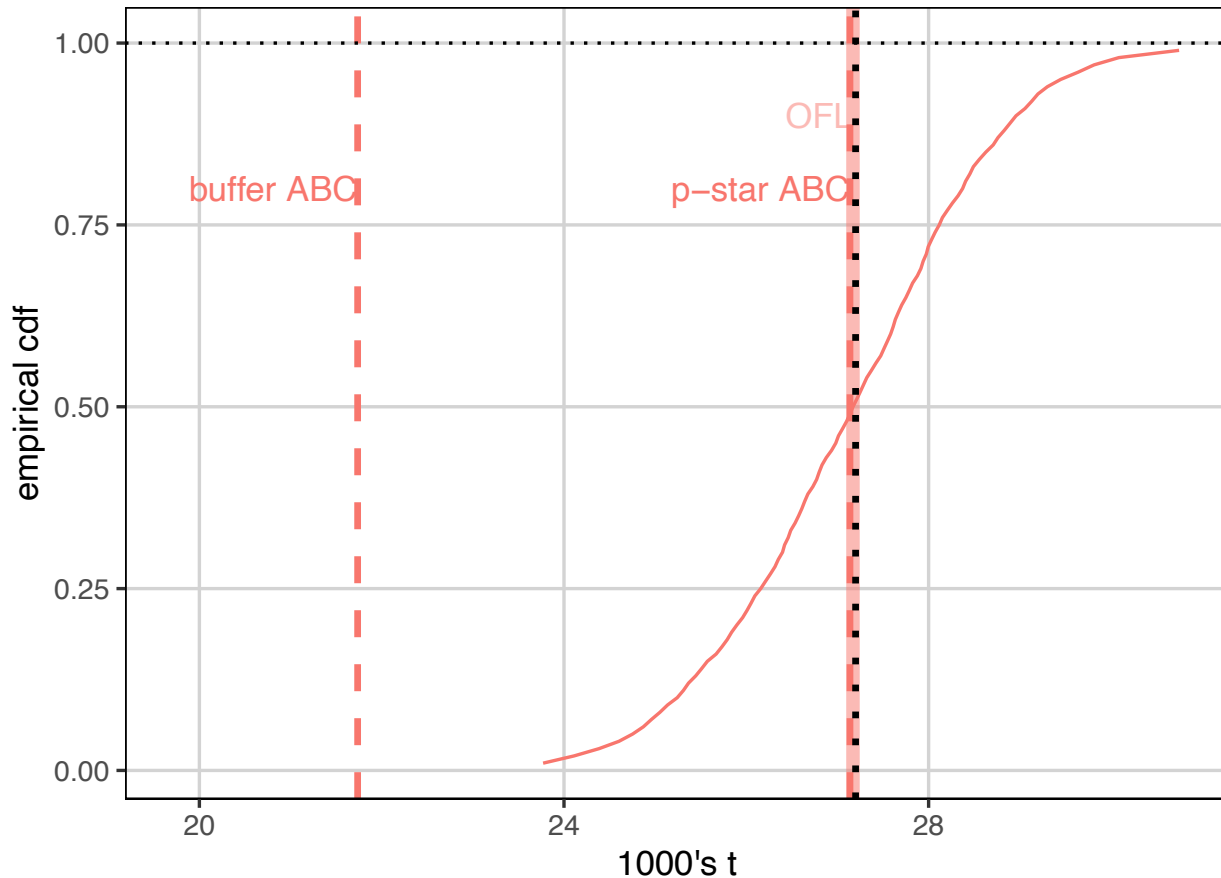
## MLE Results (21.22a)

- $MMB_{2021/22} = 42.78$  kt
- $B_{MSY} = 36.27$  kt
- $F_{MSY} = 1.19$
- $OFL = 27.20$  kt

# MCMC Results



# ABC Determination



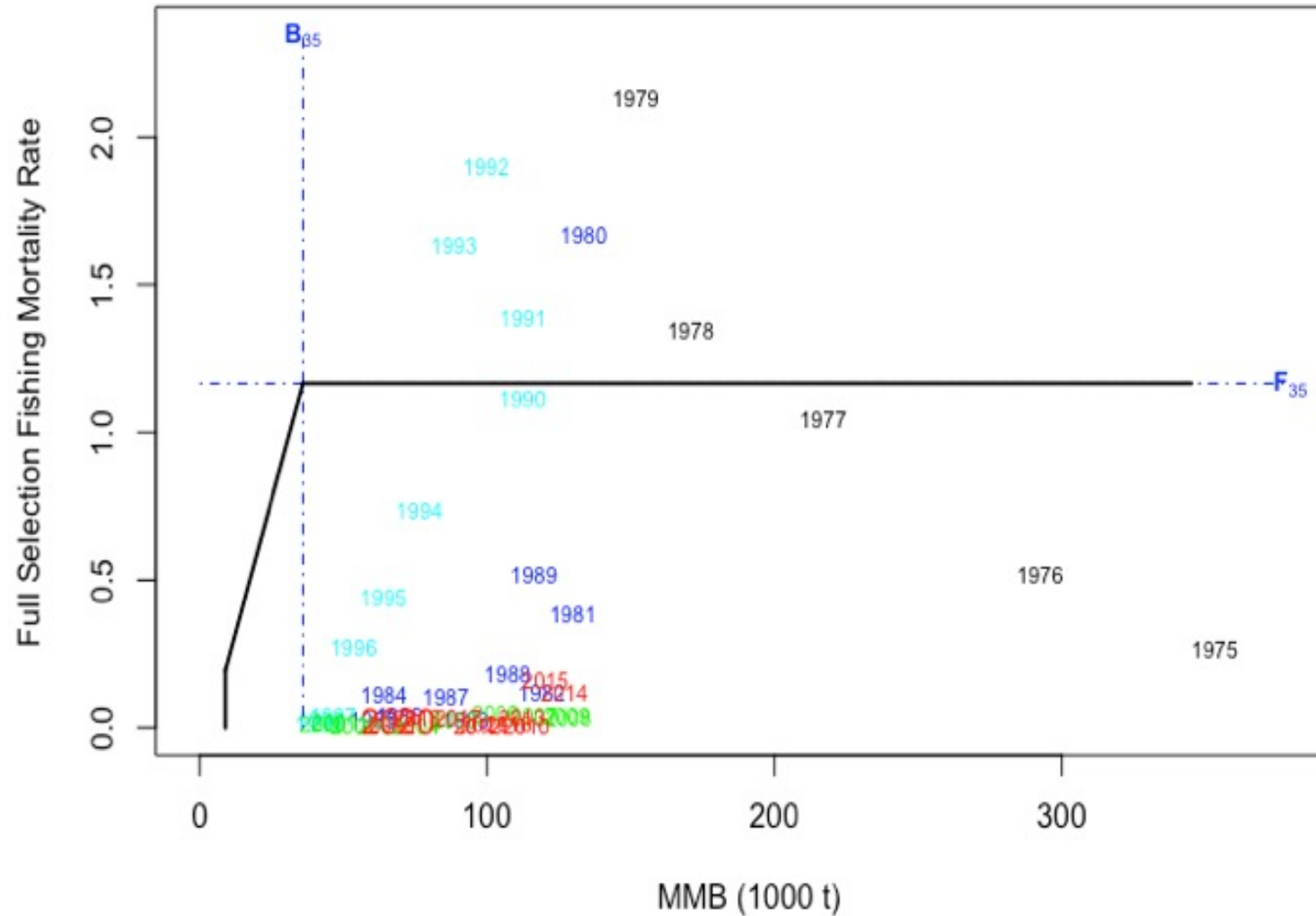
## MCMC Results

- $MMB_{2021/22.} = 42.57$  kt
- $B_{MSY} = 35.94$  kt
- $F_{MSY} = 1.17$
- OFL = 27.17 kt
- p-star ABC = 27.14 kt
- buffer ABC = 21.74 kt (20%)

## Buffer recommendation: 20%

- same as last year
- +’s: no parameters at bounds
- -’s
  - missing 2020 survey
  - issues with overestimating large crab
  - overestimating terminal survey biomass

# Stock Status



# Stock Status

- Tier 3a
- Not overfished
- No overfishing

Year	MSST	Biomass (MMB)	TAC (East + West)	Retained Catch	Total Catch Mortality	OFL	ABC
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	18.31	56.15	0.00	0.00	0.54	28.86	23.09
2020/21	17.97	56.34	1.07	0.66	0.96	21.13	16.90
2021/22		42.57				27.17	21.74

Year	Tier	B <sub>MSY</sub>	Current MMB	B/B <sub>MSY</sub>	F <sub>OFL</sub> (yr <sup>-1</sup> )	Years to define B <sub>MSY</sub>	Natural Mortality (yr <sup>-1</sup> )
2017/18	3a	29.17	47.04	1.49	0.75	1982-2017	0.23
2018/19	3a	21.87	23.53	1.08	0.93	1982-2018	0.23
2019/20	3b	41.07	39.55	0.96	1.08	1982-2019	0.23
2020/21	3b	36.62	35.31	0.96	0.93	1982-2019	0.23
2021/22	3a	35.94	42.57	1.18	1.17	1982-2020	0.23*

\*immature: 0.23, females: 0.31, males: 0.30  
(Table 40, p. 108)

# Outline

- SSC & CPT Comments
- Recent Fishery & Survey Trends
- Model Description & Scenarios
- Model Evaluation
- Status Determination & OFL Calculation
- Final Remarks





# Moving forward

- Looking for prioritization on:
  - implement projection capabilities in TCSAM02
  - implement delta approximation in TCSAM02
  - transition to GMACS
- finish BSFRF/NMFS SBS survey selectivity analysis
  - would be helpful to have 2018 BSFRF survey data
- continue exploring ways to simplify model structure
  - start model in 1982
  - drop fits to small-catch bycatch data
- investigate nonparametric approaches to selectivity
- develop model that better reflects State management structure



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