

2023-05 Tanner Crab Report

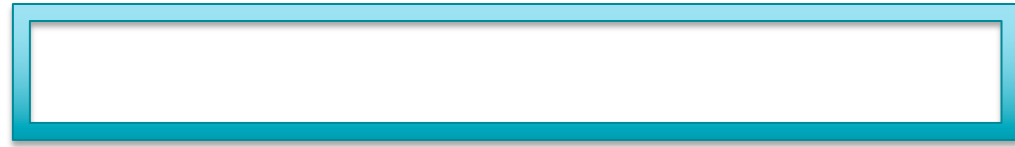
William Stockhausen

AFSC/NMFS/NOAA

May 18, 2023



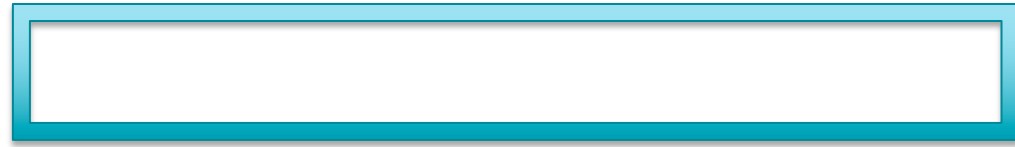
Outline



- Proposed Tier 3 Model Runs
- Tier 4 Model



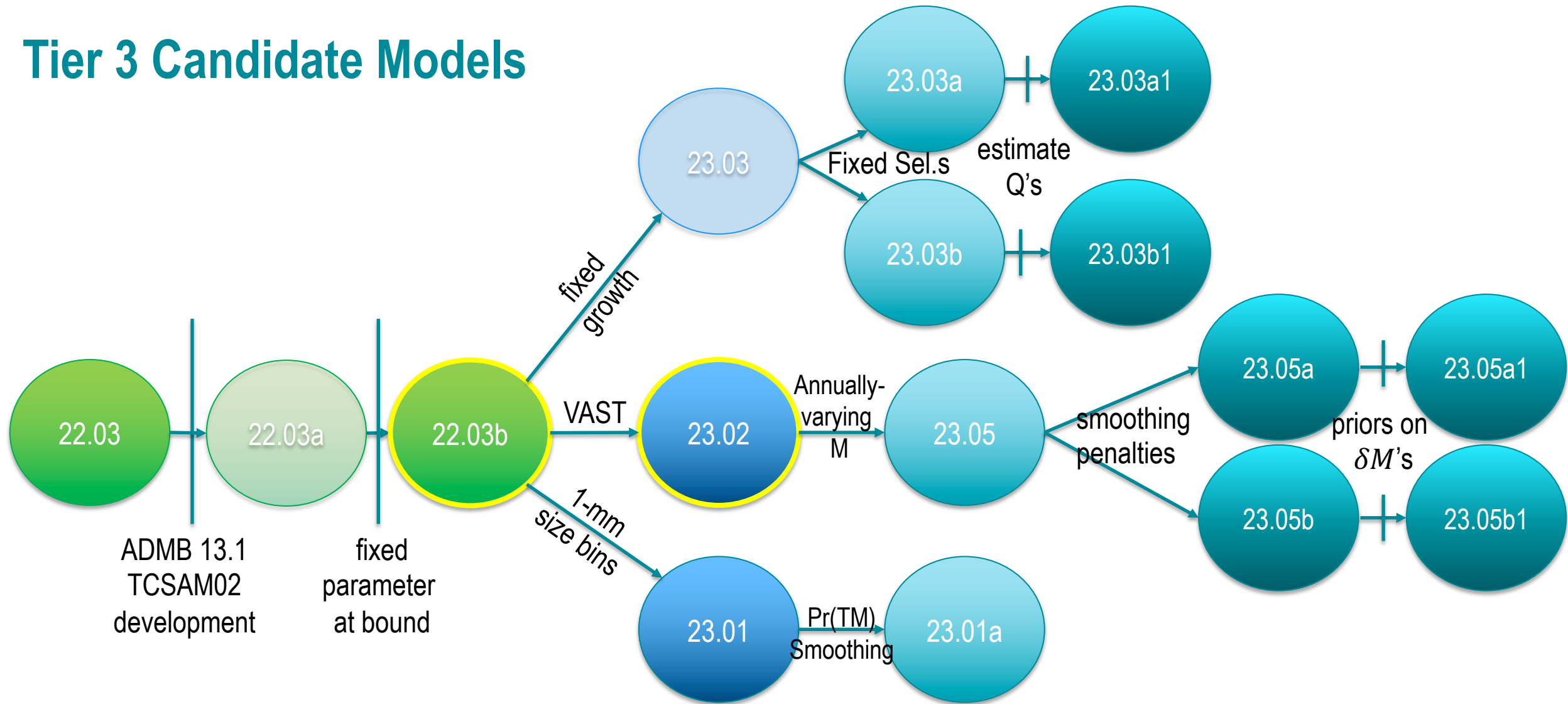
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- Proposed Tier 3 Model Runs
- Tier 4 Model



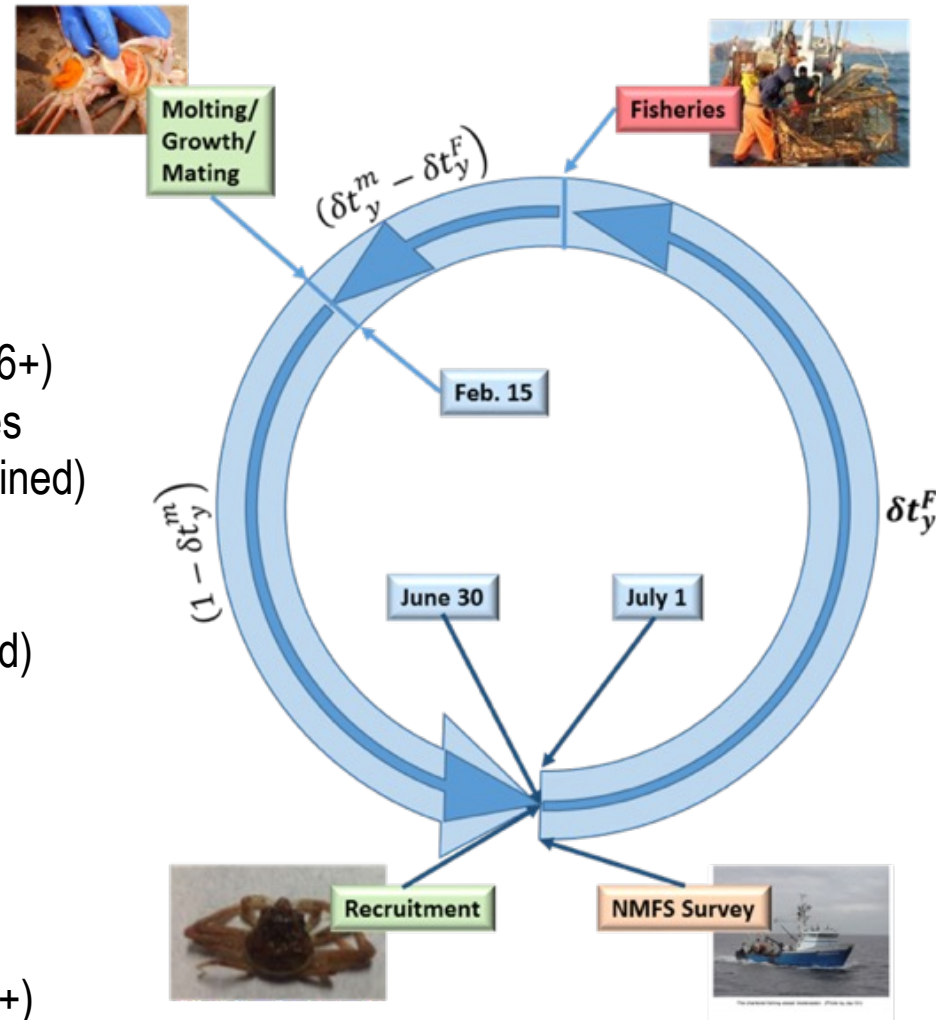
Tier 3 Candidate Models



Assessment: Tier 3 size-structured model

Fits to

- Survey data
 - biomass, size comps
 - NMFS EBS shelf survey
 - 1975-present (no 2020)
 - male maturity ogives (2006+)
 - BSFRF side-by-side haul studies
 - 2013-2017 (2018 not obtained)
- Molt increment data
- Fishery data (biomass, size comps)
 - directed fishery (areas combined)
 - retained catch (1965+)
 - total catch (1991+)
 - bycatch in
 - snow crab fishery (1990+)
 - BBRKC fishery (1990+)
 - groundfish fisheries (1973+)



Model estimates

- Natural mortality (M)
- growth (molt increment)
- probability of molt to maturity
- initial abundance
- recruitment
- fully-selected capture rates
- size-specific fishery selectivity
- size-specific retention
- NMFS survey catchability
- NMFS survey selectivity

Fixed parameters

- weight-at-size
- handling mortality rates
- availability to BSFRF survey
- fully-selected sizes

Determines

- Avg. Rec., F_{msy} , B_{msy} ,
- F_{OFL} , OFL , ABC

Population dynamics

process	time blocks	22.03 description
Population rates and quantities		
Population built from annual recruitment		
Recruitment	1949-1974	In-scale mean + annual devs constrained as AR1 process
	1975+	In-scale mean + annual devs
Growth	1949+	sigma-R fixed, sex ratio fixed at 1:1
	1949+	sex-specific
		mean post-molt size: power function of pre-molt size
Maturity		post-molt size: gamma distribution conditioned on pre-molt size
	1949+	sex-specific
		size-specific probability of terminal molt
		logit-scale parameterization
Natural mortality	1949-1979,	estimated sex/maturity state-specific multipliers on base rate
	1985+	priors on multipliers based on uncertainty in max age
	1980-1984	estimated "enhanced mortality" period multipliers



Fisheries

Fishery/process	time blocks	22.03 description
TCF directed Tanner crab fishery		
capture rates	pre-1965	male nominal rate
	1965+	male ln-scale mean + annual devs
	1949+	ln-scale female offset
male selectivity	1949-1990	ascending logistic
	1991-1996	annually-varying ascending logistic
	2005+	annually-varying ascending logistic
female selectivity	1949+	ascending logistic
male retention	1949-1990; 1991-1996; 2005-2009; 2013+	ascending logistic
% retained	pre-1988	fixed at 100%
	1991-1996	fixed at 100%
	2005-2009	fixed at 100%
	2013+	fixed at 100%
SCF bycatch in snow crab fishery		
capture rates	pre-1978	nominal rate on males
	1979-1991	extrapolated from effort
	1992+	male ln-scale mean + annual devs
	1949+	ln-scale female offset
male selectivity	1949-1996	dome-shaped (double normal) --plateau width fixed to 0 --descending limb width fixed to 1
	1997-2004	dome-shaped (double normal)
	2005+	dome-shaped (double normal)
female selectivity	1949-1996	ascending logistic
	1997-2004	ascending logistic
	2005+	ascending logistic

Fishery/process	time blocks	22.03 description
RKF bycatch in BBRKC fishery		
capture rates	pre-1952	nominal rate on males
	1953-1991	extrapolated from effort
	1992+	male ln-scale mean + annual devs
	1949+	ln-scale female offset
male selectivity	1949-1996	ascending normal, asymptote fixed
	1997-2004	ascending normal, asymptote fixed
	2005+	ascending normal, asymptote fixed
female selectivity	1949-1996	ascending normal, asymptote fixed
	1997-2004	ascending normal
	2005+	ascending normal
GTF bycatch in groundfish fisheries		
capture rates	pre-1973	male ln-scale mean from 1973+
	1973+	male ln-scale mean + annual devs
	1973+	ln-scale female offset
male selectivity	1949-1986	ascending logistic
	1987-1996	ascending logistic
	1997+	ascending logistic
female selectivity	1949-1986	ascending logistic
	1987-1996	ascending logistic
	1997+	ascending logistic



Surveys

Survey/process	time blocks	22.03 description
NMFS EBS trawl survey		
male survey q	1975-1981	In-scale
	1982+	In-scale w/ prior based on Somerton's underbag experiment
female survey q	1975-1981	In-scale
	1982+	In-scale w/ prior based on Somerton's underbag experiment
male selectivity	1975-1981	ascending normal, fixed fully-selected size at 180
	1982+	ascending normal, fixed fully-selected size at 180
female selectivity	1975-1981	ascending normal, fixed fully-selected size at 130
	1982+	ascending normal, fixed fully-selected size at 130
BSFRF SBS trawl surveys		
male catchability	2013-2017	fixed at 1 for all sizes
male availability	2013-2017	empirically-determined outside the model
female catchability	2013-2017	fixed at 1 for all sizes
female availability	2013-2017	empirically-determined outside the model

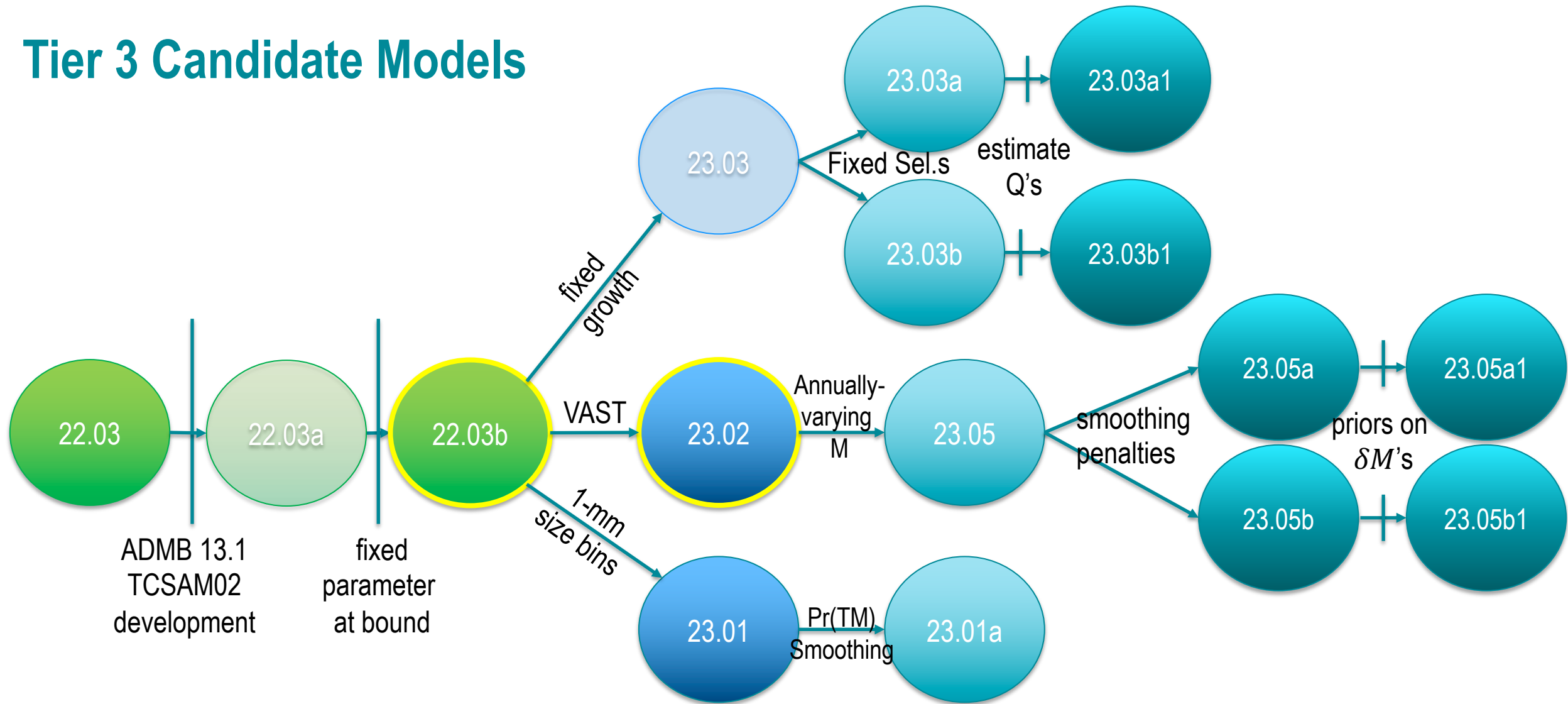


Likelihoods

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

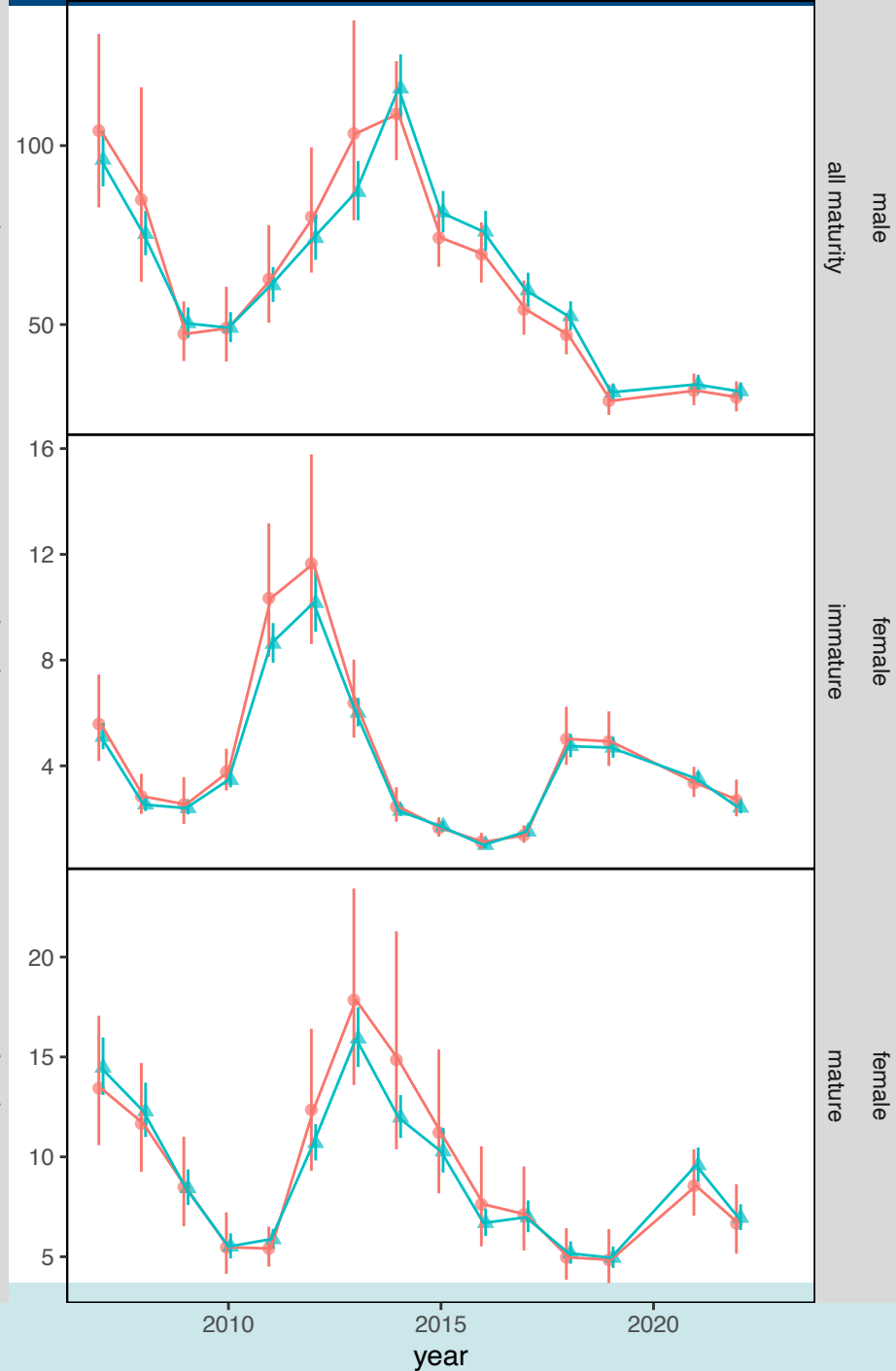
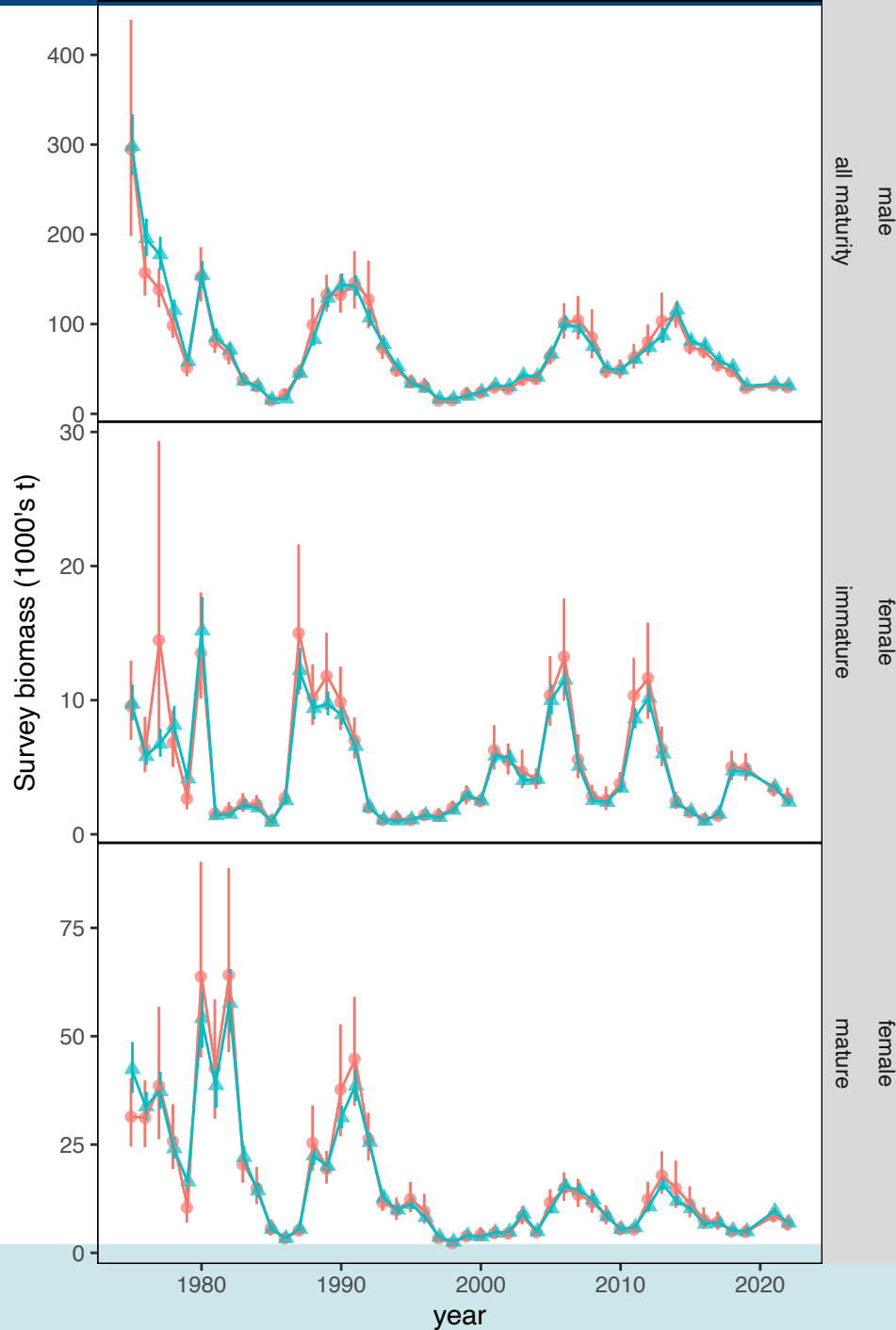


Tier 3 Candidate Models



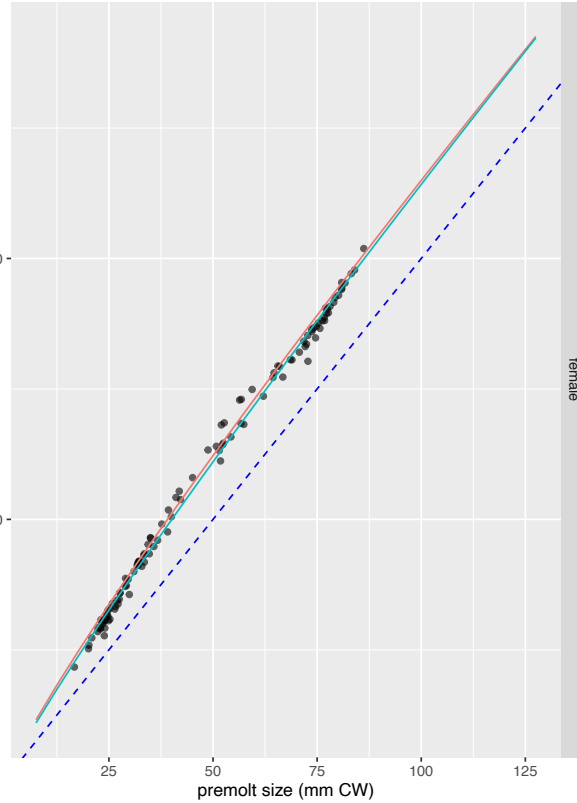
23.02

- Fits to VAST model-based biomass time series from NMFS EBS shelf survey

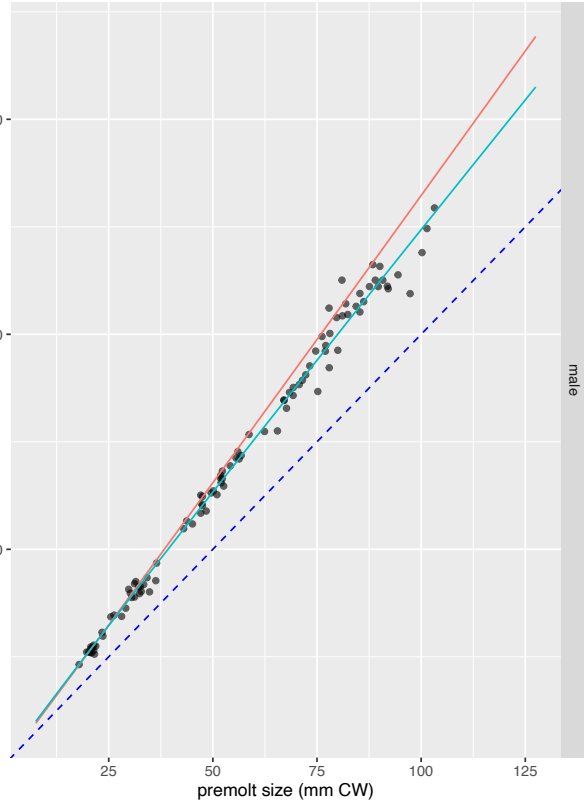


23.03's

Females

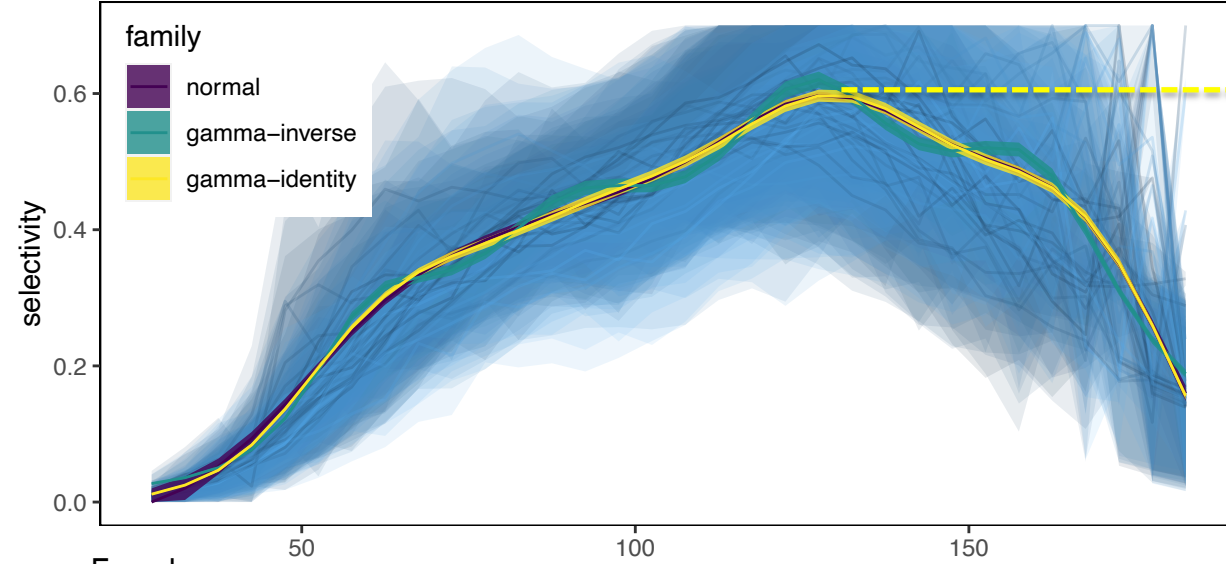


Males

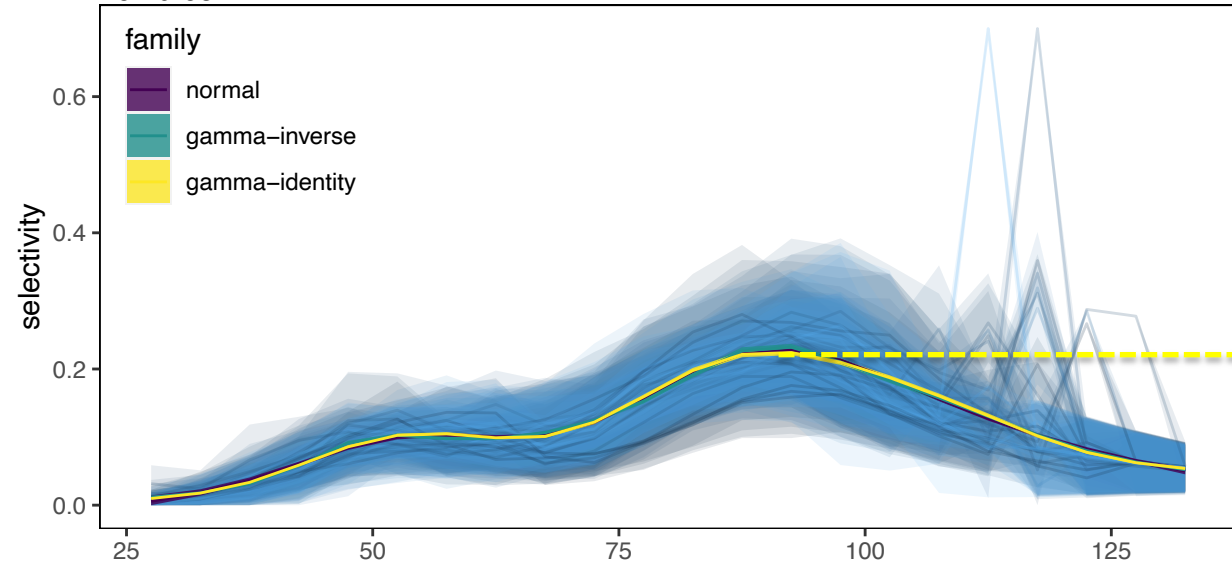


growth: 23.03's use green lines determined fit outside model

Males



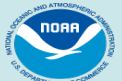
Females



size (mm CW)

Convergence

model configuration	number of parameters	no. of jitter runs	no. converged to MLE	no. of param.s at bounds	objective function value	max gradient	invertible for std. devs?
22.03	351	800	710	1	3044.61	2.92E-03	yes
22.03a	351	200	--	1	3044.51	3.93E-04	yes
22.03b	350	200	--	0	3044.51	3.08E-04	yes
23.01	460	200	184	0	3046.65	1.32E-04	yes
23.01a	460	200	187	0	3050.50	7.59E-05	yes
23.02	350	400	14	3	4156.53	2.41E-04	yes
23.03a	337	200	90	4	4033.78	1.53E-03	yes
23.03a1	341	200	134	2	3826.84	9.24E-04	yes
23.03b	337	200	79	4	4036.10	1.02E-03	yes
23.03b1	341	200	188	2	3810.22	9.30E-04	yes
23.05	489	200	5	43	2355.28	1.12E-04	yes
23.05a	489	200	147	14	2604.56	7.62E-04	yes
23.05a1	489	200	39	8	2891.94	4.42E-04	yes
23.05b	489	200	156	14	2604.56	4.65E-04	yes
23.05b1	489	200	32	8	2891.94	2.25E-04	yes



Parameters at bounds

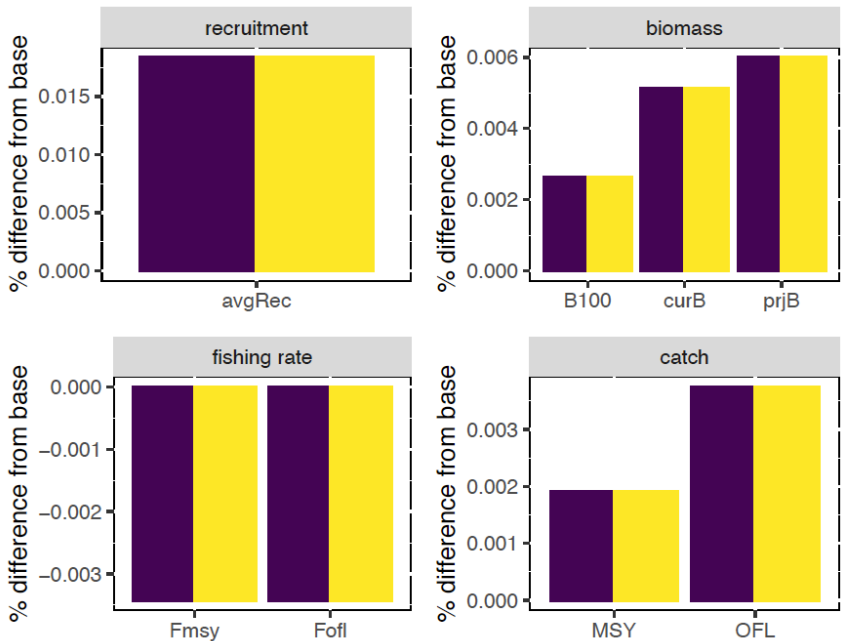
process	name	label	22.03	22.03a	22.03b	23.01	23.01a	23.02	23.03a	23.03a1	23.03b	23.03b1	23.05	23.05a	23.05a1	23.05b	23.05b1	
fisheries	pDevsLnC	RKF: 1992+	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	
natural mortality	pDevsM	time varying M for immature crab	-	-	-	-	-	-	-	-	-	-	-16	-7	-4	-7	-4	
		time varying M for mature females	-	-	-	-	-	-	-	-	-	-	-	-13	-4	-1	-4	-1
		time varying M for mature males	-	-	-	-	-	-	-	-	-	-	-	-14	-2	-2	-2	-2
recruitment	pRb[1]	scale param for rec. size dist.	-	-	-	-	-	-	-1	-1	-1	-1	-	-	-	-	-	
selectivity	pS1[17]	z50 for GF.AllGear selectivity (males, 1987-1996)	-	-	-	-	-	1	1	1	1	1	-	-	-	-	-	
	pS2[2]	width for NMFS survey selectivity (males, 1982+)	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	
	pS2[28]	slope for TCF retention (2005-2009)	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	
	pS2[5]	slope for TCF retention (pre-1991)	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	
	pS2[6]	slope for TCF retention (1991-1996)	-	-	-	-	-	-	1	-	1	-	-	1	1	1	1	



22.03 → 22.03a → 22.03b

- 22.03a: ADMB 13.1 + code development
- 22.03b: fixed retention slope parameter to upper bound (step function)
 - no parameters at bounds
- Result: very, very small differences

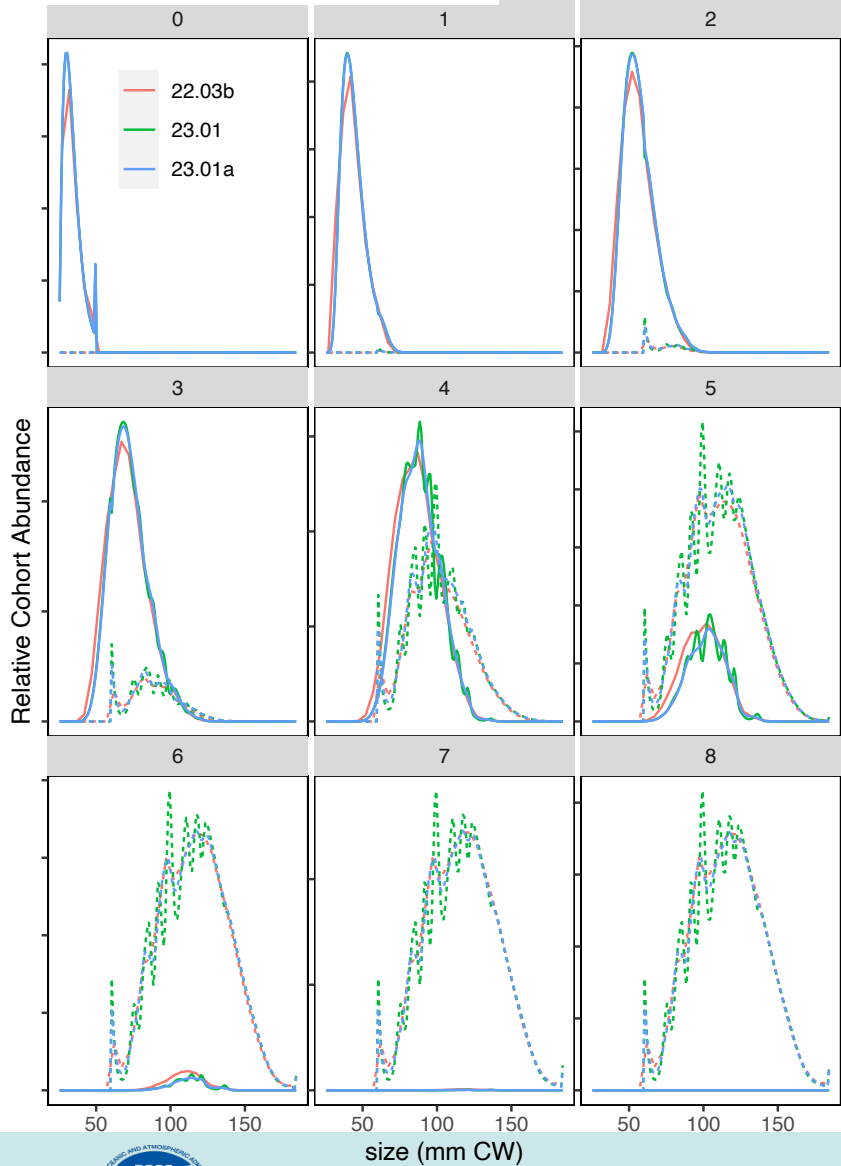
Differences from 22.03



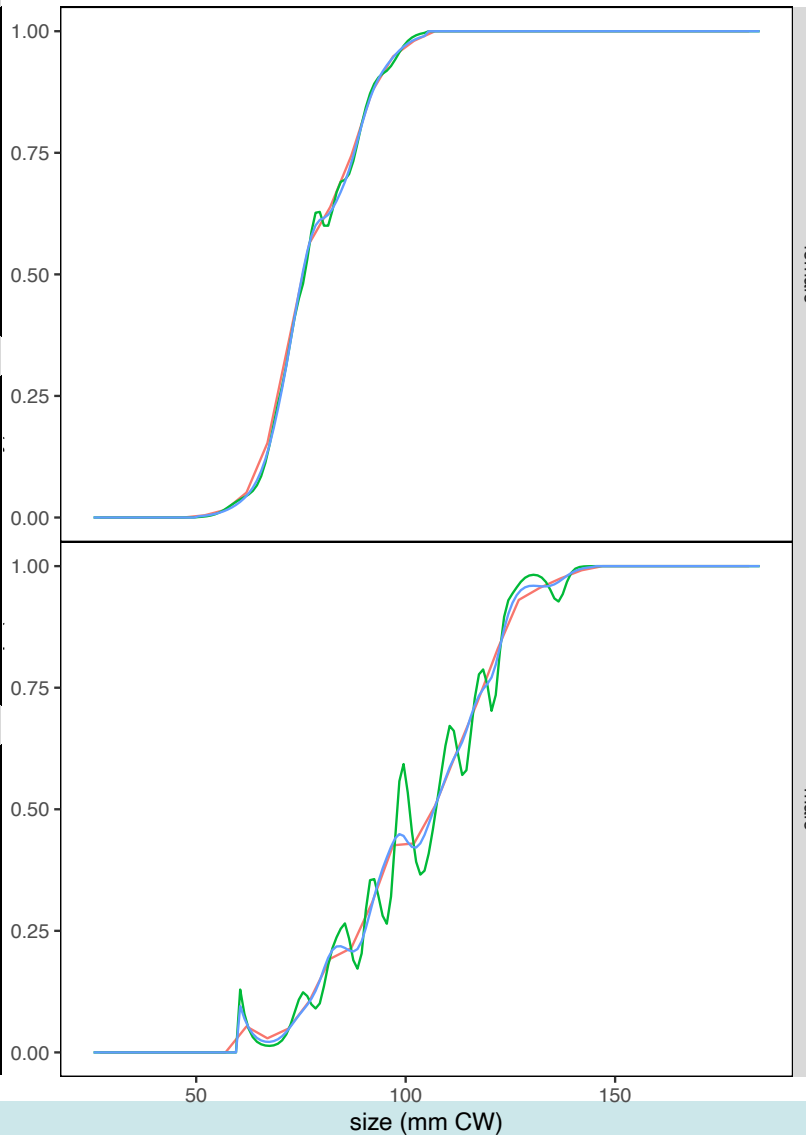
surveys					fisheries							
fleet	data type	sex	22.03a	22.03b	catch type	fleet	data type	sex	22.03a	22.03b		
NMFS M	abundance	female	-	-	retained catch		abundance	female	-	-		
		male	-	-				male	-	-		
	biomass	female	-	-			biomass		female	-	-	
		male	-0.024	-0.024					male	-0.002	-0.002	
	n.at.z	abundance	male	-0.007		-0.007	TCF		abundance	all sexes	-	-
			female	-		-				biomass	all sexes	-0.003
NMFS F	biomass	female	0.001	0.001	SCF		n.at.z	female	-0.001	-0.001		
		male	-	-				male	-0.010	-0.010		
	n.at.z	abundance	female	-0.029		-0.029		abundance	all sexes	-	-	
			male	-		-			biomass	all sexes	0.000	0.000
	SBS BSFRF M	biomass	female	-		-	total catch	GF All	n.at.z	female	0.001	0.001
			male	0.002		0.002				male	-0.003	-0.003
n.at.z		abundance	female	-	-			abundance	all sexes	0.019	0.019	
			male	-0.004	-0.004				biomass	all sexes	0.017	0.017
3S BSFRF F		biomass	female	-	-	RKF			n.at.z	female	0.037	0.037
			male	-0.009	-0.009					male	-0.023	-0.023
	n.at.z	abundance	female	-	-			abundance	all sexes	-	-	
			male	-	-				biomass	all sexes	0.000	0.000
	n.at.z	biomass	female	0.004	0.004			n.at.z	female	-0.014	-0.014	
			male	-	-				male	0.000	0.000	

1-mm Model Size Bins: 23.01, 23.01a

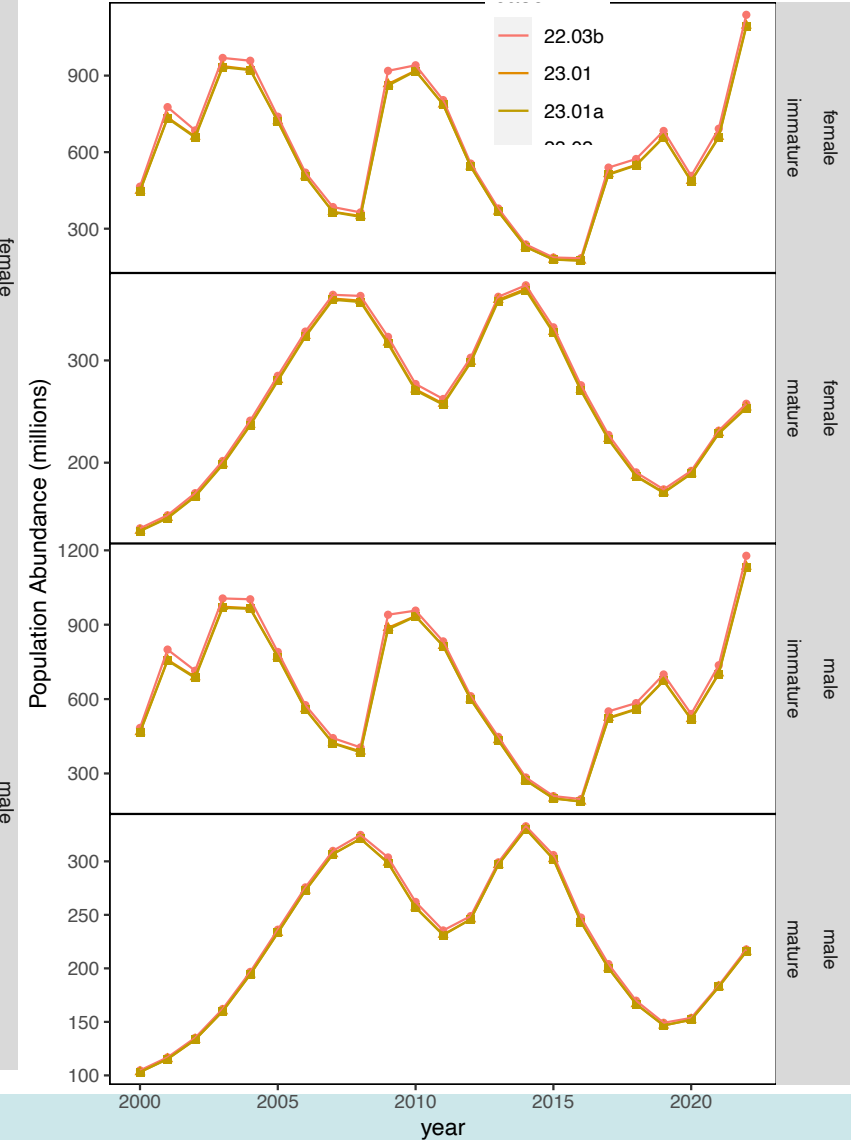
male cohort progression



pr(Molt-to-Maturity)



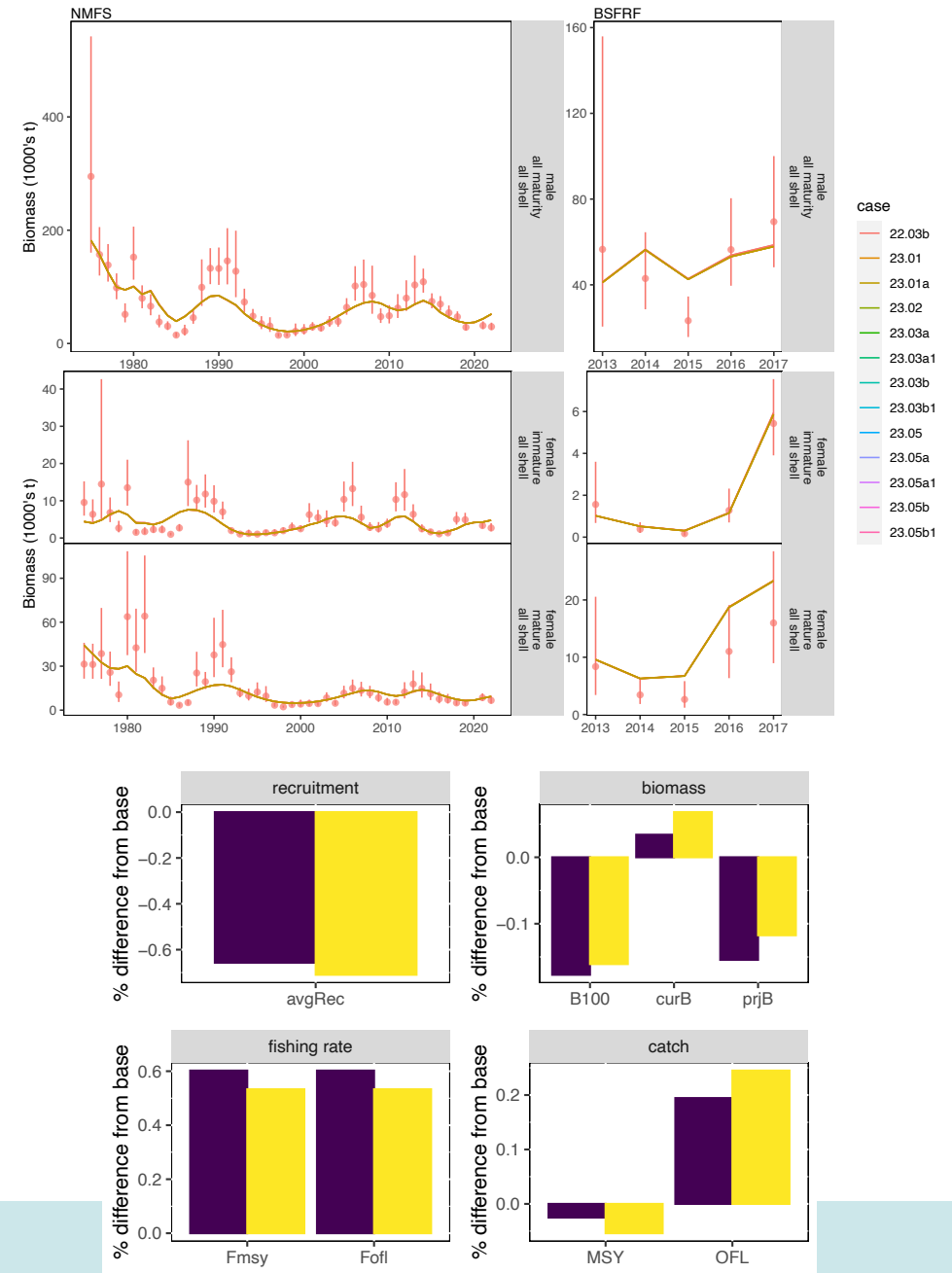
recent population abundance



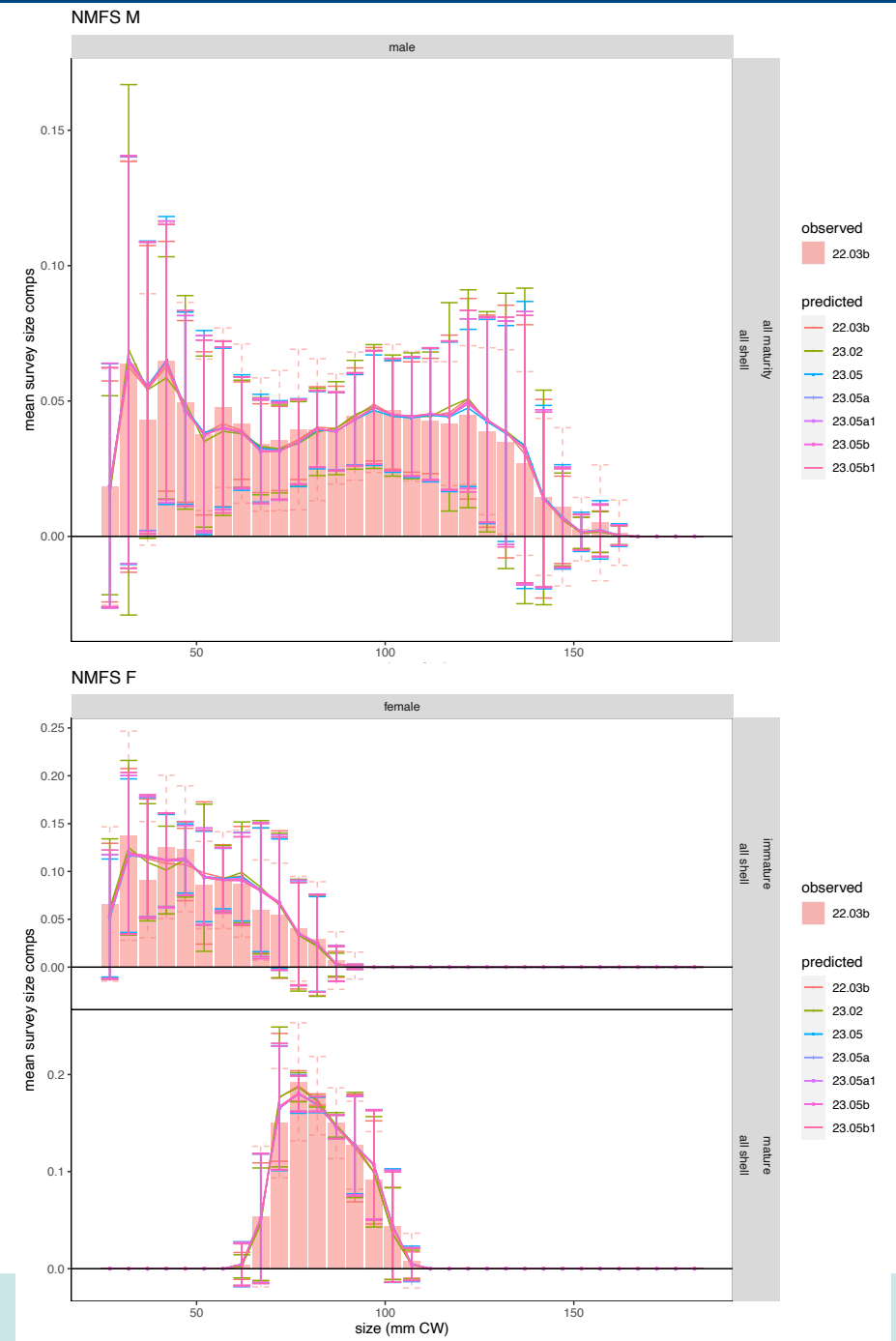
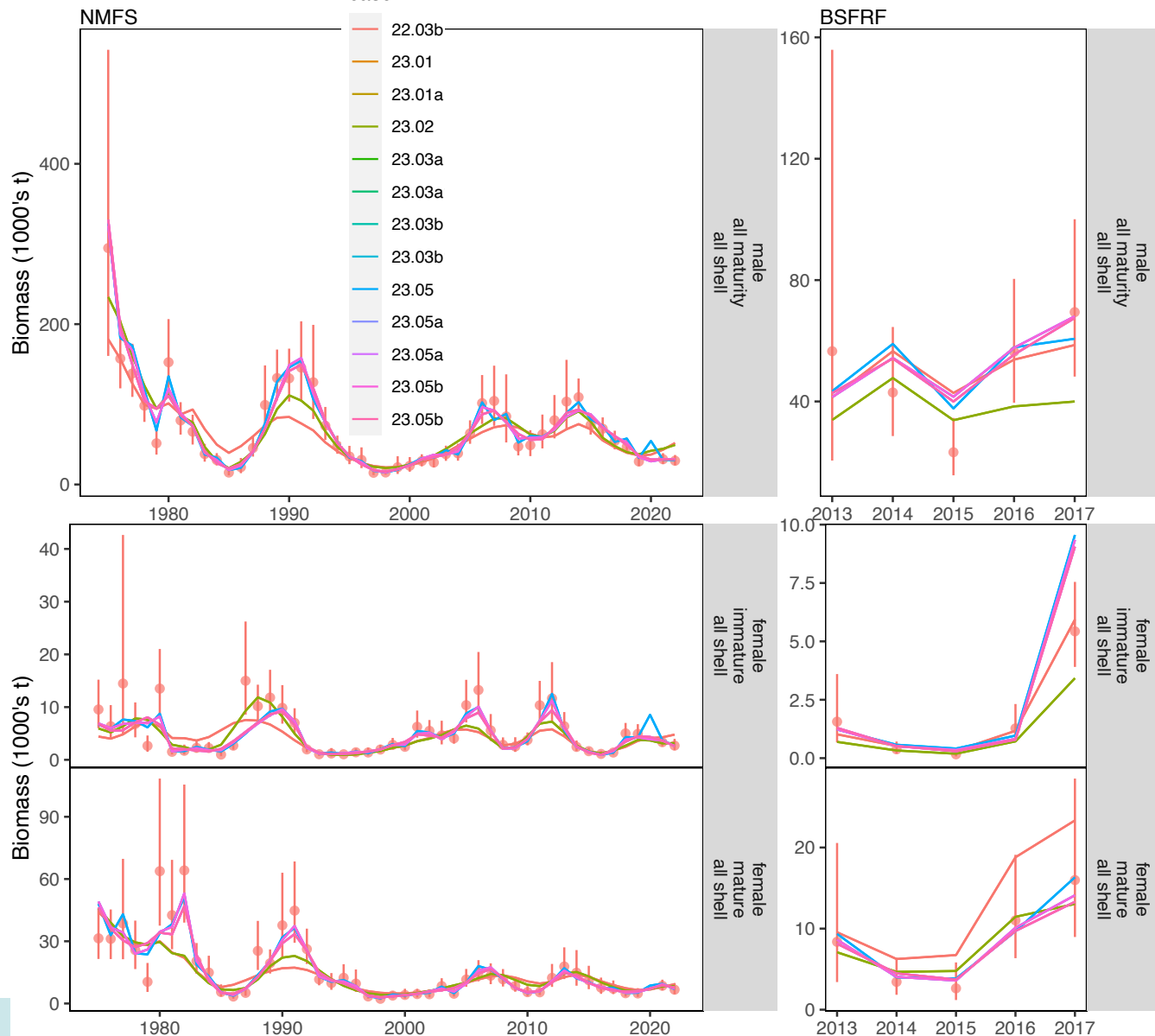
1-mm Model Size Bins: 23.01, 23.01a

fleet	catch type	data type	sex	23.01	23.01a
NMFS M	abundance		female	-	-
			male	-	-
	biomass		female	-	-
			male	-1.899	-1.798
	n.at.z		male	5.375	4.839
	NMFS F	abundance		female	-
male				-	-
biomass			female	-3.126	-3.549
			male	-	-
n.at.z			female	0.478	0.647
SBS BSFRF M		abundance		female	-
	male			-	-
	biomass	index catch	female	-	-
			male	-0.037	-0.025
	n.at.z		male	-0.021	0.325
	SBS BSFRF F	abundance		female	-
male				-	-
biomass			female	-0.128	-0.222
			male	-	-
n.at.z			female	0.082	0.134
EBS molt increment data			female	5.449	6.240
	male		-0.181	-0.011	
NMFS M	EBS mature male ratios		male	-2.298	0.158

base model: 22.03b

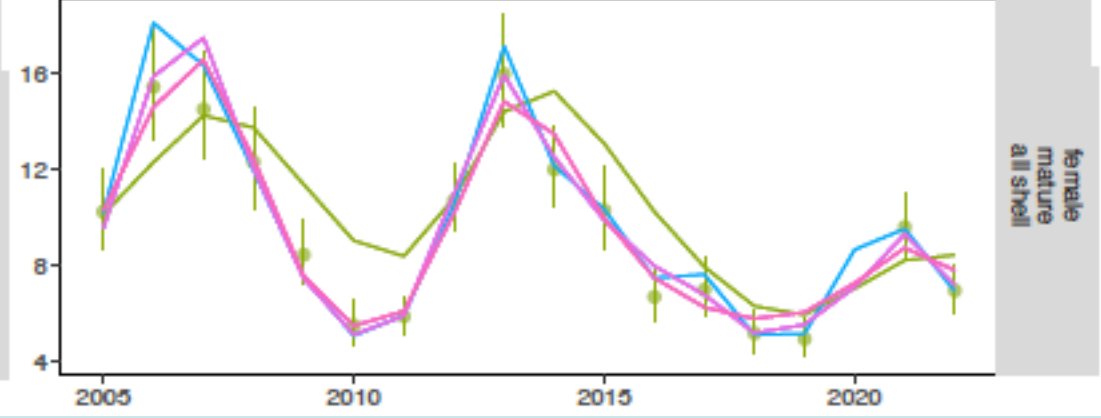
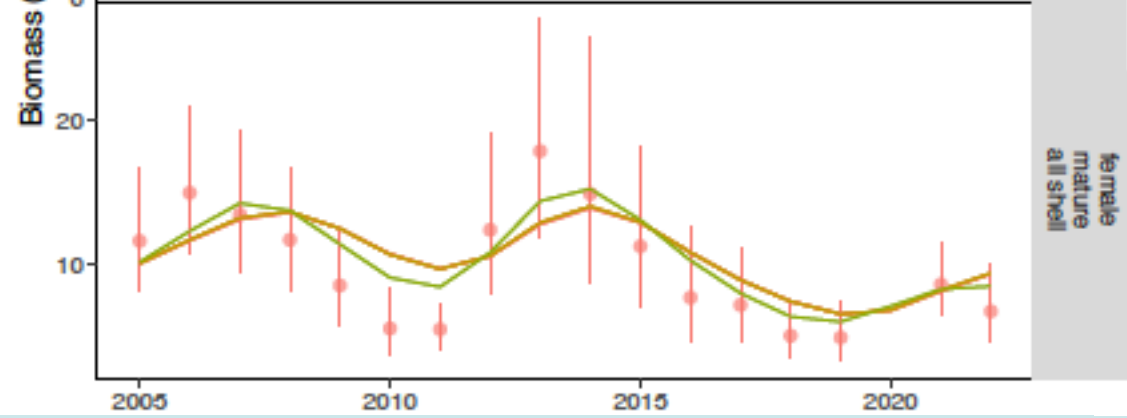
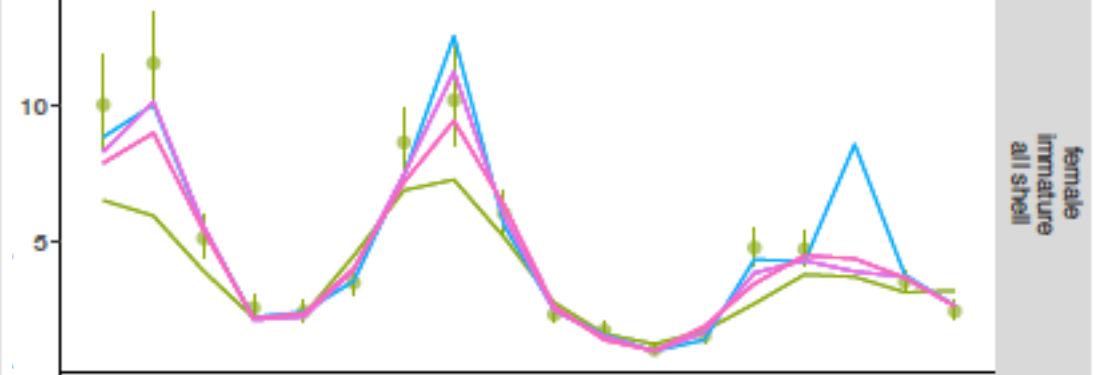
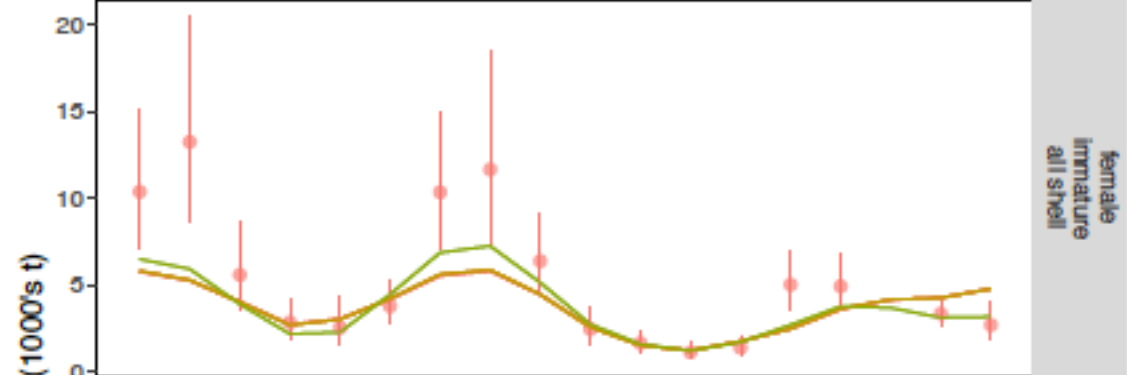


23.02 + 23.05's: Fits to NMFS EBS Survey

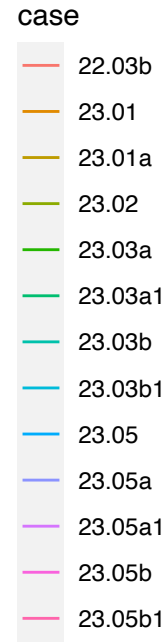
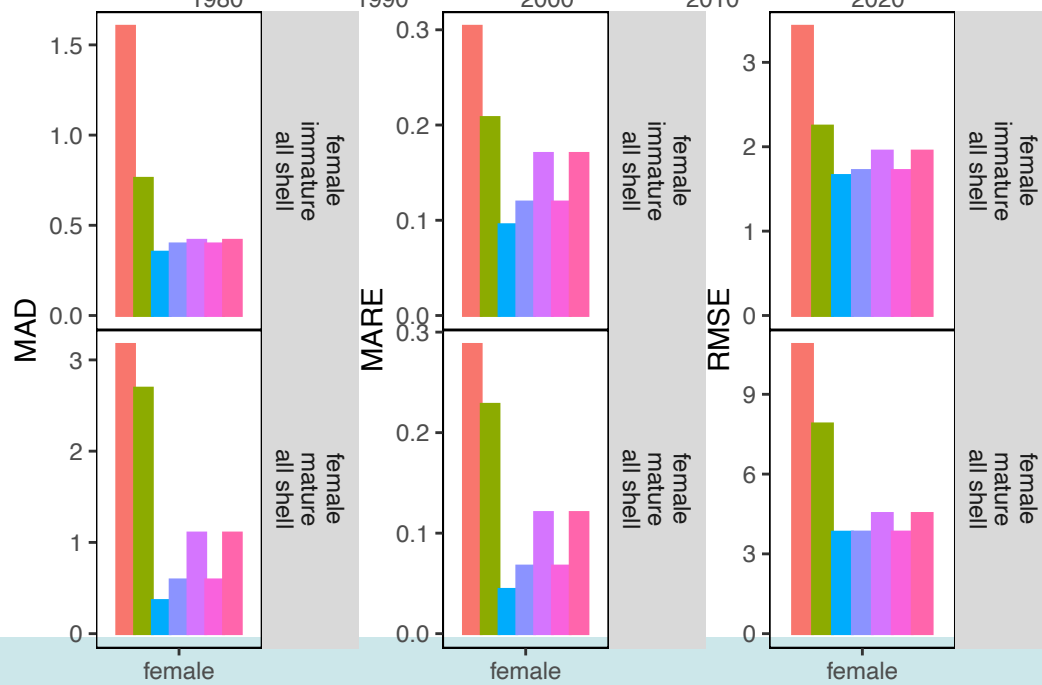
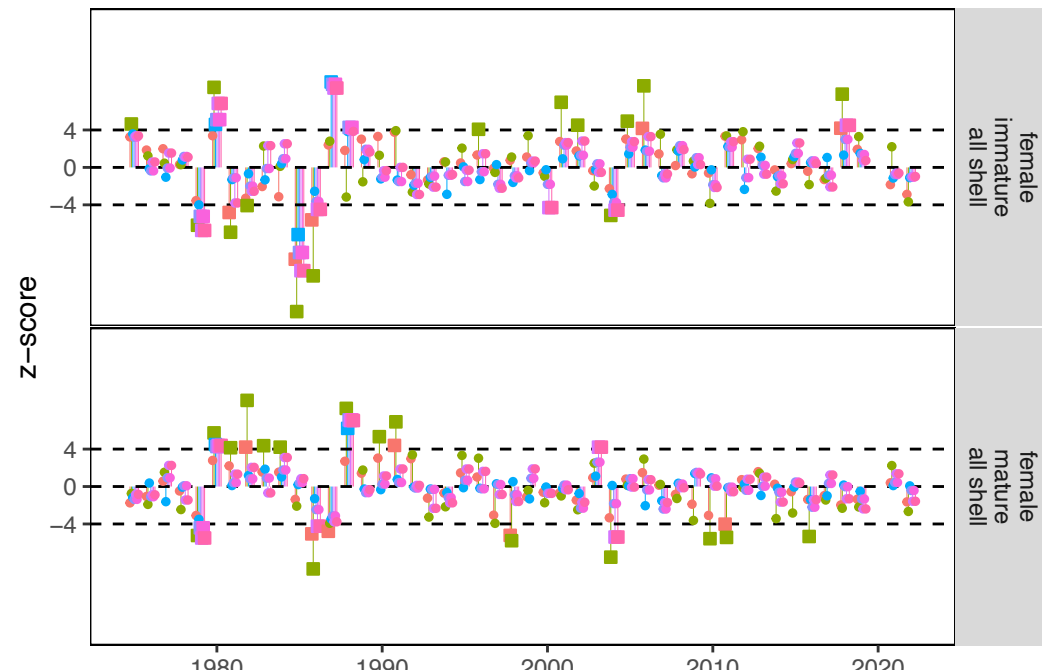
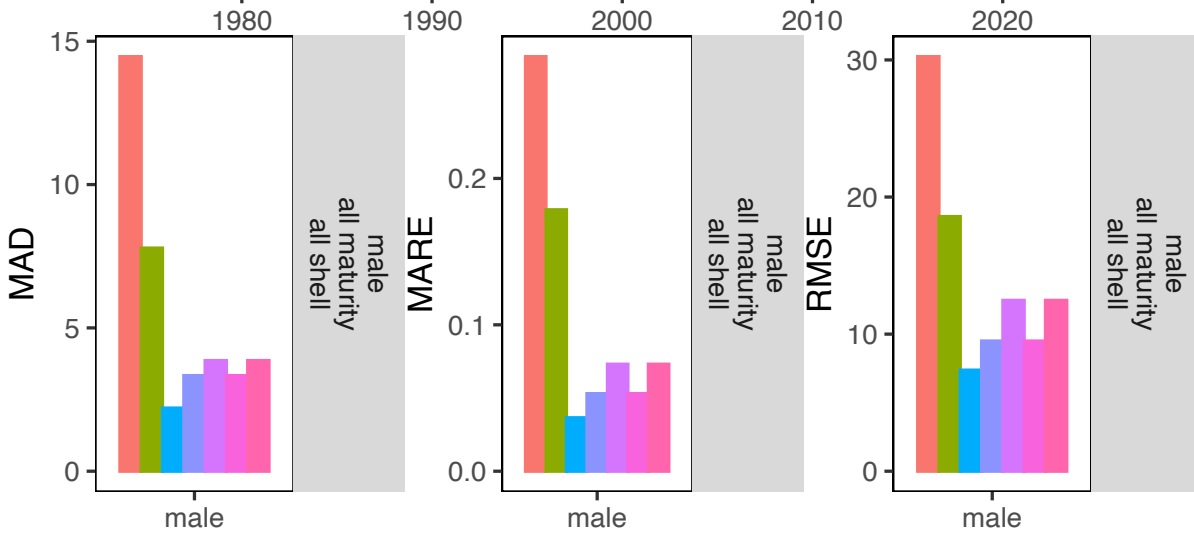
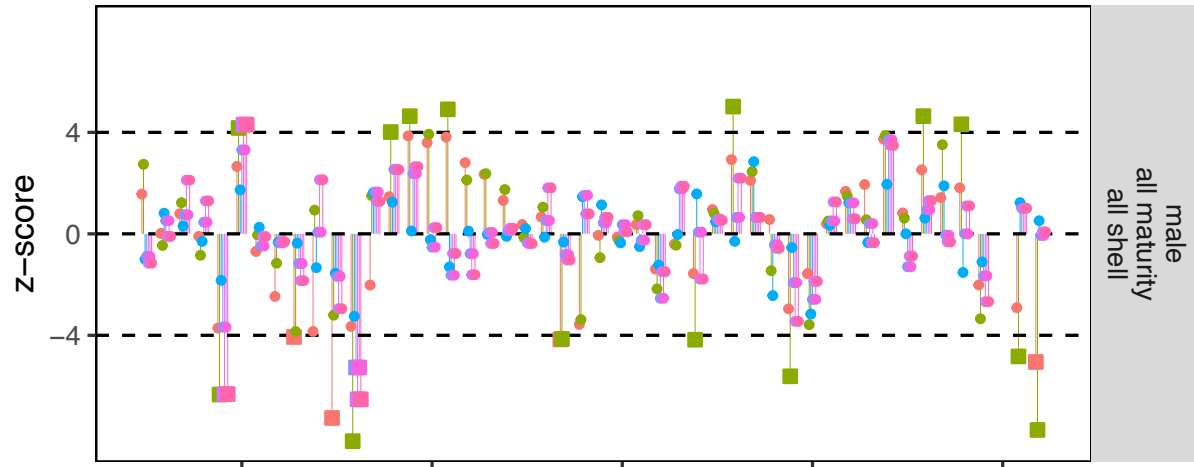


23.02 + 23.05's

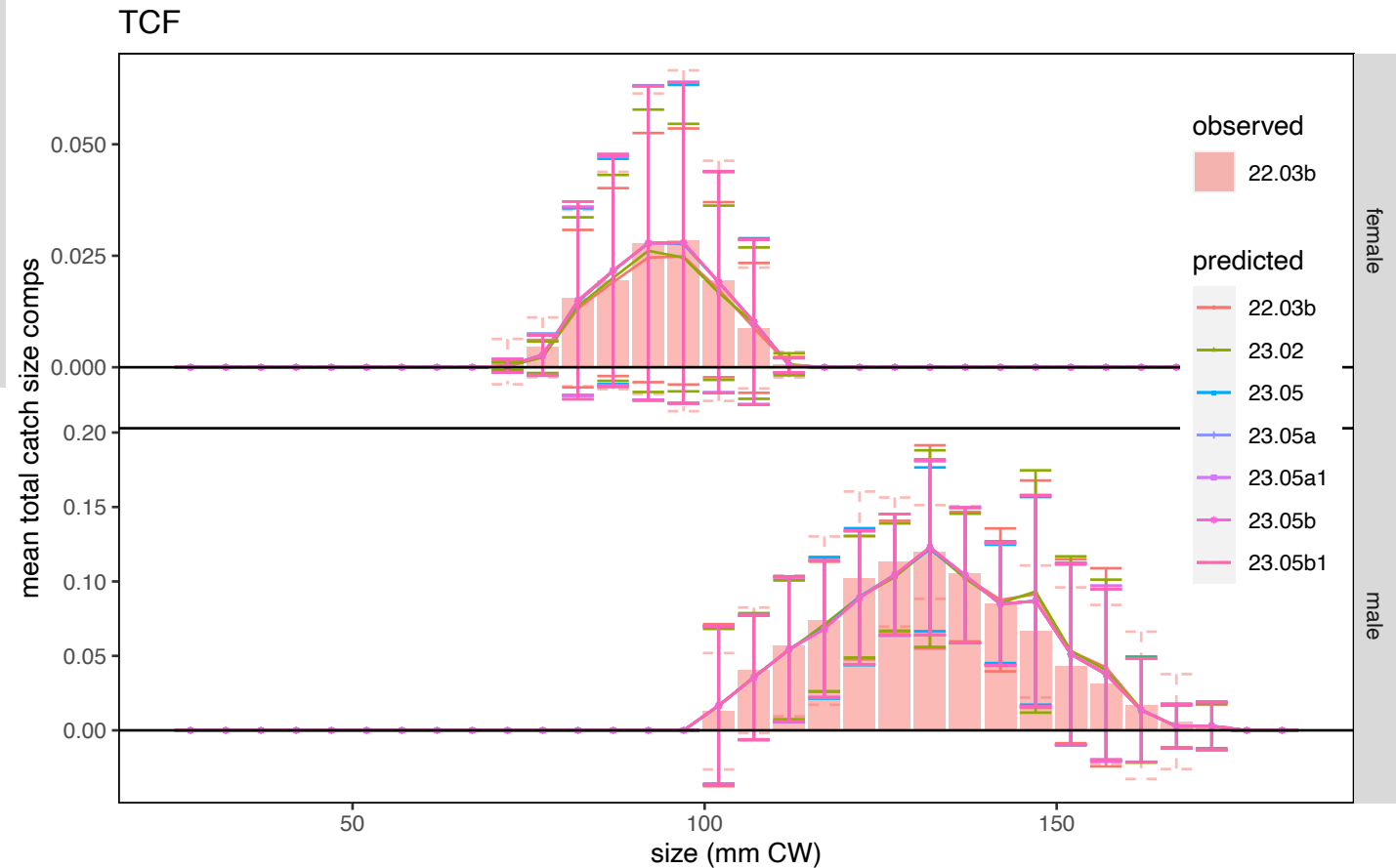
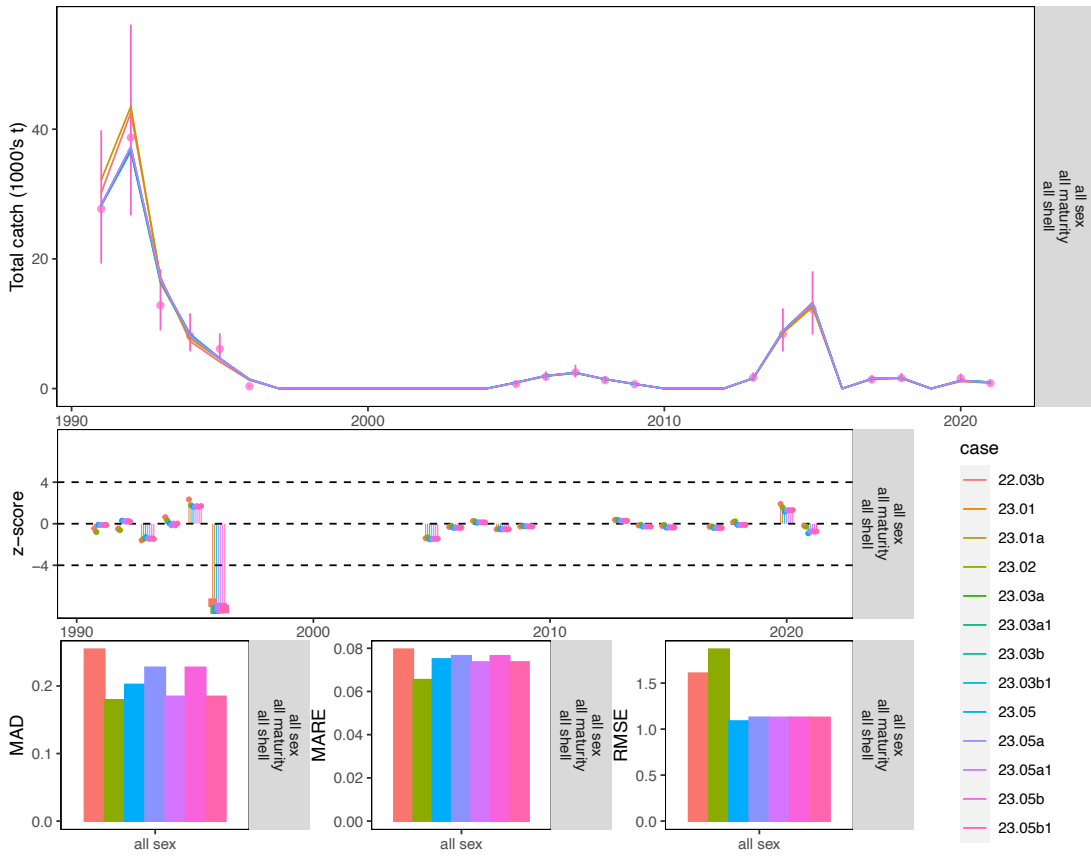
- 22.03b
- 23.01
- 23.01a
- 23.02
- 23.03a
- 23.03a
- 23.03b
- 23.03b
- 23.05
- 23.05a
- 23.05a
- 23.05b
- 23.05b



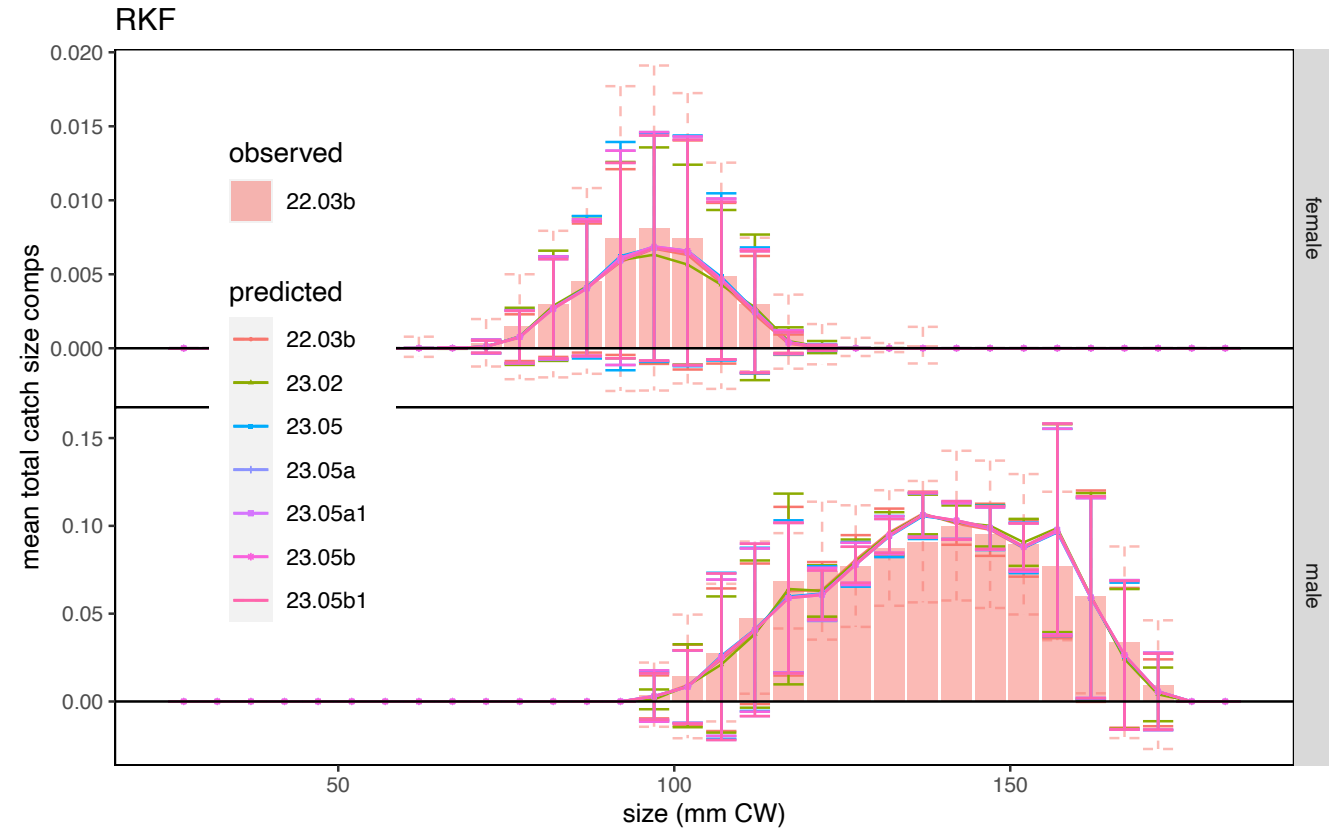
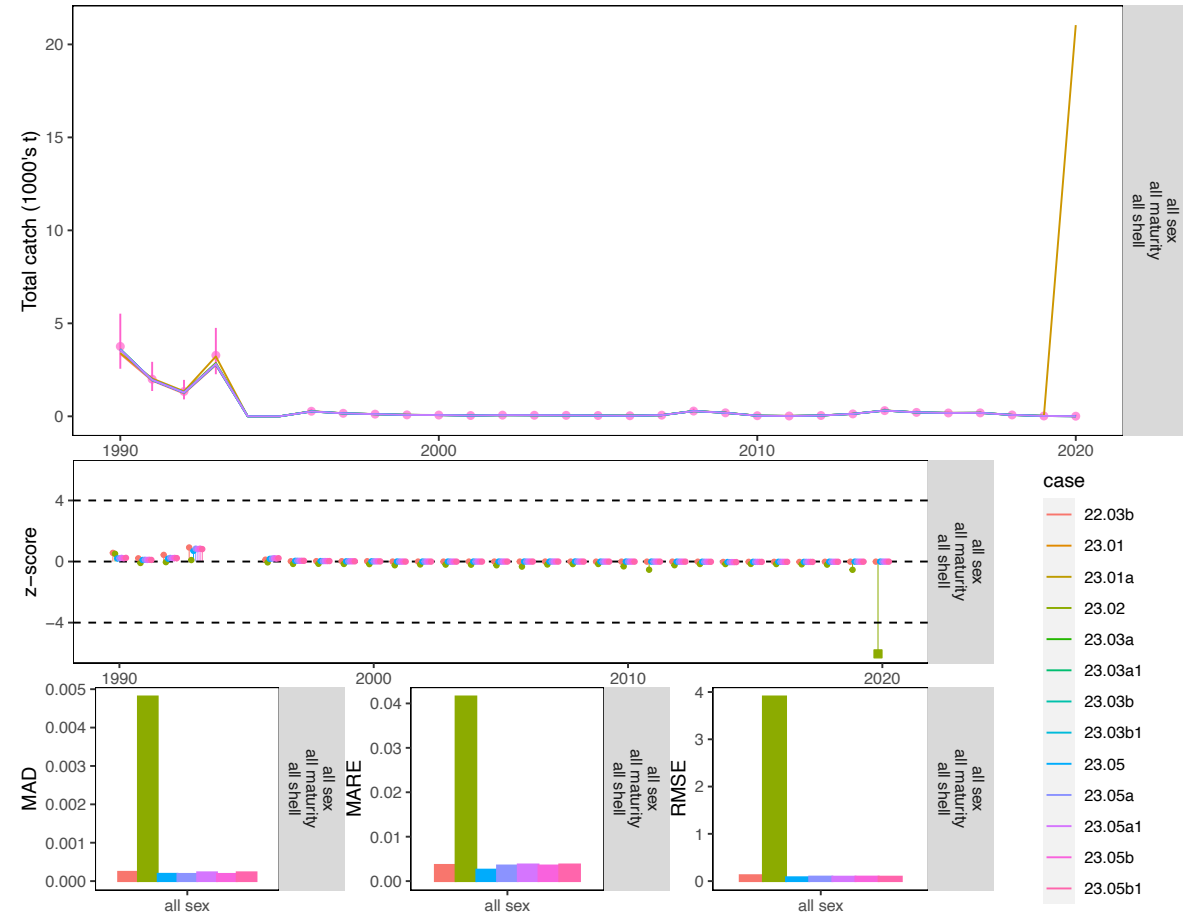
23.02 + 23.05's: Fits to NMFS EBS Survey



23.02 + 23.05's: Fits to Directed Fishery Total Catch



23.02 + 23.05's: Fits to BBRKC Total Catch



23.02 + 23.05's: Differences from 23.03b

surveys

fisheries

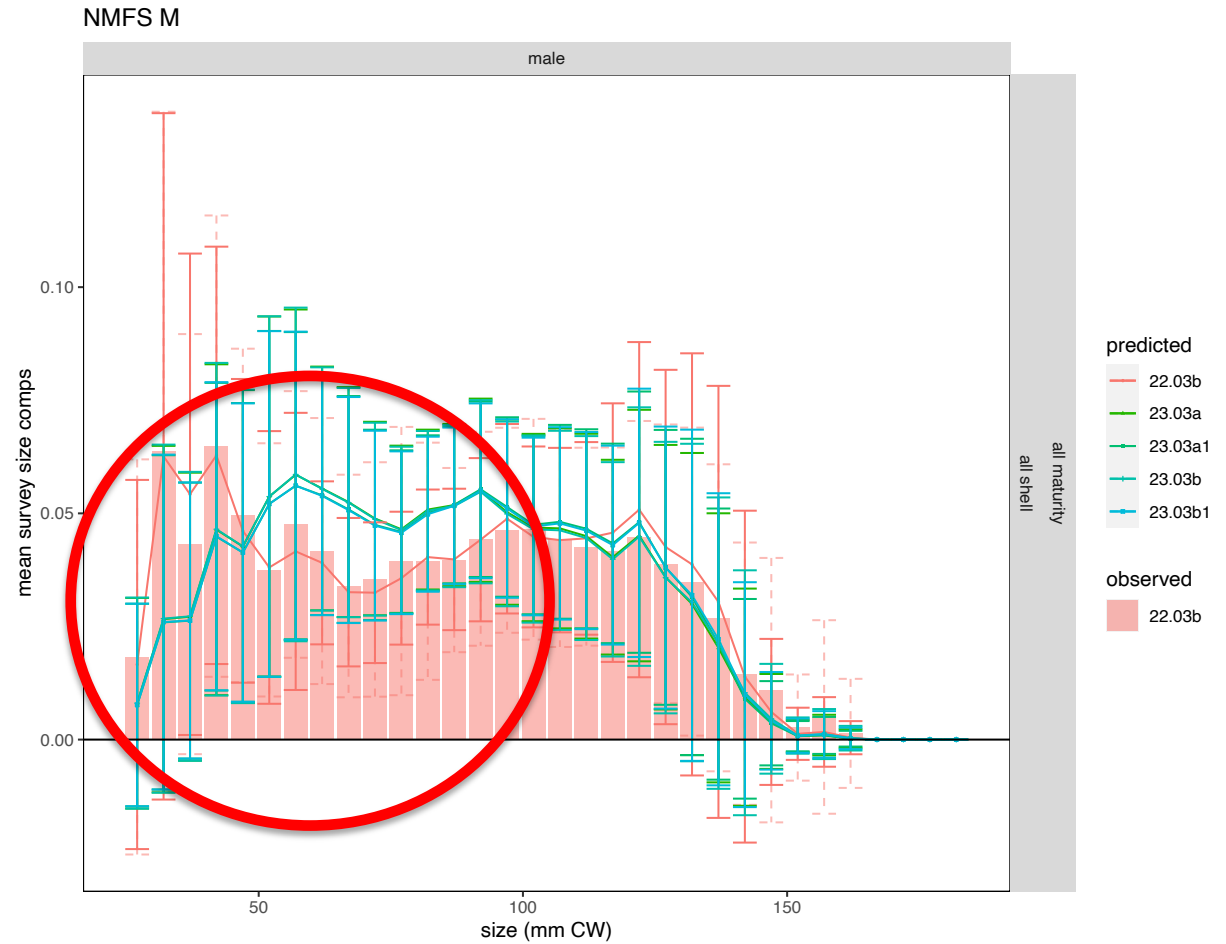
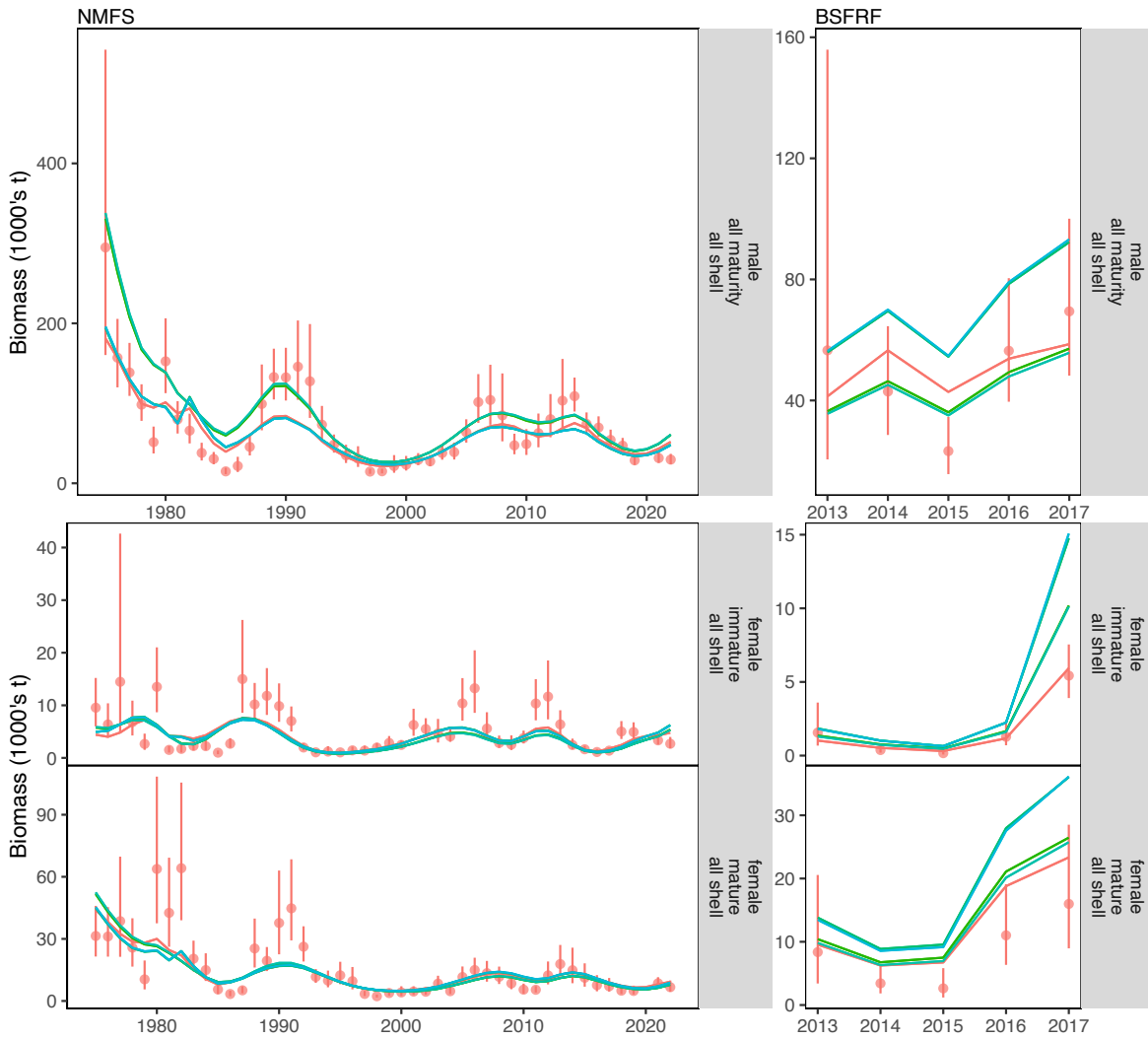
fleet	data type	sex	23.02	23.05	23.05a	23.05a1	23.05b	23.05b1
NMFS M	abundance	female	-	-	-	-	-	-
		male	-	-	-	-	-	
	biomass	female	-	-	-	-	-	
		male	78.797	-158.307	-134.634	-93.790	-134.634	-93.790
	n.at.z	male	139.617	-77.049	-67.095	-44.507	-67.095	-44.507
NMFS F	abundance	female	-	-	-	-	-	
		male	-	-	-	-	-	
	biomass	female	505.128	-204.465	-149.026	-9.392	-149.026	-9.392
		male	-	-	-	-	-	
	n.at.z	female	78.557	-37.563	-36.086	-21.341	-36.086	-21.341
SBS BSFRF M	abundance	female	-	-	-	-	-	
		male	-	-	-	-	-	
	biomass	female	-	-	-	-	-	
		male	2.927	-1.652	-1.109	-1.695	-1.109	-1.695
	n.at.z	male	8.711	9.562	6.240	5.029	6.240	5.029
SBS BSFRF F	abundance	female	-	-	-	-	-	
		male	-	-	-	-	-	
	biomass	female	-0.180	0.696	-0.390	-1.036	-0.390	-1.036
		male	-	-	-	-	-	
	n.at.z	female	7.643	-11.376	-12.821	-12.335	-12.821	-12.335

fleet	data type	sex	23.02	23.05	23.05a	23.05a1	23.05b	23.05b1
TCF	abundance	female	-	-	-	-	-	-
		male	-	-	-	-	-	
	biomass	female	-	-	-	-	-	
		male	10.239	-1.928	-1.268	-0.751	-1.268	-0.751
	n.at.z	male	5.275	-12.701	-10.869	-10.528	-10.869	-10.528
SCF	abundance	all sexes	-	-	-	-	-	
		all sexes	3.340	2.477	0.718	2.347	0.718	2.347
	biomass	female	-1.117	-18.694	-17.026	-15.712	-17.026	-15.712
		male	-7.241	-33.498	-27.585	-26.696	-27.585	-26.696
	n.at.z	all sexes	-	-	-	-	-	
GF All	abundance	all sexes	0.717	-0.174	-0.189	-0.153	-0.189	-0.153
		all sexes	2.190	-2.439	-2.293	-4.144	-2.293	-4.144
	biomass	female	15.016	5.277	2.007	1.791	2.007	1.791
		male	15.016	5.277	2.007	1.791	2.007	1.791
	n.at.z	all sexes	-2.474	-3.089	-2.830	-2.605	-2.830	-2.605
RKF	abundance	all sexes	-3.810	1.222	1.264	1.222	1.264	1.222
		all sexes	33.976	11.455	15.929	21.960	15.929	21.960
	biomass	female	38.272	-27.099	-14.143	-18.000	-14.143	-18.000
		male	38.272	-27.099	-14.143	-18.000	-14.143	-18.000
	n.at.z	all sexes	18.428	-0.406	-0.278	-0.293	-0.278	-0.293
n.at.z	female	1.147	0.370	0.194	0.246	0.194	0.246	
	male	0.091	-1.100	-1.352	-0.804	-1.352	-0.804	

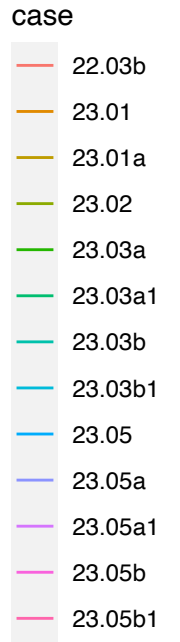
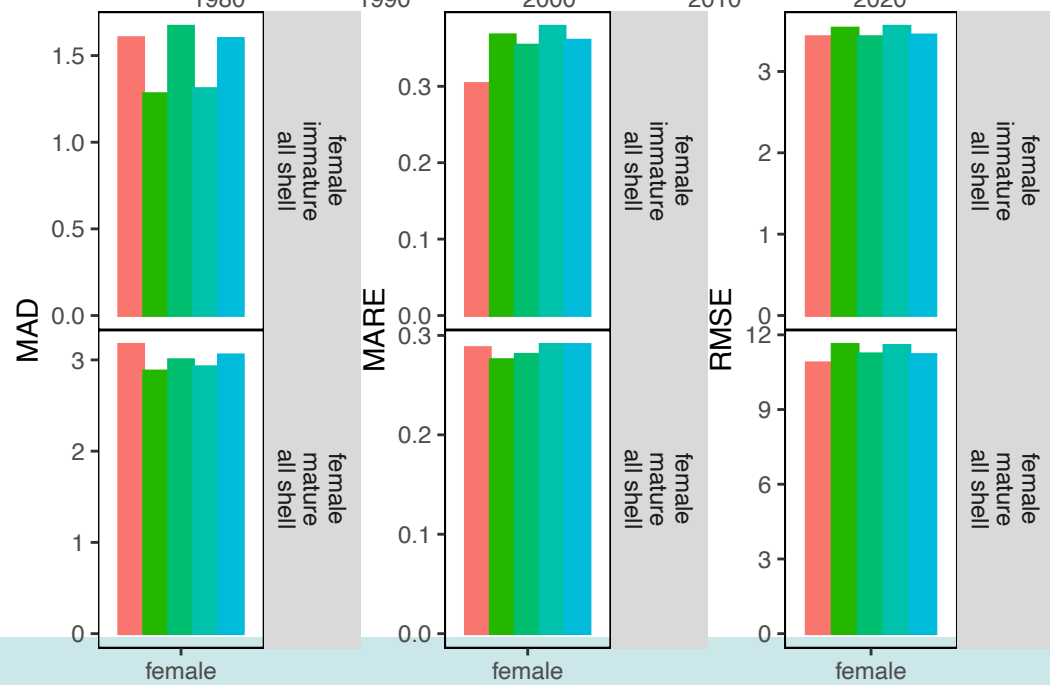
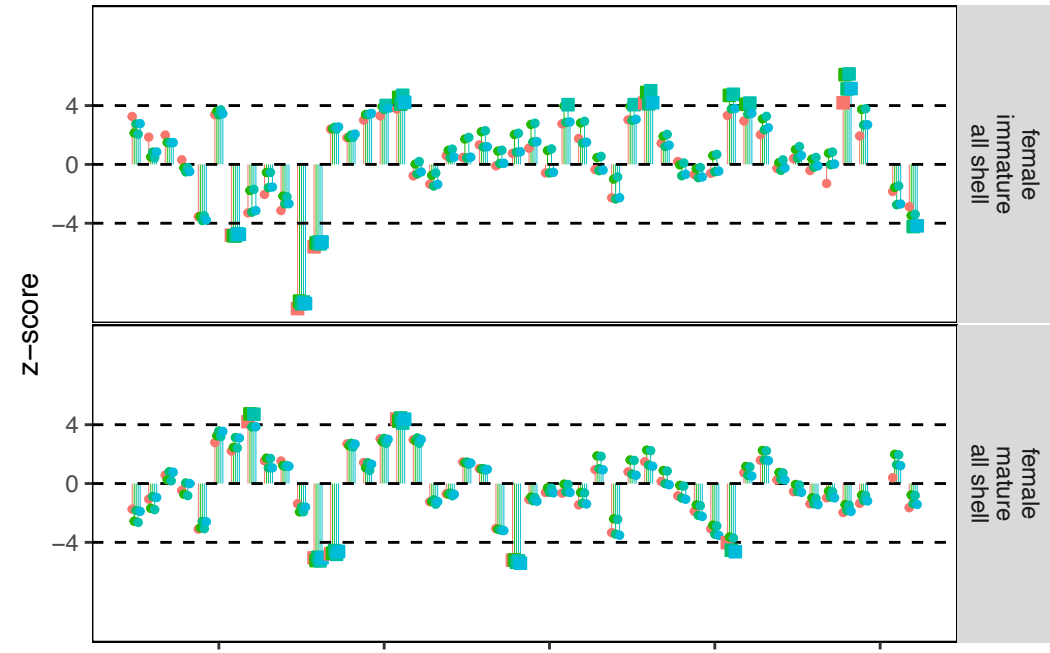
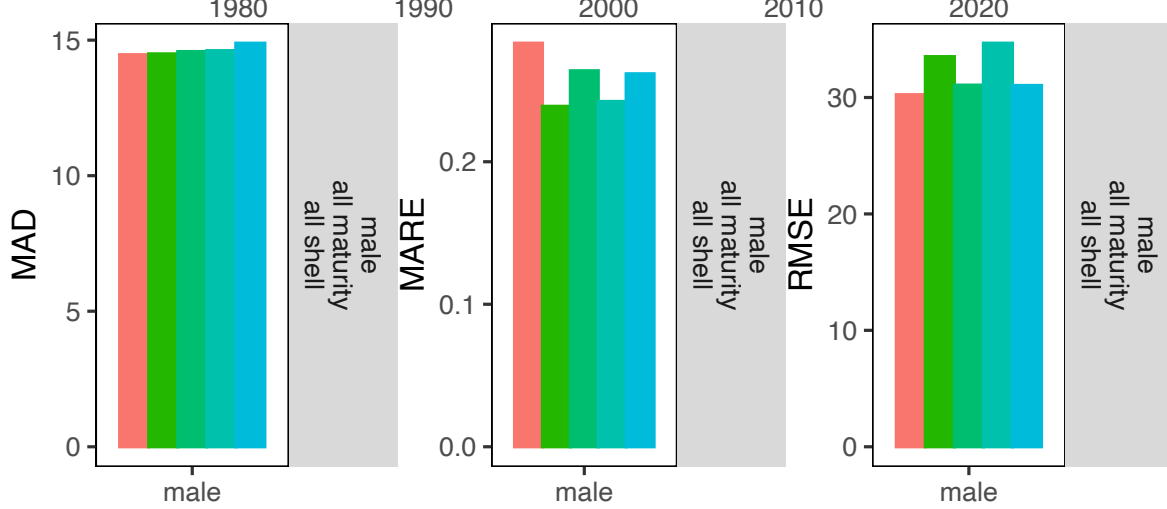
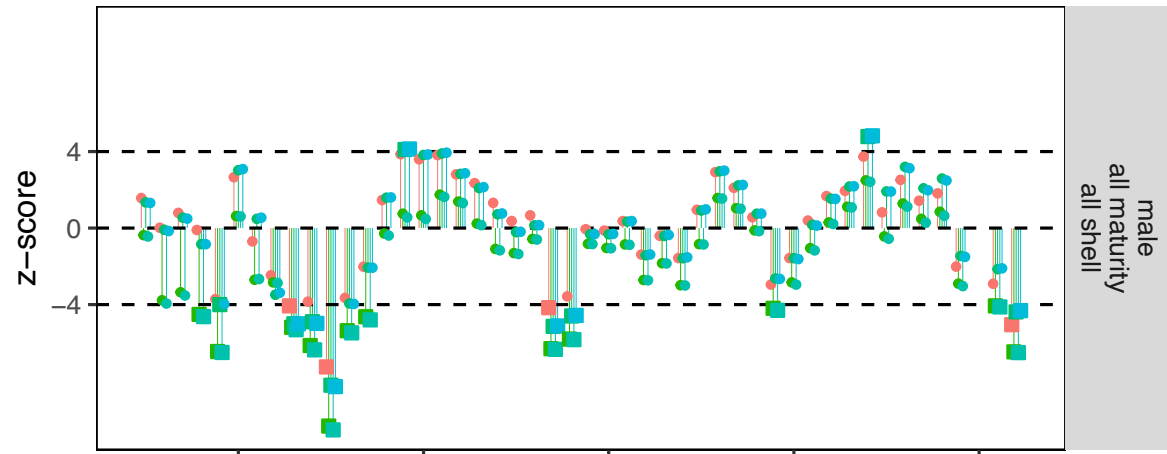
retained

total catch

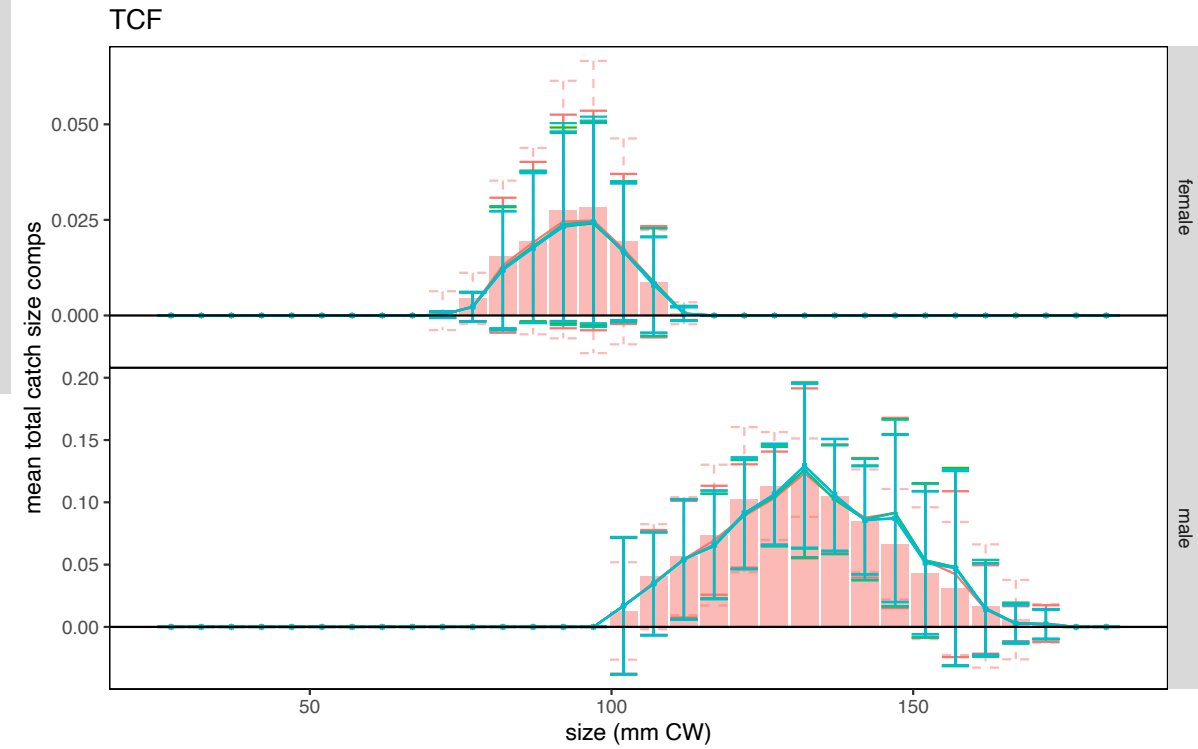
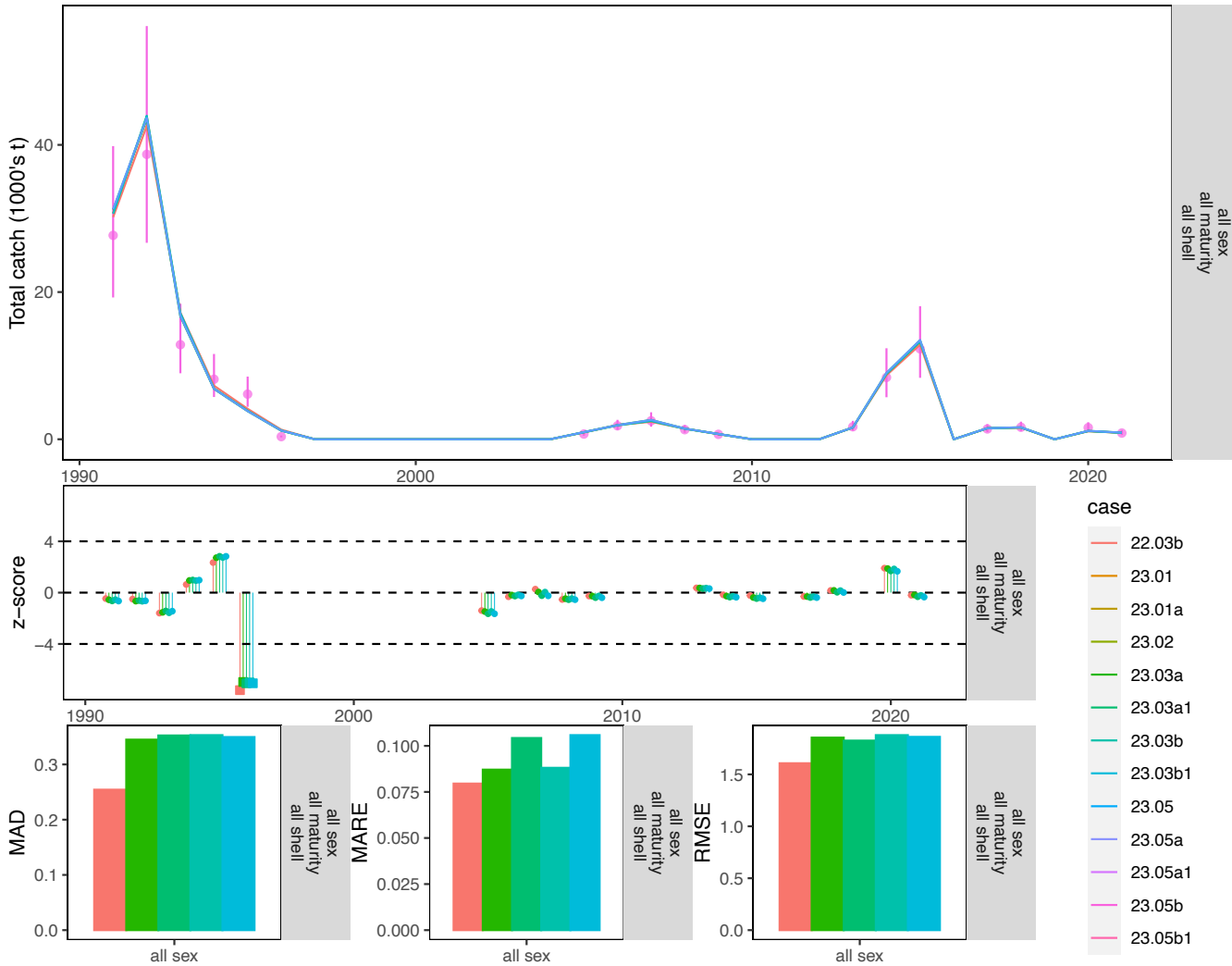
23.03's: Fits to NMFS Survey



23.03's: Fits to NMFS Survey



23.03's: Fits to Total Catch in the Directed Fishery



23.03's: Objective Function differences from 23.03b

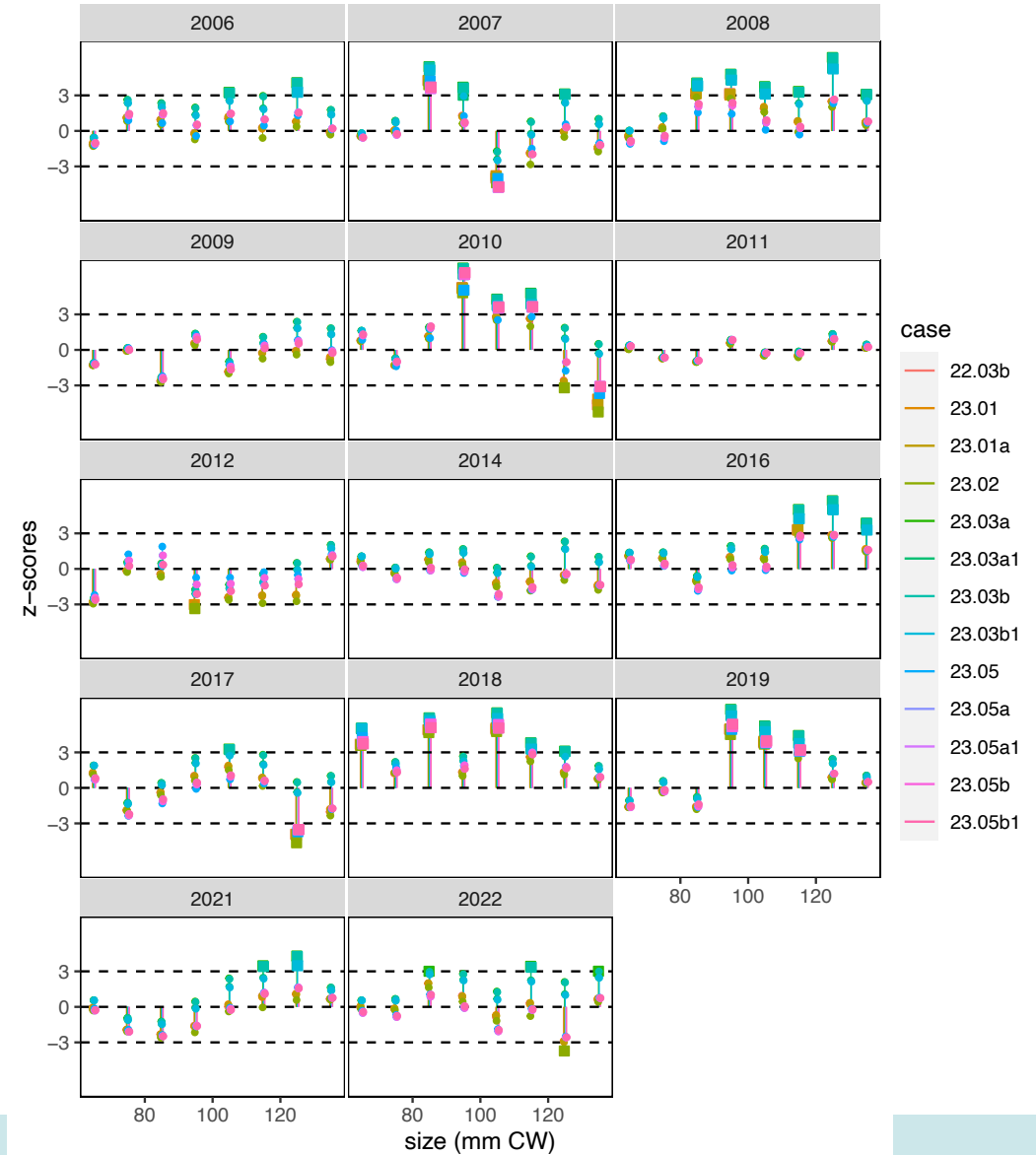
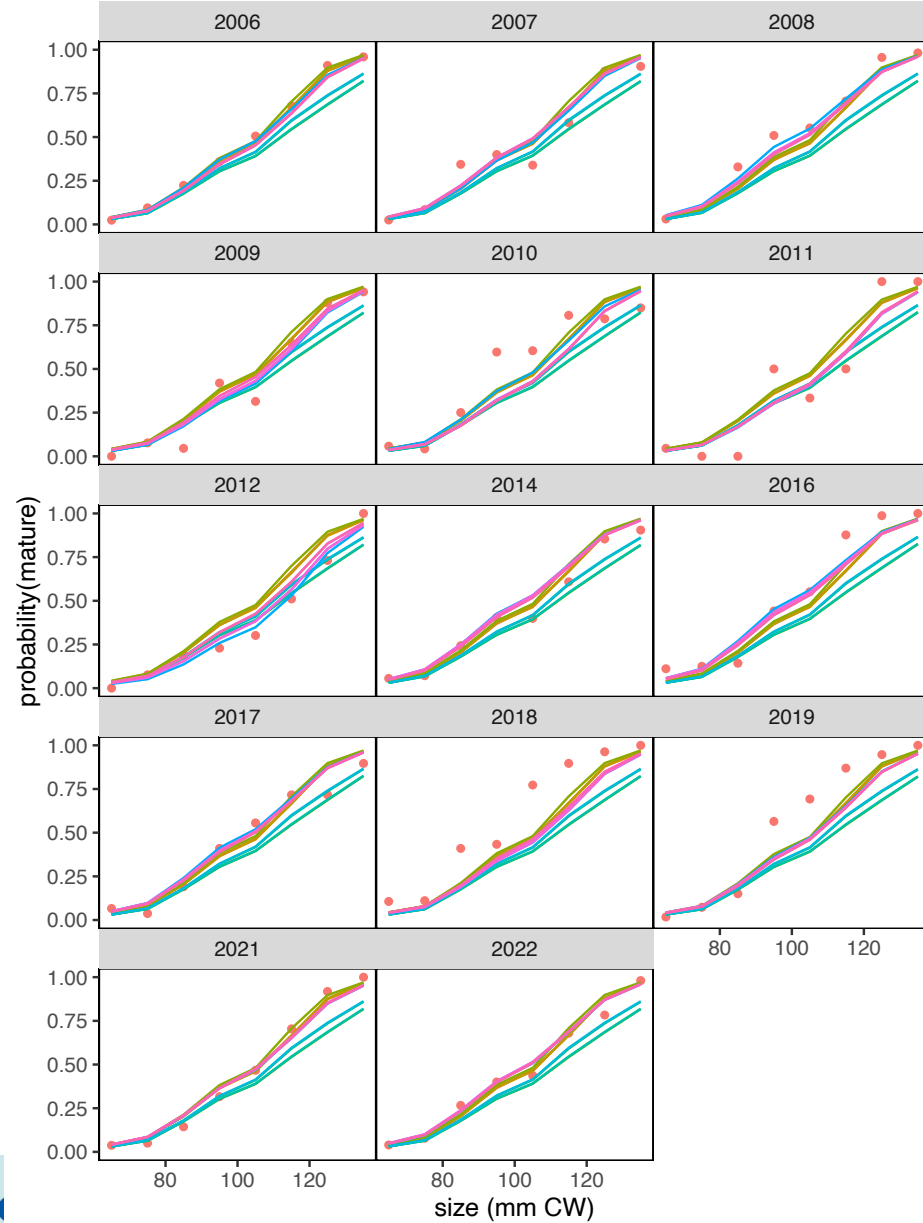
surveys

fleet	data type	sex	23.03a	23.03a1	23.03b	23.03b1
	abundance	female	-	-	-	-
		male	-	-	-	-
	biomass	female	-	-	-	-
		male	107.528	36.672	116.510	37.266
n.at.z	male	307.892	300.040	294.859	282.789	
	female	-	-	-	-	
NMFS M	abundance	female	-	-	-	-
		male	-	-	-	-
	biomass	female	38.604	16.355	44.183	18.852
		male	-	-	-	-
n.at.z	female	143.429	140.120	140.312	135.388	
	male	-	-	-	-	
NMFS F	abundance	female	-	-	-	-
		male	-	-	-	-
	biomass	female	-	-	-	-
		male	-	-	-	-
n.at.z	female	-	-	-	-	
	male	-	-	-	-	
SBS BSFRF M	biomass	female	-	-	-	-
		male	-2.455	8.326	-2.476	8.664
	n.at.z	male	-3.114	-8.058	-2.480	-7.700
		female	-	-	-	-
SBS BSFRF F	abundance	female	-	-	-	-
		male	-	-	-	-
	biomass	female	13.522	39.600	11.404	39.347
		male	-	-	-	-
n.at.z	female	-16.618	-17.028	-16.848	-16.799	
	male	-	-	-	-	

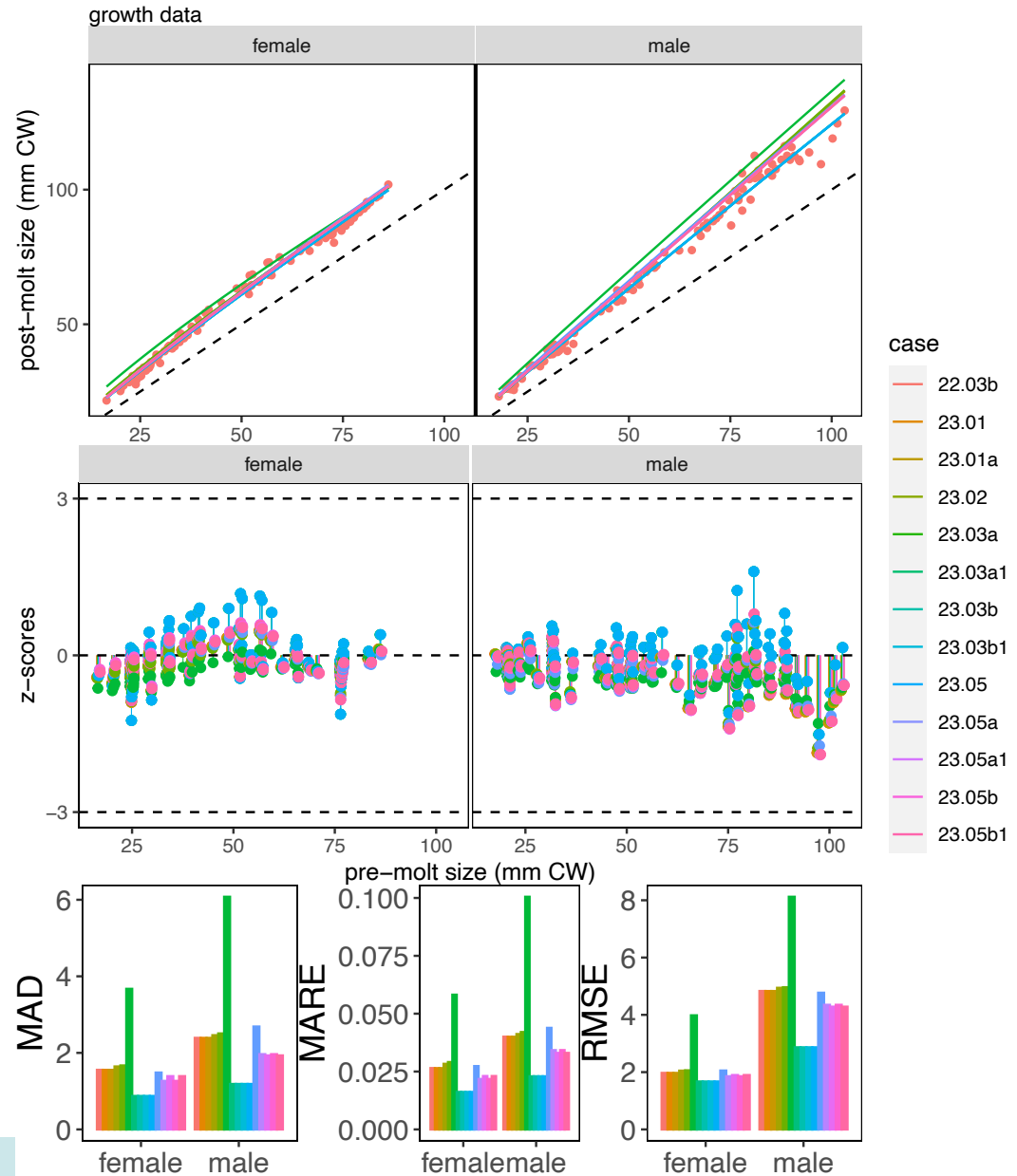
fisheries

fleet	data type	sex	23.03a	23.03a1	23.03b	23.03b1
	abundance	female	-	-	-	-
		male	-	-	-	-
	biomass	female	-	-	-	-
		male	25.373	1.783	28.033	1.852
n.at.z	male	14.120	-8.101	16.174	-7.848	
	female	-	-	-	-	
TCF	abundance	all sexes	-	-	-	-
		all sexes	-3.363	-2.318	-3.095	-2.292
	n.at.z	female	2.385	6.351	1.873	6.317
		male	2.057	-15.966	0.845	-16.873
SCF	abundance	all sexes	-	-	-	-
		all sexes	0.462	-0.068	0.496	-0.080
	n.at.z	female	1.045	1.440	0.088	0.654
		male	6.641	4.445	6.751	4.526
GF All	abundance	all sexes	0.430	-0.359	0.550	-0.352
		all sexes	0.134	0.399	0.094	0.381
	n.at.z	female	37.371	29.700	38.228	30.237
		male	100.440	86.710	103.713	88.232
RKF	abundance	all sexes	-	-	-	-
		all sexes	4.172	1.209	4.370	1.195
	n.at.z	female	-0.434	0.066	-0.557	0.000
		male	3.715	2.170	4.111	2.306

Other Data



Other Data



data type	sex	23.03a	23.03a1	23.03b	23.03b1
EBS molt increment	female	-30.229	-30.229	-30.229	-30.229
	male	-45.765	-45.765	-45.765	-45.765
EBS mature male ratios	male	231.408	130.123	224.125	122.043

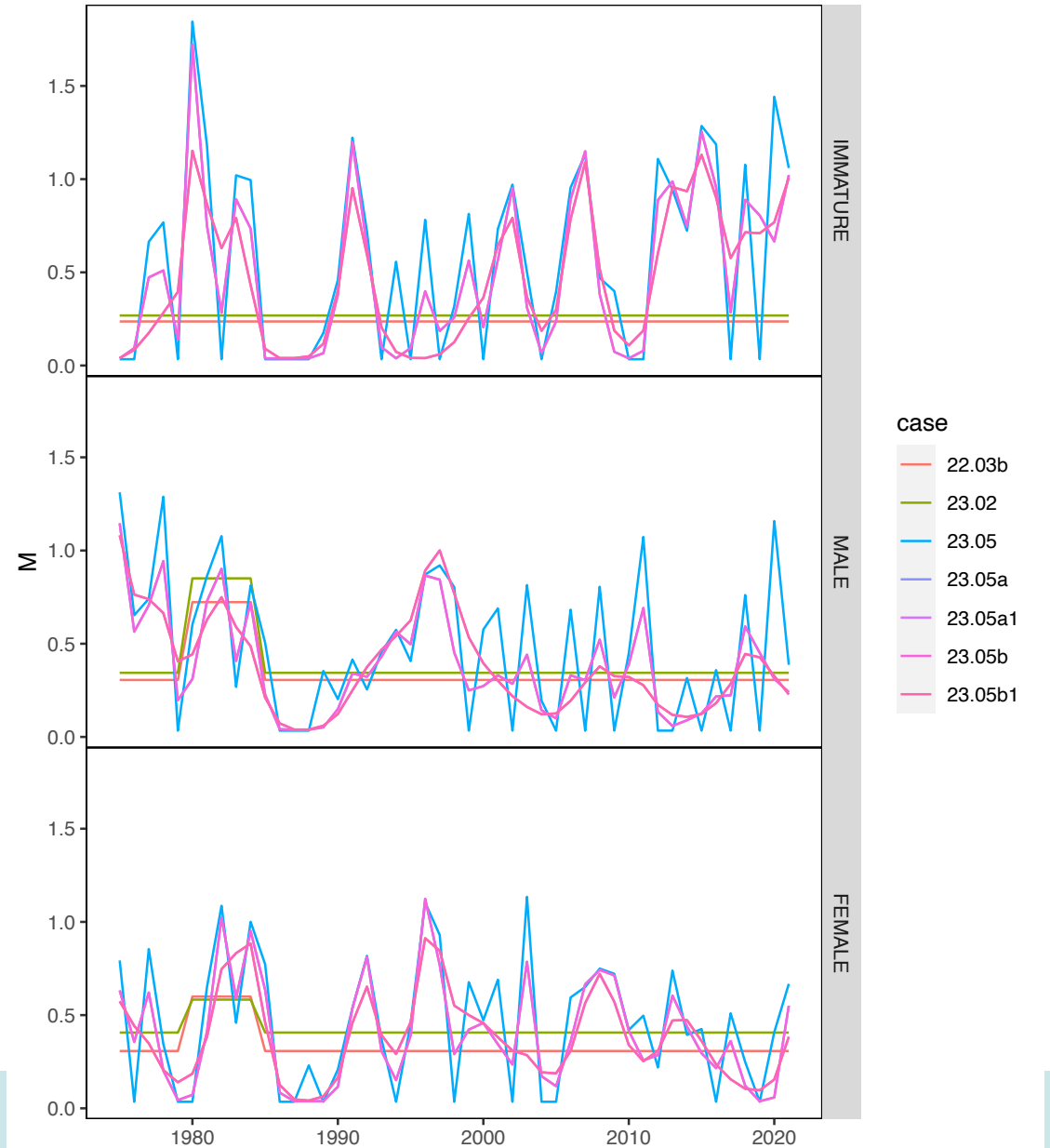
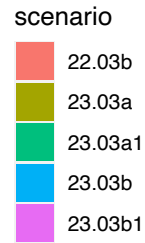
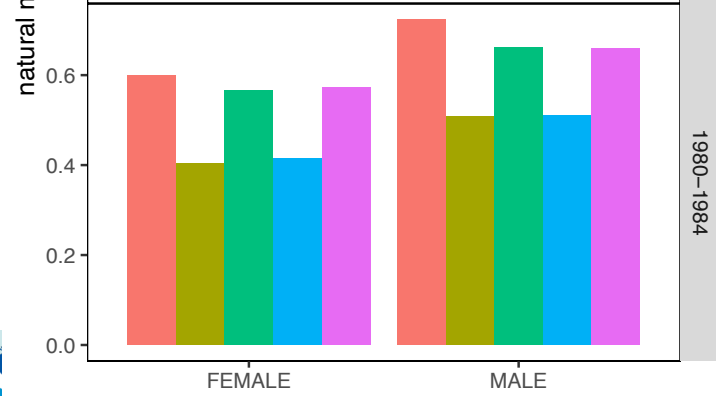
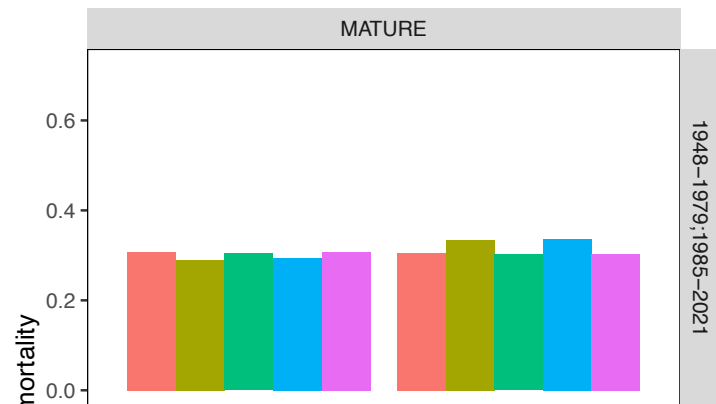
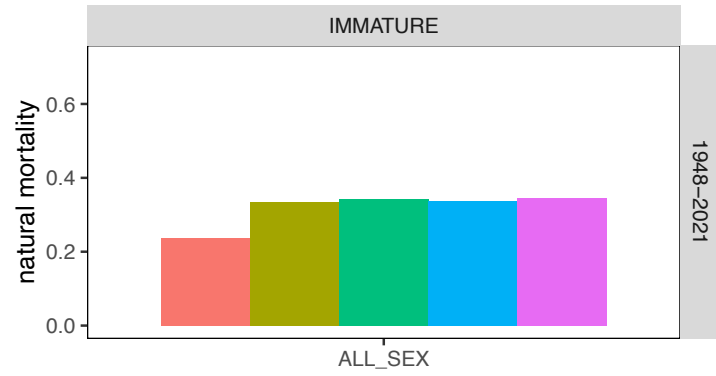
data type	sex	23.02	23.05	23.05a	23.05a1	23.05b	23.05b1
EBS molt increment	female	62.537	1.845	-8.969	-7.822	-8.969	-7.822
	male	40.597	0.170	-7.132	-9.573	-7.132	-9.573
EBS mature male ratios	male	-4.212	-18.308	3.339	5.858	3.339	5.858

Summary of model fits

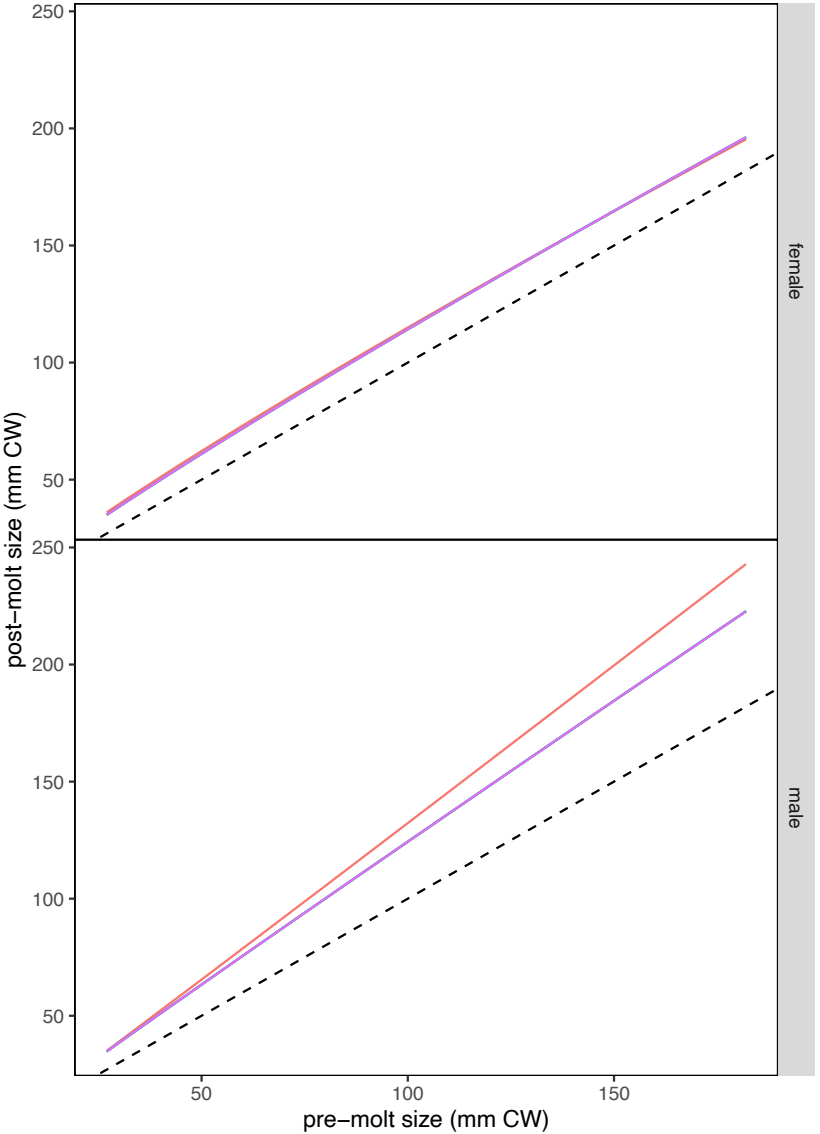
- 22.03b almost identical to 22.03
 - 22.03b taken as base model for remaining comparisons
- 23.01, 23.01a very similar to 22.03b, just slightly worse
- 23.02: likelihoods for NMFS survey biomass not comparable with 22.03b
 - better absolute-scale fits to NMFS survey biomass
 - worse fits to NMFS size compositions
 - worse fits generally to other data sources
- 23.05's: substantial improvements in fits to NMFS survey biomass over 23.02
 - generally improved fits to size compositions compared with 22.03b (and 23.02)
- 23.03's: fits substantially degraded by fixing growth, NMFS survey selectivity



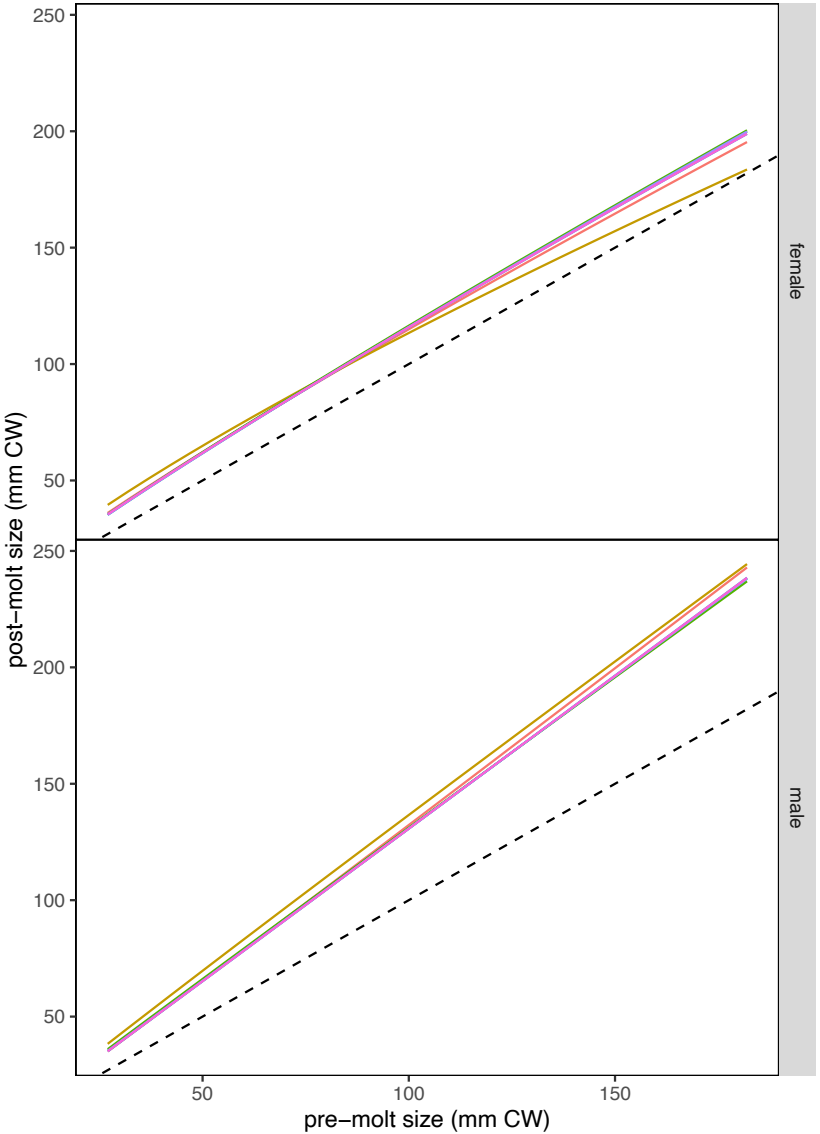
M



Mean Growth



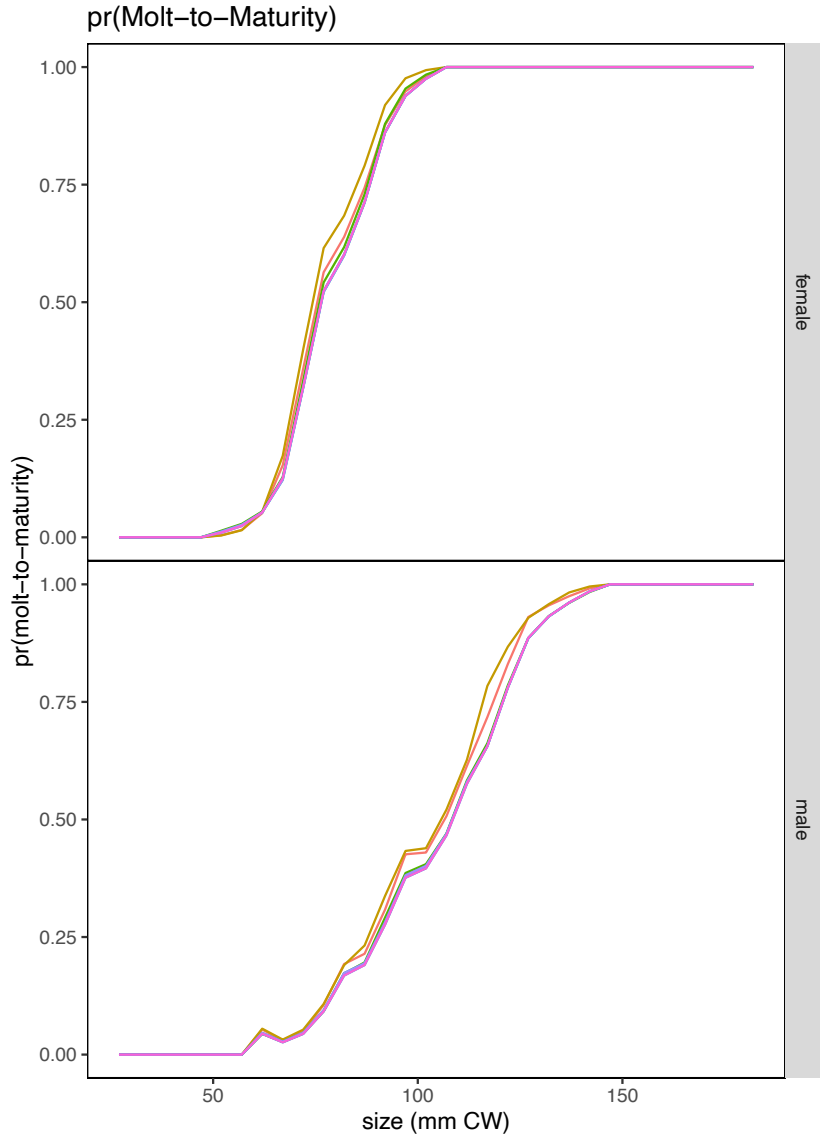
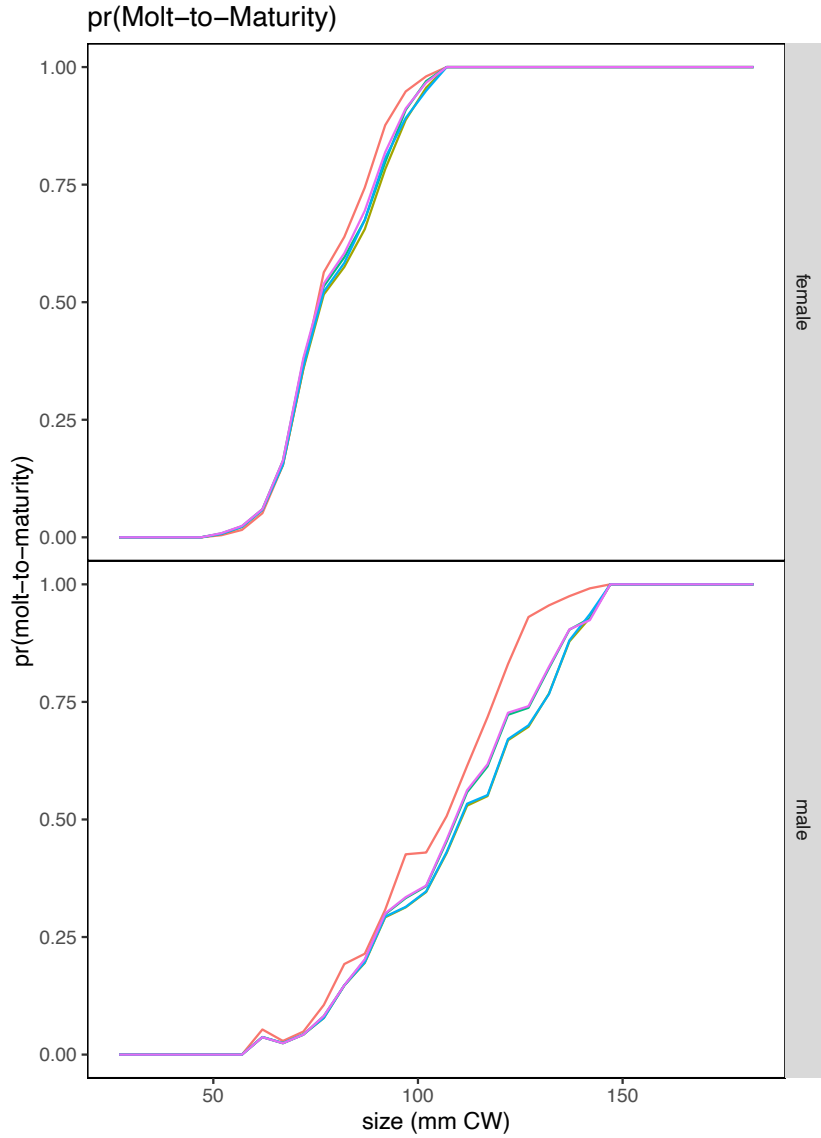
- case
- 22.03b
 - 23.03a
 - 23.03a1
 - 23.03b
 - 23.03b1



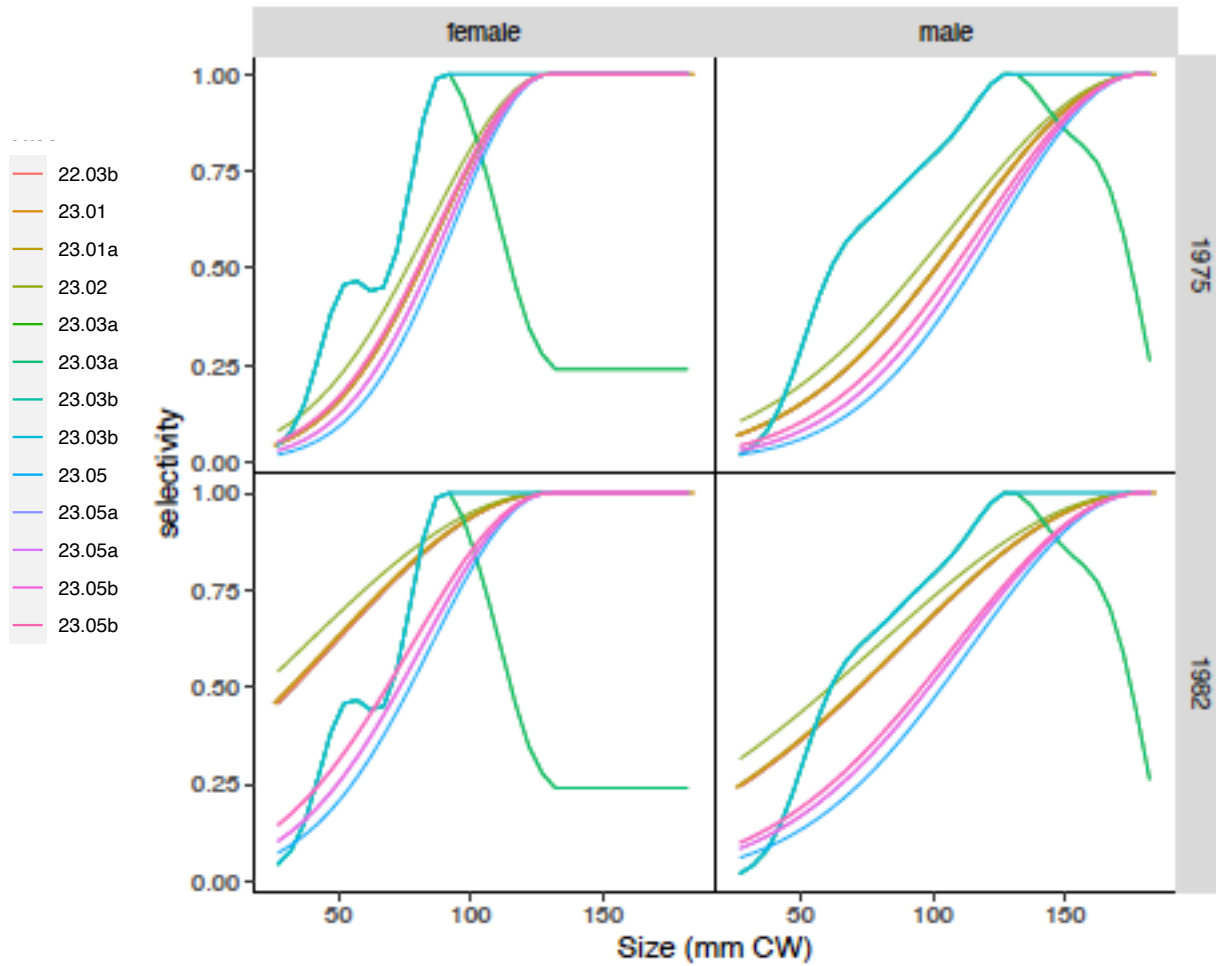
- case
- 22.03b
 - 23.02
 - 23.05
 - 23.05a
 - 23.05a1
 - 23.05b
 - 23.05b1



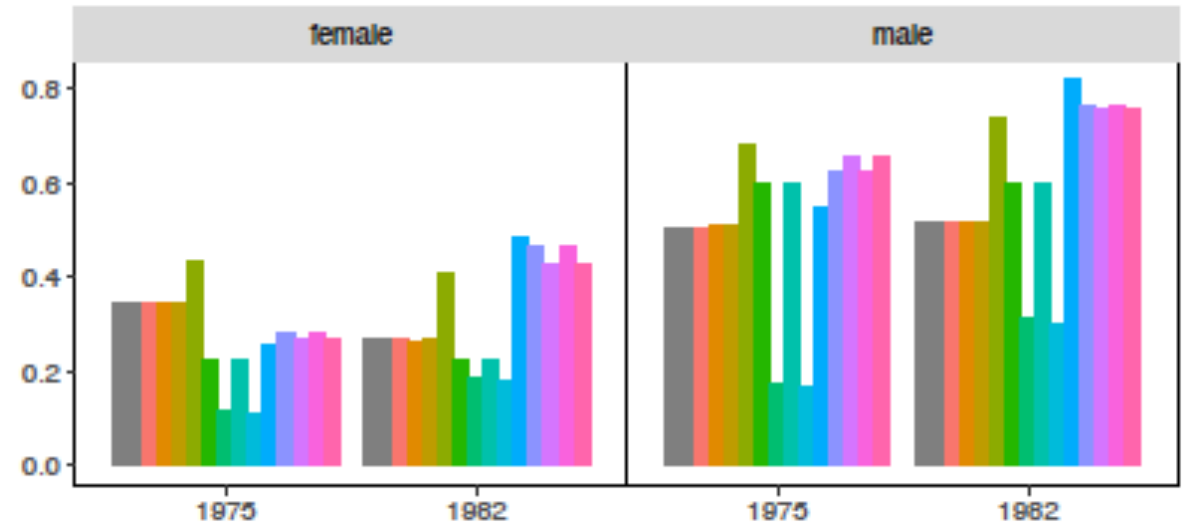
Pr(terminal molt|pre-molt size)



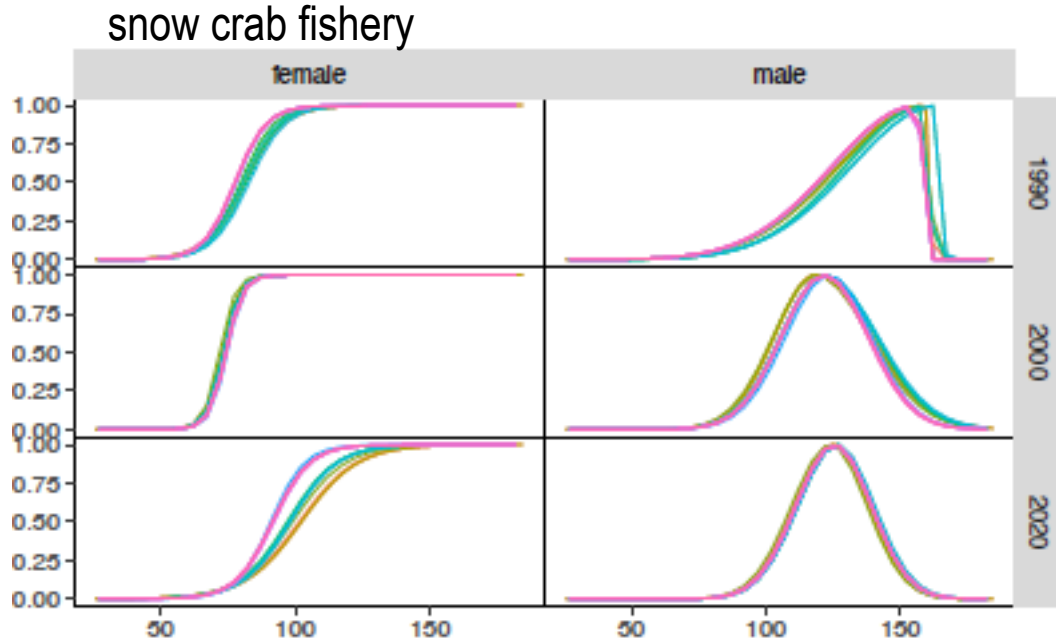
Survey catchability



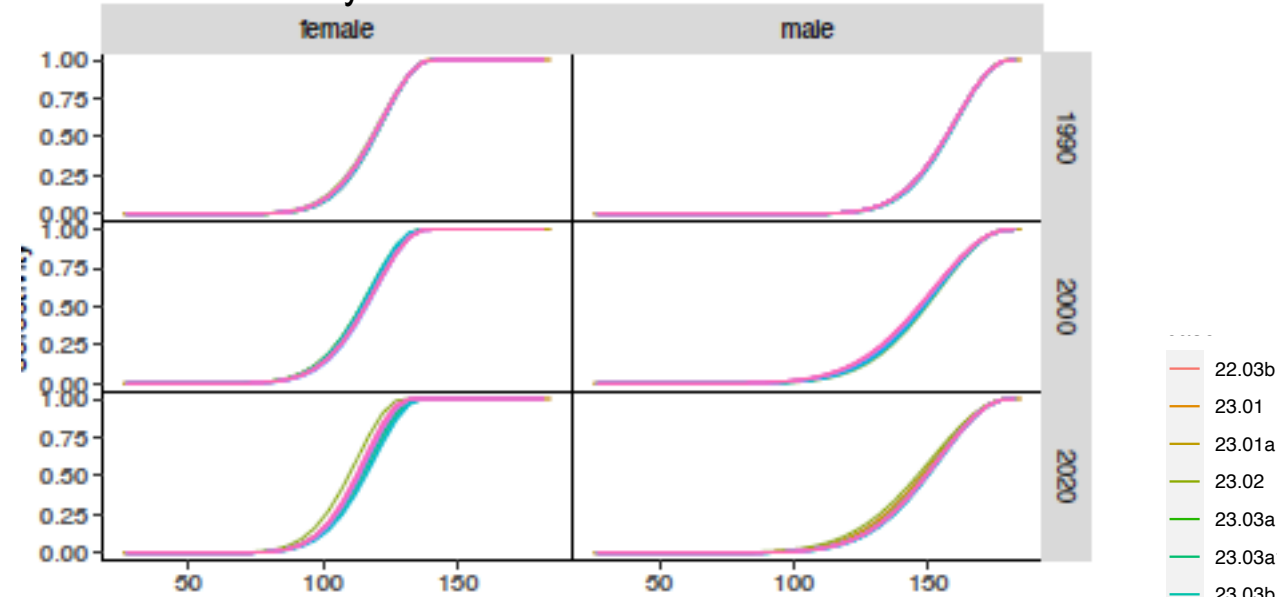
NMFS Survey Q



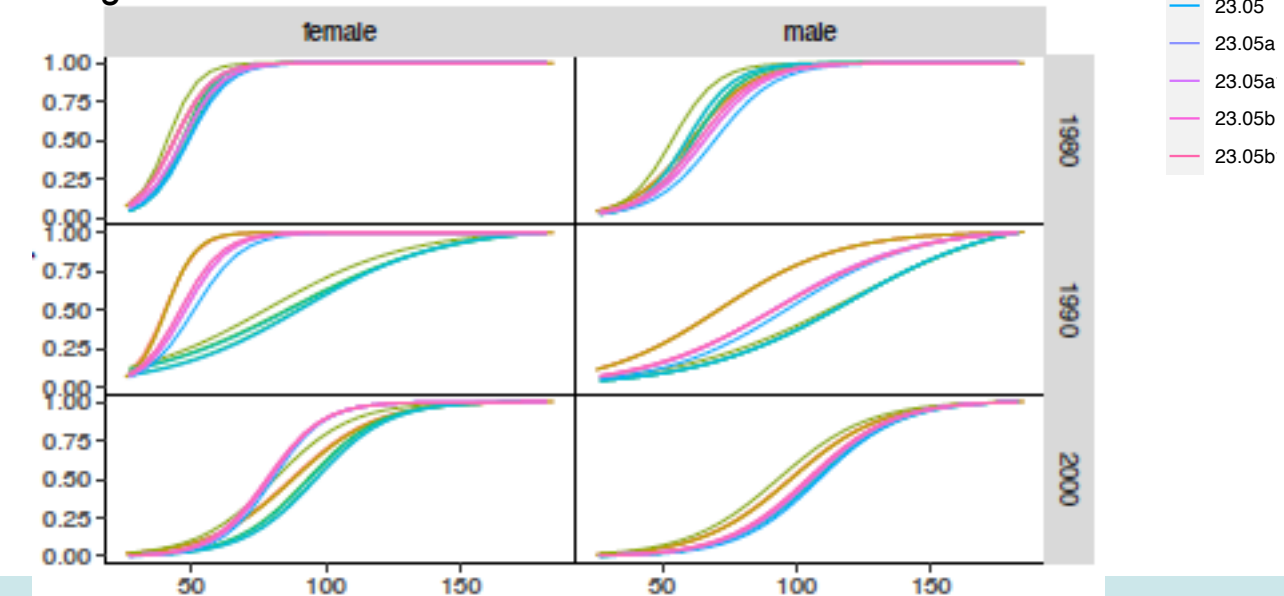
Fishery bycatch selectivity curves



BBRKC fishery



groundfish fisheries

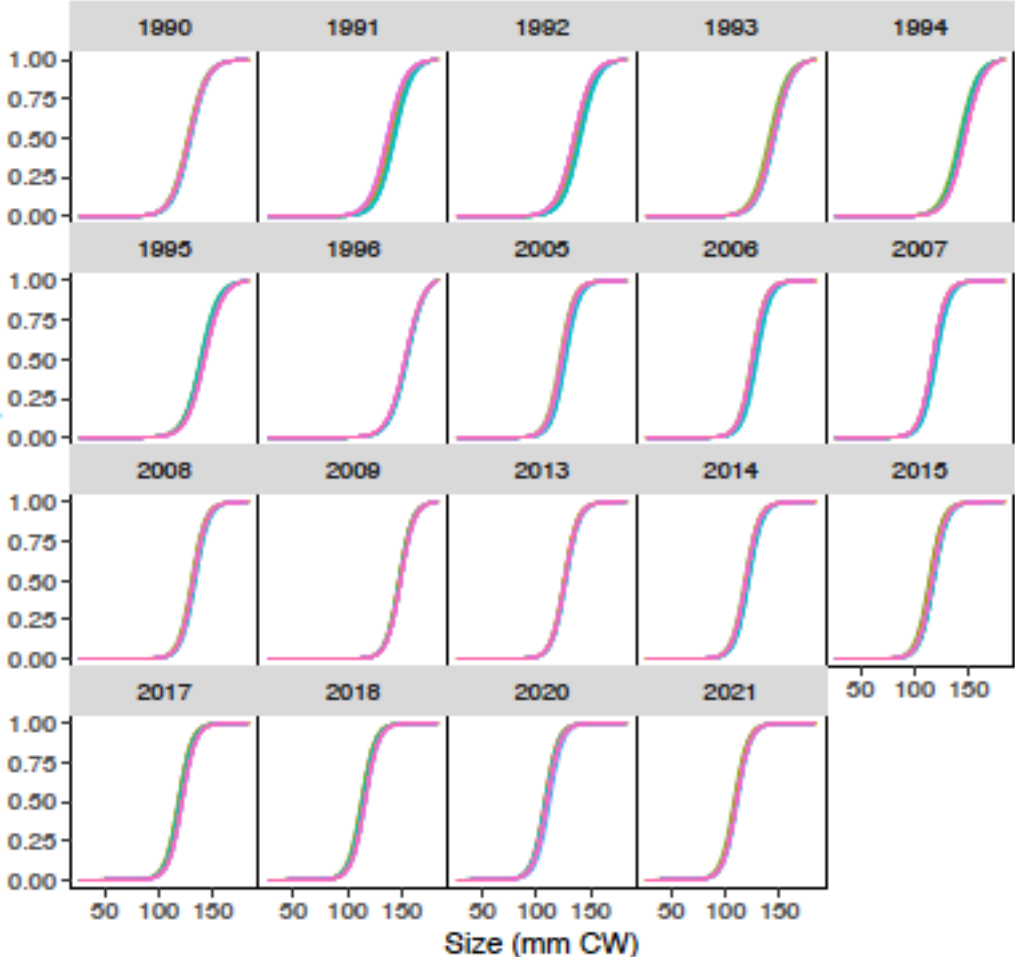


- 22.03b
- 23.01
- 23.01a
- 23.02
- 23.03a
- 23.03a
- 23.03b
- 23.03b
- 23.05
- 23.05a
- 23.05a
- 23.05b
- 23.05b

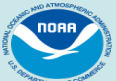
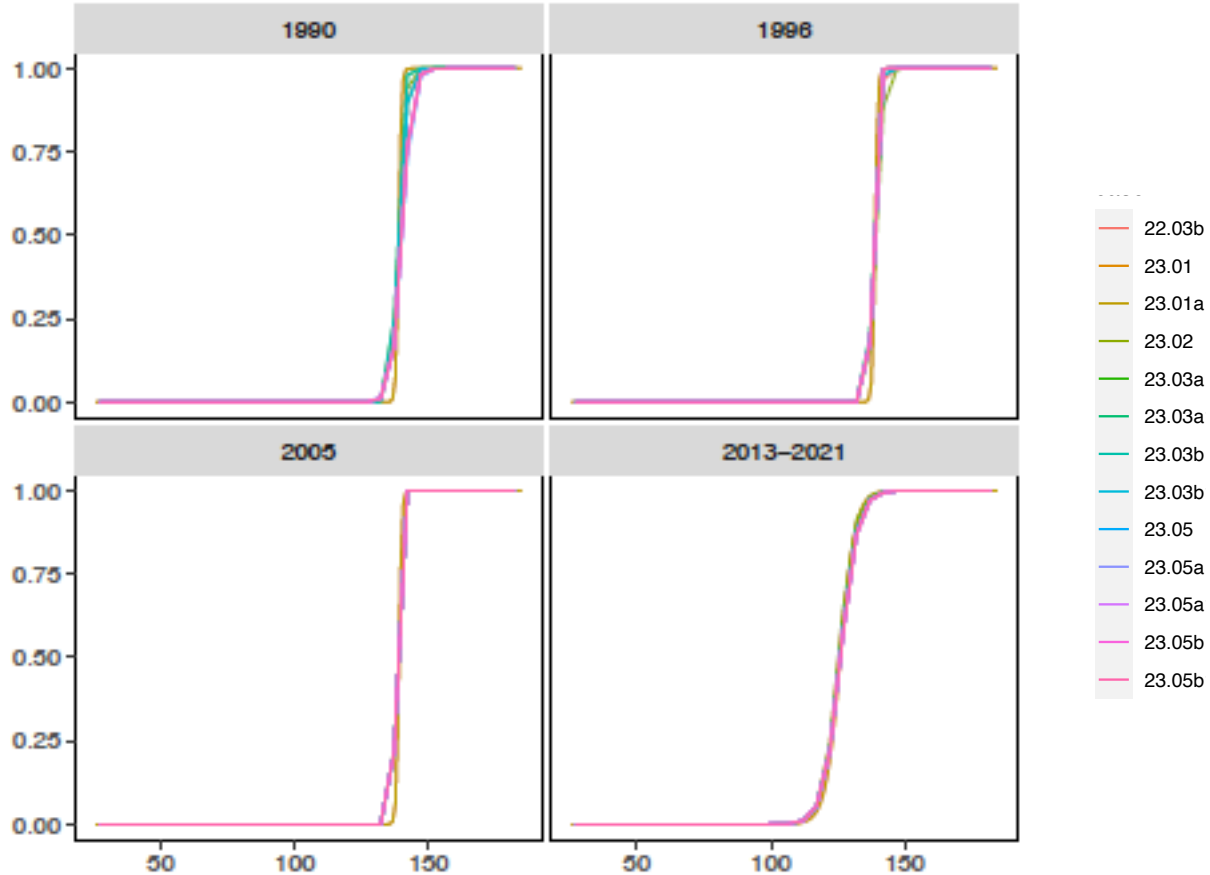


Directed fishery male selectivity/retention curves

selectivity

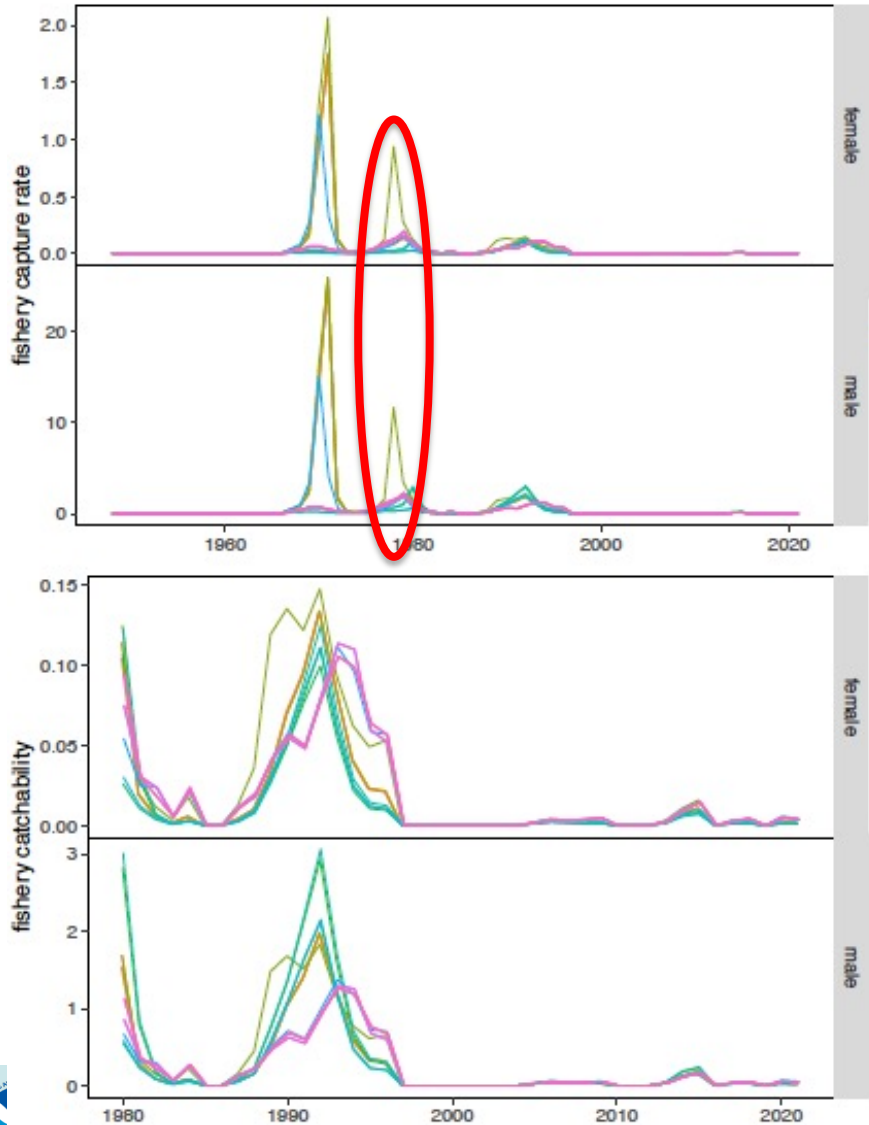


retention

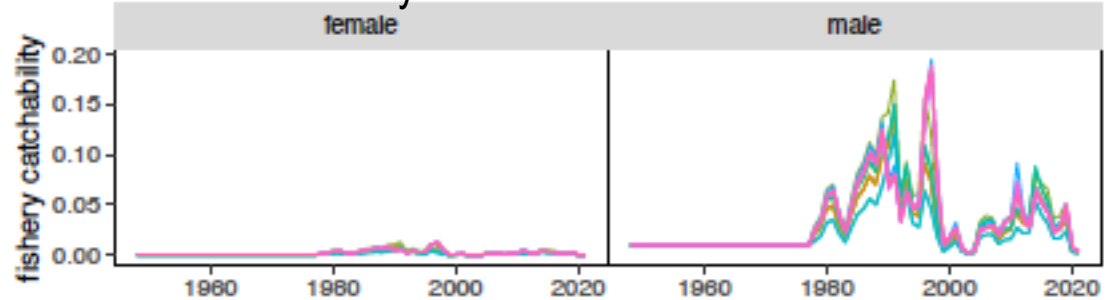


Estimated capture rates

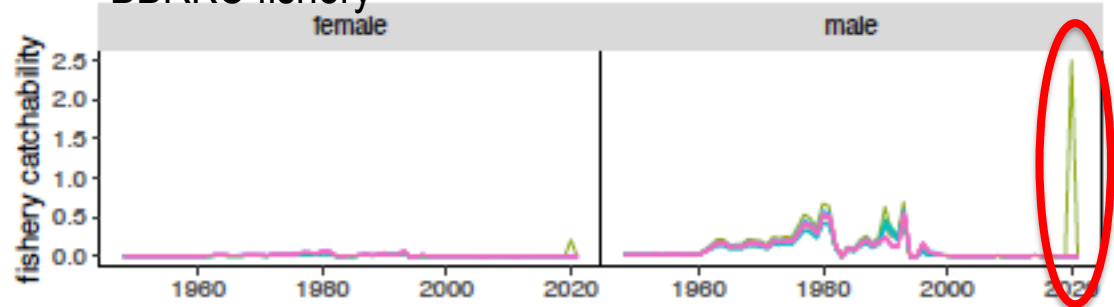
directed fishery



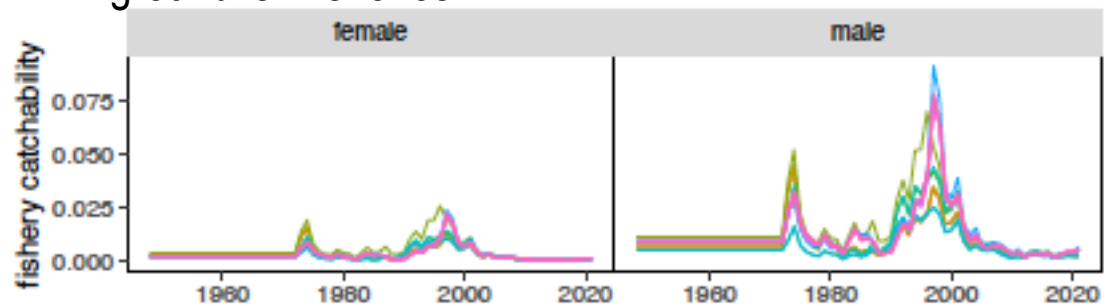
snow crab fishery



BBRKC fishery

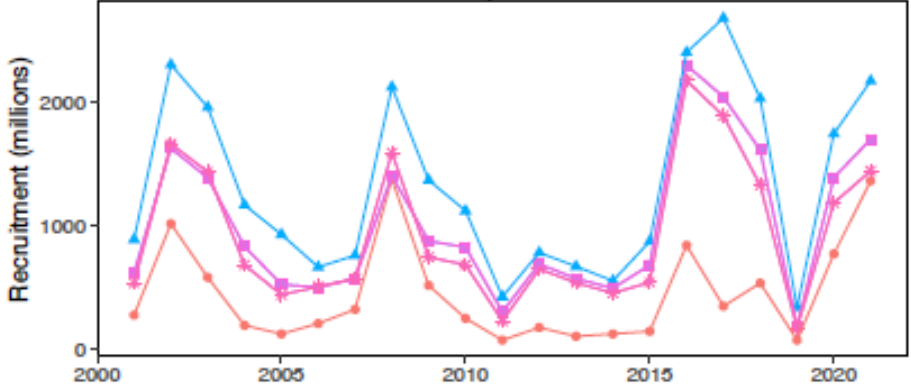
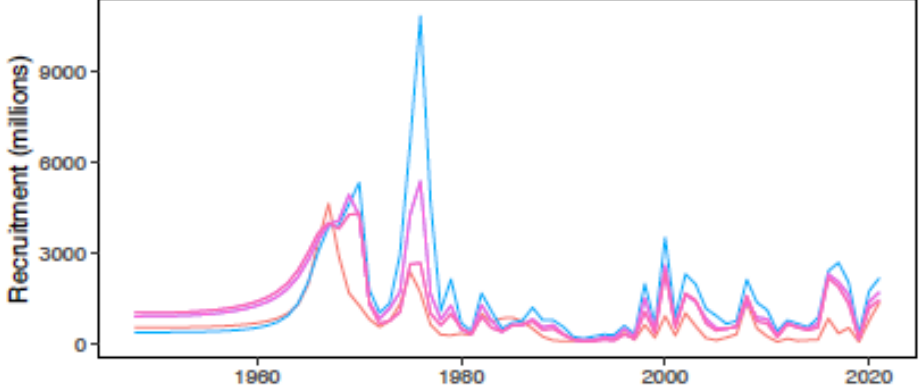
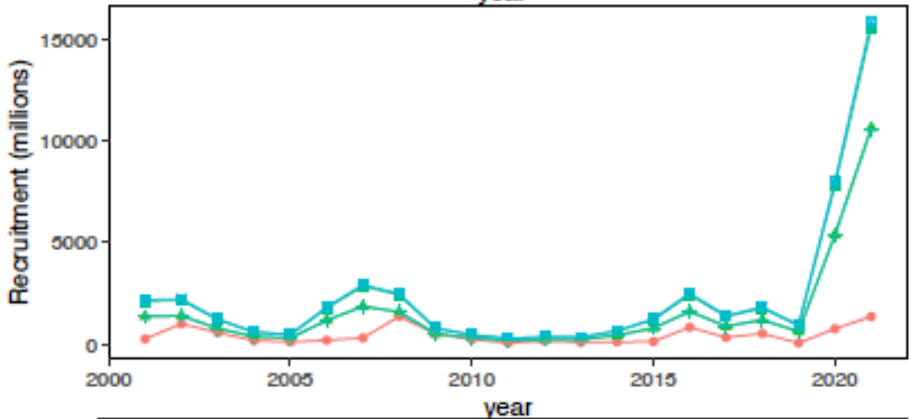
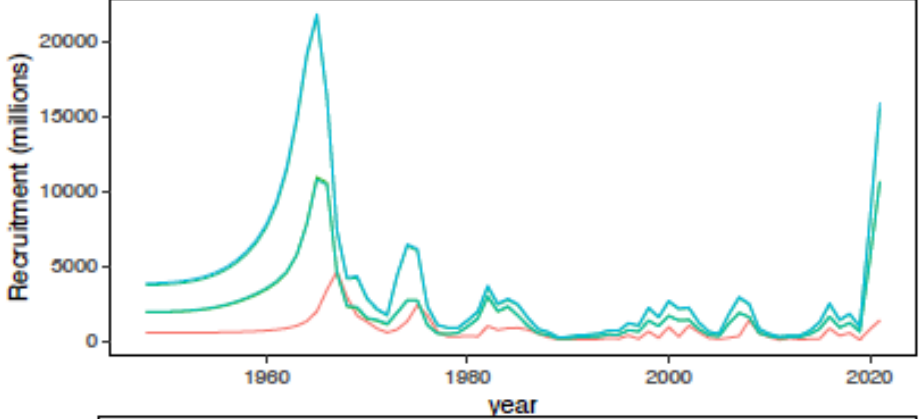
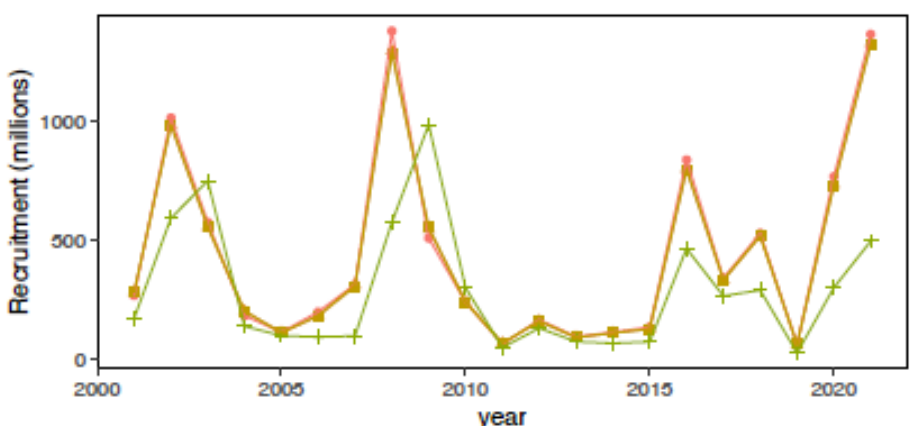
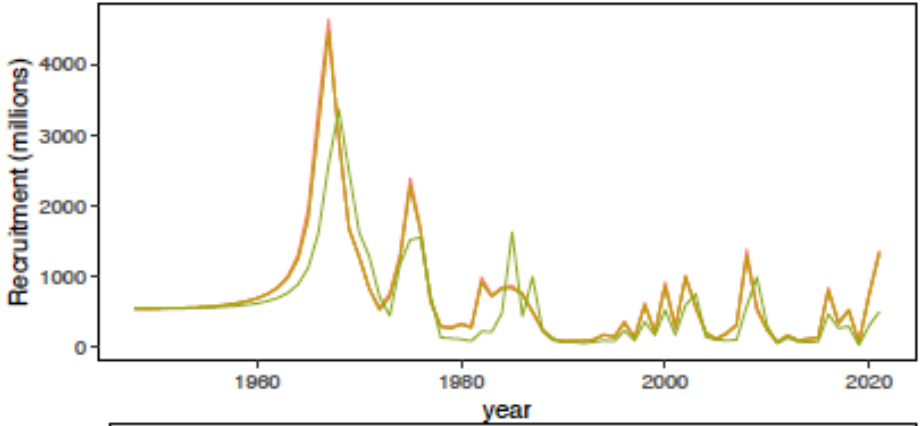


groundfish fisheries



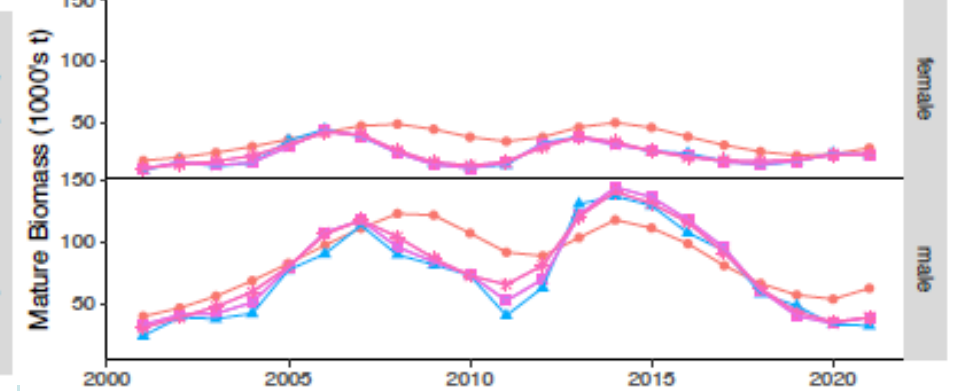
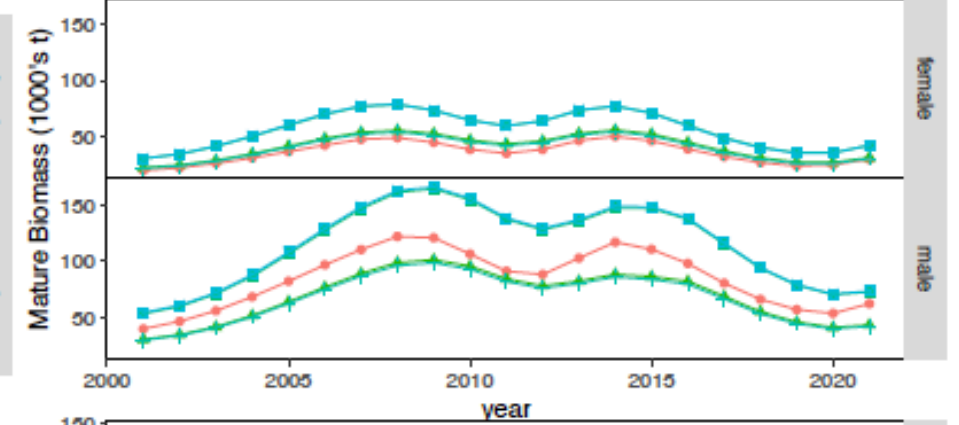
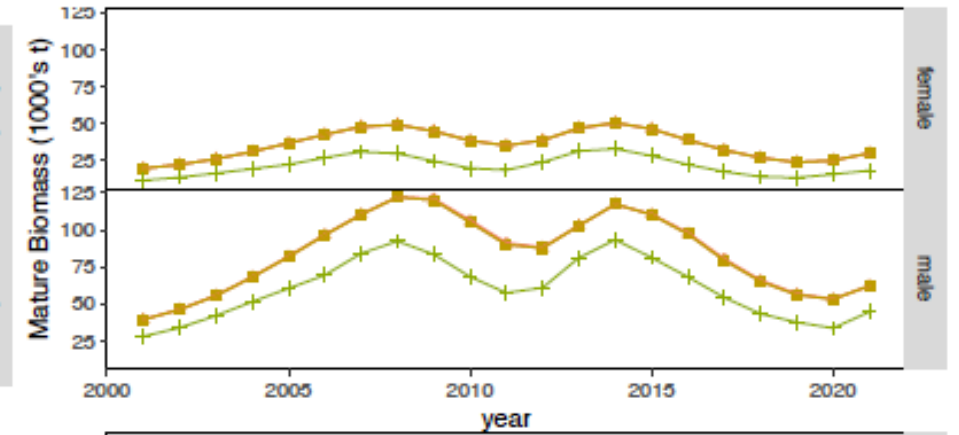
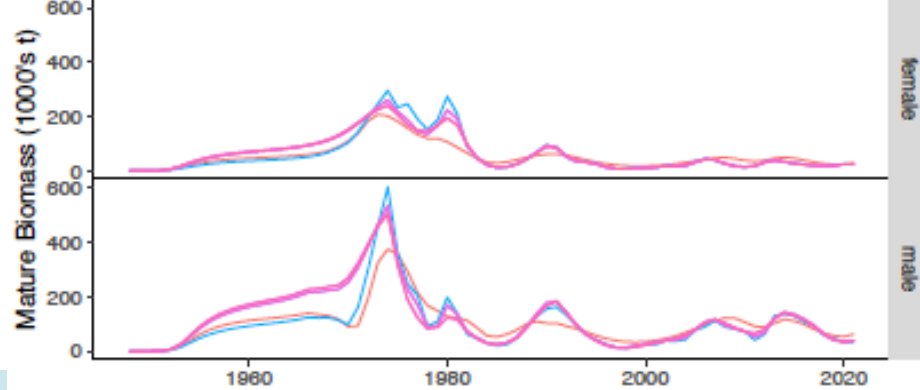
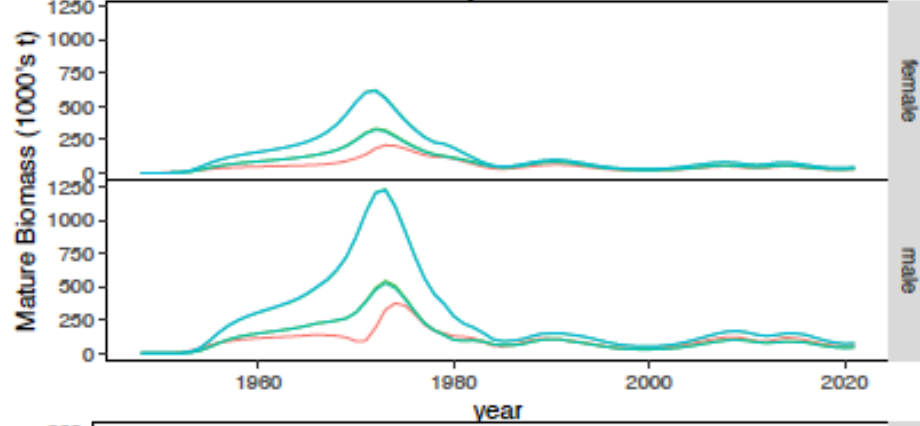
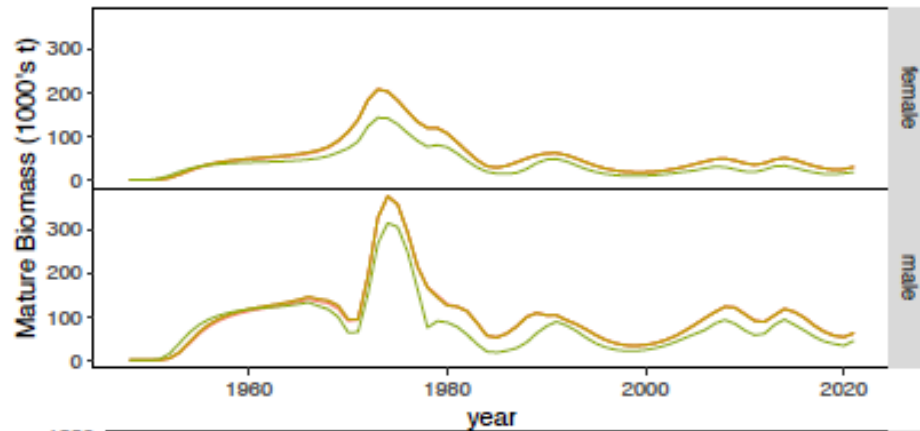
- 22.03b
- 23.01
- 23.01a
- 23.02
- 23.03a
- 23.03a
- 23.03b
- 23.03b
- 23.05
- 23.05a
- 23.05a
- 23.05b
- 23.05b

Estimated recruitment



- case
- 22.03b
 - 23.01
 - 23.01a
 - 23.02
 - 23.03a
 - 23.03a1
 - 23.03b
 - 23.03b1
 - 23.05
 - 23.05a
 - 23.05a1
 - 23.05b
 - 23.05b1

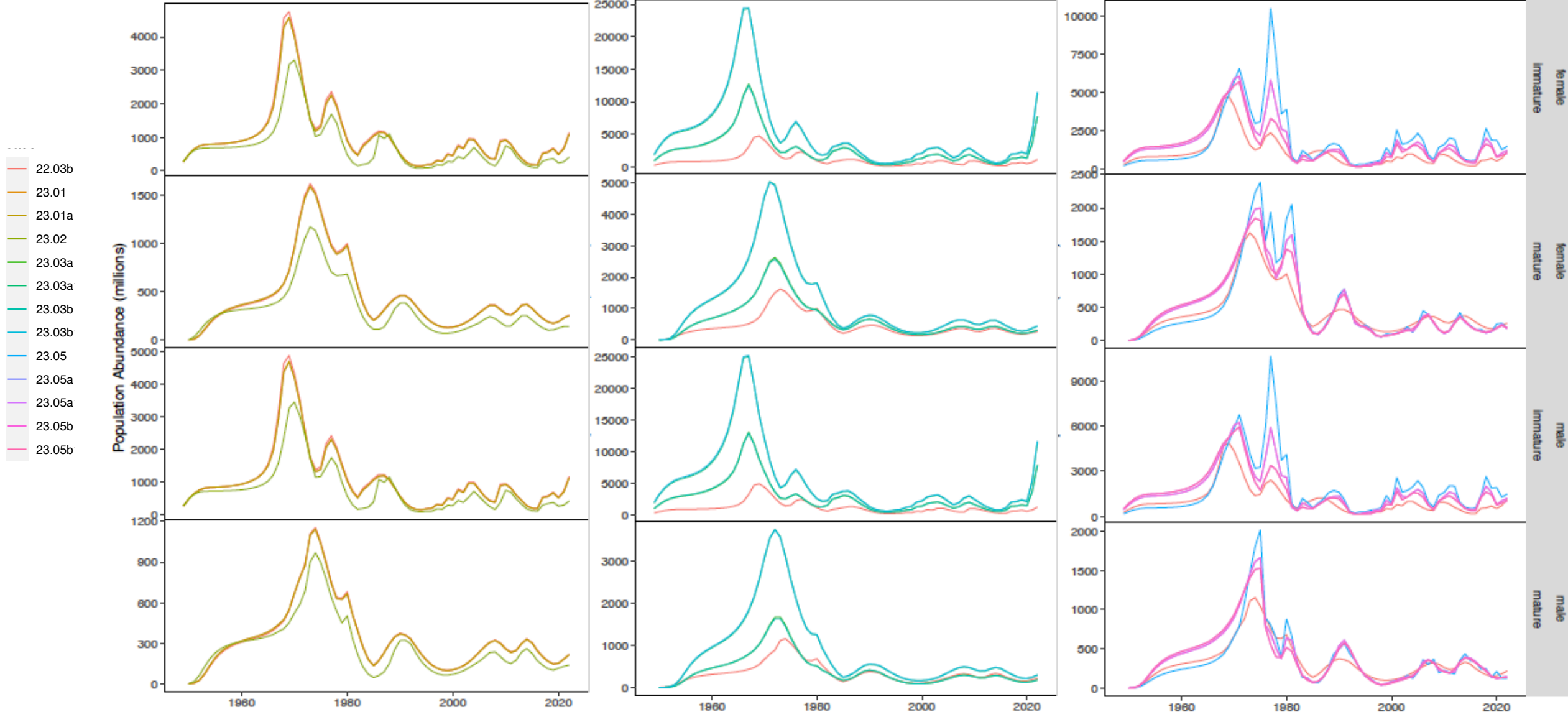
Estimated MMB



- case
- 22.03b
 - 23.01
 - 23.01a
 - 23.02
 - 23.03a
 - 23.03a1
 - 23.03b
 - 23.03b1
 - 23.05
 - 23.05a
 - 23.05a1
 - 23.05b
 - 23.05b1

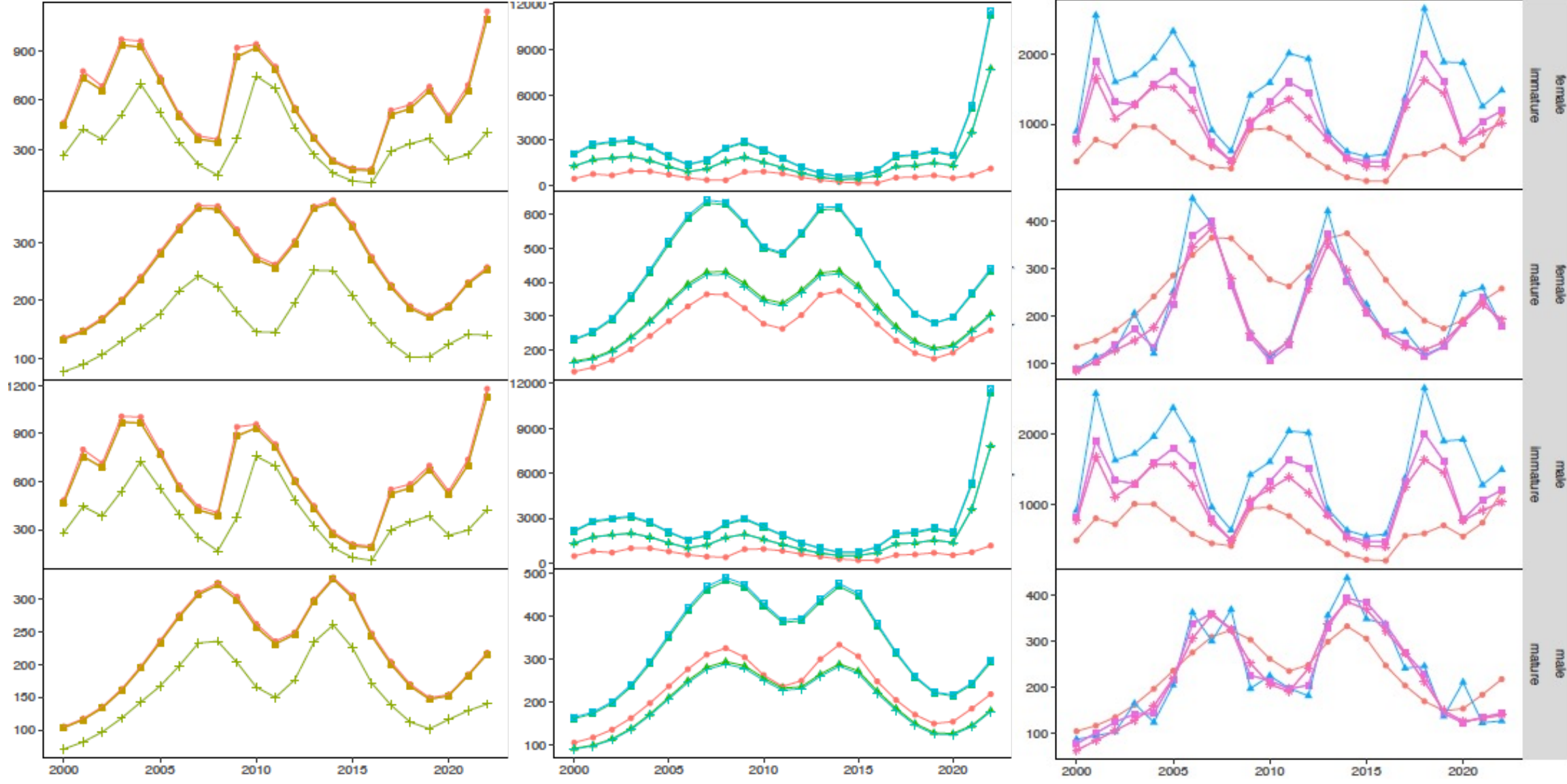


Population abundance

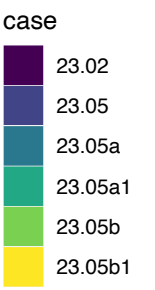
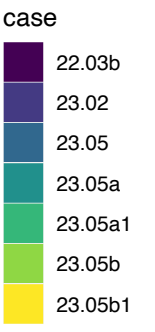
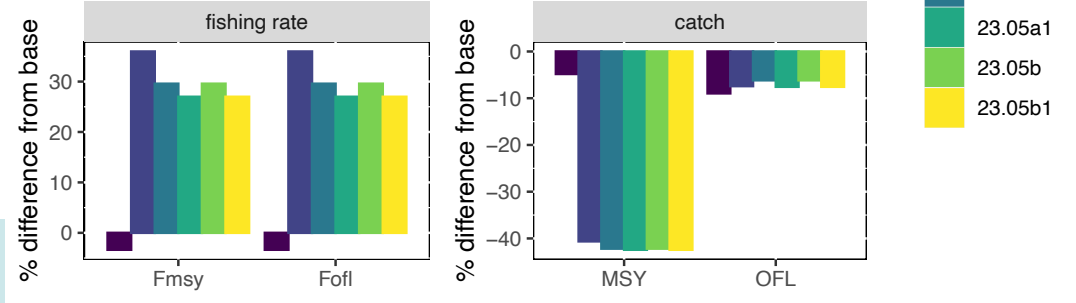
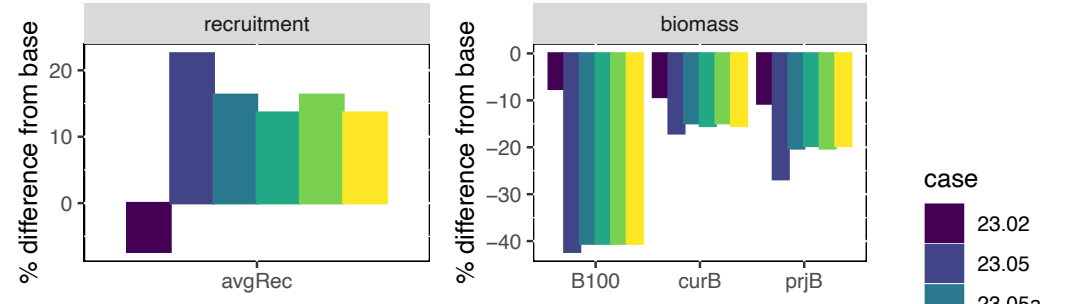
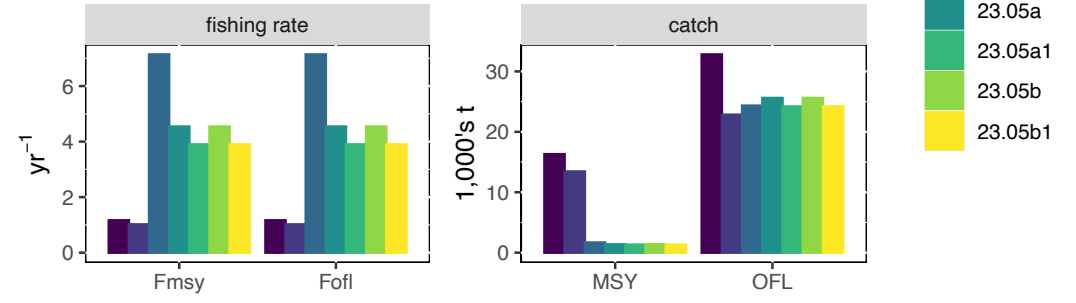
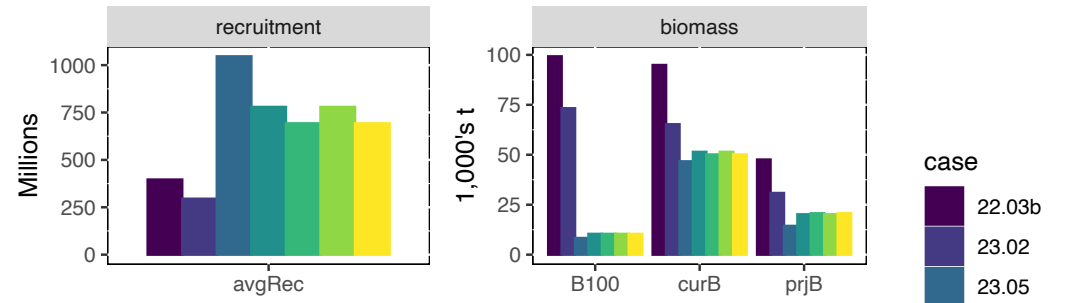
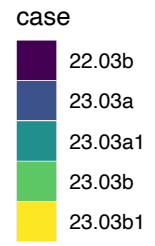
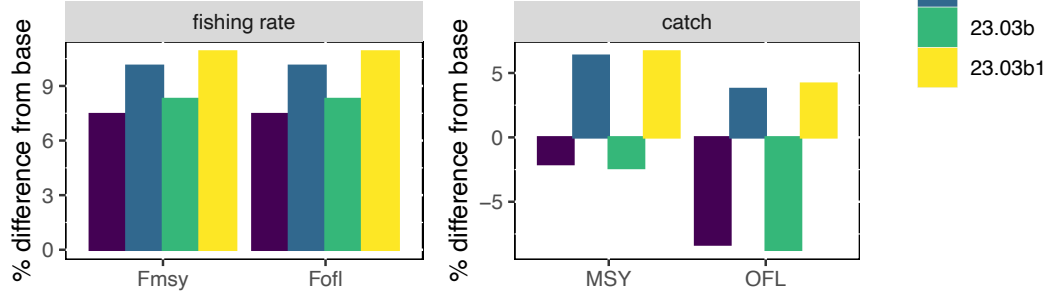
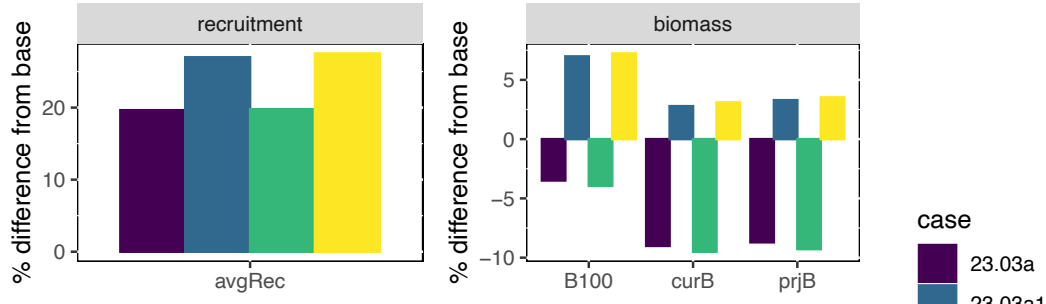
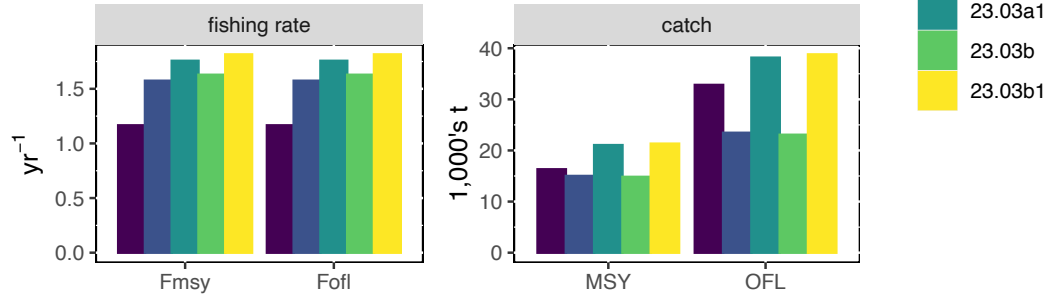
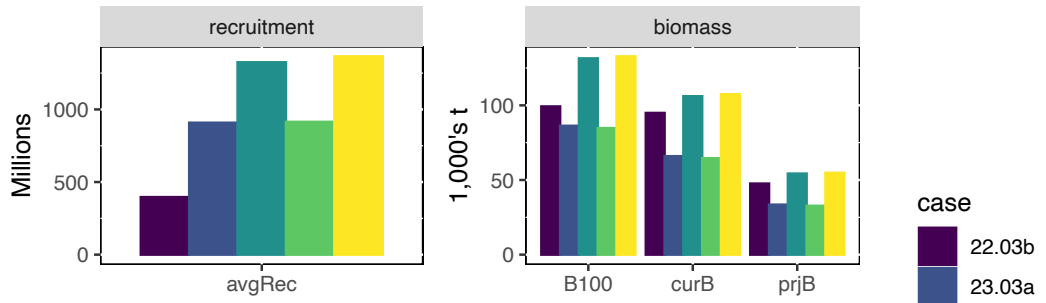


Population abundance

- 22.03b
- 23.01
- 23.01a
- 23.02
- 23.03a
- 23.03a
- 23.03b
- 23.03b
- 23.05
- 23.05a
- 23.05a
- 23.05b
- 23.05b



Management Quantities



Tier 3 models for September

- 22.03b recommended as “base” model
- 23.02 suggested as alternative model
 - develop model with no parameters at bounds
- No other models are recommended at this time
 - continue to develop annually-varying M models
 - get 2018 SBS study data to complete selectivity analysis



Outline

- Proposed Tier 3 Model Runs

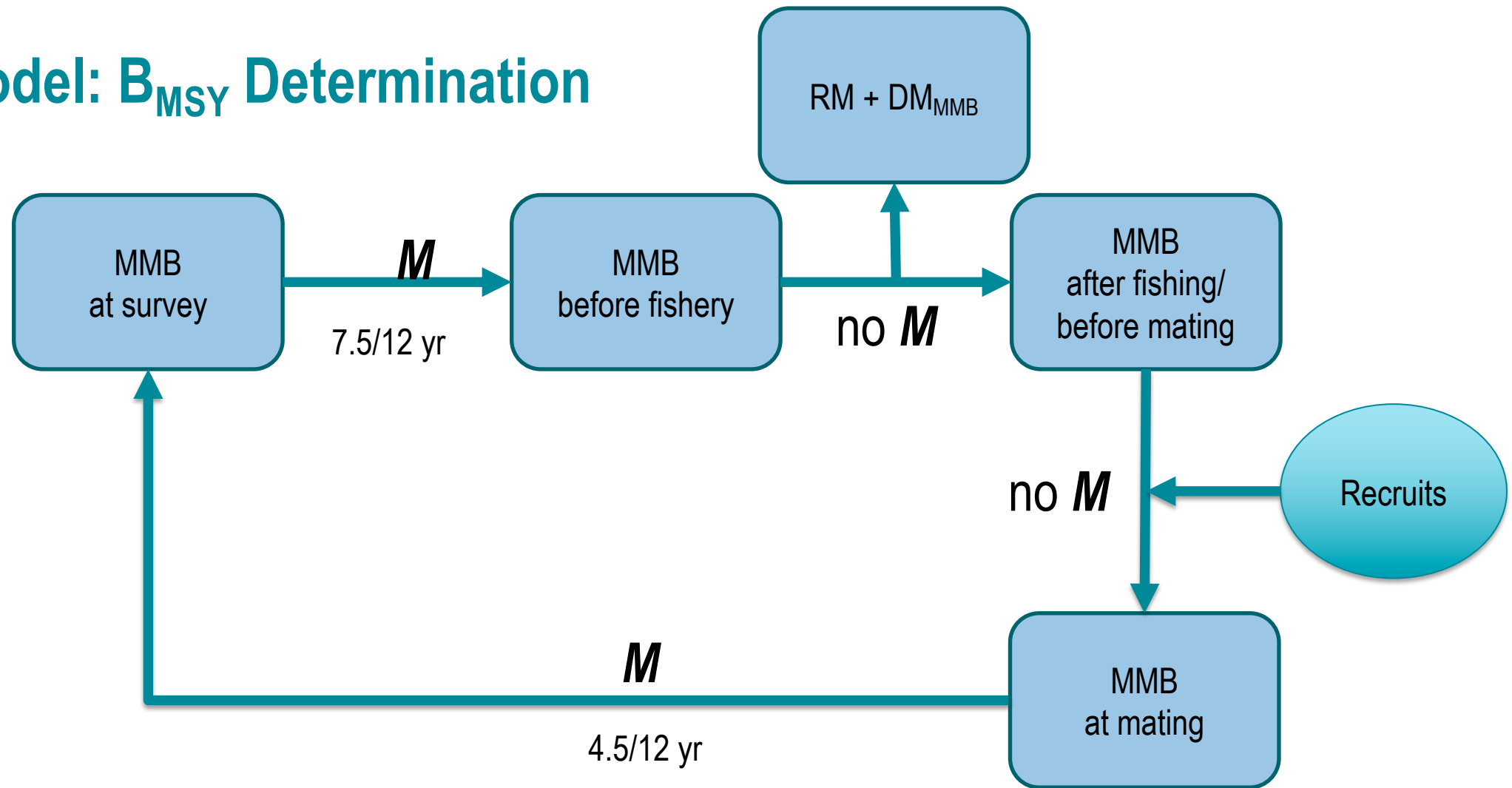
- Tier 4 Model



Why Tier 4?

- Provides “fallback” for unsatisfactory Tier 3 model

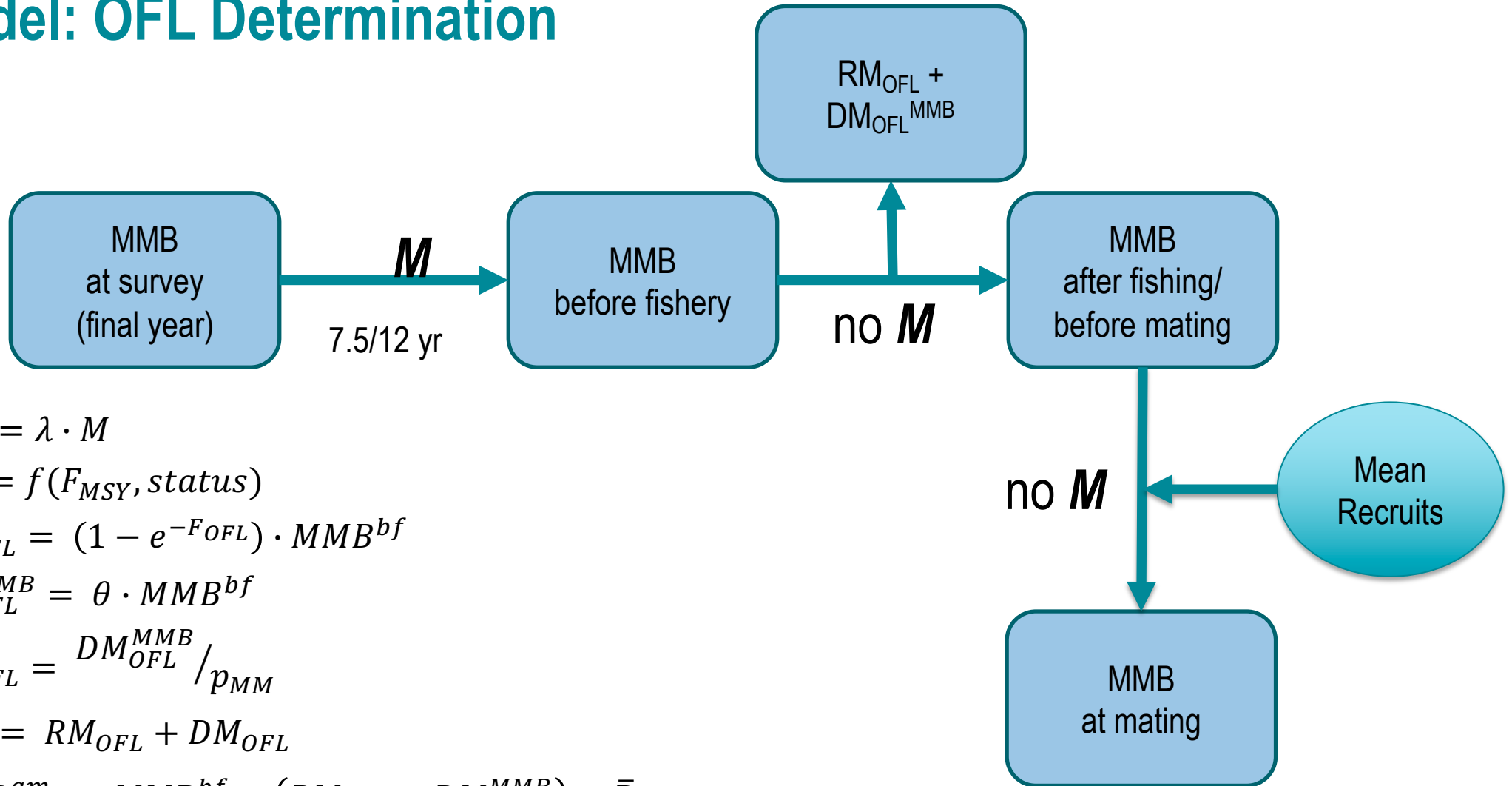
Tier 4 Model: B_{MSY} Determination



$$R_y^{MMB} = MMB_{y+1}^s \cdot e^{M \cdot \frac{4.5}{12}} - MMB_y^{bm}$$

- B_{MSY} = average MMB-at-mating over some time period

Tier 4 Model: OFL Determination



$$F_{MSY} = \lambda \cdot M$$

$$F_{OFL} = f(F_{MSY}, status)$$

$$RM_{OFL} = (1 - e^{-F_{OFL}}) \cdot MMB^{bf}$$

$$DM_{OFL}^{MMB} = \theta \cdot MMB^{bf}$$

$$DM_{OFL} = DM_{OFL}^{MMB} / p_{MM}$$

$$OFL = RM_{OFL} + DM_{OFL}$$

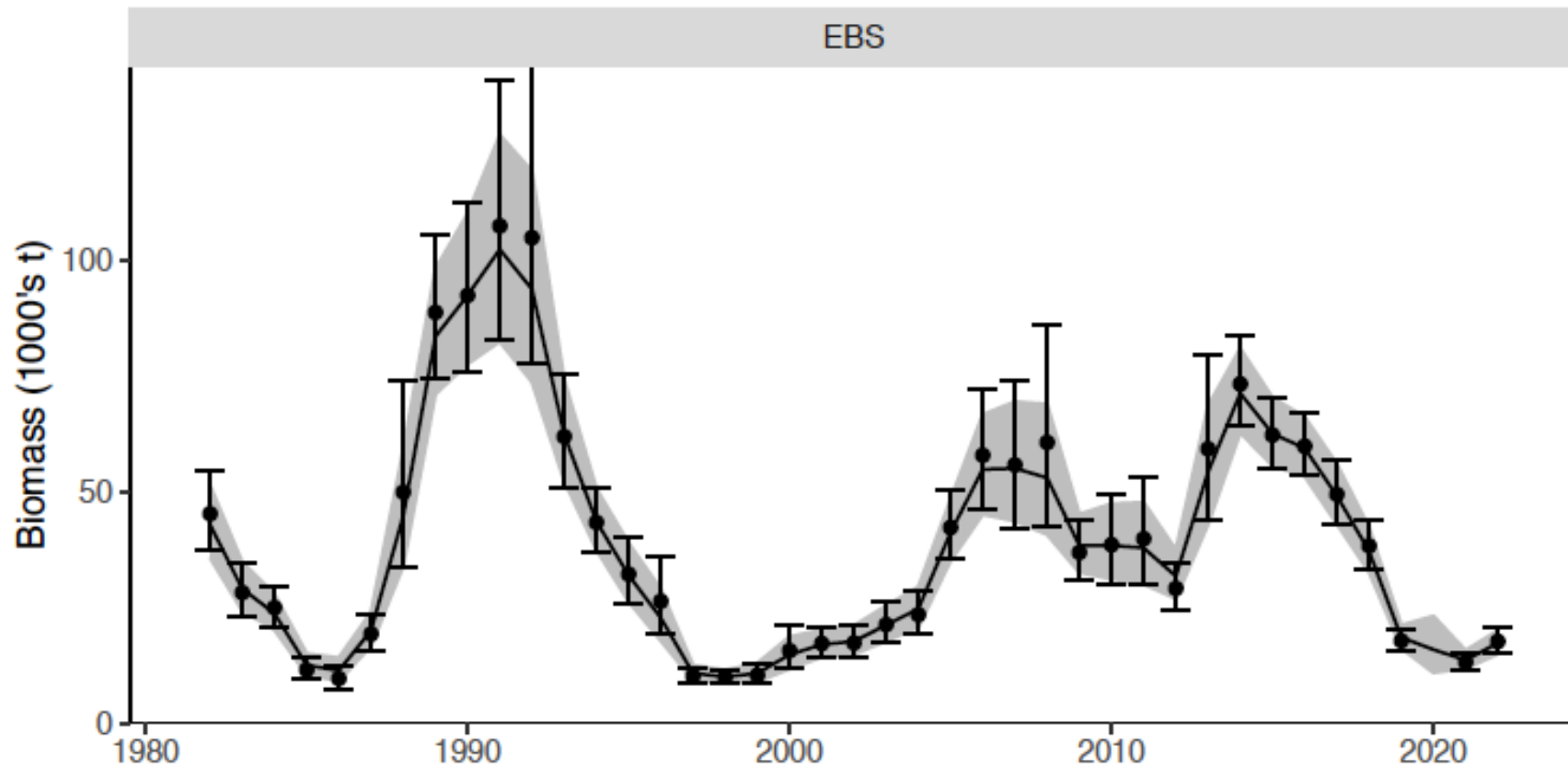
$$MMB_{OFL}^{am} = MMB^{bf} - (RM_{OFL} + DM_{OFL}^{MMB}) + \bar{R}$$

$$status = MMB_{OFL}^{am} / B_{MSY}$$

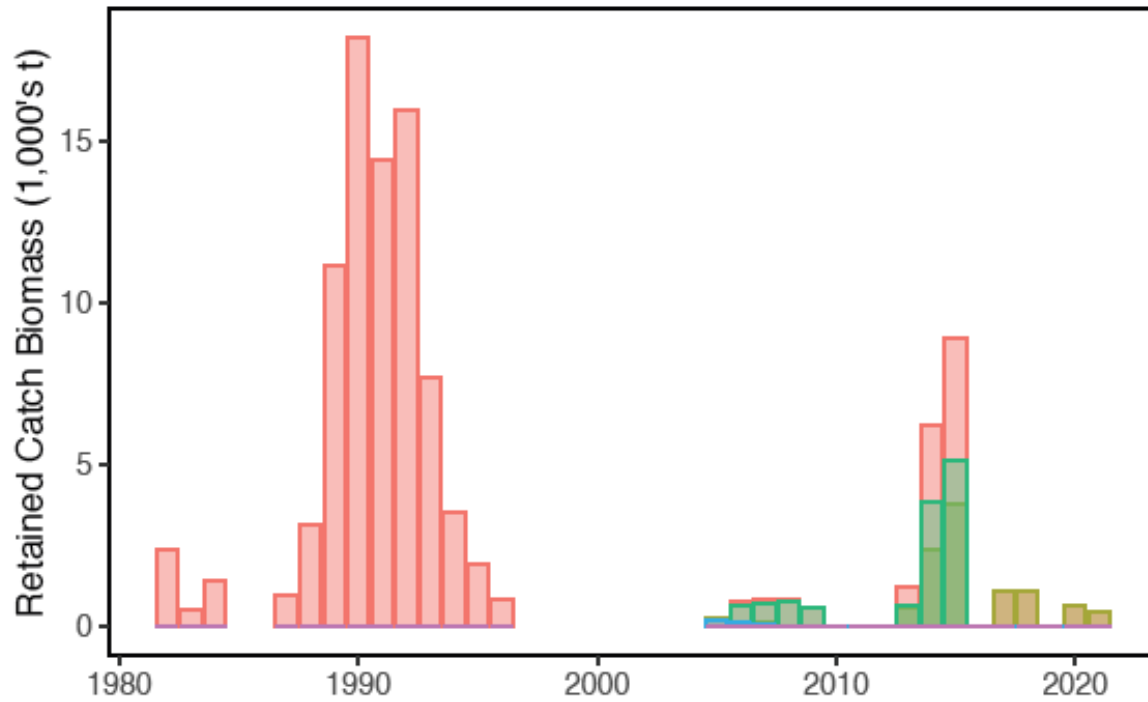


Determine Survey MMB

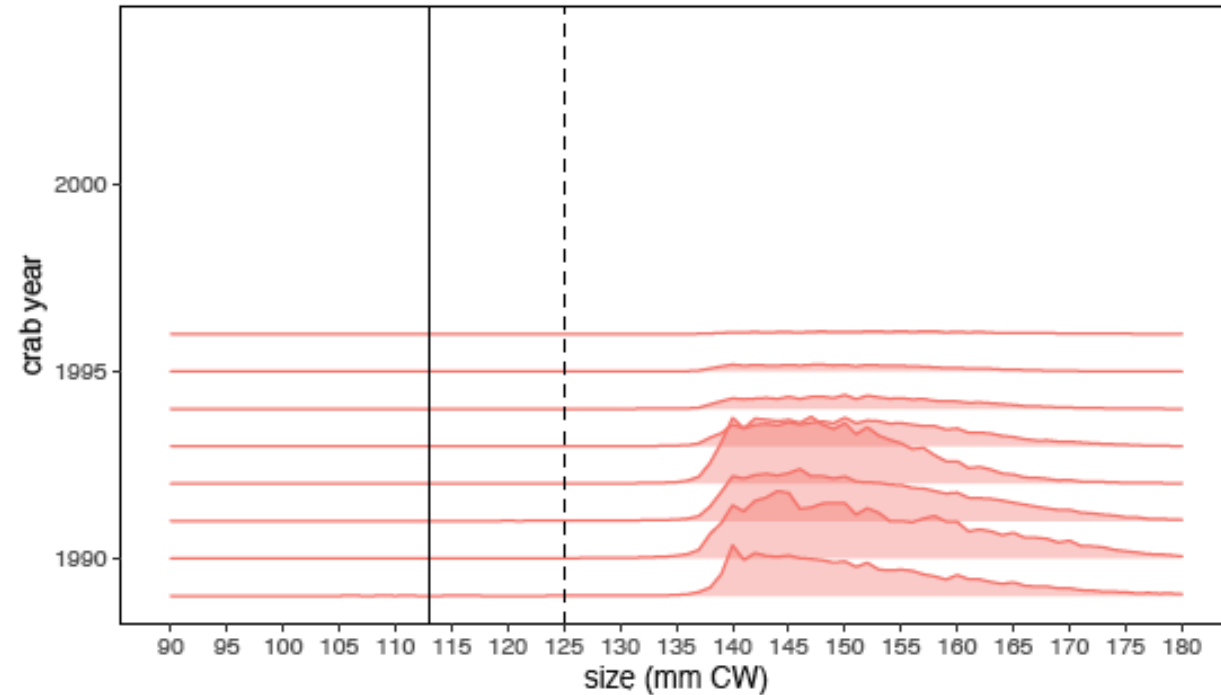
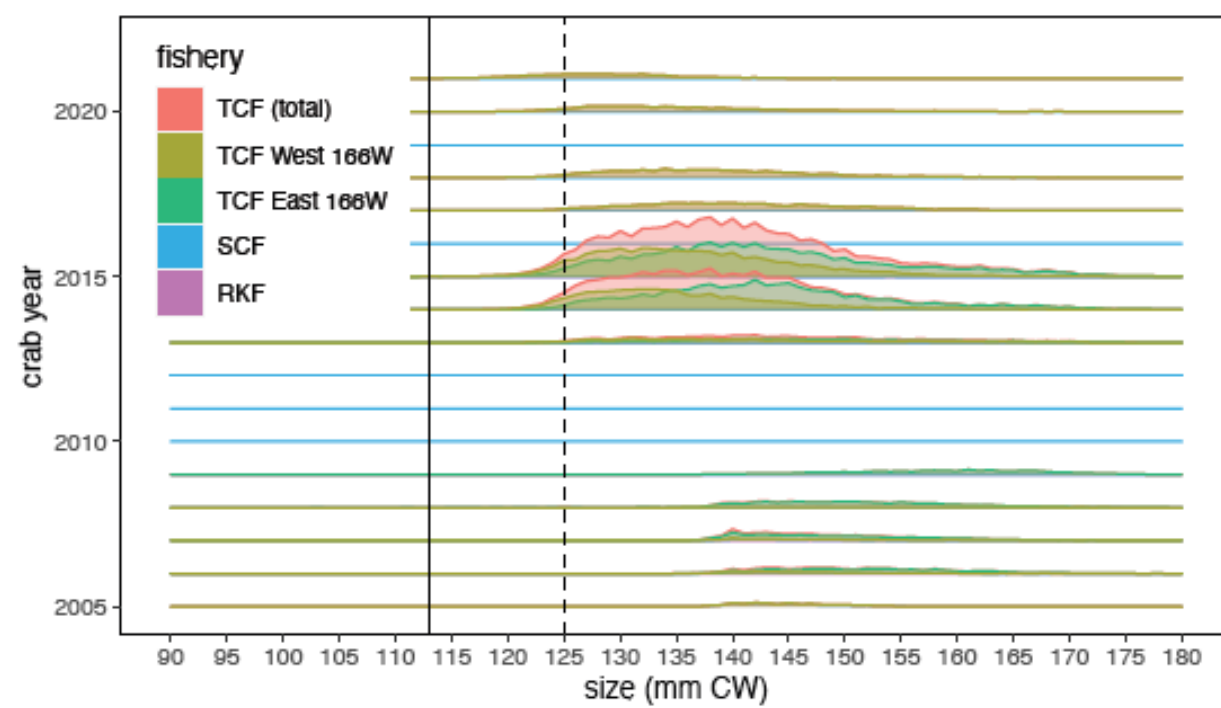
- Use state-space RW model (*rema* package) to estimate survey MMB time series
 - better capture trend
 - estimate missing values



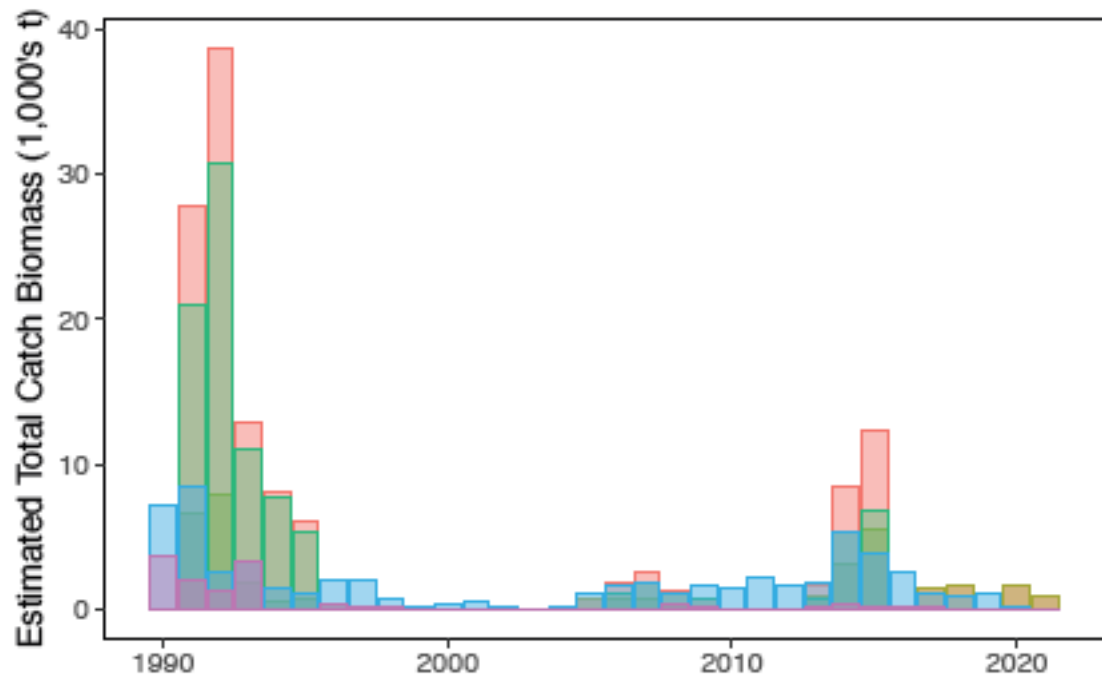
Retained catch



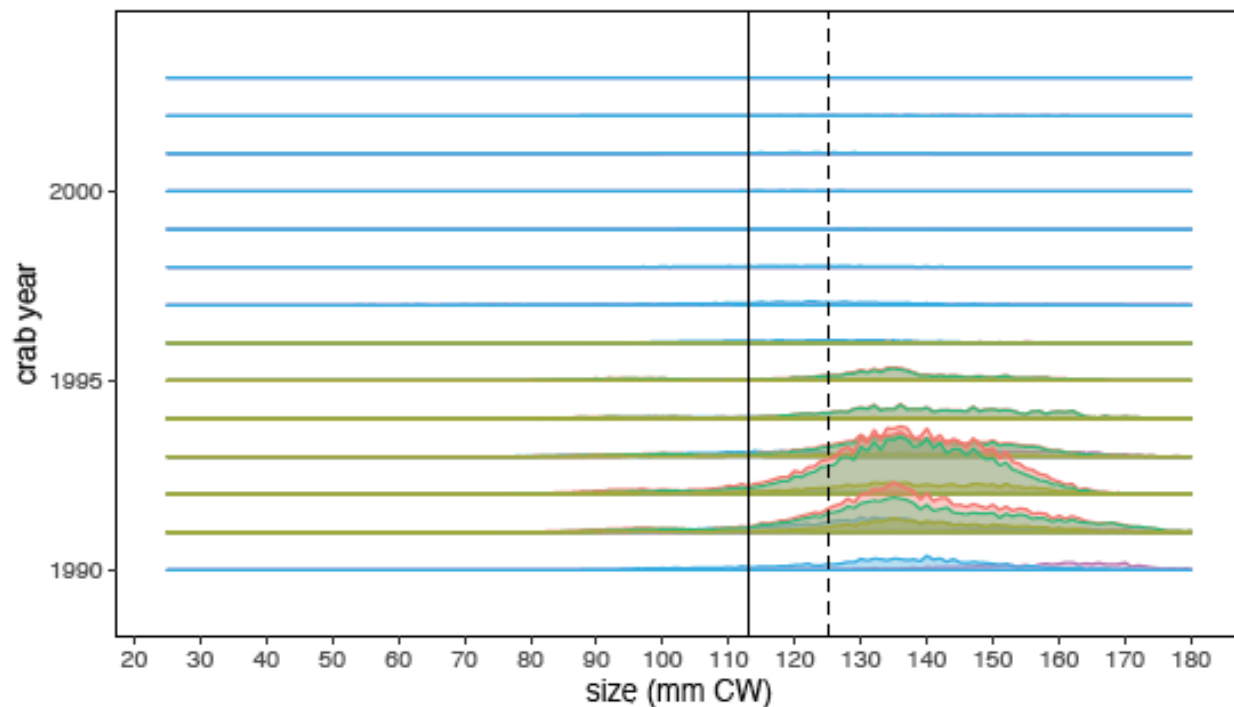
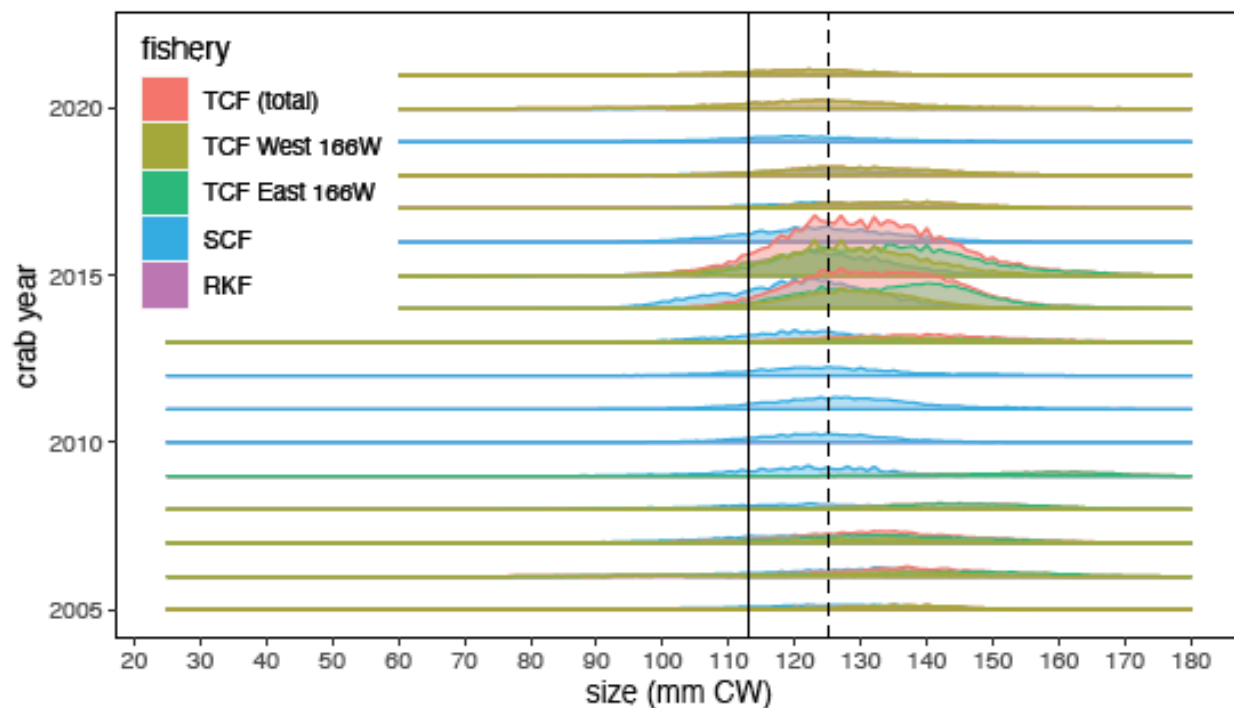
- assumed to be all mature males



Total Catch: Crab Fisheries

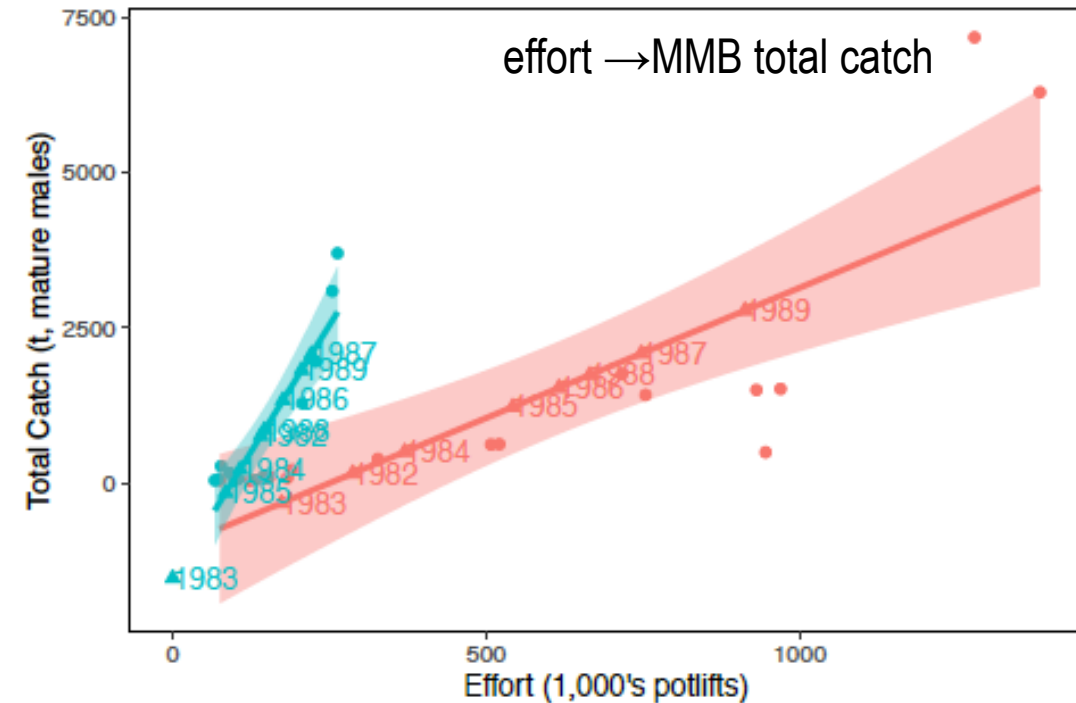
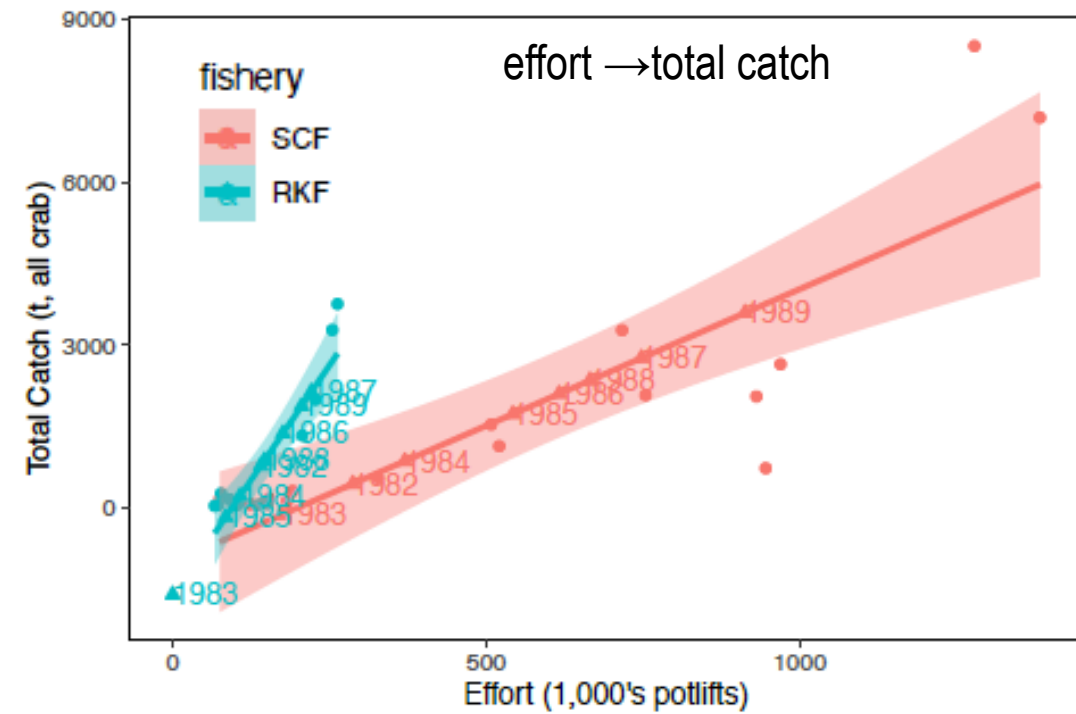
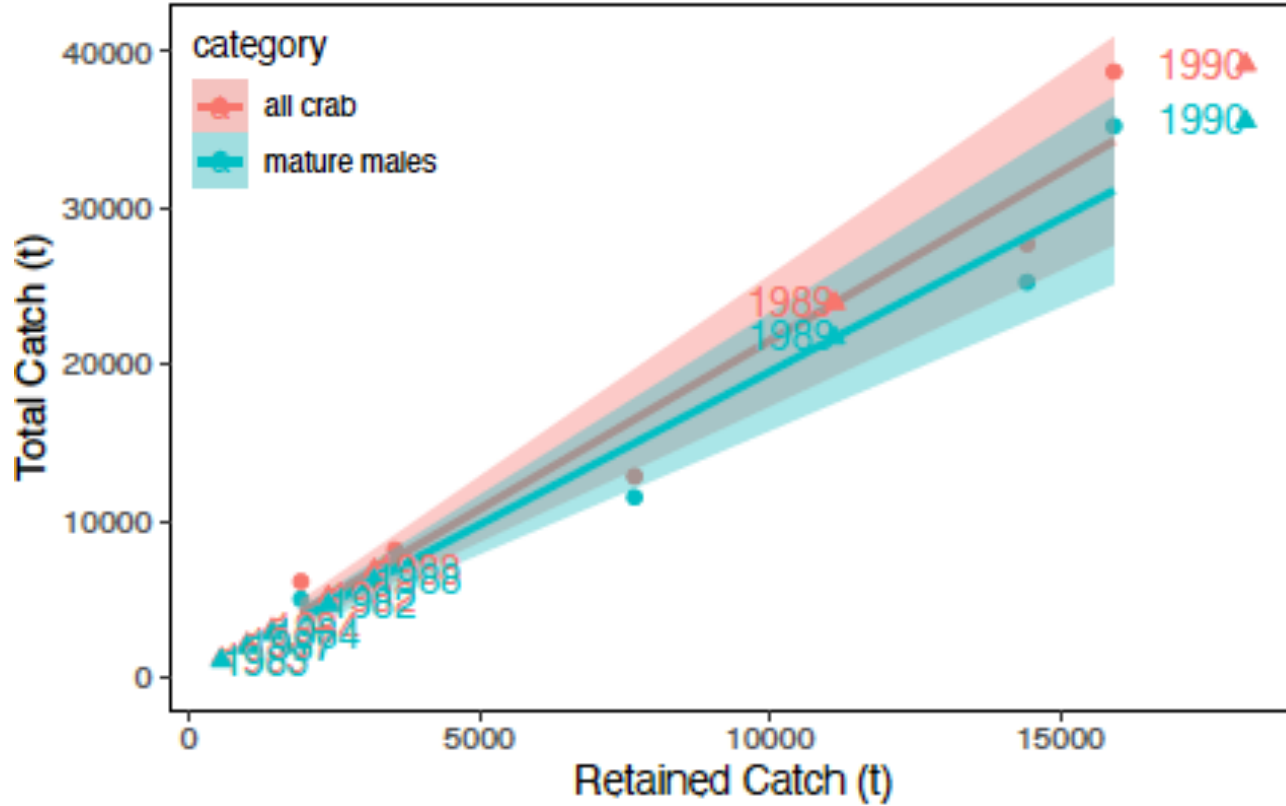


- mostly (but not all) mature males

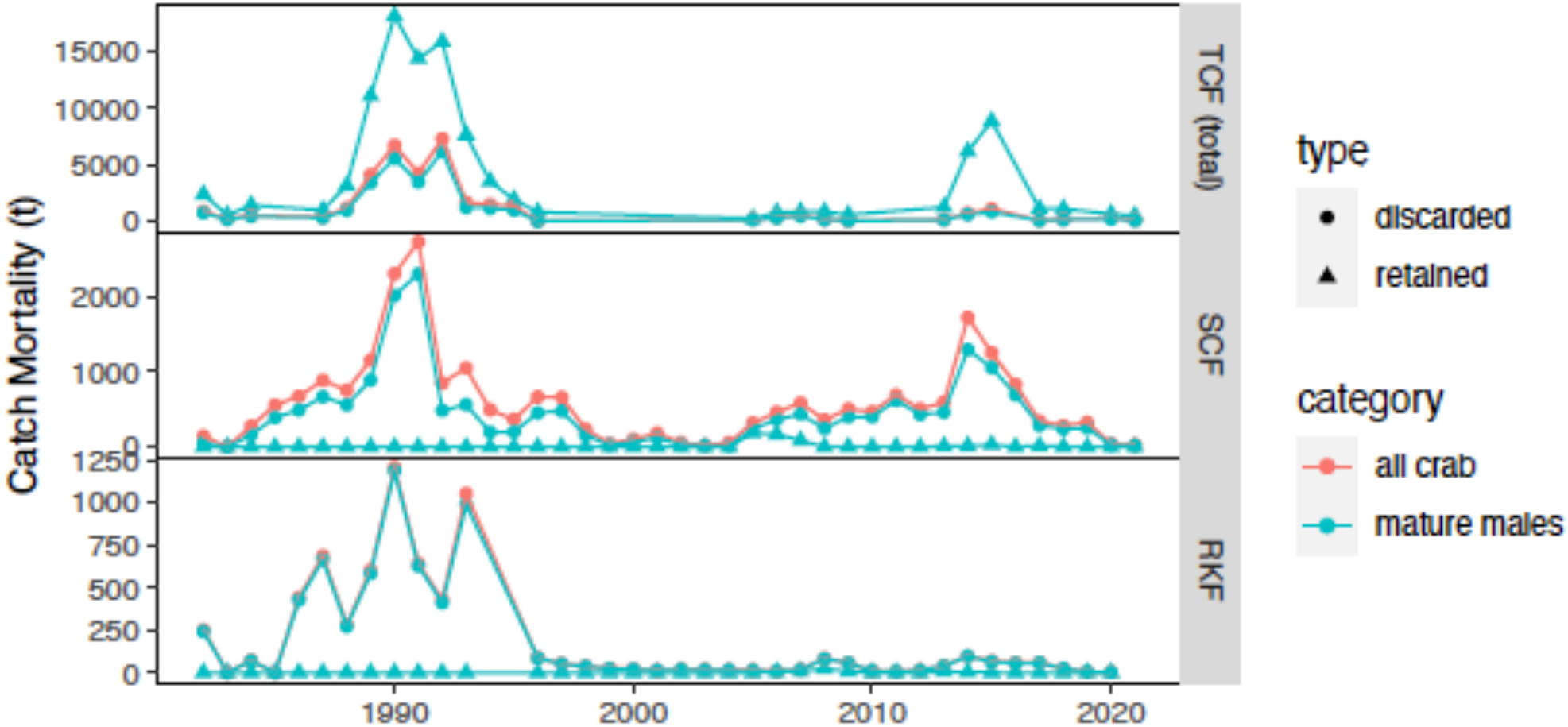


Extrapolating Catch Data

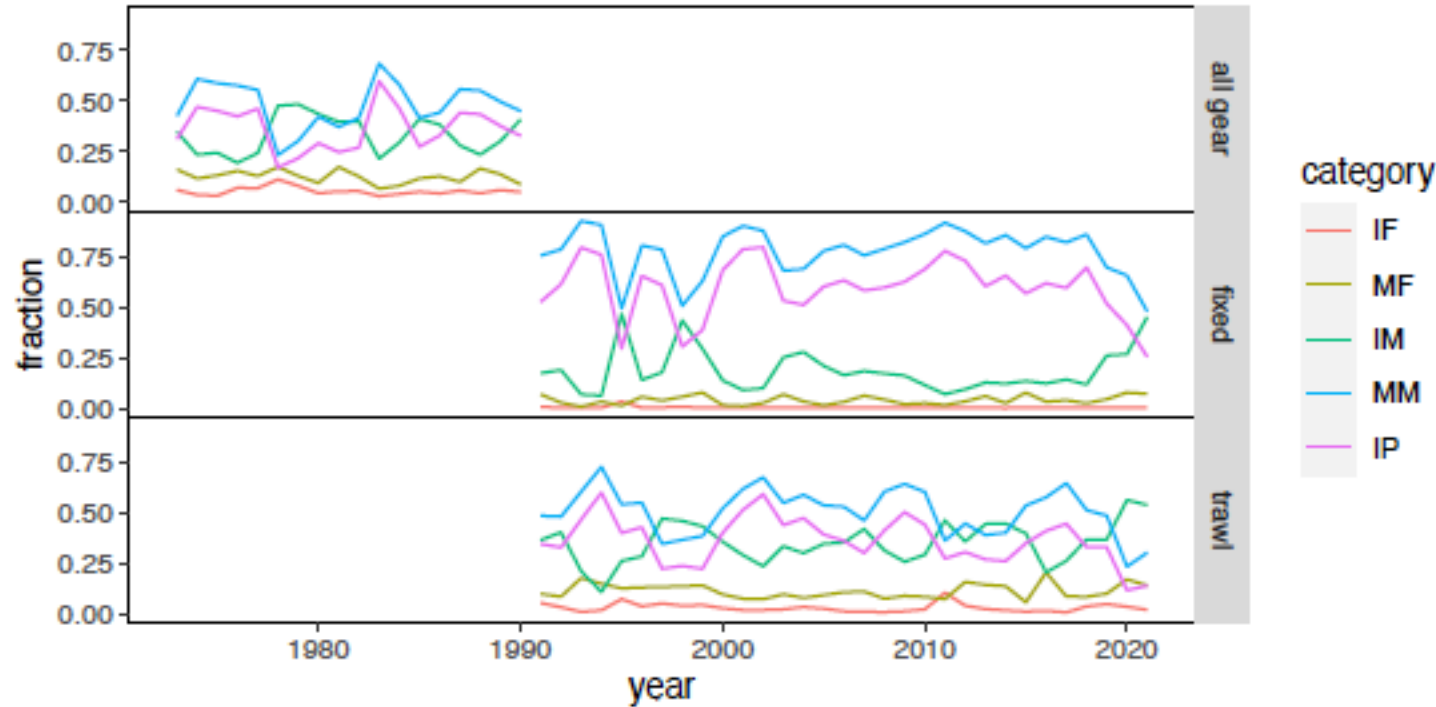
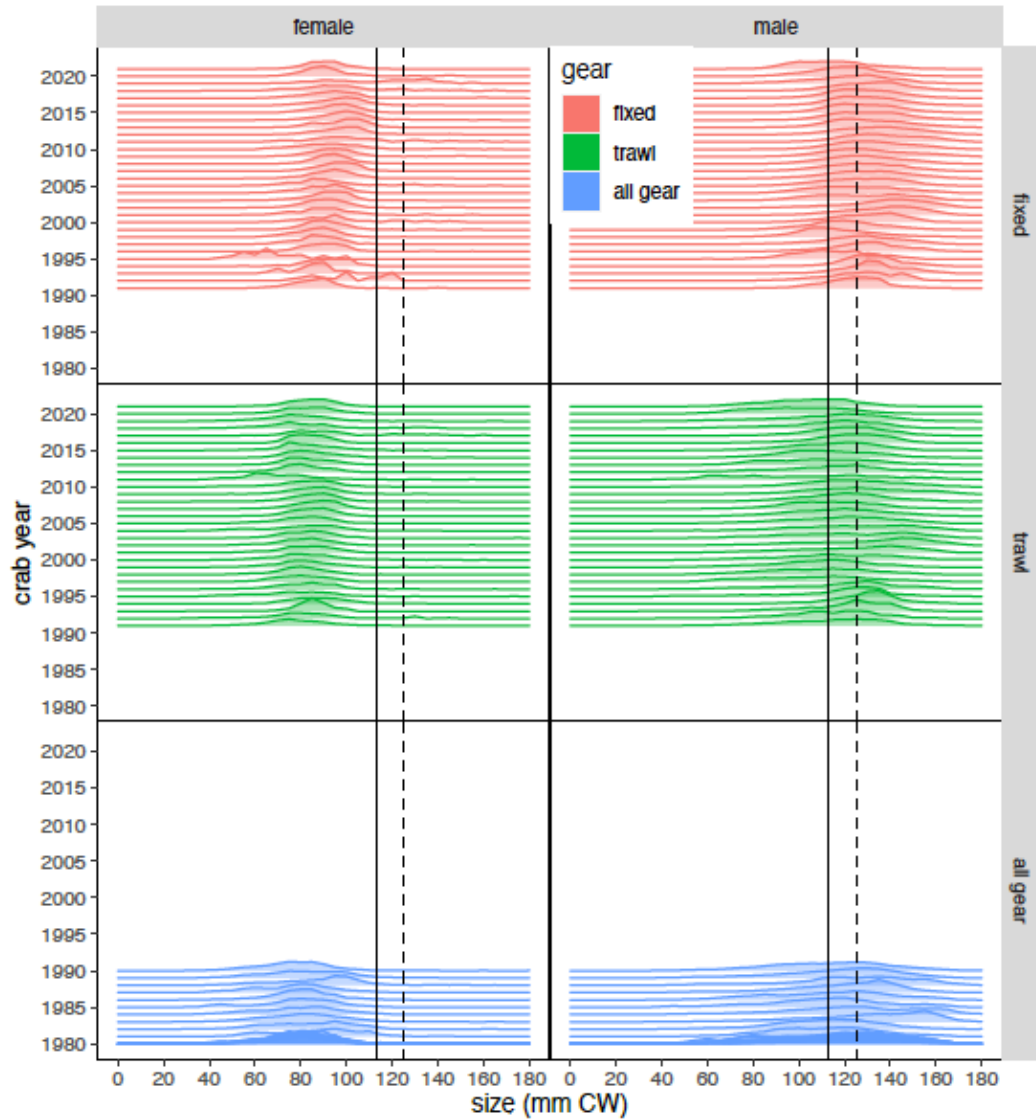
Directed fishery: retained catch → total catch



Estimated Catch Mortality in Crab Fisheries

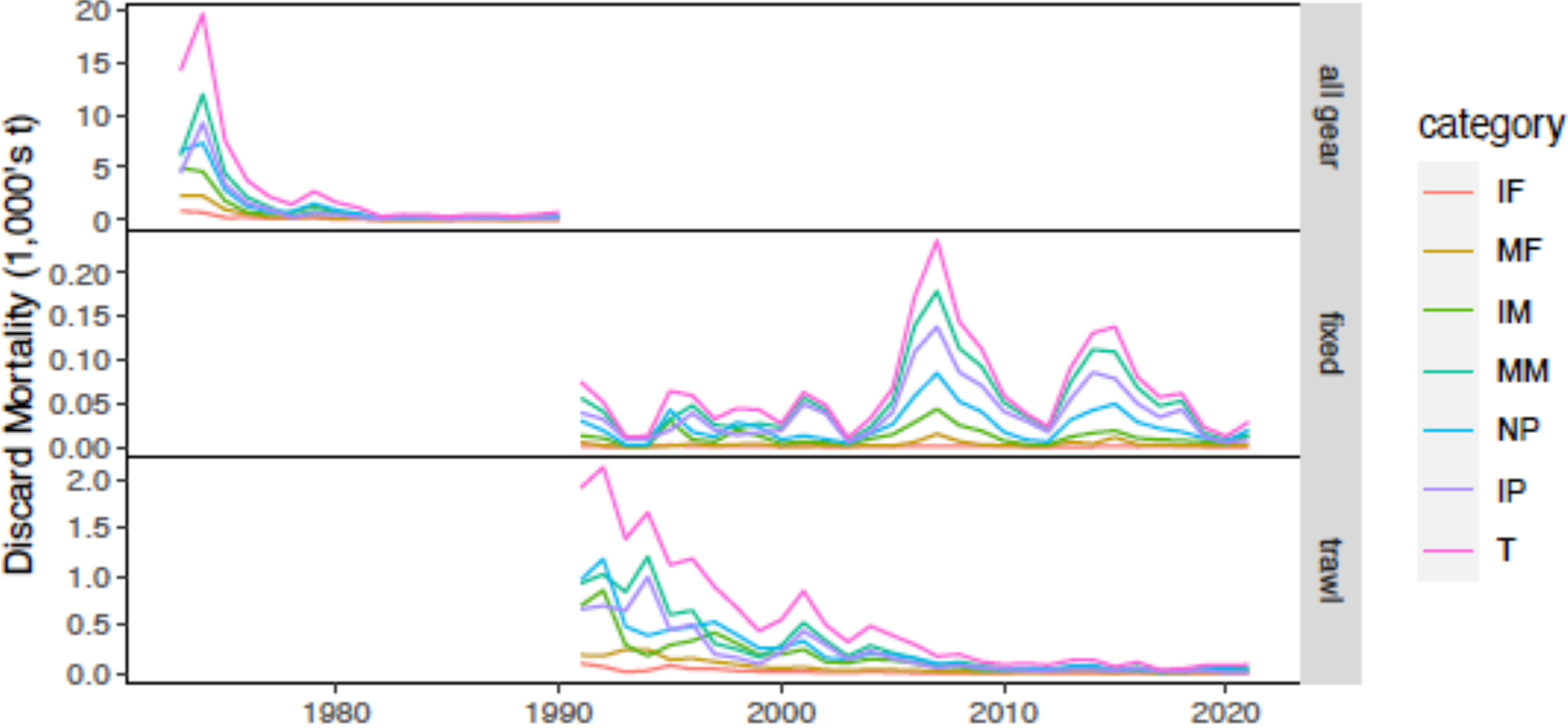


Bycatch in the Groundfish Fisheries

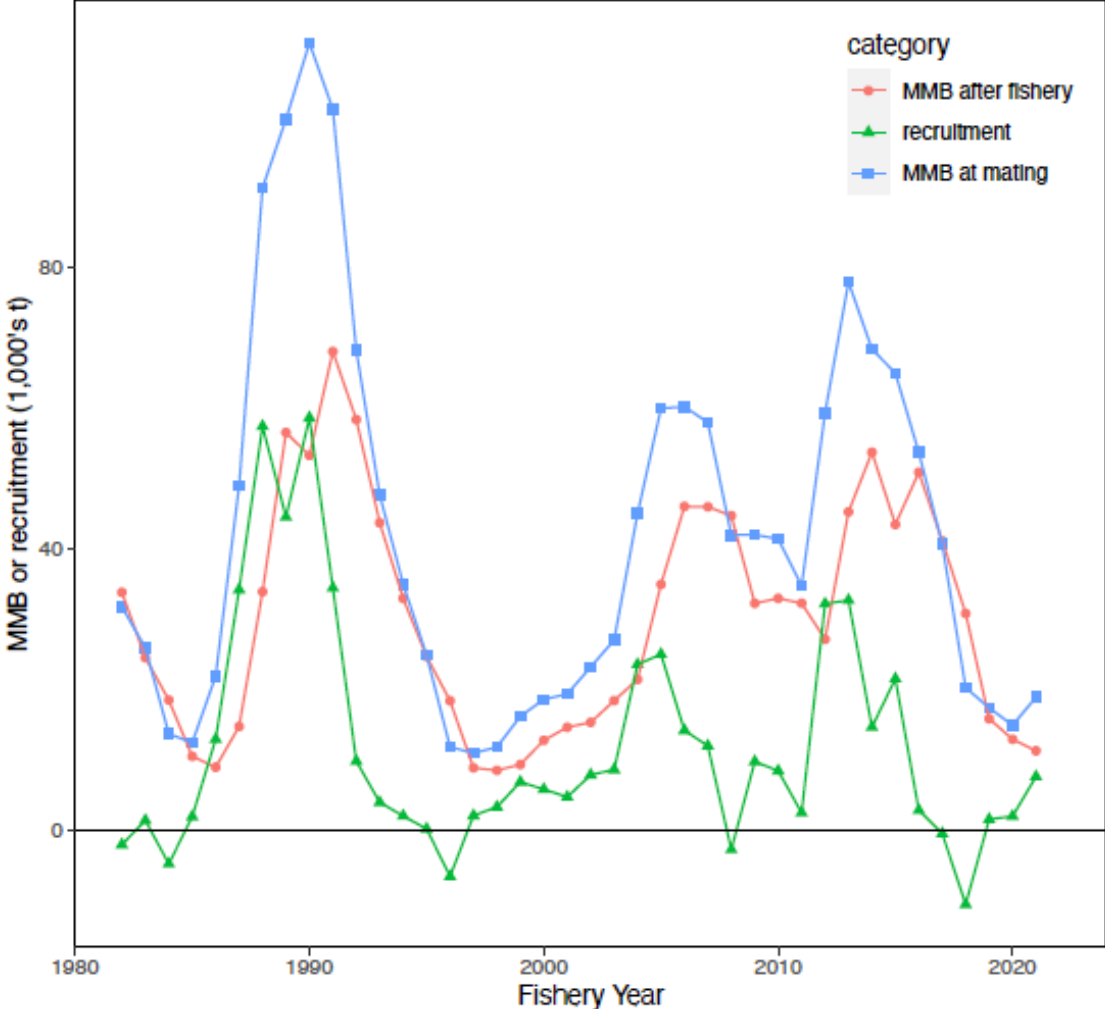
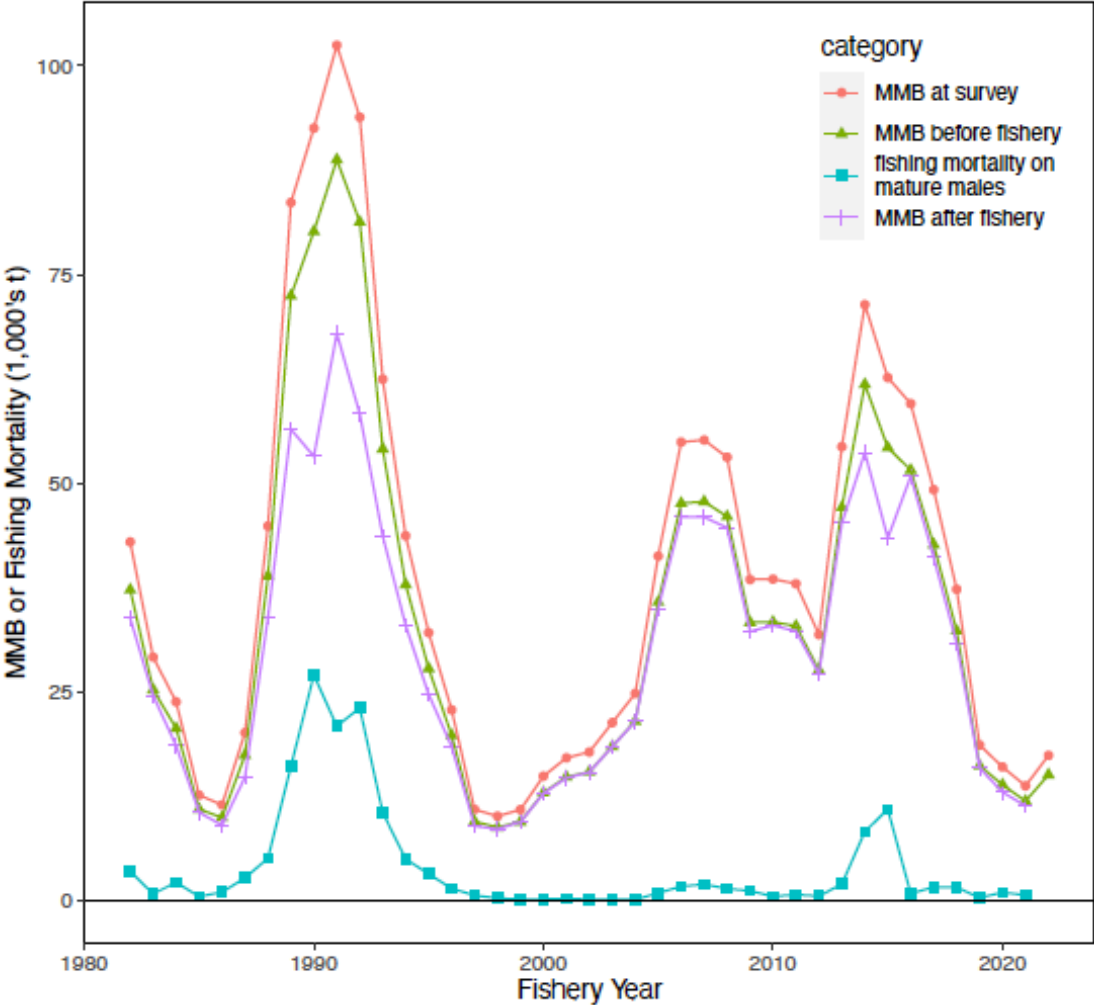


- substantial fraction **not** mature males

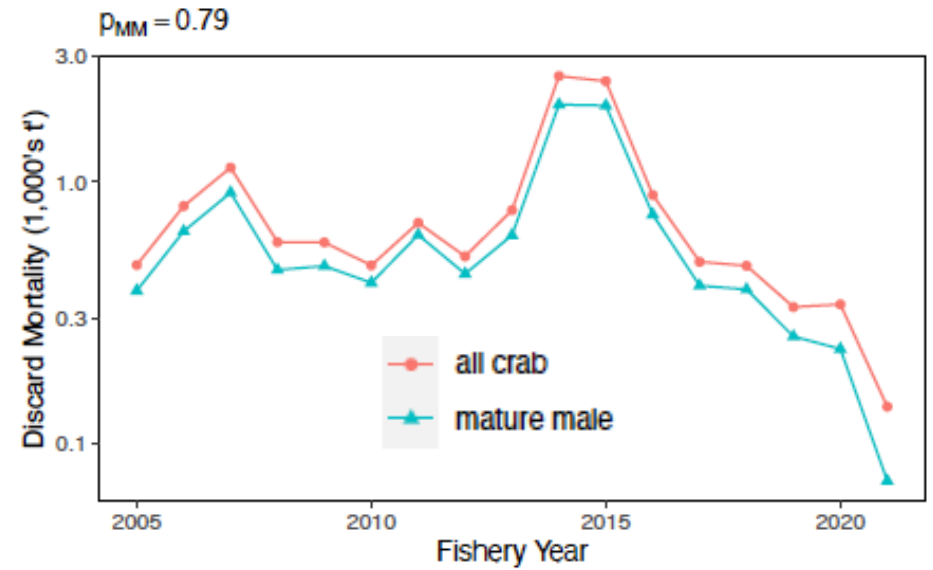
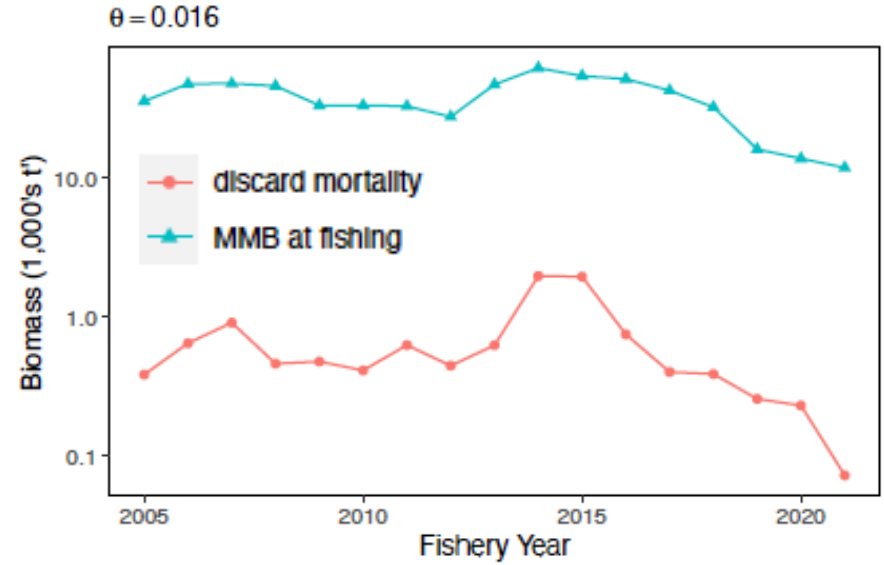
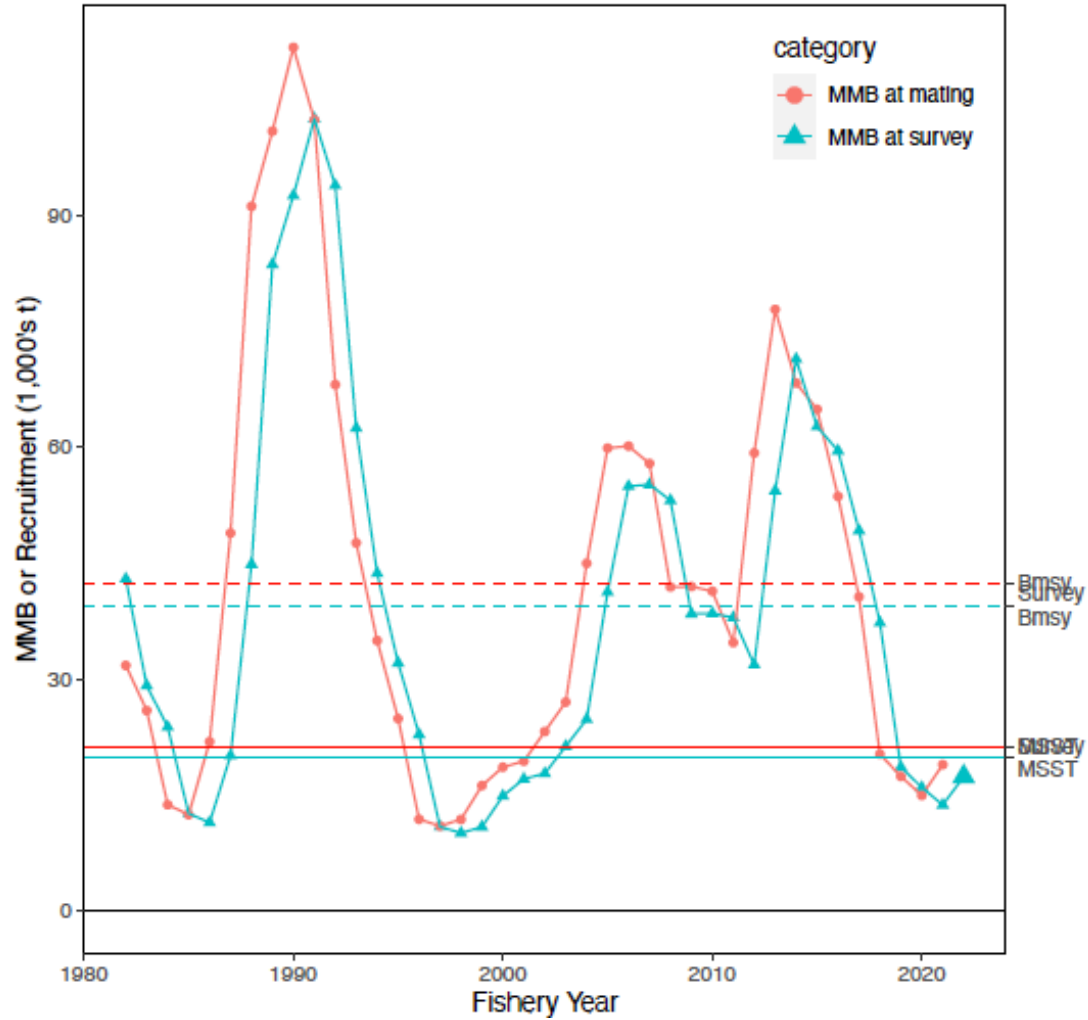
Estimated Catch Mortality in the Groundfish Fisheries



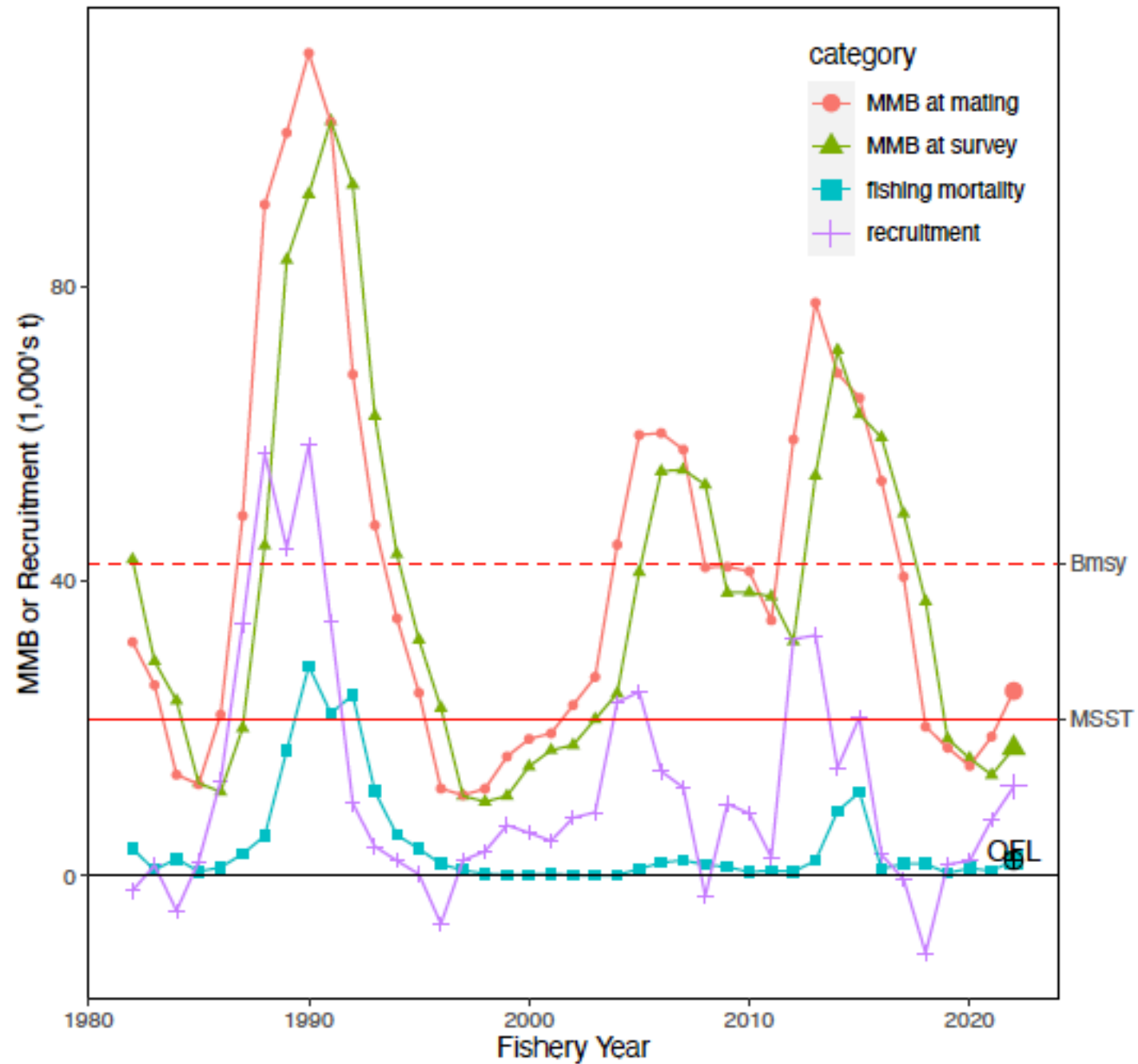
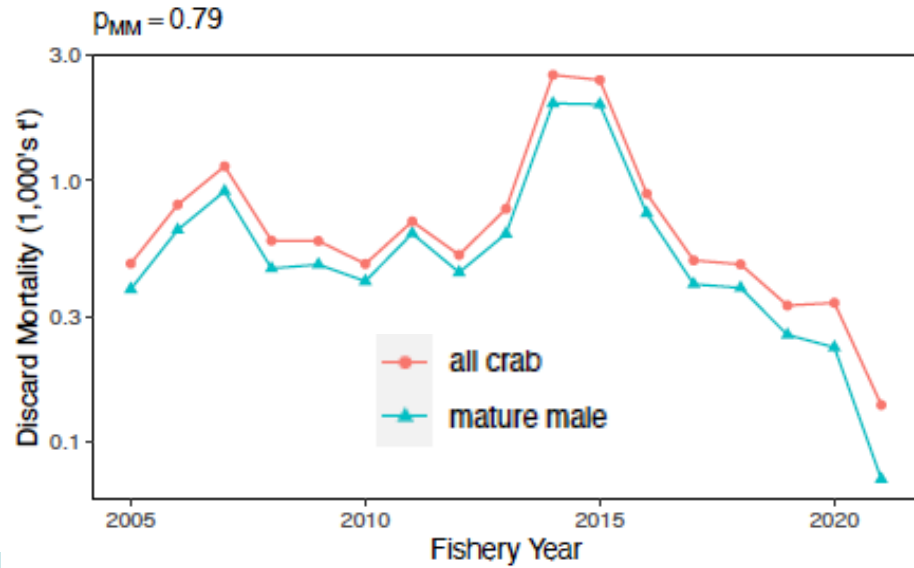
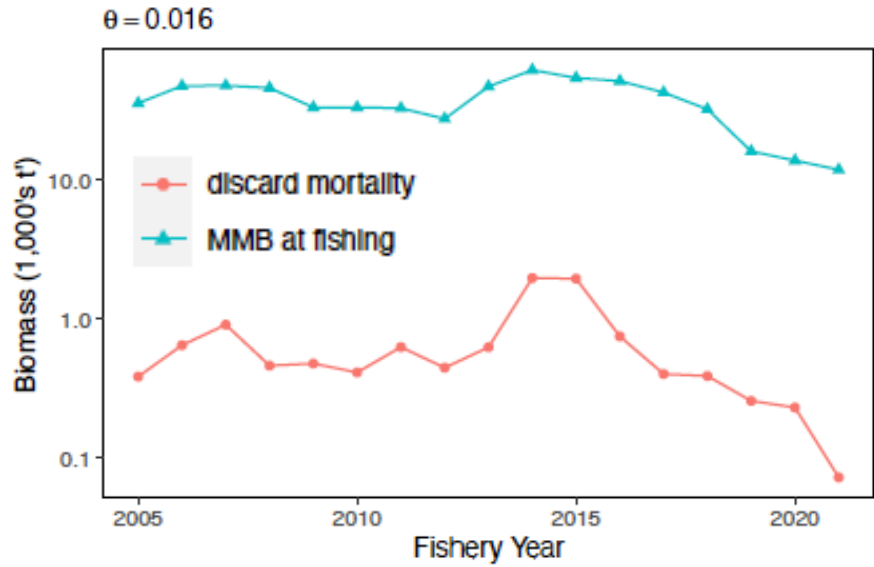
Estimating MMB at mating



Estimating B_{MSY}



Status and OFL



Tier 4 Model Results

- M was set to 0.23.
- The period 1982-2021 was used to determine
 - B_{MSY}
 - average recruitment
- The period 2005-2021 was used to determine
 - θ
 - ρ_{MM} .

Quantity	Value	Units
assessment year	2022/23	–
MMB-at-mating	25,068	t
<i>MSST</i>	21,160	t
status ratio	0.592	–
status	not overfished	–
<i>F_{MSY}</i>	0.23	–
<i>F_{OFL}</i>	0.126	–
OFL	2,076	t
retained OFL	1,774	t
discard OFL	303	t



Tier 4 Model Issues

- value for M
- The period used to determine
 - B_{MSY}
 - average recruitment
- The period used to determine
 - θ
 - ρ_{MM}
- Include recruitment in status/OFL calculation?
 - don't
 - use average
 - bootstrap

