2023 Tanner Crab Stock Assessment

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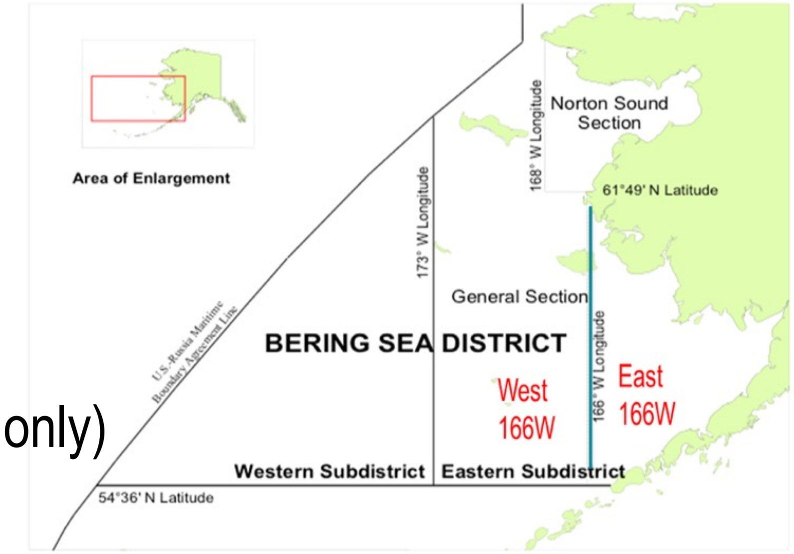
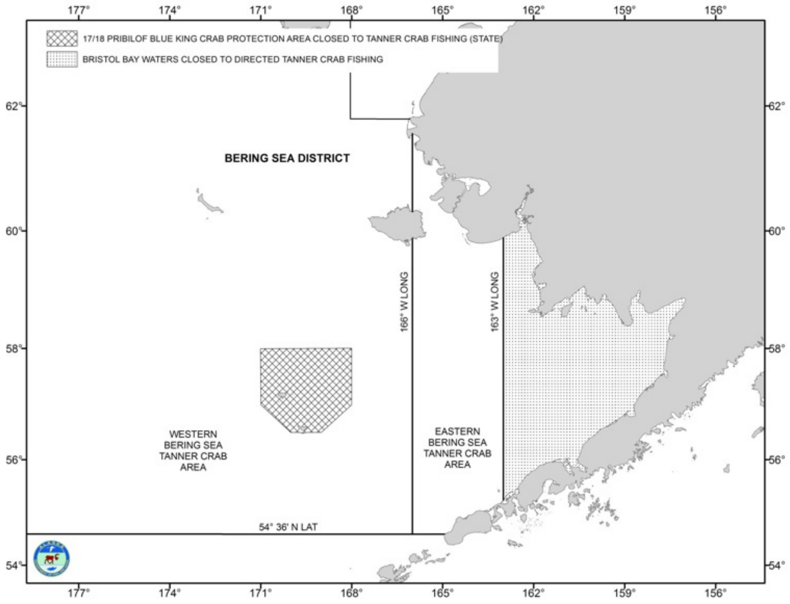
AFSC/NMFS/NOAA

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 ($B>B_{MSY}$; not overfished)
  - OFL: 36,200 t, ABC: 27,150 t





Concerns

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

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.

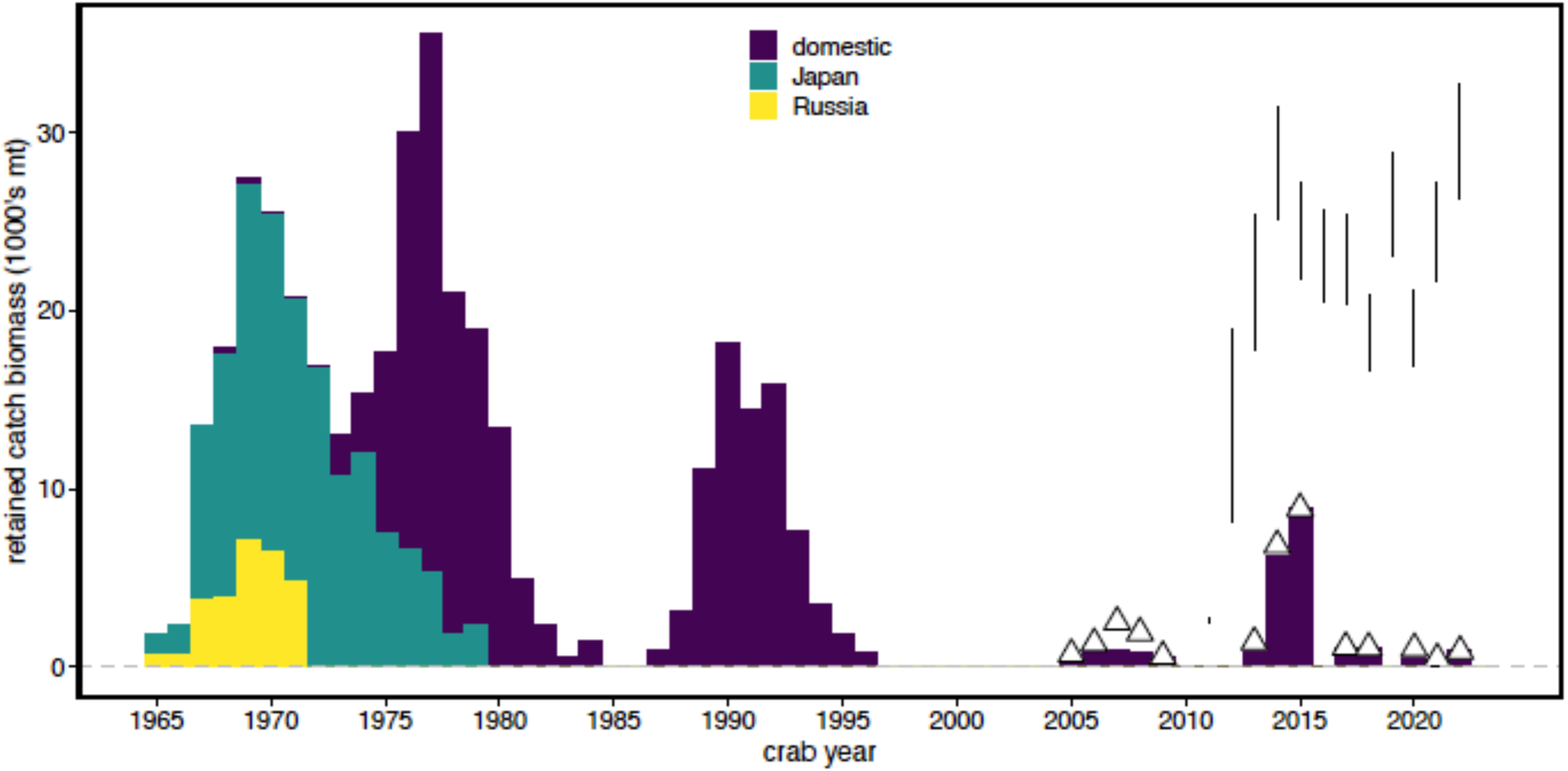
Recent model explorations

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

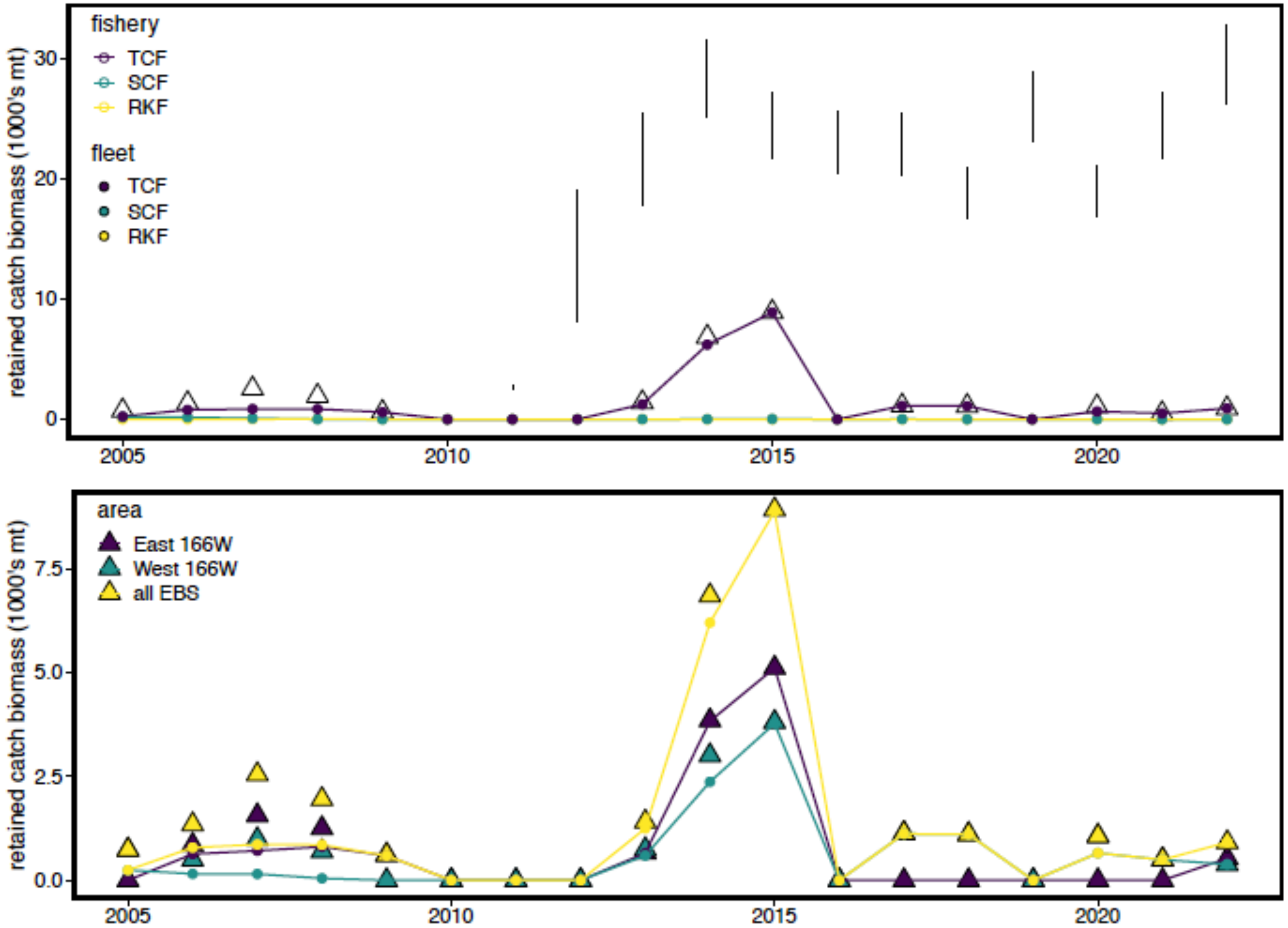
- fit VAST time series
- fit aggregated total catch data
- bootstrapped effective sample sizes as input sample sizes for NMFS survey size comps
- compress size composition tails
- Dirichlet-multinomial likelihood used to estimate effective size comp sample sizes

Fleets-as-areas models
- ADFG two-area management
- Bycatch by groundfish gear type

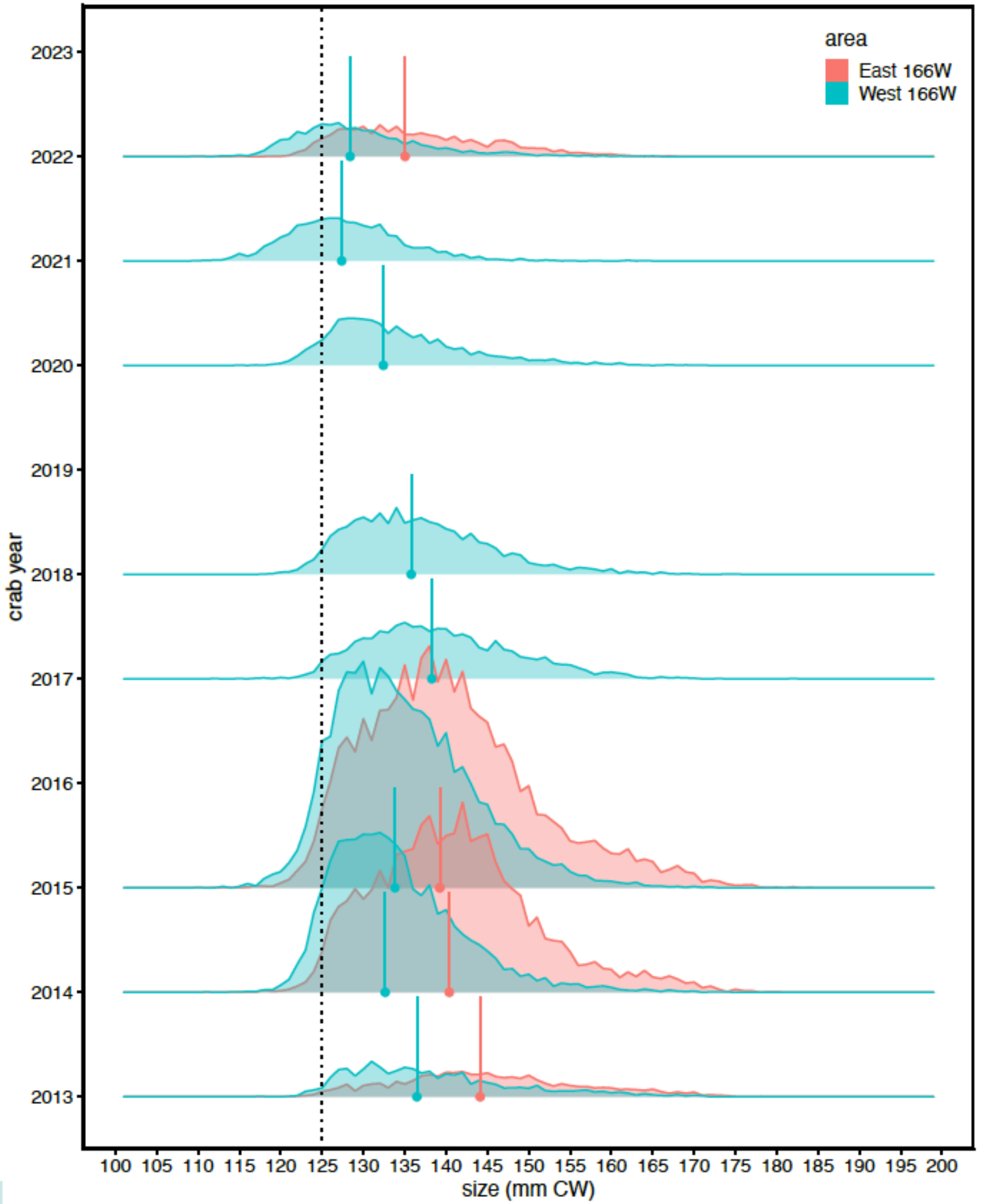
Retained catch

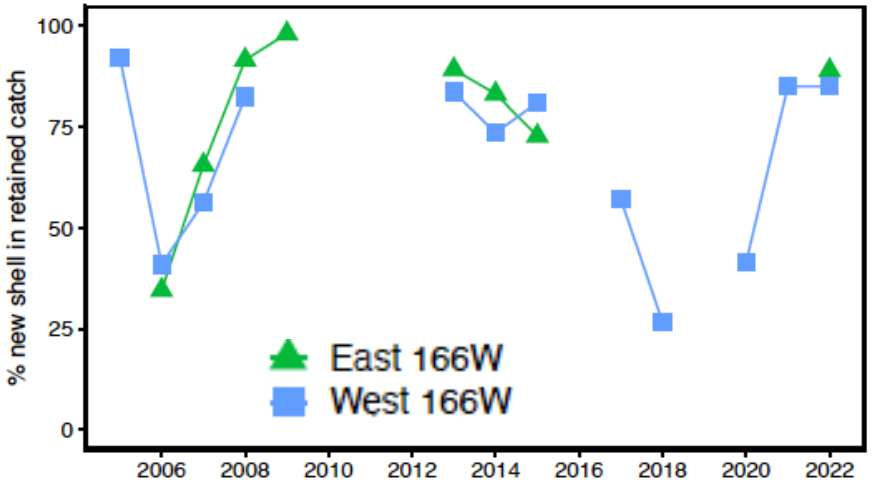


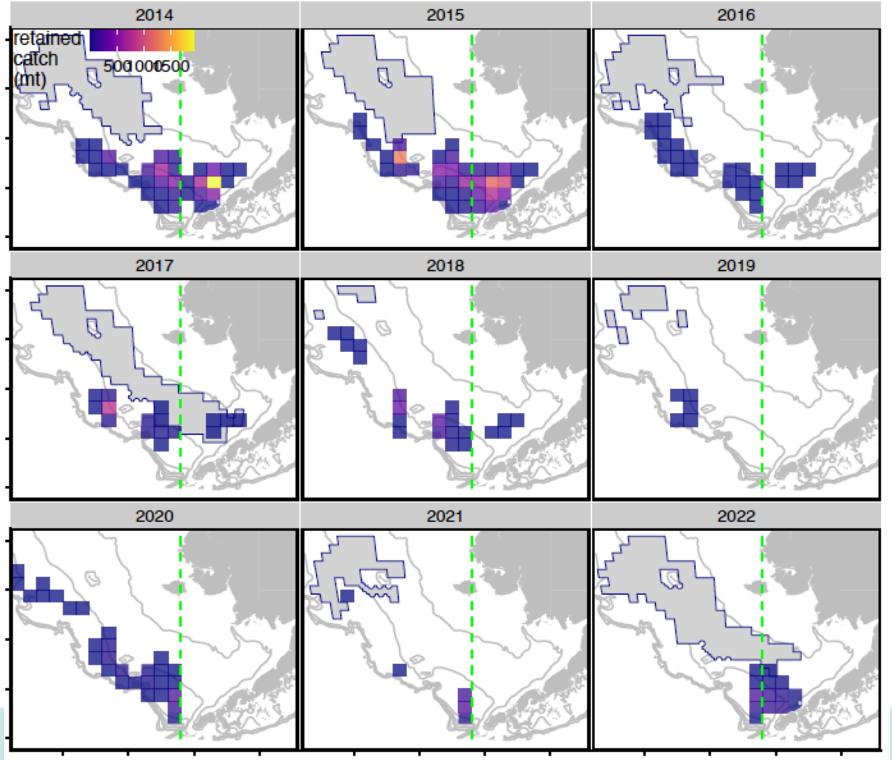
Retained catch



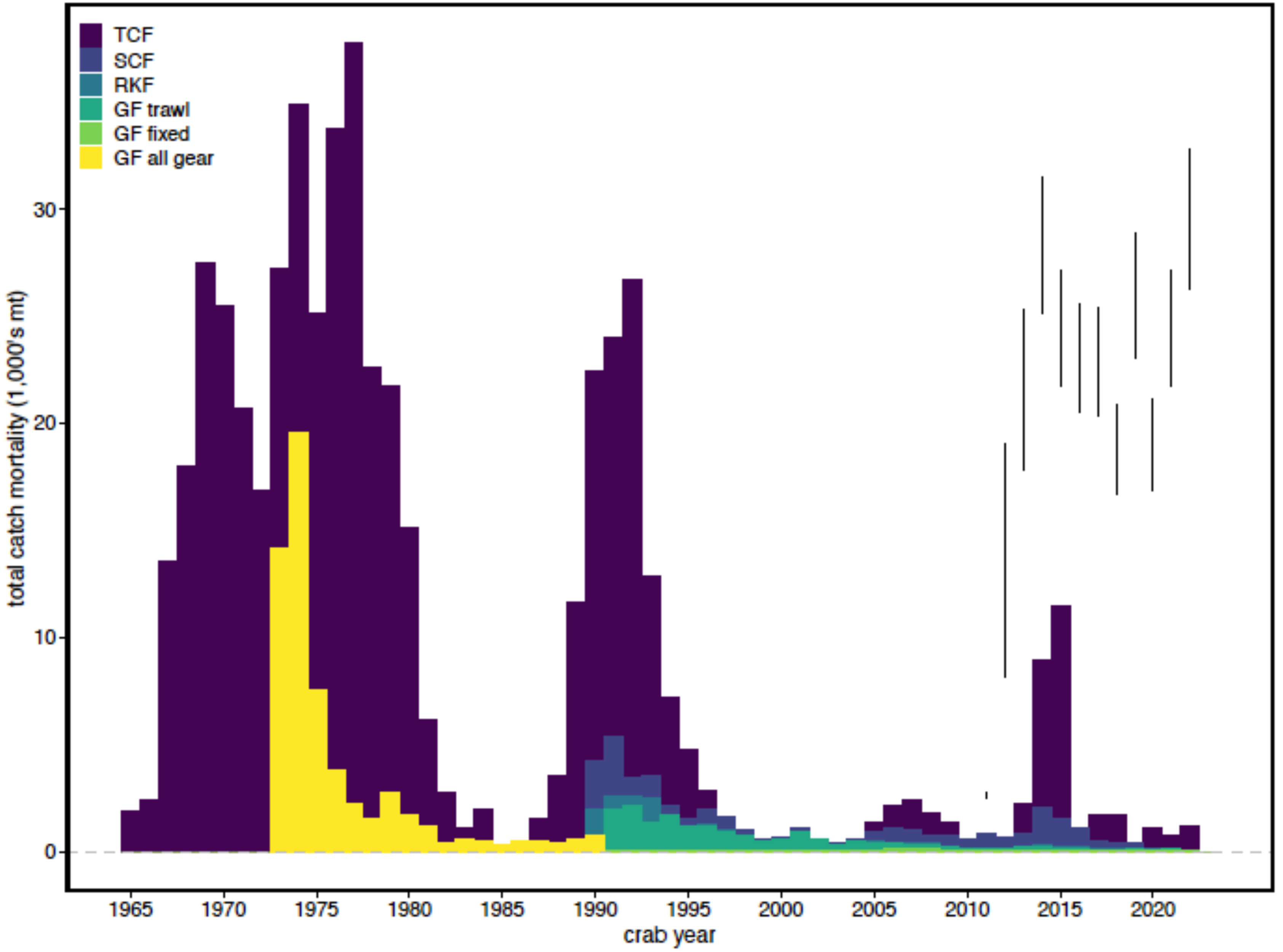
Retained catch



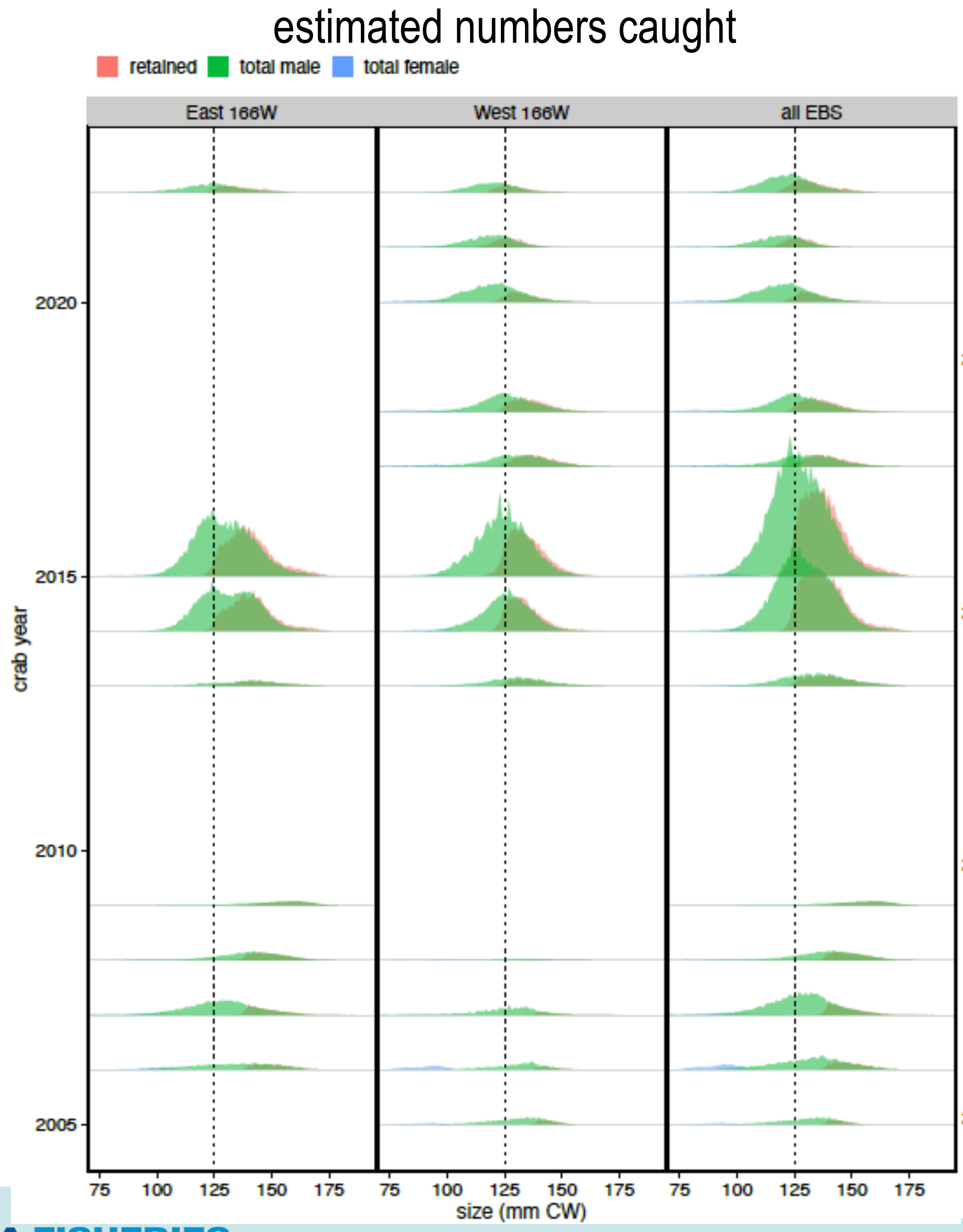


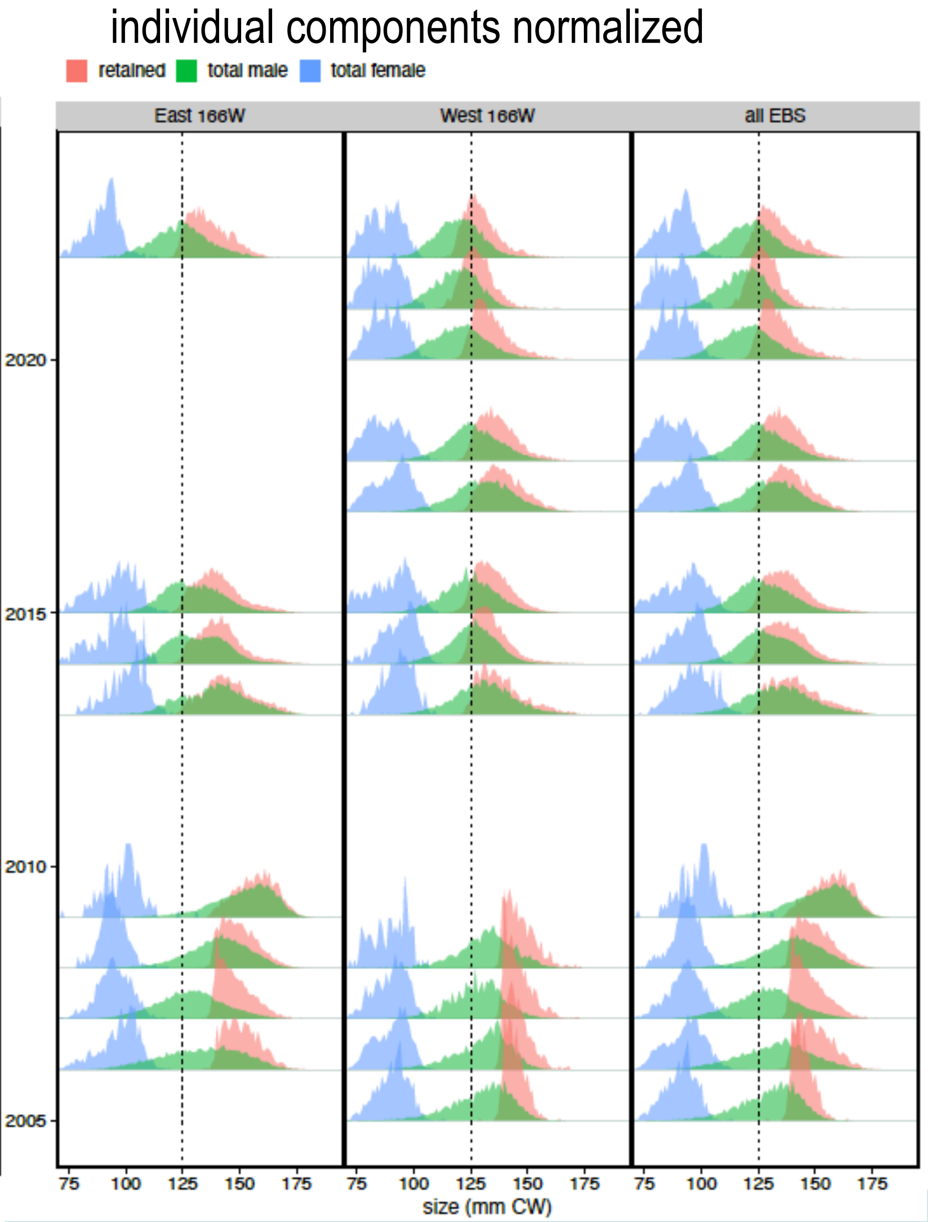


Total catch mortality

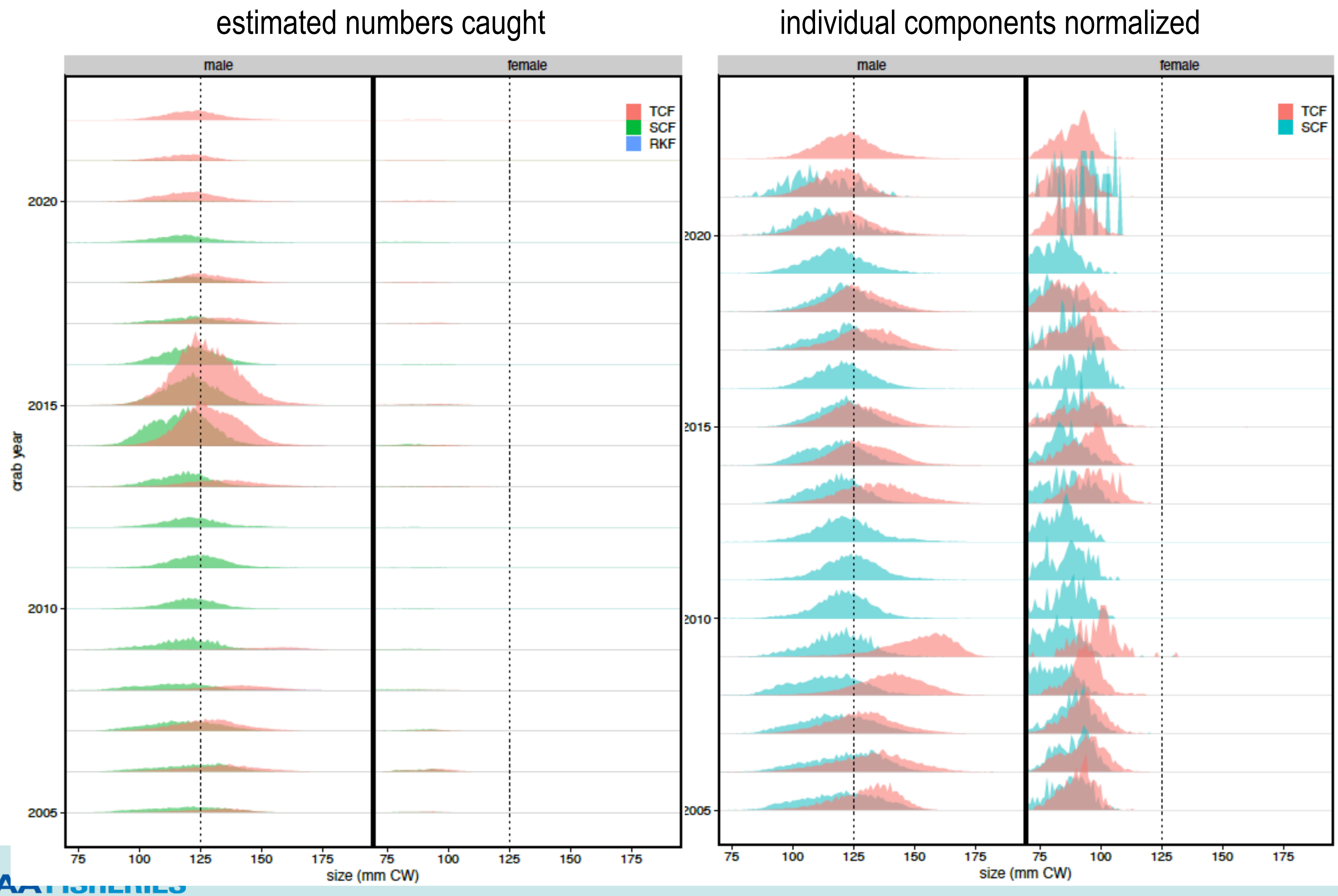


Total catch mortality in the directed fishery



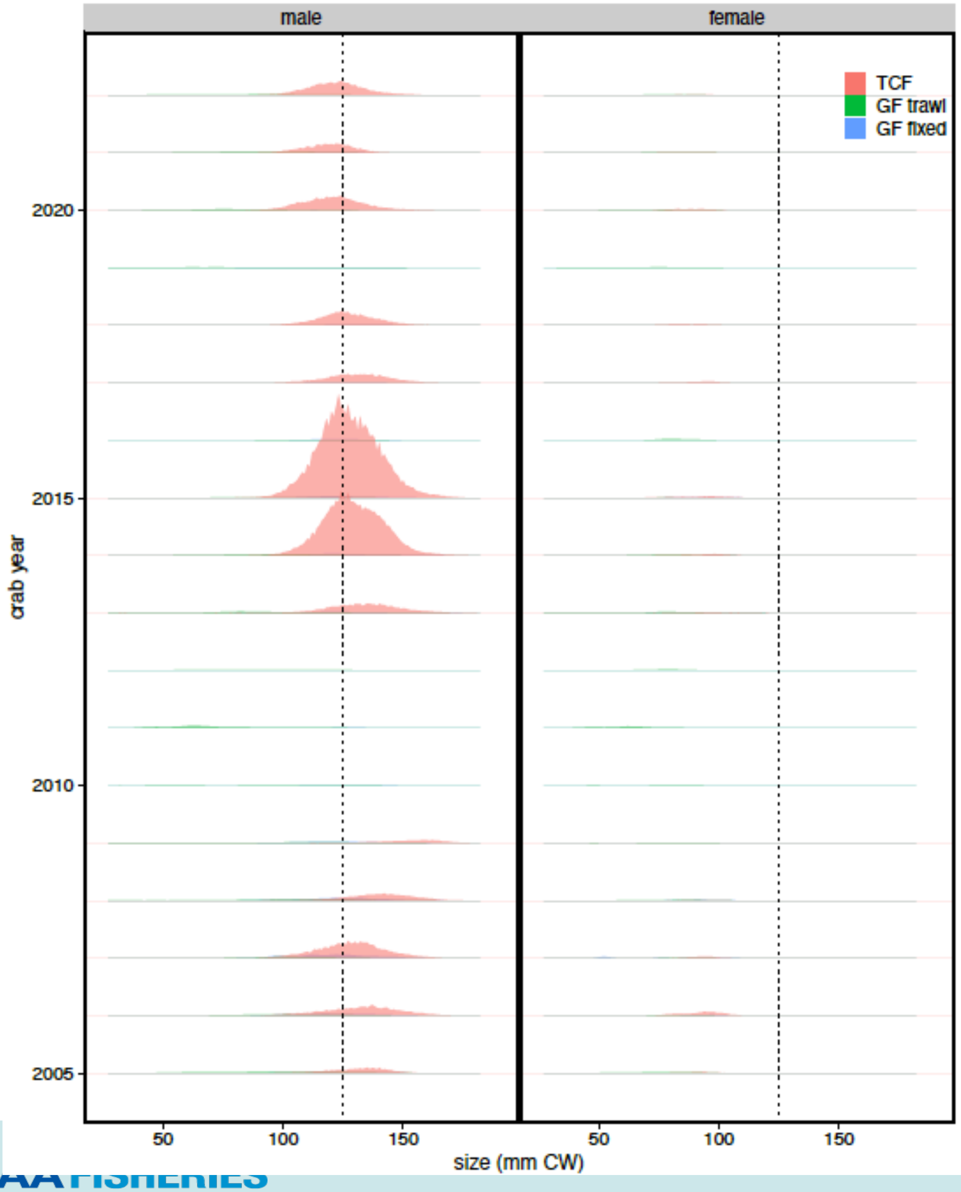


Total catch comparisons: bycatch in snow crab fishery

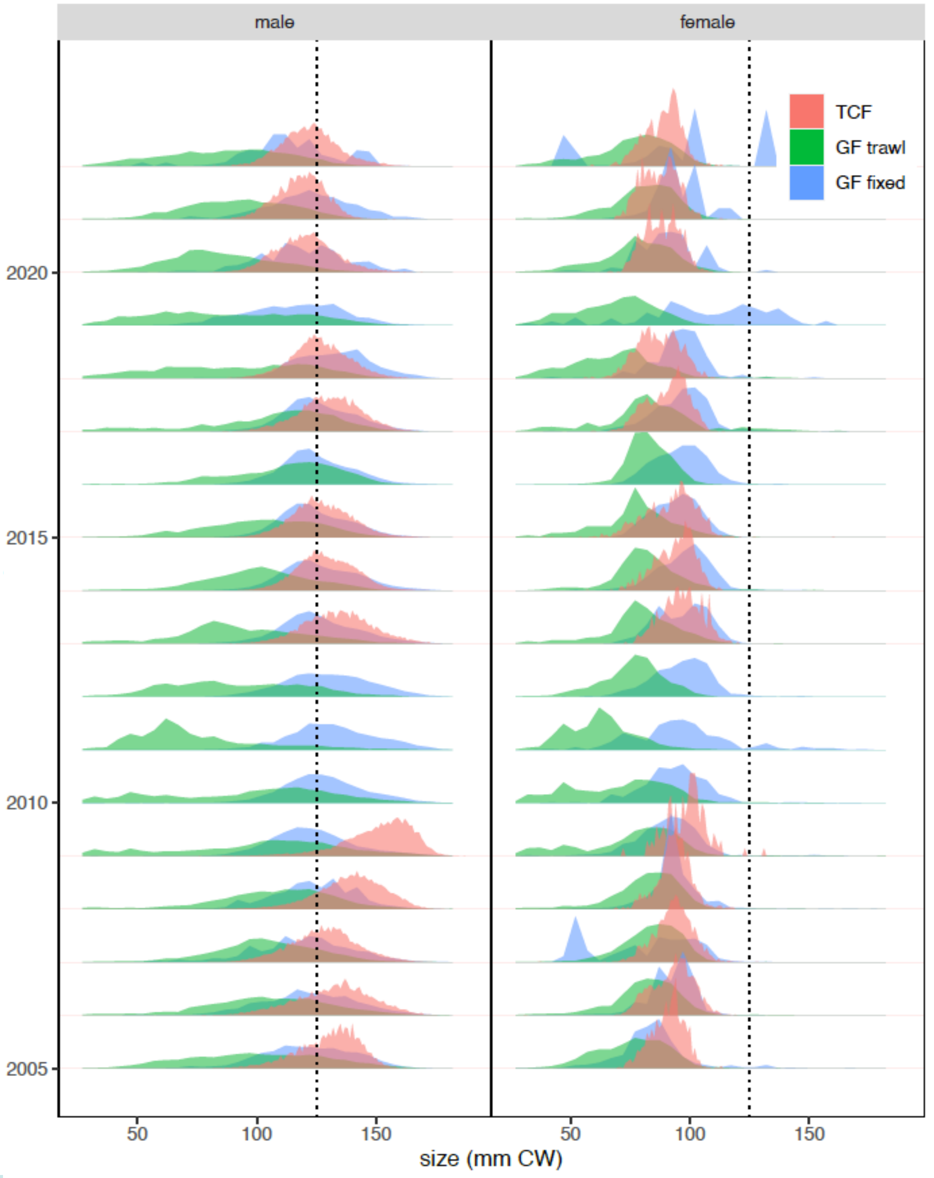


Total catch comparisons: bycatch in groundfish fisheries

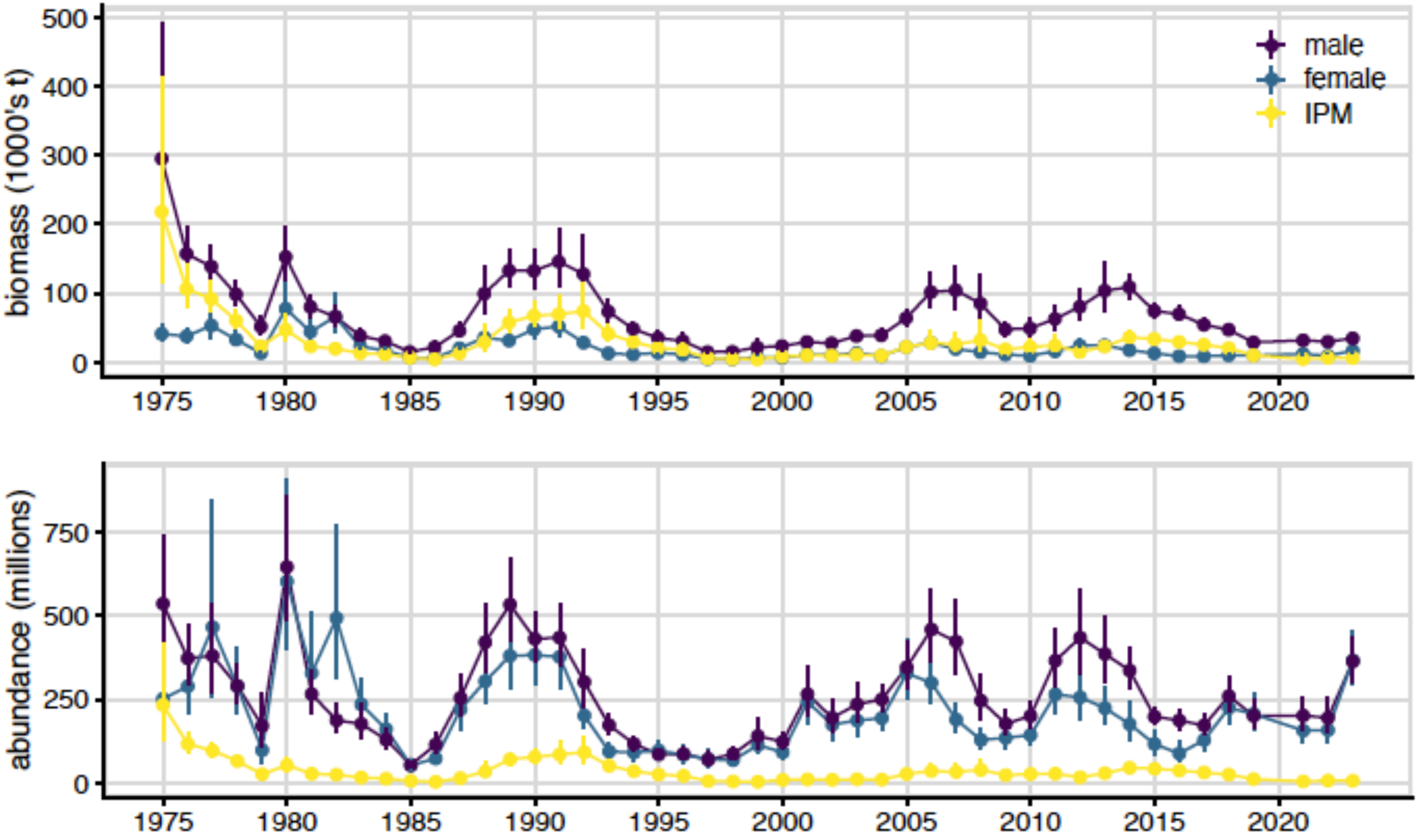
estimated numbers caught



individual components normalized



NMFS EBS Survey Data



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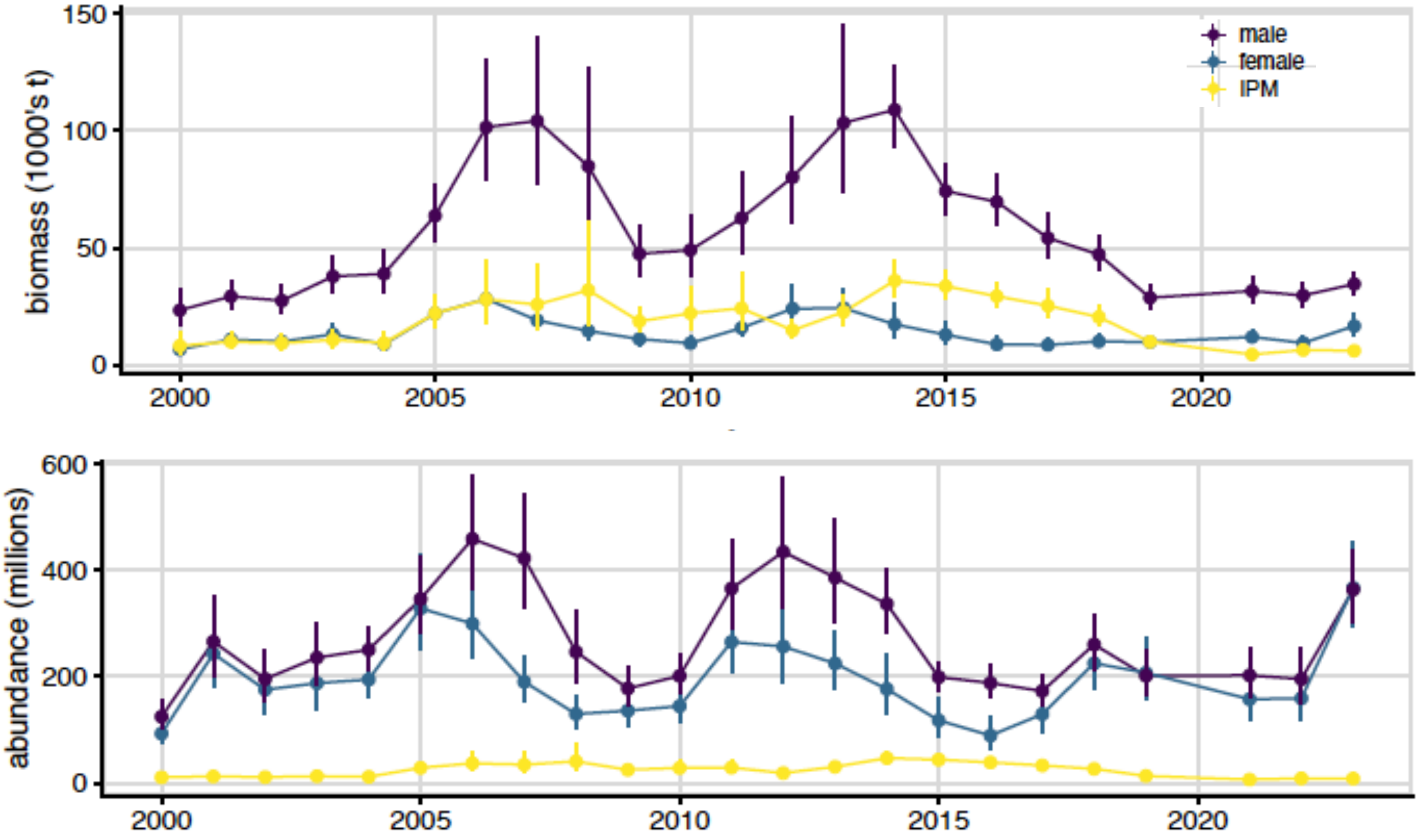
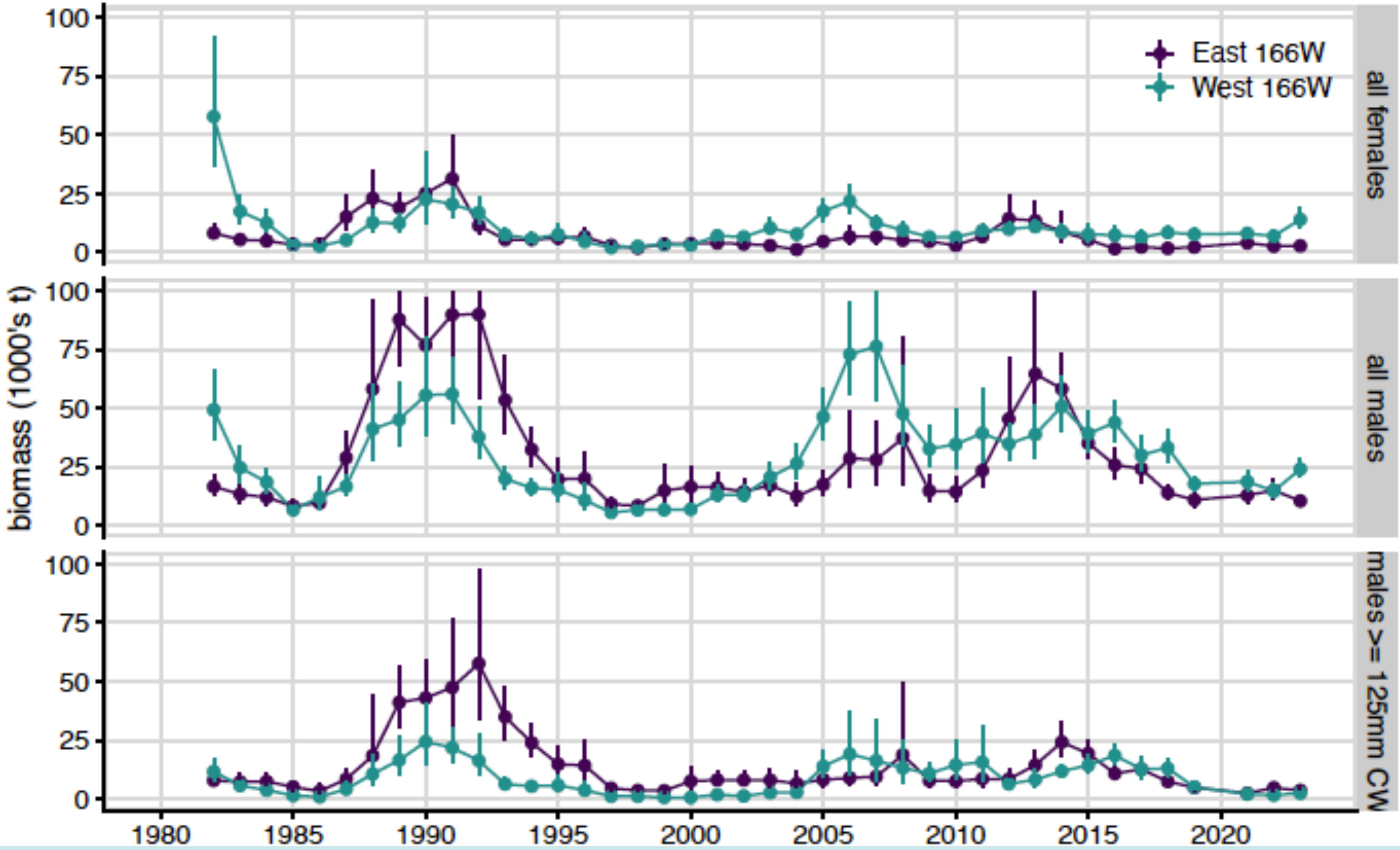


Survey Data By Management Region



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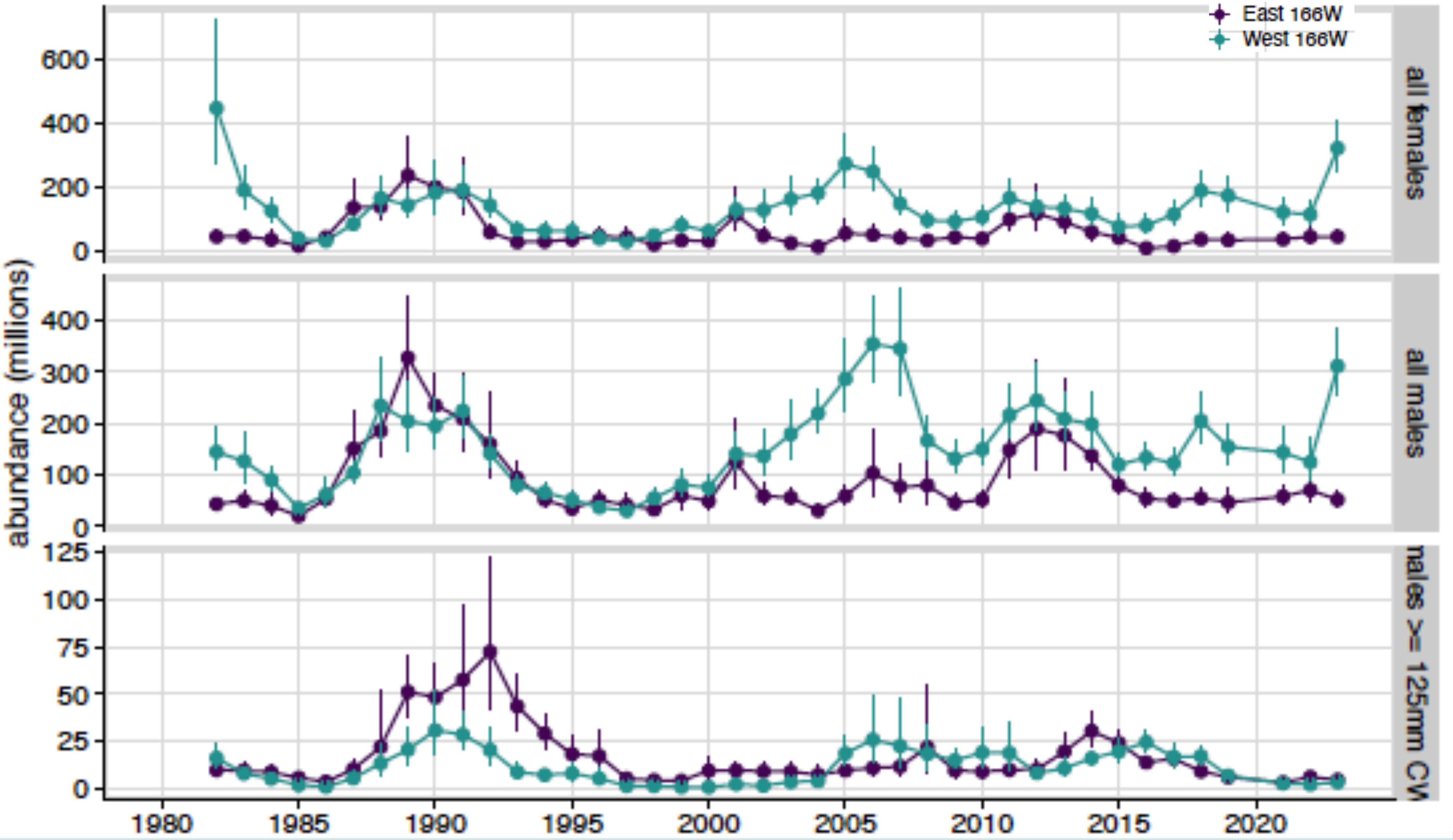
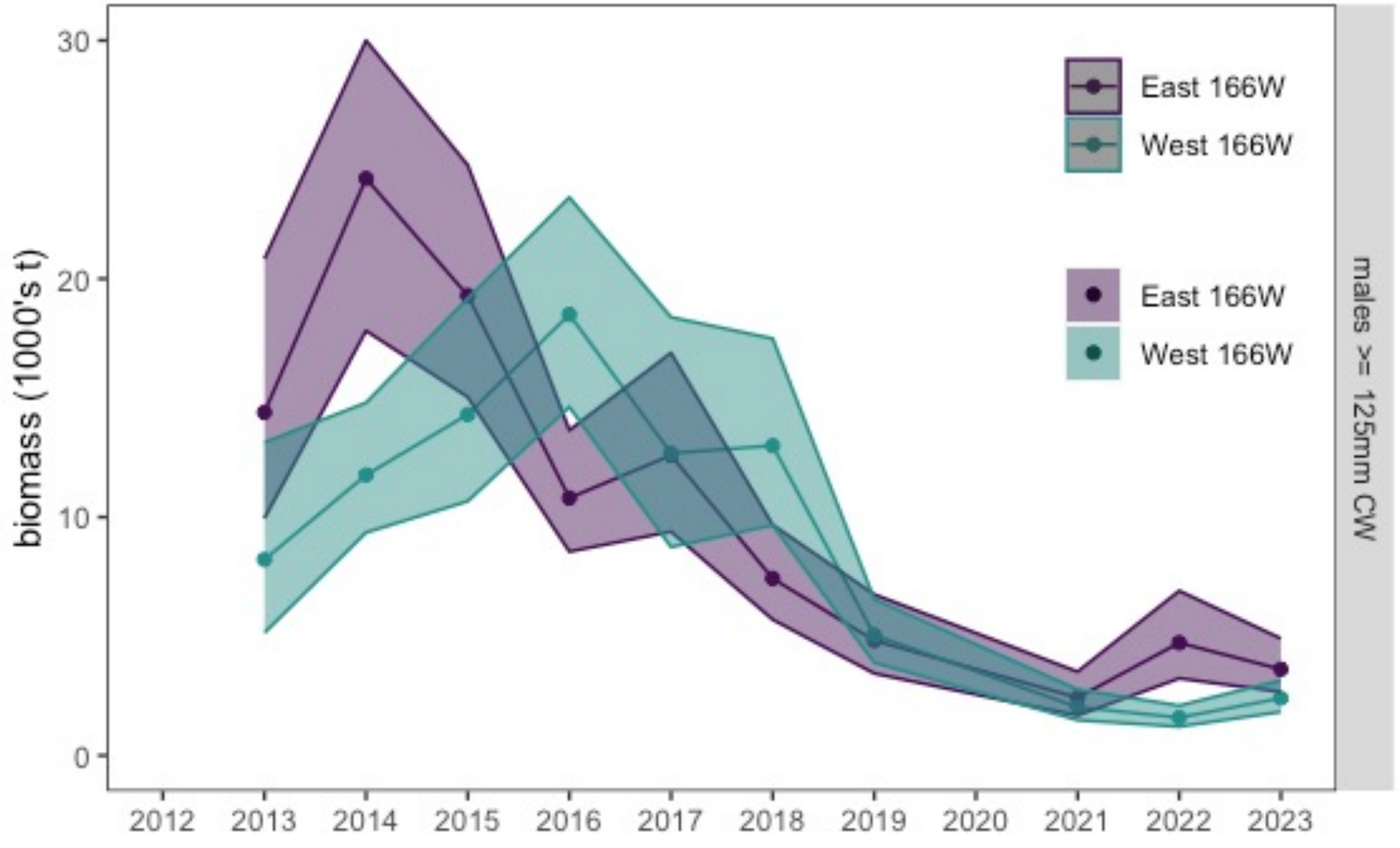
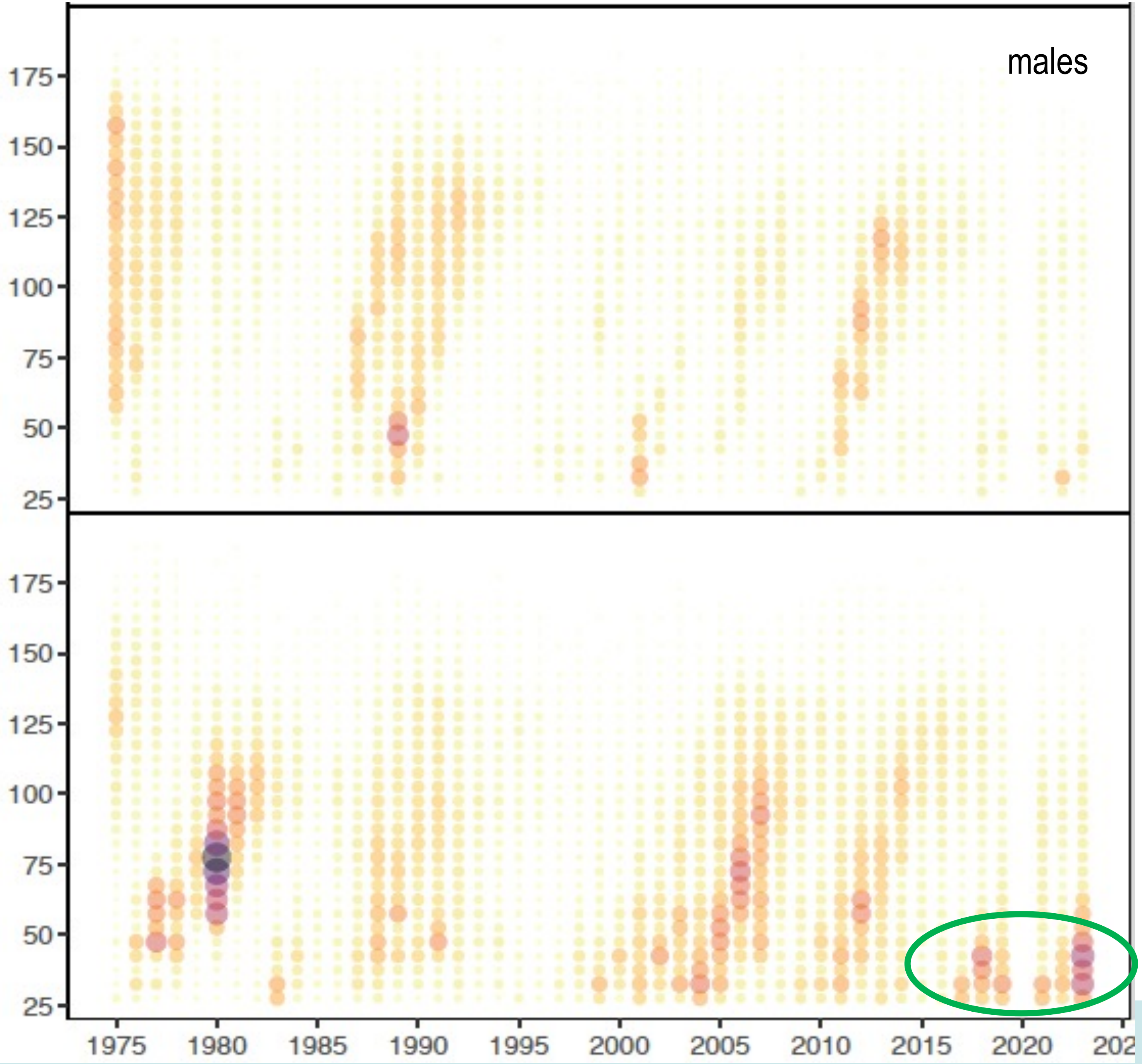


NMFS EBS Survey Data: Industry-preferred males



Survey Size Comps

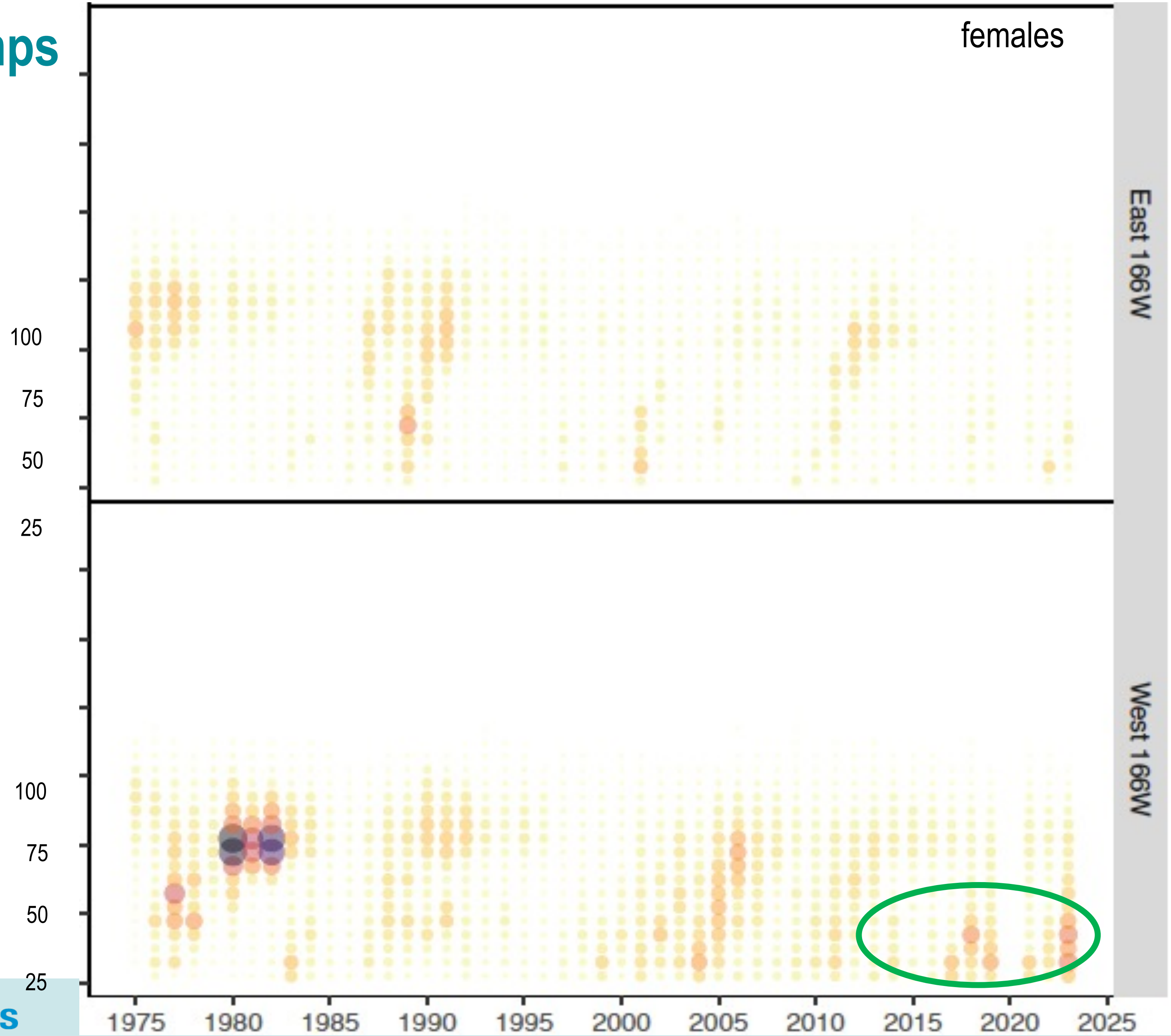


East 166W

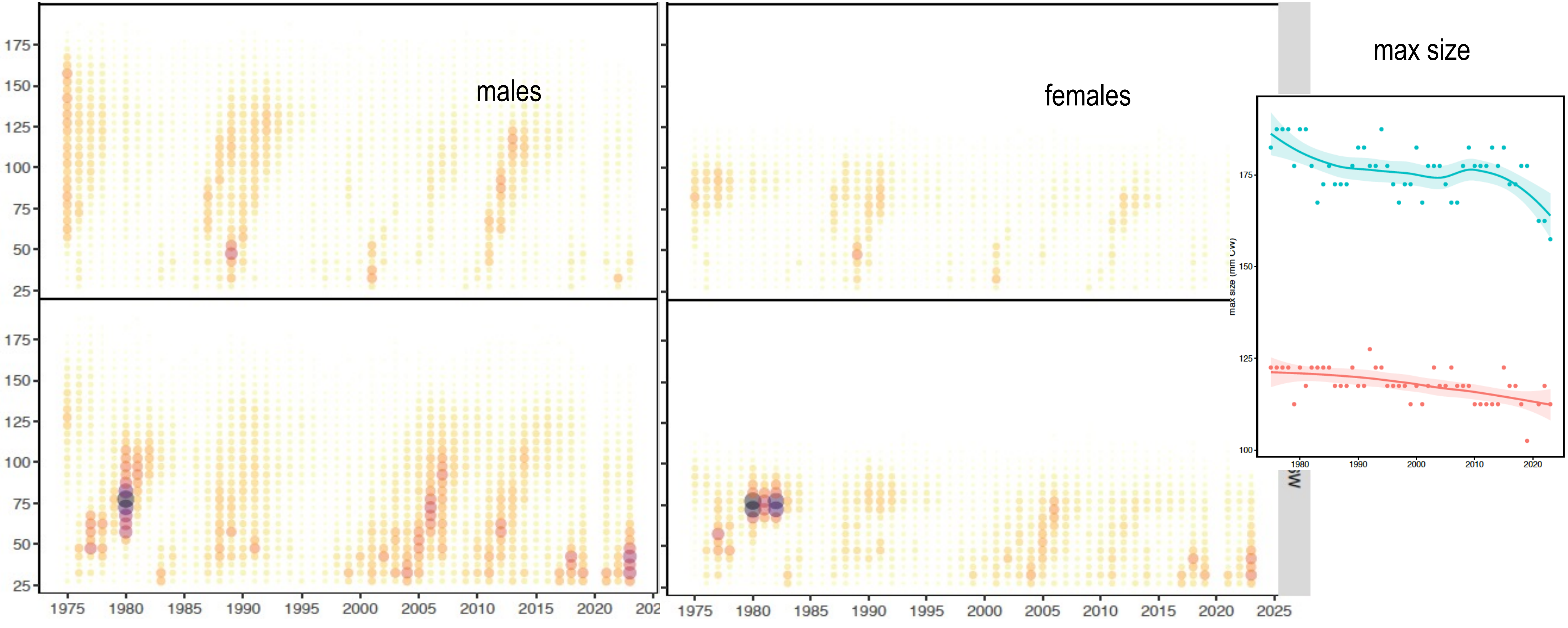
West 166W

NOAA FISHERIES

Survey Size Comps

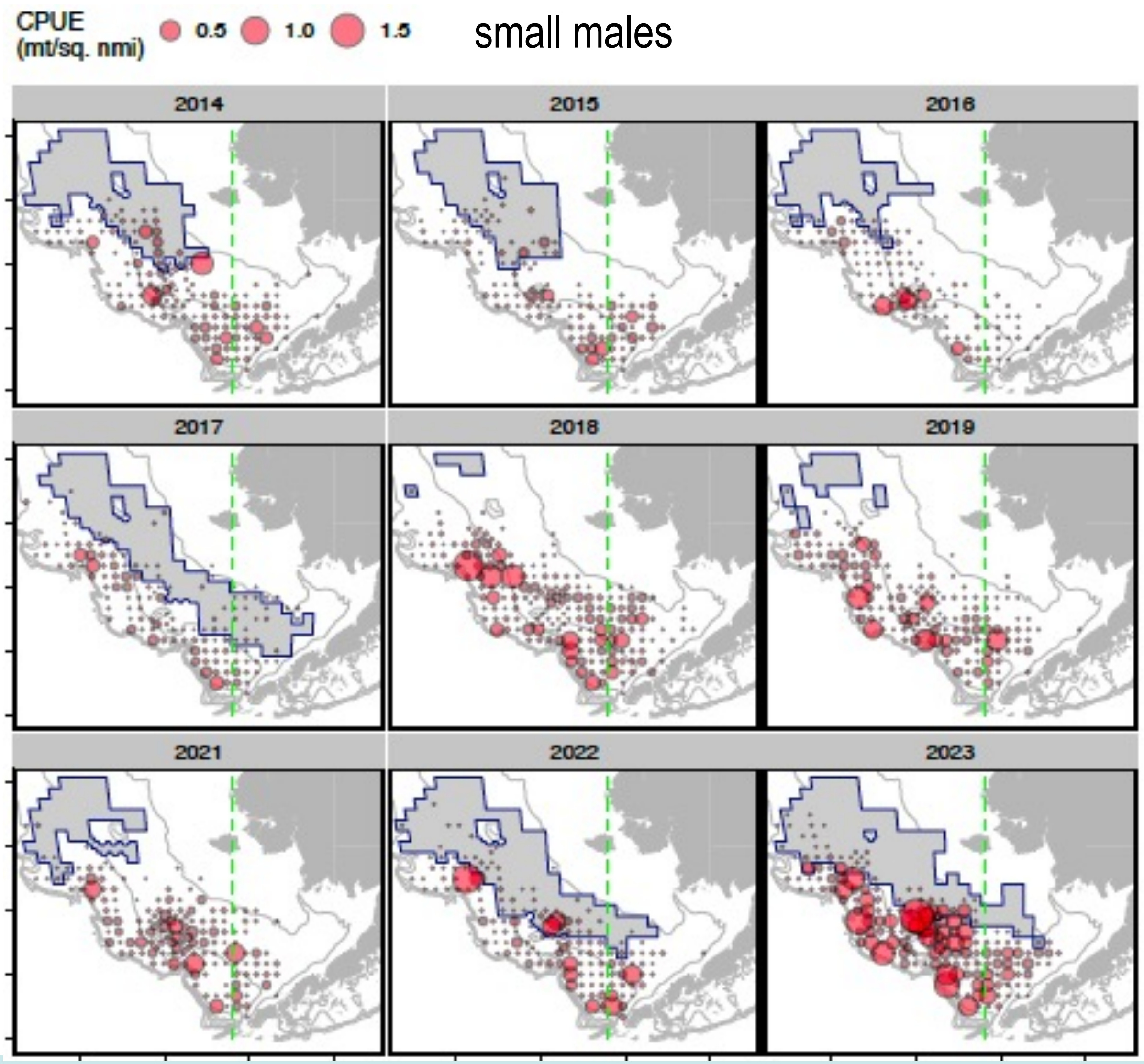


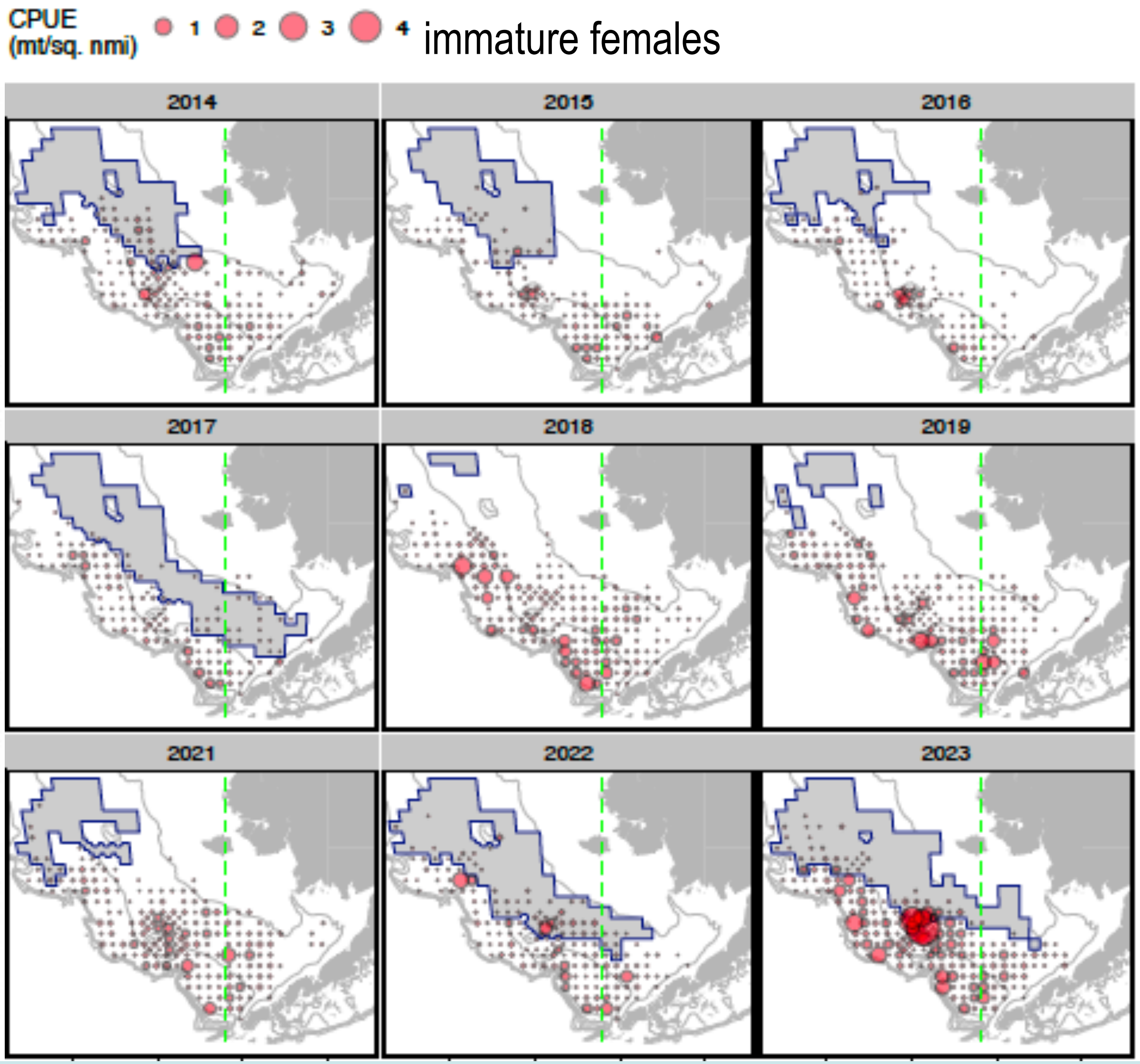
Survey Size Comps



NOAA FISHERIES

Survey spatial patterns





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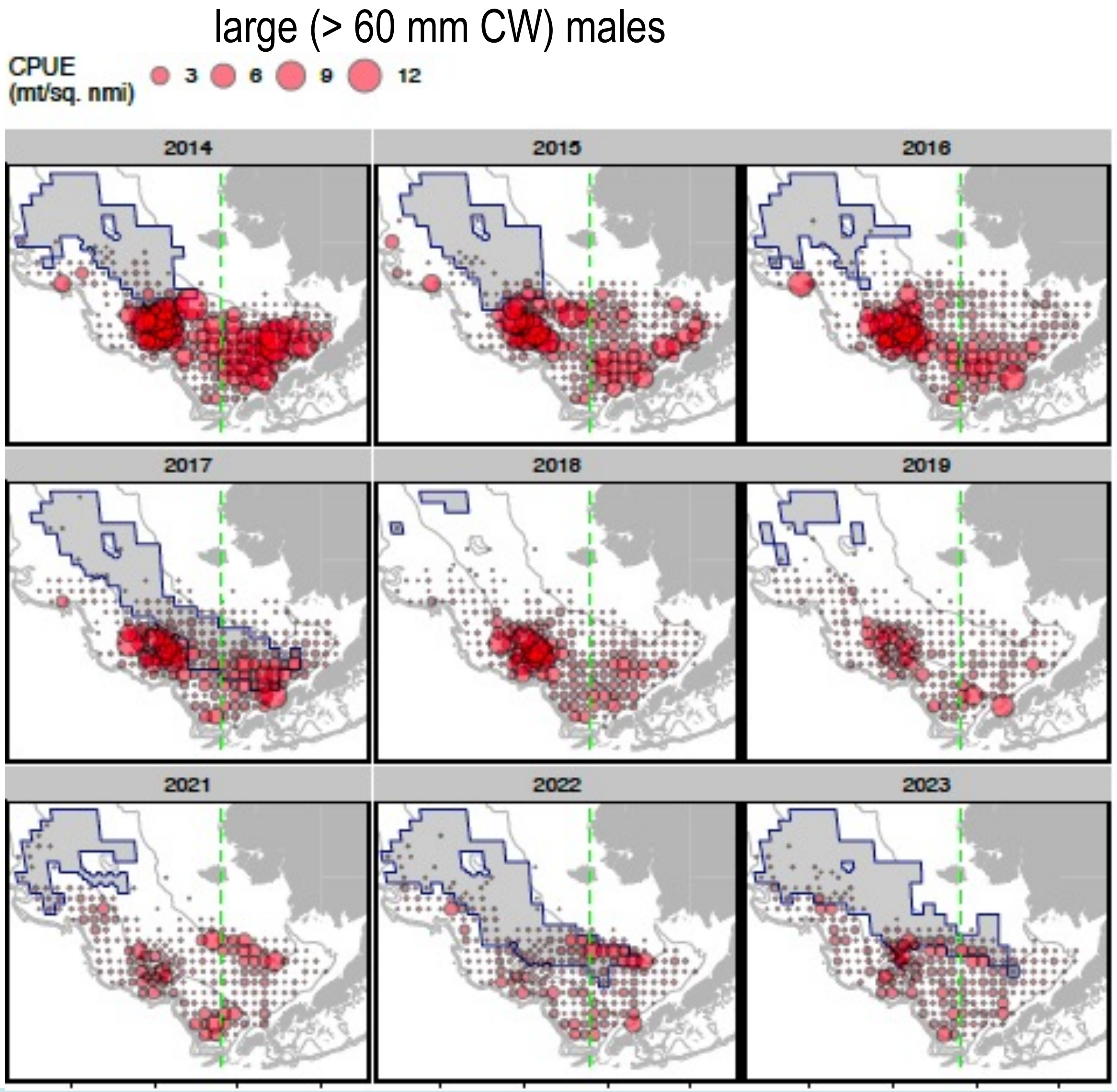
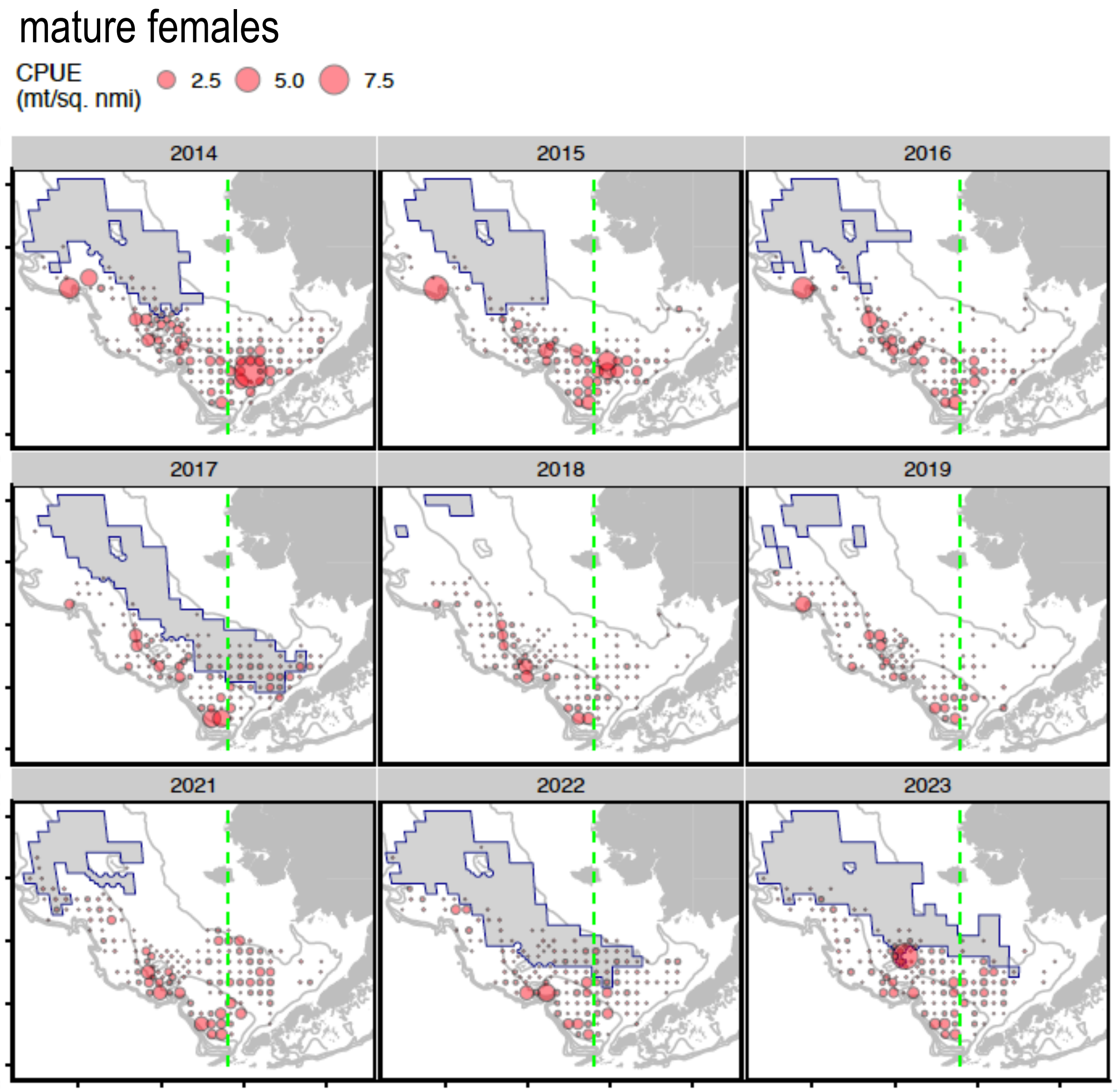
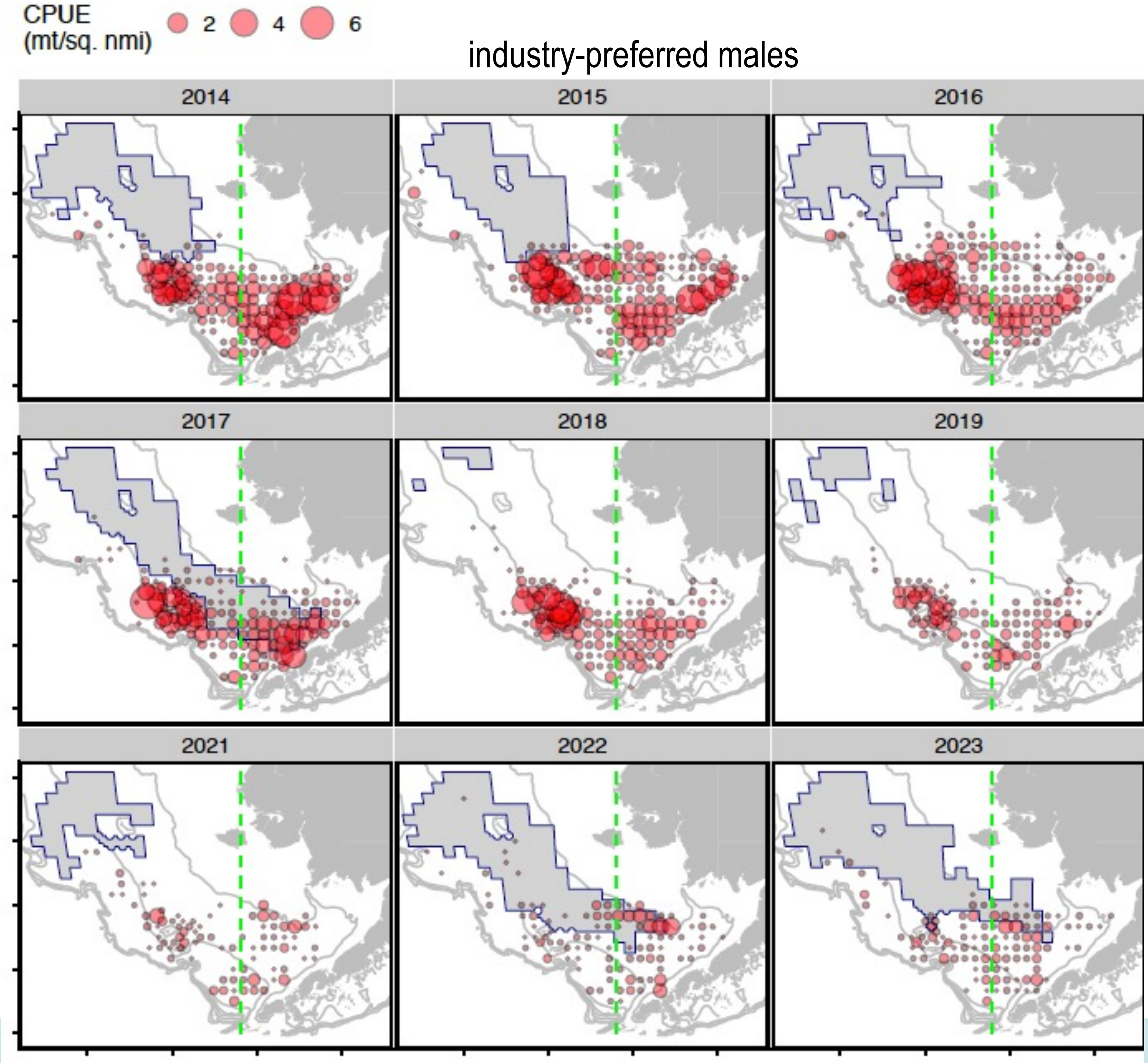


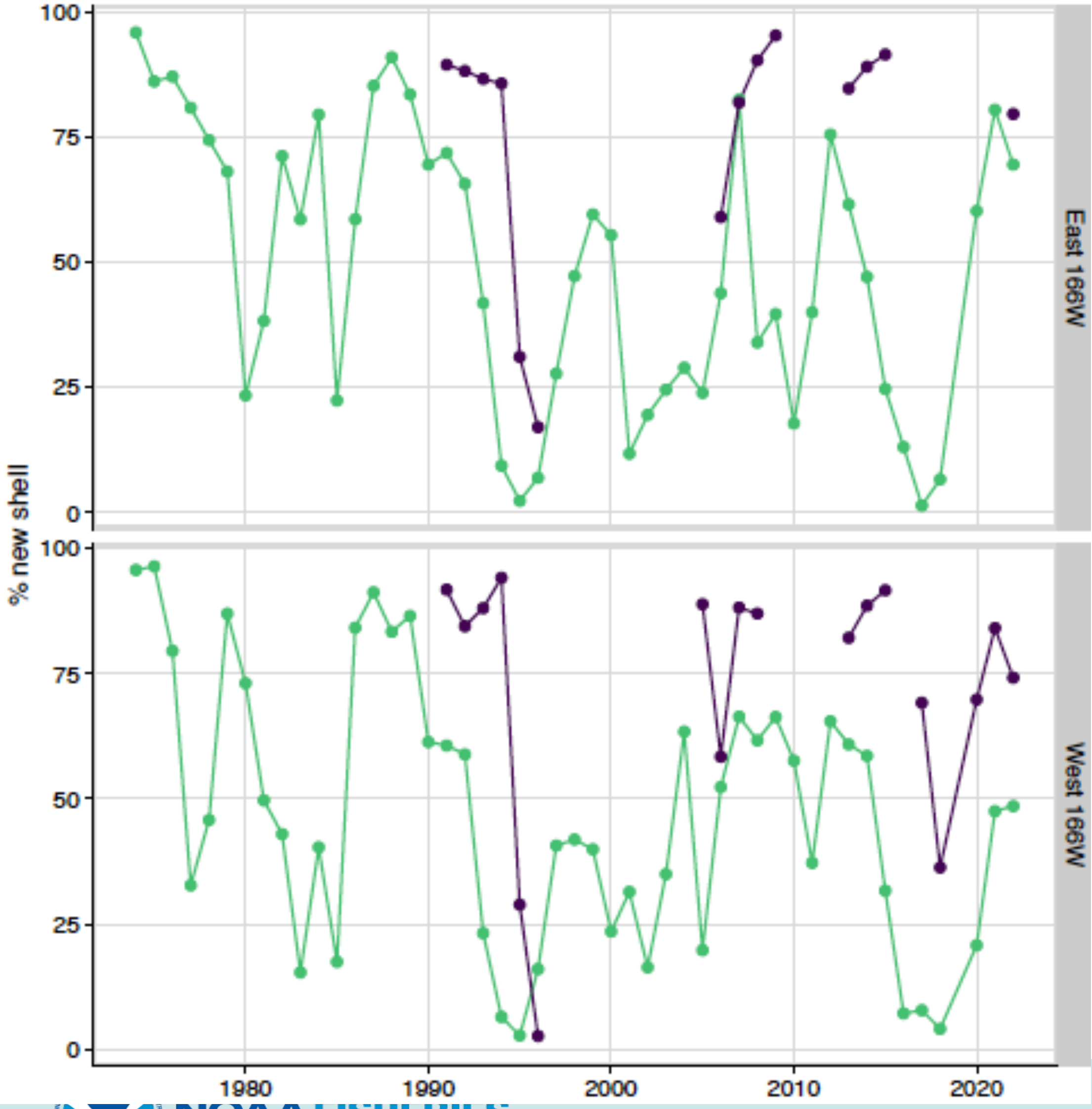


Survey spatial patterns

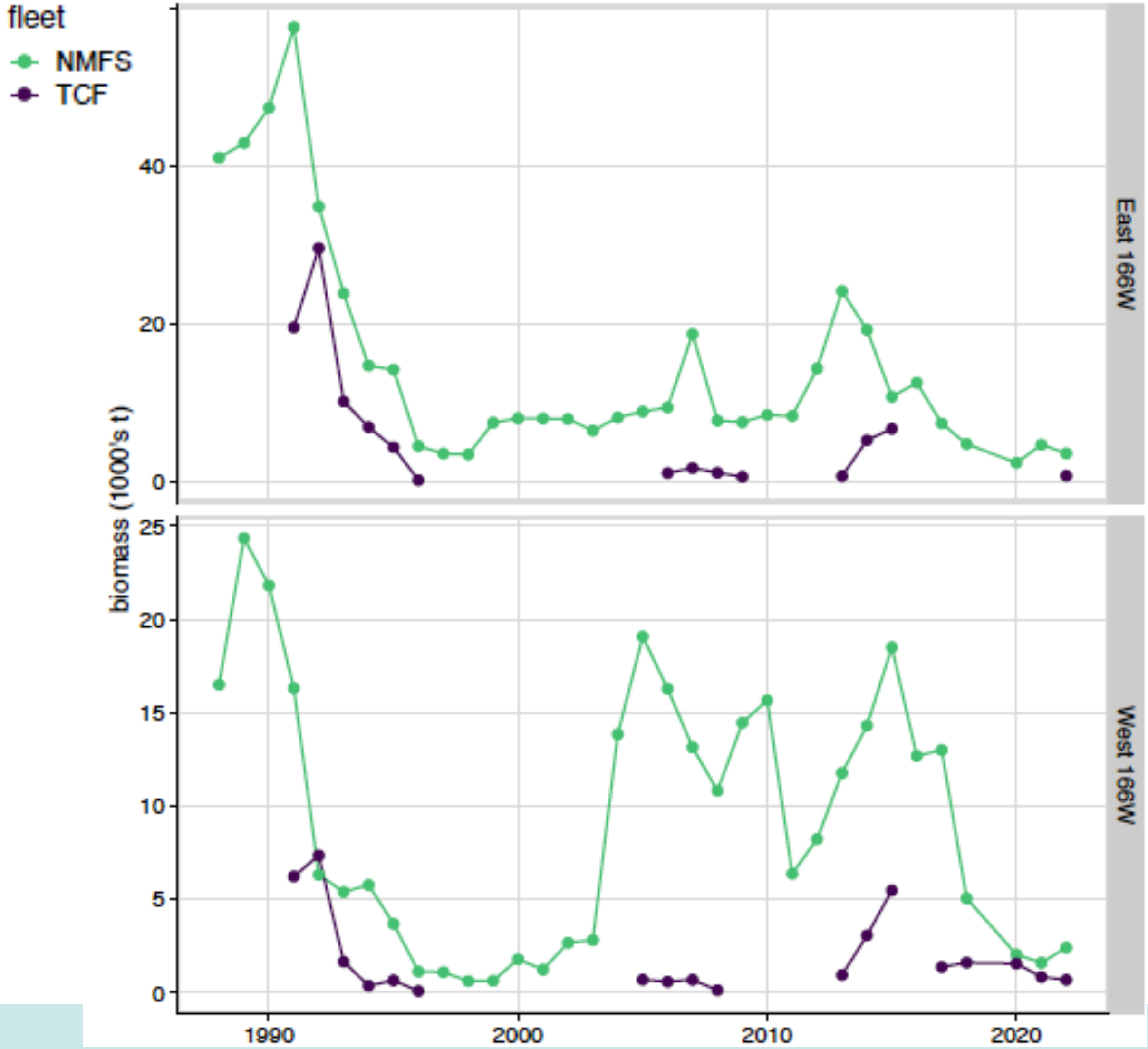


Survey-Fishery Comparisons

% new shell males

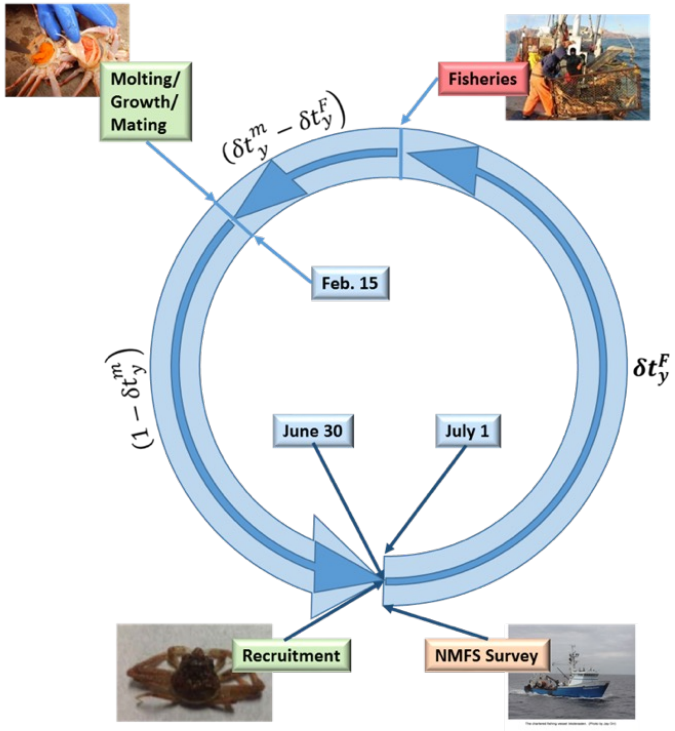


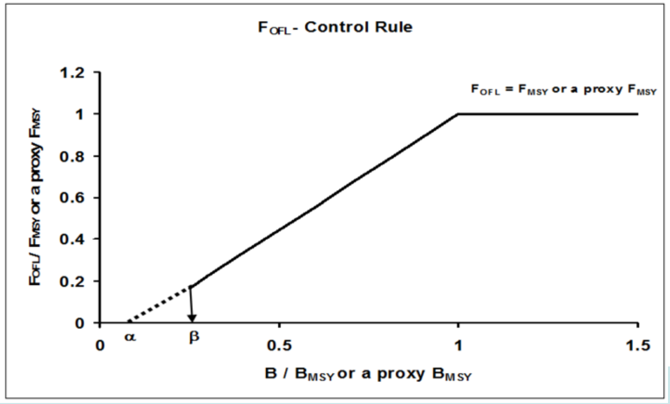
industry-preferred male biomass



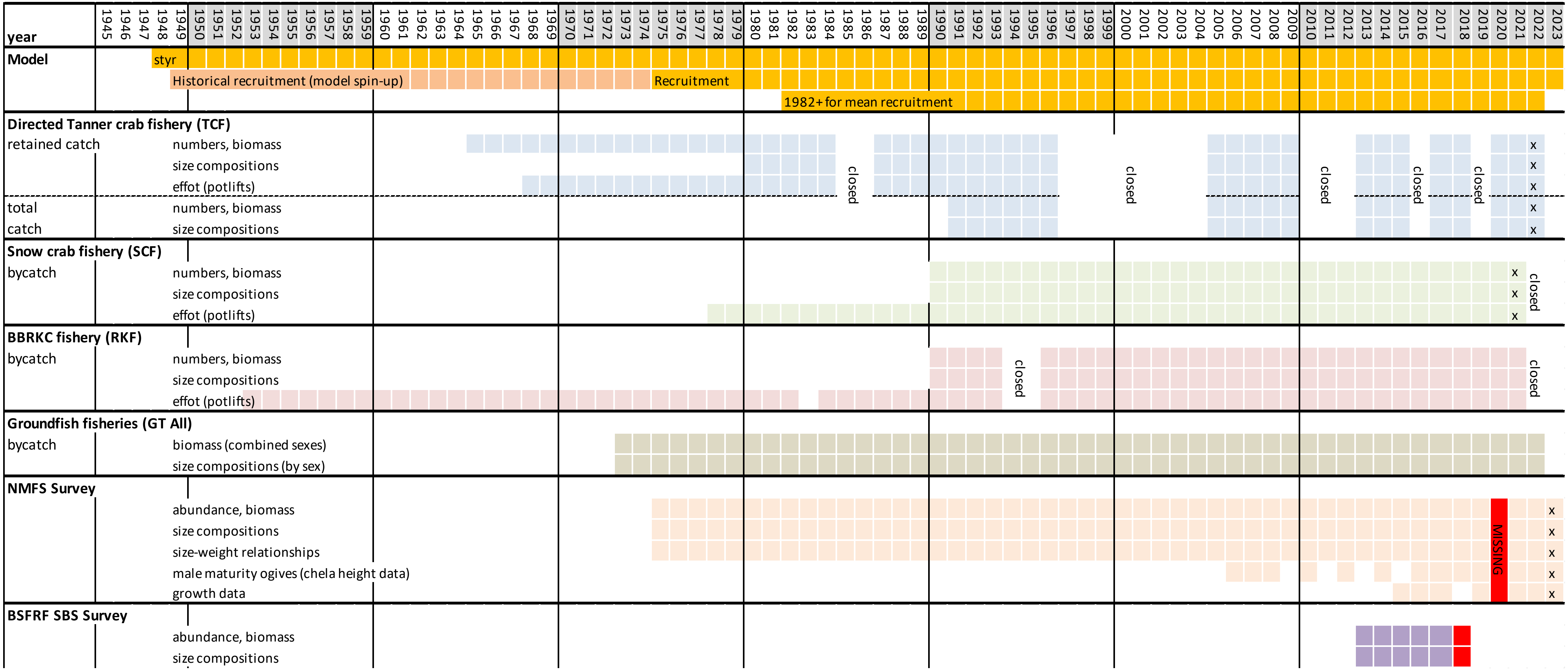
Assessment

- 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

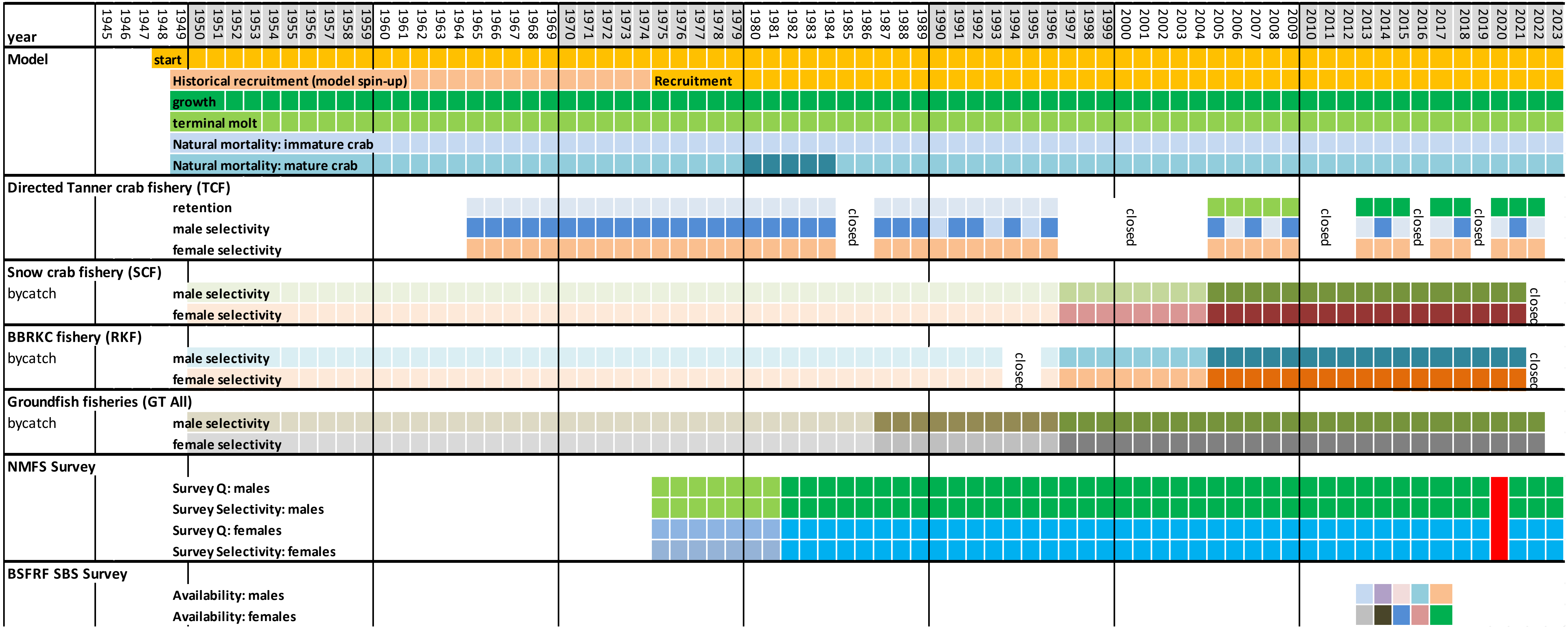




Assessment time frames: data



Assessment time frames: model processes



Objective Function Values

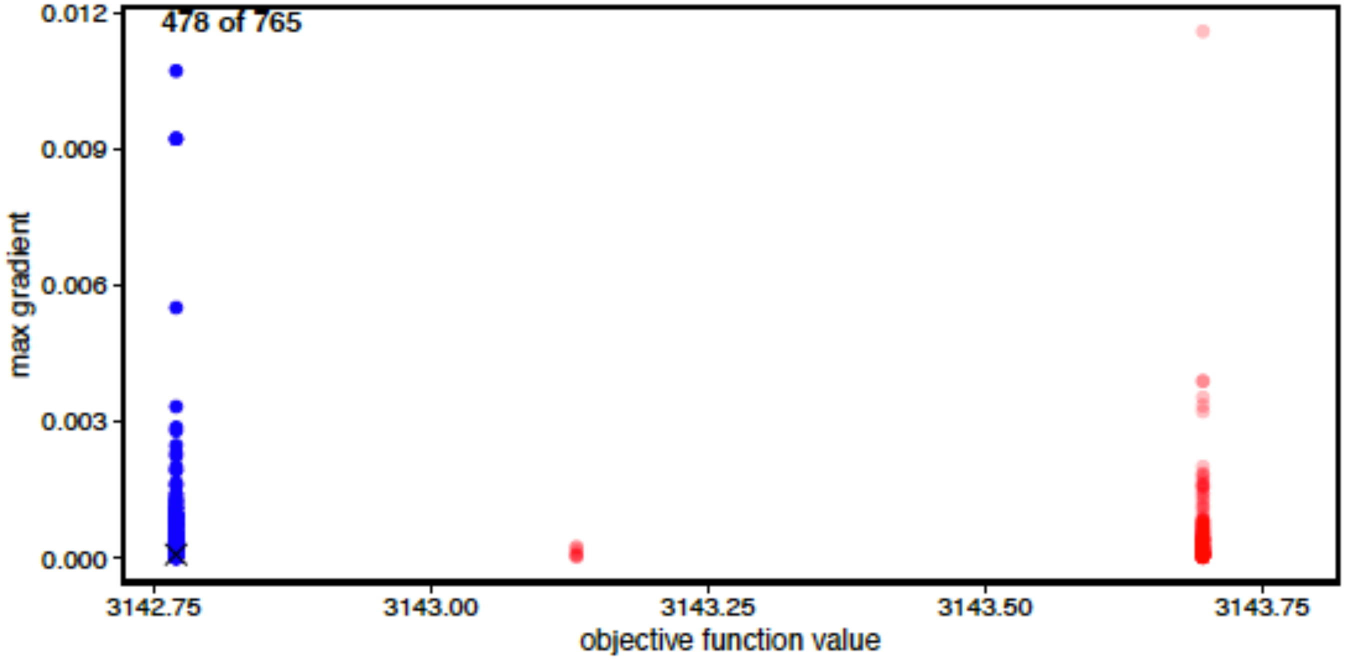
category	fleet	catch type	data type	sex	22.03	22.03b
surveys data	NMFS M	index catch	abundance	female	–	–
				male	–	–
			biomass	female	–	–
				male	70.699	79.289
			n.at.z	male	411.493	415.477
	NMFS F		abundance	female	–	–
				male	–	–
			biomass	female	163.916	165.612
				male	–	–
			n.at.z	female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

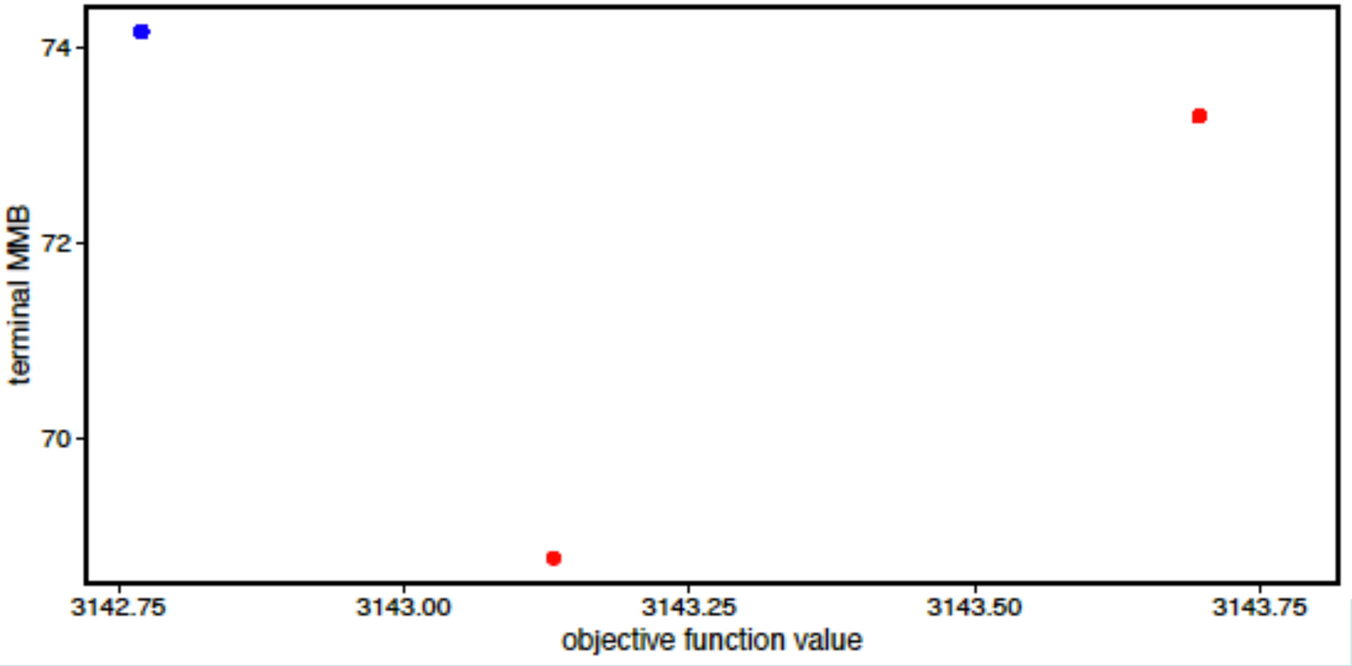
category	fleet	catch type	data type	sex	22.03	22.03b
surveys data	SBS BSFRF F	index catch	n.at.z	female	231.943	232.897
fisheries data	TCF	retained catch	abundance	female	–	–
				male	–	–
			biomass	female	–	–
				male	-143.049	-147.653
			n.at.z	male	64.684	66.936
		total catch	abundance	all sexes	–	–
			biomass	all sexes	6.586	4.793
			n.at.z	female	89.435	91.380
				male	83.283	93.482
	SCF		abundance	all sexes	–	–
			biomass	all sexes	-52.237	-52.247
			n.at.z	female	52.316	52.392
				male	80.186	80.300
	GF All		abundance	all sexes	-37.835	-39.433
			biomass	all sexes	-68.910	-70.213
			n.at.z	female	224.001	224.620
				male	291.464	307.289
	RKF		abundance	all sexes	–	–

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

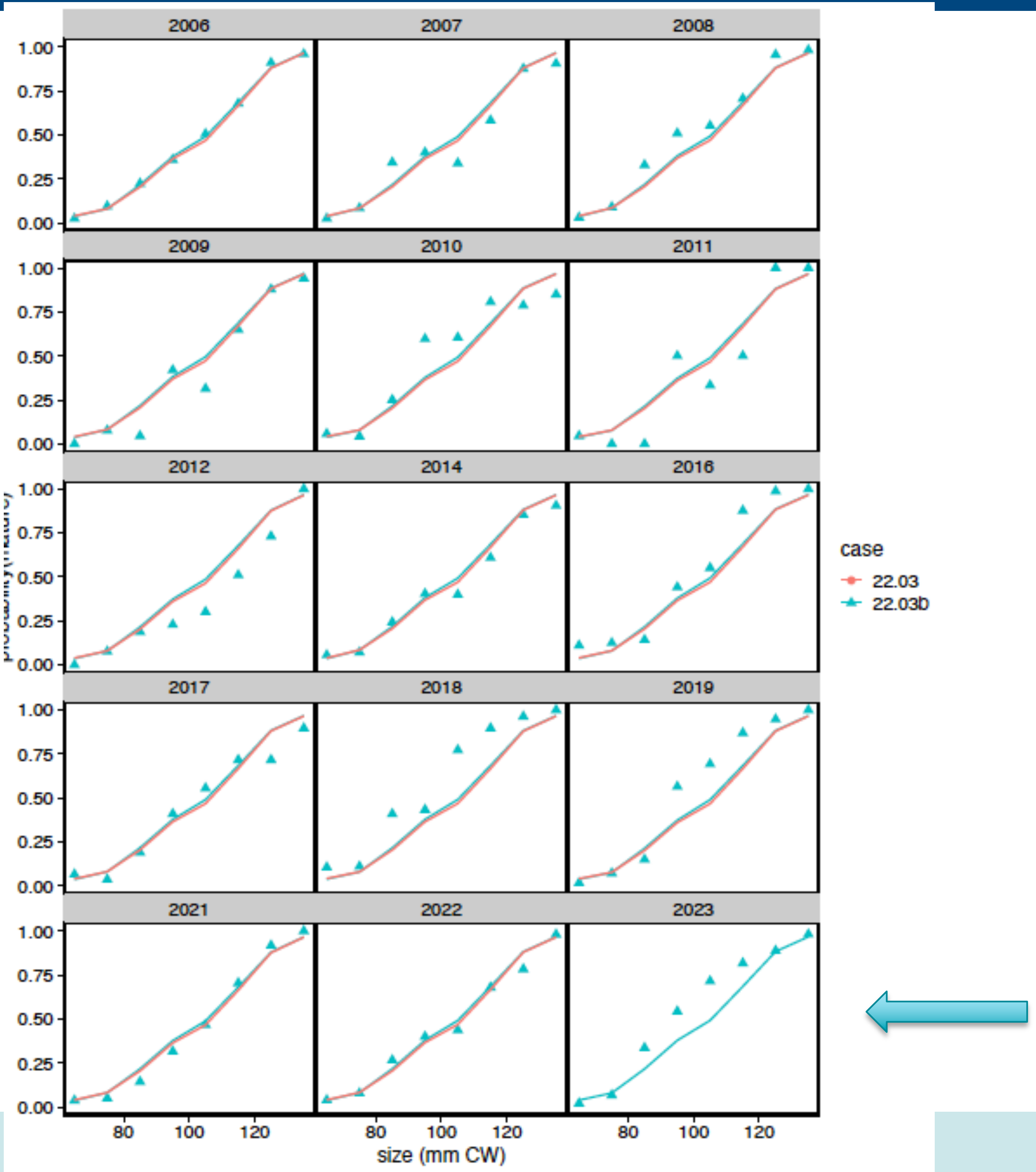
Model Convergence

- 476 out of 800 jitter runs converged to MLE
- max. gradient at MLE: 8×10^{-5}
- no parameters at bounds

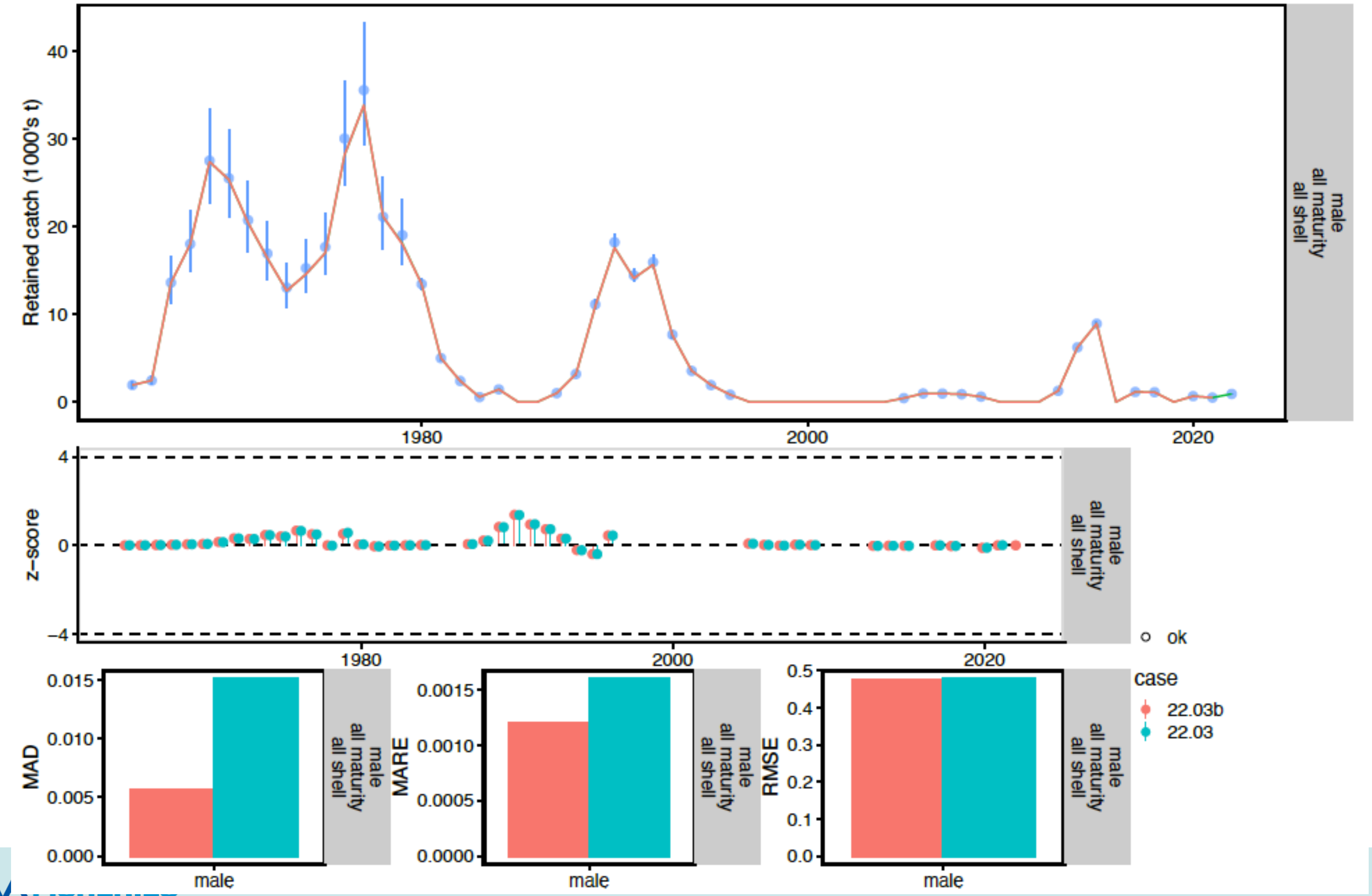




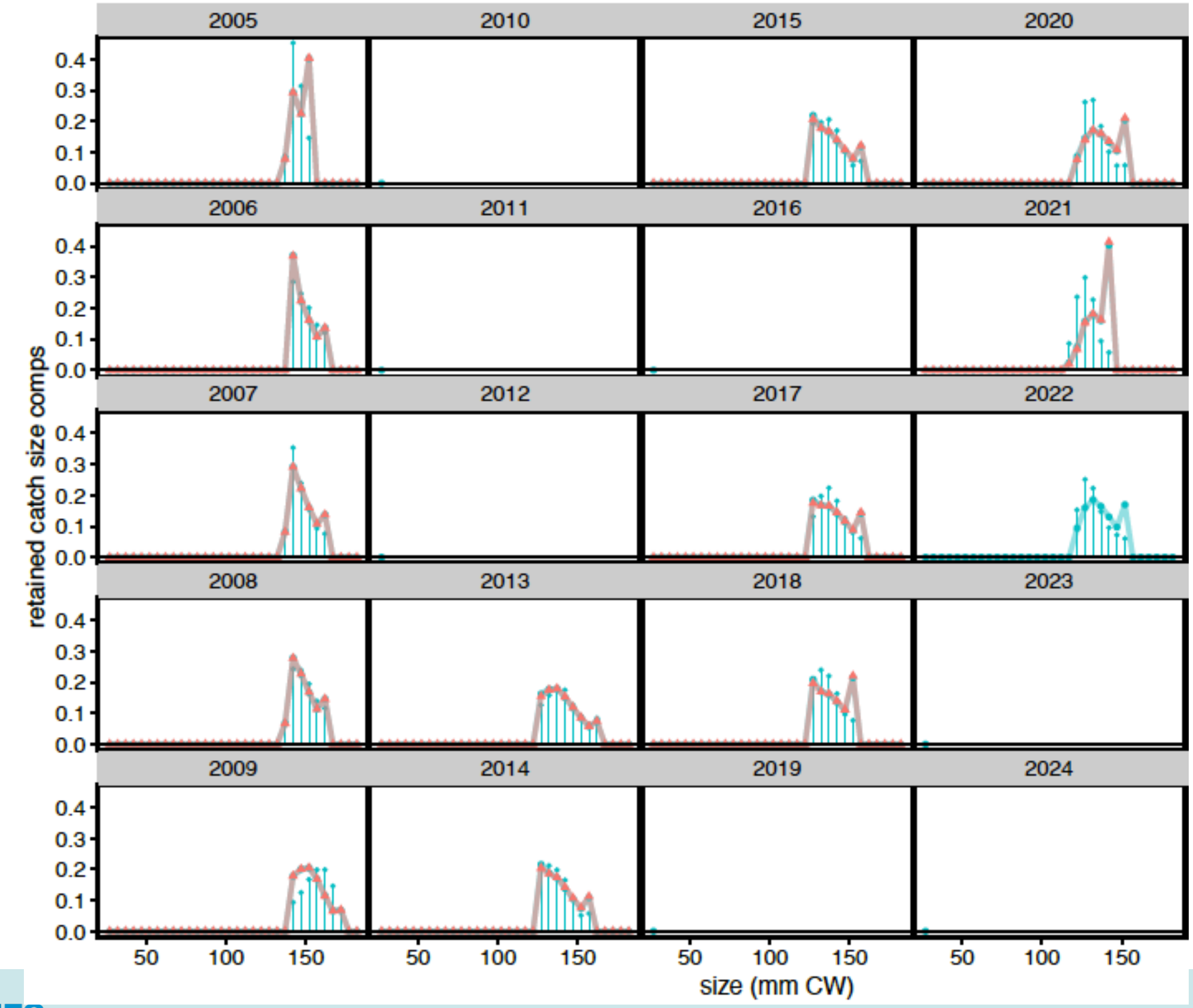
Fits to
Male Maturity Ogive Data



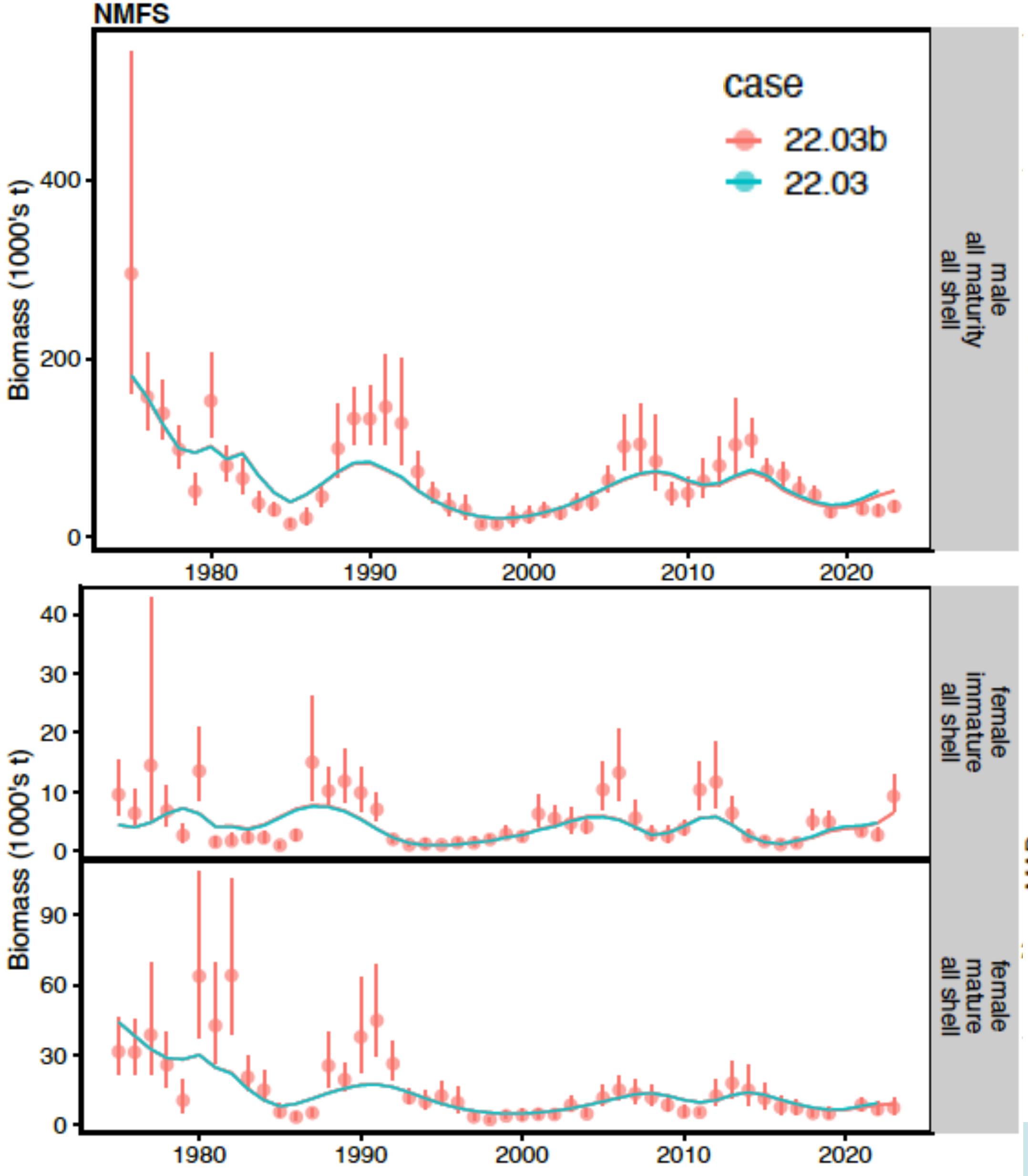
Fits to Retained Catch in Directed Fishery

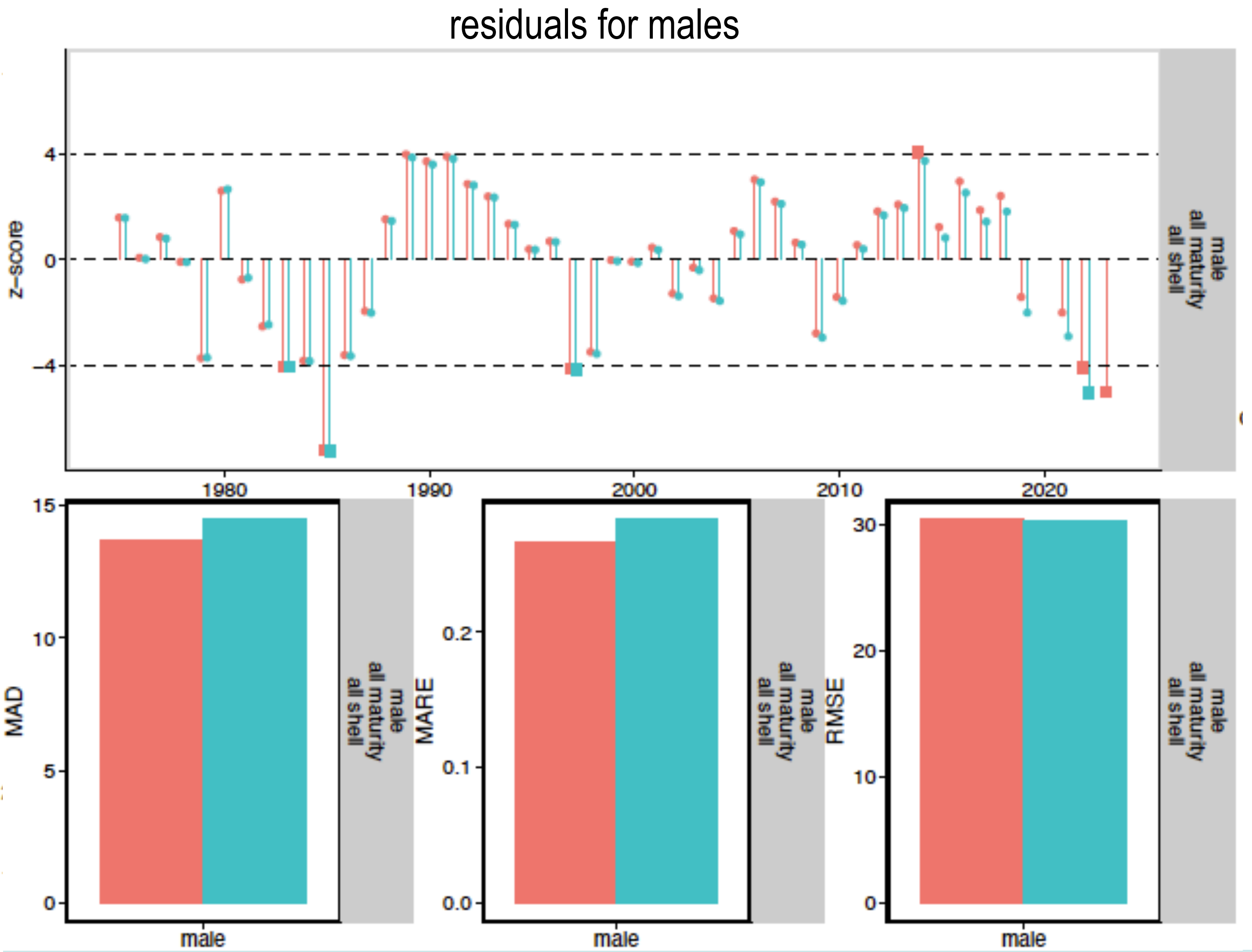


Fits to Retained Catch in Directed Fishery

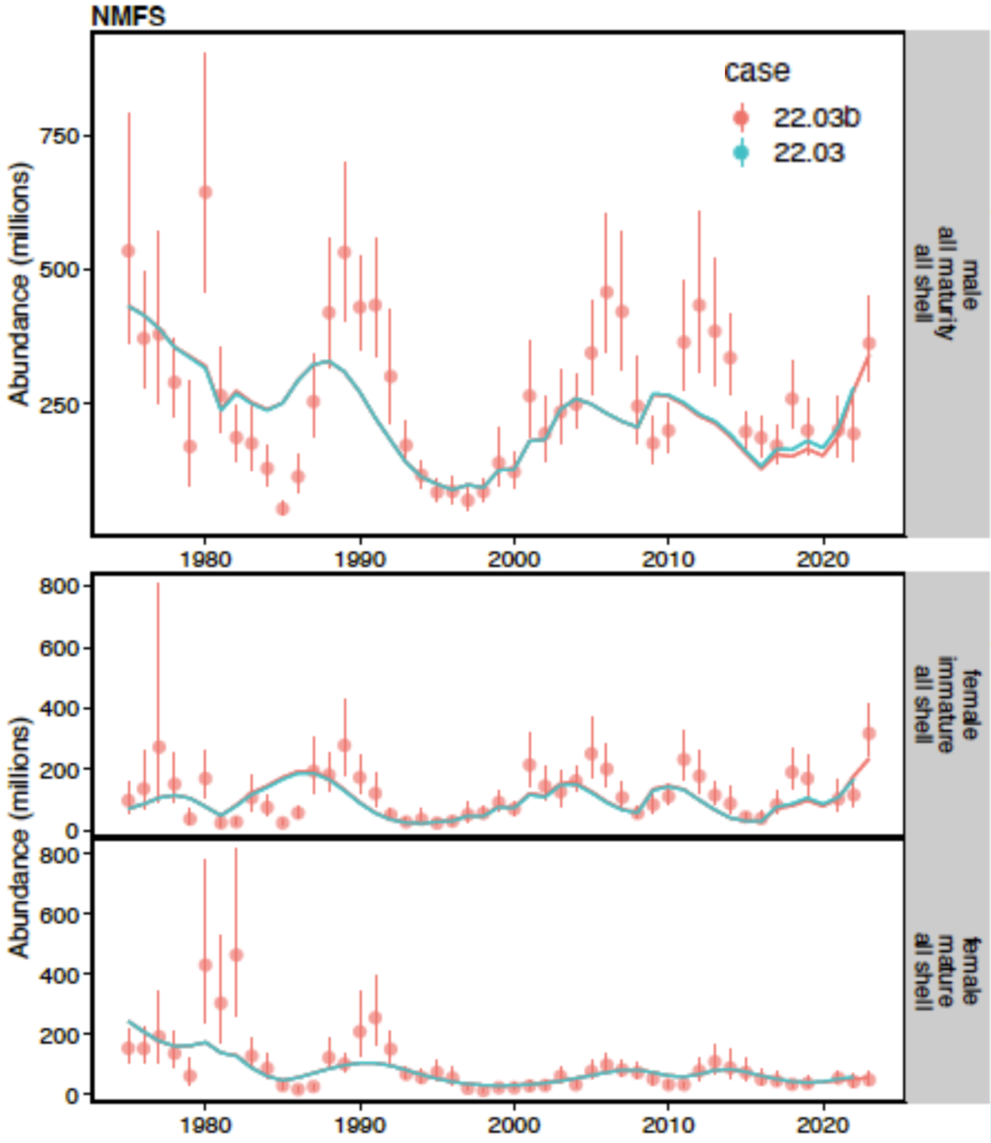


Fits to NMFS Survey Biomass

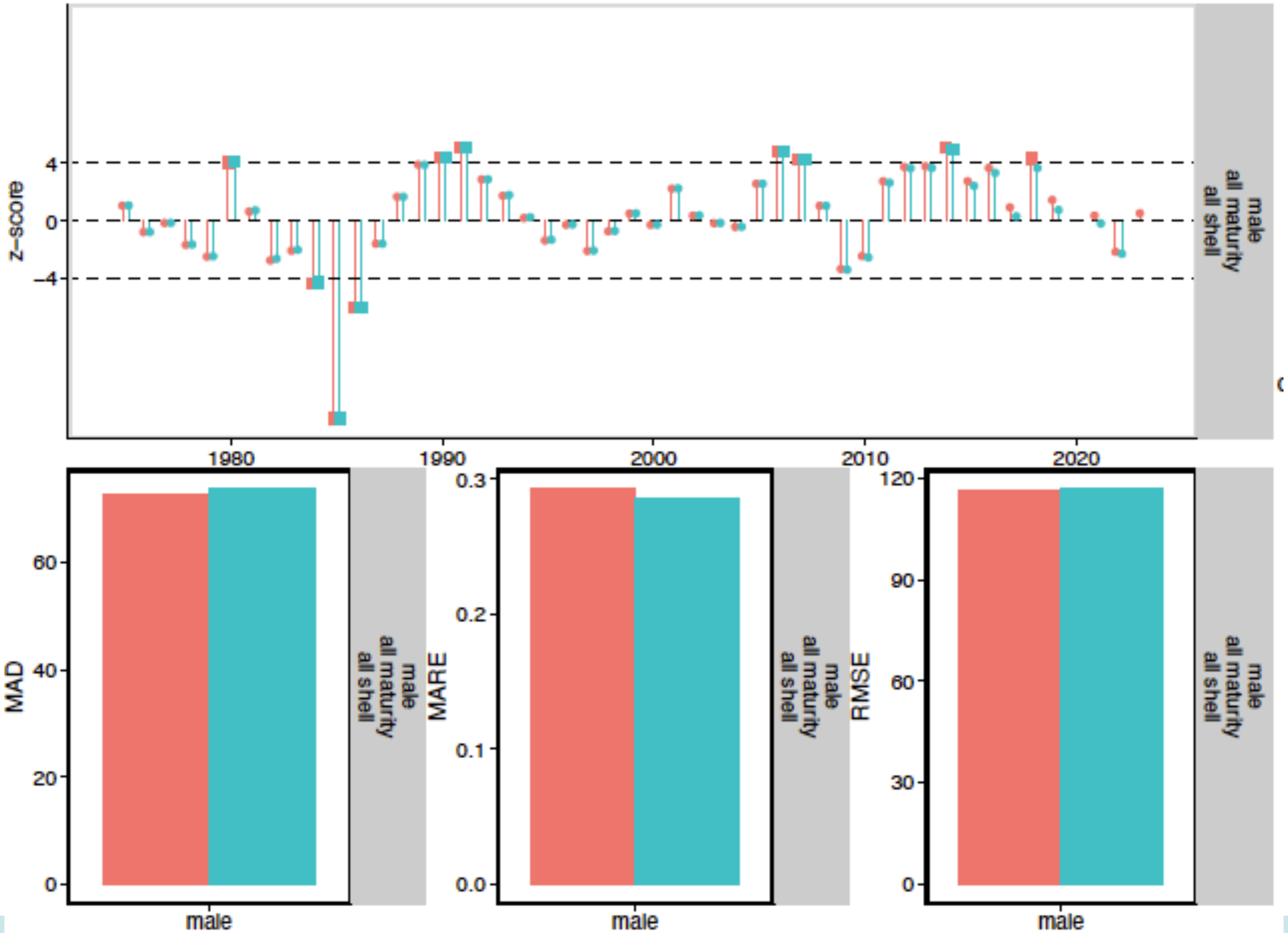




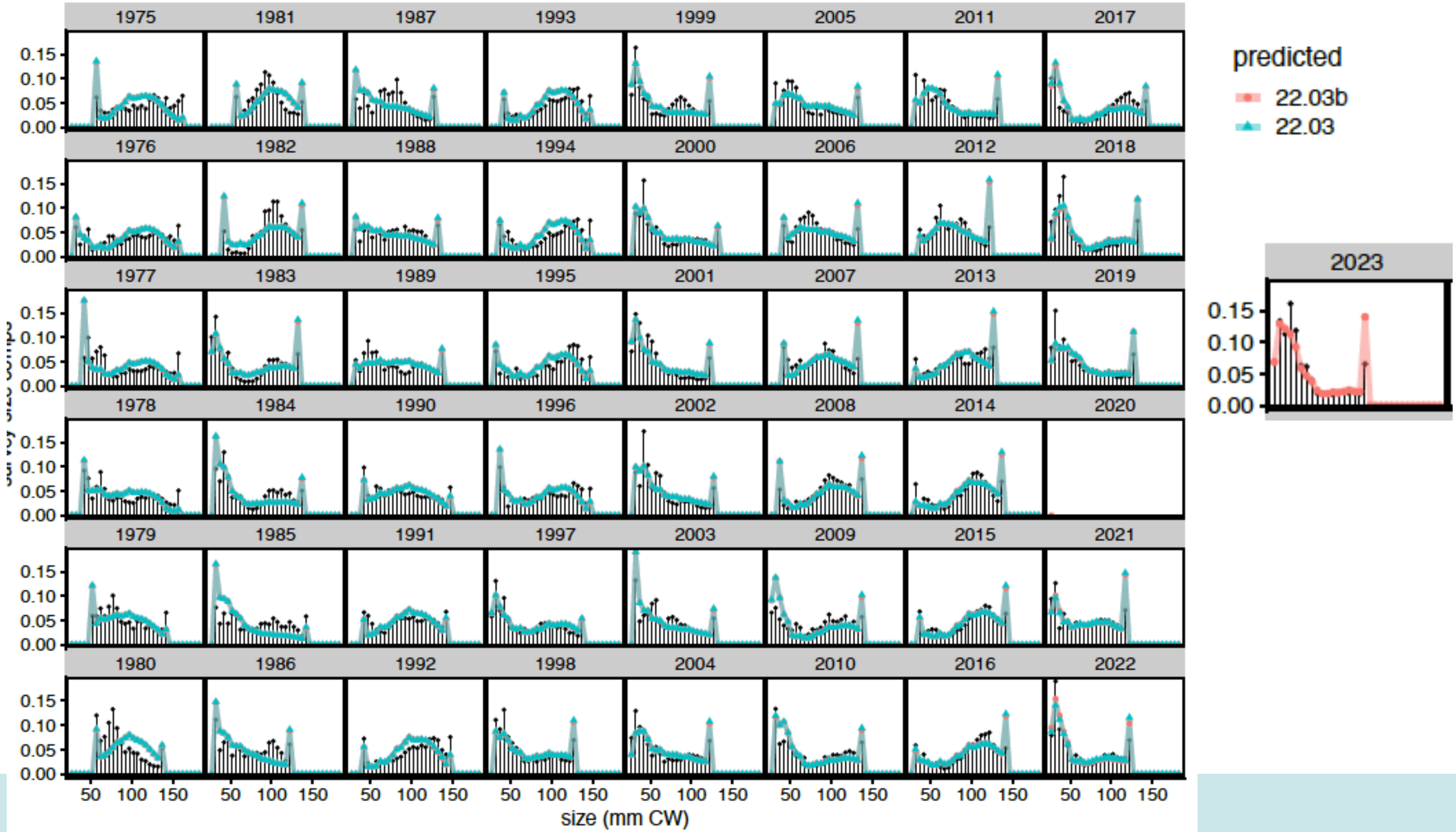
“Fits” to NMFS Survey Abundance



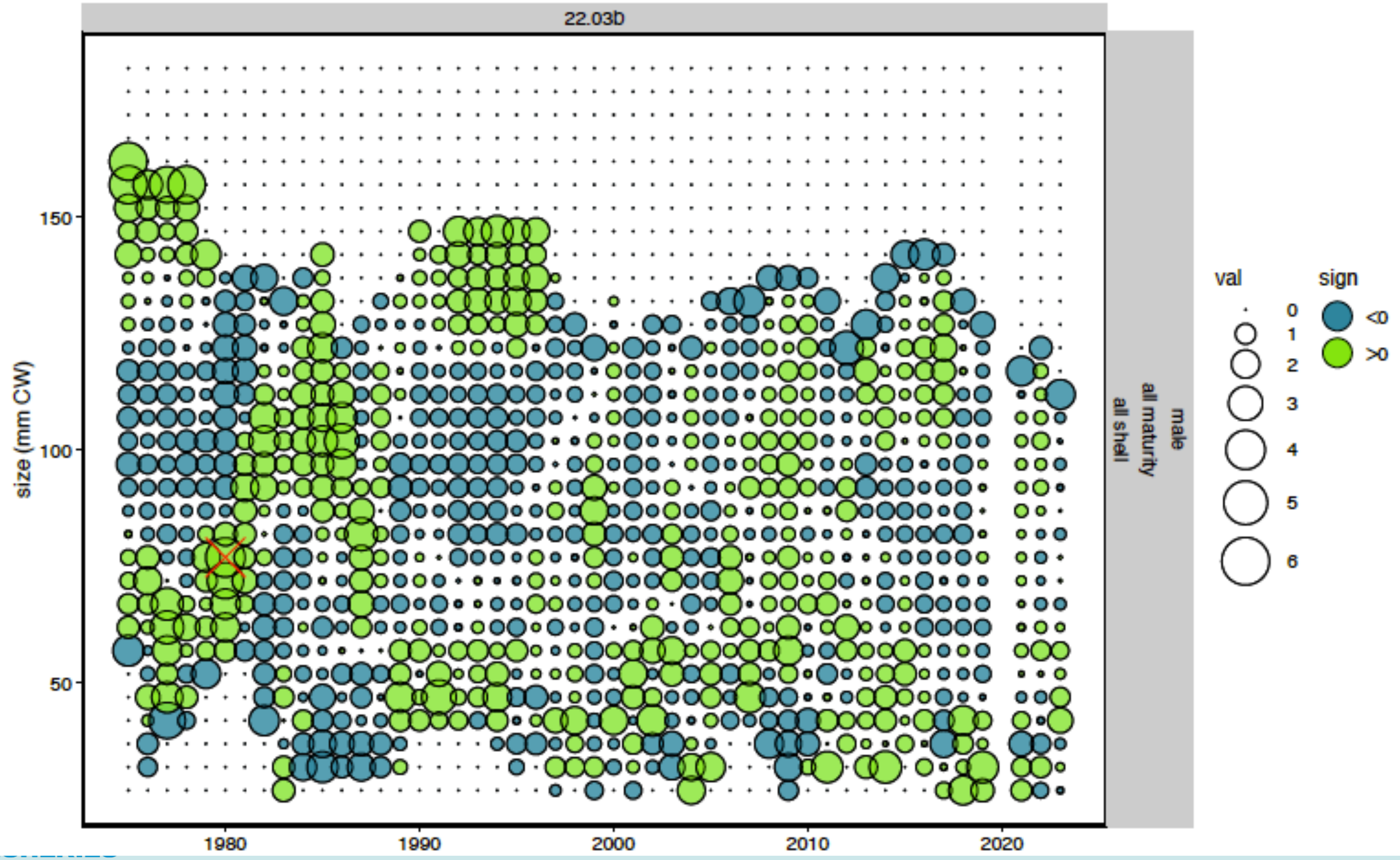
residuals for males



Fits to NMFS Survey Size Comps (males)

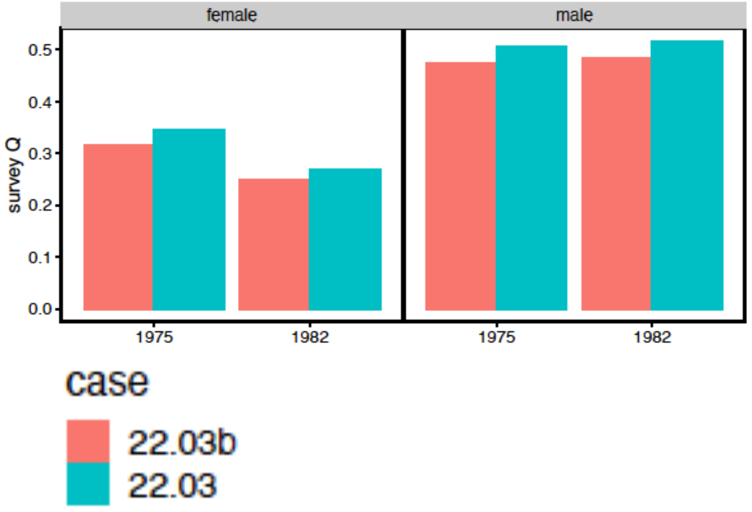


Residuals to NMFS Survey Size Comps (males)

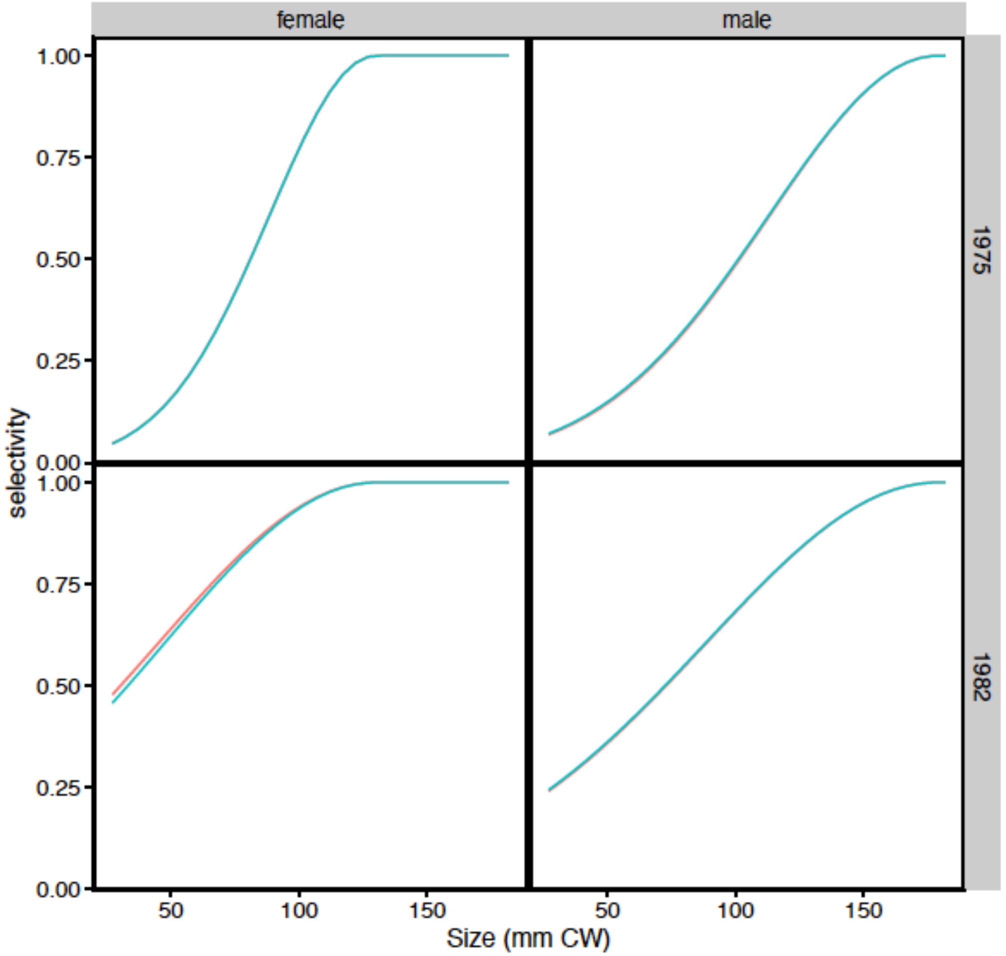


Assessment: Estimated Quantities

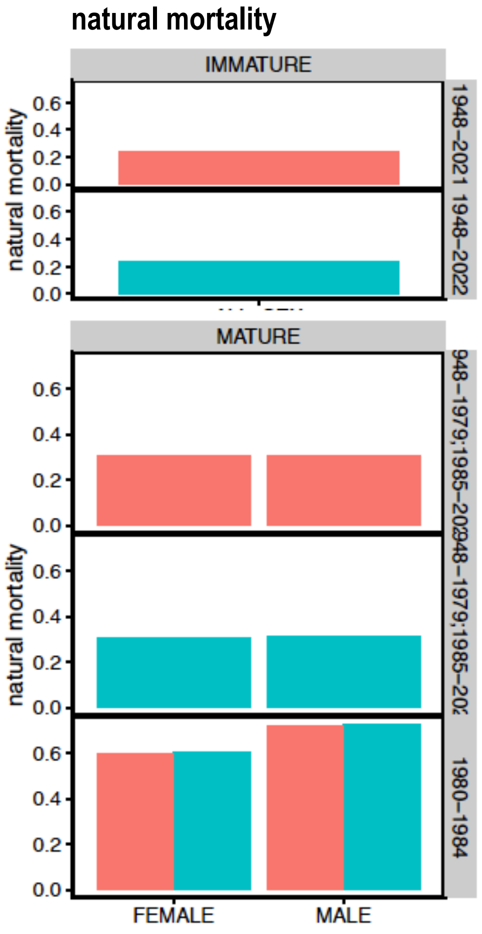
NMFS survey Q

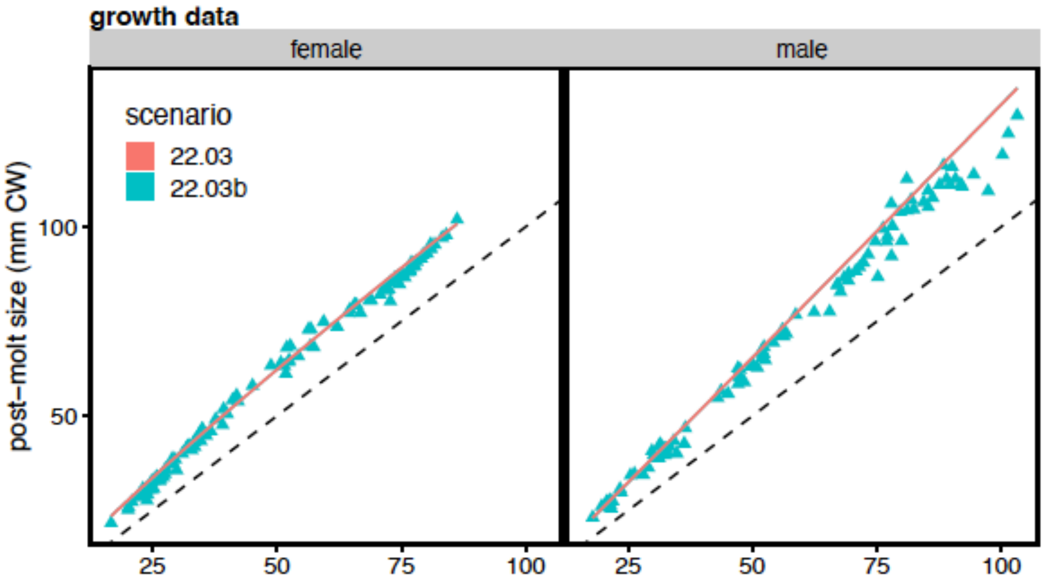


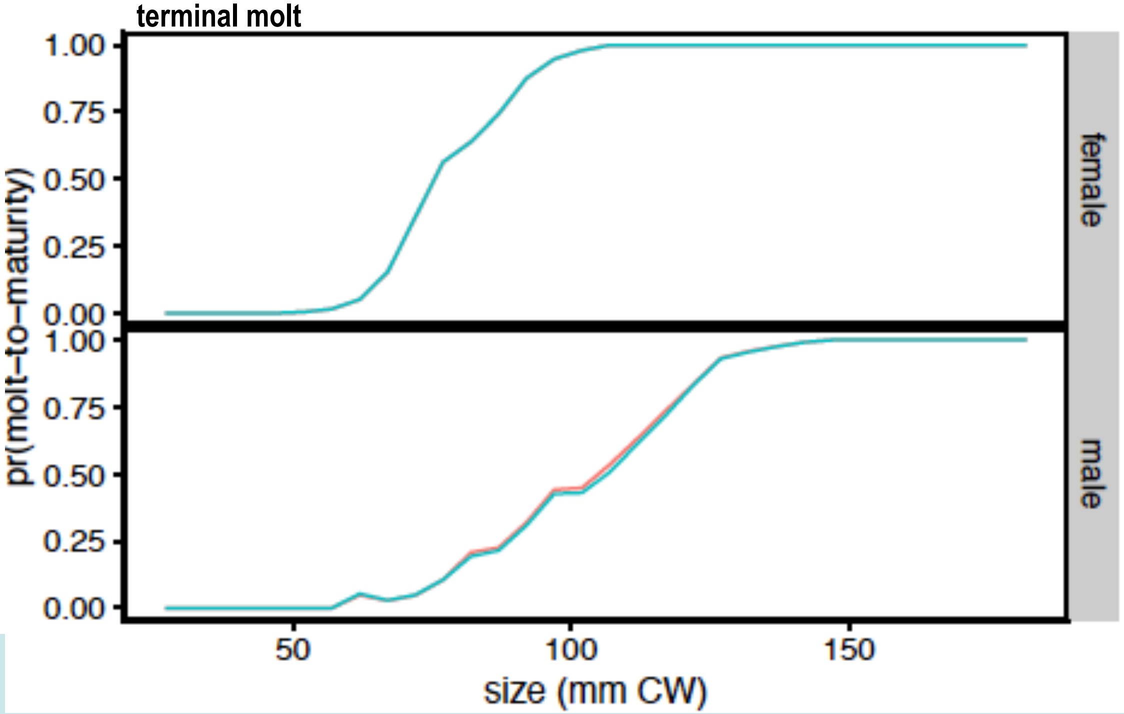
NMFS survey selectivity



Assessment: Estimated Quantities







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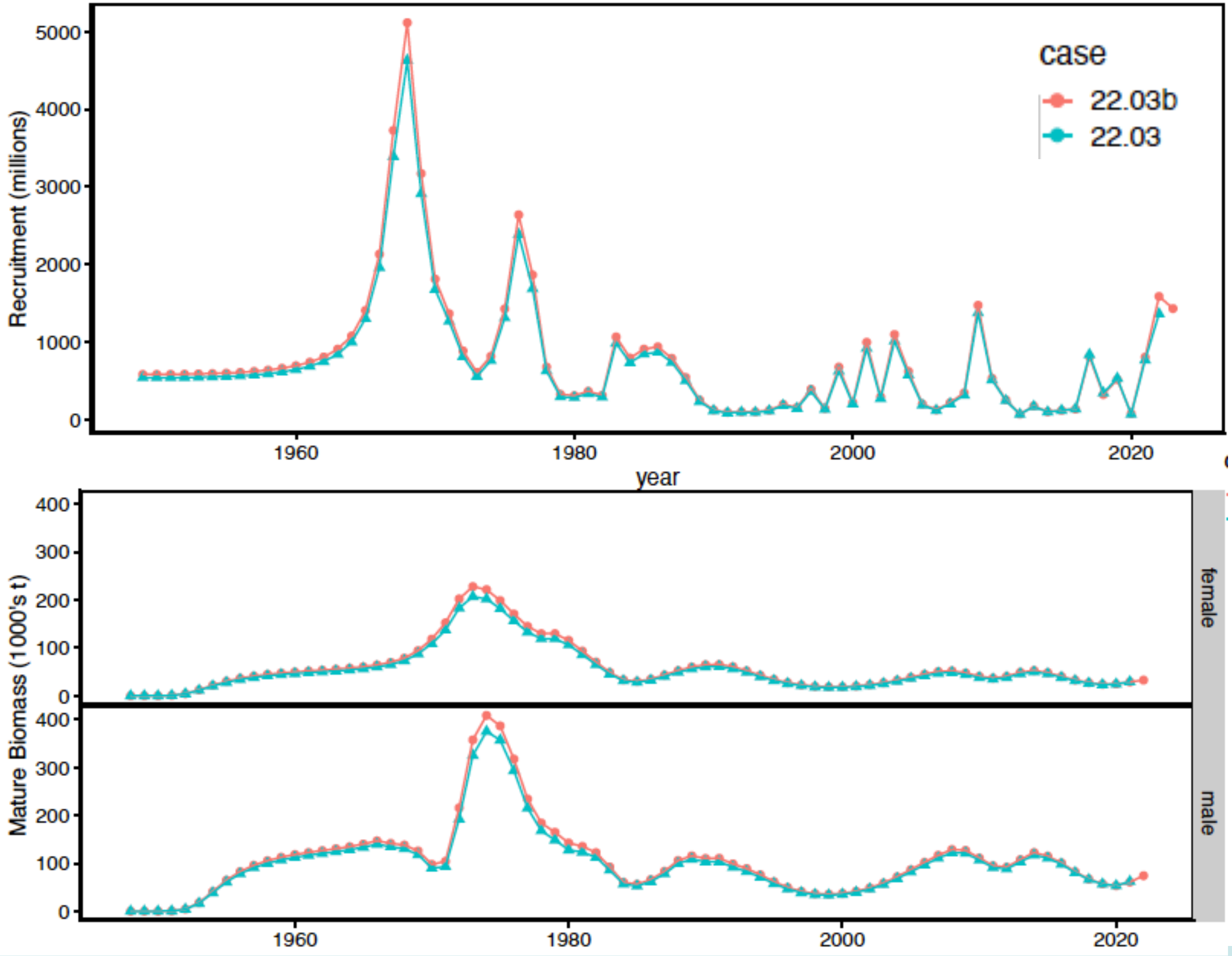

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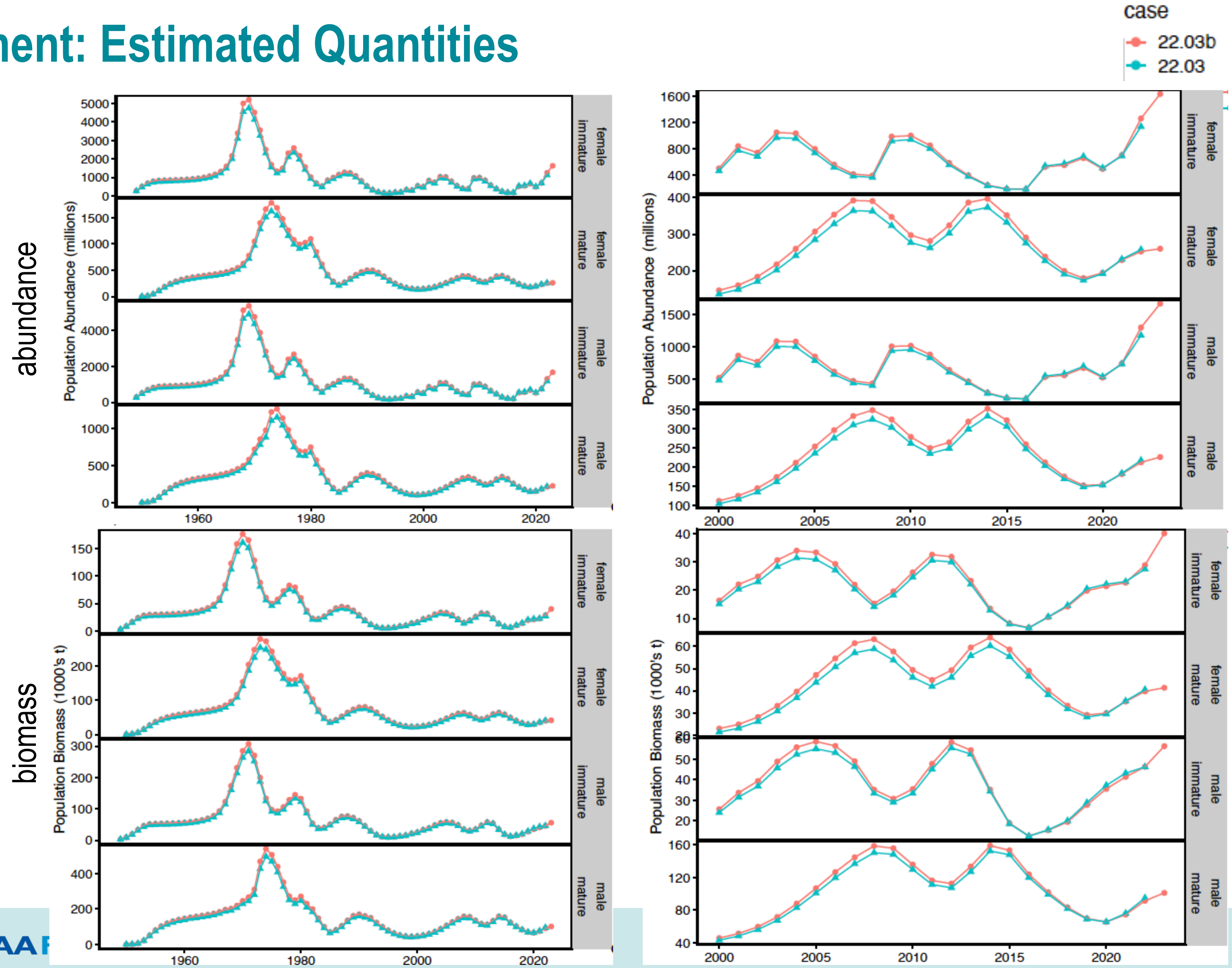
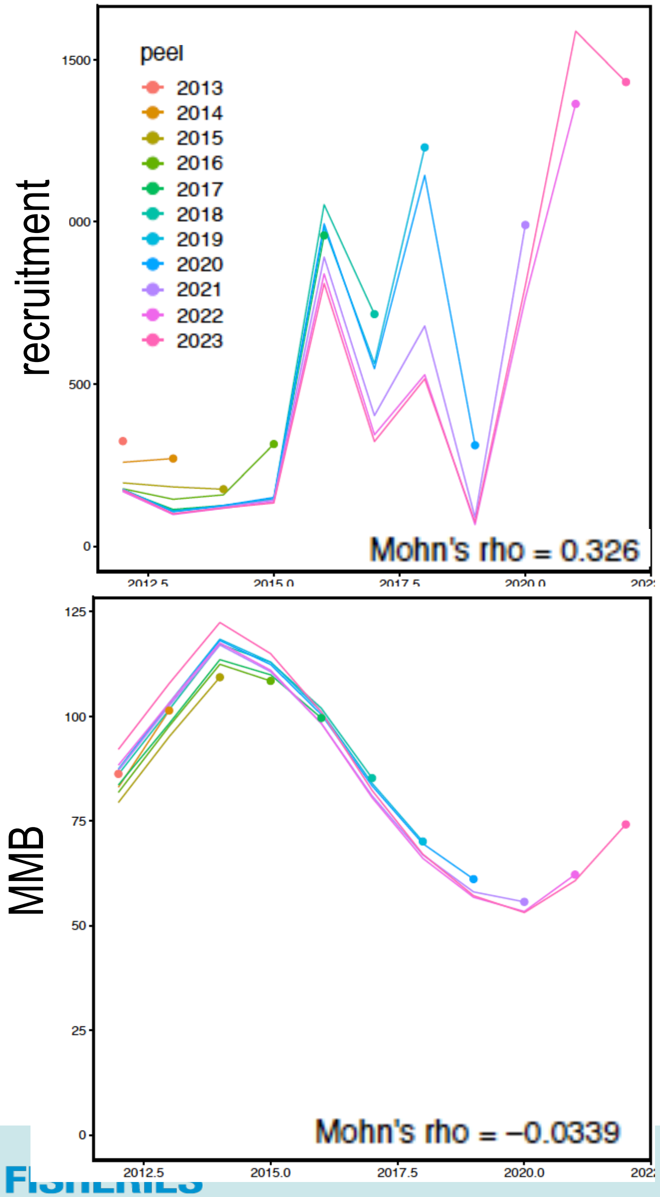
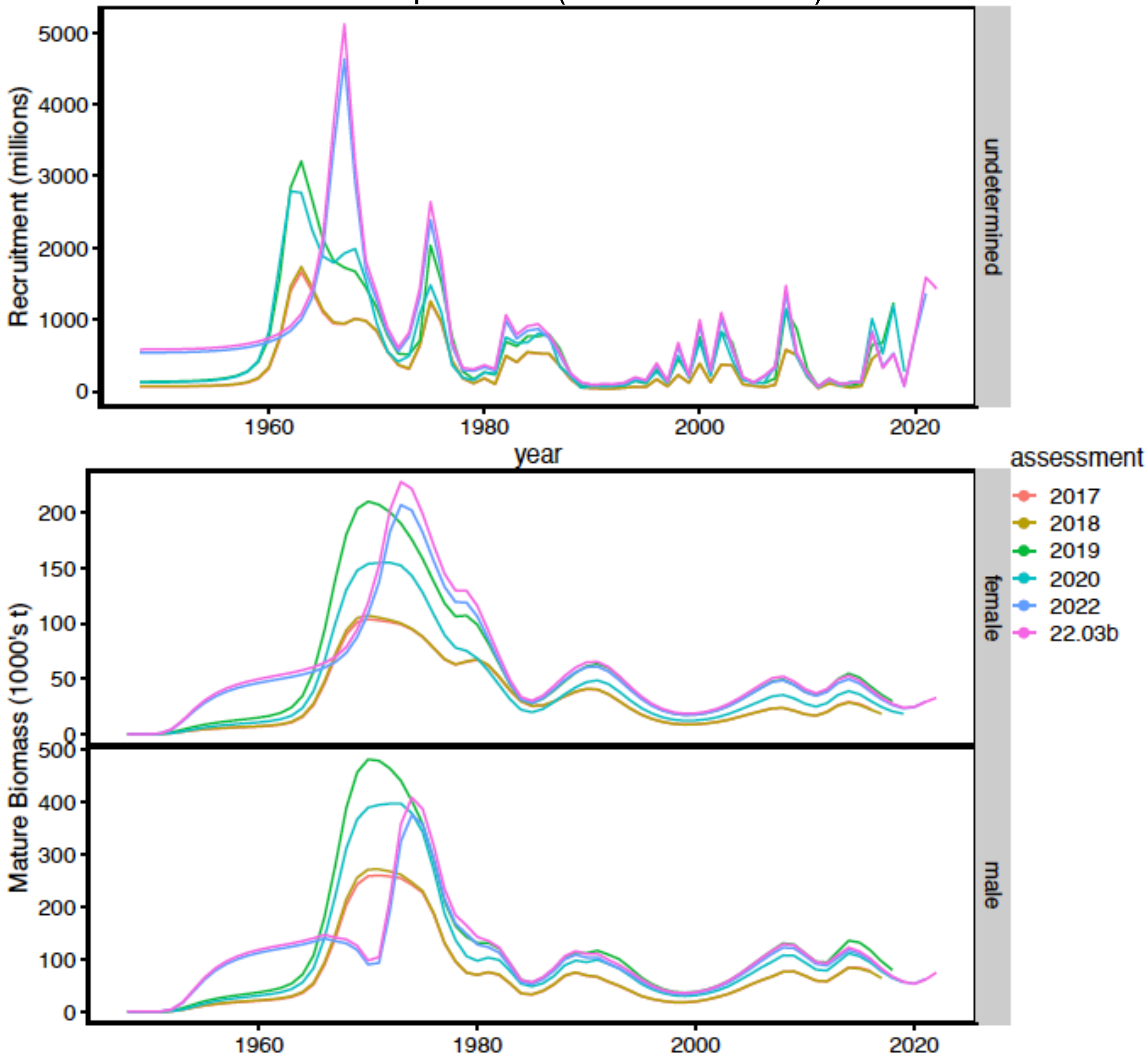


Retrospective patterns

retrospective comparisons



historical comparisons (different models)

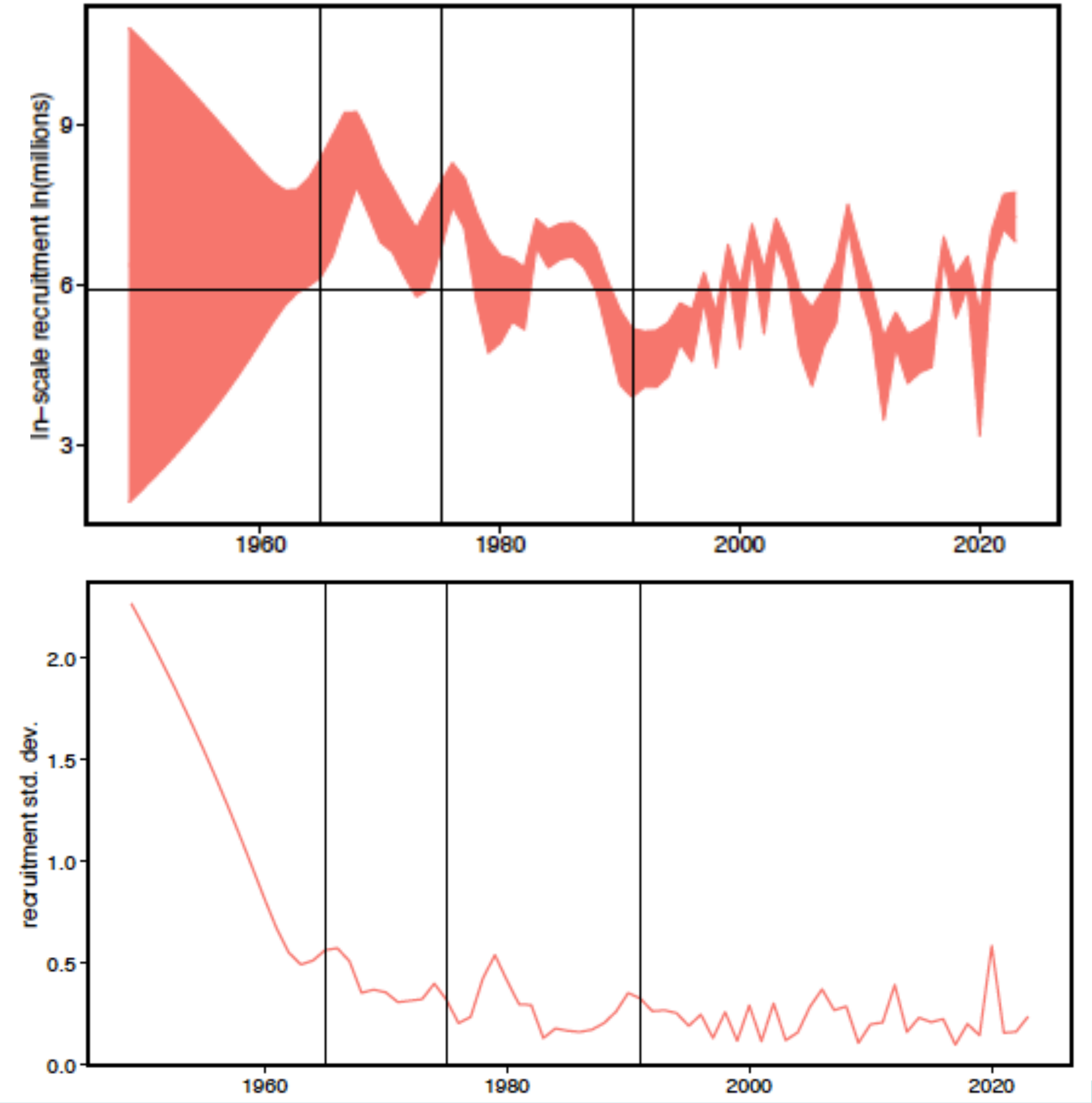


Average recruitment time period

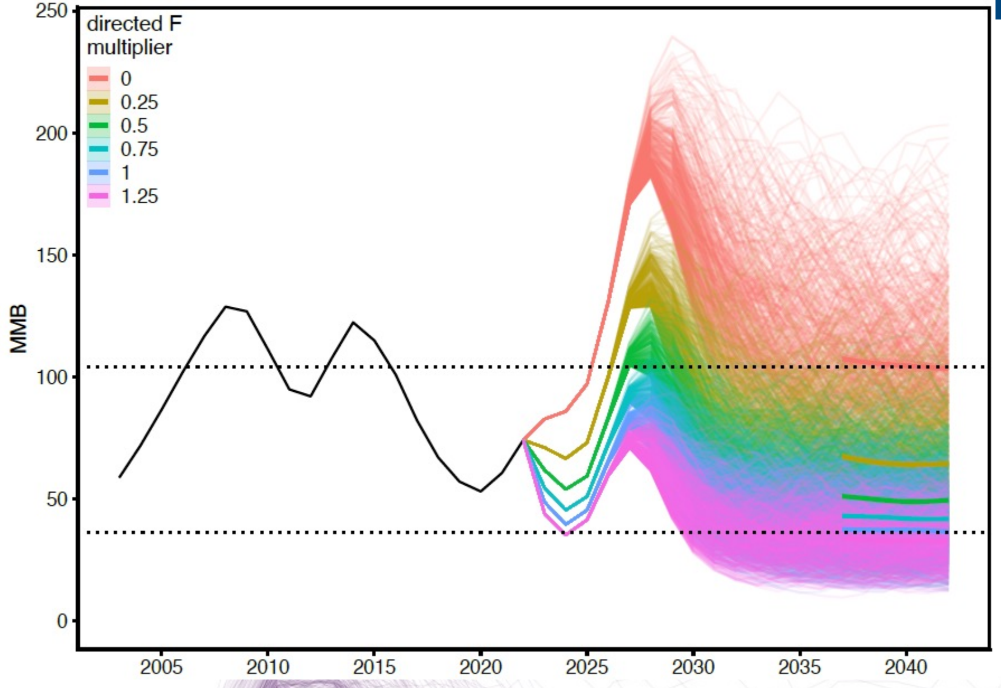
Author's recommendation

- Drop terminal year estimate
    - larger uncertainty
    - retro. pattern suggests estimate will decrease with time
    - consistent with other assessments
    - consistent with last year

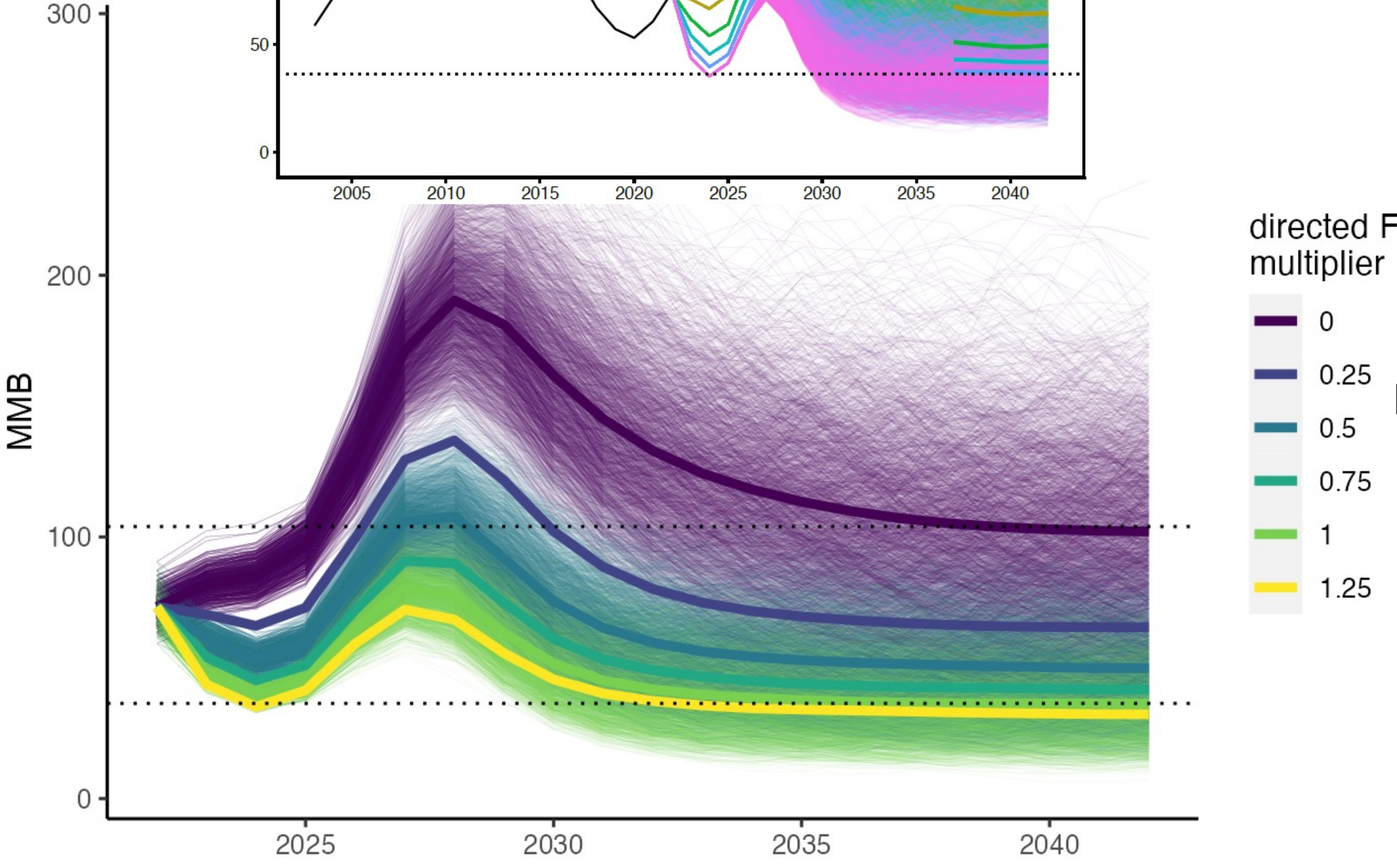
- time period: 1982-2022 (year of entry into population)



Projections

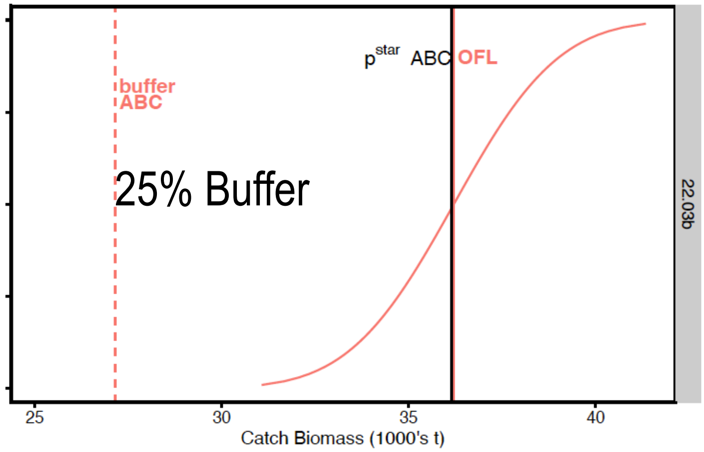


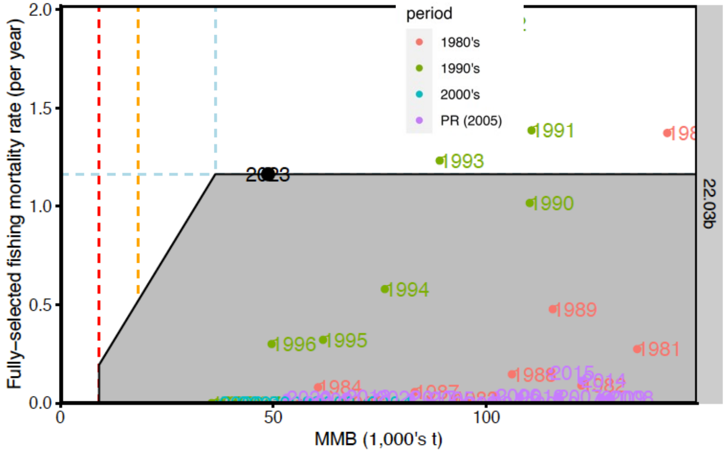
Projections w/out MCMC

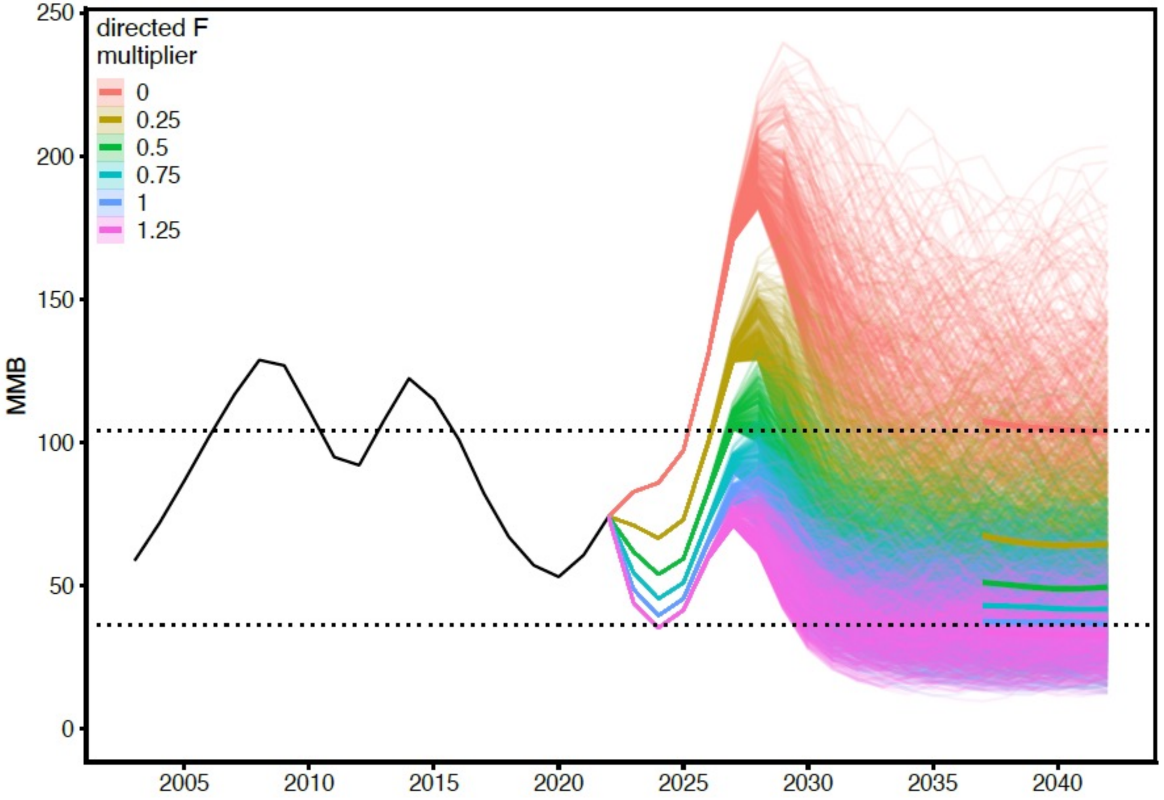


Projections with MCMC

Stock Status: Tier 3a







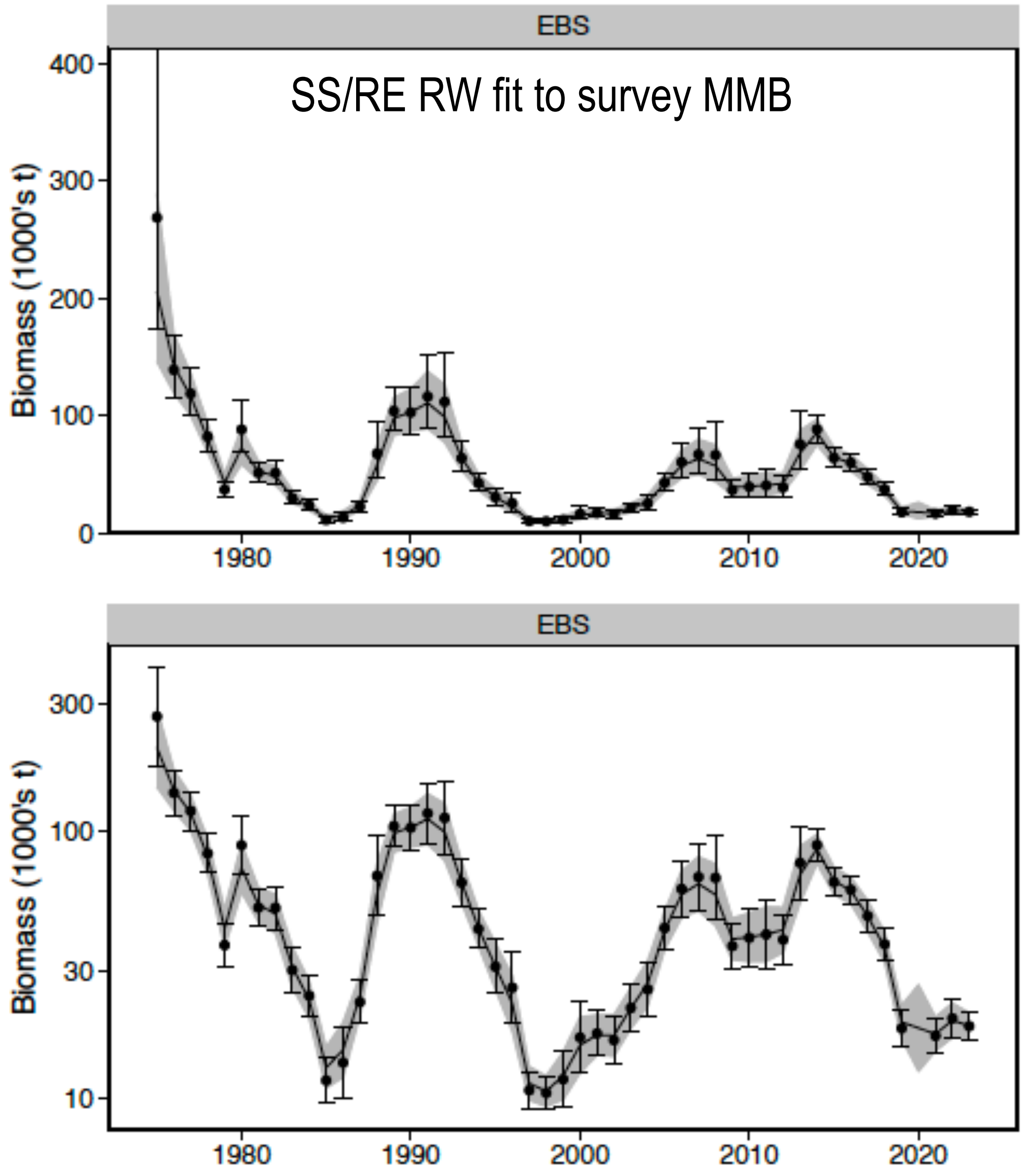
Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2019/20	18.31	56.15	0.00	0.00	0.54	28.86	23.09
2020/21	17.97	56.34	1.07	0.66	0.96	21.13	16.90
2021/22	17.37	62.05	0.50	0.49	0.78	27.17	21.74
2022/23	18.19	74.17	0.91	0.91	1.19	32.81	26.25
2023/24	–	48.77	–	–	–	36.20	27.15

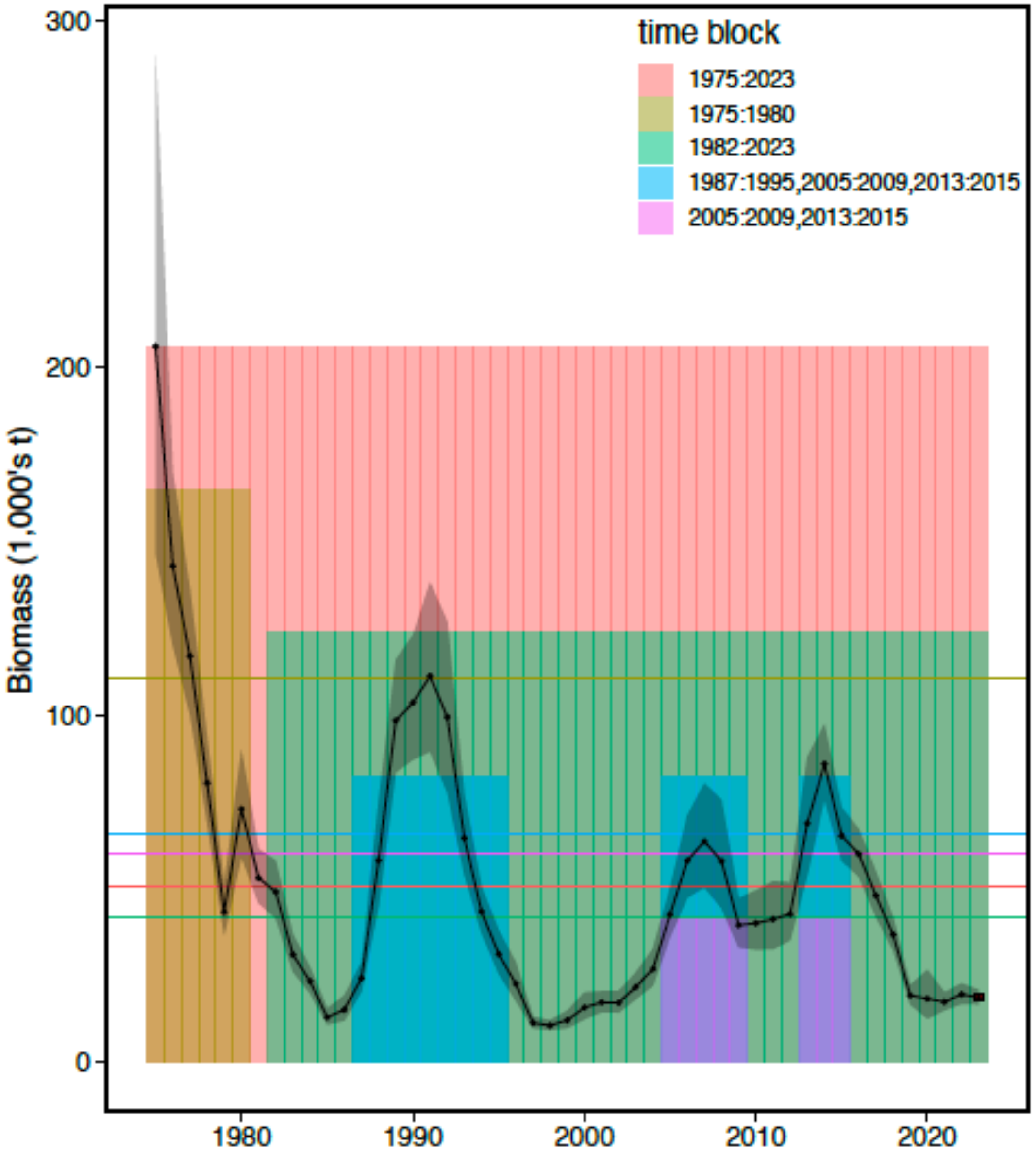
Recommendations

- 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 $F_{35\%}$, $B_{35\%}$ as metrics for a sustainable fishery

Tier 4 “Fallback”

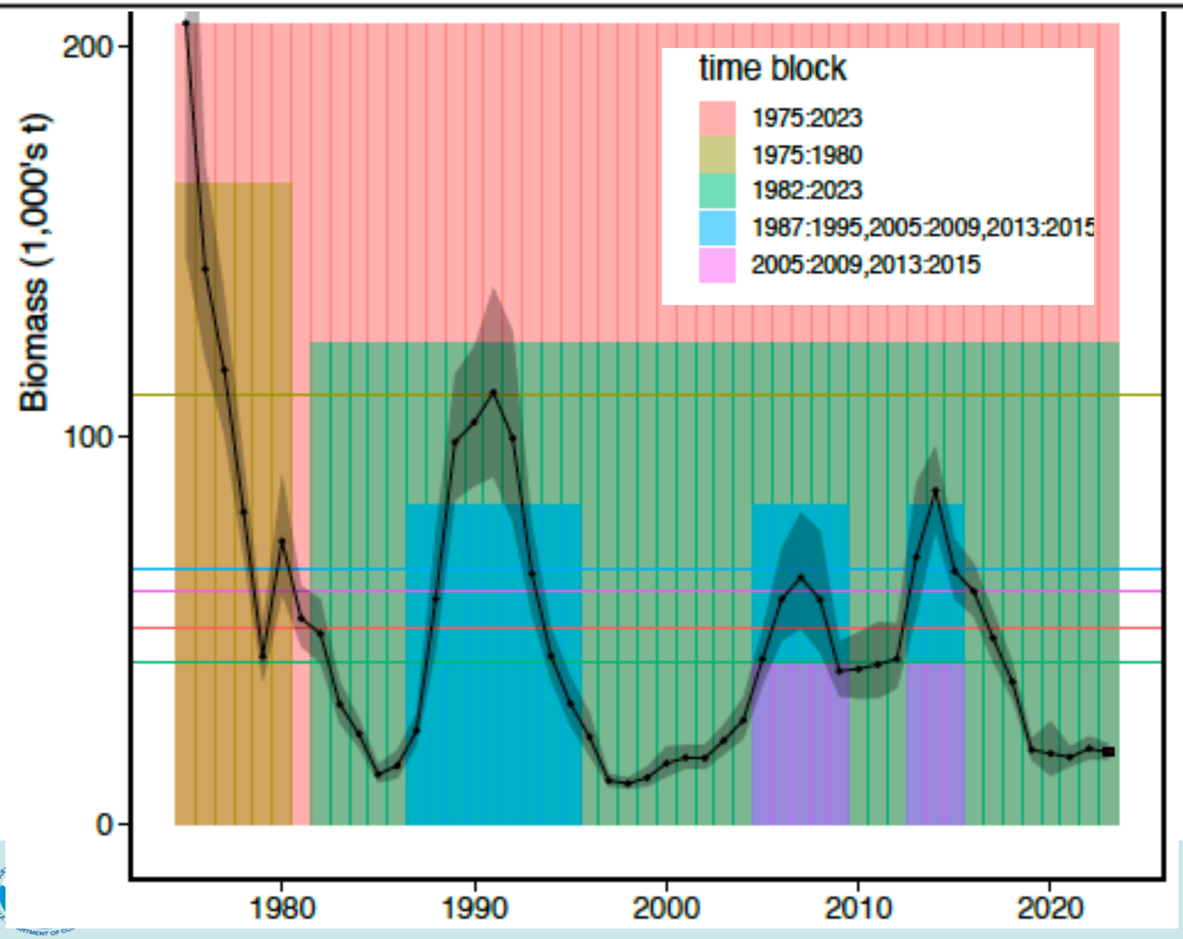




Tier 4 “Fallback”

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

fishery closed



ABC buffer

- recommend using cv on model-estimated terminal biomass (8.9%) as basis
- 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