BSAI Tanner Crab

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Changes From 2015 Assessment

- Changes to model
  - Gmacs fishing mortality
  - Female F multipliers
  - estimating Fs for BBRKC fishery
  - normalization for groundfish size comps
  - enforced logistic selectivity = 1 in max size bin
  - evaluating convergence with 200 runs with jittered initial parameter values
- New trawl survey data for 2016
  - mature survey biomass
    - new cv calculation
  - size compositions by sex, shell condition, maturity
  - EBS growth data! (not incorporated yet)
- New Fishery Data for 2015/16
  - Tanner crab pot fishery
    - 2015/16 catch, size compositions
  - snow crab pot fishery
    - 2015/16 bycatch, size compositions
  - BBRKC pot fishery
    - 2015/16 bycatch, size compositions
  - groundfish fisheries
    - 2015/16 bycatch, size compositions
- New ADFG Harvest Strategy for 2015/16
  - Old strategy: area-specific TAC's based on
    - 5" min preferred size West of 166^{o}W
    - 5.5" min preferred size East of 166^{o}W
  - New strategy: area-specific TAC's based on
    - 5" min preferred size West of 166^{o}W
    - 5" min preferred size East of 166^{o}W

Management Reference Points

Not overfished
No overfishing

Basis for the OFL

Year	Tier[A]	B_{MSY}[A]	Current MMB[A]	B/B_{MSY}[A]	F_{OFL}[A]	Years to define B_{MSY}[A]	Natural Mortality[A,B]
2012/13	3a	33.45	58.59	1.75	0.61 yr^{-1}	1982-2012	0.23 yr^{-1}
2013/14	3a	33.54	59.35	1.77	0.73 yr^{-1}	1982-2013	0.23 yr^{-1}
2014/15	3a	29.82	63.80	2.14	0.61 yr-1	1982-2014	0.23 yr-1
2015/16	3a	26.79	53.70	2.00	0.58 yr-1	1982-2015	0.23 yr-1
2016/17	3a	25.65	45.34	1.77	0.79 yr^{-1}	1982-2016	0.23 yr^{-1}

Management Performance

Year	MSST	Biomass (MMB)	TAC (East + West)	Retained Catch	Total Catch Mortality	OFL	ABC
2012/13	16.77	59.35[A]	0.00	0.00	0.71	19.02	8.17
2013/14	16.98	72.70[A]	1.41	1.26	2.78	25.35	17.82
2014/15	13.40	71.57[A]	6.85	6.16	9.16	31.48	25.18
2015/16	12.82[C]	73.93[A]	8.92	8.91	11.38	27.19	21.75
2016/17		45.34[B]				25.61[C]	20.49[C]

Biomass units: 1000's t

Action Items

The CPT outlined the base model to be used for this assessment, based on results presented by the author for a suite of models.
Response: The base model recommended by the CPT is the base model used here (Model B).

The CPT outlined a number of alternative models built on its recommended base model to be evaluated.
Response: These models were evaluated for the assessment.

Comment: **"The SSC was unable to fully compare models, as the summary tables in the assessment did not include the number of model parameters for evaluating differences in likelihoods."**
Response: The number of model parameters are included in at least one summary table.

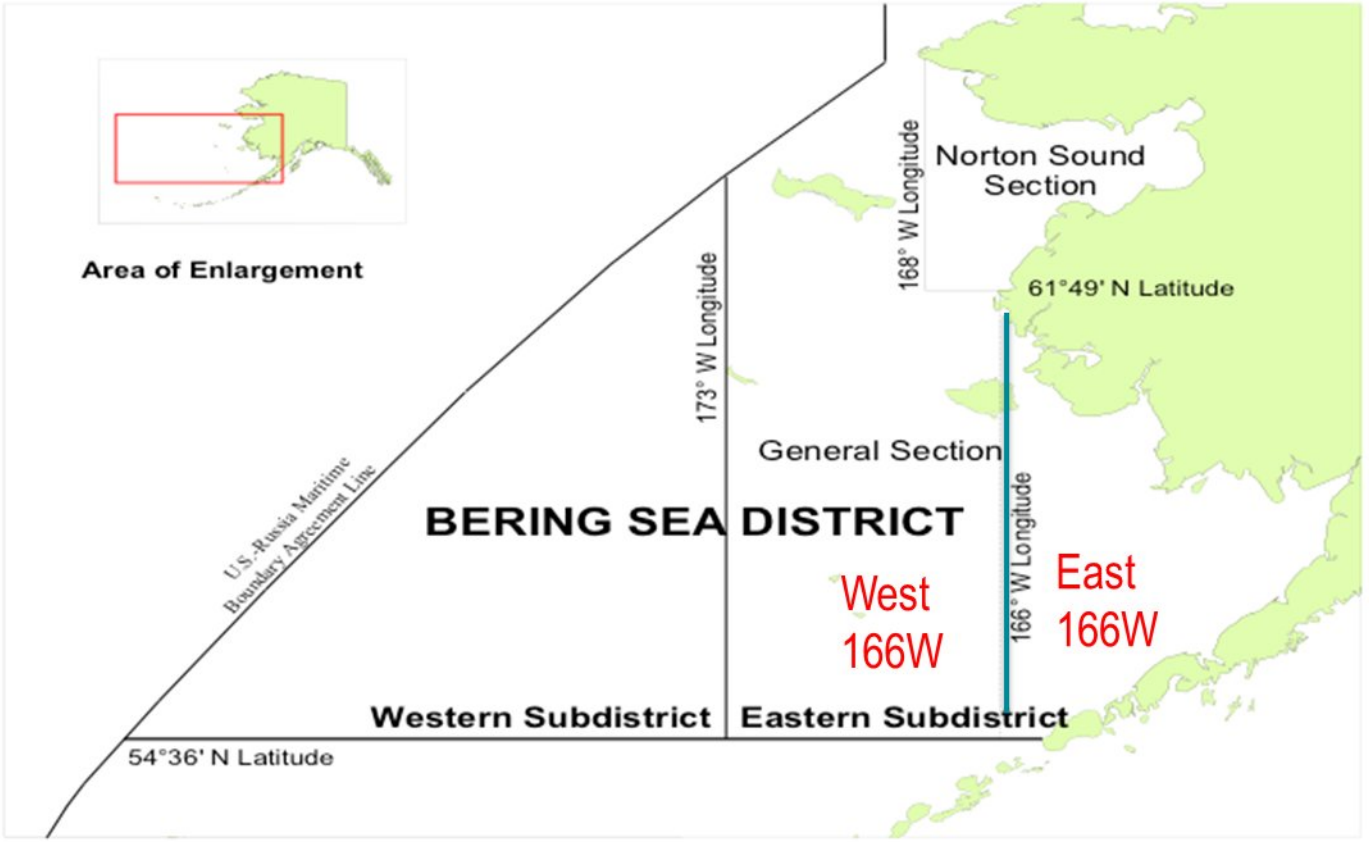
Comment: **"There are continuing concerns about the most appropriate weights to use for different data components (CVs, effective N, etc.), and the SSC looks forward to recommendations from the data-weighting workshop."**
Response: The CPT endorsed using an iterative approach to weighting composition data (the "Francis method"), but it has not yet been implemented for this model.

Comment: **"Strong residual patterns in numbers at size remain a concern and suggest model mis-specification with respect to growth."**
Response: Growth increment data for Tanner crab in the Bering Sea was collected in 2015 for sub-adults and April-June, 2016 for smaller crab. This data was made available to the author this summer, but time did not permit substantive results to include in this assessment. The data appears to be very consistent with previous growth data collected near Kodiak Island.

Comment: **"It was not clear why the model estimates full selection [for males in the directed fishery] in 1996 at roughly 100 cm…"**
Response: This occurs due to a combination of two factors: 1) the sample size for male size comps from the directed fishery in 1996 is quite small, meaning that a poor fit to this size frequency has little effect on the overall likelihood, and 2) the size-at-50% selected in the directed fishery prior to 1992 is based on the mean size-at-50% selected in the directed fishery after 1991 (size-at-50% selected in the directed fishery is allowed to vary annually after 1991). Although it has cascading effects through many likelihood components because of its influence on underling population structure, the size-at-50% selected in the directed fishery prior to 1992 most directly influences (I think) fits to retained catch size compositions prior to 1992. If the fit to the pre-1992 retained catch size compositions can be improved by changing the size-at-50% selected in the pre-1992 directed fishery, there is little "cost" to doing so even by making the size-50%-selected in 1996 any value whatsoever.

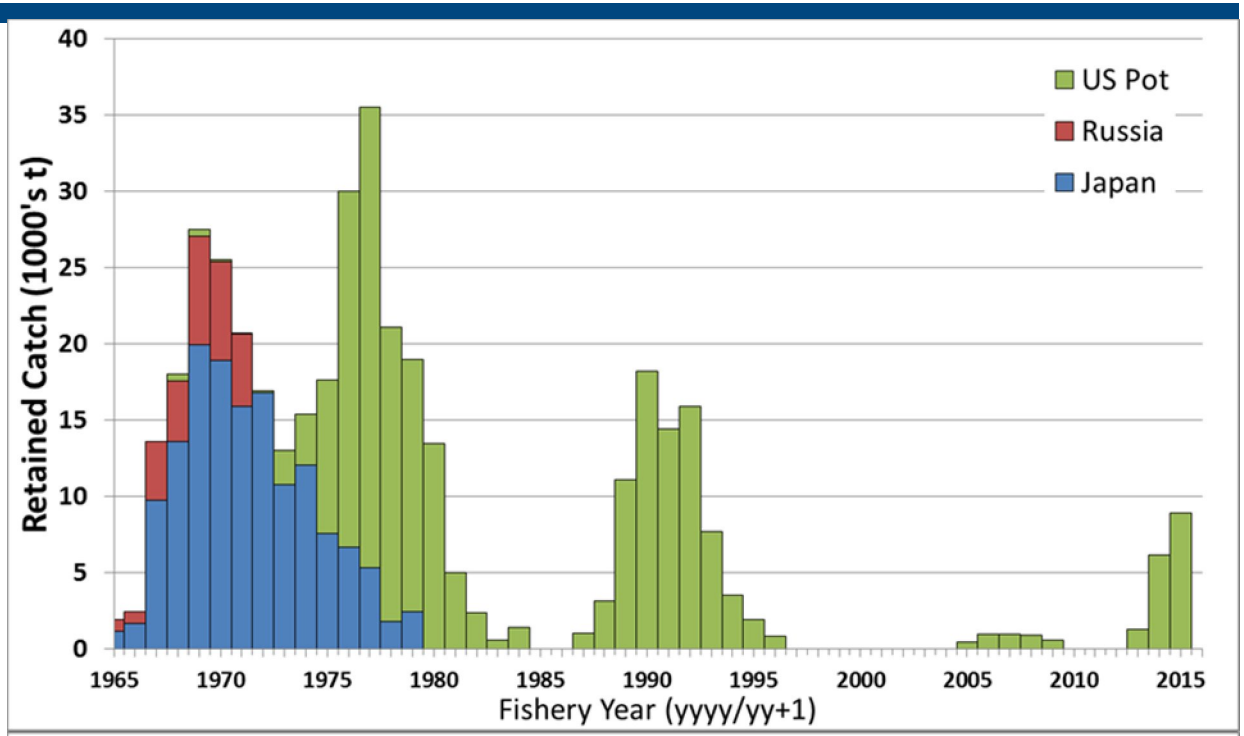
Fishery Trends

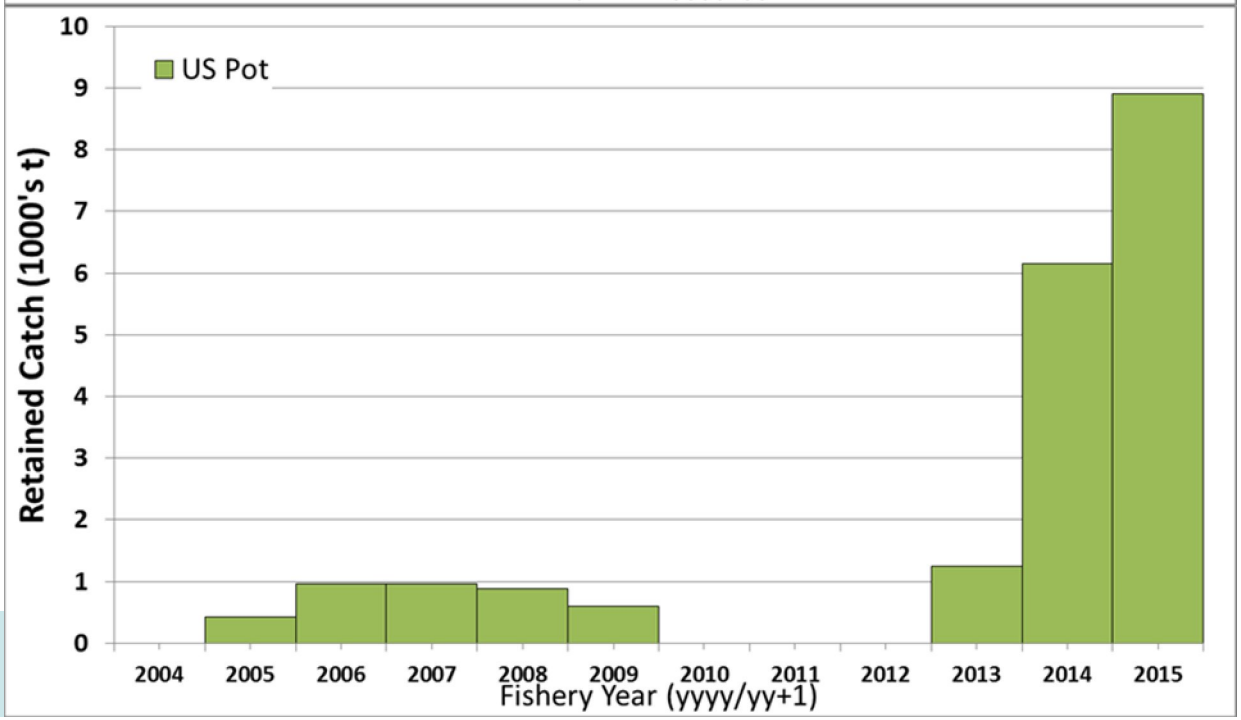
Management Regions



Fishery Trends

Retained catch





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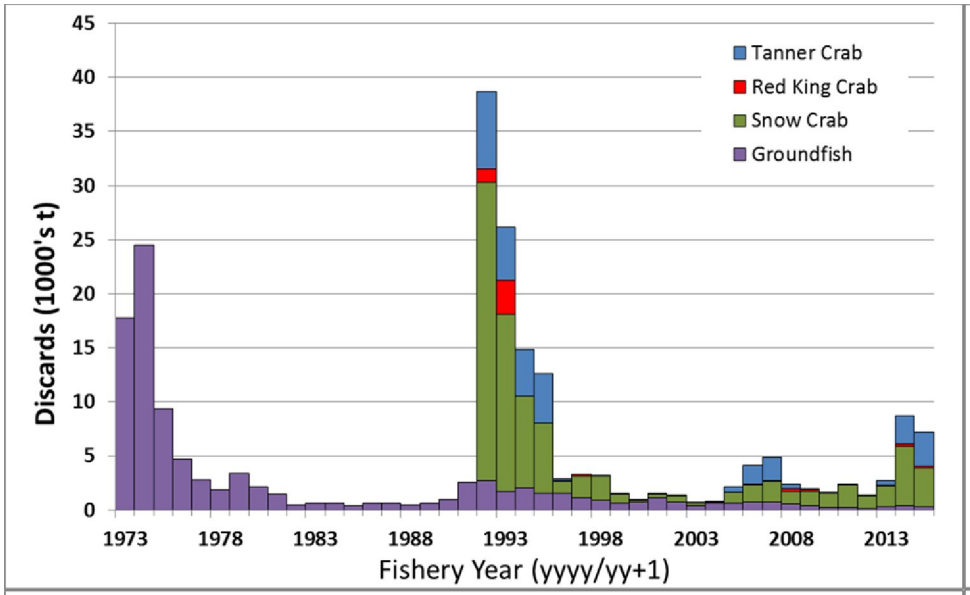
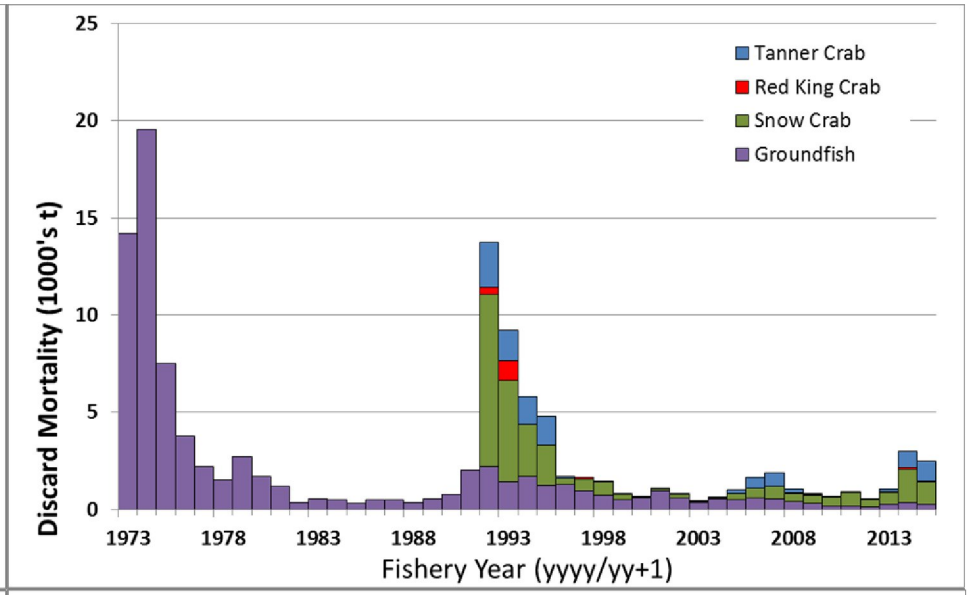
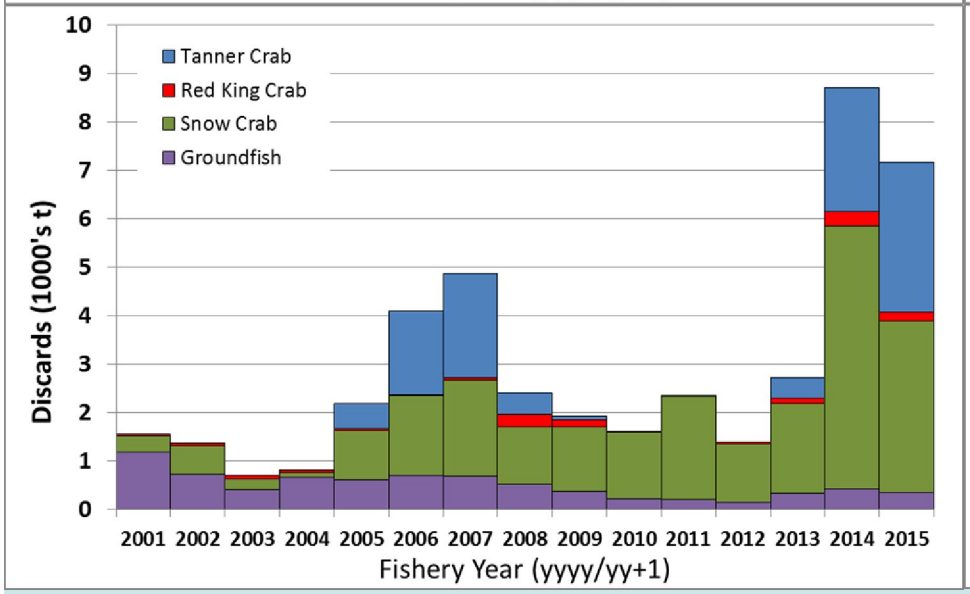
Fishery Trends

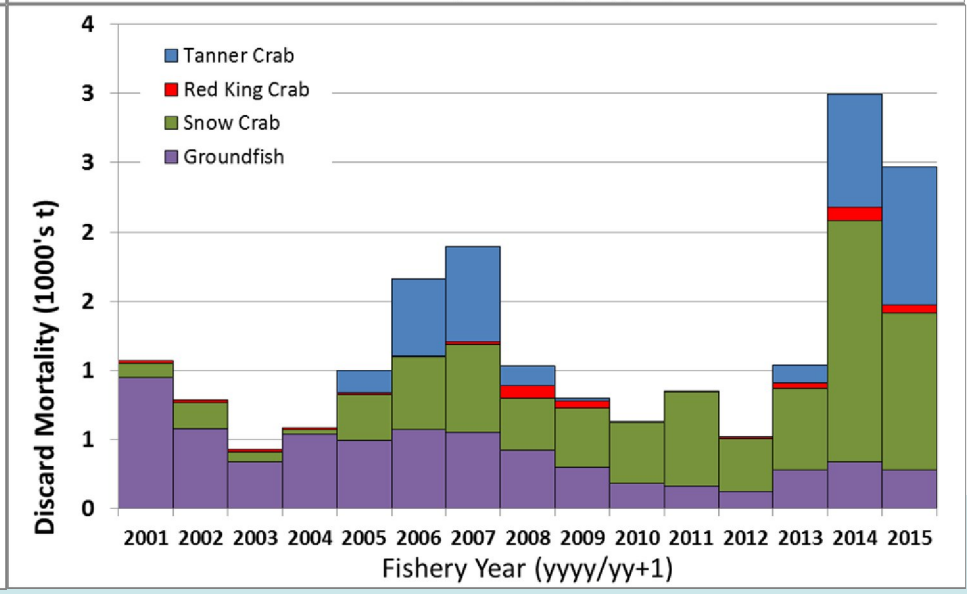
Bycatch



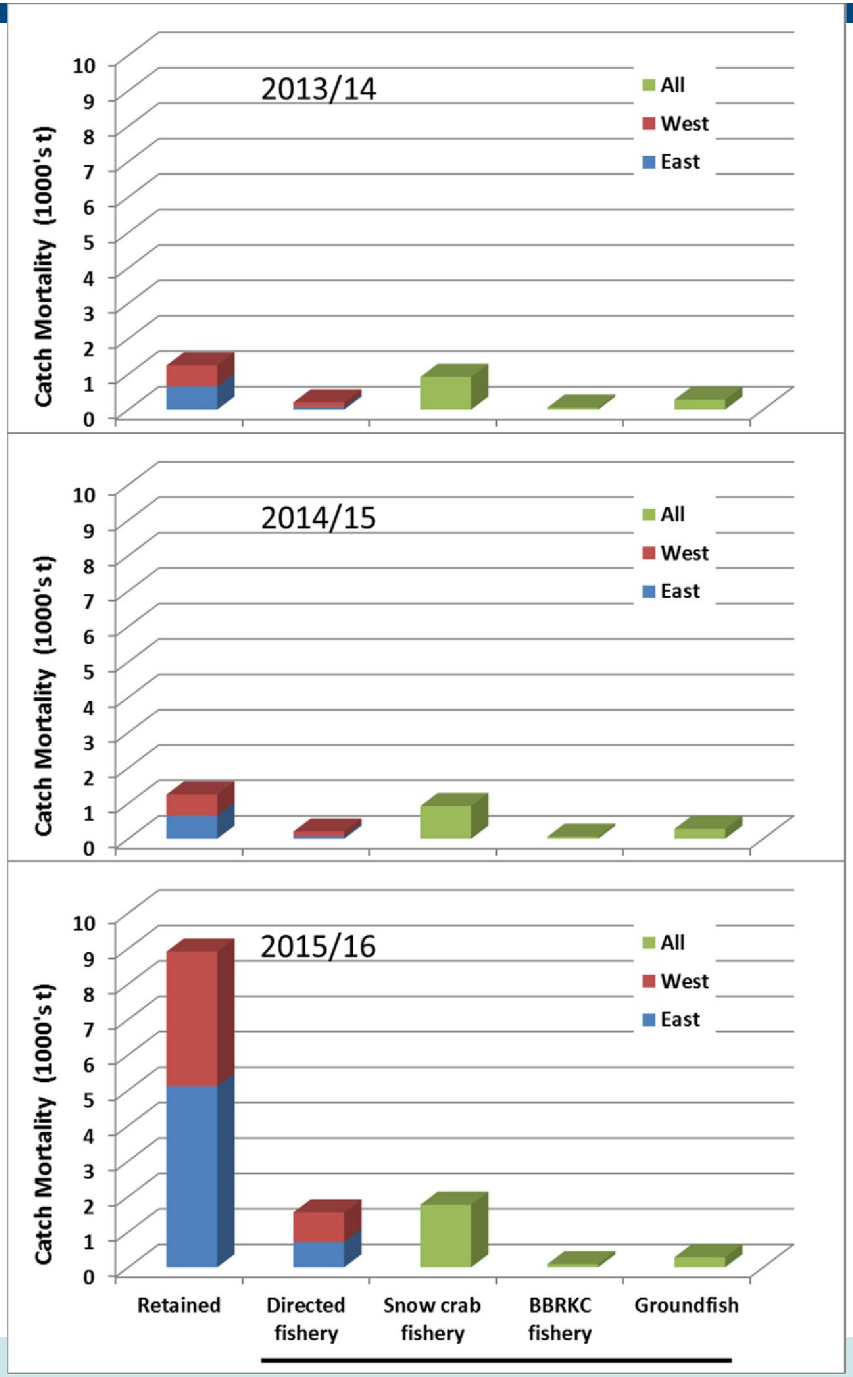
Bycatch Mortality





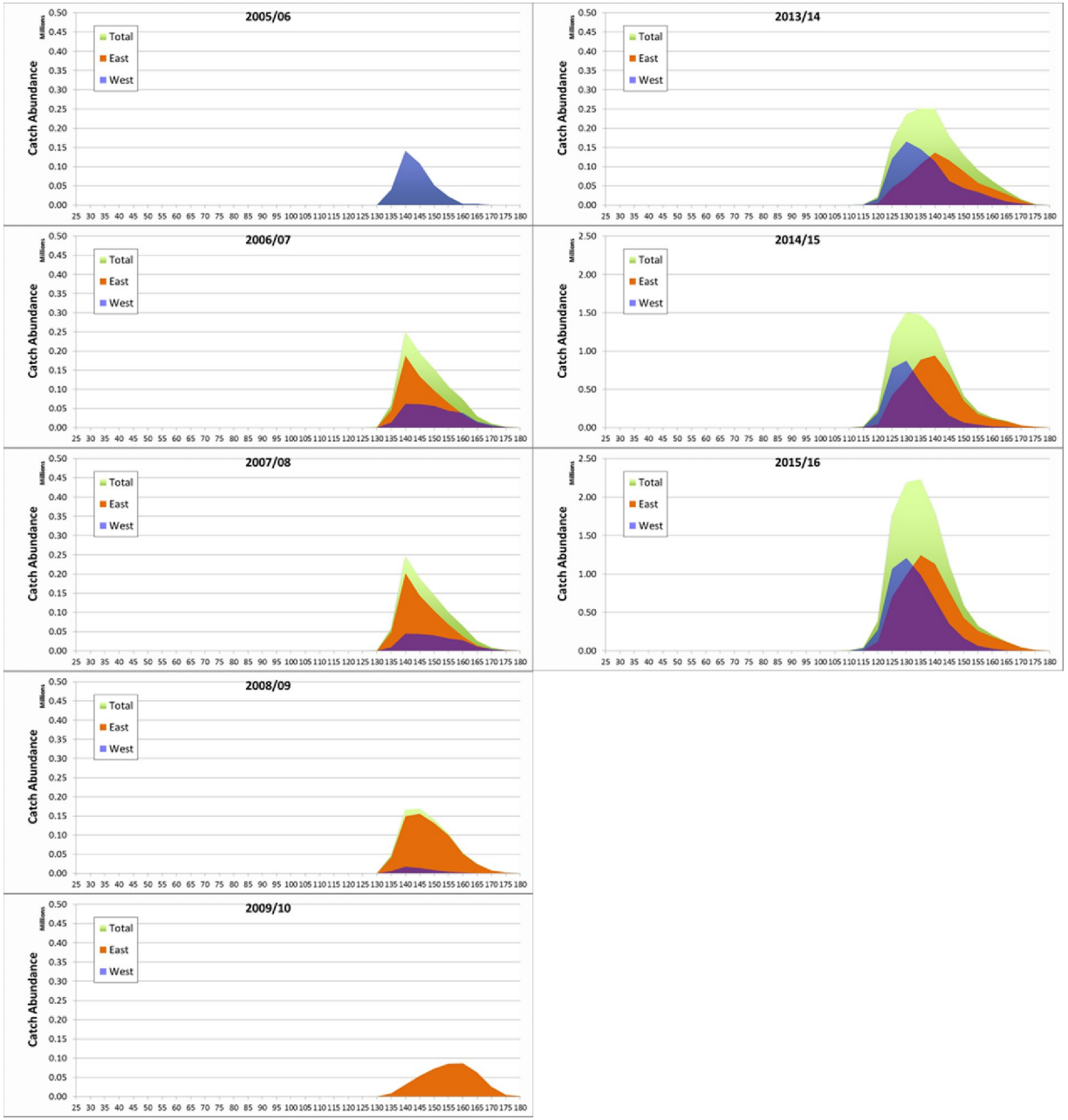


Recent Fishery Trends

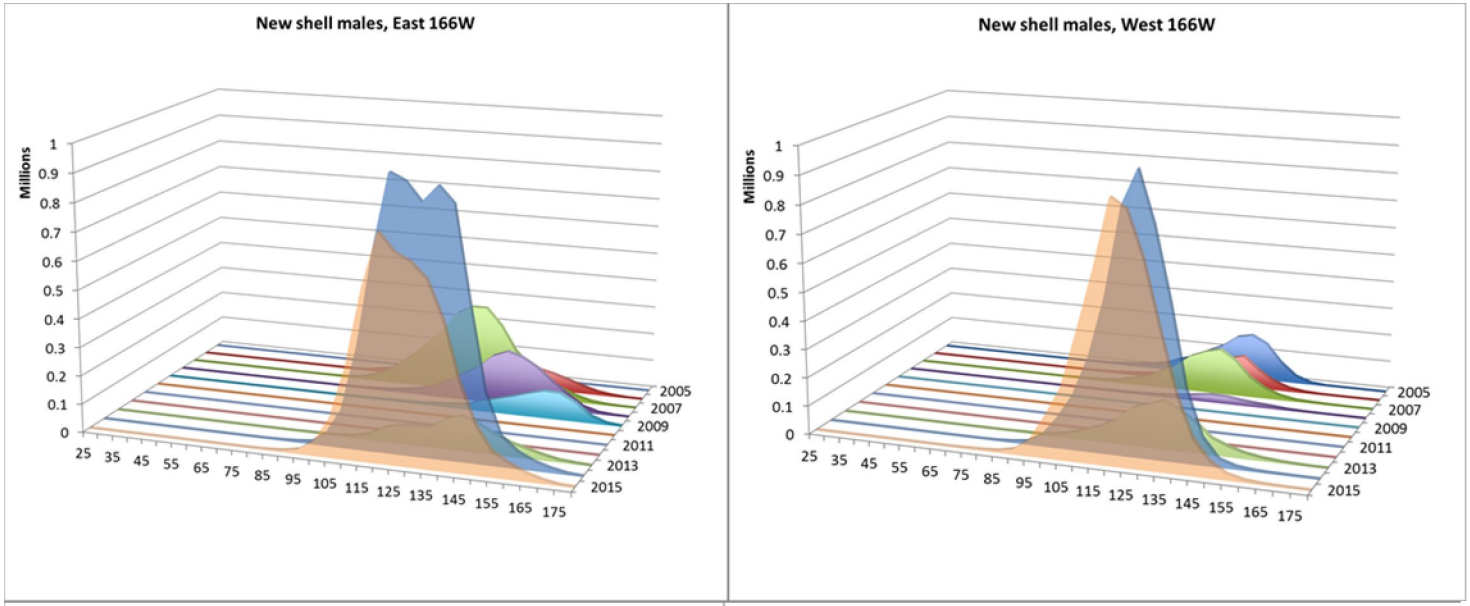


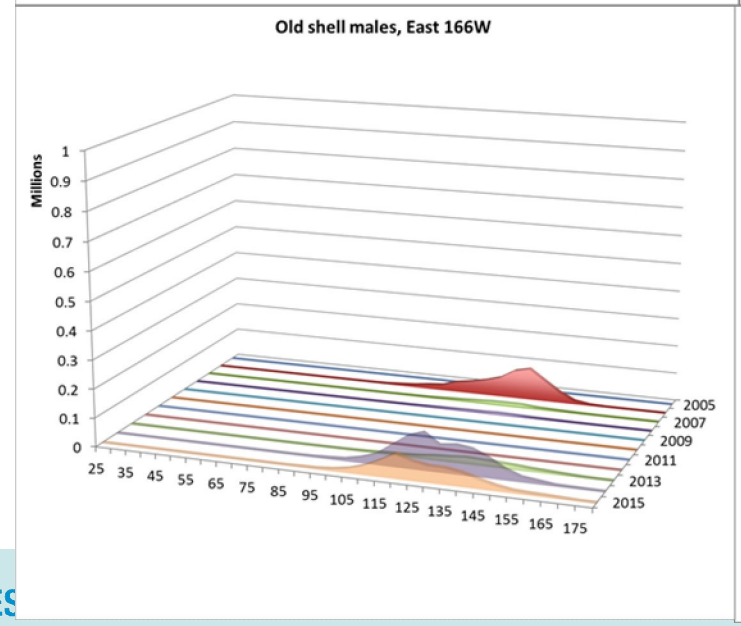
Discard Mortality

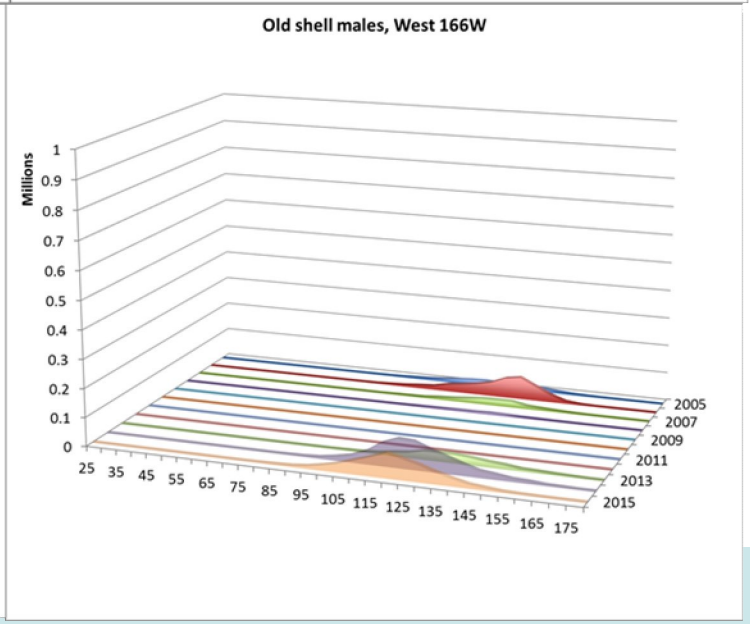
Recent Fishery Trends: Retained Catch Size Compositions



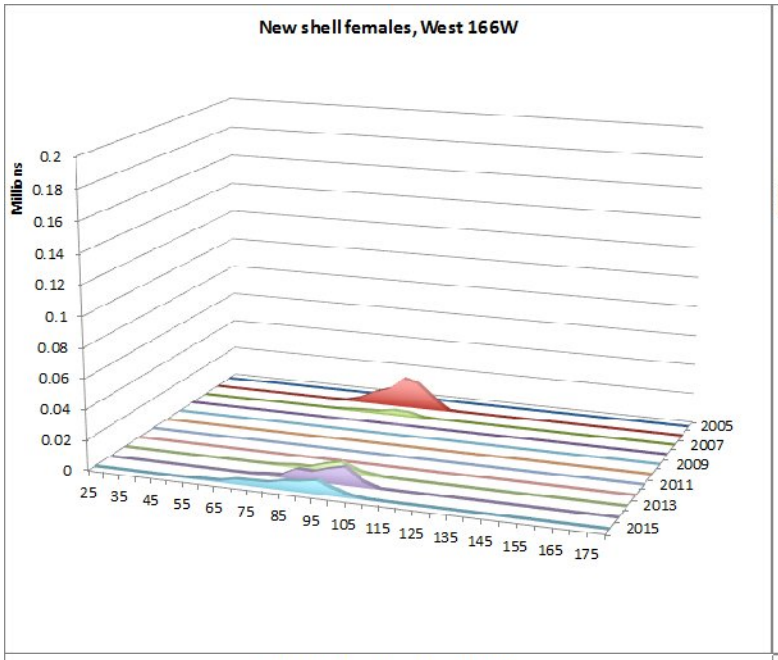
Directed Fishery: Total Catch Male Size Compositions

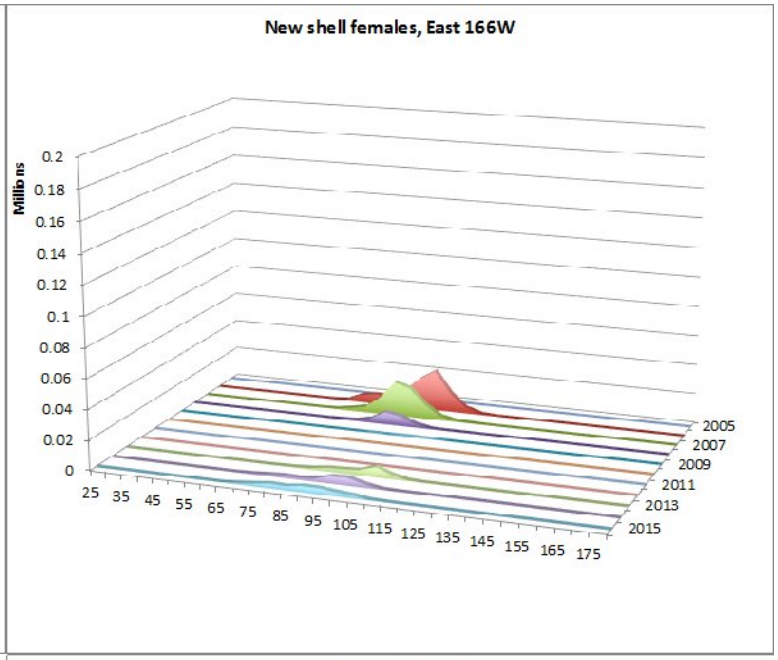


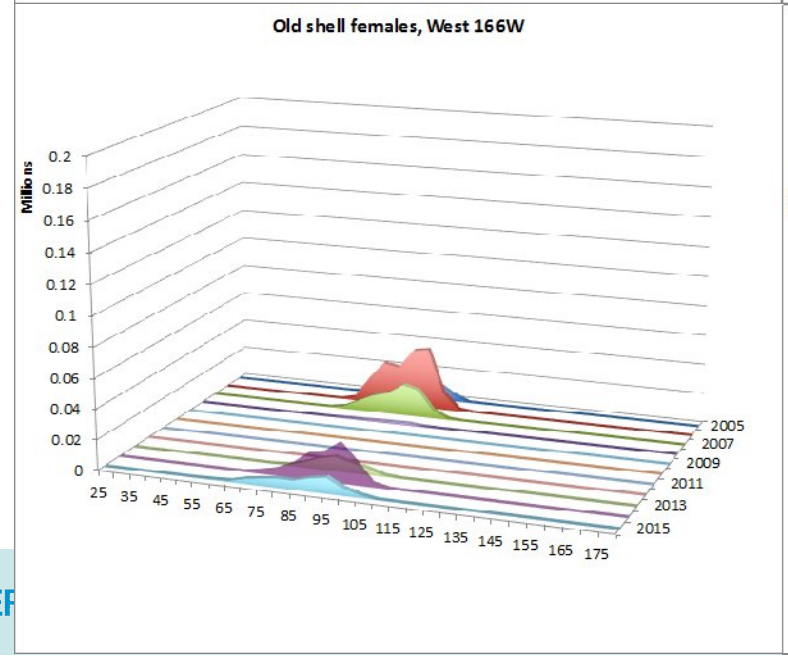


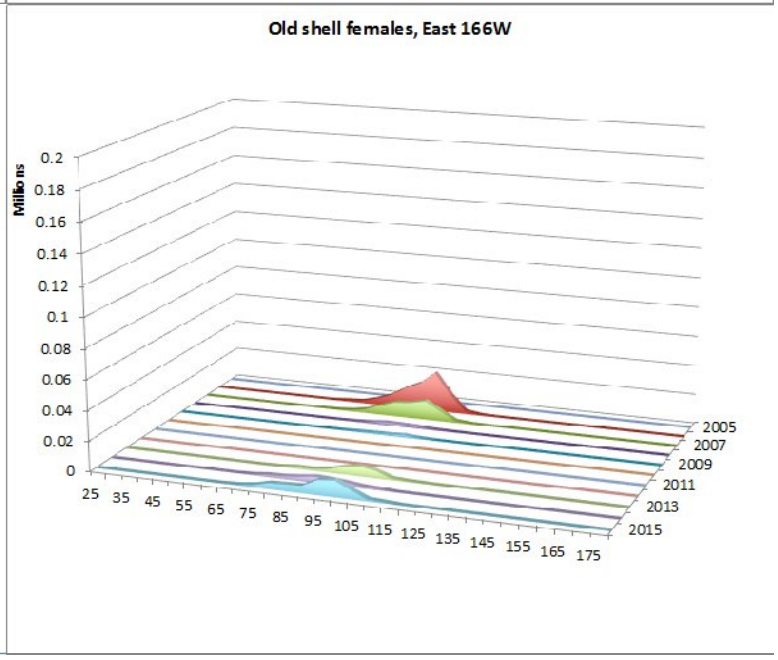


Directed Fishery: Female Bycatch Size Compositions

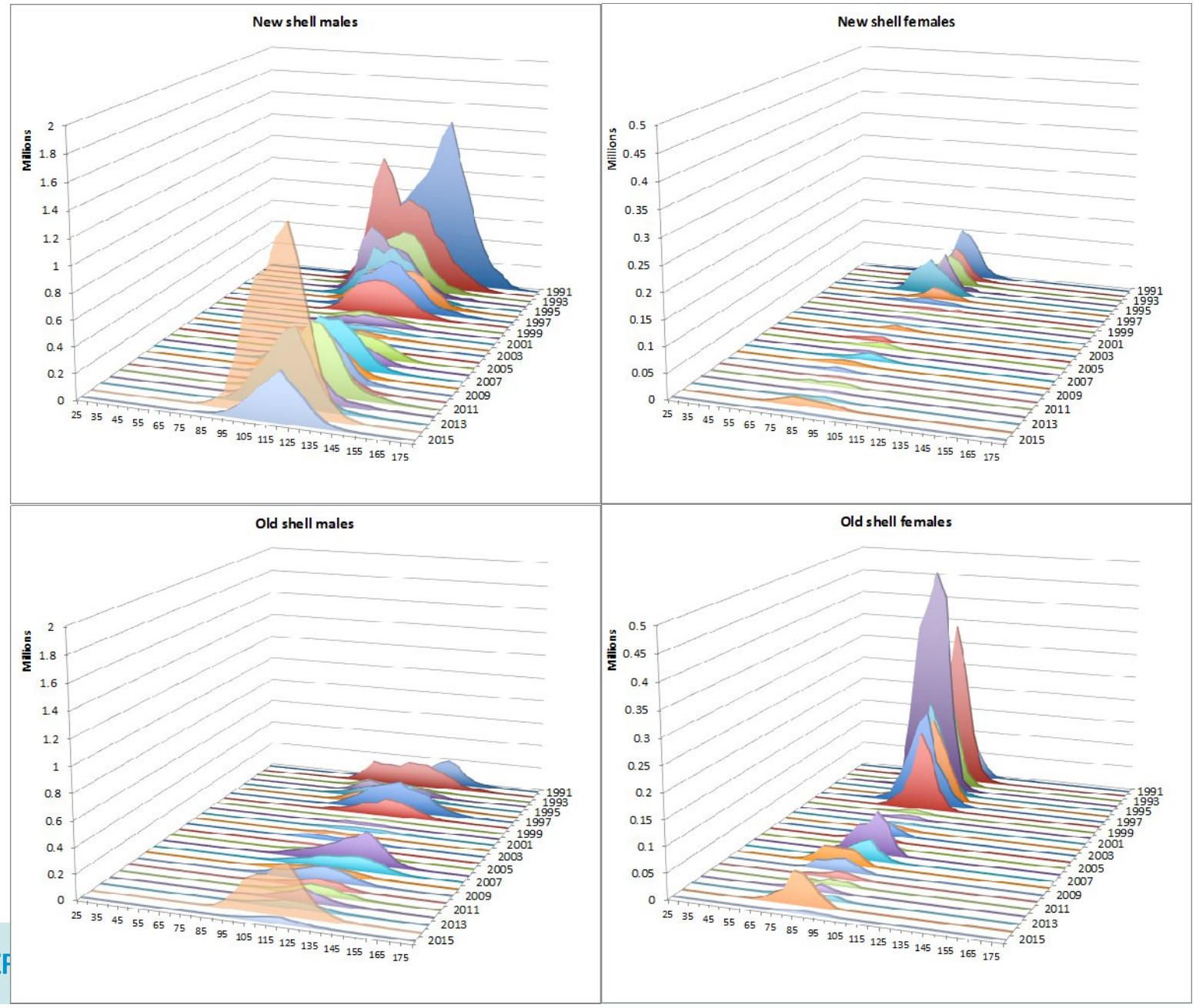




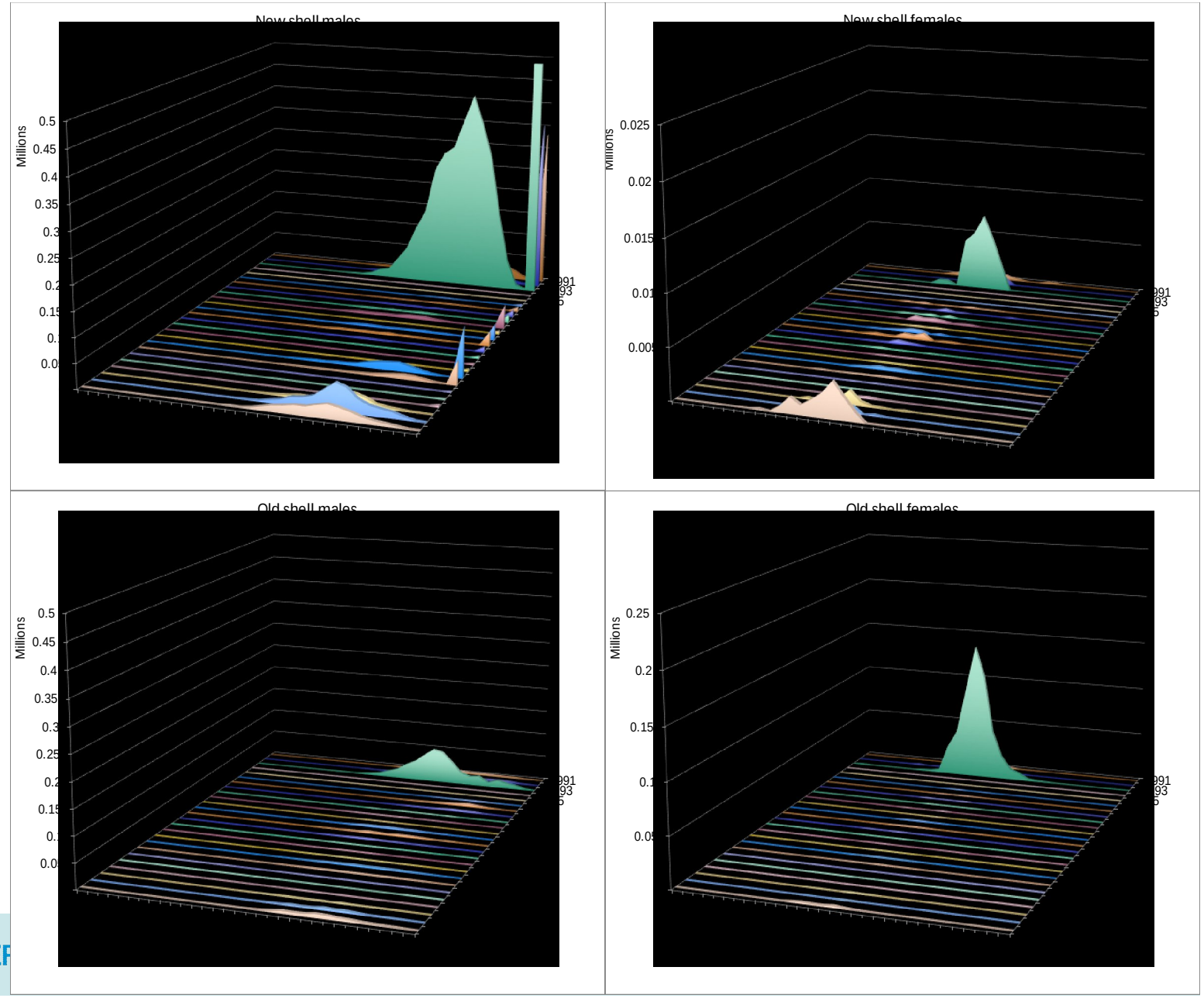




Snow Crab Fishery: Bycatch Size Compositions



BBRKC Fishery: Bycatch Size Compositions



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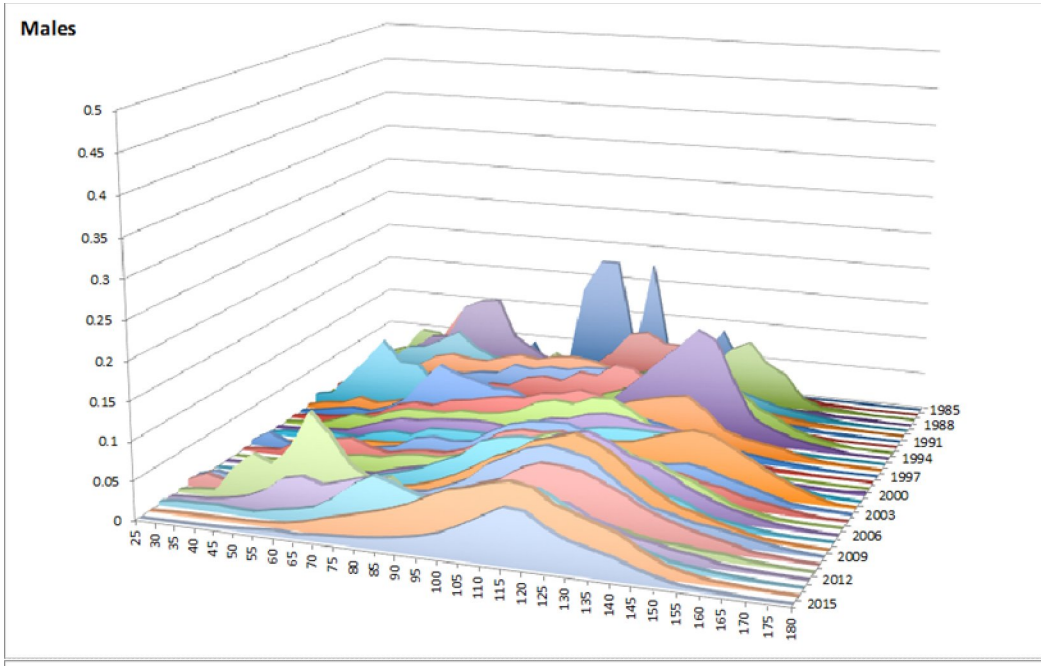
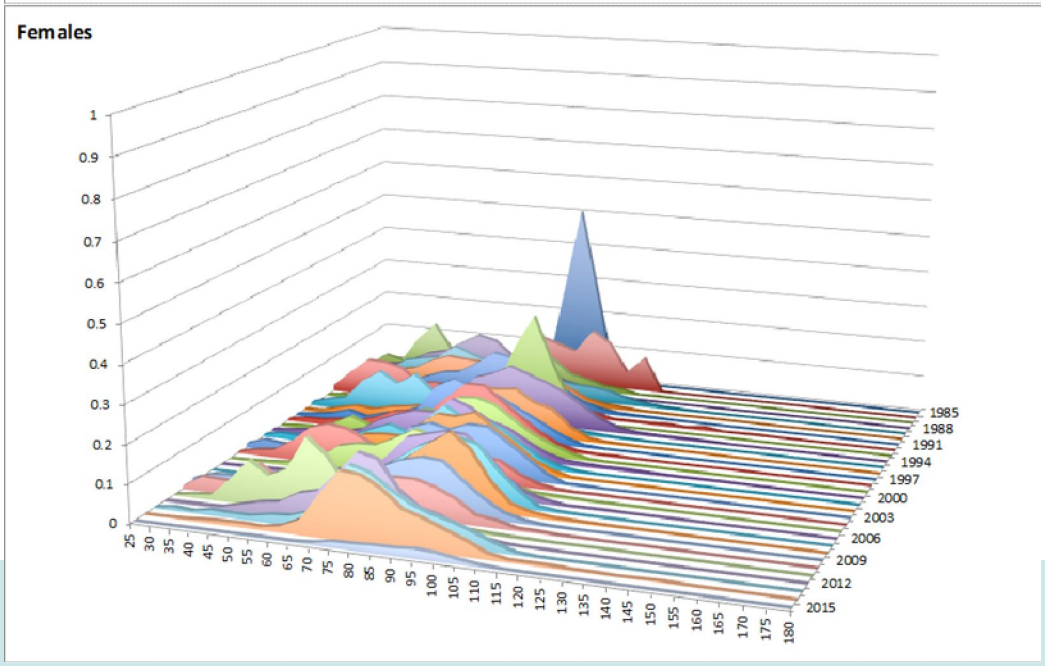
Groundfish Fisheries: Bycatch Size Compositions





NMFS EBS Trawl Survey Trends

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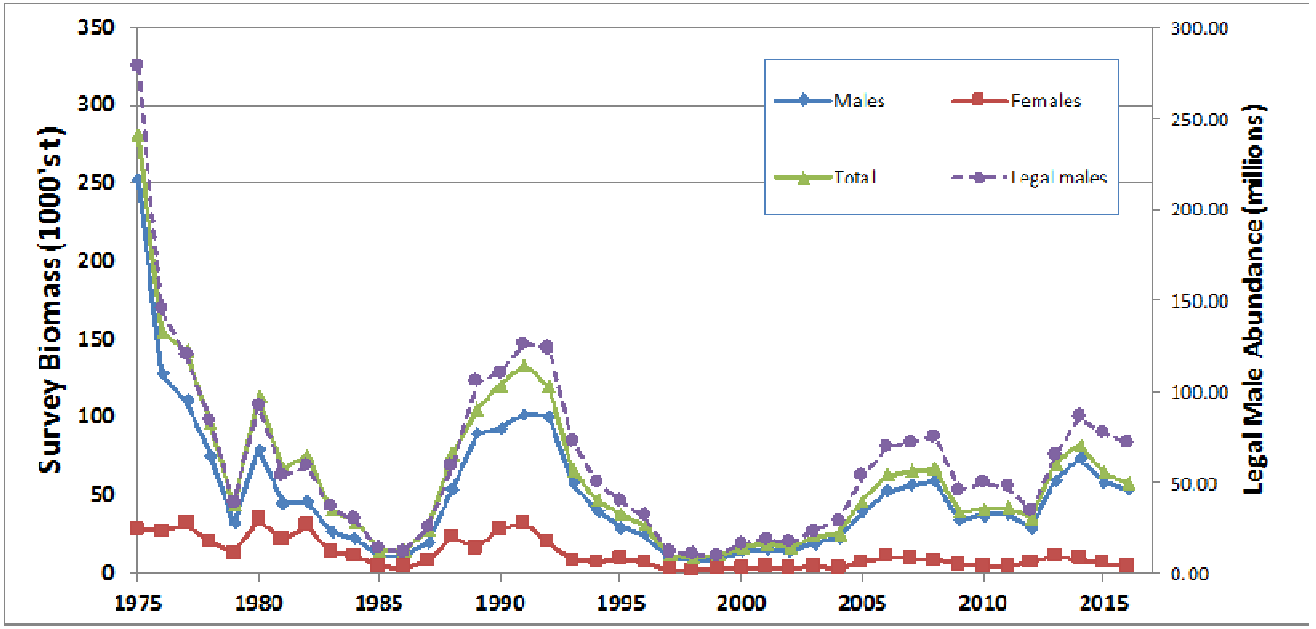
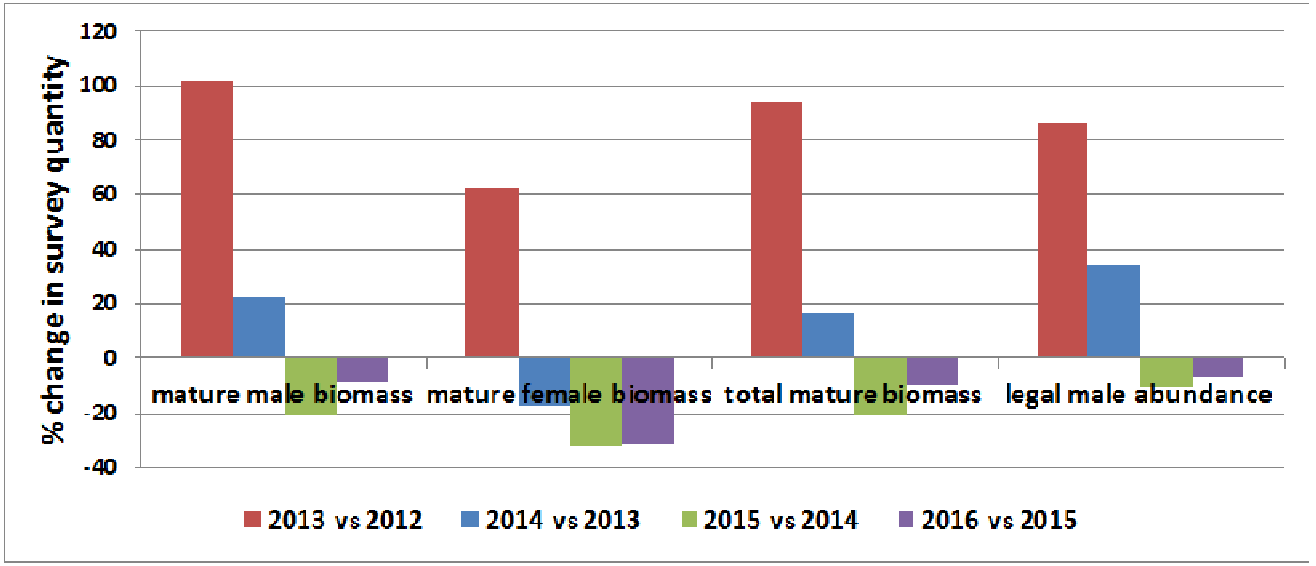
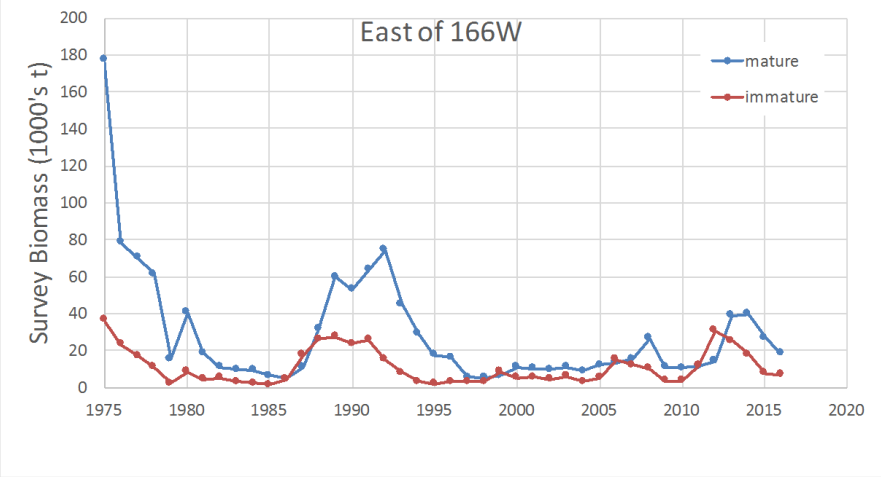
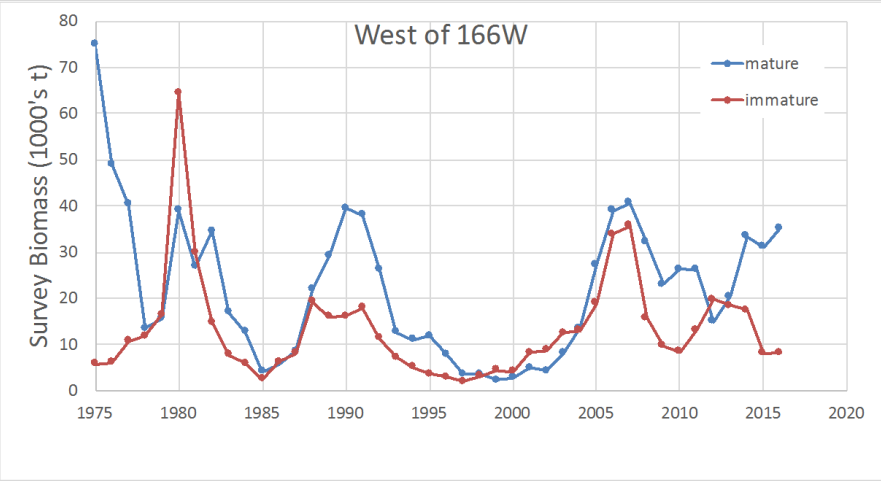




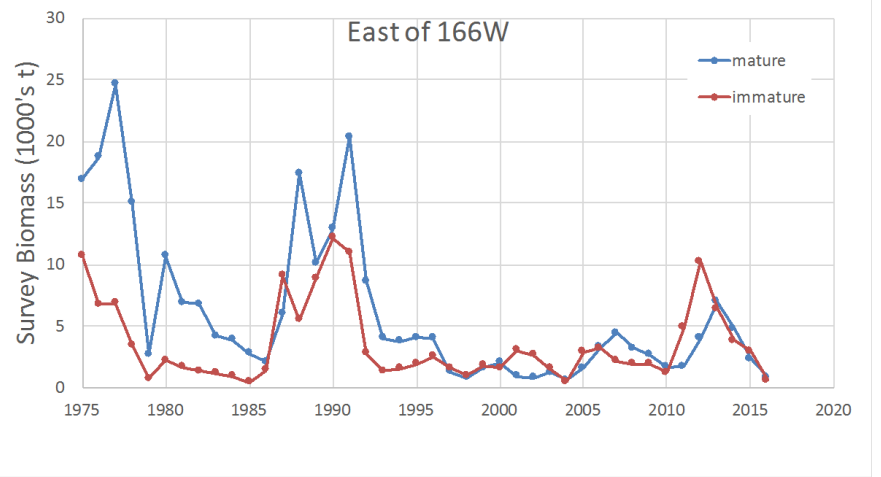
NMFS EBS Trawl Survey Trends

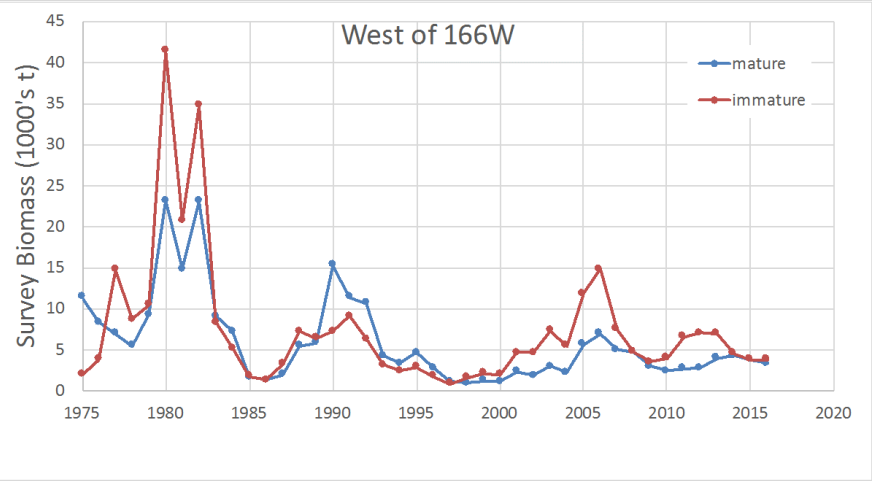
Males





Females

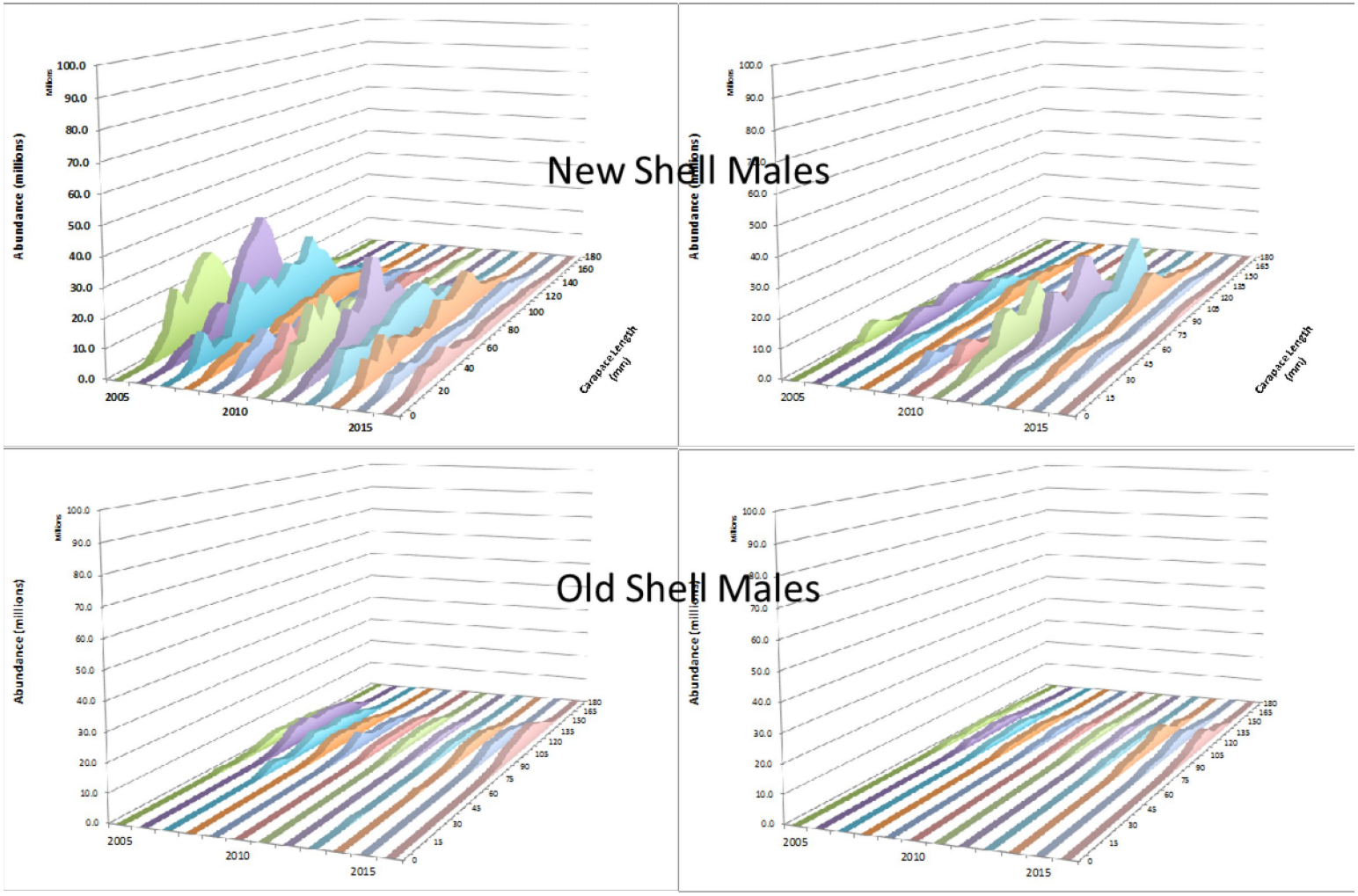




Trawl Survey Size Comps: Males

West of 166W

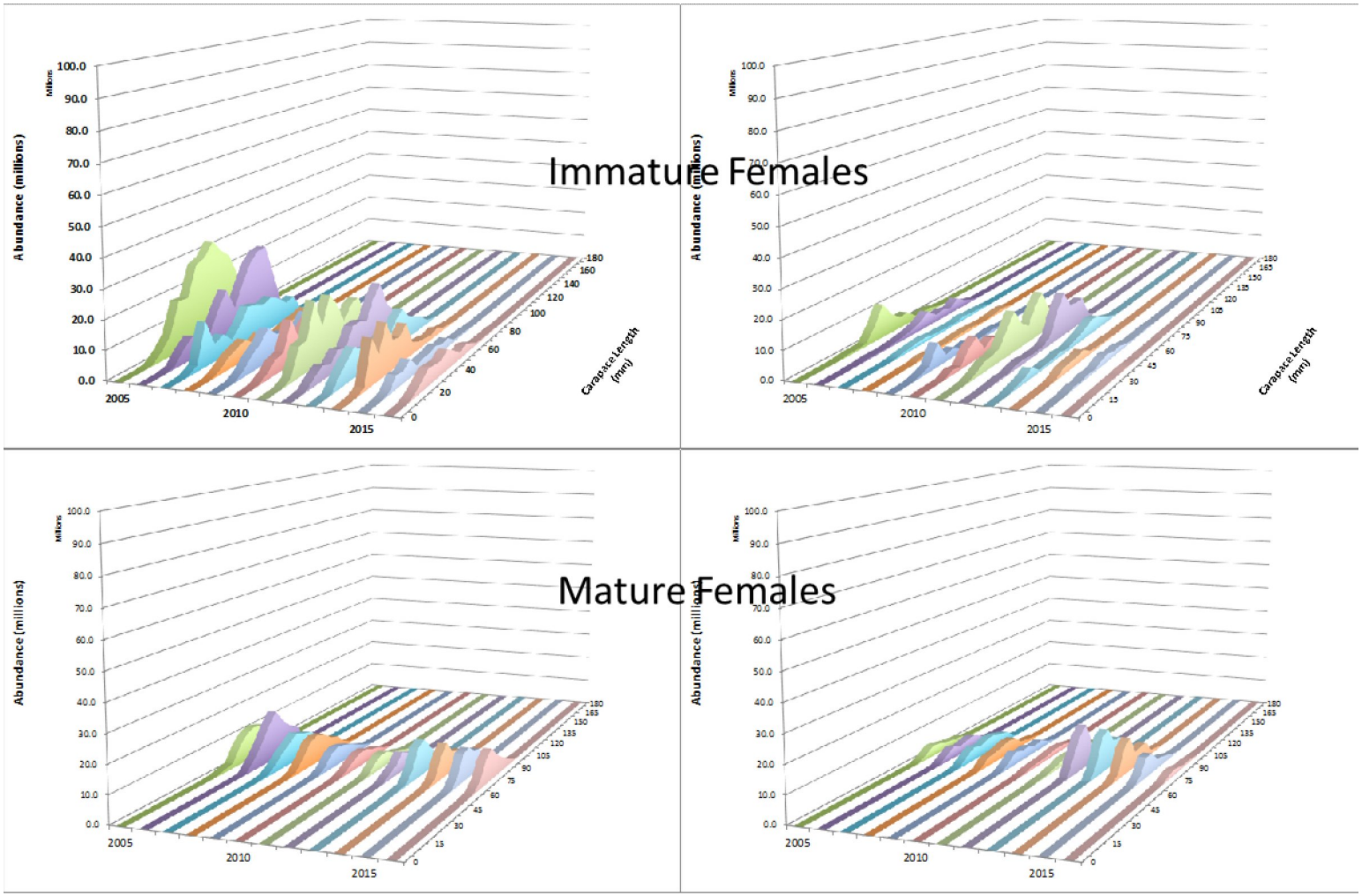
East of 166W



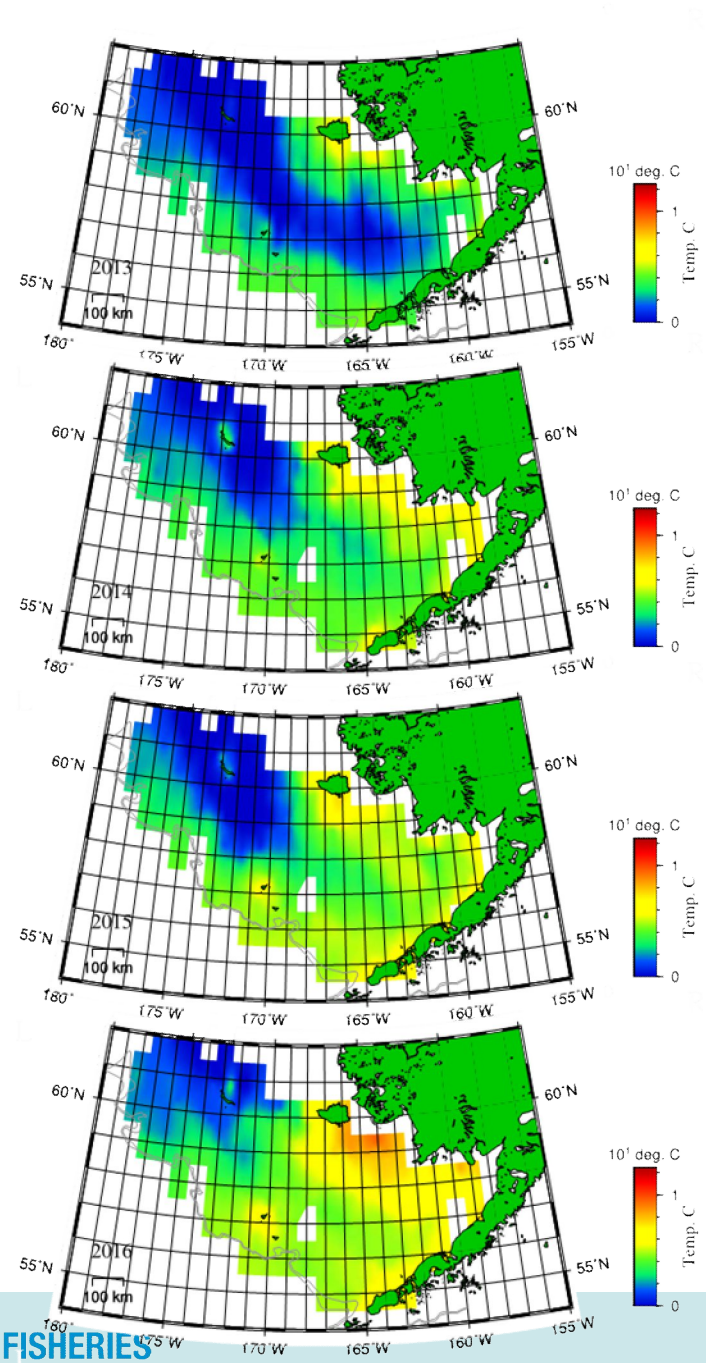
Trawl Survey Size Comps: Females

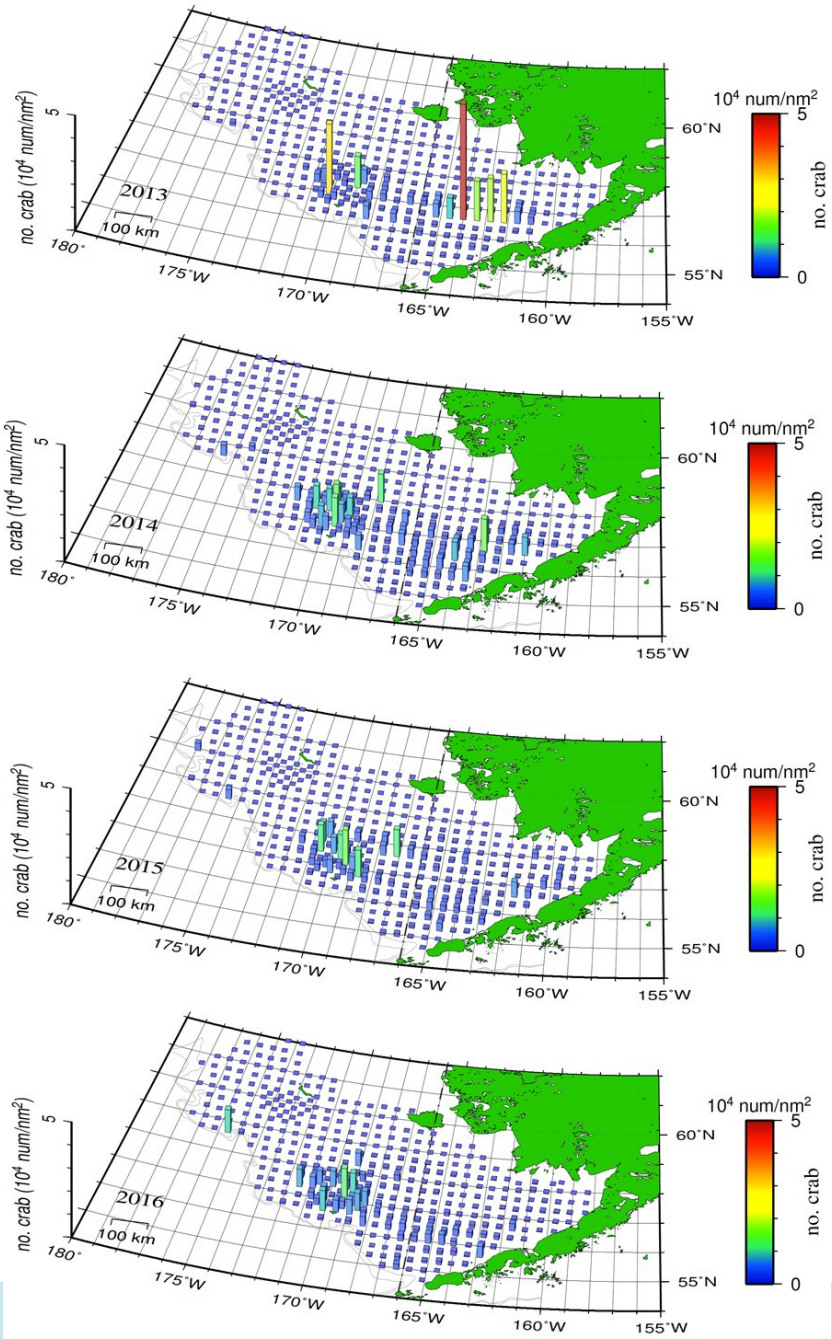
West of 166W

East of 166W



Survey Results: Mature Males





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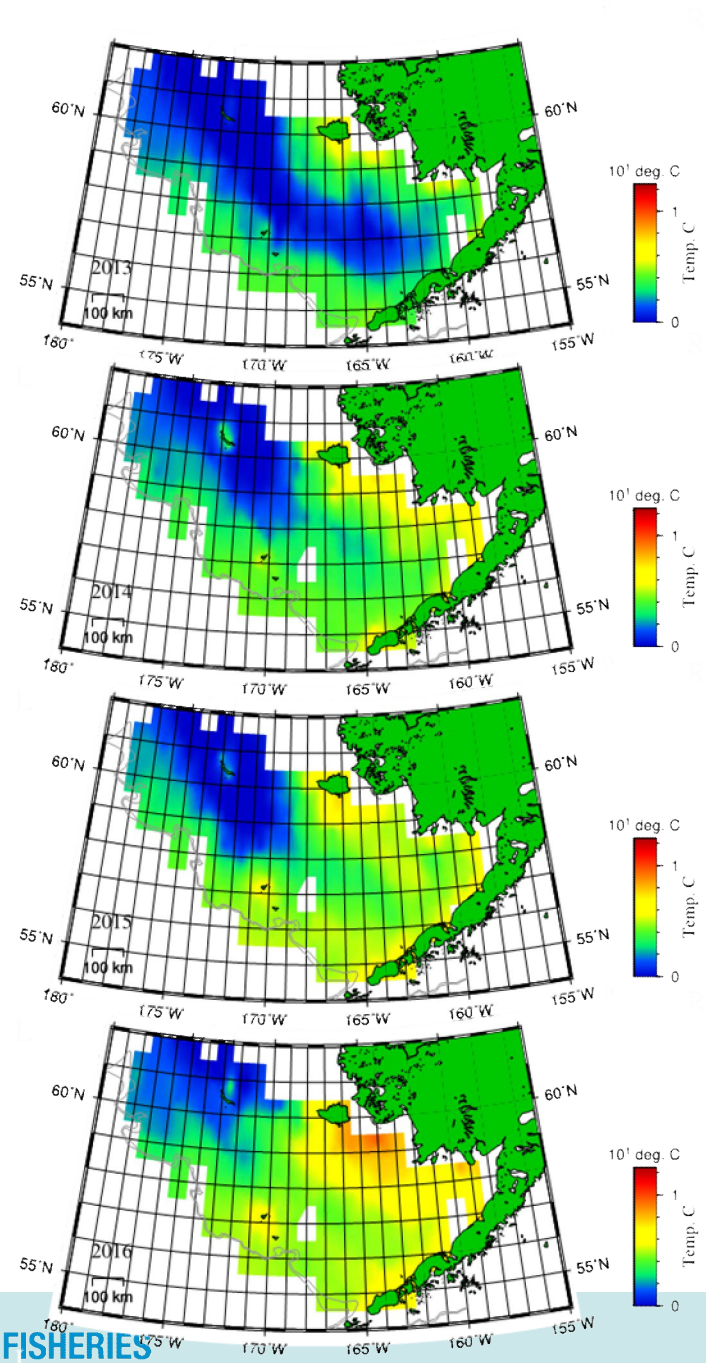
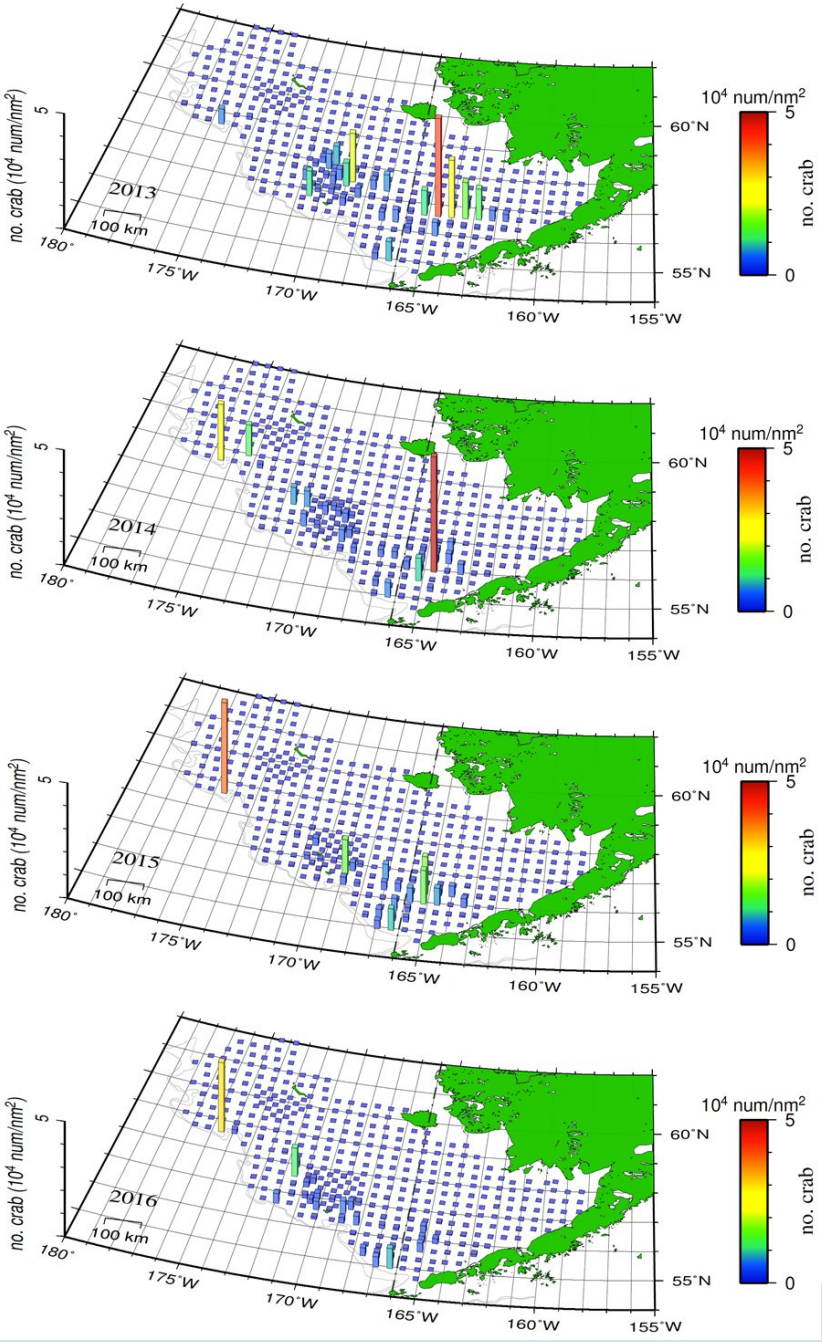
Survey Results: Mature Females





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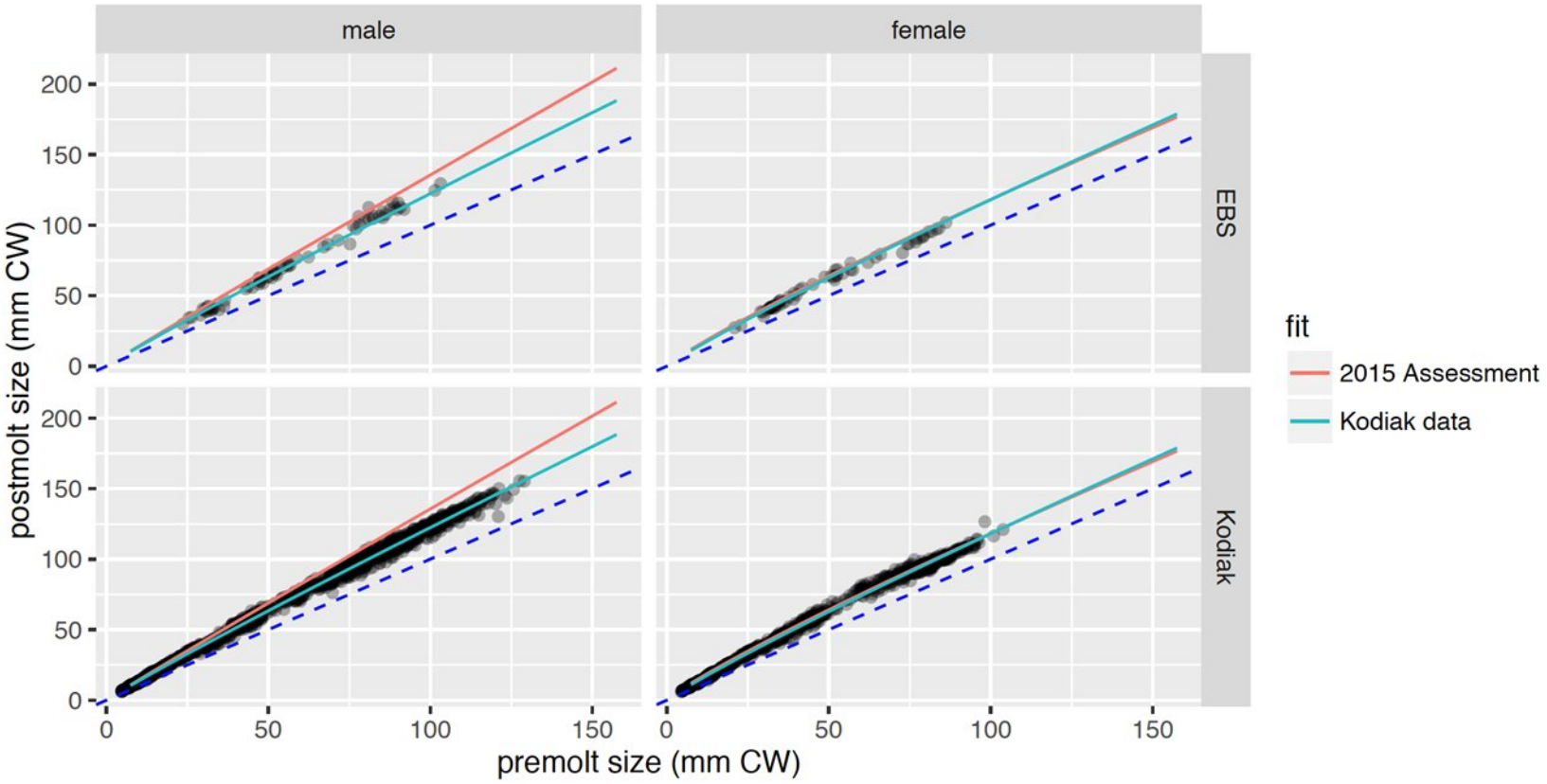
EBS Growth Data



Model Overview

Tier 3 stage/size-based population dynamics model

- model year runs July 1 to June 30
- sex, shell condition, maturity state, carapace width
- sex/stage-based natural mortality (2 time stanzas)
- trawl survey occurs July 1
- fisheries occur Feb. 15
    - directed fishery (retained and bycatch)
    - bycatch in snow crab fishery
    - bycatch in BBRKC fishery
    - bycatch in groundfish fisheries
- sex-specific growth & maturity (after fisheries)
    - pre-molt/post-molt size transition matrix
    - size-specific probability of maturing on molt
    - terminal molt to maturity
- spawning stock (MMB) assessed at mating

Model Inputs

Annual NMFS EBS Survey Data
- 1975-2016
- size compositions
  - sex x maturity x shell condition
- cv's for mature survey biomass

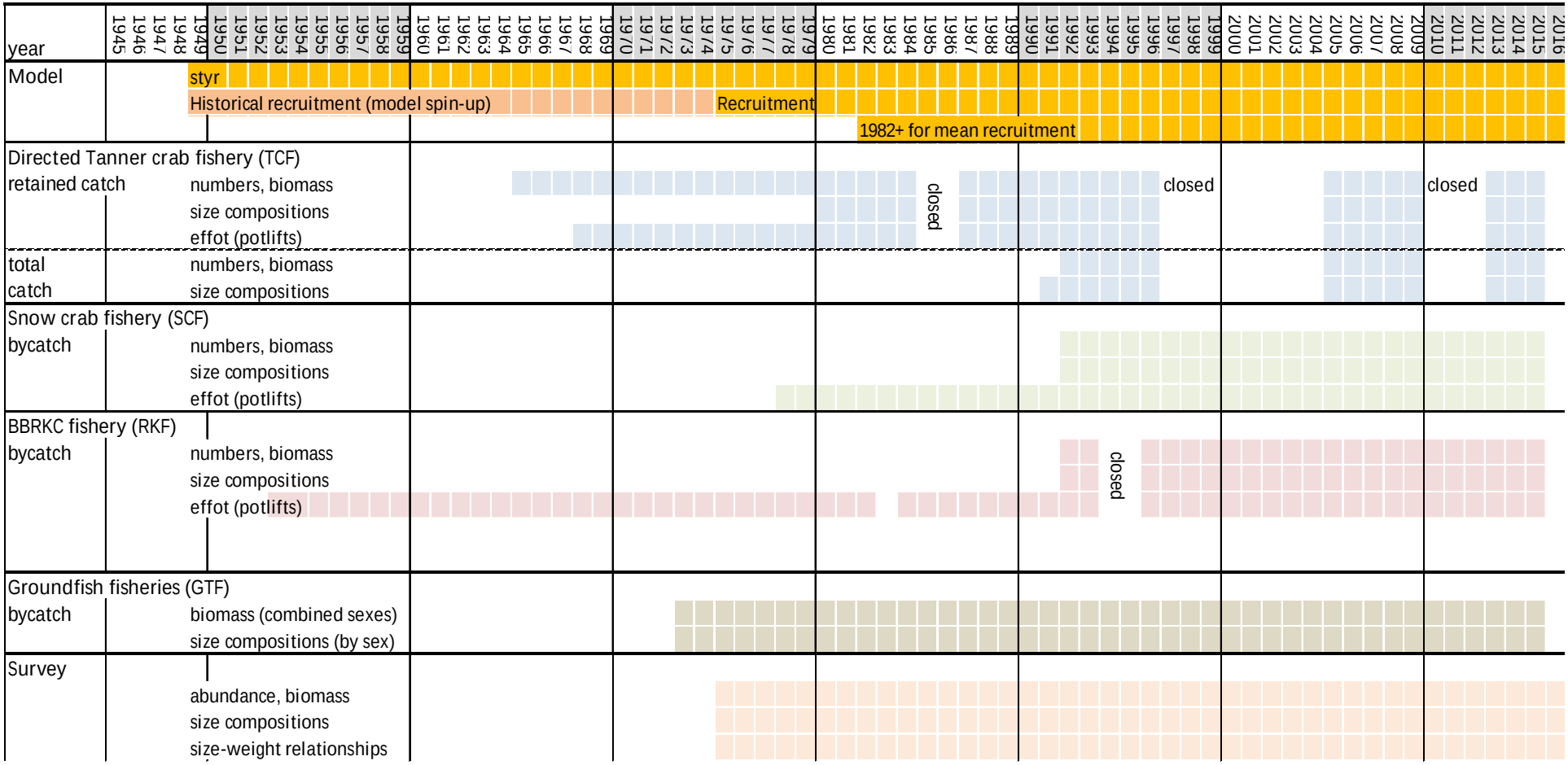
Retained catch in directed fishery
- from fish ticket data and "dockside" observer sampling
- Aggregated across 166^{o}W
- catch biomass
- size compositions

Total catch data in crab fisheries
- from "at-sea" observer sampling
  - total (by)catch biomass (by sex)
  - size compositions (by sex, shell condition)
- directed Tanner crab fishery
- snow crab fishery
- BBRKC fishery

Total catch groundfish fisheries
- from "at-sea" observer sampling
  - bycatch biomass (aggregated over sexes)
  - size compositions (by sex)
- 1973/74-2015/16

Assumed discard mortality rates
- 0.321 for crab fisheries
- 0.800 for groundfish fisheries

Model Data Coverage



CV'S for Trawl Survey Biomass: An Aggregation Issue (1)

- Survey data (hosted by AKFIN)
  - estimates for "total" (EBS) biomass, by sex in 1-mm size bins
  - cv's for 1-mm size bins
- Need cv's for "total" (EBS) biomass, by sex $\geq$ 25 mm CW

Calculating size-aggregated cv from 1-mm bin cv's

$$X_T = \sum_z X_z \quad \sigma_T^2 = \sum_z \sigma_z^2$$

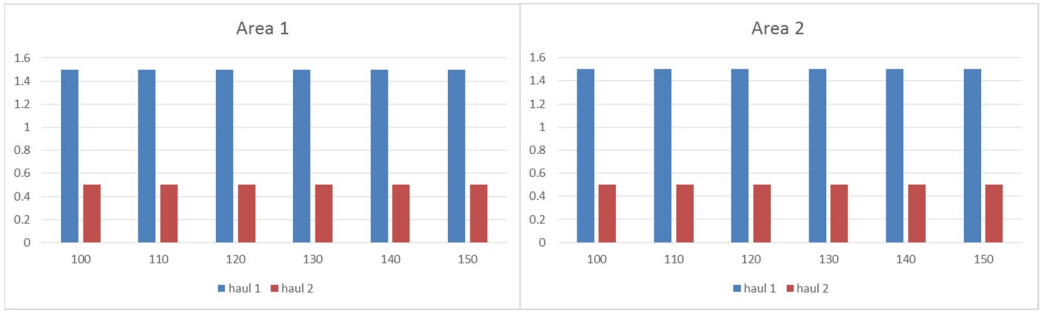
- assumes independence of variability across size bins
- ignores between-bin, within-haul correlations
- within-haul abundance tends to be positively correlated across nearby size bins

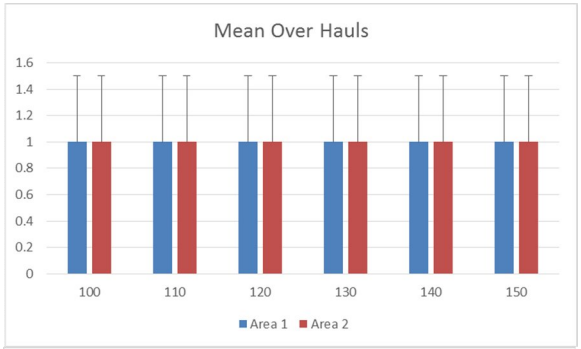
An Aggregation Issue: An Alternative Approach

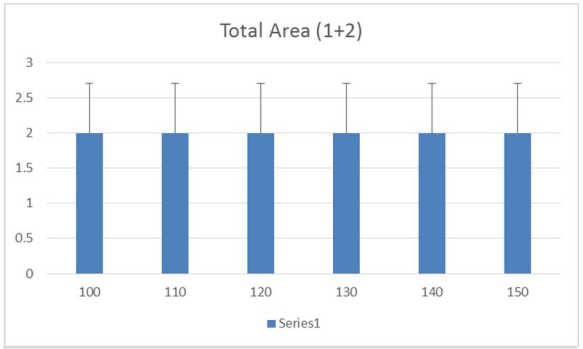
- 2015 (“Old”) approach:
  - Calculate mean CPUE, variance across hauls in stratum by 1-mm CW bins
  - scale by stratum area for total abundance/biomass by 1-mm CW bin
  - Sum across sizes to get aggregated abundance/biomass

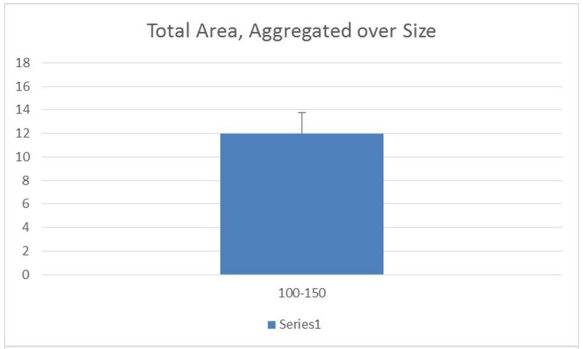
- 2016 (“New”) approach:
  - Aggregate across sizes at haul level
  - Calculate mean CPUE, variance across hauls in stratum
  - scale by stratum area for total abundance/biomass
  - actually: pre-2015 approach

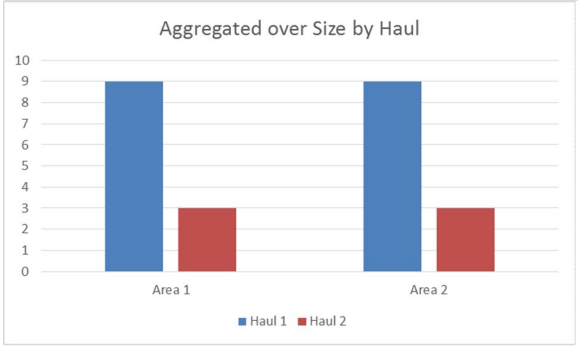
An Aggregation Issue: A Simple Illustration

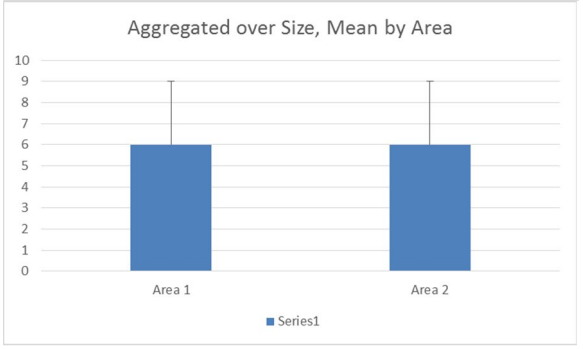


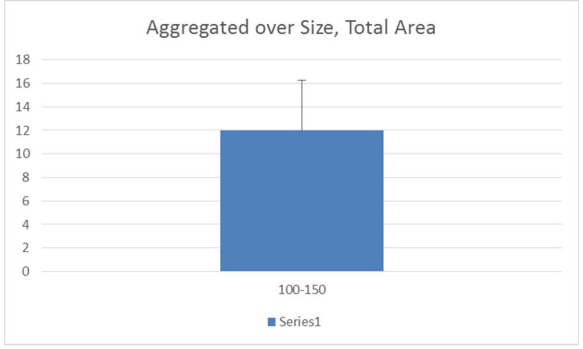






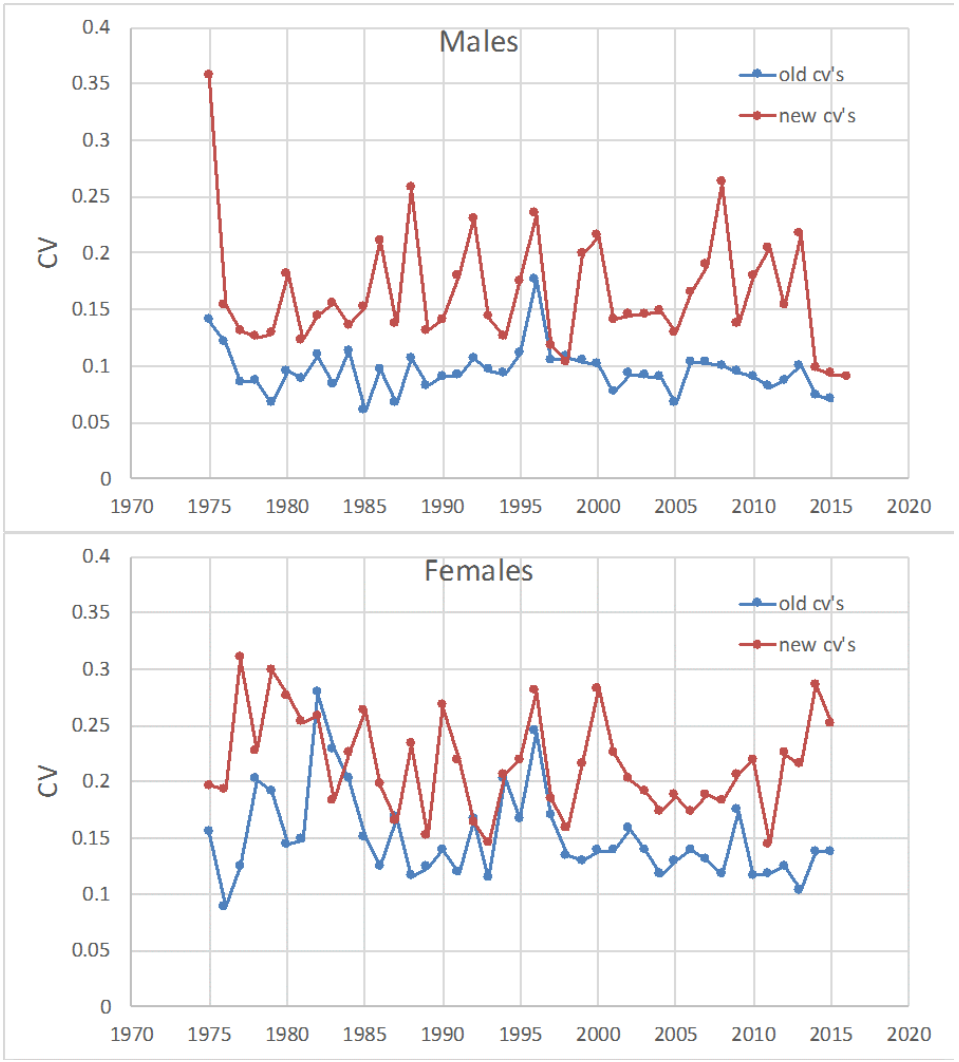






An Aggregation Issue: Application to Trawl Survey Data

- Calculating cv's for aggregated estimates using cv's for 1-mm size bin results underestimates true cv's
- Using these cv's means model "overfits" survey data relative to other types



Model Scenarios

CPT "Base" Model for 2016 (from May CPT Meeting)

Change	Description
A	start "current" recruitment estimation in 1975, instead of 1974
B	normalize groundfish fishery size comps using original sample sizes, not input sample sizes
C	estimate log-scale fishing mortality/capture rate offsets for female crab
E	turn on fishing mortality/capture rate estimation for BBRKC
G	estimate probability of molt-to-maturity using logit-scale parameterization
I	enforce logistic selectivity = 1 in largest size bin
J	use GMACS fishing mortality model

Model Scenarios run for September

Scenario	Description
2015AMO	2015 assessment model and data
2015AMR	2015AMO re-evaluated using parameter jittering
2015AMN	2015AMO + new approach to calculate CVs for mature survey biomass
2015AM	2015AMN + 2016 data (using new approach to calculate CVs for mature survey biomass)
Model A	Model B, but using old fishing mortality model
Model B	Model selected by CPT in May as "base" model for 2016 assessment
Model C	Model B + no minimum F's imposed on BBRKC fishery bycatch
Model D	Model C + effort extrapolation parameters estimated
Model E	Model D + penalty on F-devs reduced to 0 in final estimation phase
Model F	Model D + lognormal likelihoods assumed for fishery catch data (change L0 from May)
Model G	Model E + lognormal likelihoods assumed for fishery catch data (change L0 from May)

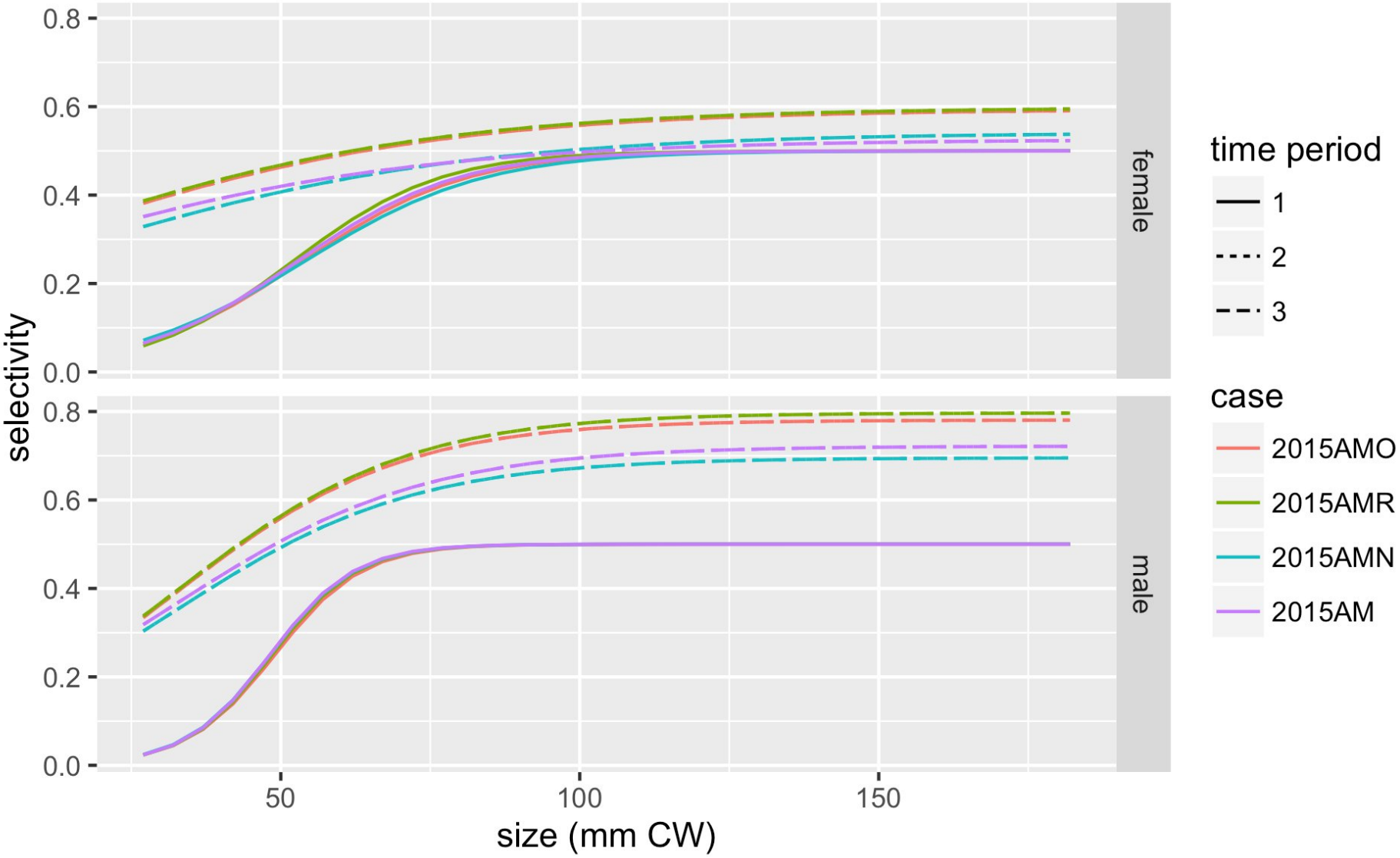
Summary Results

Model Scenario	Final Year	Data	# params	# of jitter runs	Objective Function		invertible hessian?	Mean Recruitment		MMB (1000's t)		
					value	max gradient		1982+	2000+	1982+	last 3 years	final year
2015AMO	2015	old cv's	307	--	2049.07	0.0000875	yes	179.4	164.9	36.5	59.6	71.6
2015AMR	2015	old cv's	307	200	2048.68	0.0002388	yes	176.8	163.9	35.8	57.7	69.3
2015AMN	2015	new cv's	307	200	1838.14	0.0003343	yes	193.4	188.1	42.7	68.7	83.3
2015AM	2016	new cv's	312	200	1952.73	0.0002182	yes	183.5	174.1	41.8	71.3	74.3
Model A	2016	new cv's	341	200	2338.77	1.5256000	yes	--	--	--	--	--
Model B	2016	new cv's	341	200	2406.67	0.0002237	yes	182.2	171.4	39.7	70.2	73.9
Model C	2016	new cv's	341	200	2406.75	0.0004336	yes	182.3	171.5	40.7	70.2	73.9
Model D	2016	new cv's	343	200	2391.11	0.0004838	yes	168.8	165.2	37.9	63.7	67.2
Model E	2016	new cv's	343	200	2286.11	0.0000145	yes	174.2	176.0	40.1	68.3	72.4
Model F	2016	new cv's	343	200	2997.88	0.0003812	yes	163.6	160.8	37.6	61.8	63.3
Model G	2016	new cv's	343	200	2672.99	0.0000301	yes	172.7	175.6	40.5	68.8	70.9

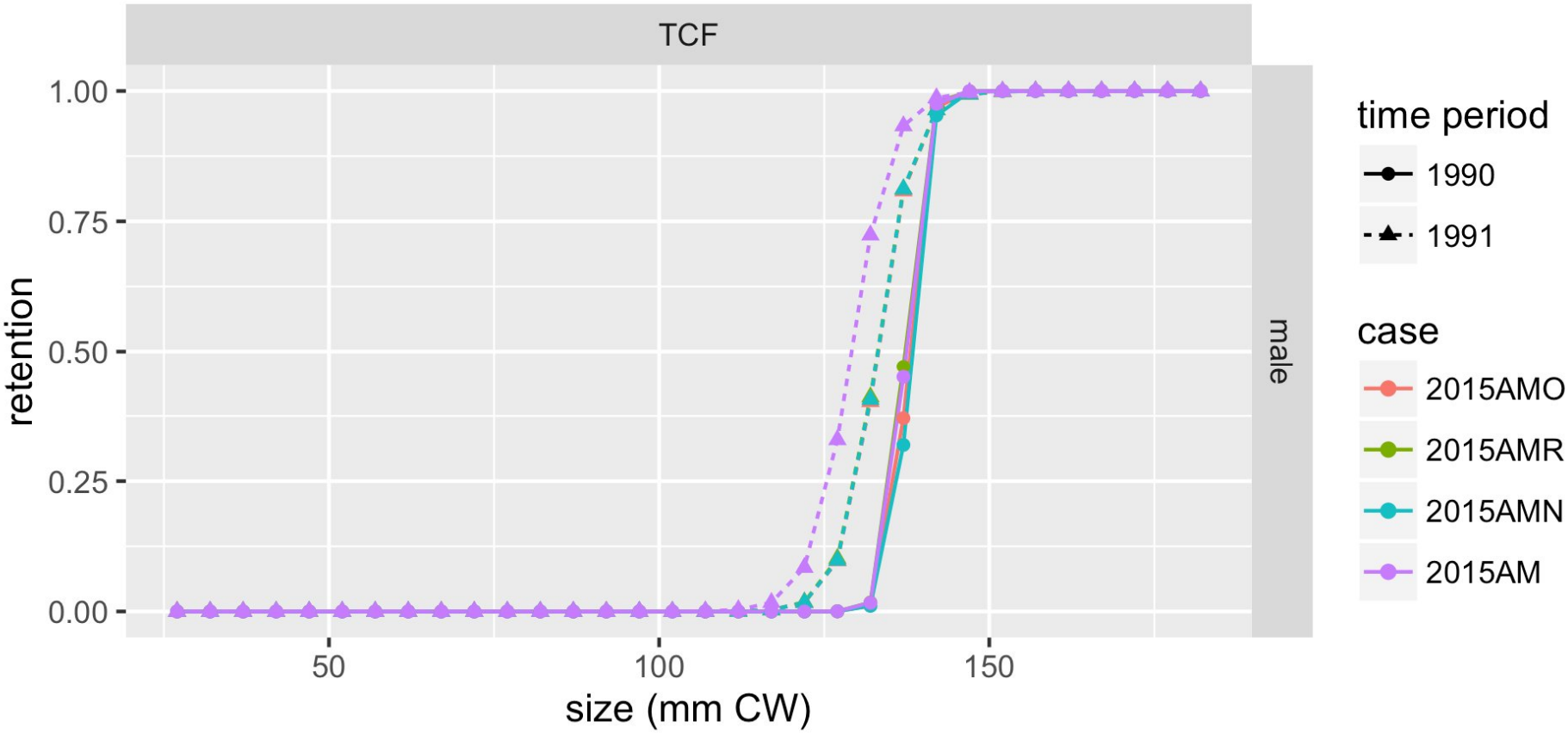
Model Results: New CVs vs Old CVs

- AMO: original 2015 assessment model
- AMR: 2015 AM re-run 200 times with jittered initial parameters
- AMN: 2015 AM w/ new CVs (200 runs)
- AM: 2015 AM with 2016 data (new CVs, 200 runs)

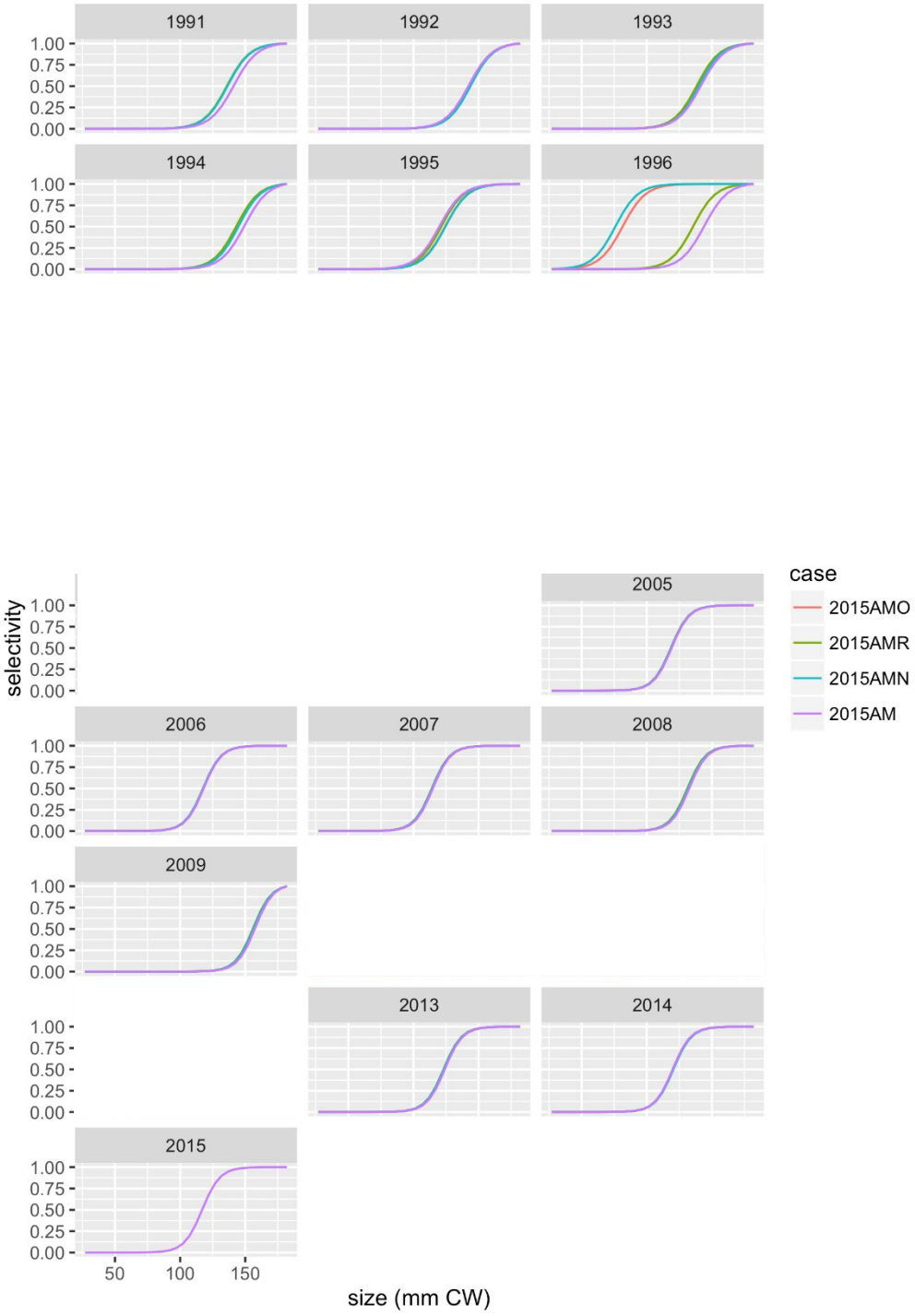
New CVs vs Old CVs: Survey Selectivities



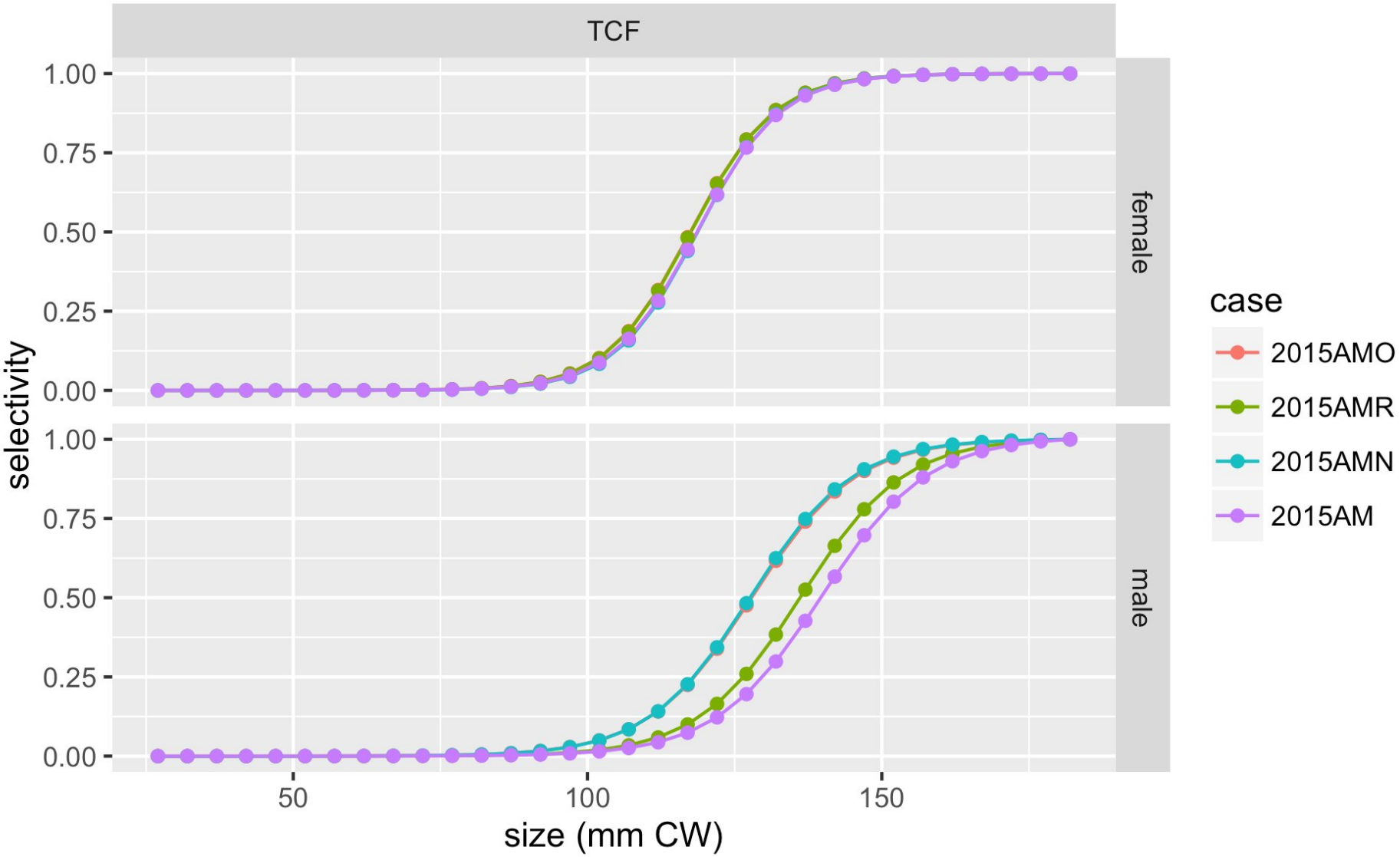
New CVs vs Old CVs: Directed Fishery Retention Functions



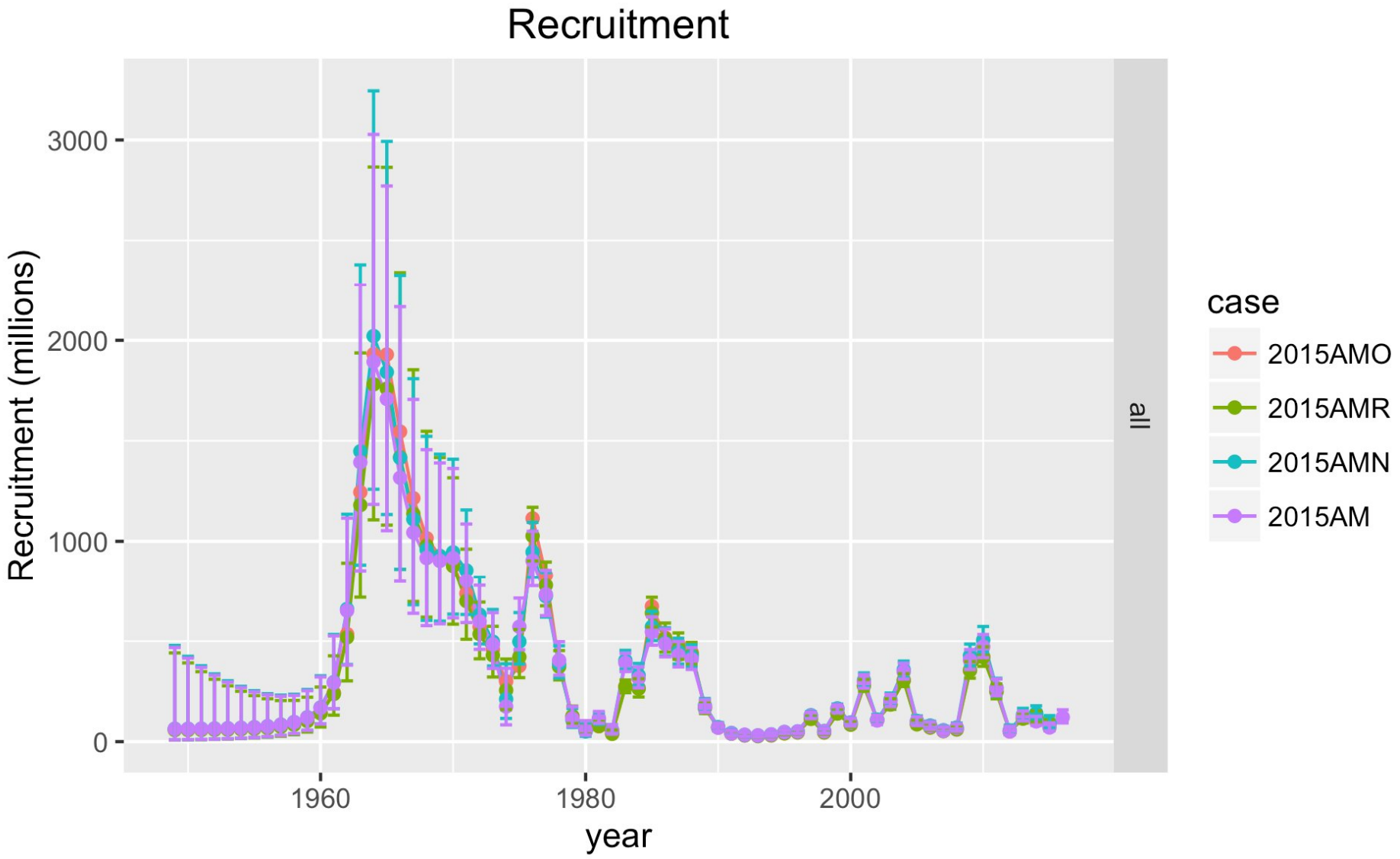
New CVs vs Old CVs: Directed Fishery Selectivity Functions



New CVs vs Old CVs: Directed Fishery Selectivity Functions

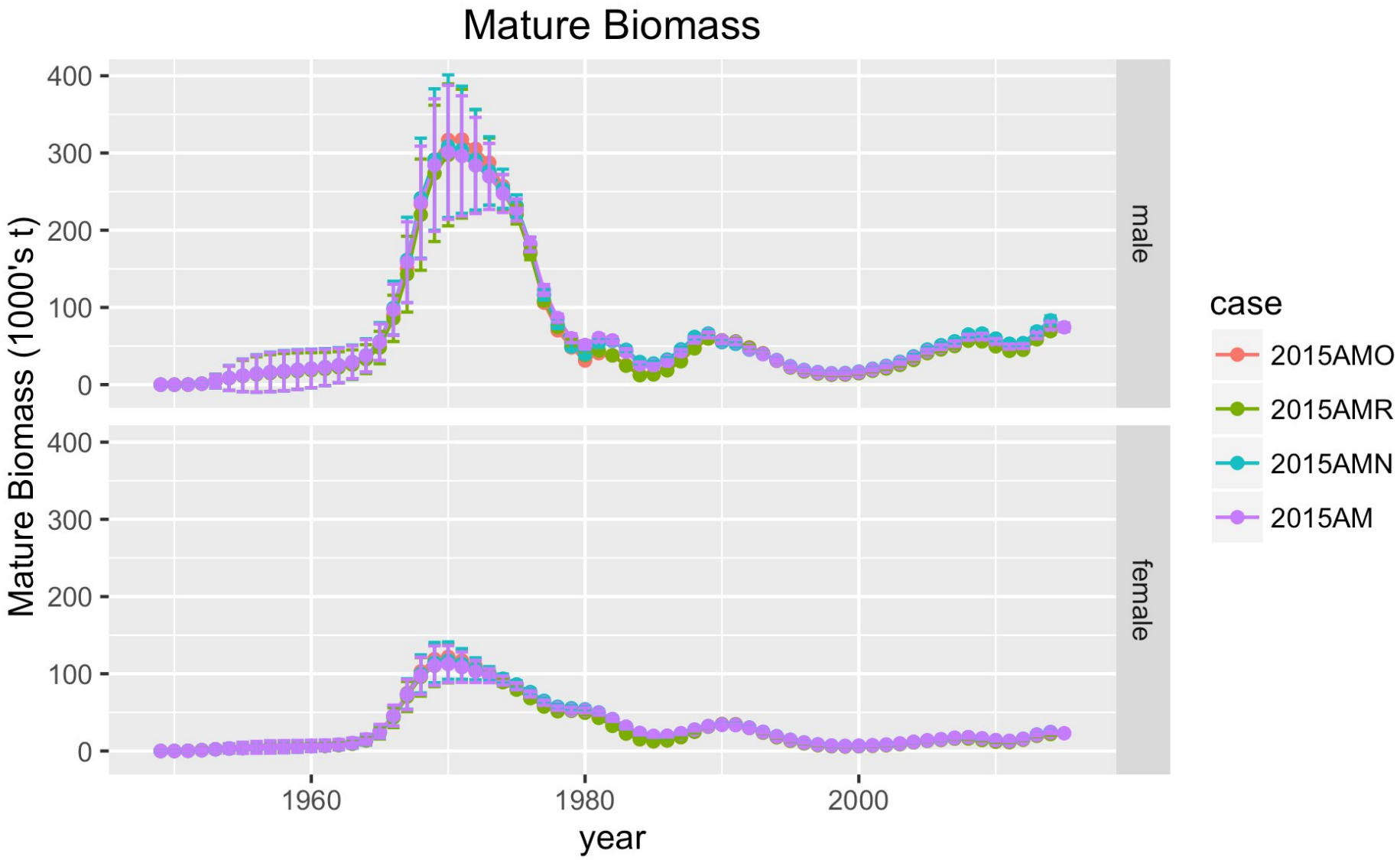


New CVs vs Old CVs: Recruitment

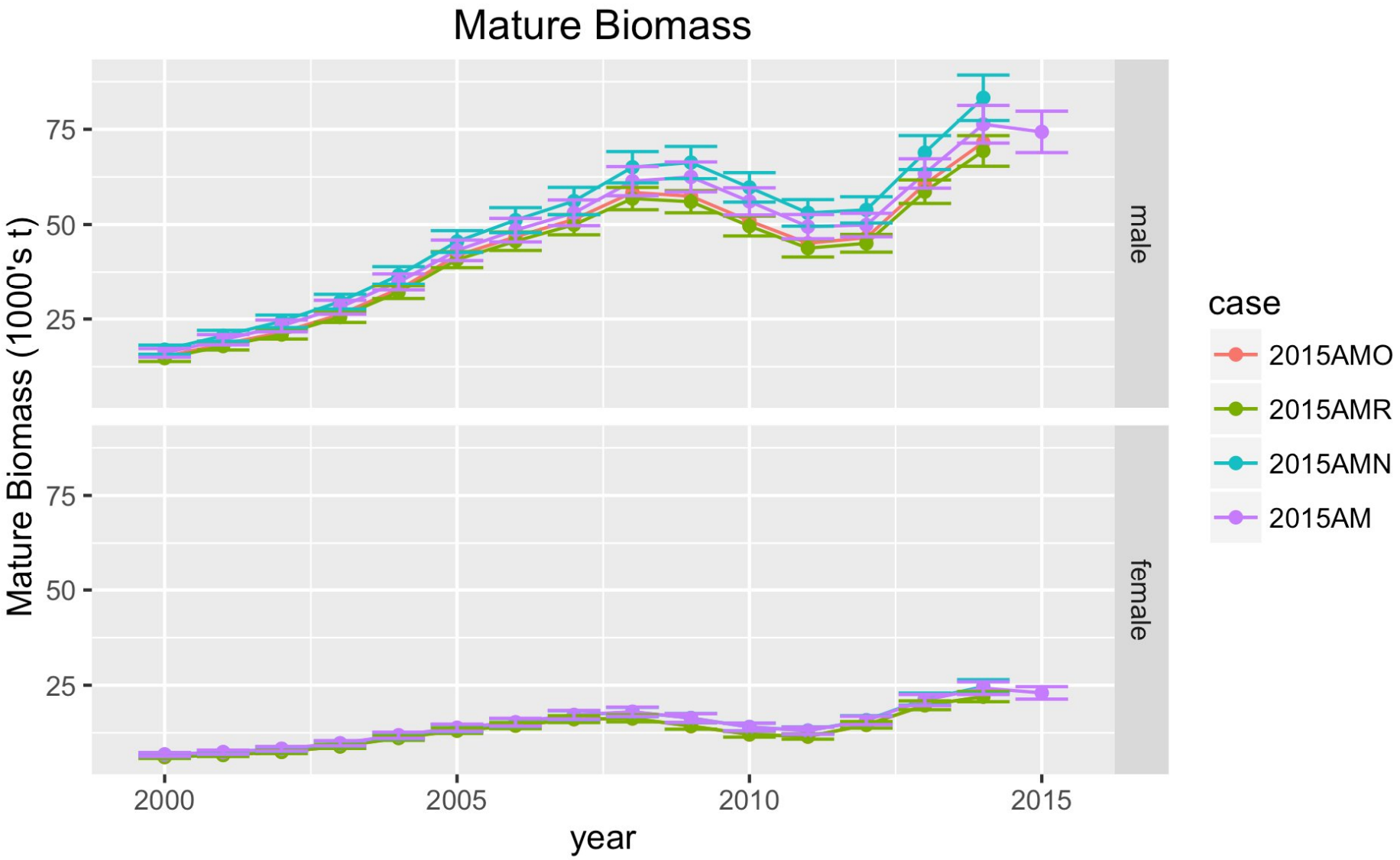


New CVs vs Old CVs: Recruitment

New CVs vs Old CVs: MMB



New CVs vs Old CVs: MMB

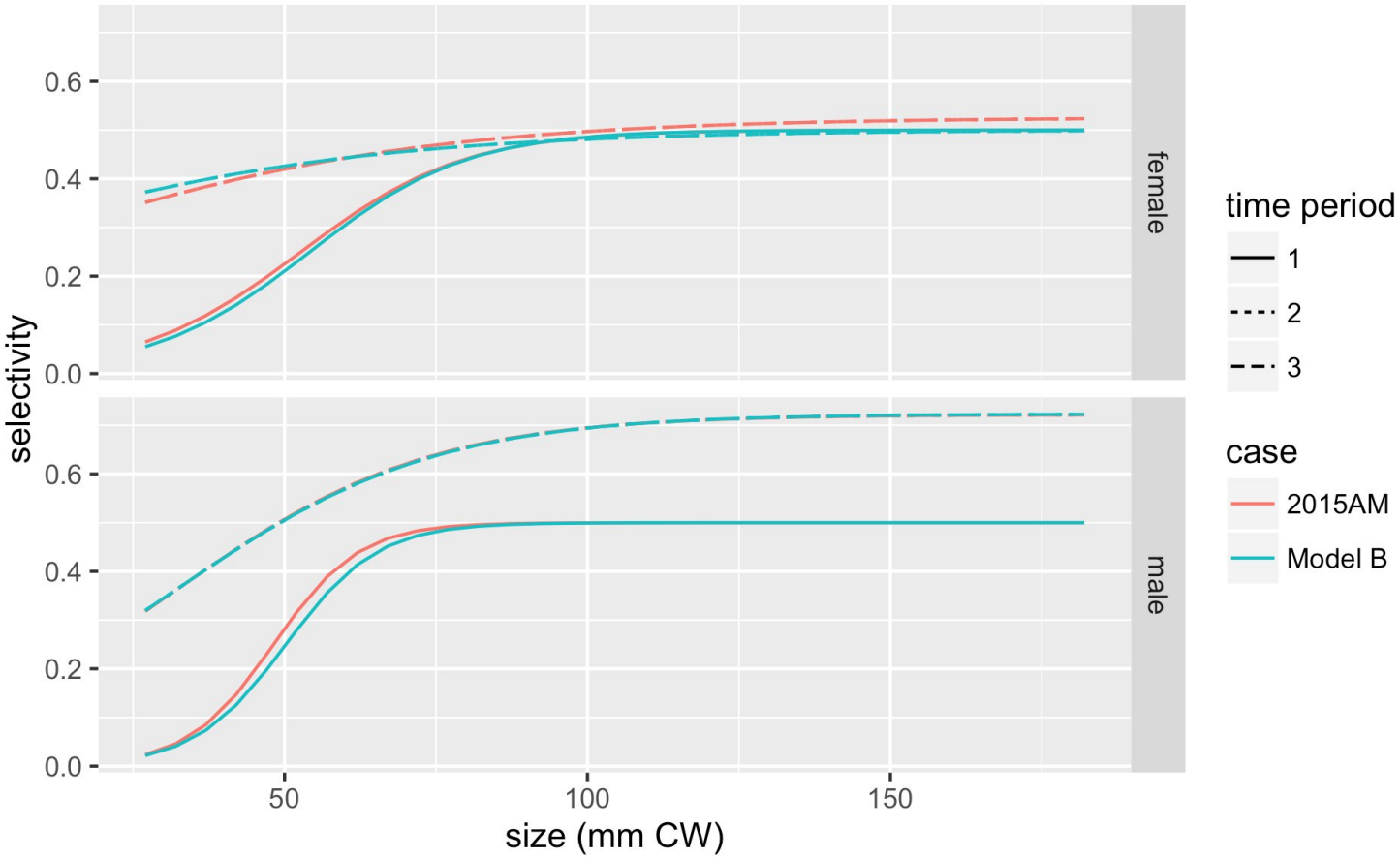


Model Results: 2015AM To 2016 Base Model (Model B)

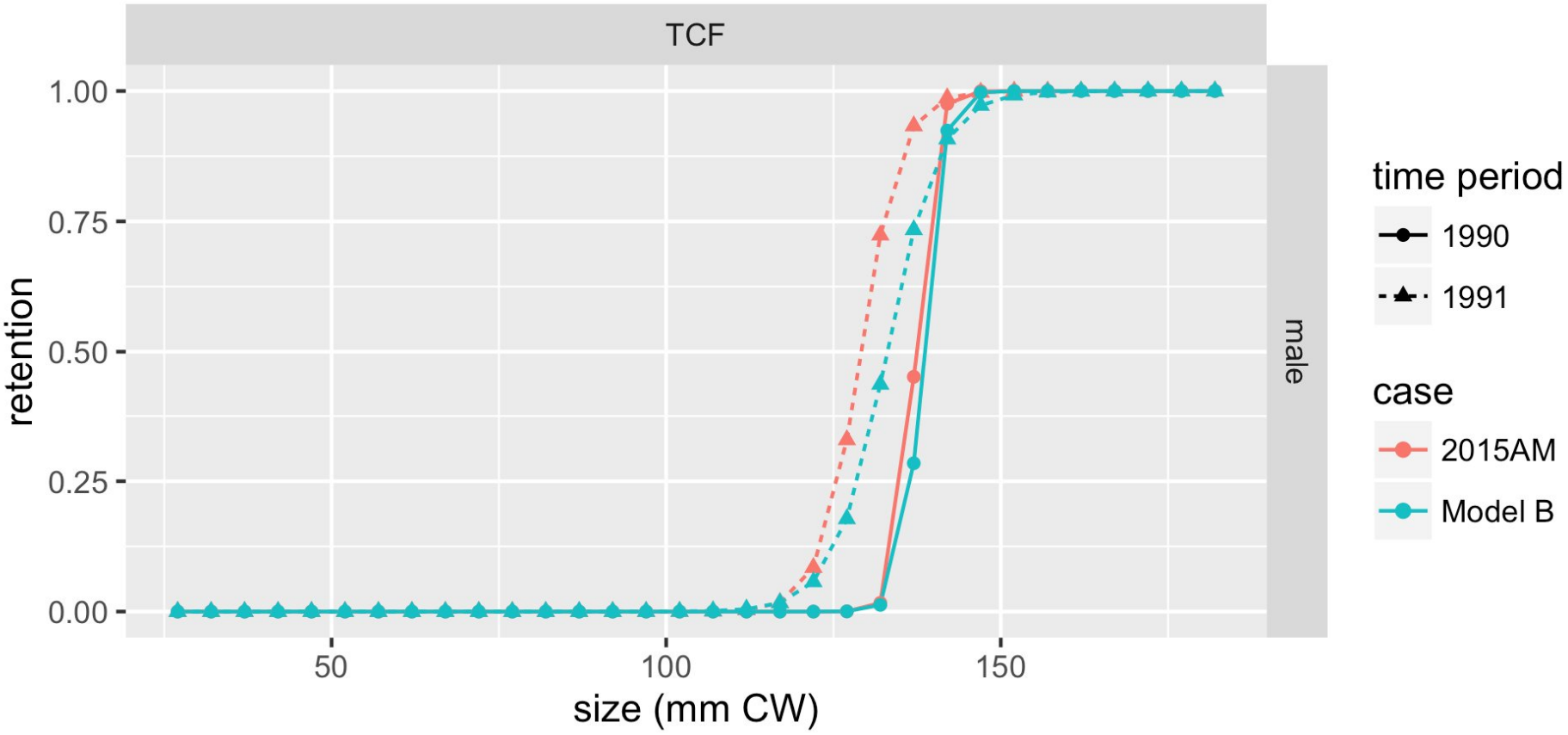
Model B

Change	Description
A	start "current" recruitment estimation in 1975, instead of 1974
B	normalize groundfish fishery size comps using original sample sizes, not input sample sizes
C	estimate log-scale fishing mortality/capture rate offsets for female crab
E	turn on fishing mortality/capture rate estimation for BBRKC
G	estimate probability of molt-to-maturity using logit-scale parameterization
I	enforce logistic selectivity = 1 in largest size bin
J	use GMACS fishing mortality model

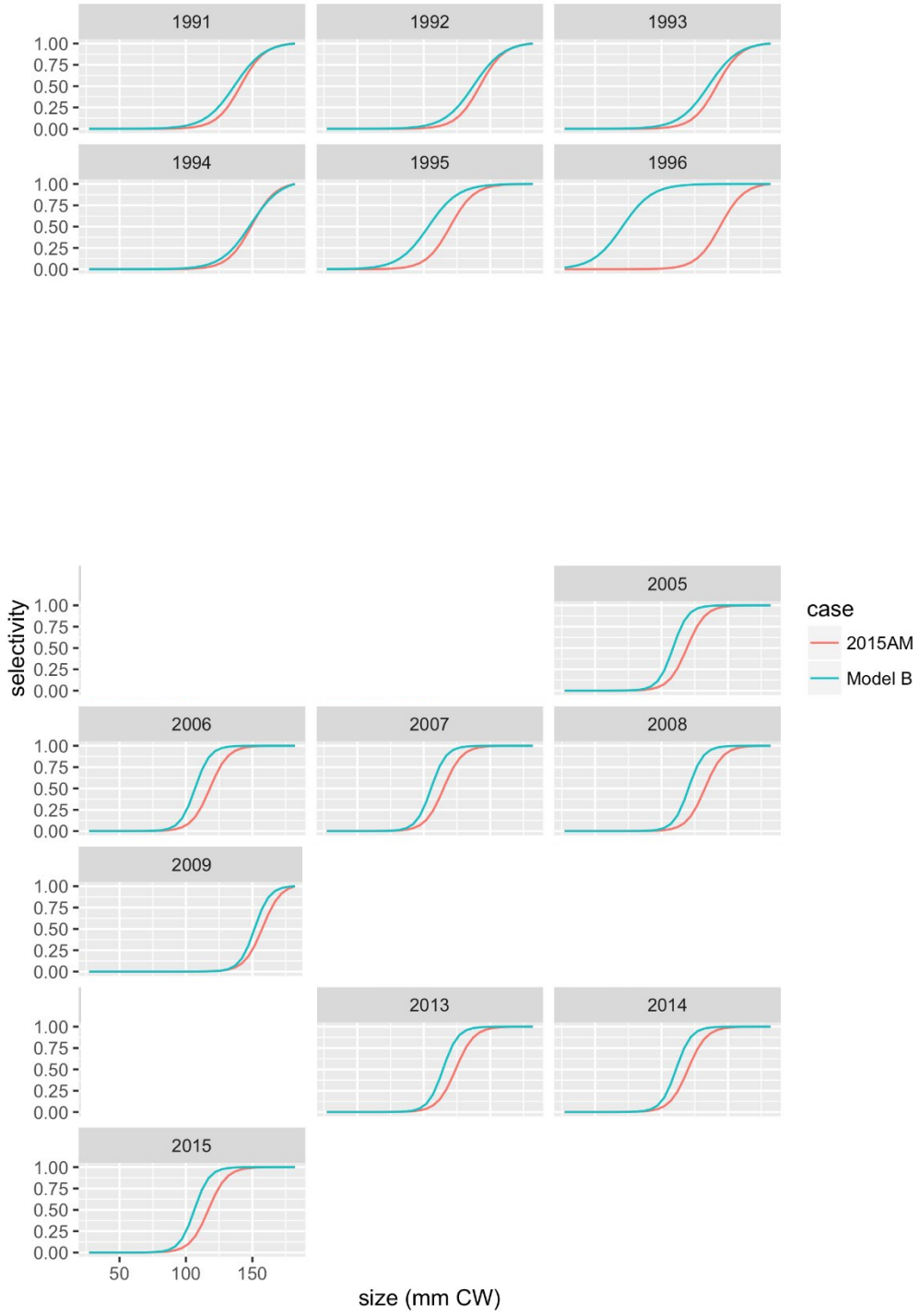
2015AM To Model B: Survey Selectivity



2015AM To Model B: Directed Fishery Retention



2015AM To Model B: Directed Fishery Male Selectivity



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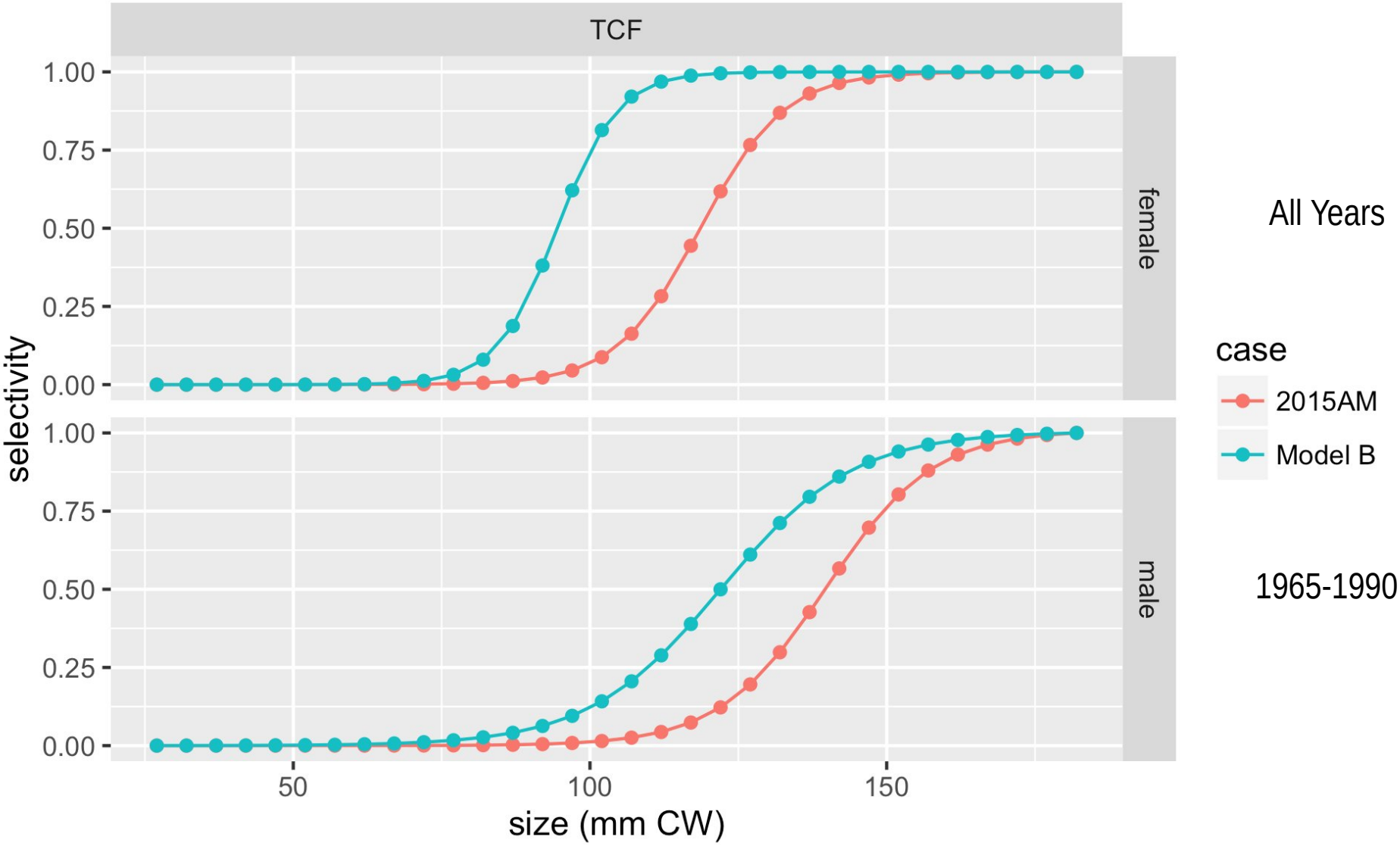
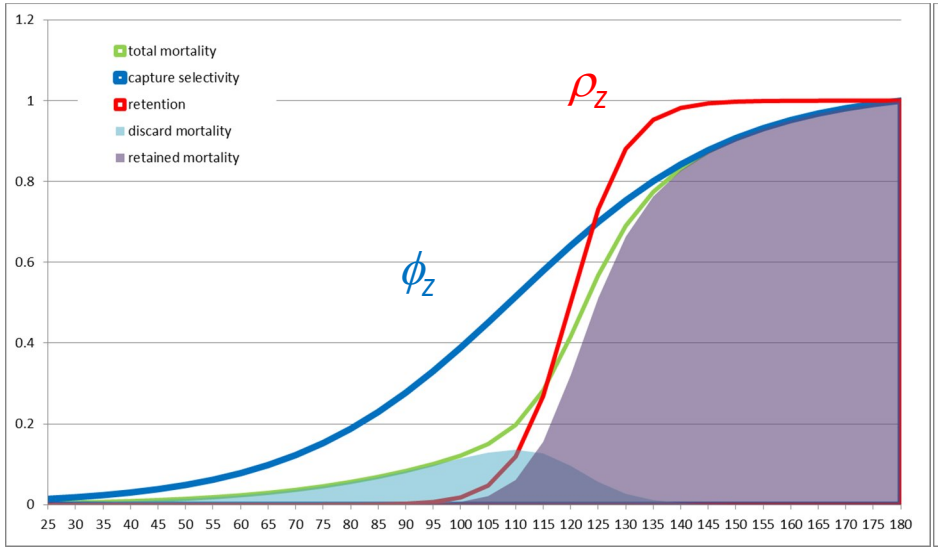
2015AM To Model B: Directed Fishery Selectivity



Gmacs vs. TCSAM2013 Fishing Mortality & “Selectivity”

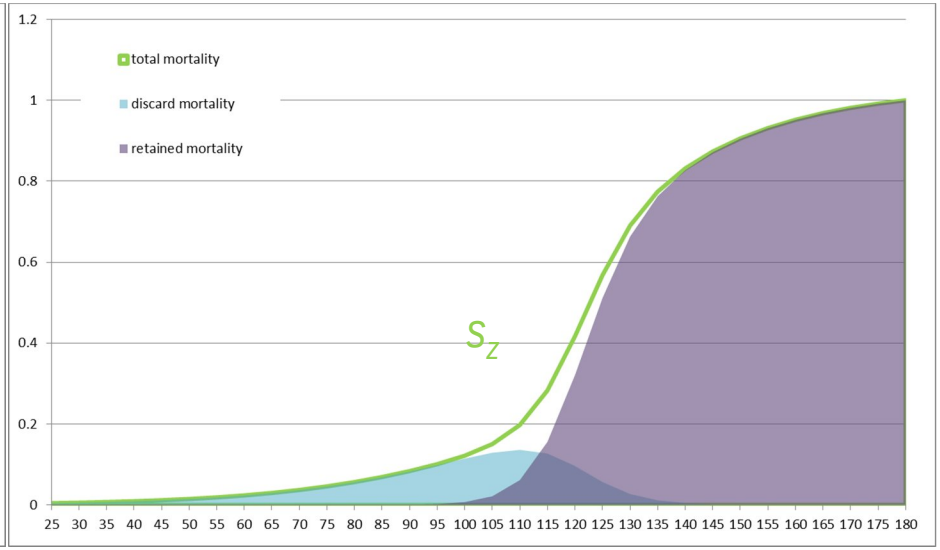
Gmacs

$$F_z = [h_m \cdot (1 - \rho_z) + \rho_z] \cdot \phi_z \cdot \kappa$$

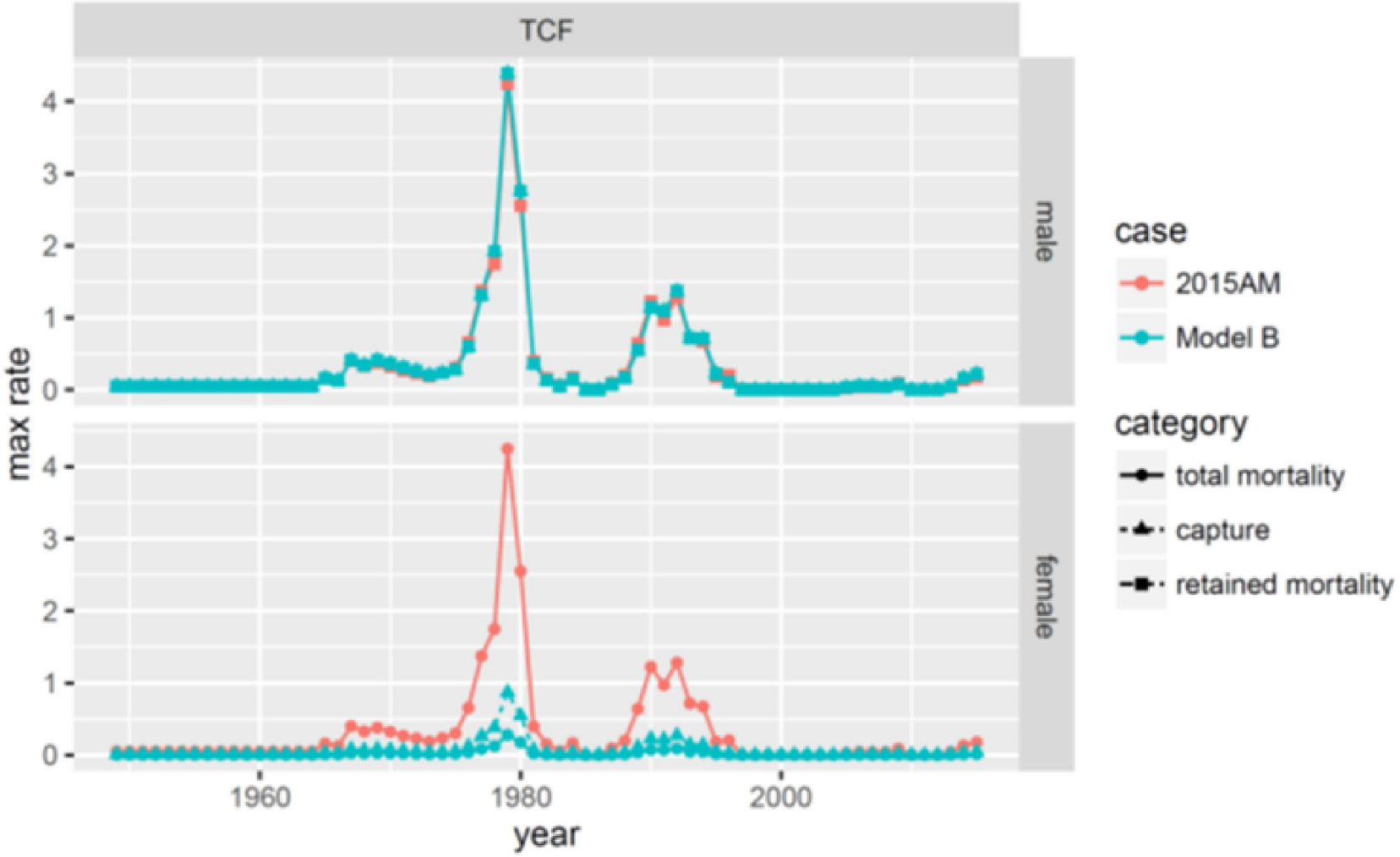


TCSAM2013

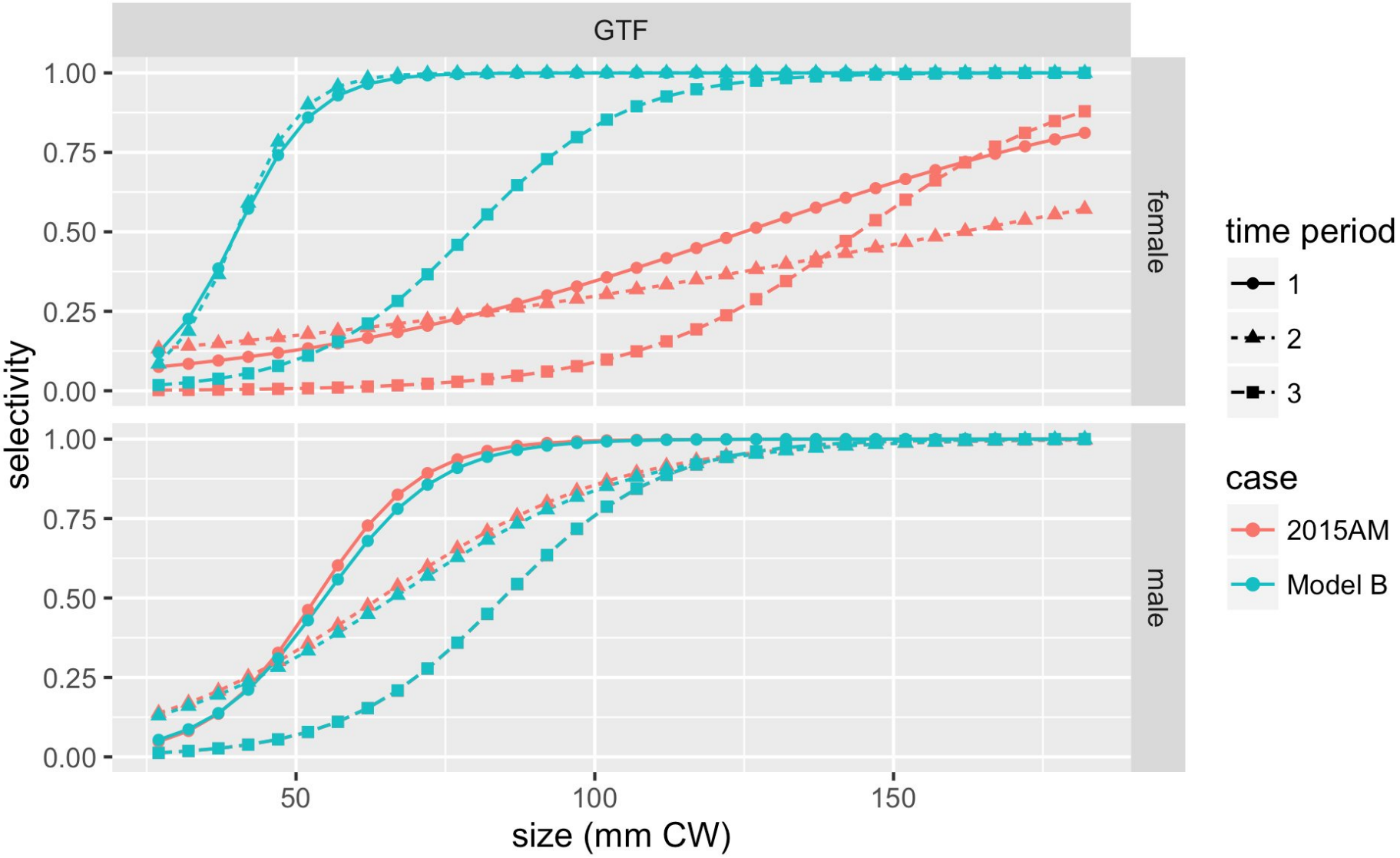
$$F_z = s_z \cdot F$$



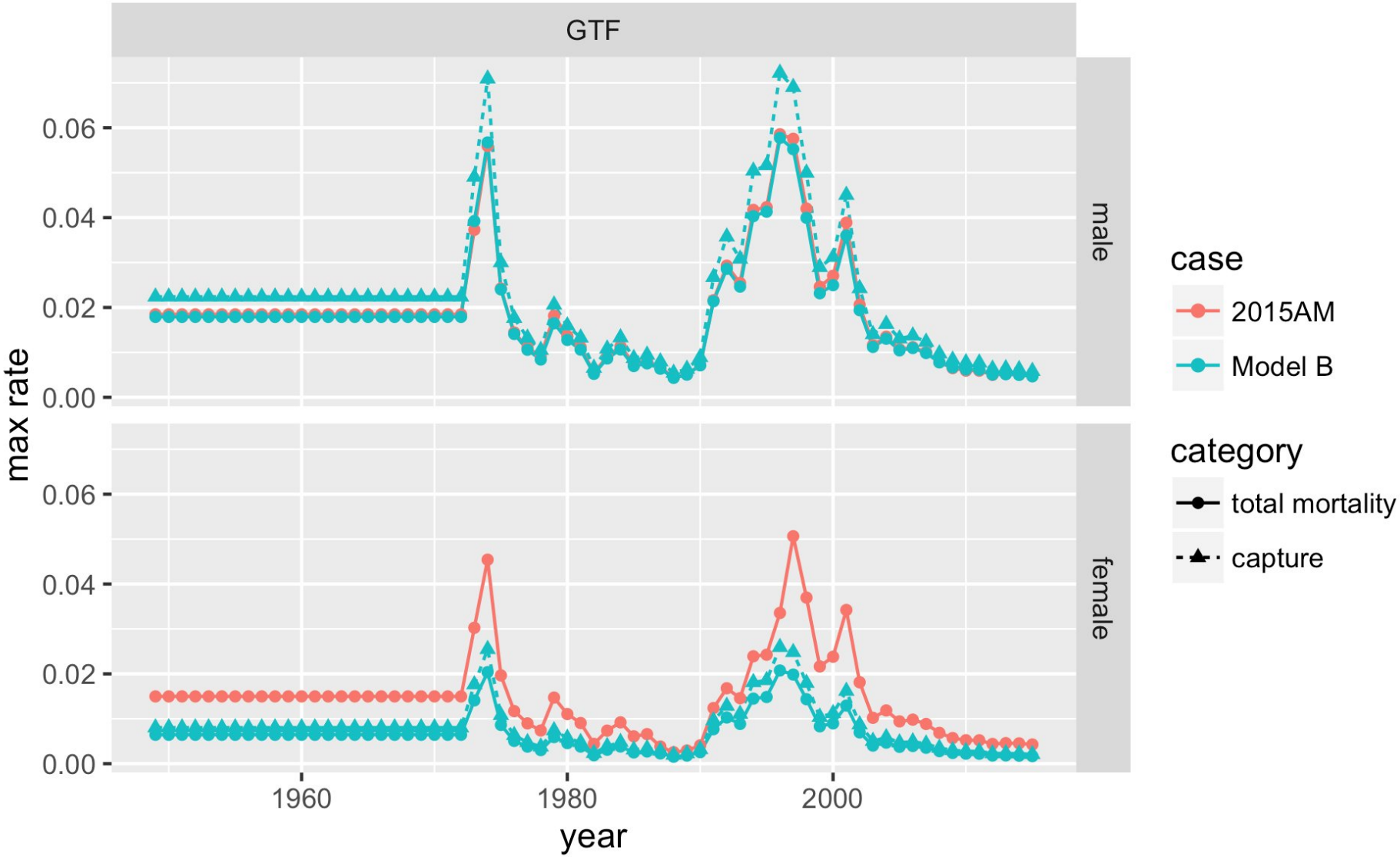
2015AM To Model B: Directed Fishery Fully-selected Rates



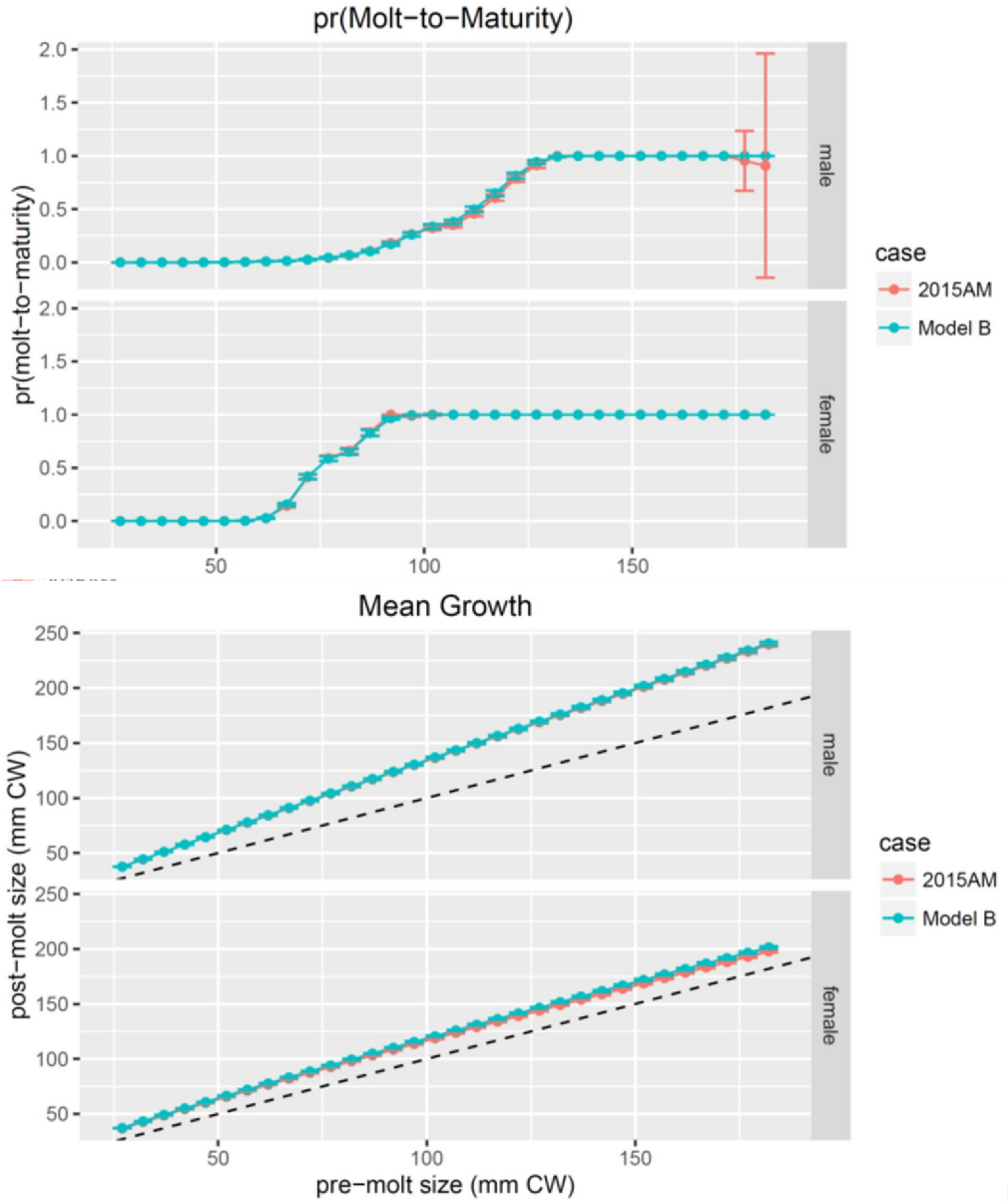
2015AM To Model B: Groundfish Fisheries Bycatch Selectivity



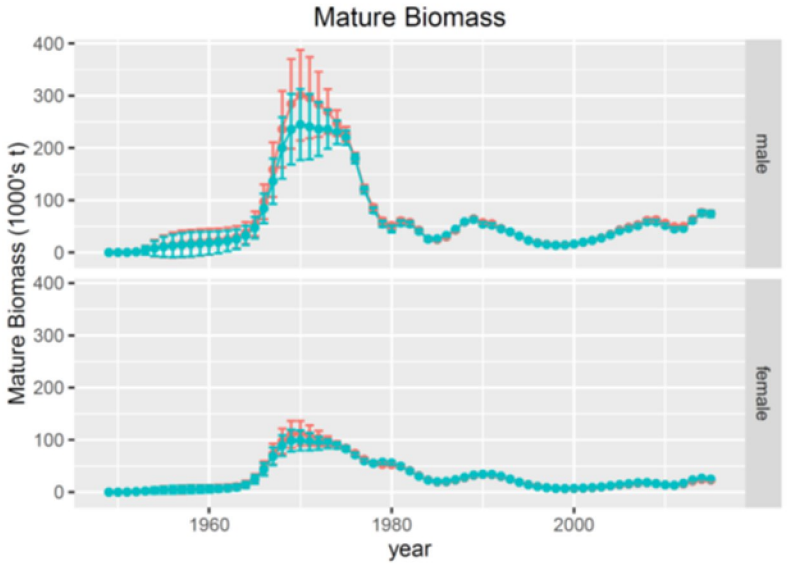
2015AM To Model B: Groundfish Fisheries Bycatch Rates

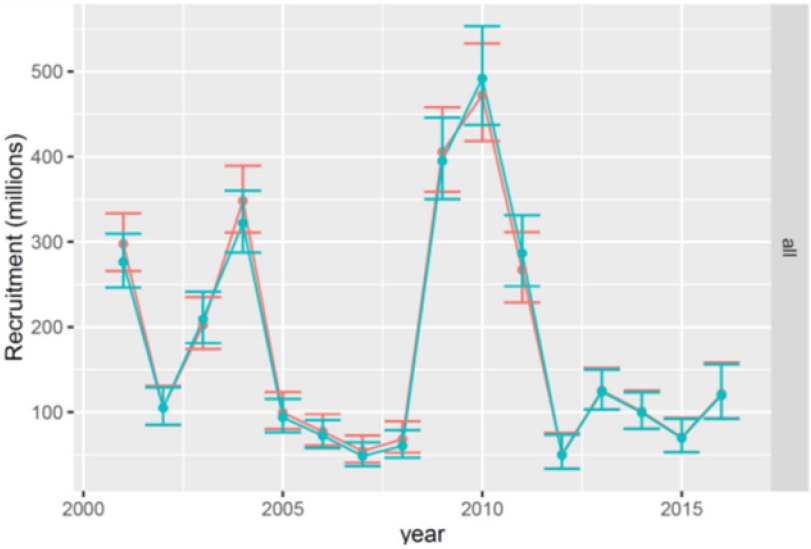


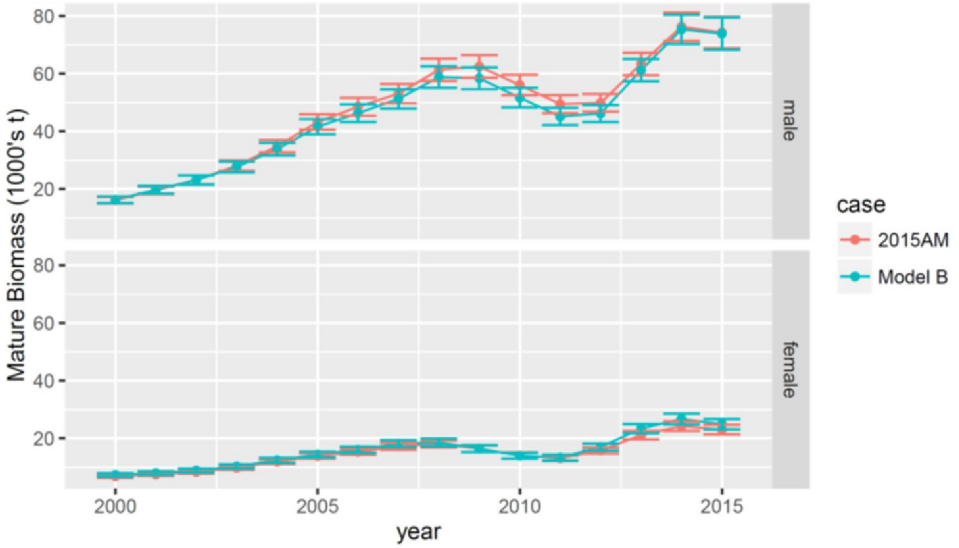
2015AM To Model B: Population Processes



2015AM To Model B: Population Quantities

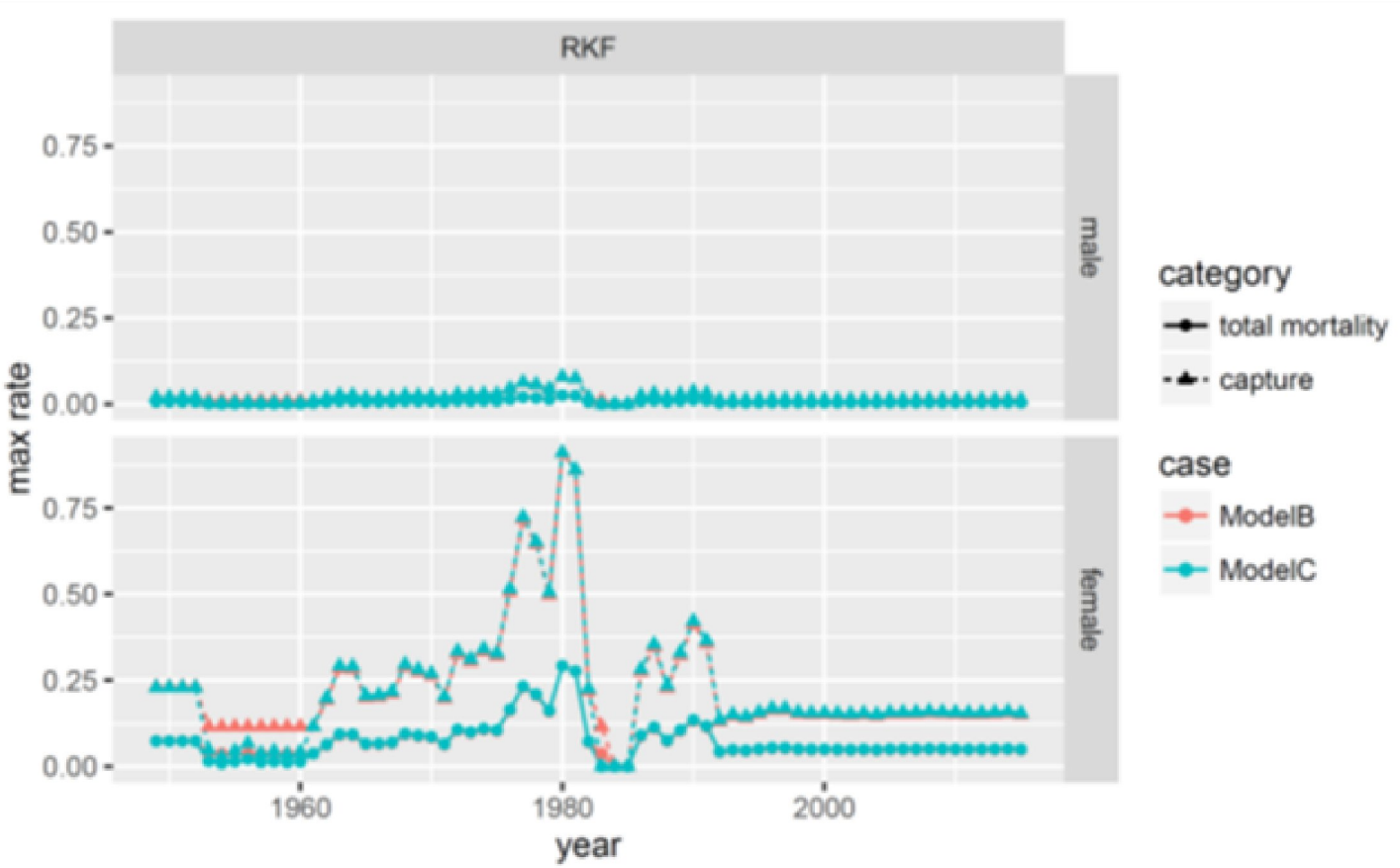






Model Results: Model B vs. Model C

- Model C = Model B + no min F's for BBRKC bycatch rates



- Otherwise, results for Model C practically identical to Model B

Model Results: Model C vs. Models D, E, F, G

Scenario	Description
Model C	Model B + no minimum F's imposed on BBRKC fishery bycatch
Model D	Model C + effort extrapolation parameters estimated
Model E	Model D + penalty on F-devs reduced to 0 in final estimation phase
Model F	Model D + lognormal likelihoods assumed for fishery catch data (change L0 from May)
Model G	Model E + lognormal likelihoods assumed for fishery catch data (change L0 from May)

Effort extrapolation: F = q E

Model C (and previous)

$$q = \frac{\sum_{?} E_{?}}{\sum_{?} F_{?}} \qquad y > 1991$$

$$F_{?} = q \cdot E_{?} \qquad y < 1992$$

Model D (and subsequent)

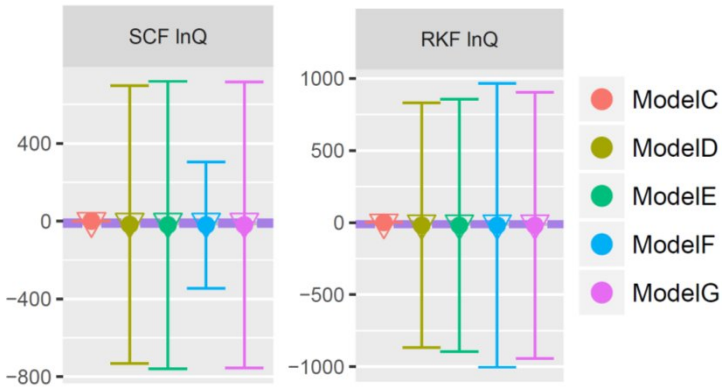
lnQ is an estimated *parameter* based on minimizing the objective function

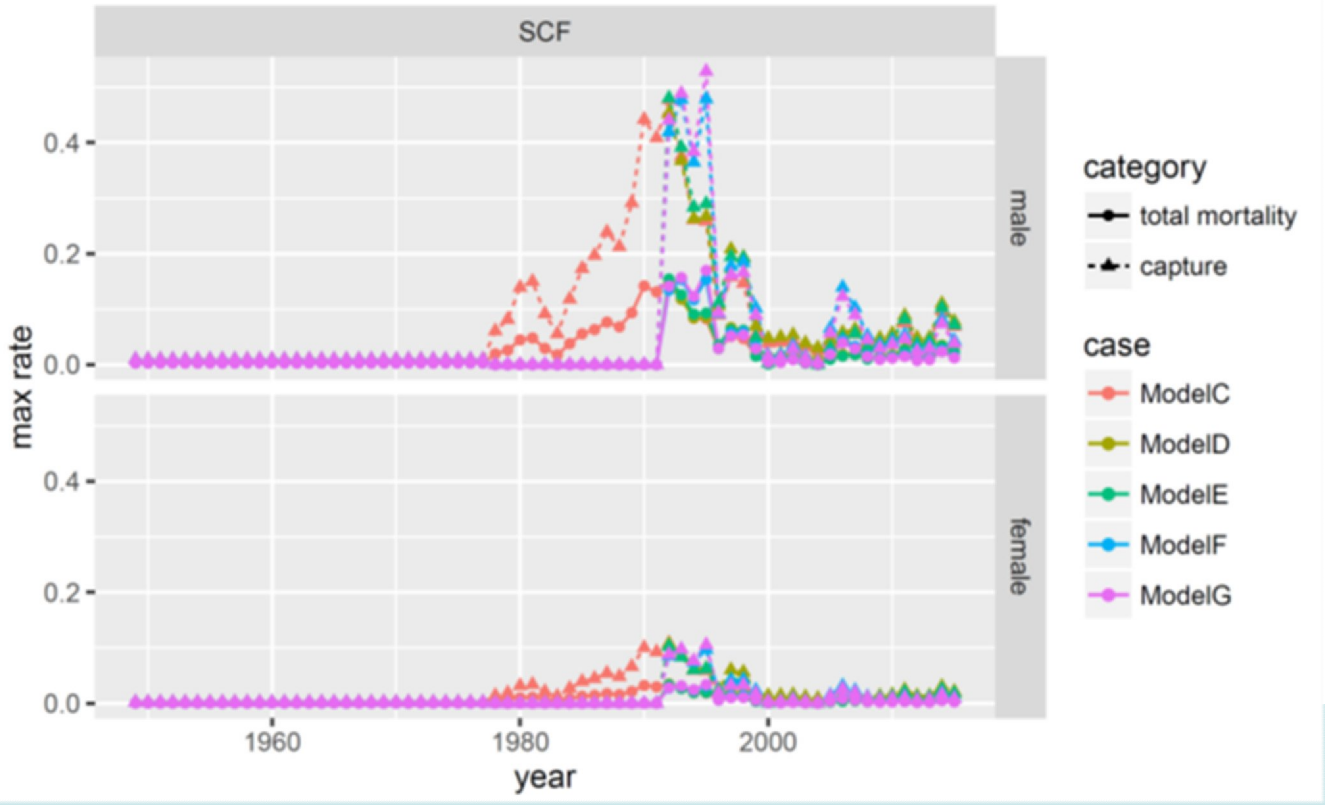
$$F_{?} = e^{??\,?} \cdot E_{?} \qquad y < 1992$$

Model Results: Model C vs. Models D, E, F, G

Estimated effort extrapolation (Fishery q's)

Fishery	Model C	Model D	Model E	Model F	Model G
BBRKC	0.01	9.61E-09	2.57E-09	4.23E-09	2.59E-09
snow crab	0.11	1.82E-08	2.44E-09	2.44E-09	2.47E-09





Model Comparisons: Summary & Author's Preferred Model

Summary

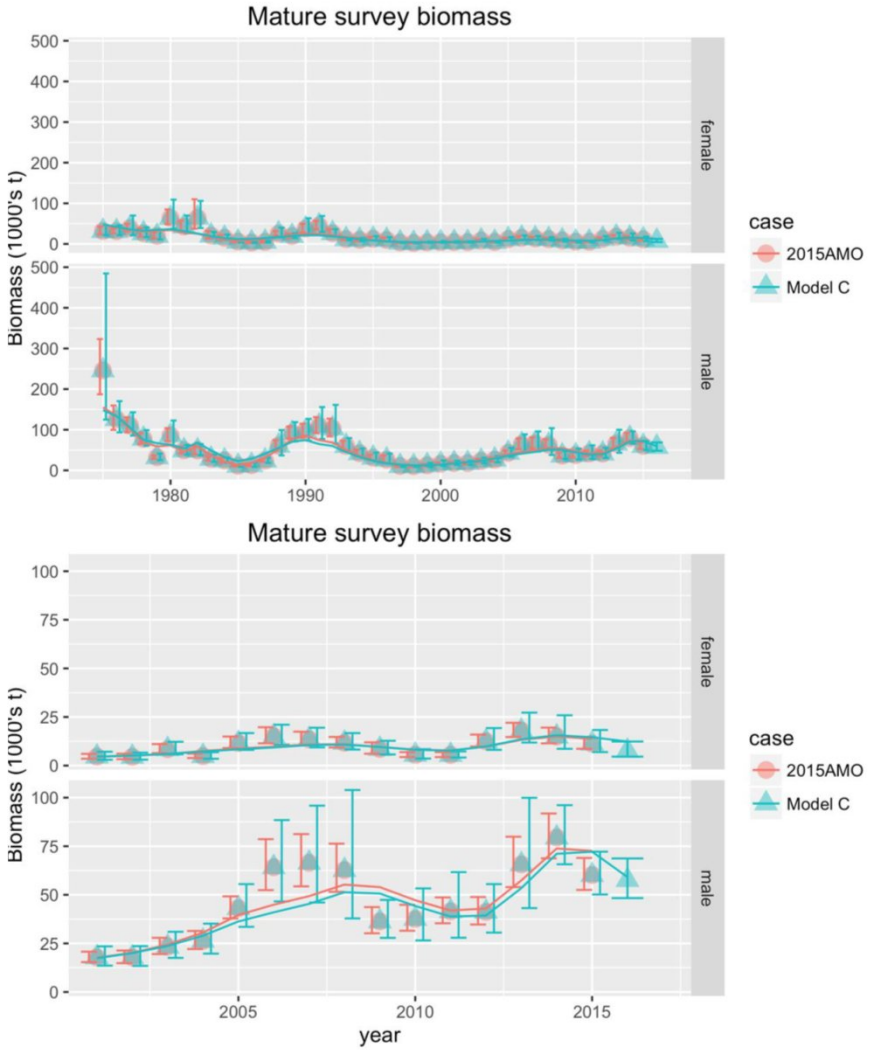
- Using new mature survey biomass CV's increased recruitment, MMB 10-15%
- Many model changes from 2015AM to Model B (Base Model), but almost no differences in population estimates (recruitment, MMB)
- Results from Models B and C almost identical
- Models D, E, F, G based on questionable effort extrapolation parameter values, unsure how this affects overall model performance. Needs further work.

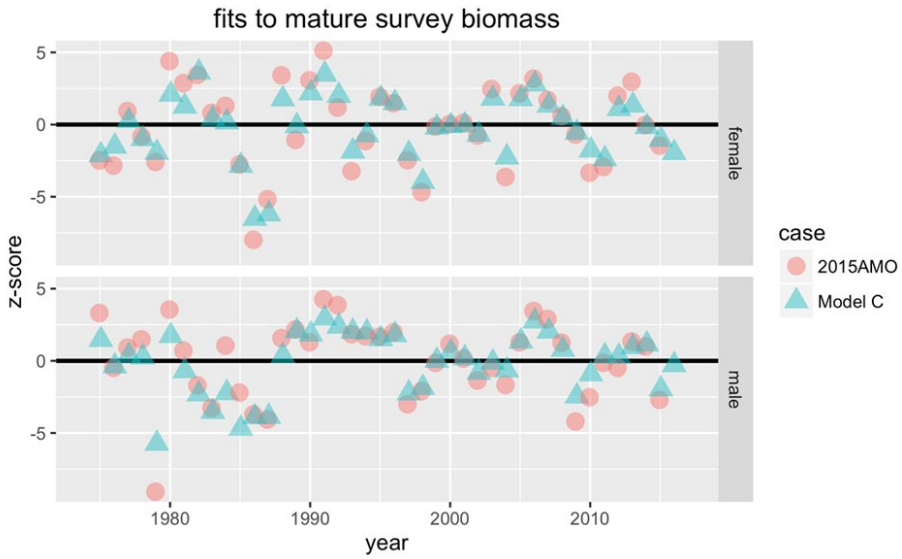
Author's preferred model

- Model C (CPT Base Model + min F constraints in BBRKC fishery removed)

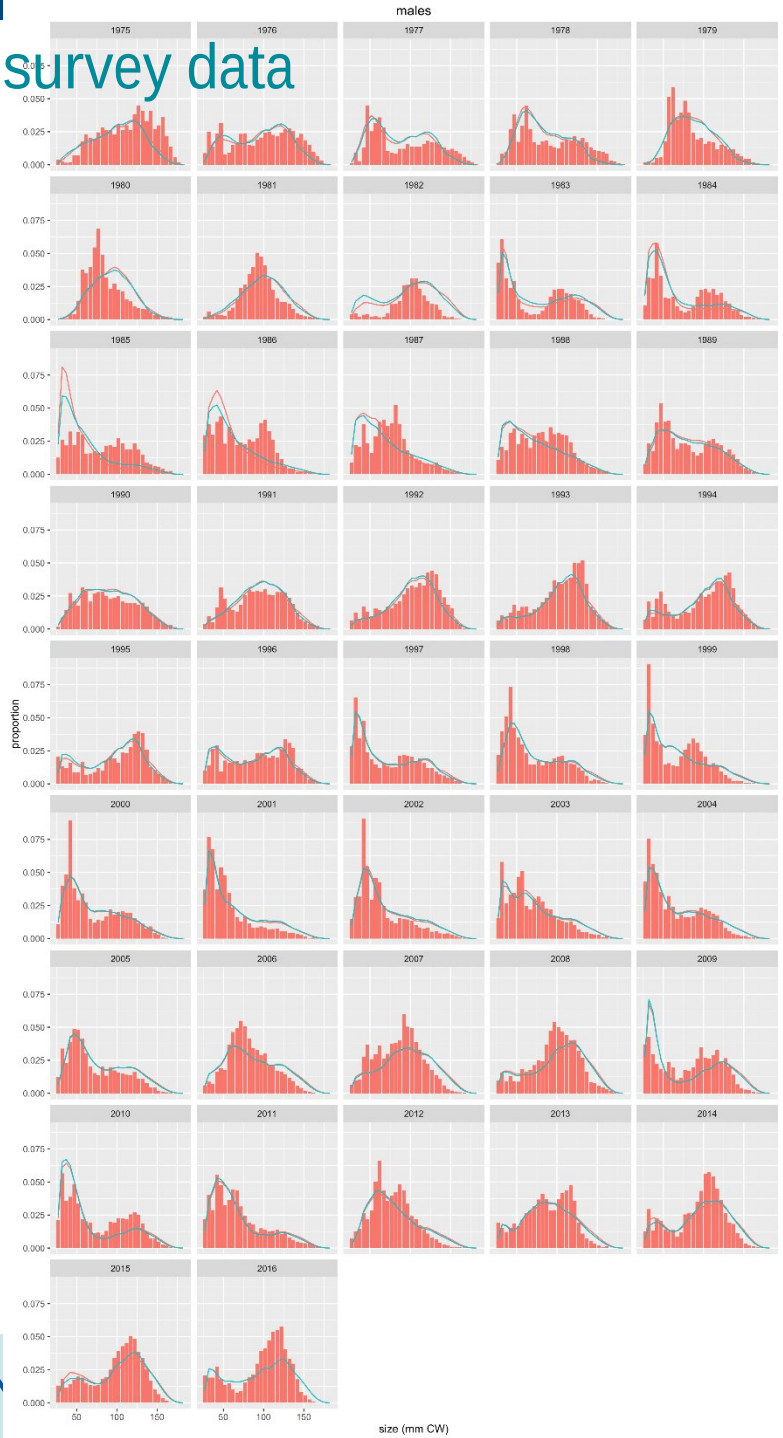
2015 Assessment Model vs. Model C (Preferred Model)

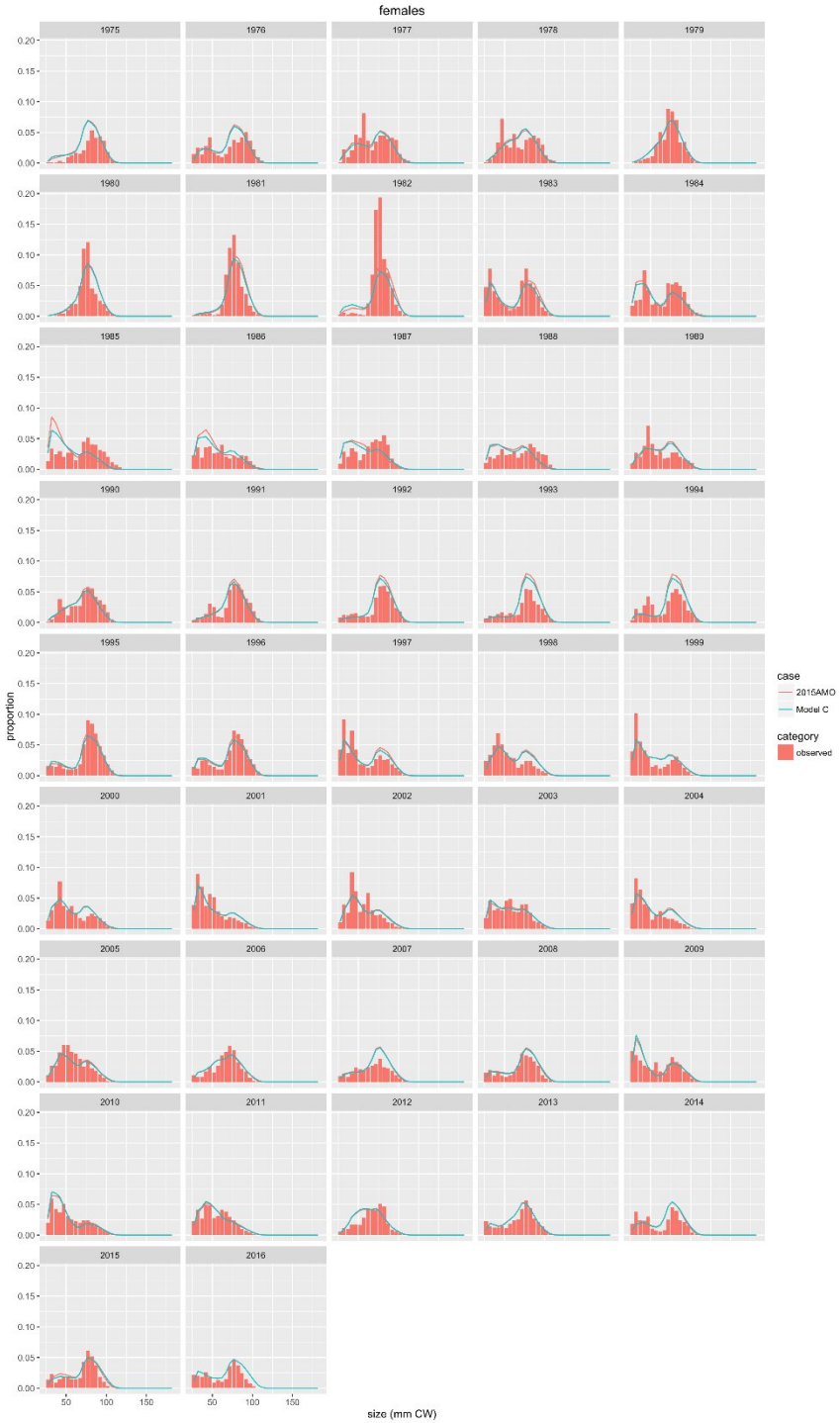
Fits to survey data



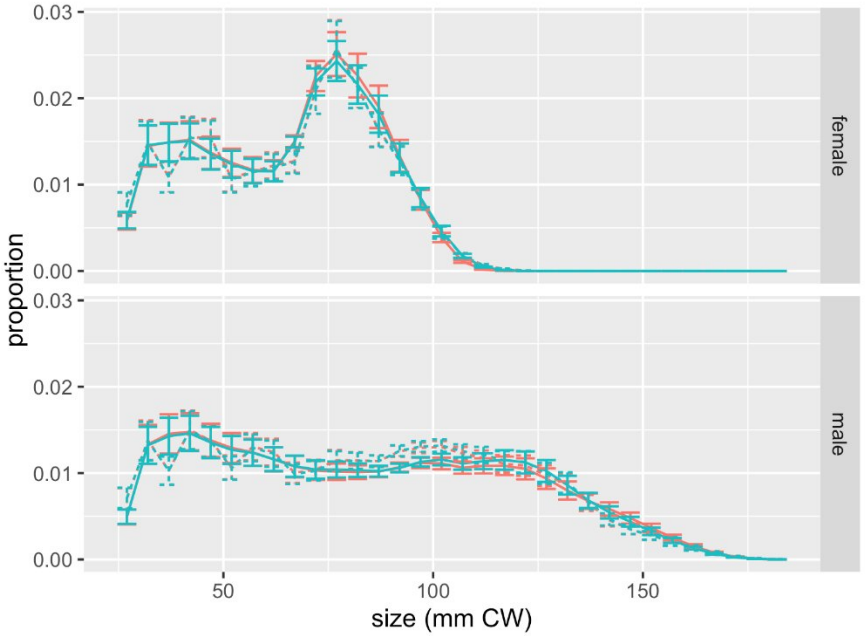


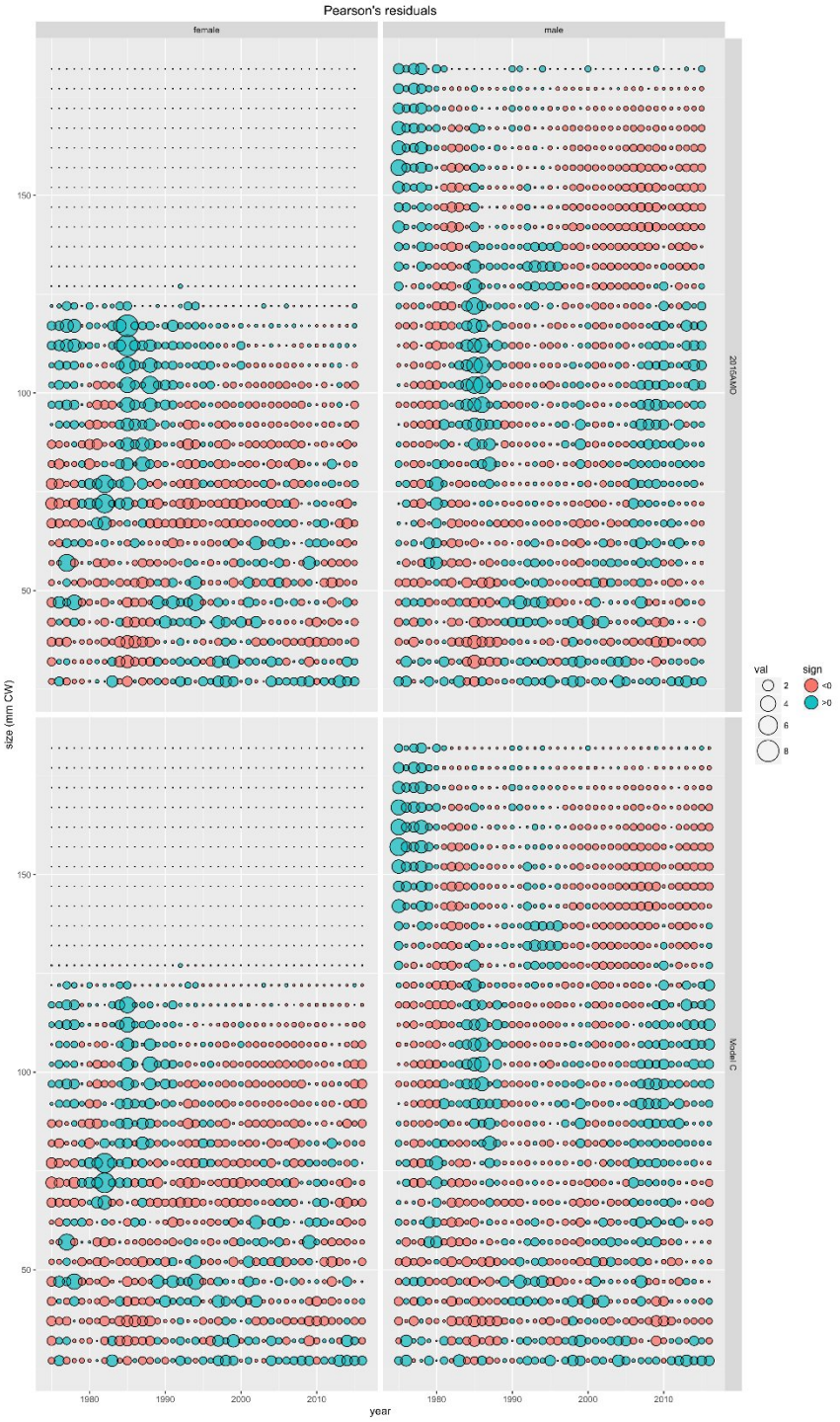
Fits to survey data





Fits to survey data





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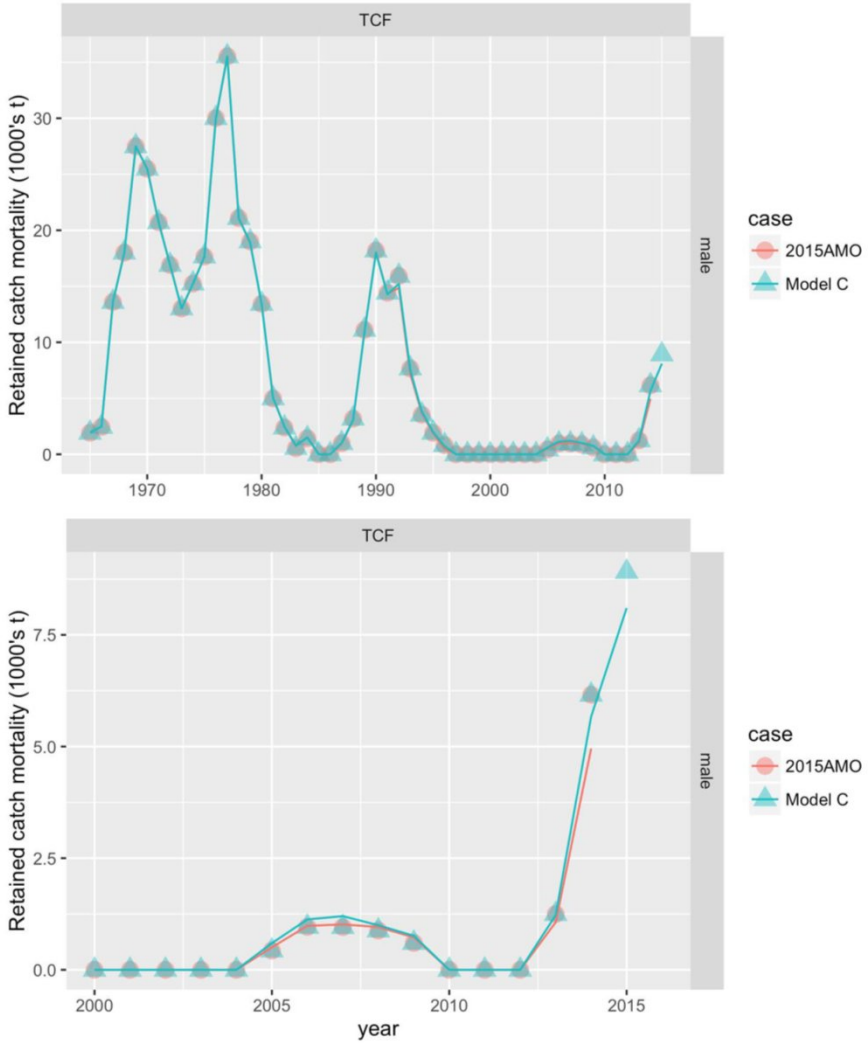
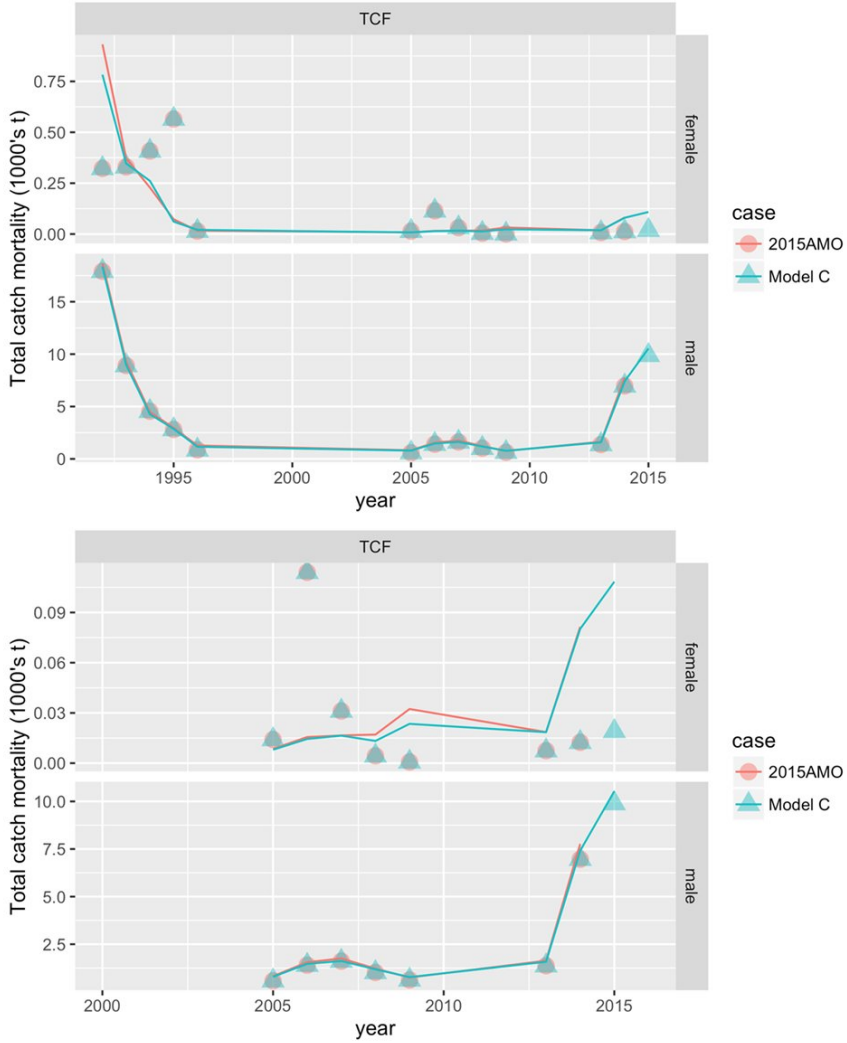
Fits to fishery data

Retained catch

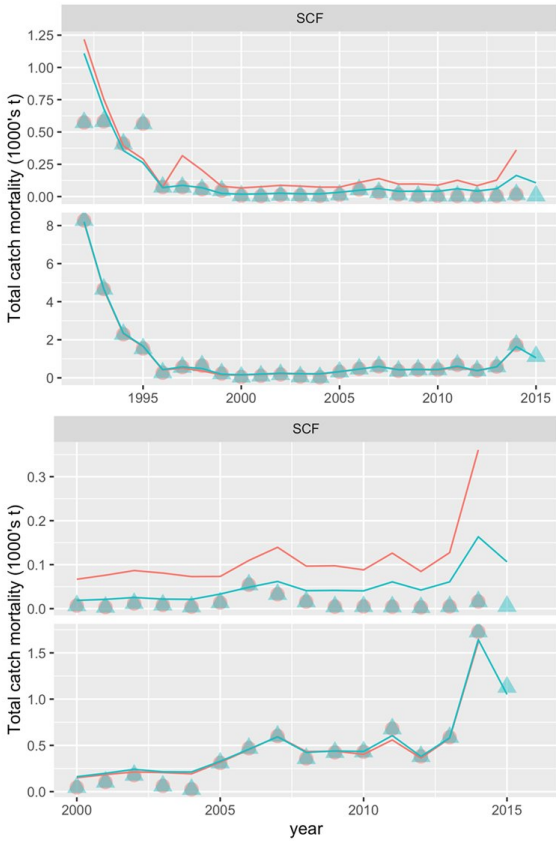


Total catch in directed fishery

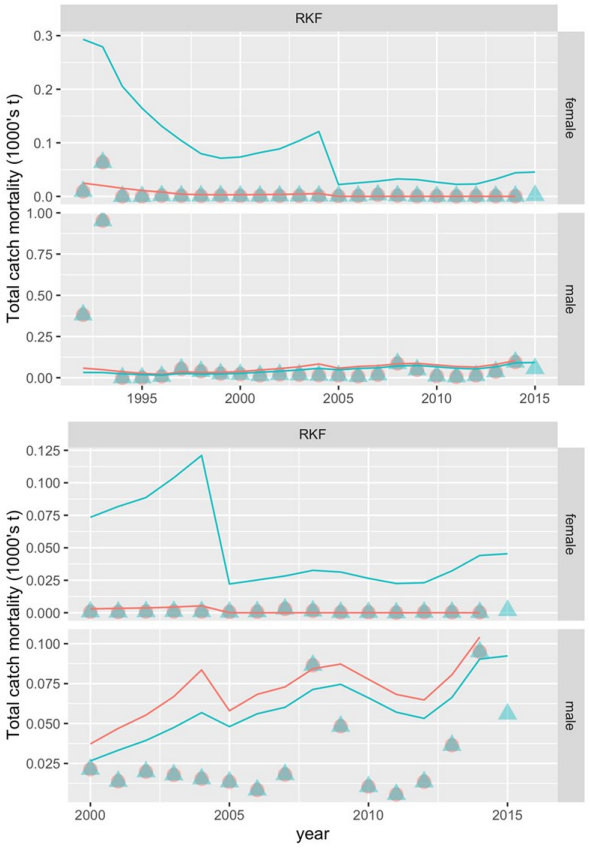


Fits to fishery data

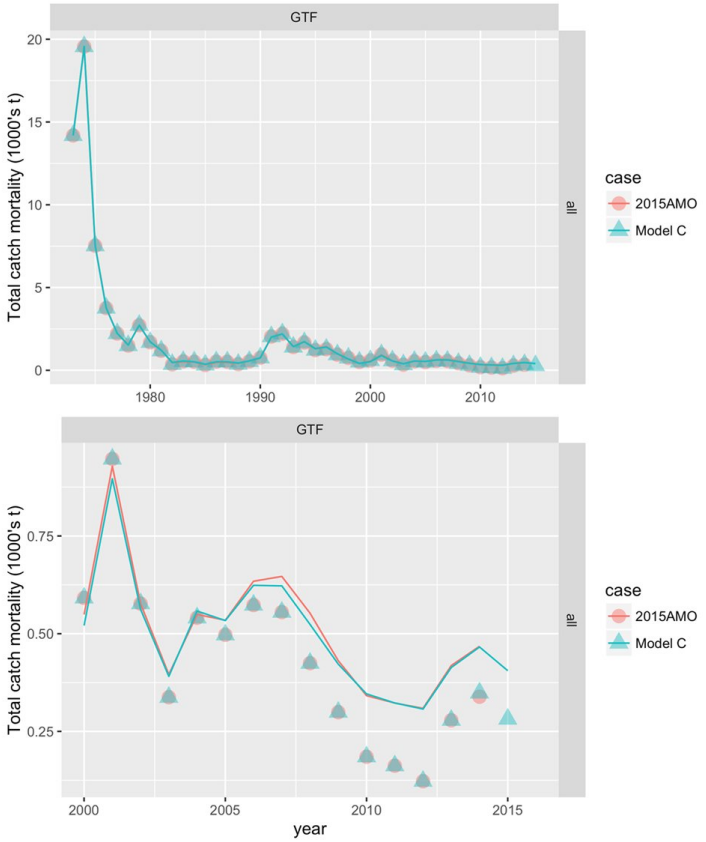
Snow crab fishery



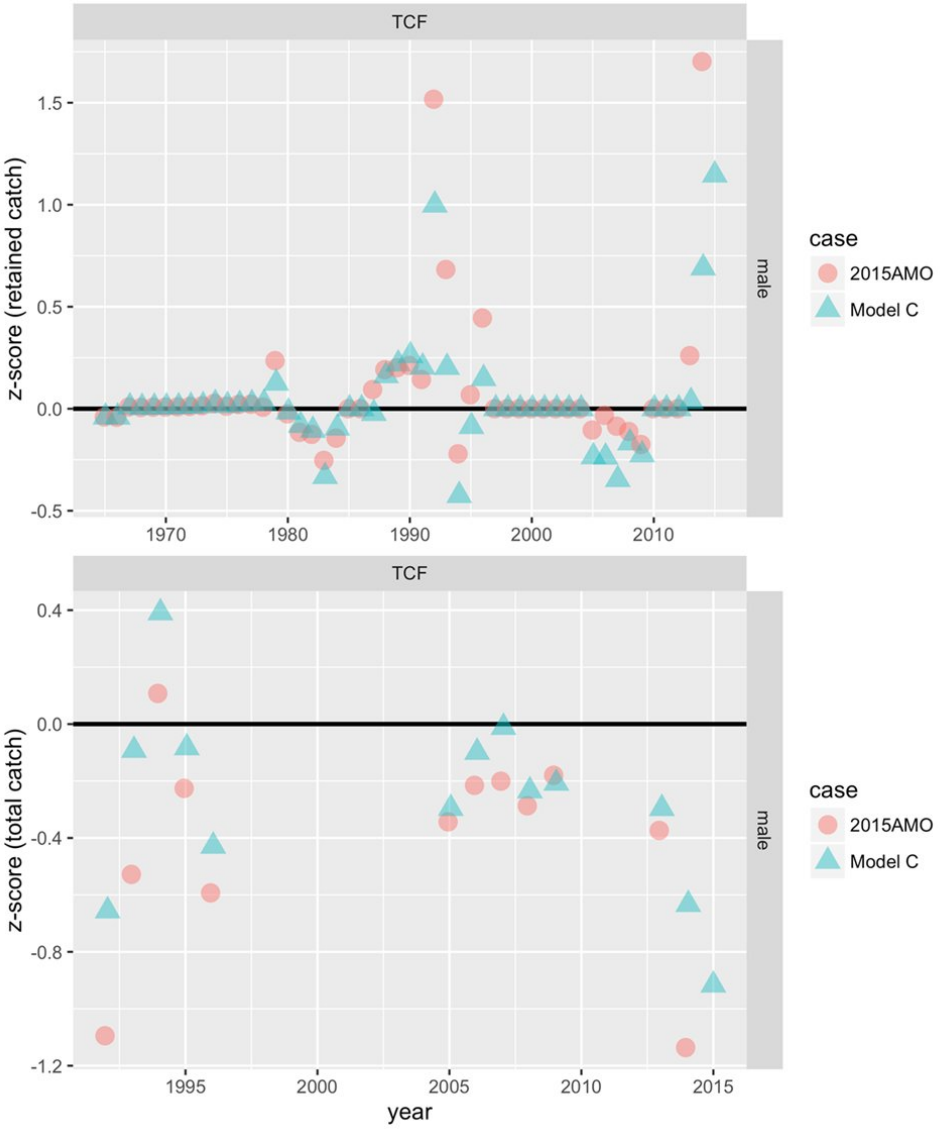
BBRKC fishery

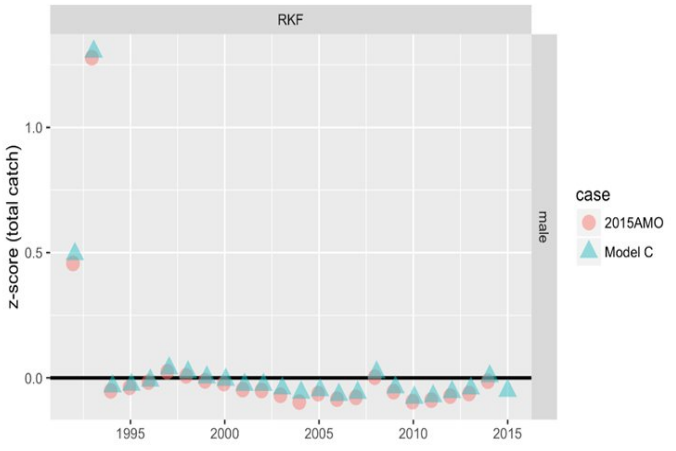


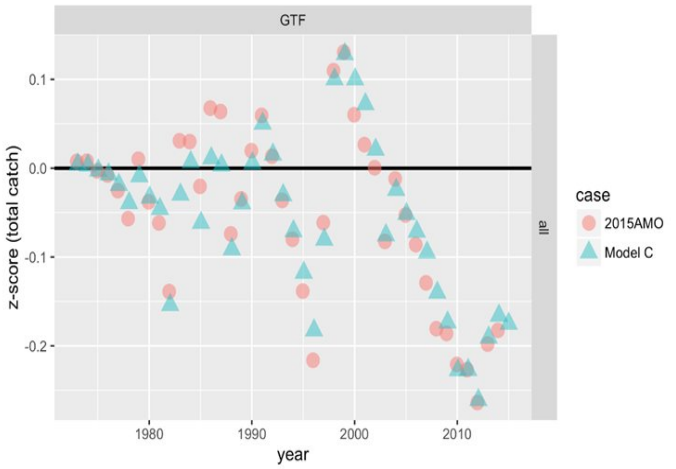
Groundfish fisheries



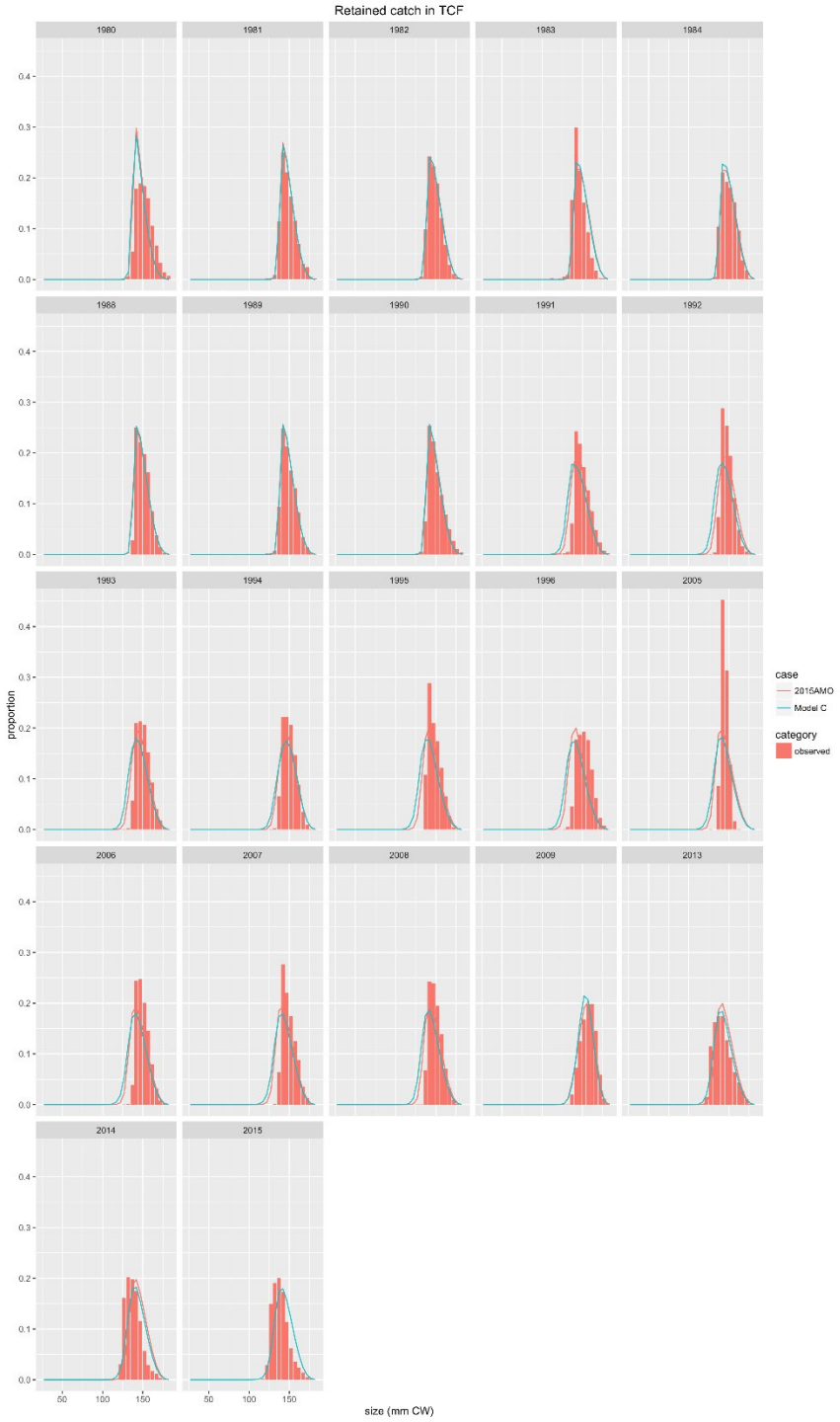
Fits to fishery data





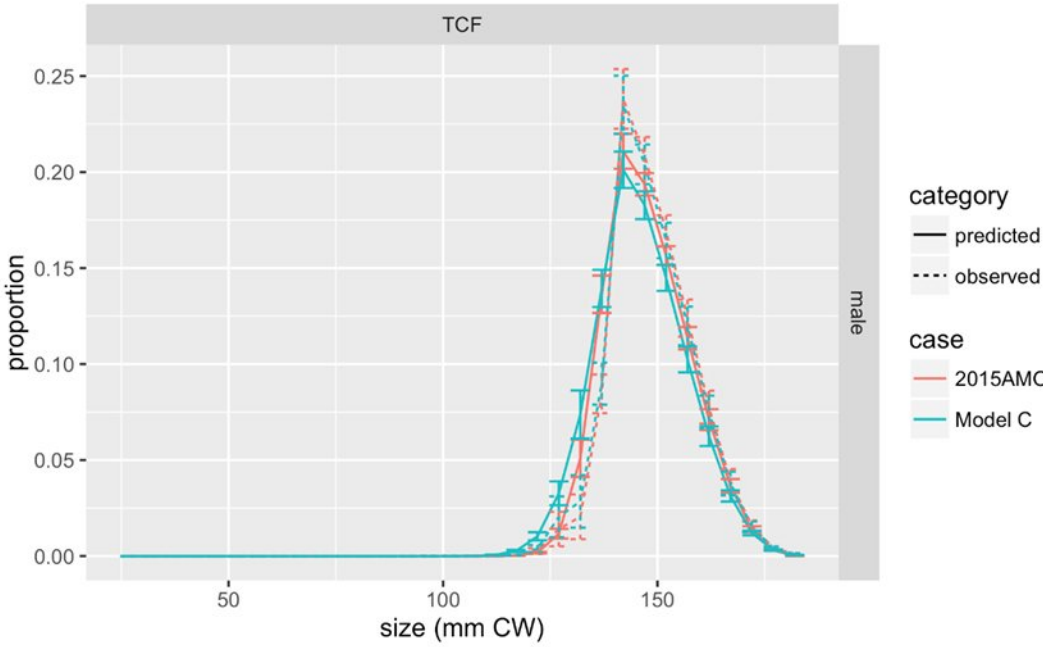


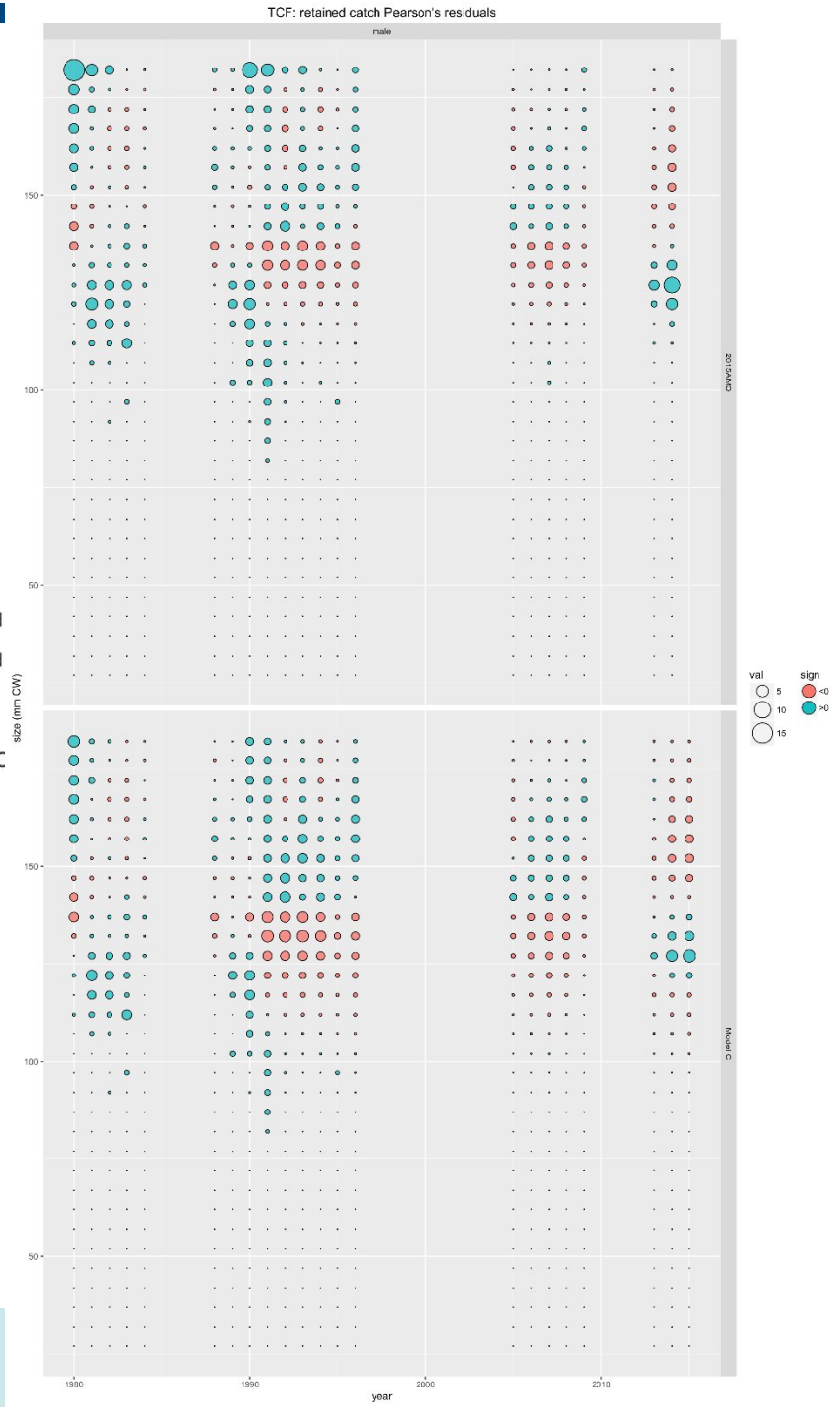
Tanner crab fishery
Retained catch



NOAA FISHERIES

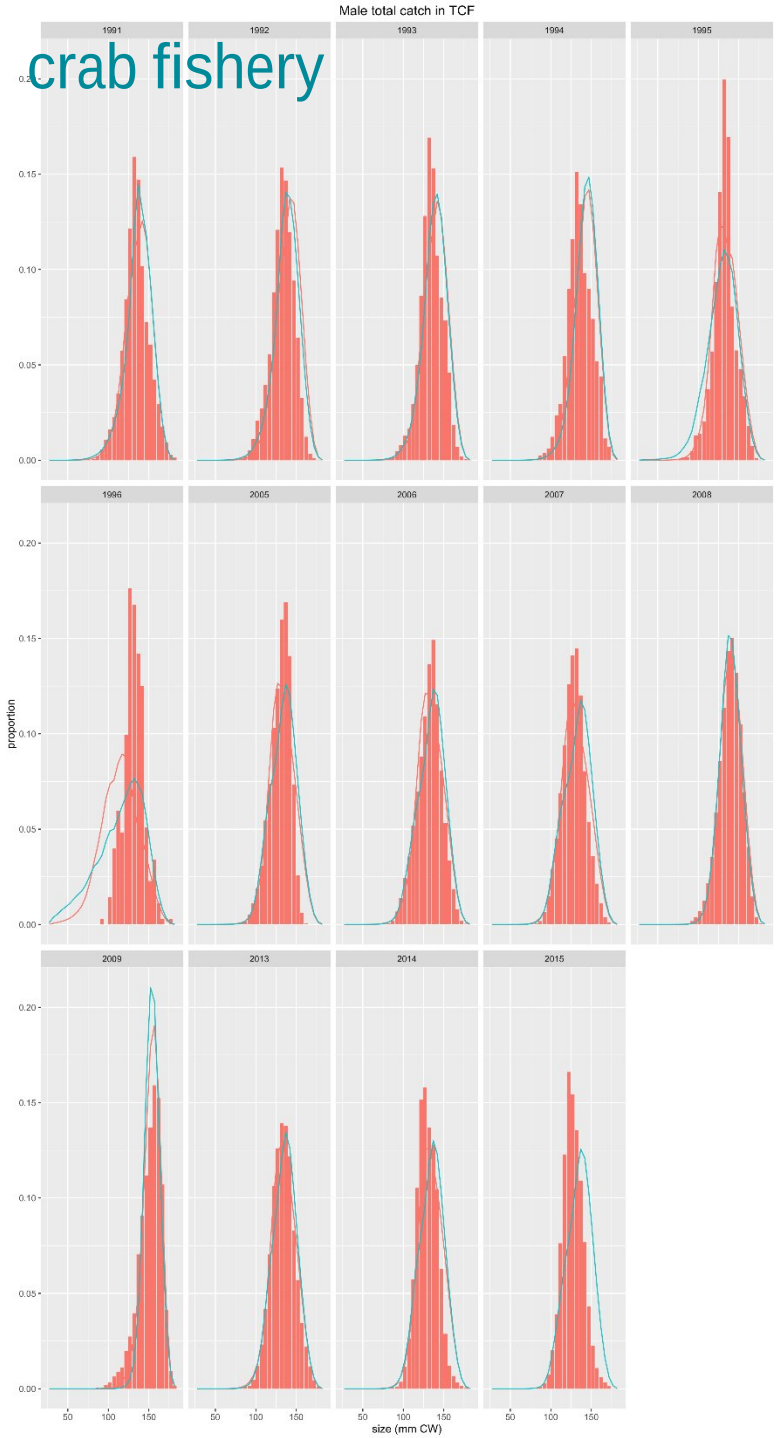
Tanner crab fishery

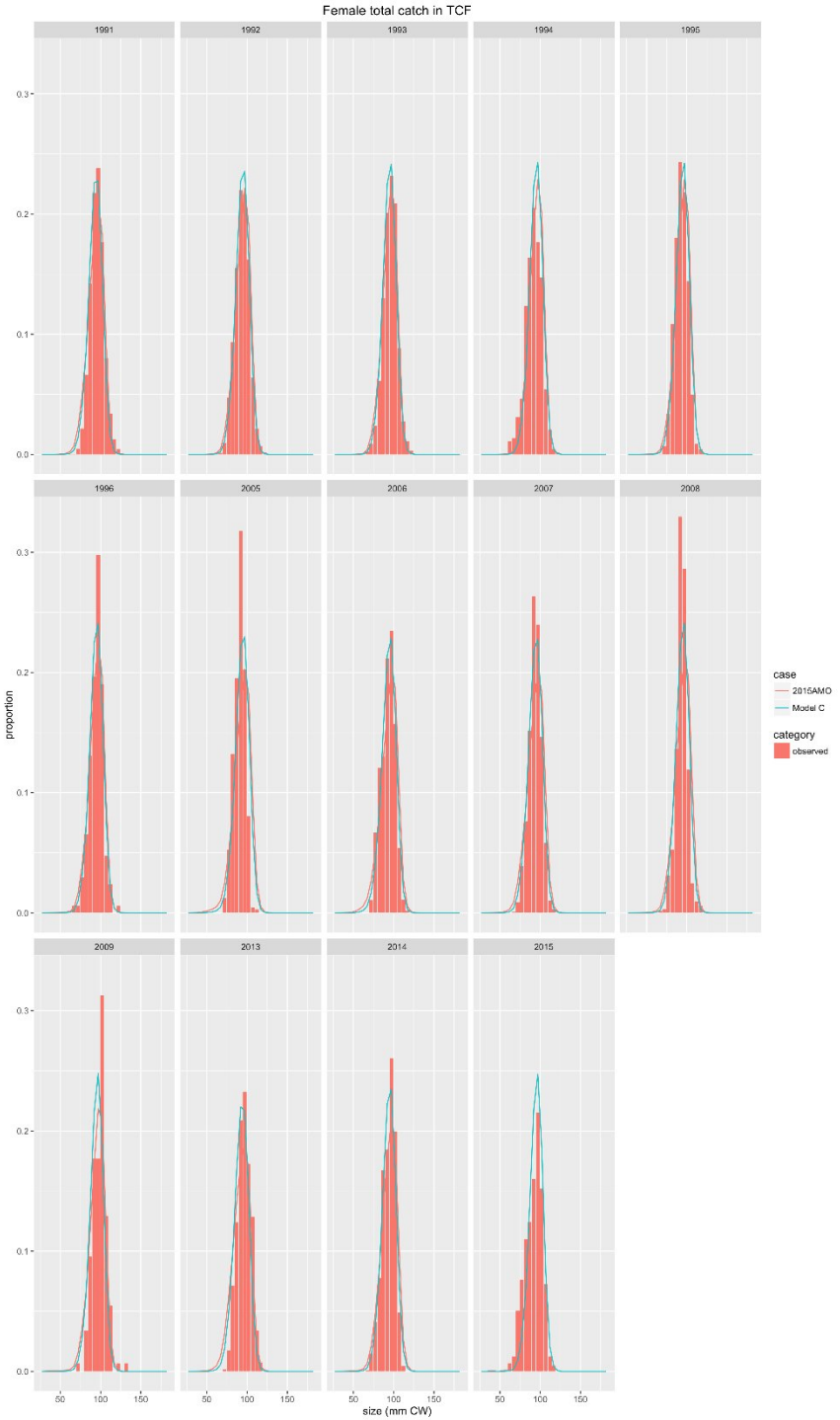




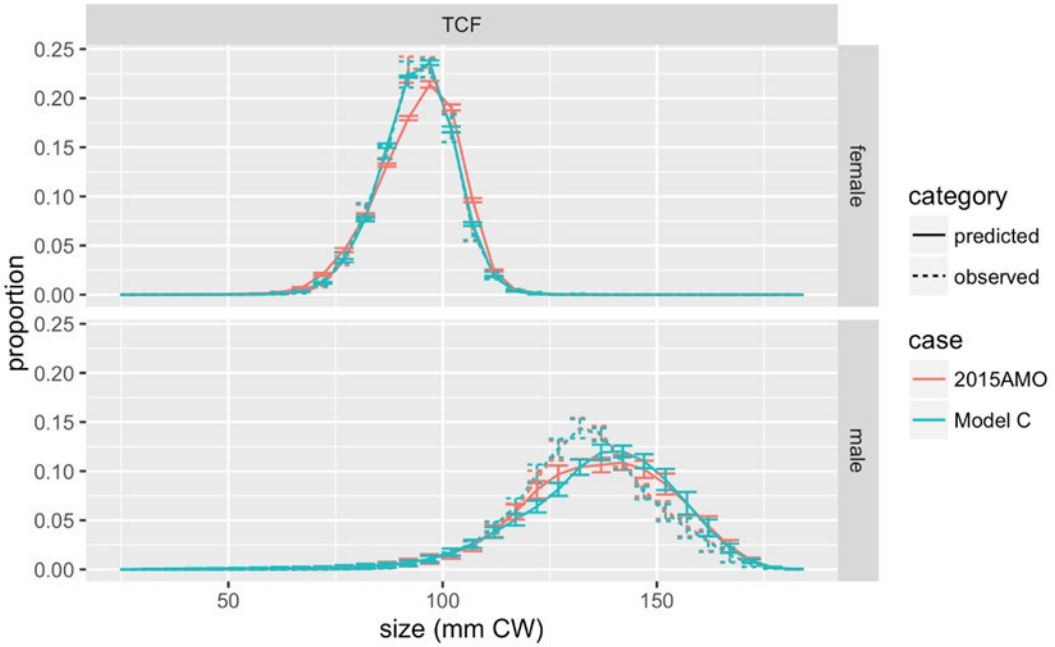
NOAA FISHERIES

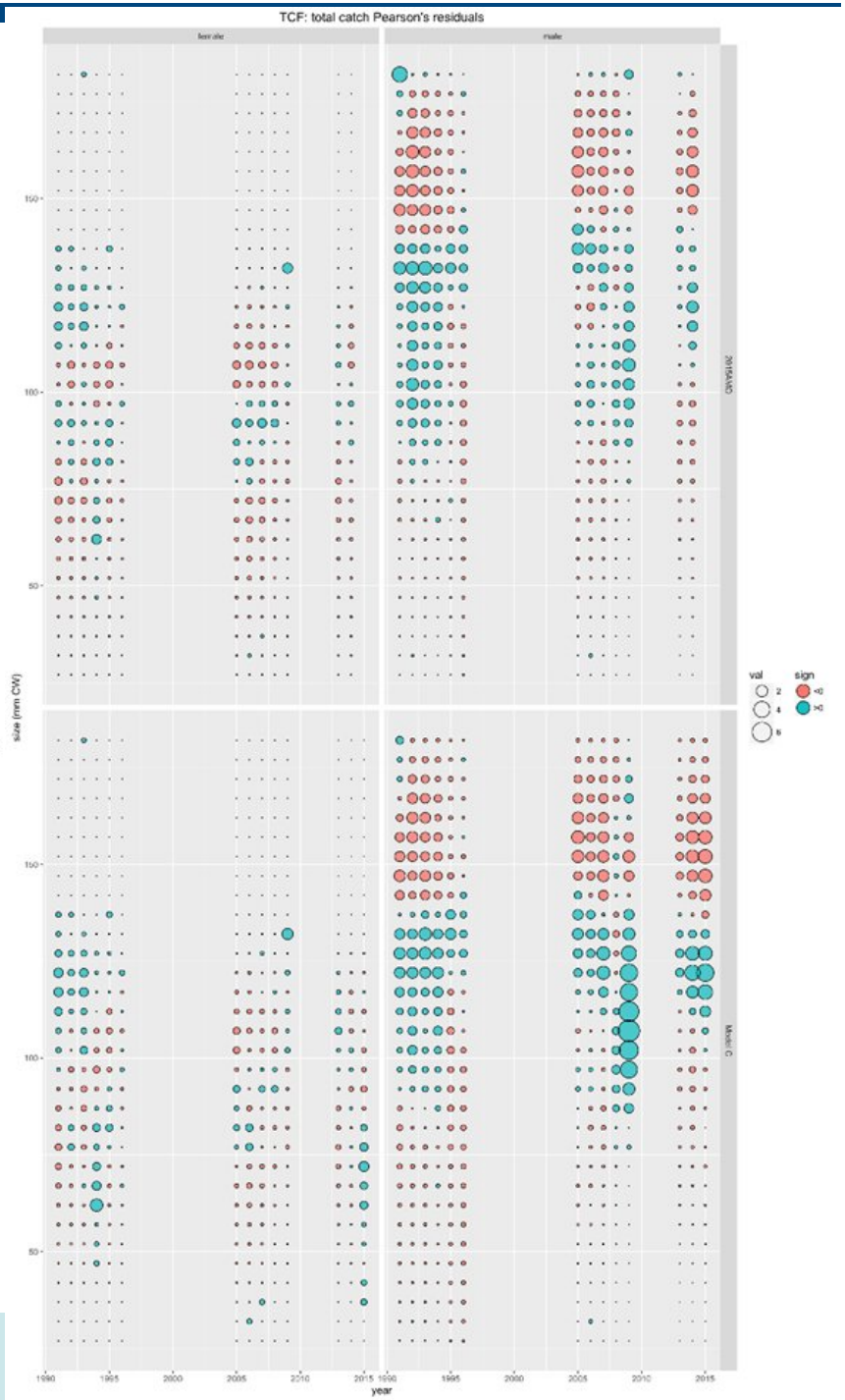
Tanner crab fishery





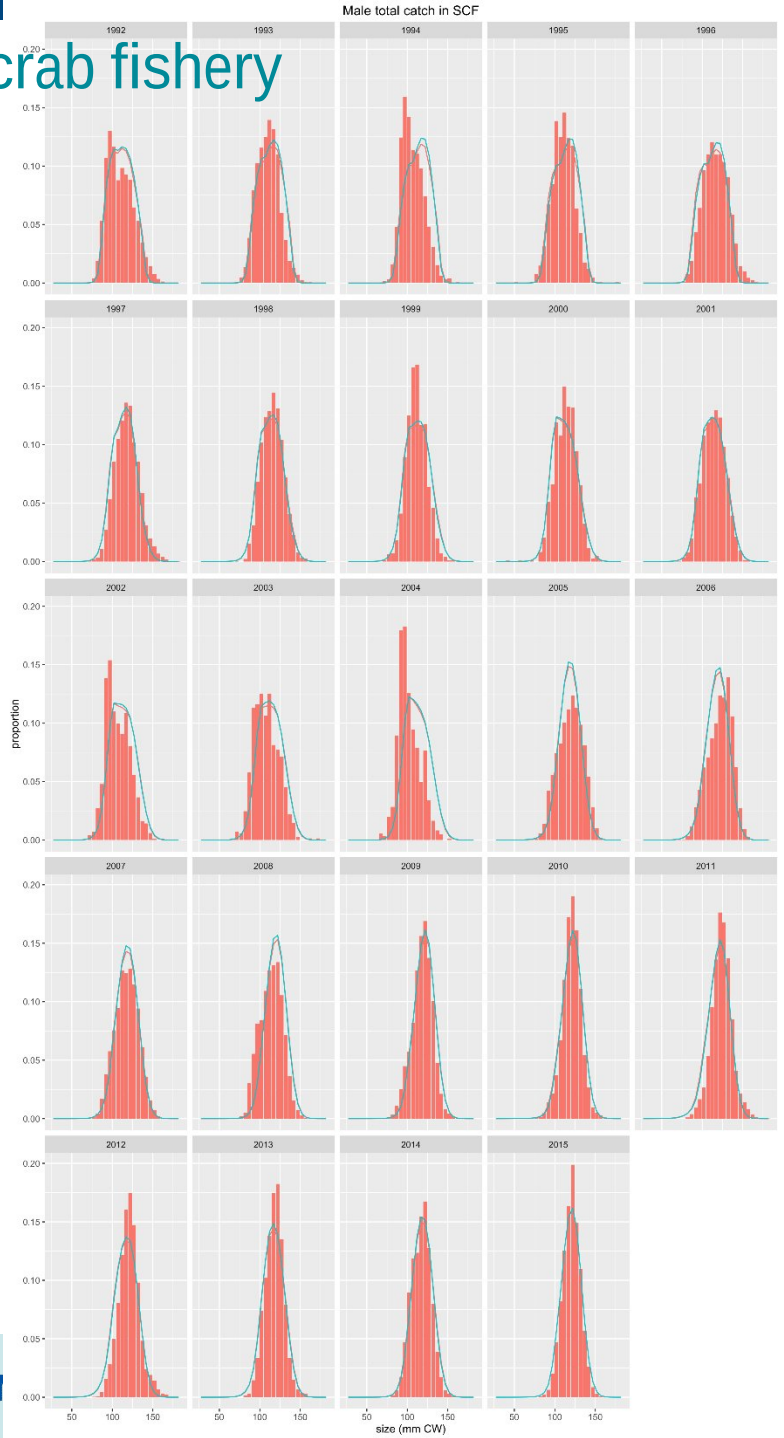
Tanner crab fishery

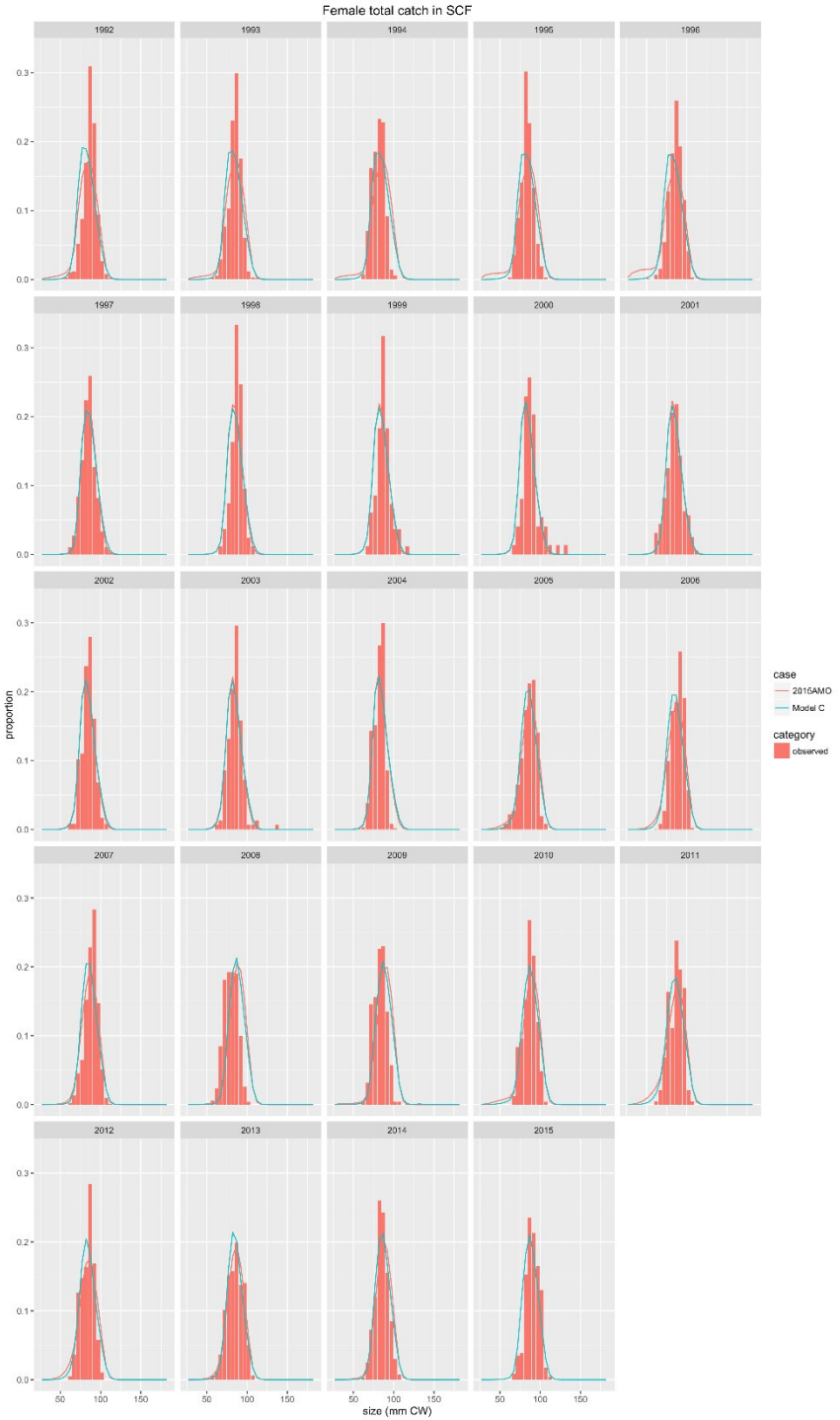




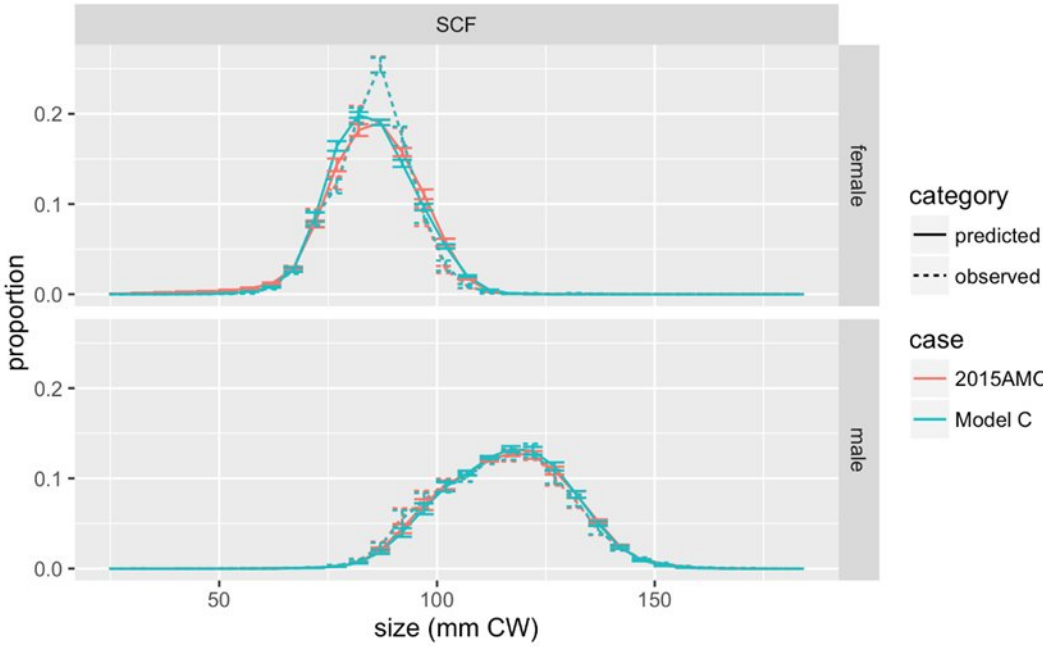
NOAA FISHERIES

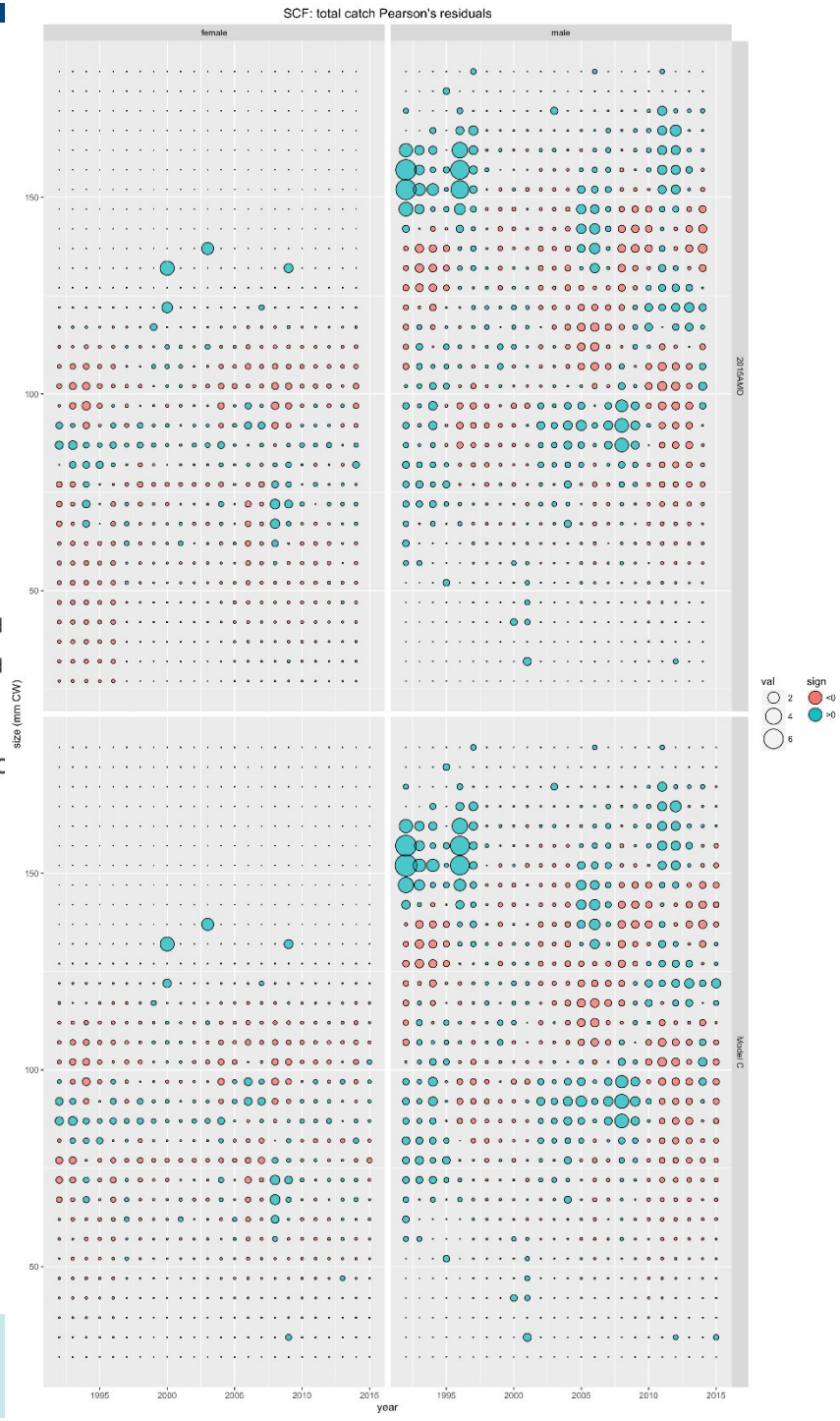
Snow crab fishery



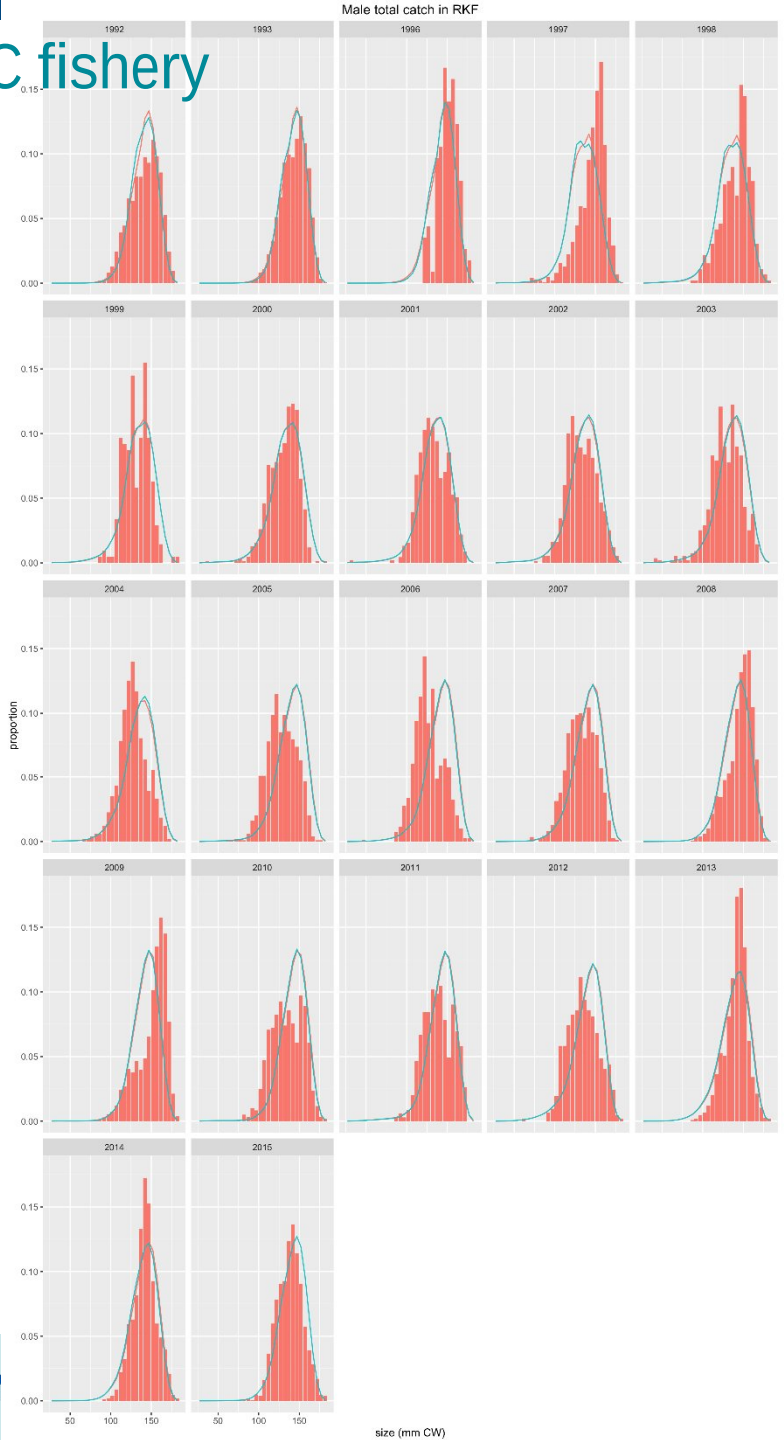


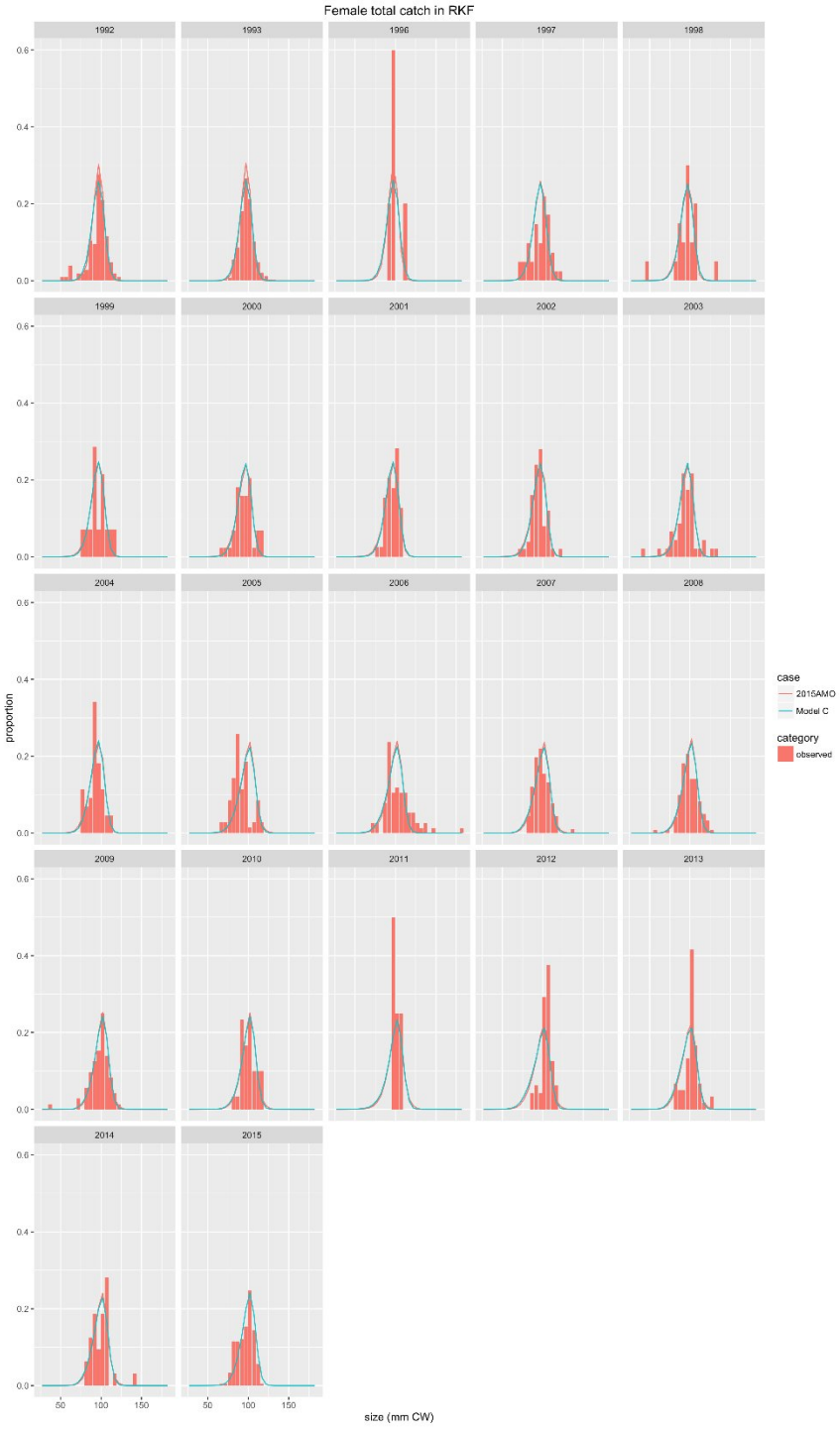
Snow crab fishery



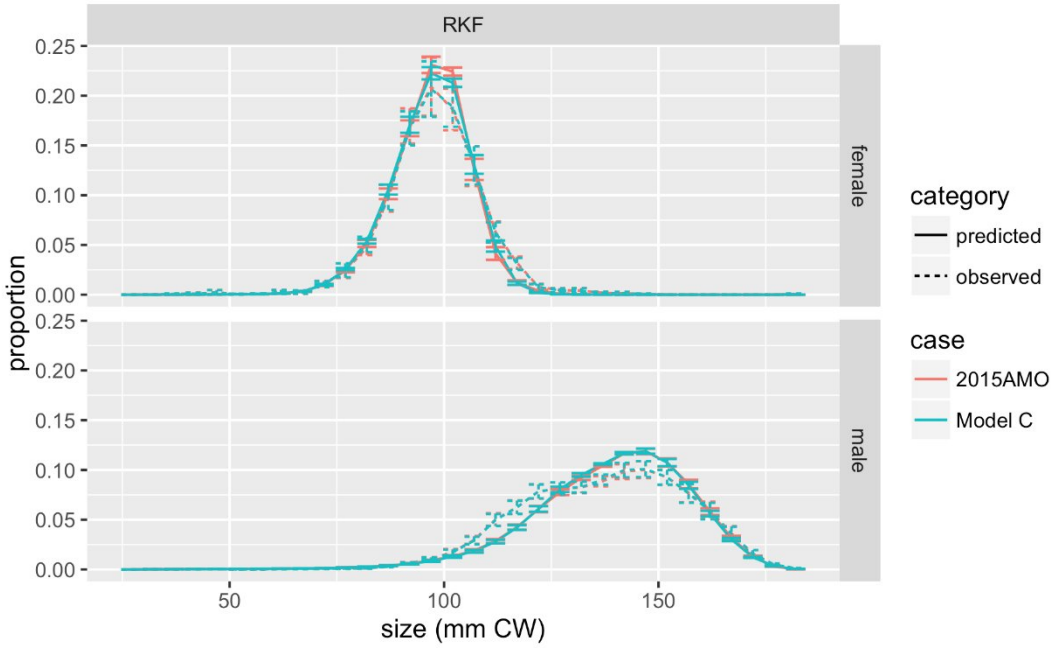


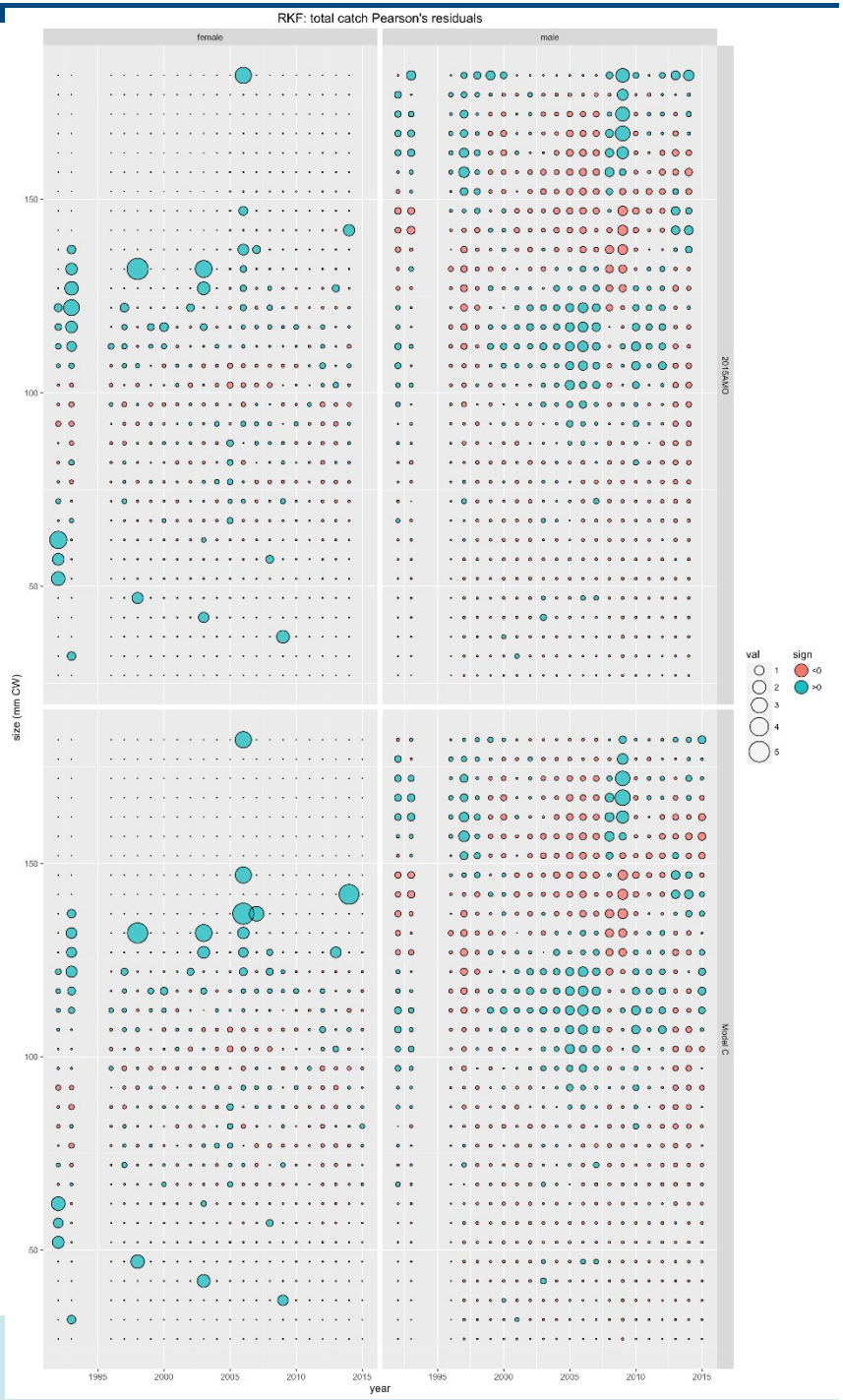
BBRKC fishery



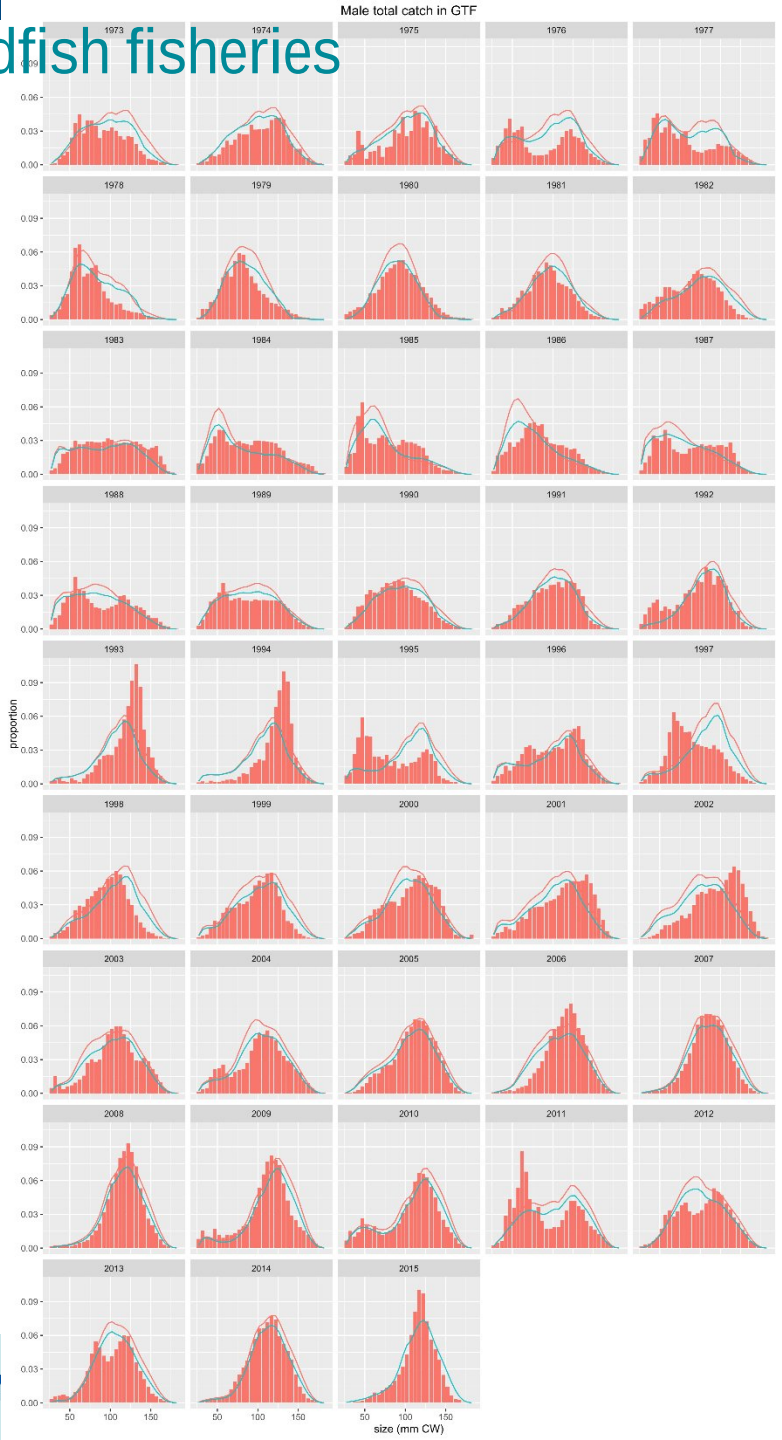


BBRKC fishery

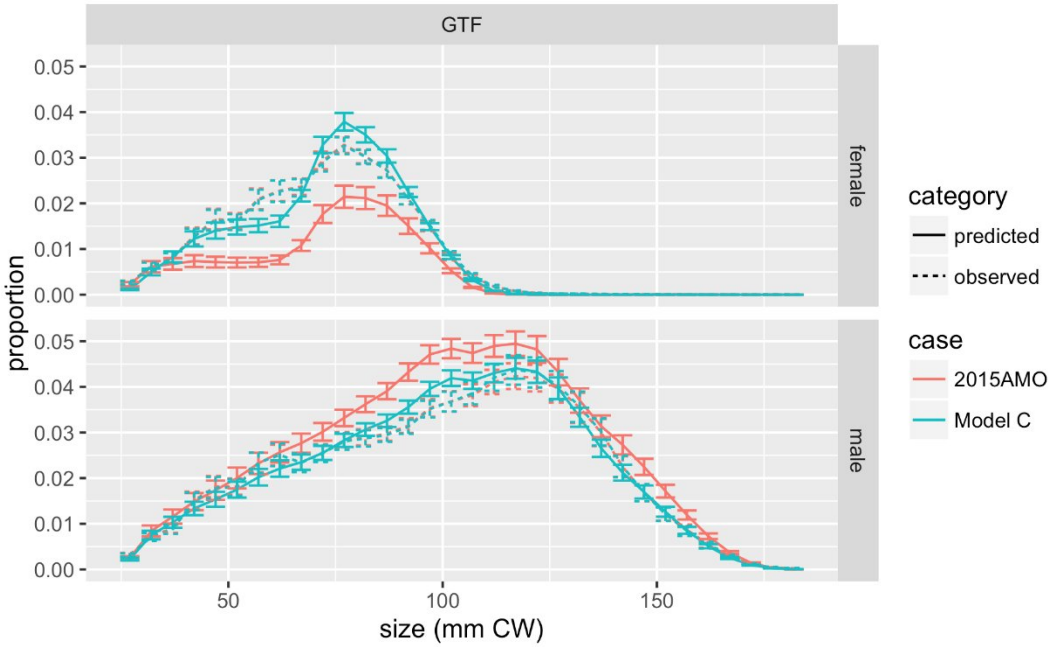


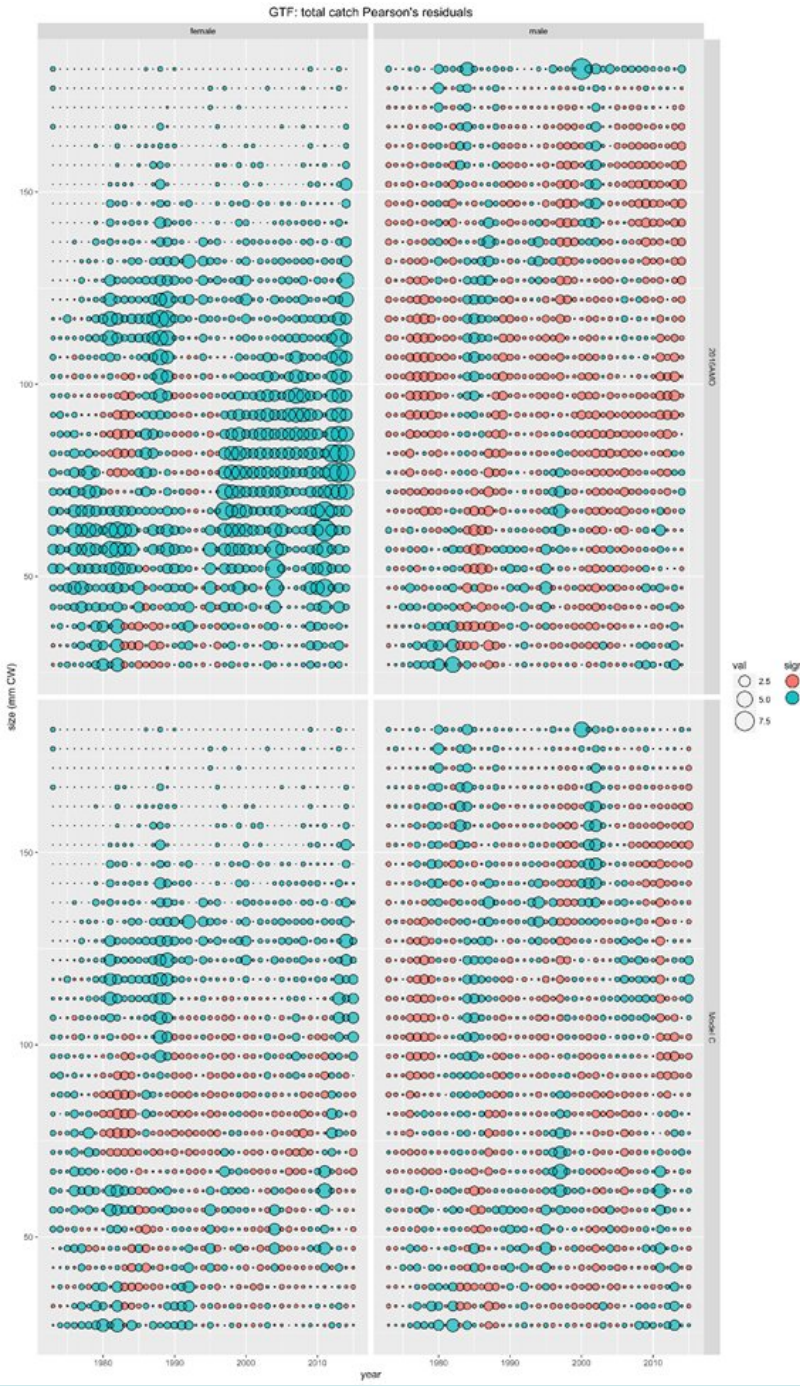


Groundfish fisheries

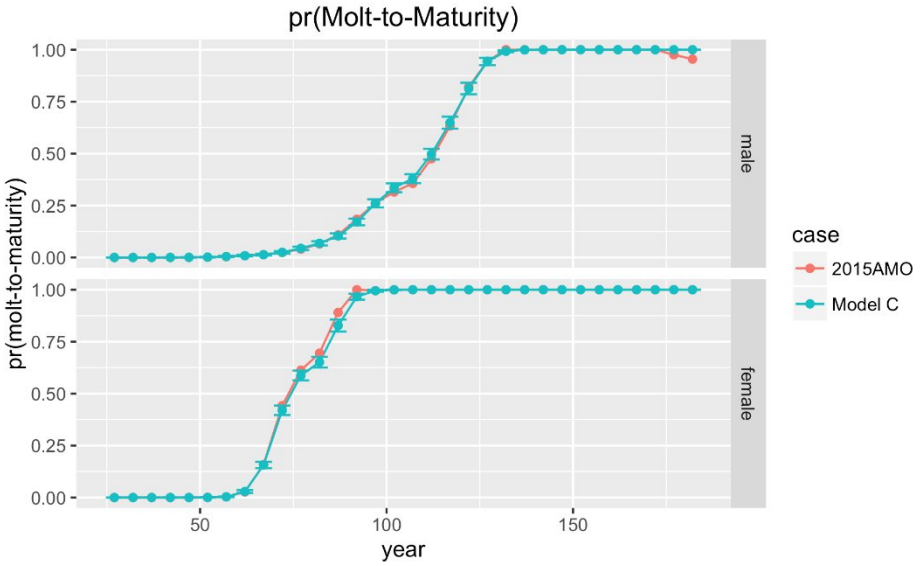


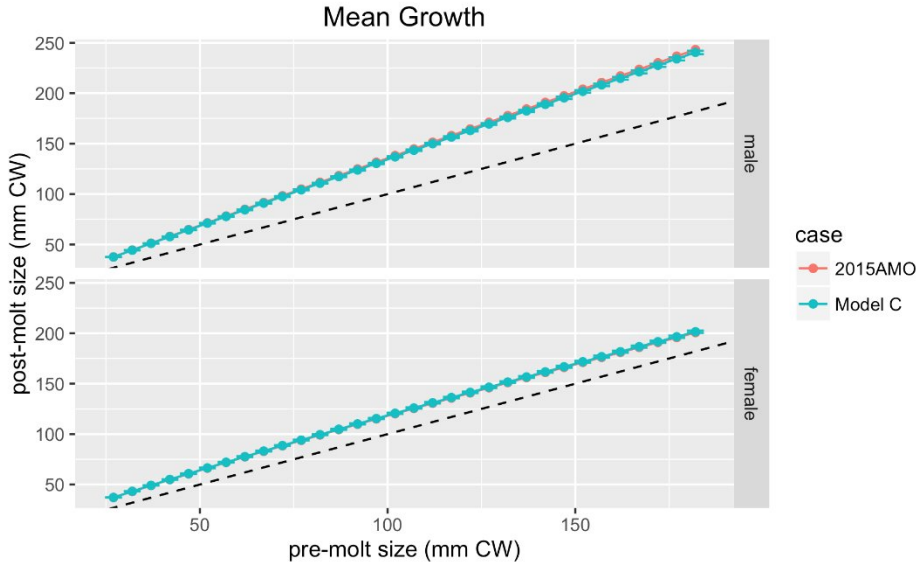
Groundfish fisheries



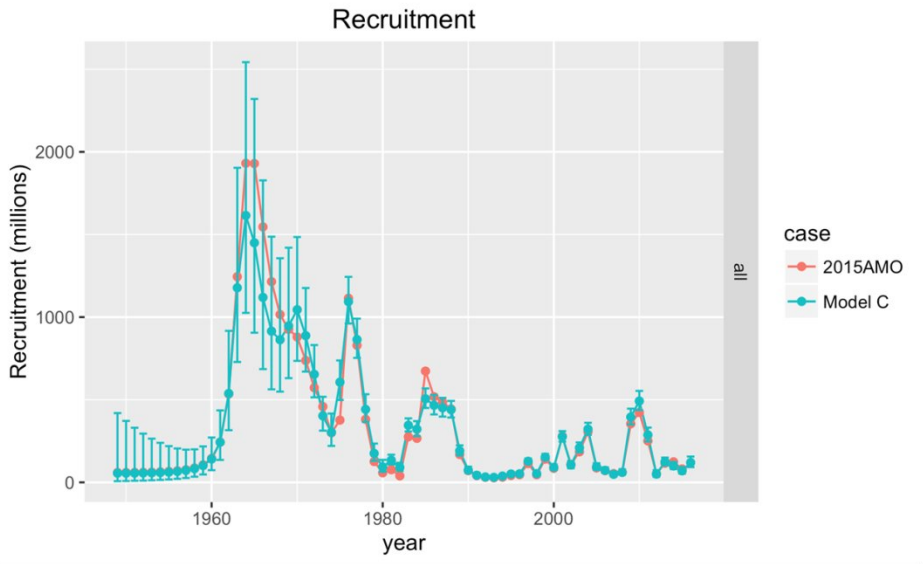


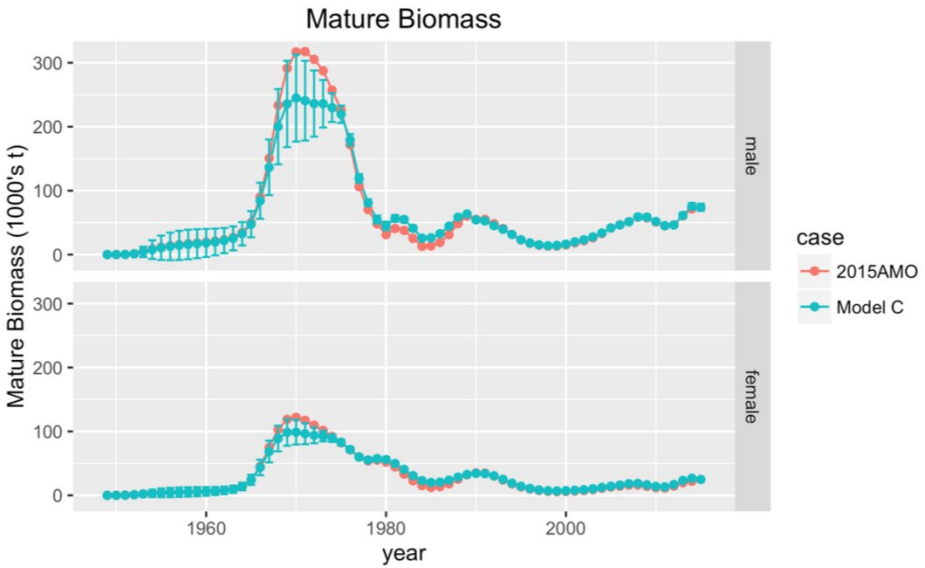
Population Processes

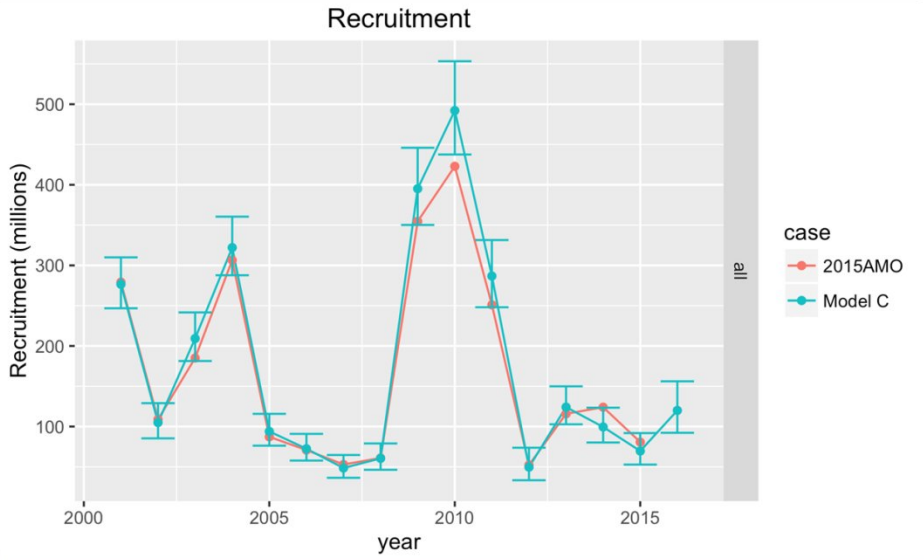


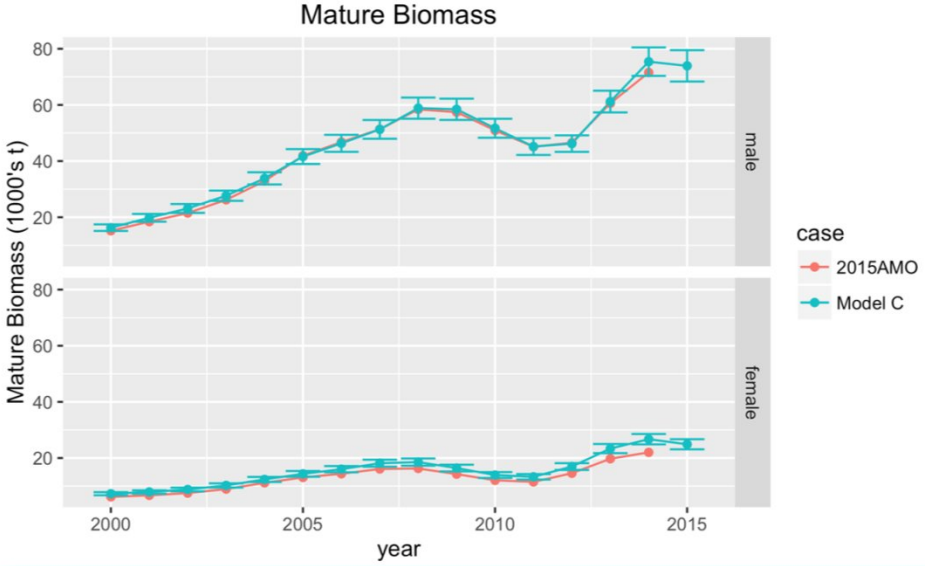


Population quantities

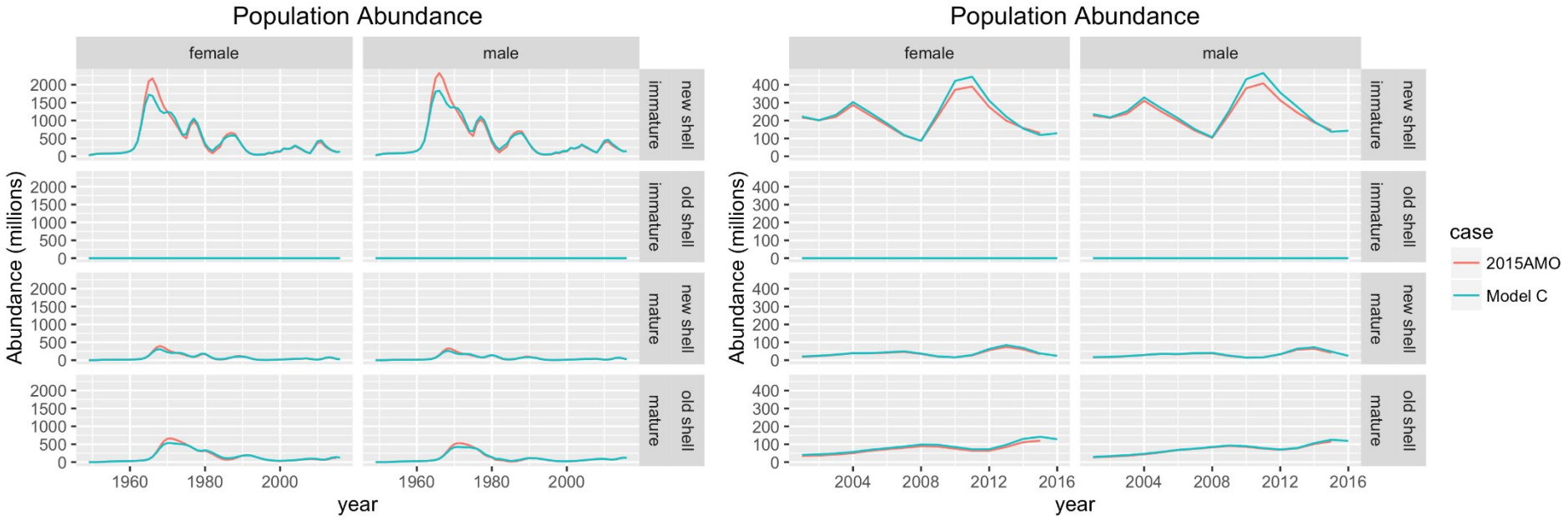




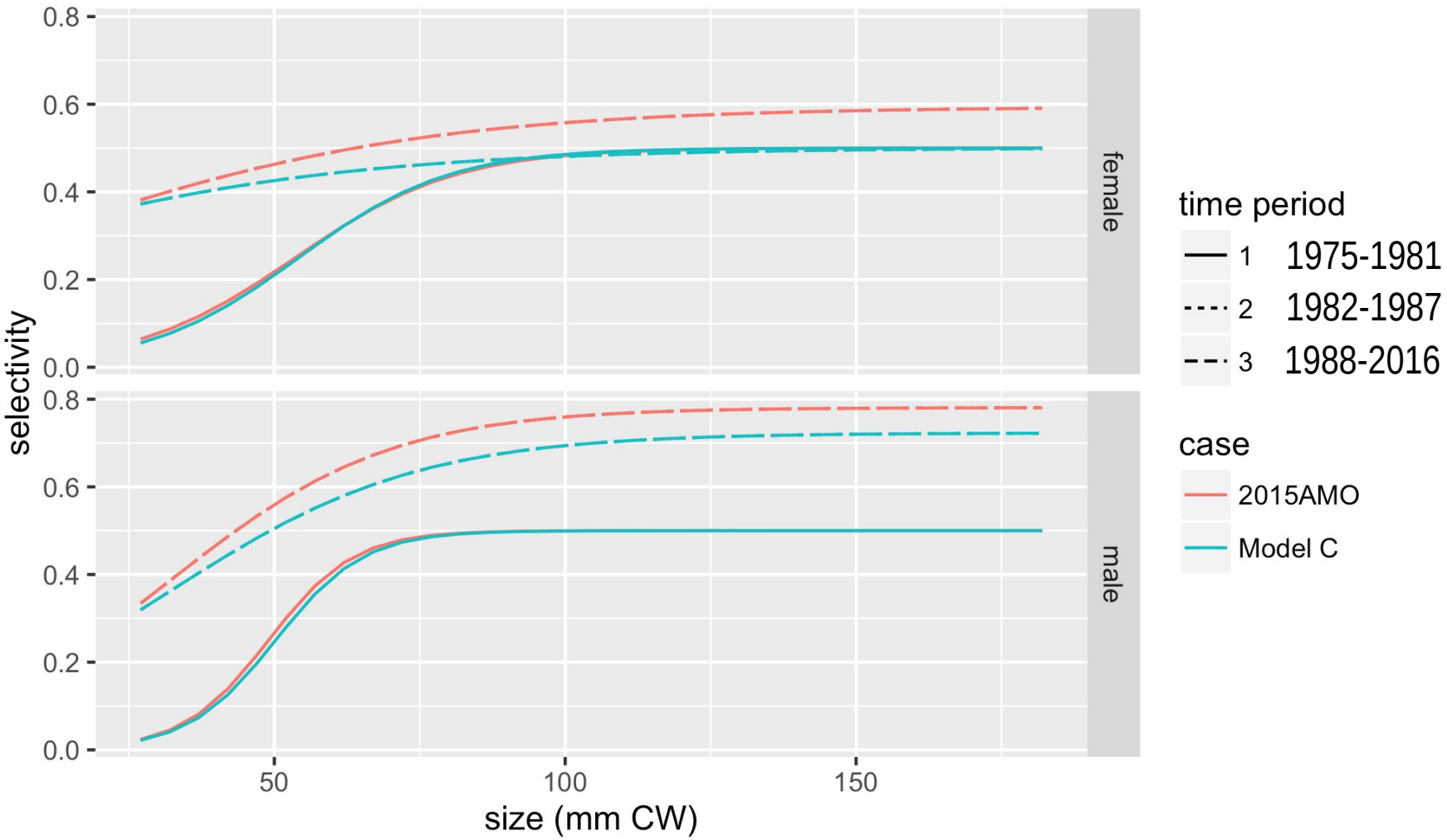




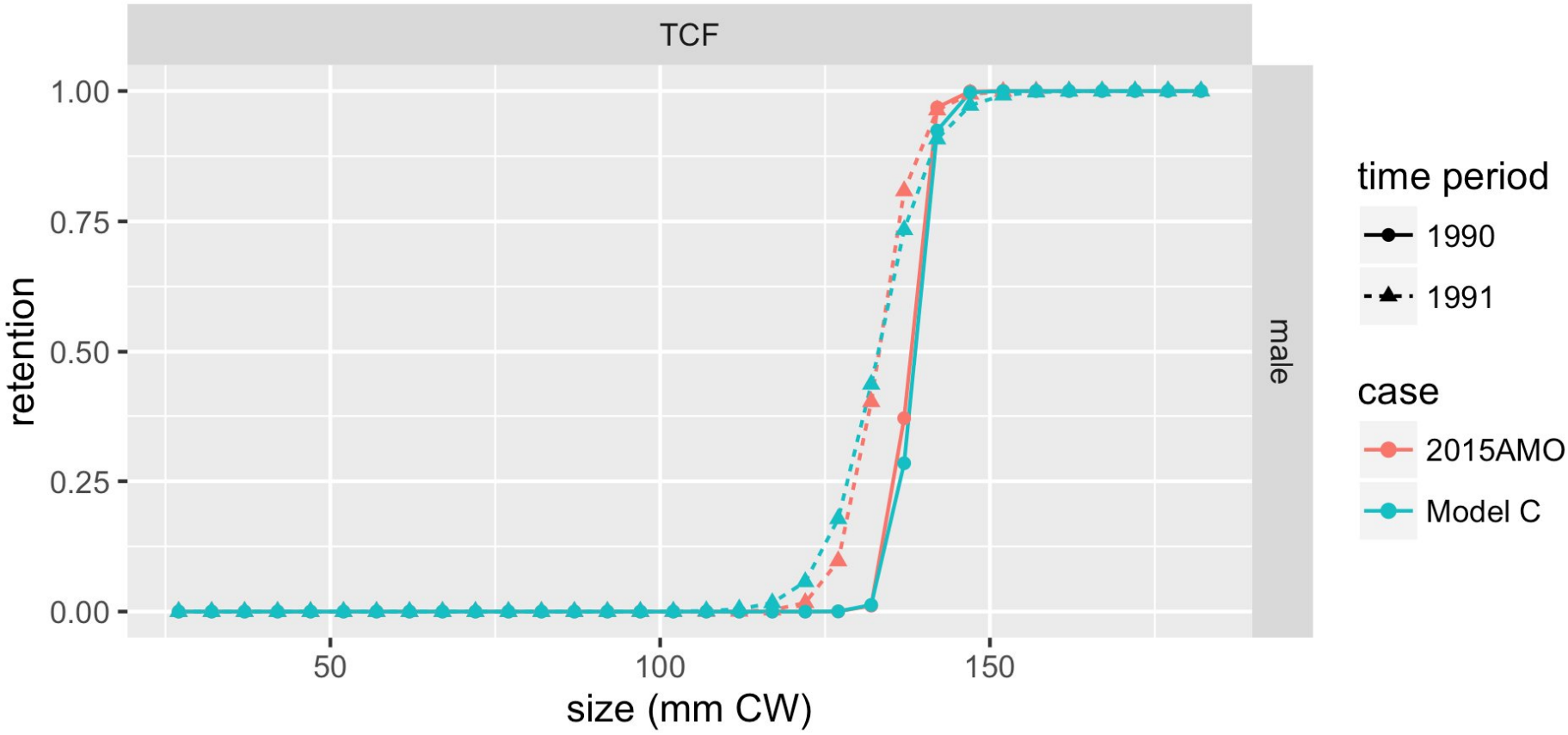
Population quantities



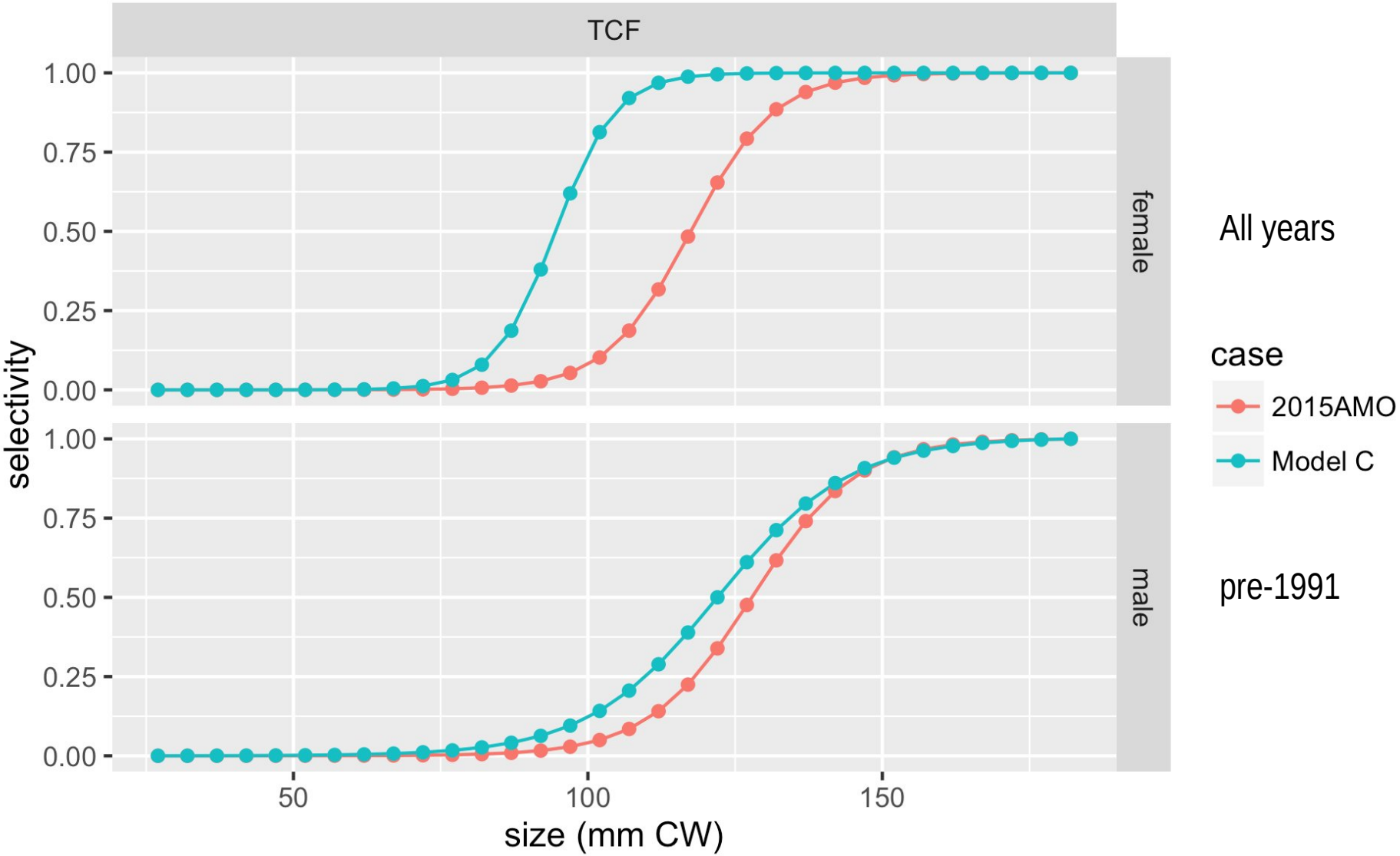
Survey selectivity



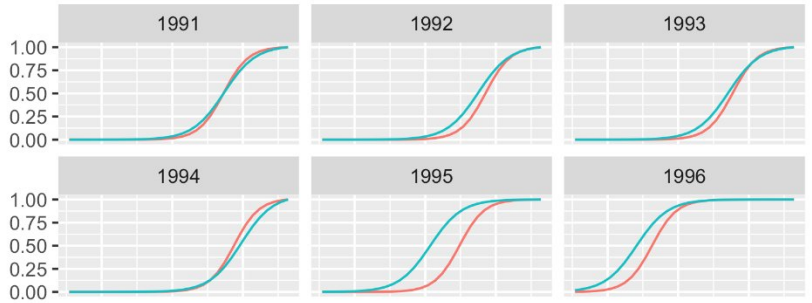
Directed fishery retention functions



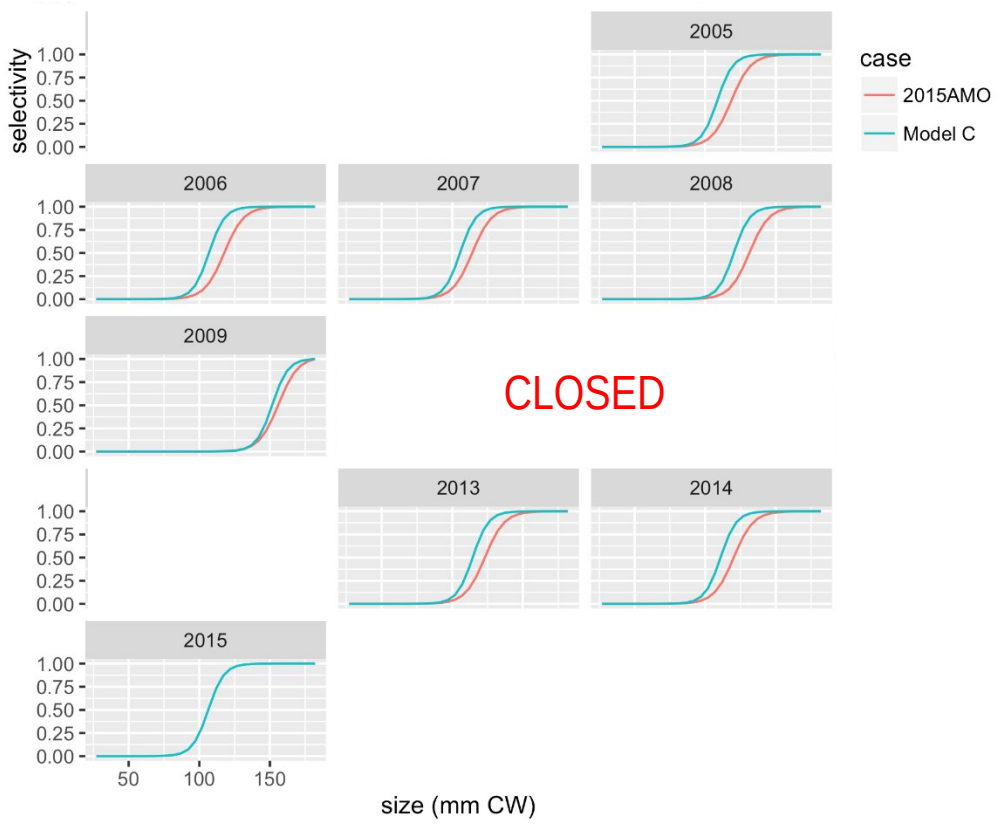
Directed fishery selectivity functions



Directed fishery
male selectivity functions

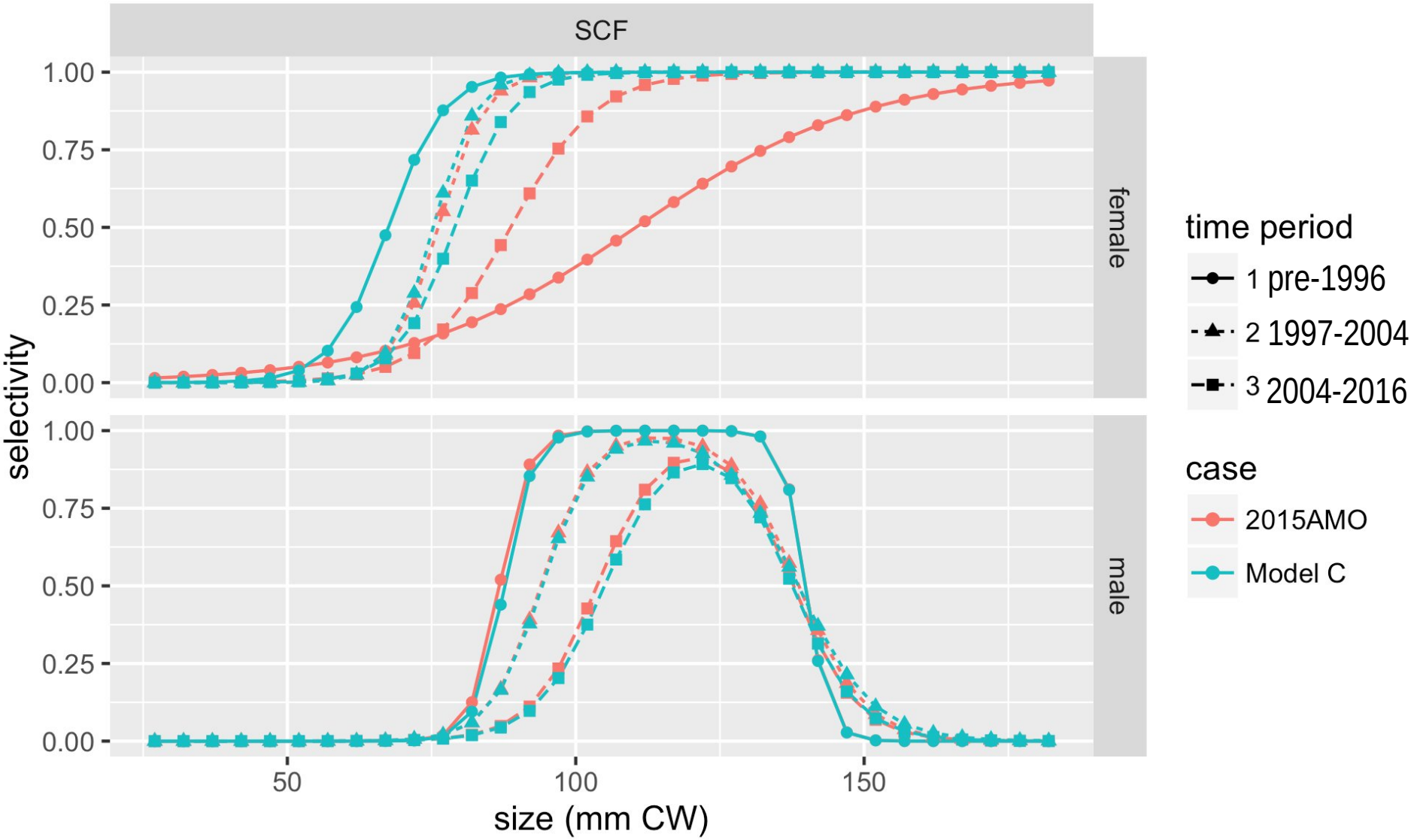


CLOSED

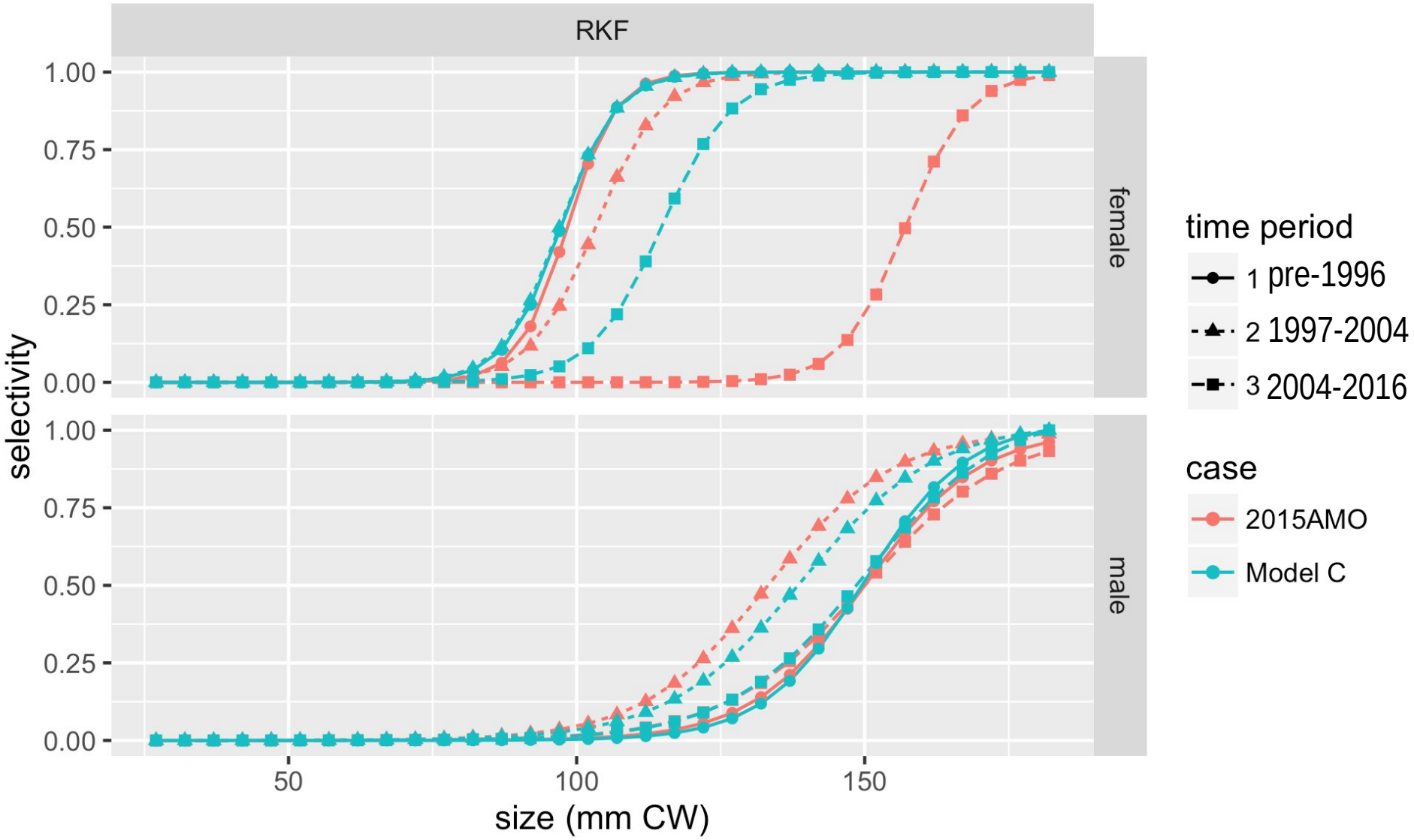


CLOSED

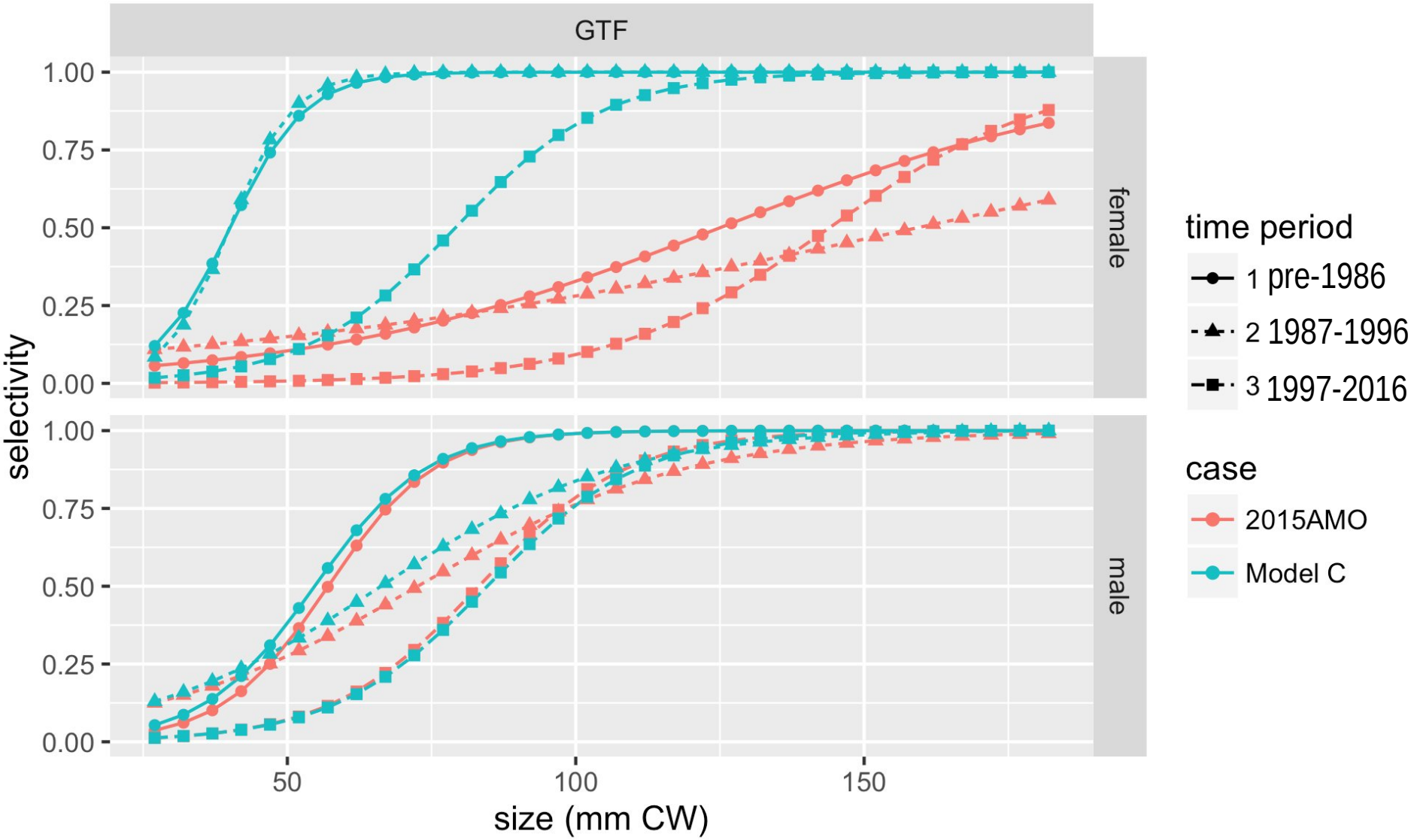
Snow crab fishery selectivity functions



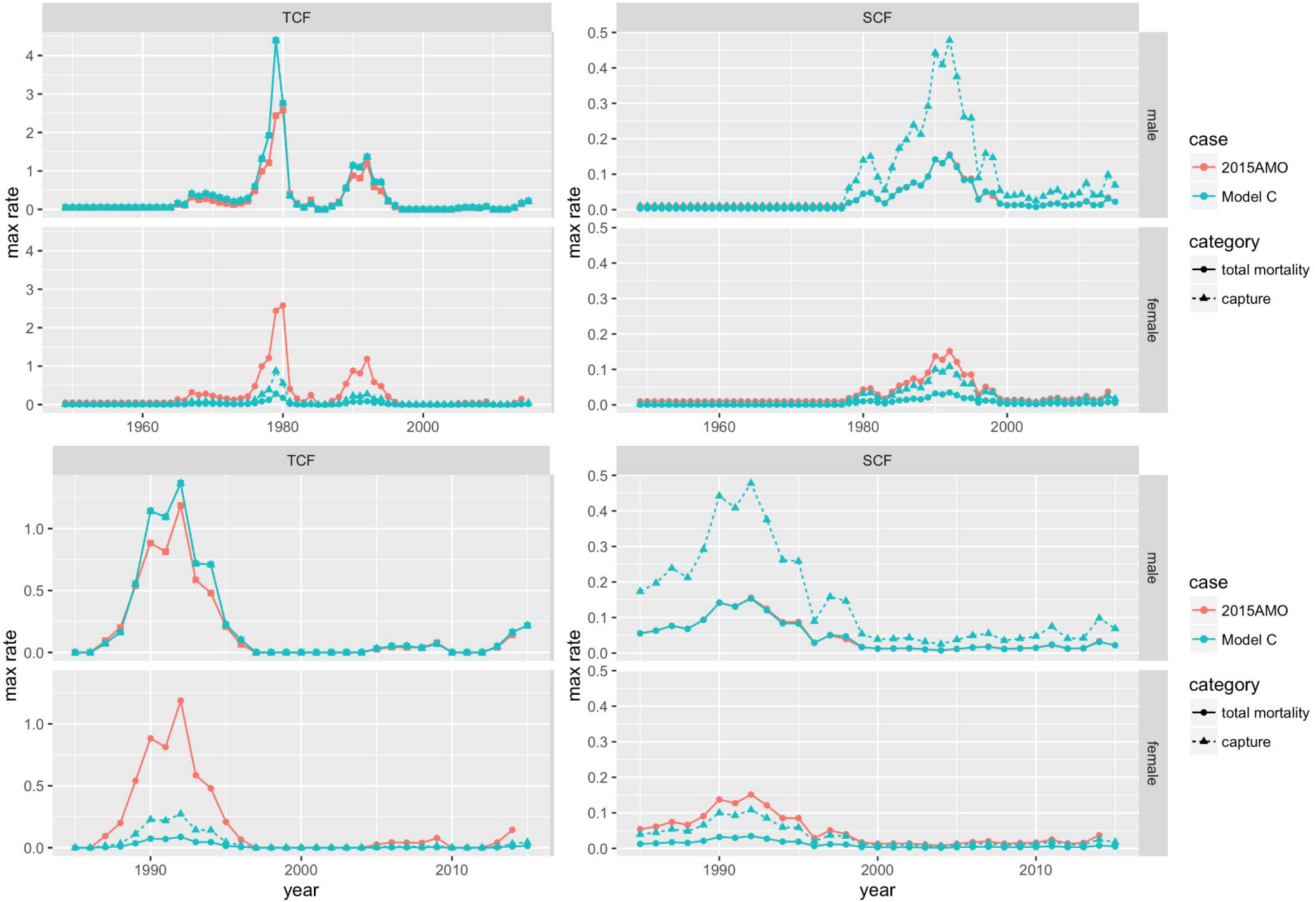
BBRKC fishery selectivity functions



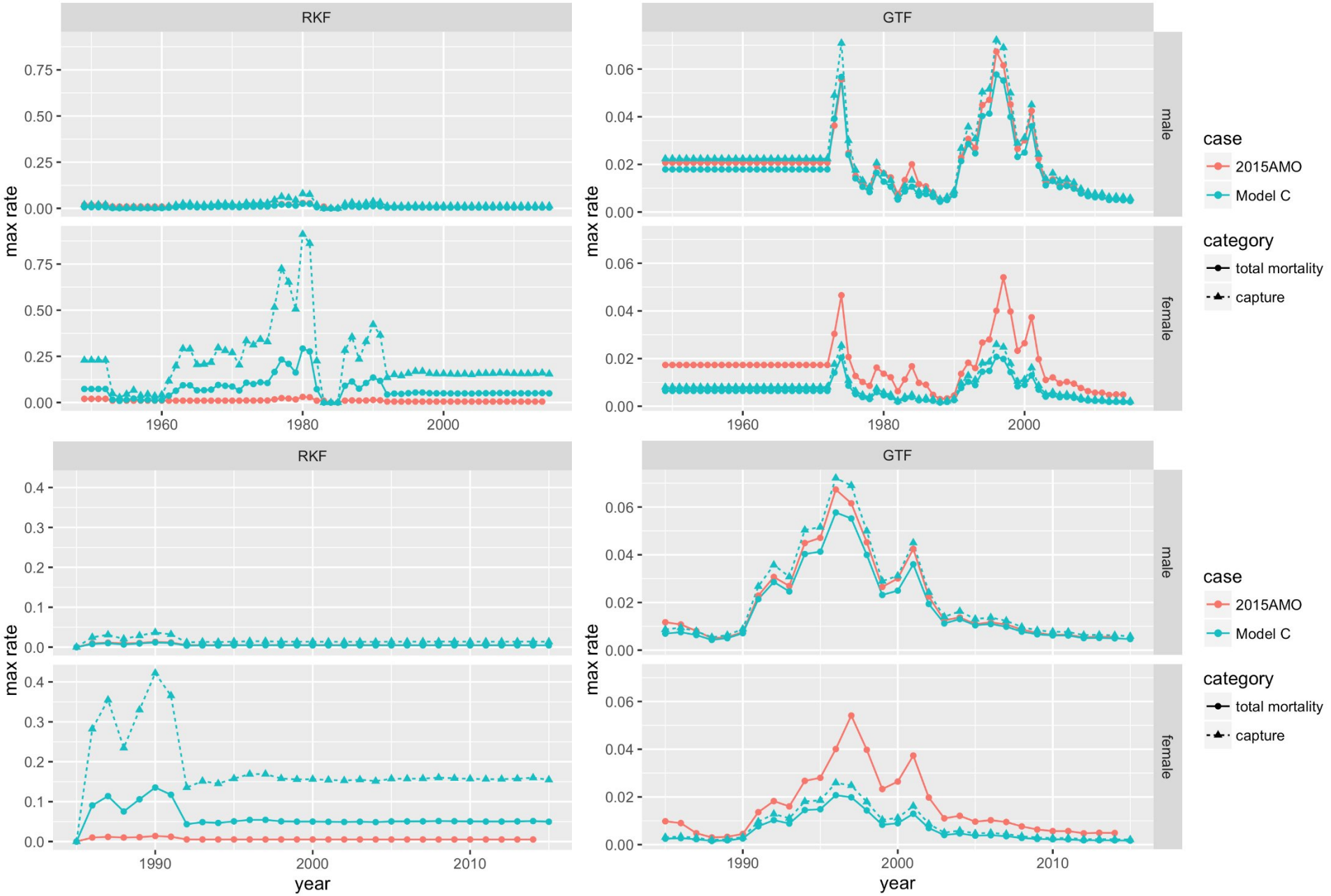
Groundfish fisheries selectivity functions



Fully-selected Fs



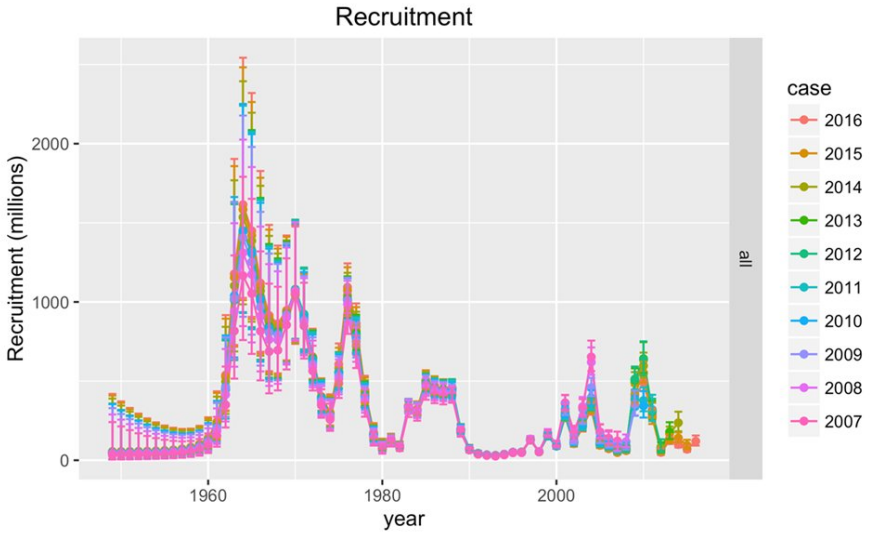
Fully-selected Fs

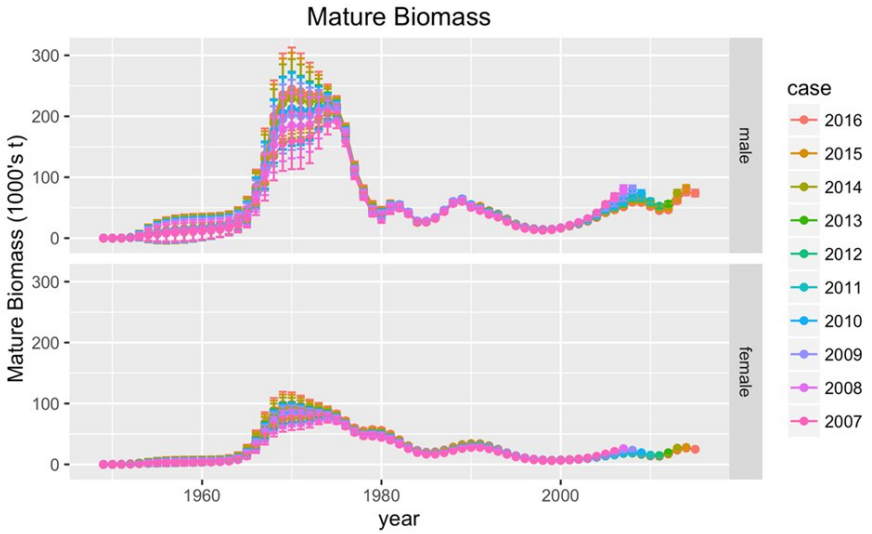


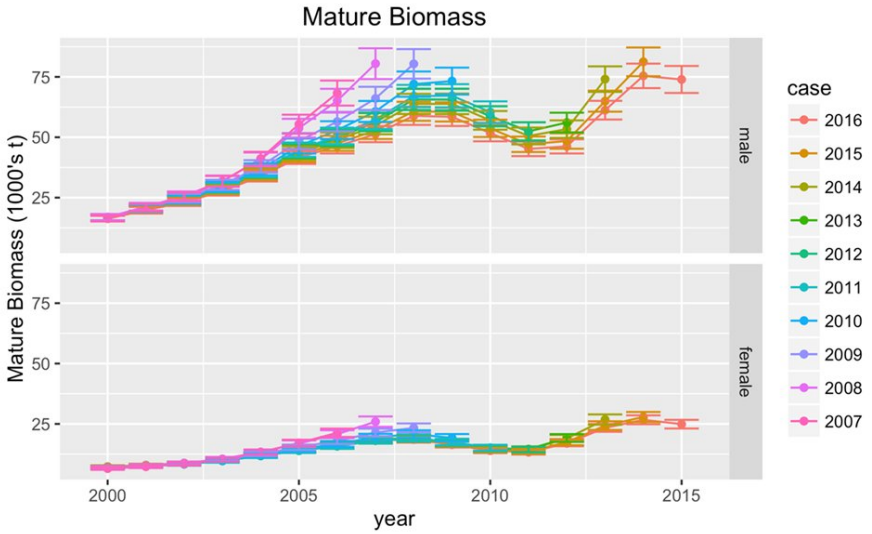
Parameter values hitting bounds

Process	Parameter	Description	2015AMO	Model C
growth	pGrAF1	female mean growth a parameter	0.7	0.7
survey Q	pSrv1_QM	males [1975-1981]	0.5	0.5
survey Q	pSrv1_QF	females [1975-1981]	0.5	0.5
survey selectivity	pSrv2F_dz5095	female offset to 95%-selected [1982+]	100	100
RKF selectivity	pSelRKFM_z50A1	male size at 50%-selected [-1996]	150	150
GTF selectivity	pSelGTFF_z50A2	female size at 50%-selected [1988-1996]	159.214	40

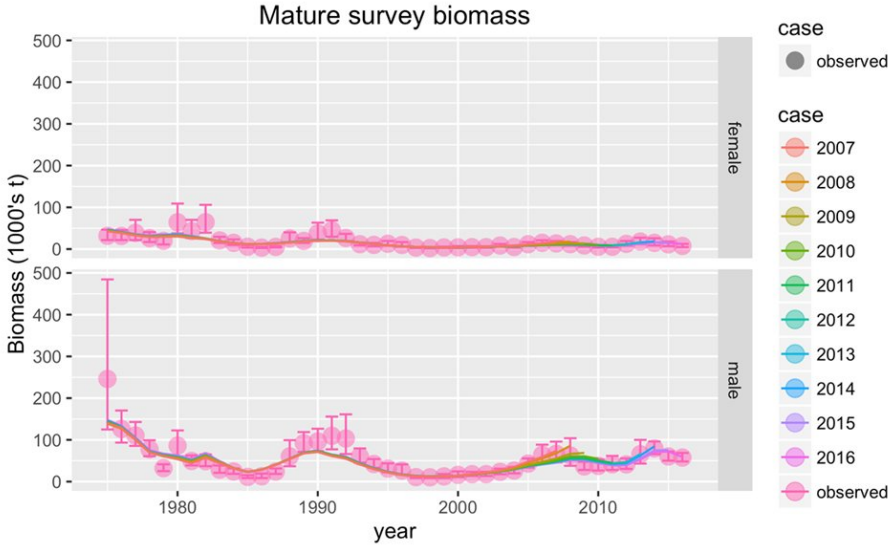
Retrospective Analysis: 2016 Preferred Model

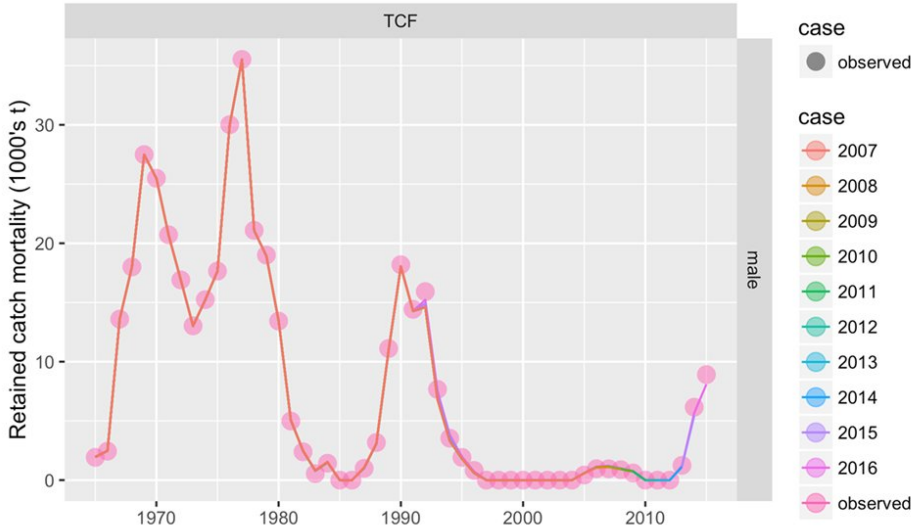


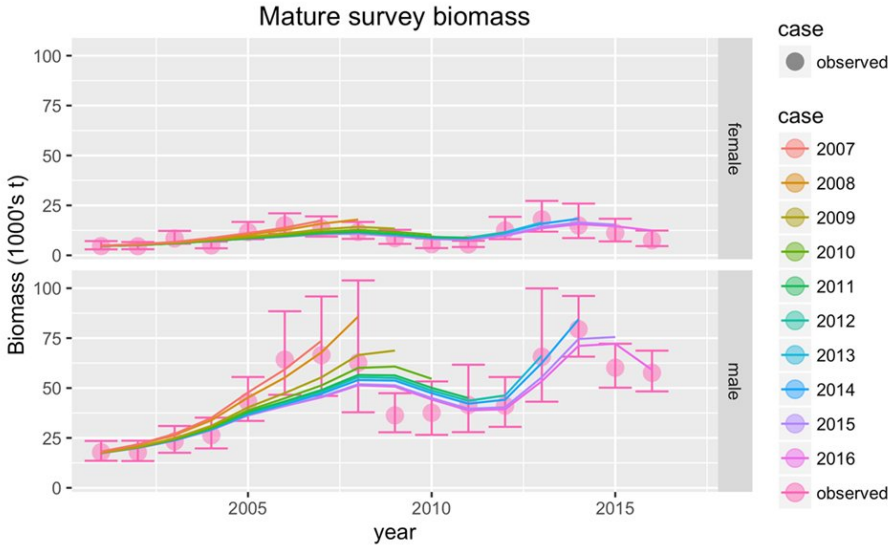


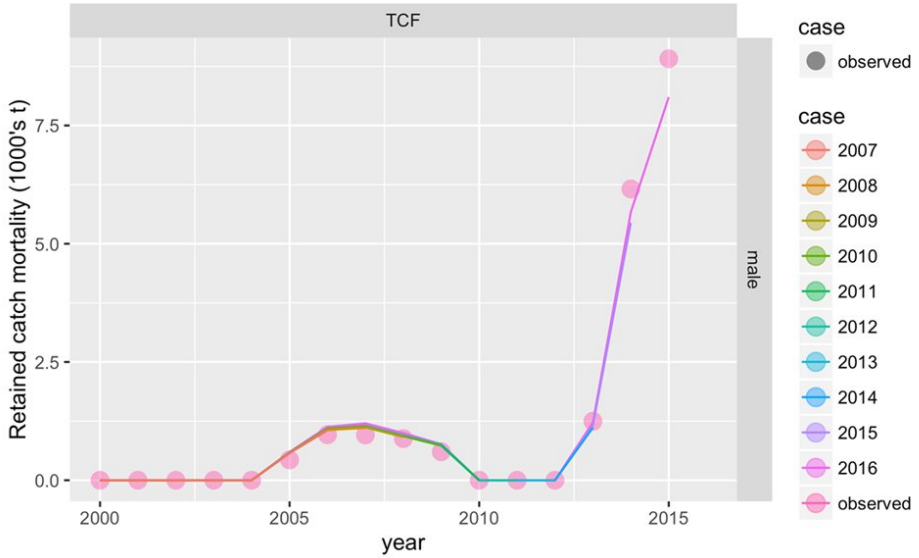


Retrospective Analysis: 2016 Preferred Model

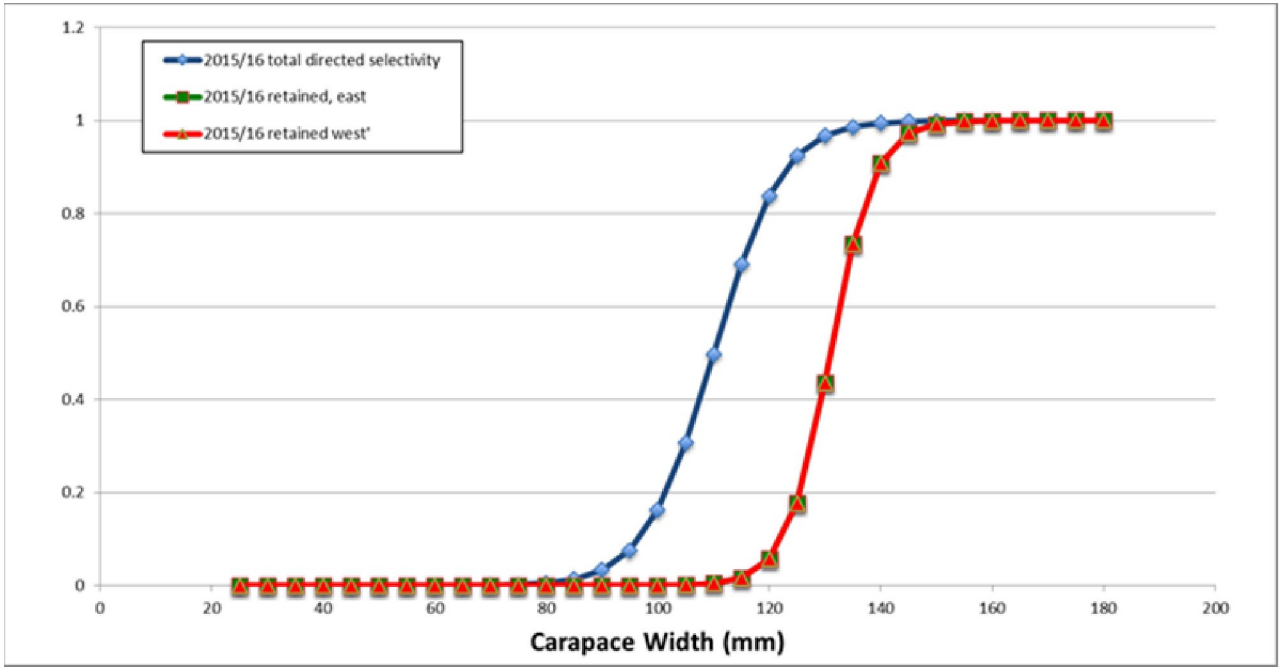


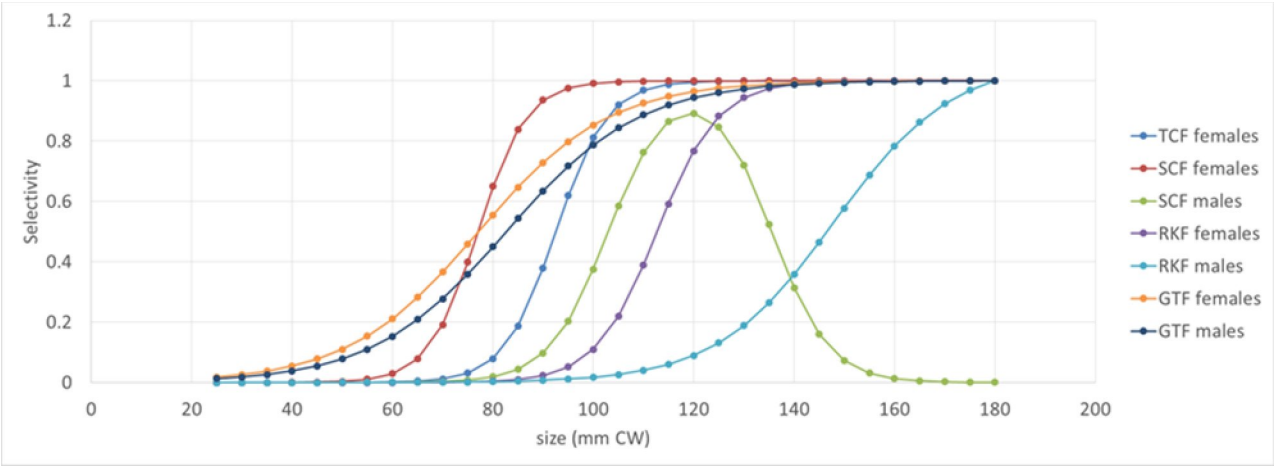






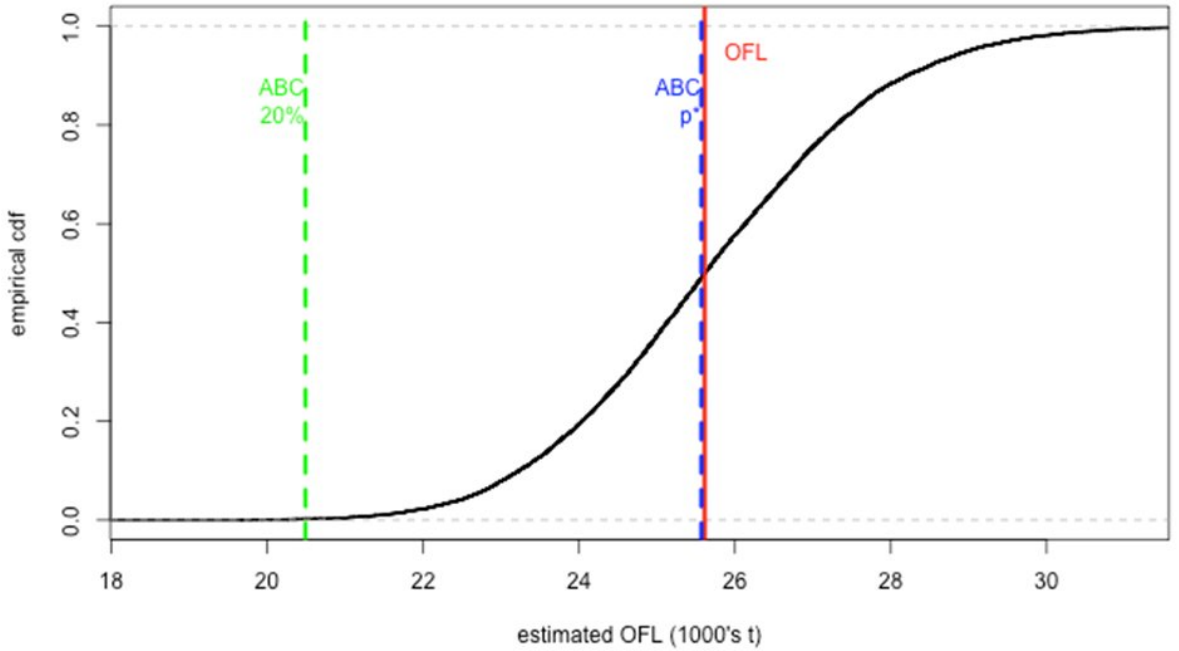
Status Determination & OFL Calculation



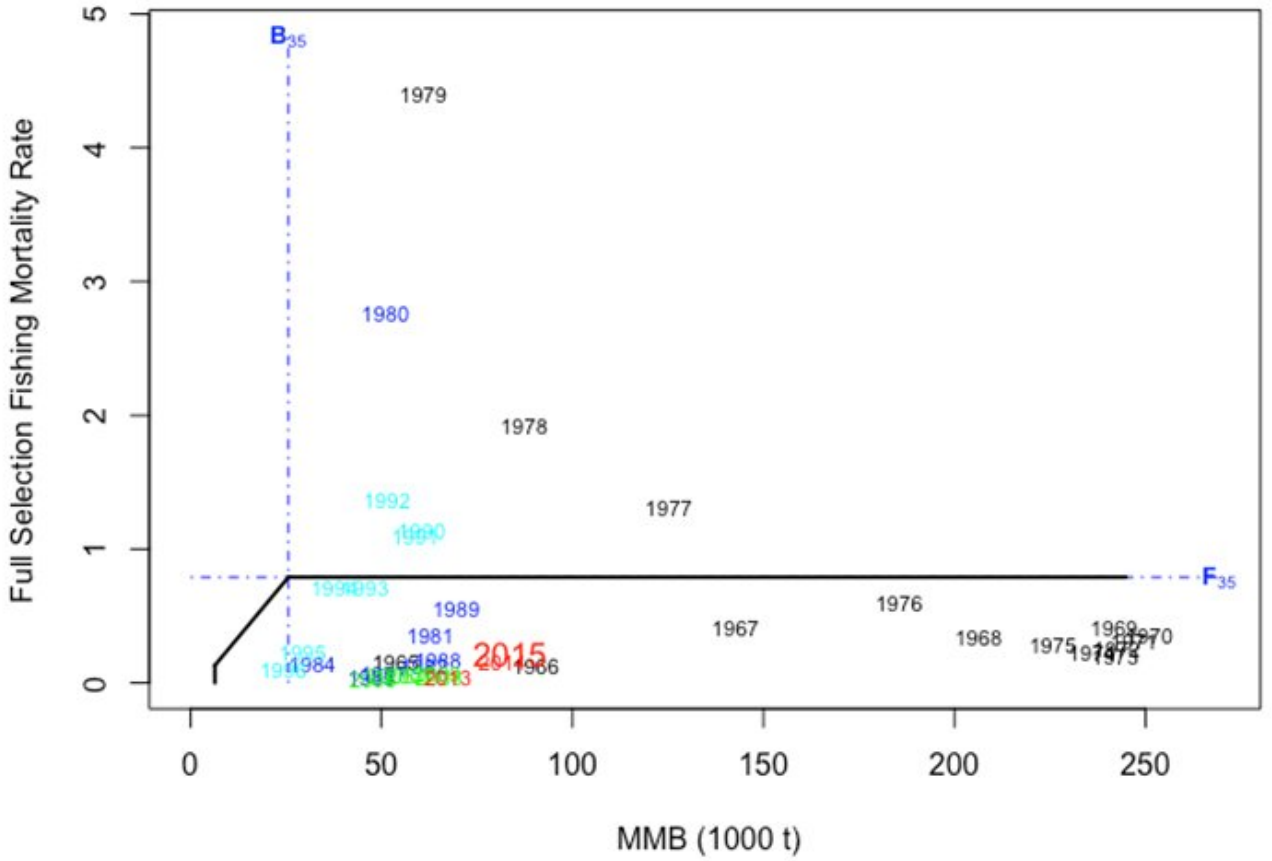


Status Determination & OFL Calculation

- snow crab F_{OFL} = 1.24 yr^{-1}
- effective $F_{snow\ crab}$ = 0.09 yr^{-1}
- F_{MSY} = 0.79 yr^{-1}
- mean recruitment = 182.27 million
- B_{MSY} = 25.65 thousand t
- 2016/16 MMB-at-mating = 45.34 thousand t
- B/BMSY = 1.77
- Tier = 3a



Status Determination & OFL Calculation



Management Reference Points

Not overfished
No overfishing

Basis for the OFL

Year	Tier[A]	B_{MSY}[A]	Current MMB[A]	B/B_{MSY}[A]	F_{OFL}[A]	Years to define B_{MSY}[A]	Natural Mortality[A,B]
2012/13	3a	33.45	58.59	1.75	0.61 yr^{-1}	1982-2012	0.23 yr^{-1}
2013/14	3a	33.54	59.35	1.77	0.73 yr^{-1}	1982-2013	0.23 yr^{-1}
2014/15	3a	29.82	63.80	2.14	0.61 yr-1	1982-2014	0.23 yr-1
2015/16	3a	26.79	53.70	2.00	0.58 yr-1	1982-2015	0.23 yr-1
2016/17	3a	25.65	45.34	1.77	0.79 yr^{-1}	1982-2016	0.23 yr^{-1}

Management Performance

Year	MSST	Biomass (MMB)	TAC (East + West)	Retained Catch	Total Catch Mortality	OFL	ABC
2012/13	16.77	59.35[A]	0.00	0.00	0.71	19.02	8.17
2013/14	16.98	72.70[A]	1.41	1.26	2.78	25.35	17.82
2014/15	13.40	71.57[A]	6.85	6.16	9.16	31.48	25.18
2015/16	12.82[C]	73.93[A]	8.92	8.91	11.38	27.19	21.75
2016/17		45.34[B]				25.61[C]	20.49[C]

Biomass units: 1000's t

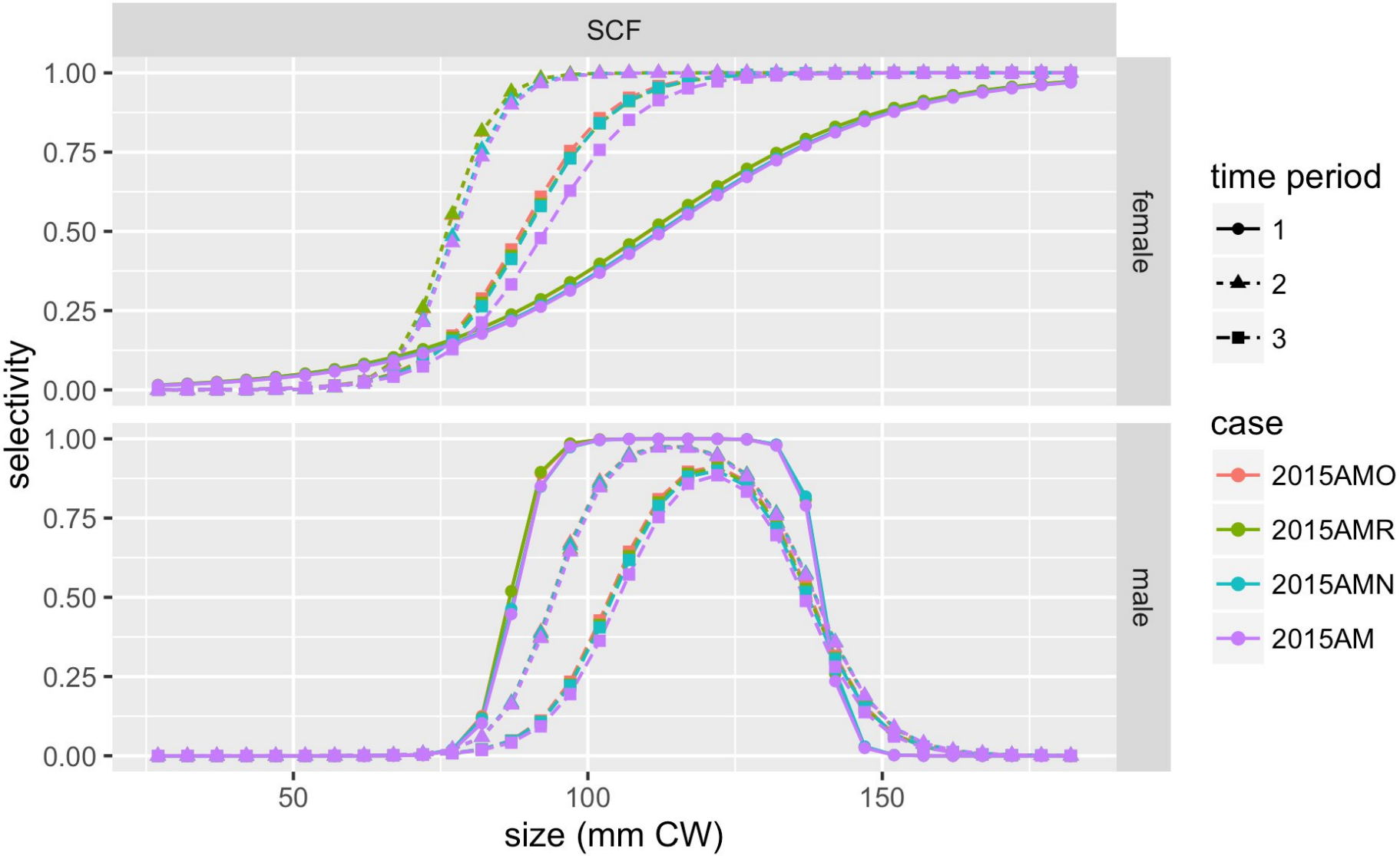
Future Directions

- Modeling Workshop/May 2017: switch to new model code
  - TCSAM2015 (will be TCSAM2017)
  - much more flexible than current version
    - arbitrary time periods for model processes
    - priors available on all model parameters
    - status determination incorporated w/in model
      - separate projection model not necessary
      - uses analytic equilibrium solutions
    - ability to simulate data/test model
    - ability to easily run retrospective analyses
    - can address some other outstanding CPT/SSC requests
  - A transition to a Gmacs-based model
- Extended:
  - incorporate chela height data directly in model
  - incorporate growth data directly in model
  - incorporate BSFRF survey data
  - disaggregate East/West directed fisheries in model
  - disaggregate groundfish bycatch (fixed gear, trawl fisheries) in model
  - develop recruitment hindcasts/forecasts using early life biophysical IBM

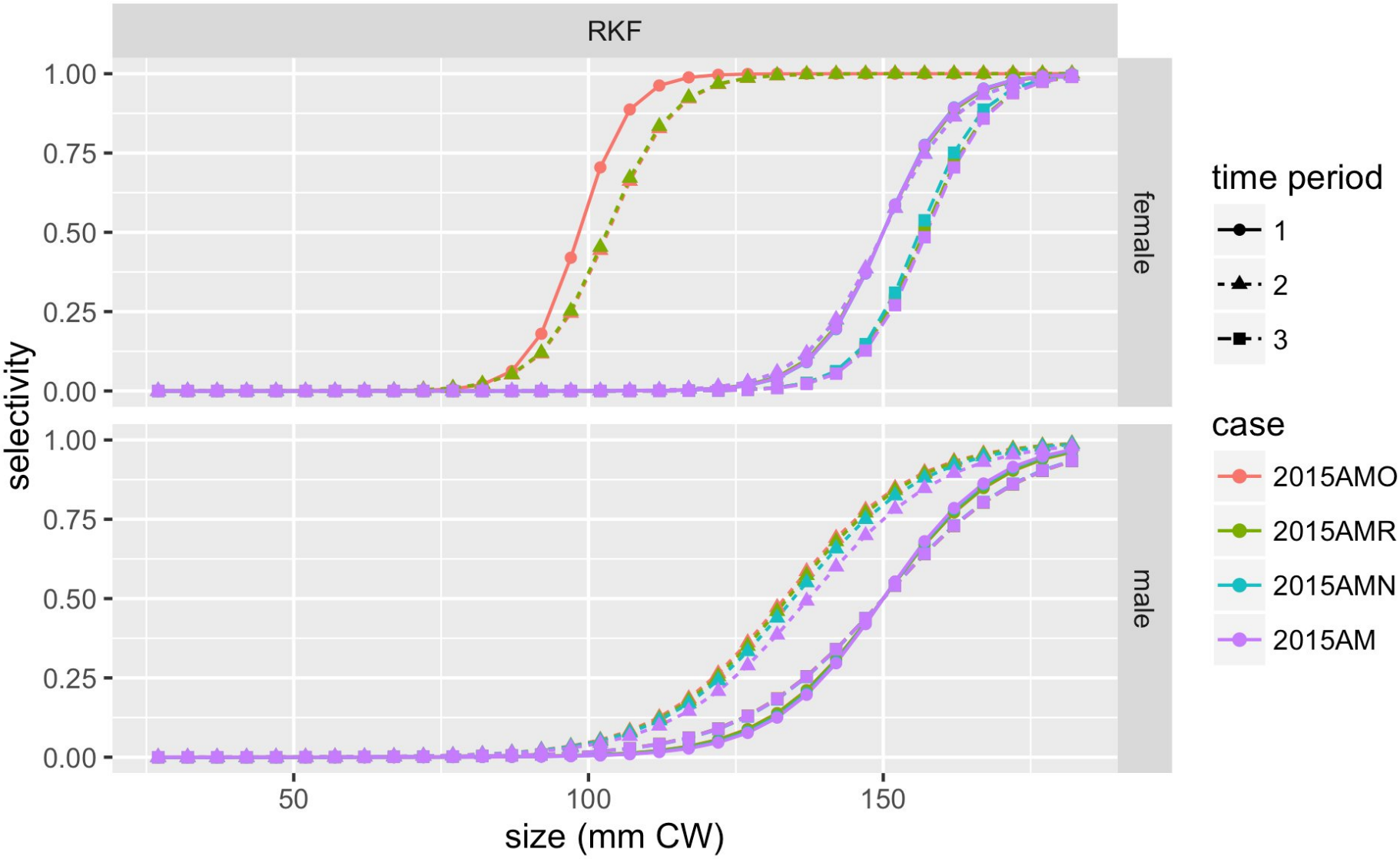
Alternative Models: Status Determination & OFL Calculation

Model	Snow Crab Fofl	Efffective Snow Crab F	Average Recruitment	B	Fmsy	Bmsy	B/Bmsy	OFL	ABC P-star	ABC (20% buffer)
2015 Model	1.32	0.049	179.37	53.70	0.58	26.79	2.00	27.19	27.15	21.75
2015AMR	1.32	0.051	176.78	51.41	0.64	25.68	2.00	27.27	27.23	21.82
2015AMN	1.32	0.044	193.44	63.85	0.56	29.42	2.17	30.96	30.91	24.77
2015AM	1.24	0.030	183.46	48.07	0.59	26.68	1.80	23.79	23.75	19.03
Model A	–	–	–	–	–	–	–	--	–	–
Model B	1.24	0.092	182.17	45.32	0.79	25.64	1.77	25.60	25.56	20.48
Model C	1.24	0.092	182.27	45.34	0.79	25.65	1.77	25.61	25.57	20.49
Model D	1.24	0.111	168.84	39.06	0.09	22.85	1.71	25.79	25.75	20.63
Model E	1.24	0.097	174.24	42.19	0.44	23.06	1.83	27.36	27.31	21.89
Model F	1.24	0.070	163.57	39.52	0.96	22.41	1.76	21.83	21.79	17.46
Model G	1.24	0.061	171.74	43.26	1.02	23.70	1.83	24.55	24.51	19.64

New CVs vs Old CVs: Snow Crab Fishery Bycatch Selectivity Functions



New CVs vs Old CVs: BBRKC Fishery Bycatch Selectivity Functions



New CVs vs Old CVs: Groundfish Fisheries Bycatch Selectivity Functions