Tanner Crab

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AFSC/NMFS

April 30, 2019

Topics

- Responses to CPT/SSC Comments
- BSFRF side-by-side haul integration
- Fishery data issues
- Issues related to the overestimation of large crab abundance
- Proposed scenarios for Fall, 2019

Responses to recent CPT/SSC Comments

October 2018 SSC Meeting

- ***Comment:*** **The SSC supports "the author's plans to investigate the sensitivity of the model to just a few early years of catch data".**
- ***Comment:*** **"The SSC continues to recommend that the authors try to resolve the parameters on the bounds issue by either simplifying the model or experimenting with removing the bounds".**
- ***Comment:*** **"The author should justify fitting both abundance and biomass indices in the model or fit only one index".**
- ***Comment:*** **"The team looks forward to seeing the BSFRF work included in the future If the catchability study is to be used to inform selectivity and catchability estimates in the model, it could be as a prior instead of as fixed inputs".**

September 2018 CPT Meeting

- ***Comment: None(?!)***

Responses to recent CPT/SSC Comments

June 2018 SSC Meeting

- ***Comment:*** **The SSC requested an evaluation of all parameters estimated to be at or very near bounds, or substantially limited by priors (unless those priors can be logically defended).**

May 2018 CPT Meeting

- ***Comment: The CPT outlined a number of alternative models built on the 2017 assessment model (2017AM) as the base model to be evaluated.***

BSFRF side-by-side survey integration

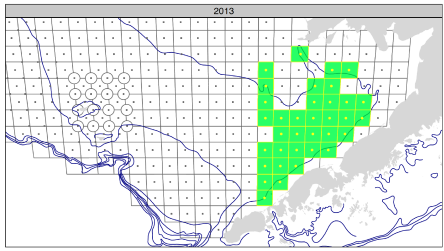
- BSFRF and NMFS conducted side-by-side haul studies to better characterize catchability for Tanner crab in
  - 2013-2017
  - 2018 (not yet available)

- NMFS hauls
  - 83-112 trawl gear
  - 30 min. tow

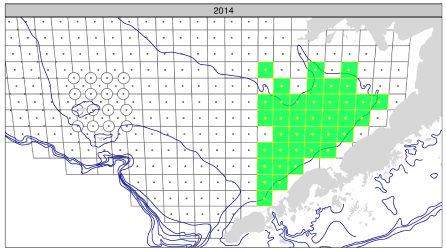
- BSFRF hauls
  - modified nephrops trawl gear
  - 5 min. tow

Study Locations

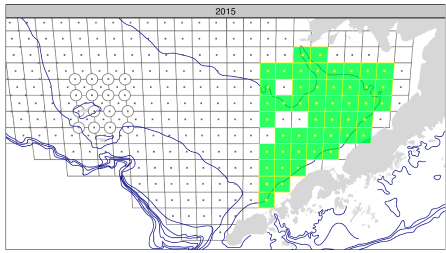
2013



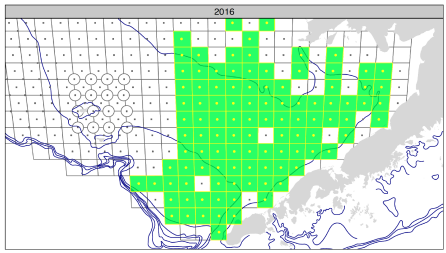
2014



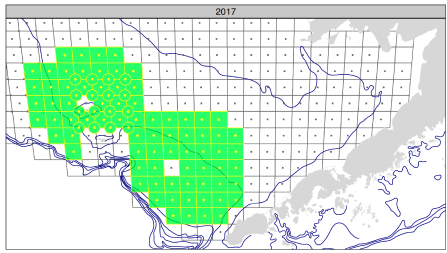
2015

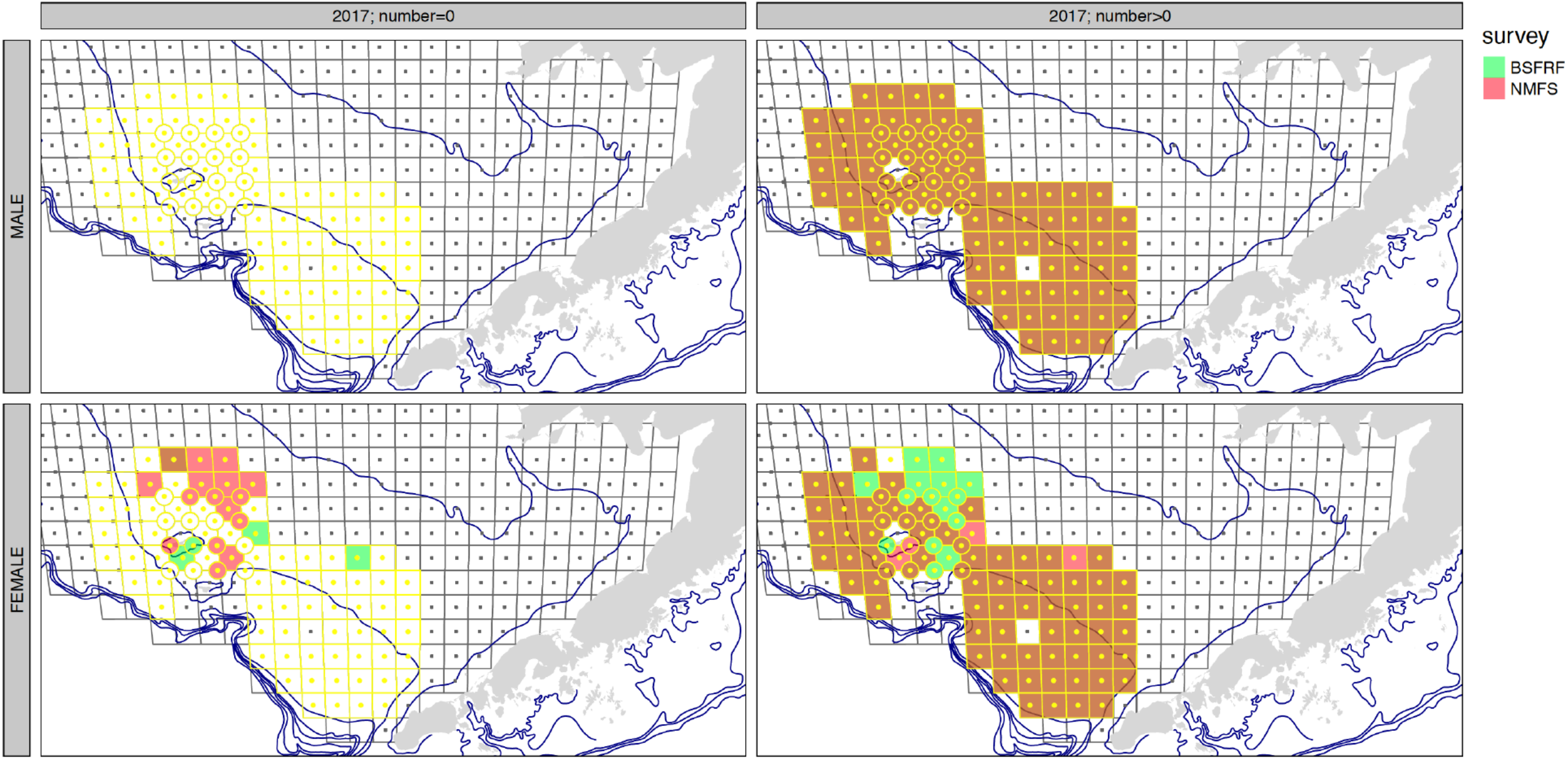


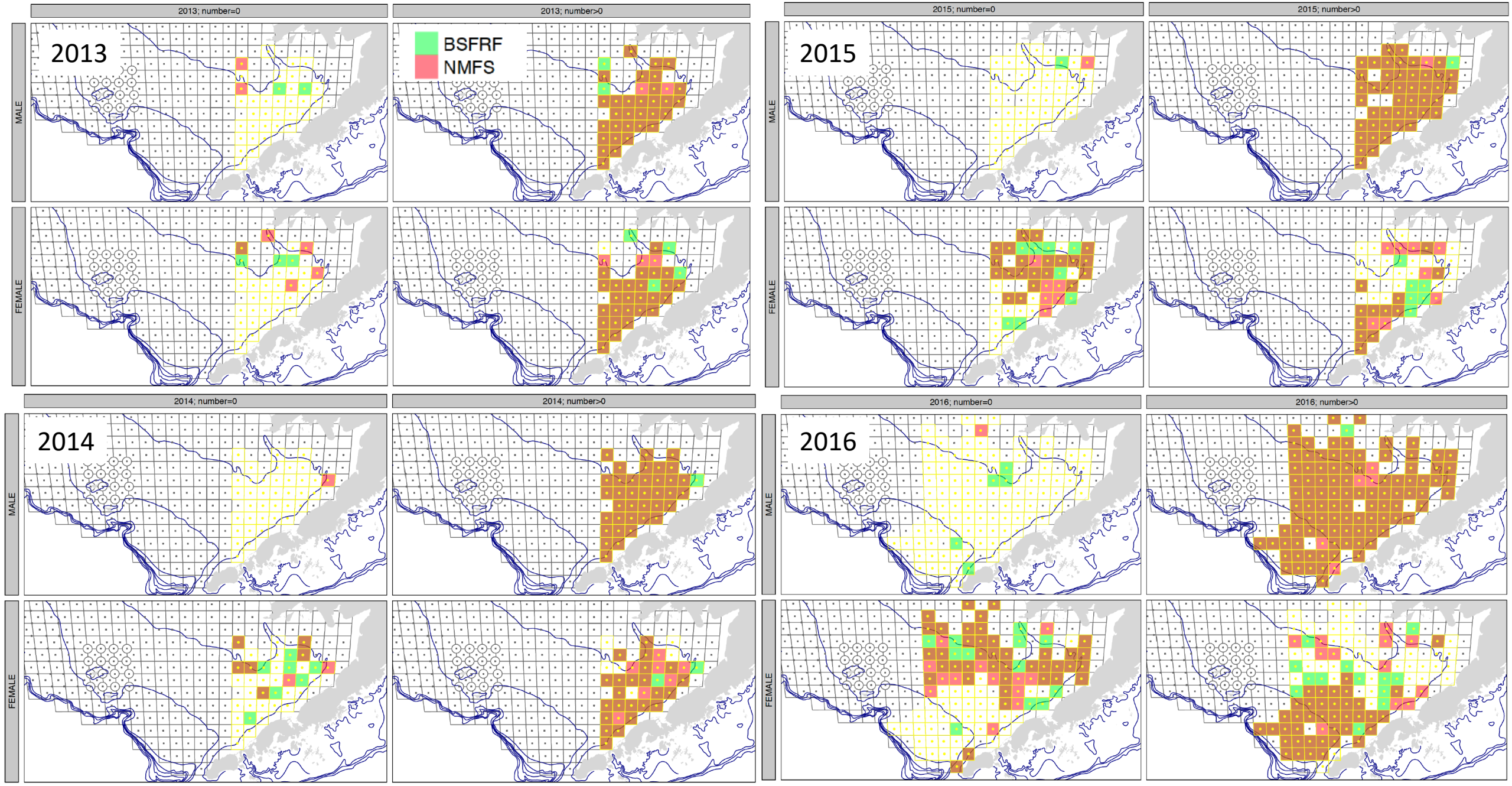
2016



2017

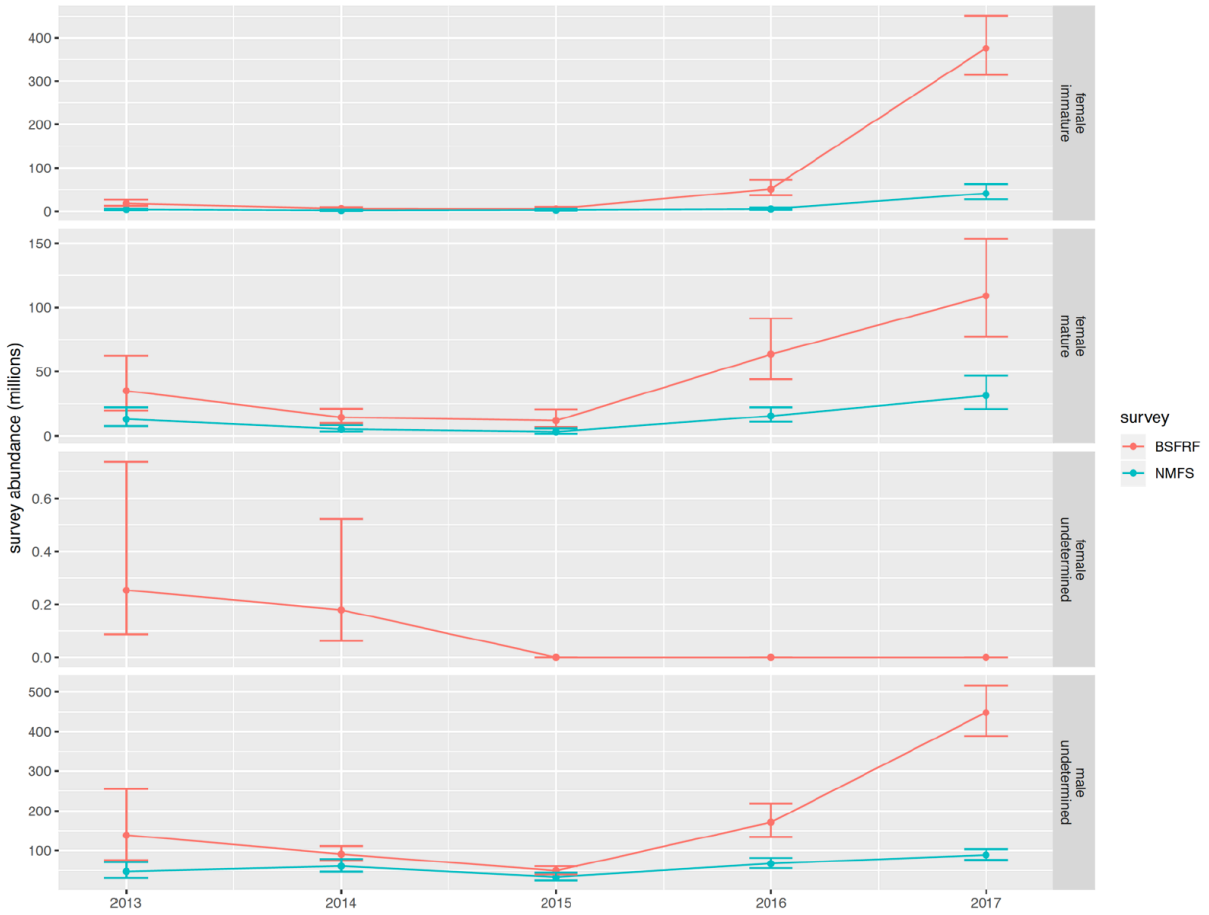



2017; number=0
2017; number>0
MALE
FEMALE
survey
BSFRF
NMFS

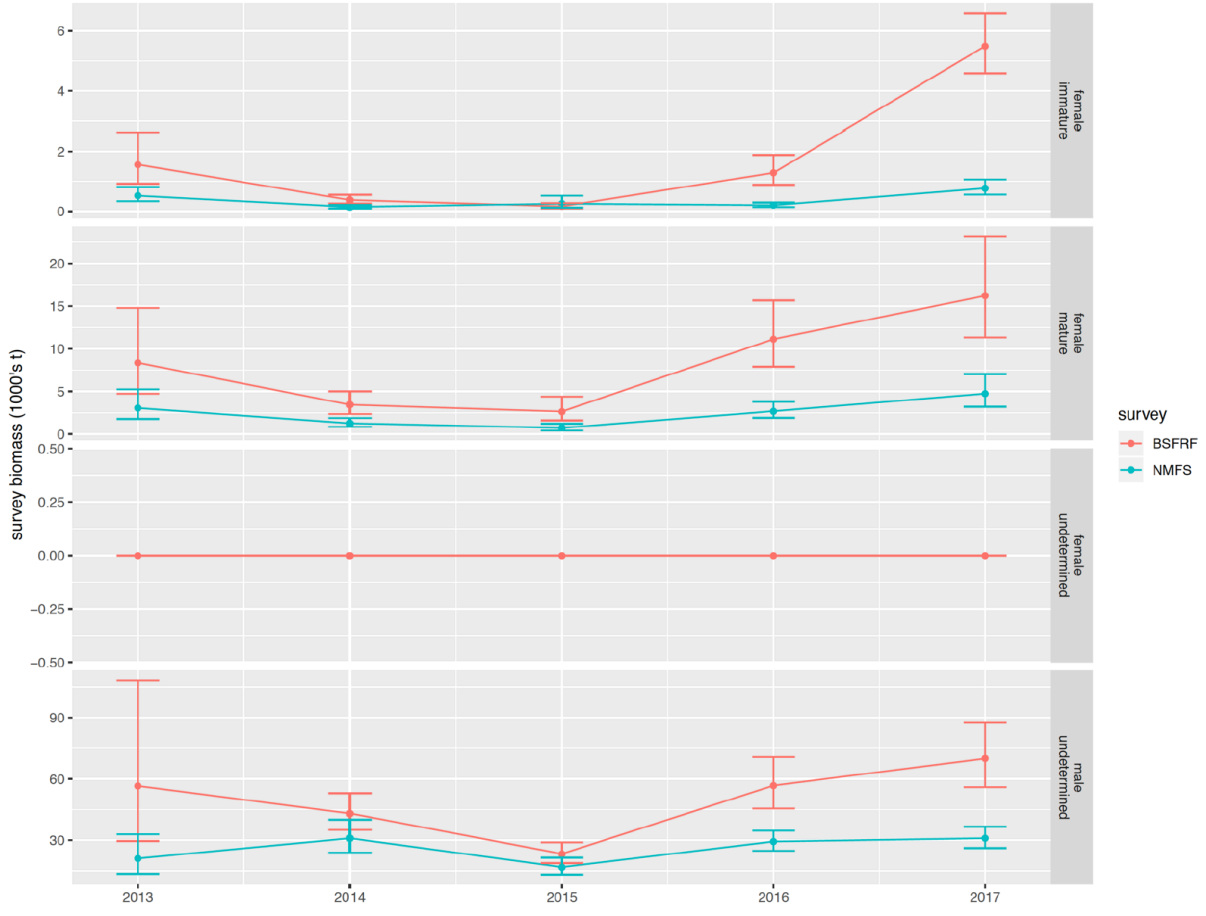

2013; number=0
2013; number>0
2015; number=0
2015; number>0
2013
BSFRF
NMFS
2015
MALE
FEMALE
2014; number=0
2014; number>0
2016; number=0
2016; number>0
2014
2016

Estimated total survey abundance and biomass within SBS area

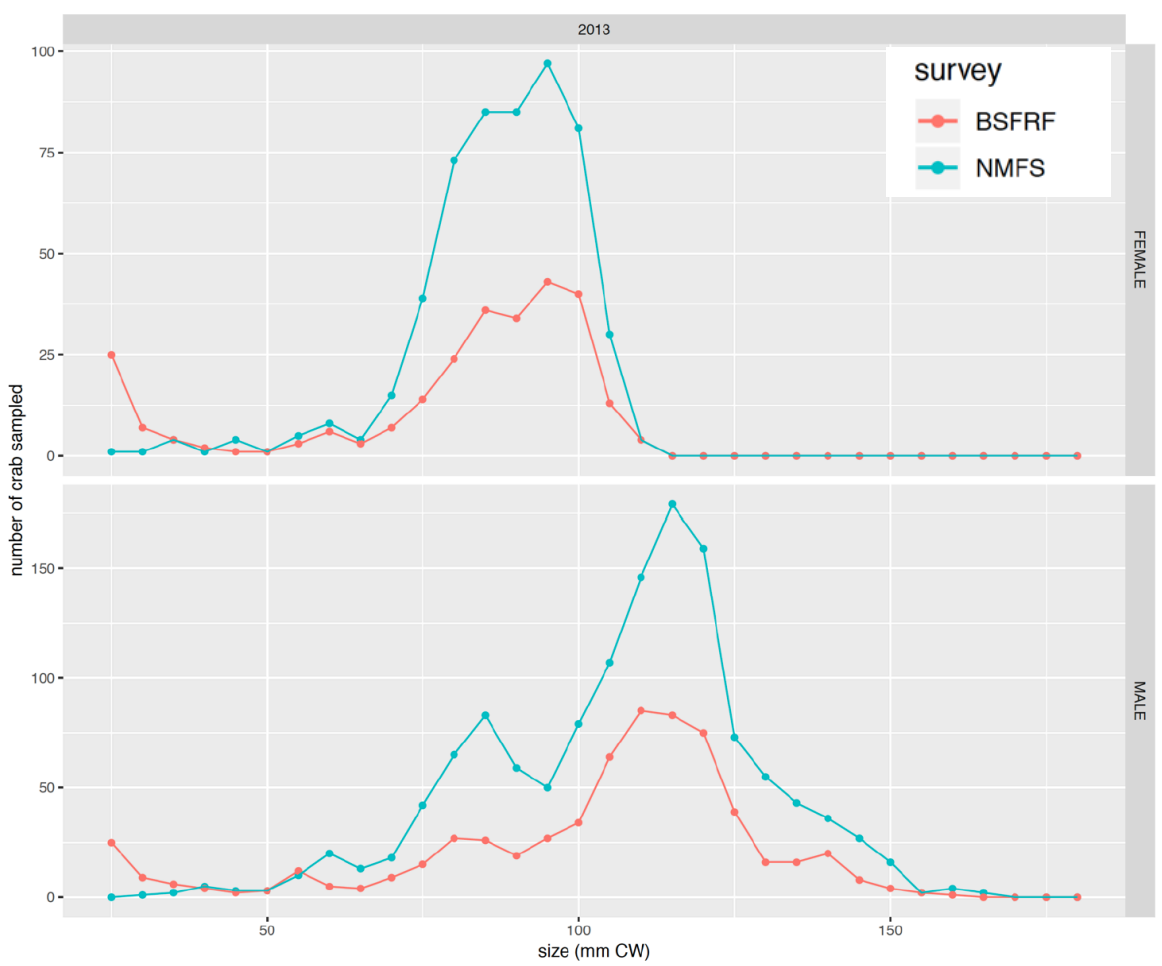
Abundance

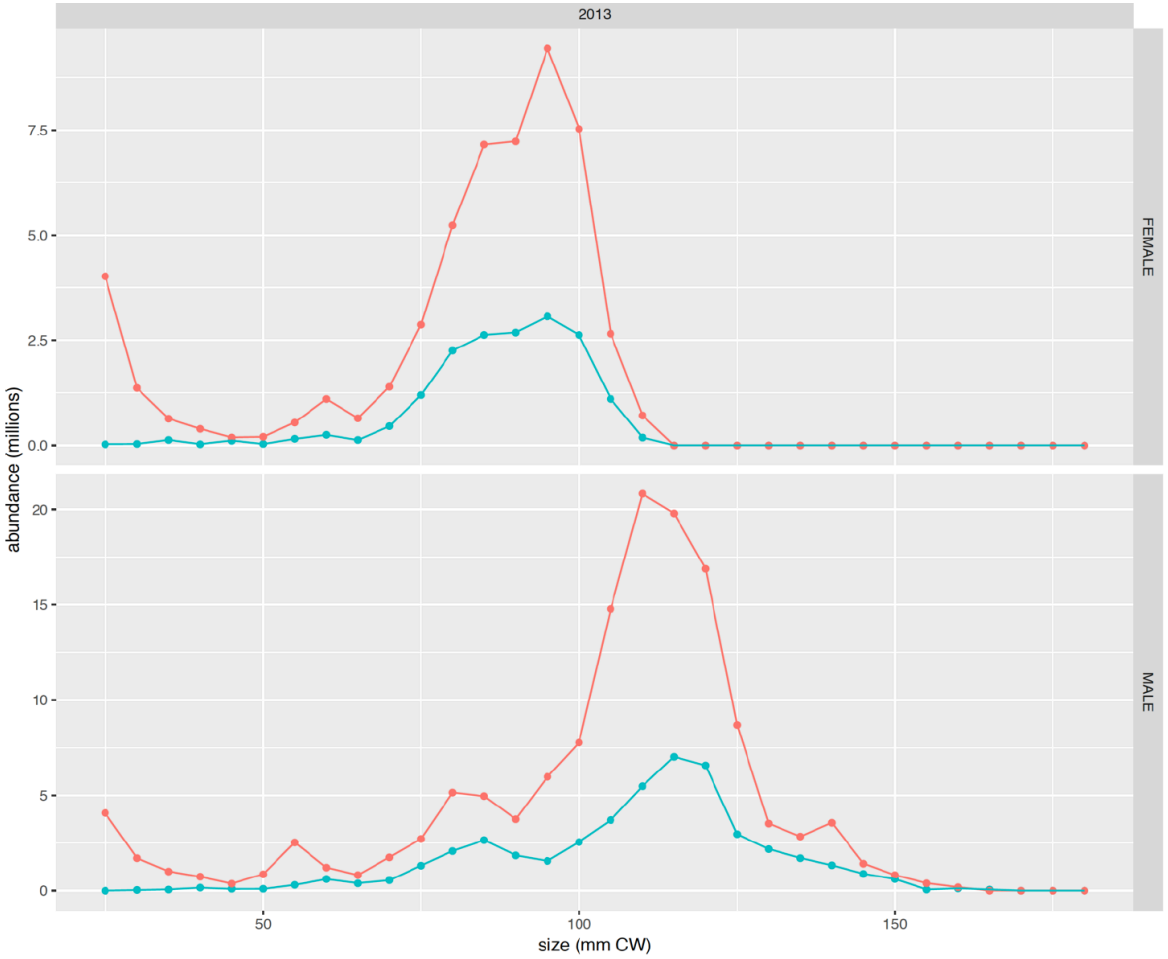


Biomass

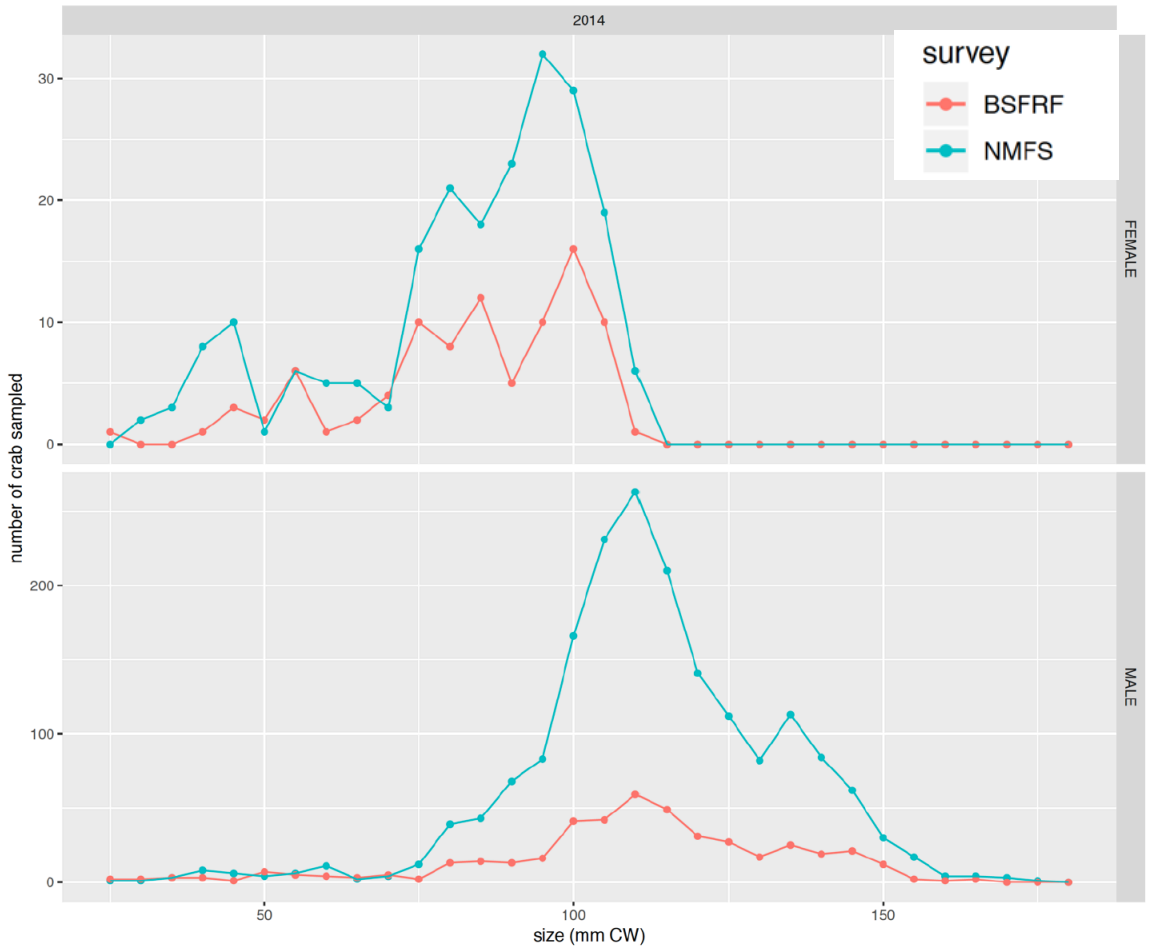


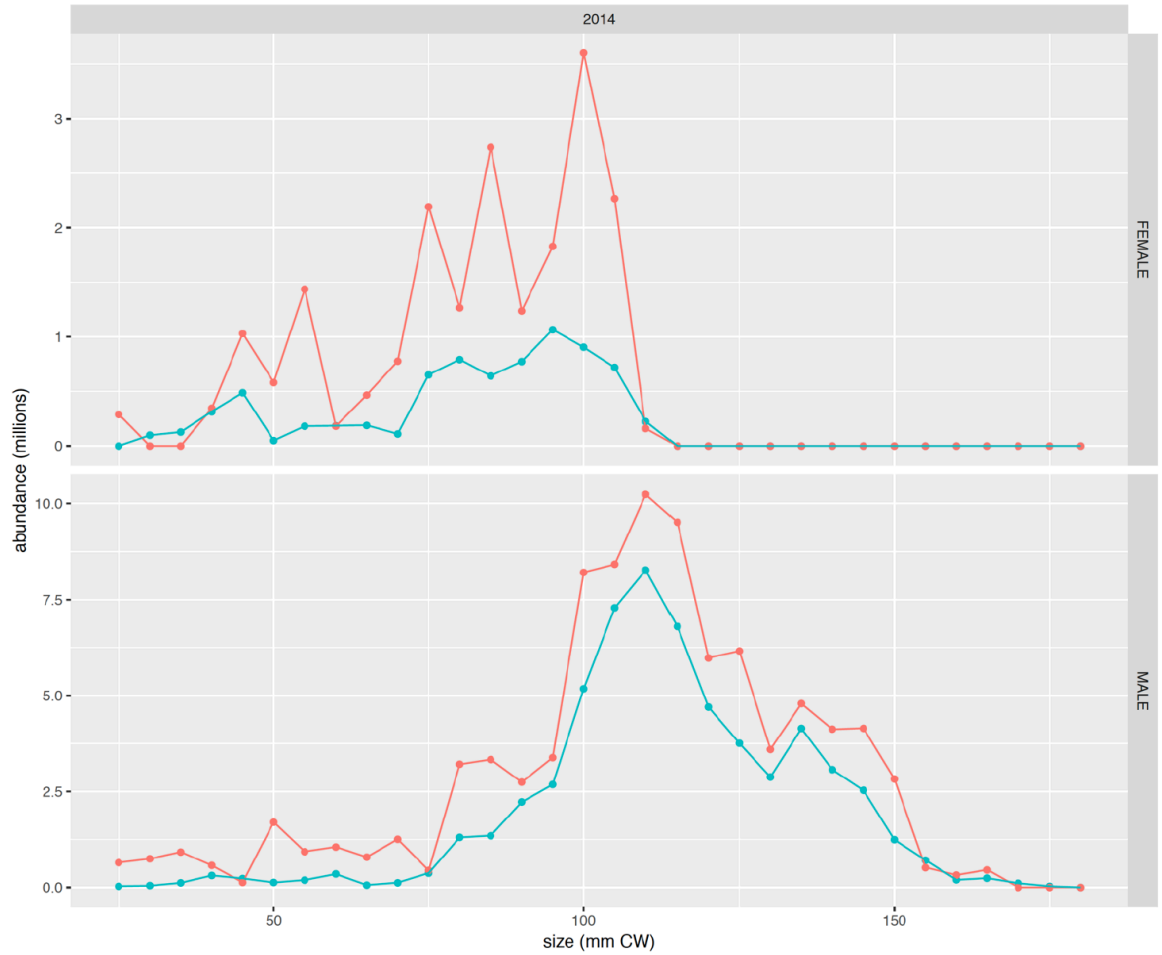
2013 SBS Sampling-by-Size Class and Estimated Survey Abundance



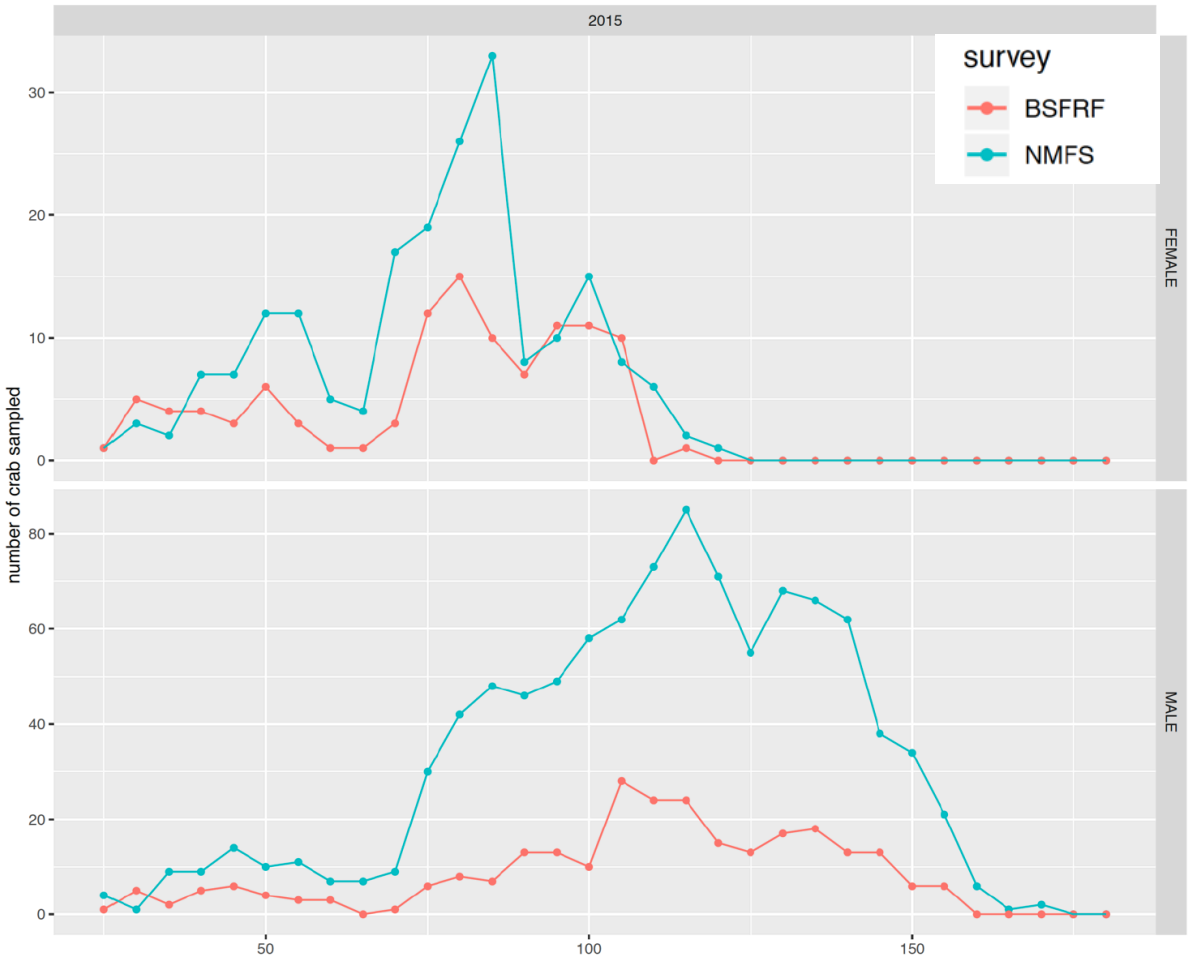


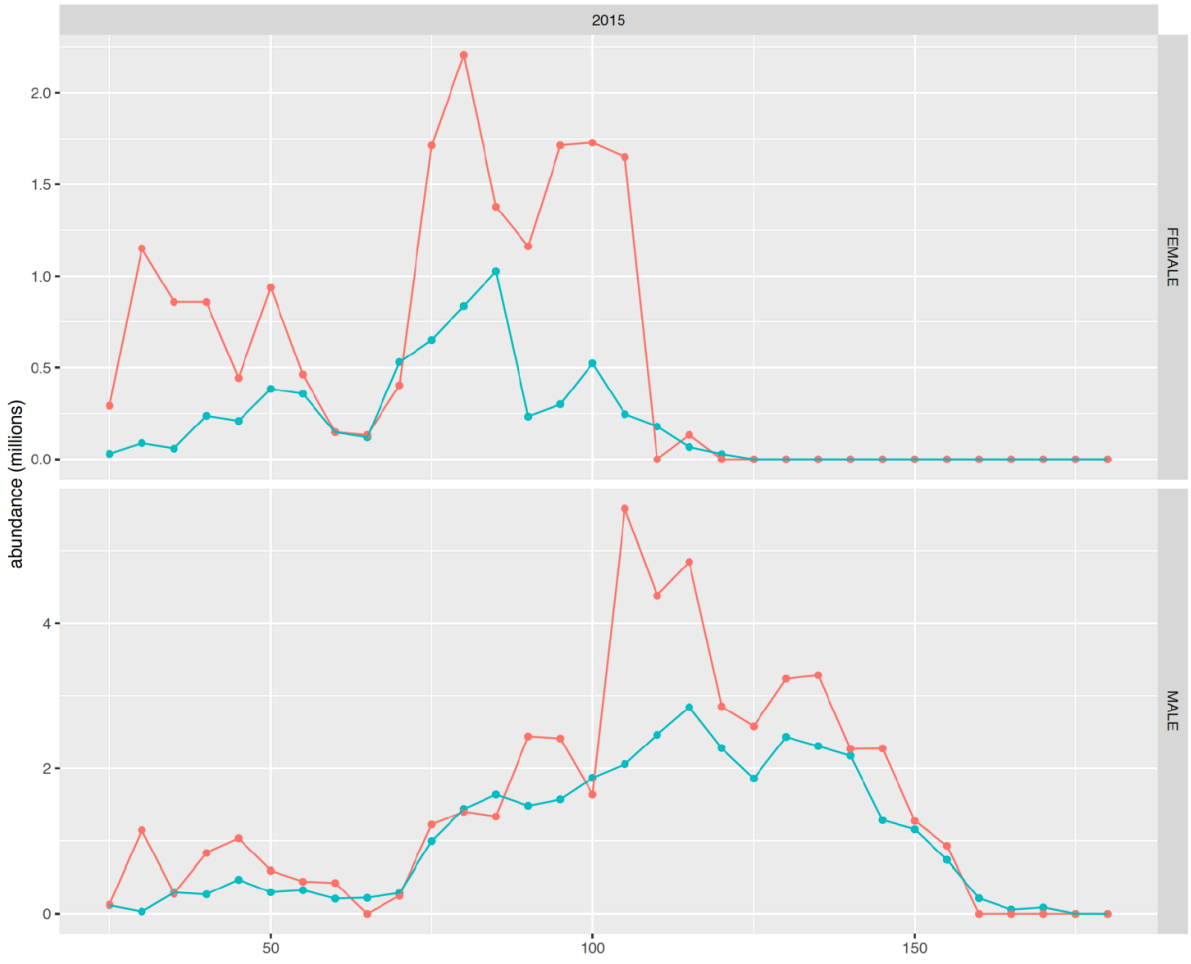
2014 SBS Sampling-by-Size Class and Estimated Survey Abundance



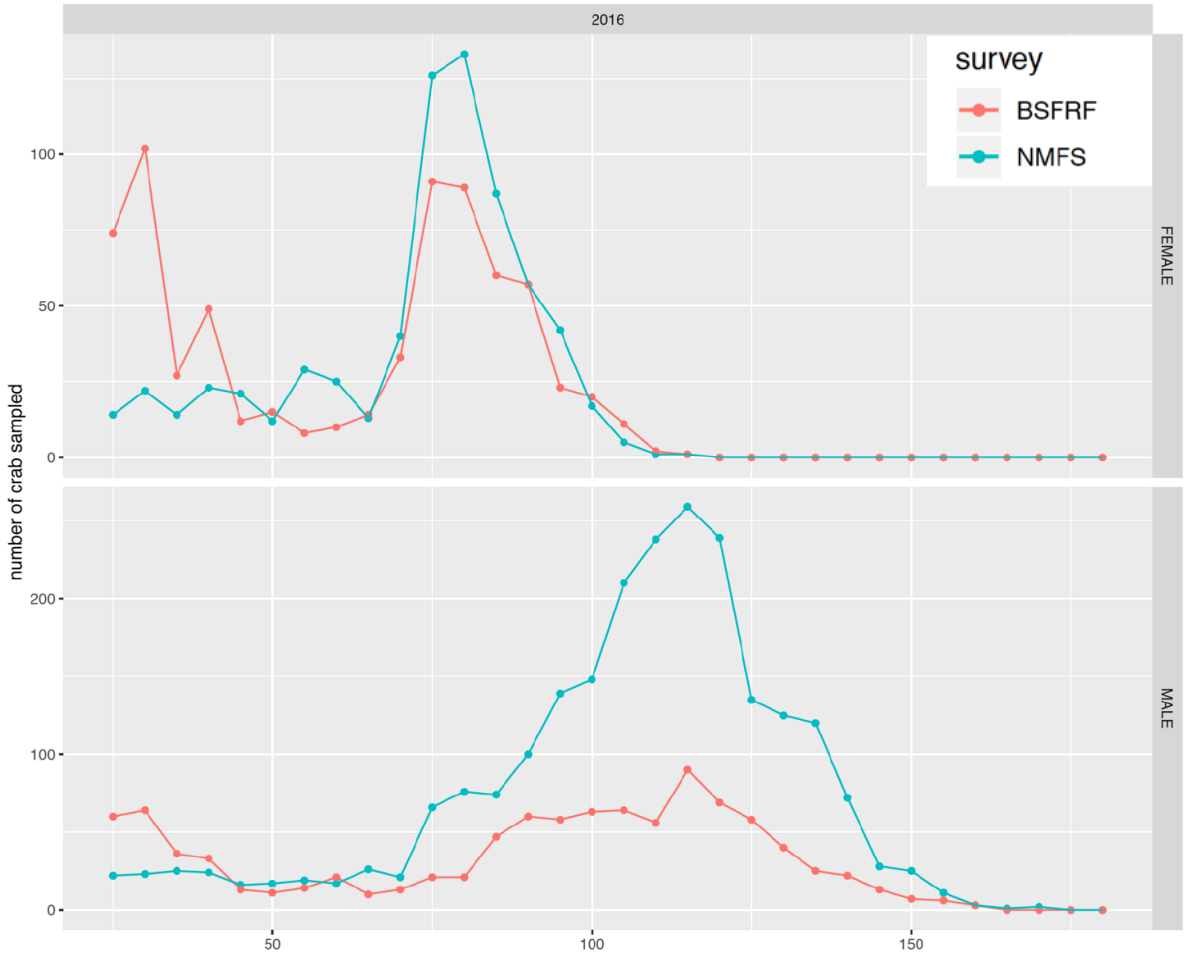


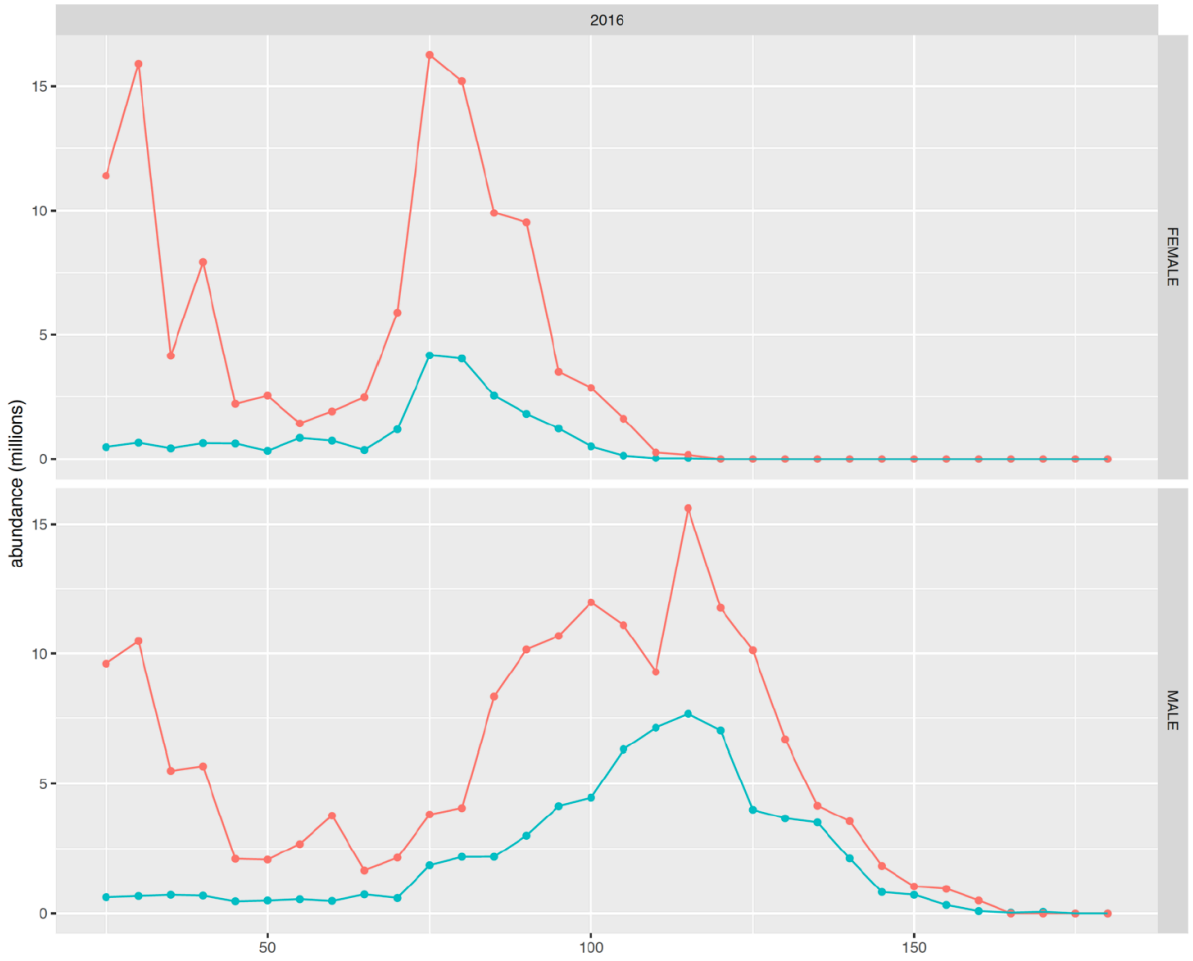
2015 SBS Sampling-by-Size Class and Estimated Survey Abundance



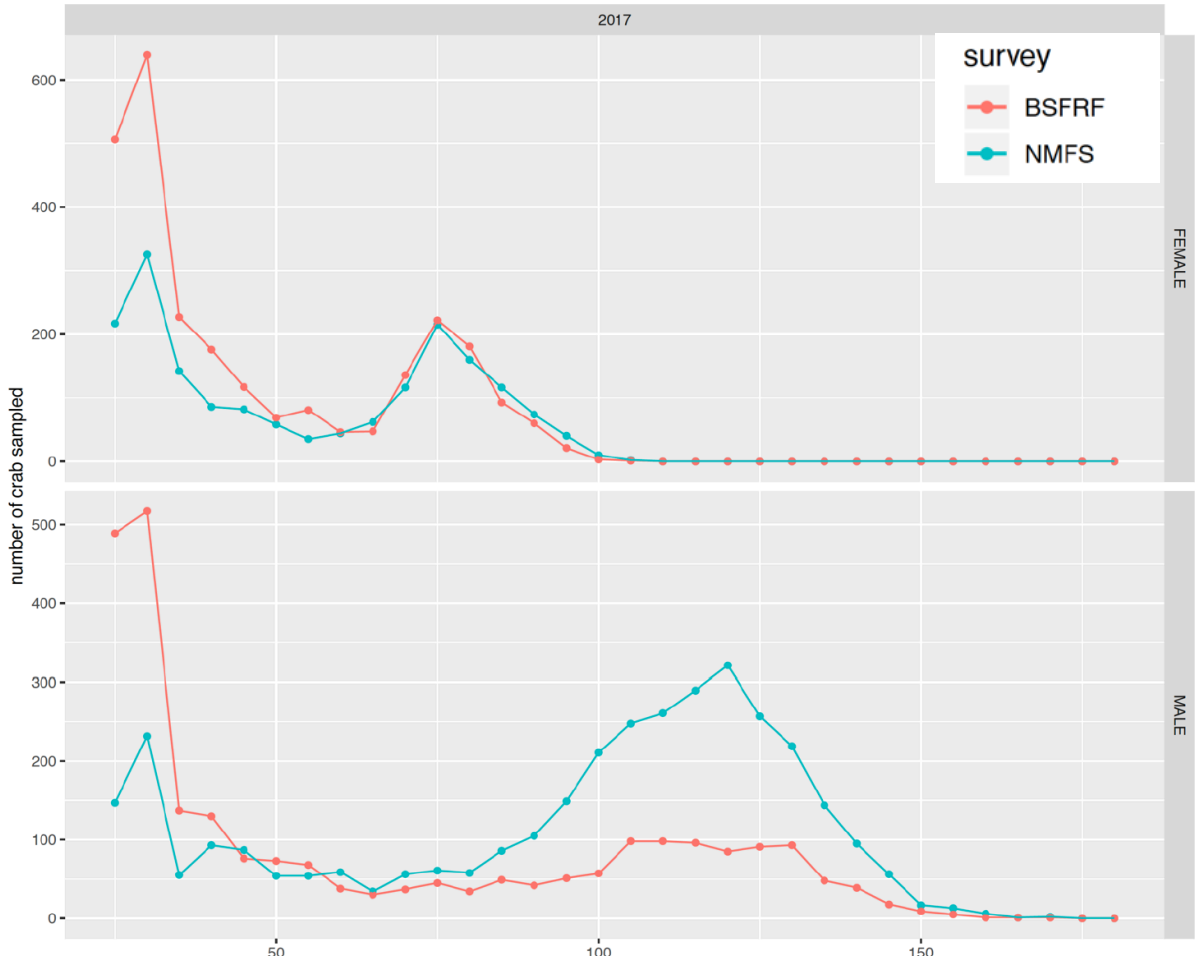


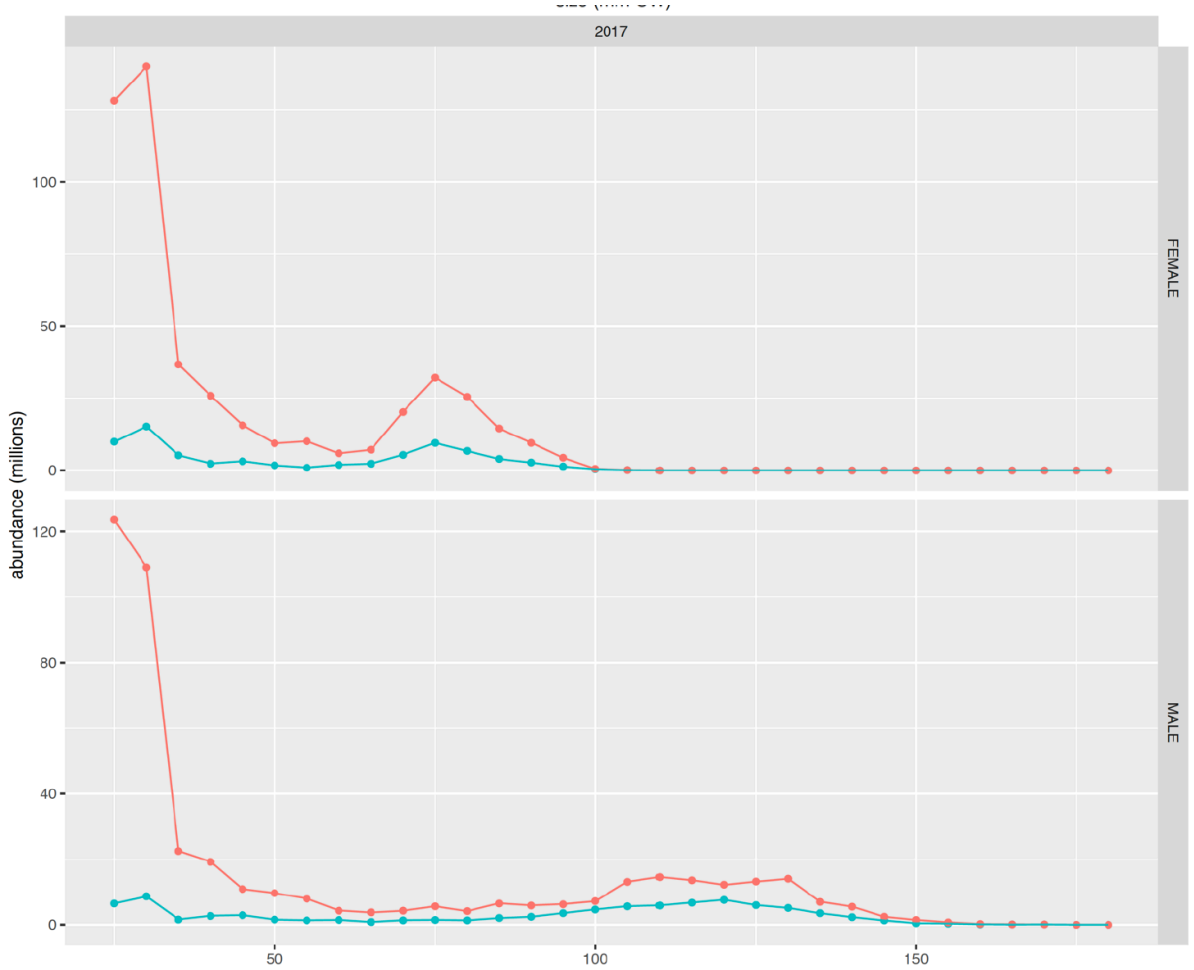
2016 SBS Sampling-by-Size Class and Estimated Survey Abundance

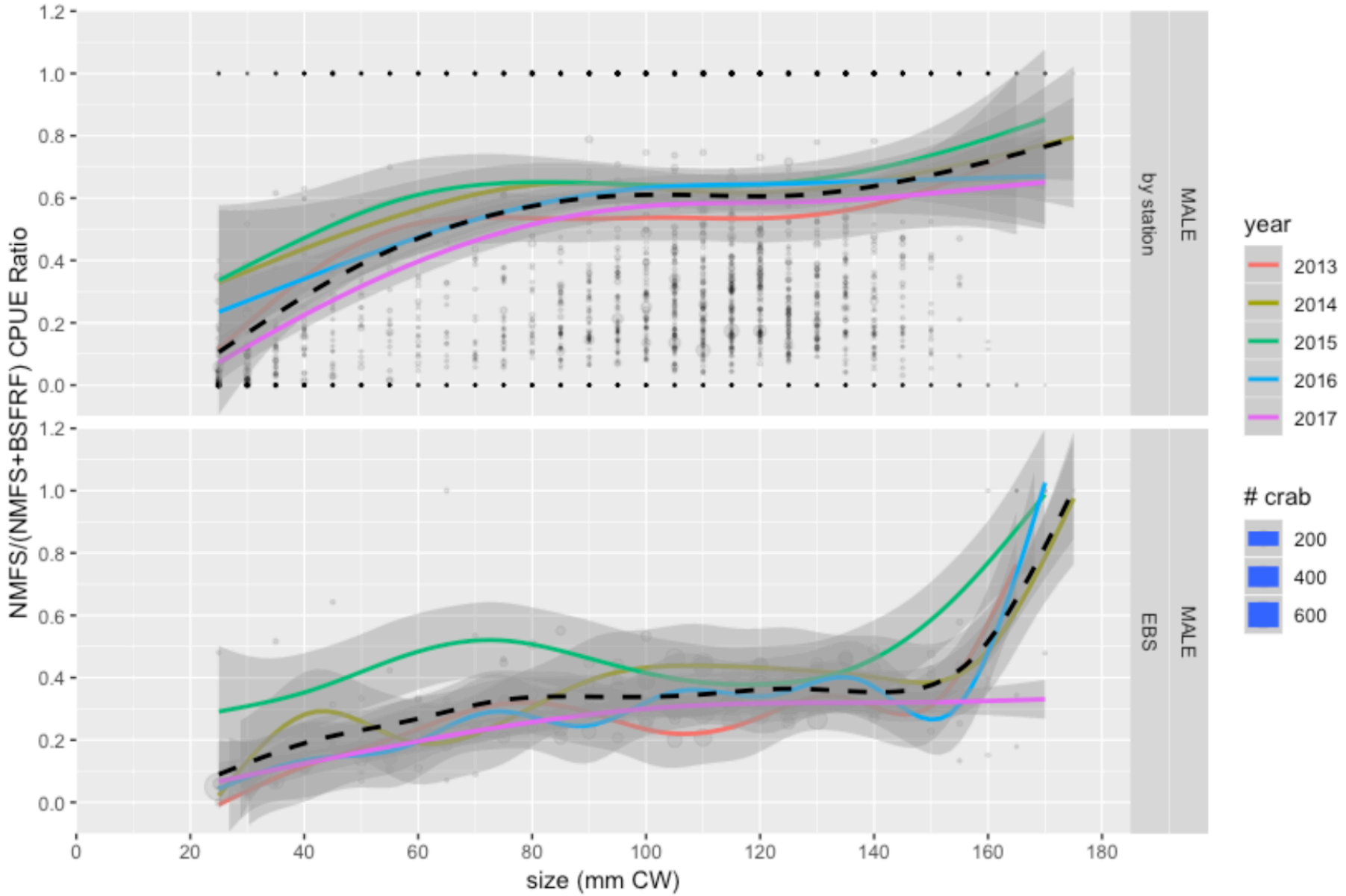


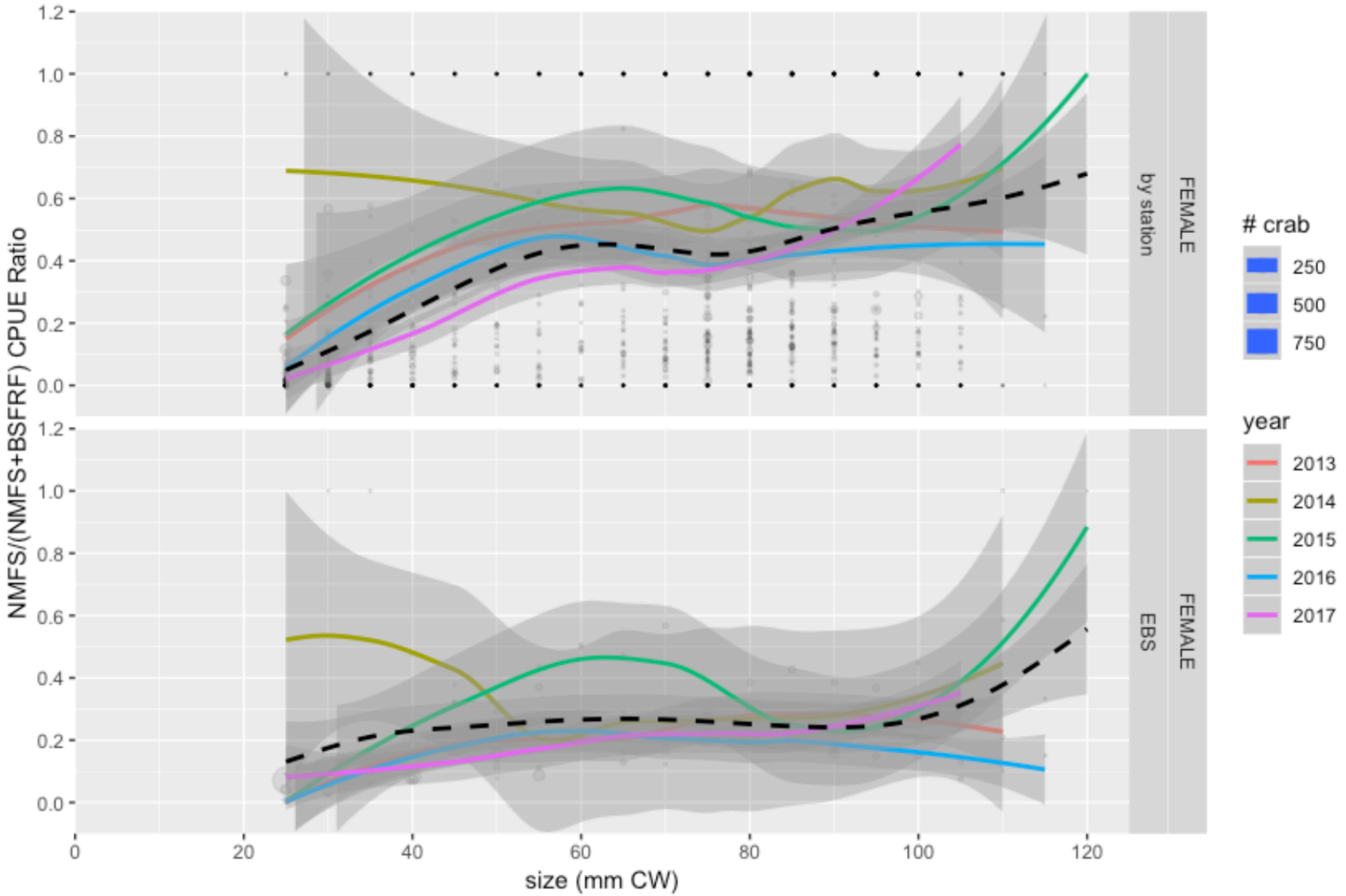


2017 SBS Sampling-by-Size Class and Estimated Survey Abundance






NMFS/(NMFS+BSFRF) CPUE Ratio
size (mm CW)
MALE
by station
MALE
EBS
year
2013
2014
2015
2016
2017
crab
200
400
600


NMFS/(NMFS+BSFRF) CPUE Ratio
1.2
1.0
0.8
0.6
0.4
0.2
0.0
FEMALE
by station
FEMALE
EBS
0
20
40
60
80
100
120
size (mm CW)
crab
250
500
750
year
2013
2014
2015
2016
2017

Modeling availability and selectivity

$$\tilde{n}^{s}_{x,z} = q^{s}_{x} \cdot S^{s}_{x,z} \cdot A_{x,z} \cdot n_{x,z}$$

NMFS ($A_{x,z} \equiv 1$): $\hat{n}^{NMFS}_{x,z} = q^{NMFS}_{x} \cdot S^{NMFS}_{x,z} \cdot n_{x,z}$

BSFRF ($q^{BSFRF}_{x}, S^{BSFRF}_{x,z} \equiv 1$): $\tilde{n}^{BSFRF}_{x,z} = A_{x,z} \cdot n_{x,z}$

NMFS SBS: $\tilde{n}^{NMFS}_{x,z} = q^{NMFS}_{x} \cdot S^{NMFS}_{x,z} \cdot A_{x,z} \cdot n_{x,z}$

Estimation

$$A_{x,z} = \frac{1}{1+\exp(-p_{x,z})} \qquad \mathcal{L}_S = \lambda \cdot \left[\nabla(\nabla p_{x,z})\right]^2$$

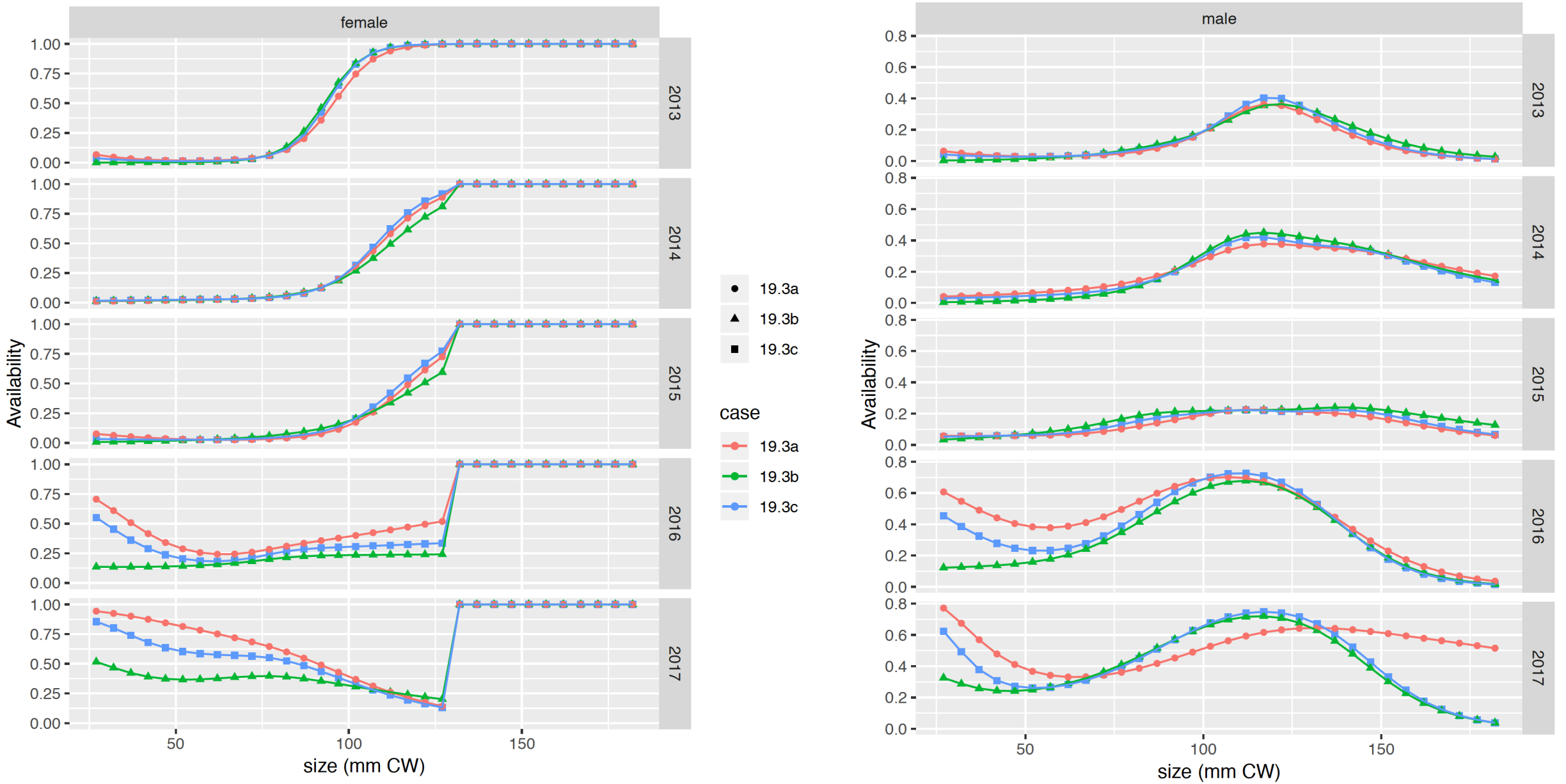
2018 Assessment Model (Model 19.0)

Component	Type	Distribution	Likelihood
TCF: retained catch	abundance	--	--
	biomass	norm2	males only
	size comp.s	multinomial	males only
TCF: total catch	abundance	--	--
	biomass	norm2	by sex
	size comp.s	multinomial	by sex
SCF: total catch	abundance	--	--
	biomass	norm2	by sex
	size comp.s	multinomial	by sex
RKF: total catch	abundance	--	--
	biomass	norm2	by sex
	size comp.s	multinomial	by sex
GTF: total catch	abundance	--	--
	biomass	norm2	by sex
	size comp.s	multinomial	by sex
NMFS survey	abundance	--	--
	biomass	lognormal	by sex, for mature crab only
	size comp.s	multinomial	by sex/maturity
	chela height data	--	--
growth data	EBS only	gamma	by sex

Estimated availability fixing other model parameters

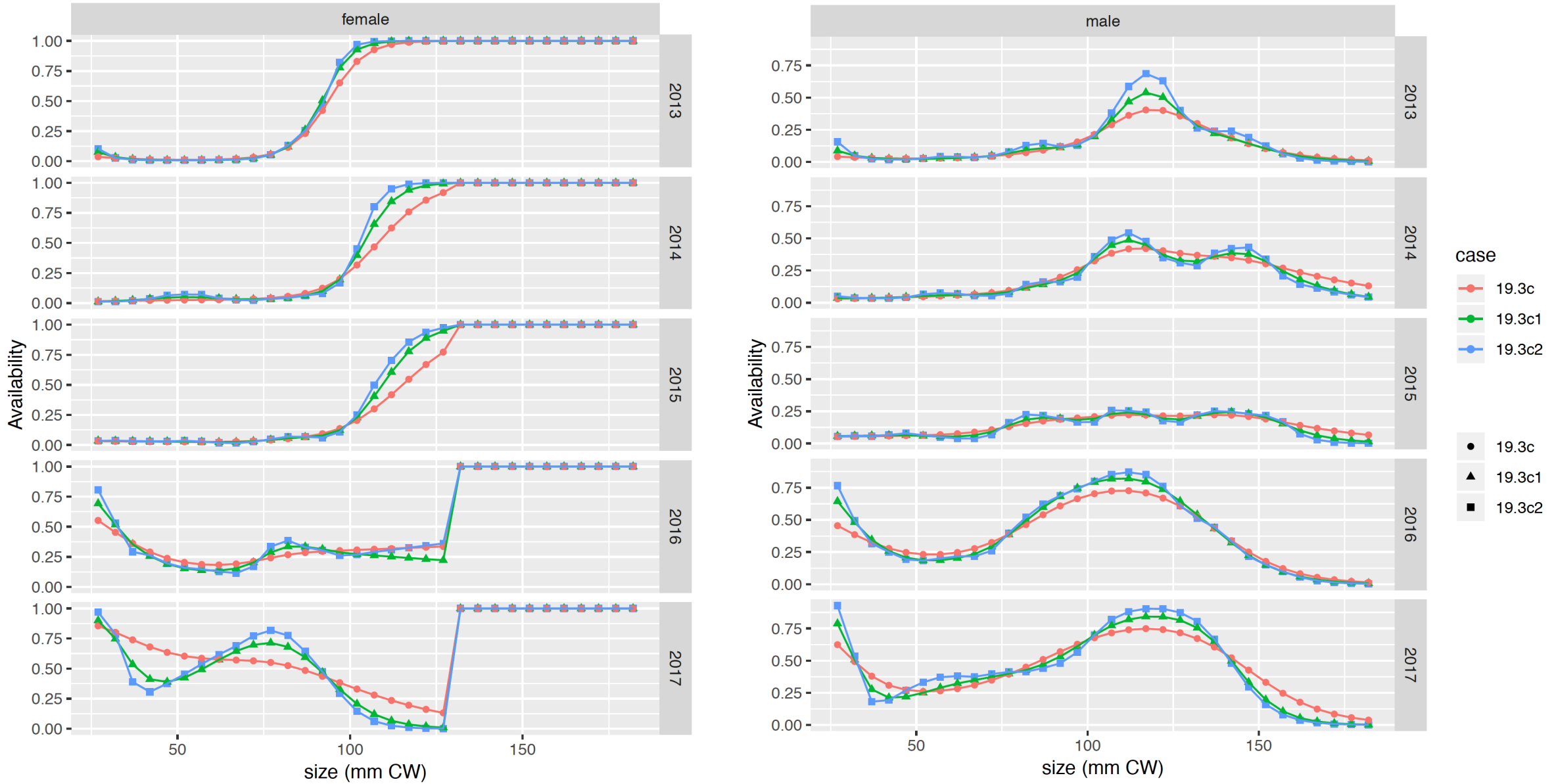
- Compared estimated availability by
  - fixing all base model parameters to 2018 assessment model (357 params)
  - estimating only availability parameters (265 params)
- SBS data: fits to
  - male biomass, size compositions
  - female biomass and size compositions by maturity state
- Scenarios:
  - 19.0: base model (2018 assessment model, no SBS data)
  - 19.3a: 19.0 + BSFRF SBS data (SMP: 100)
  - 19.3b: 19.0 + NMFS SBS data (SMP: 100)
  - 19.3c: 19.0 + all SBS data (SMP: 100)

Estimated availability fixing other model parameters



Estimated availability: effects of decreased smoothing

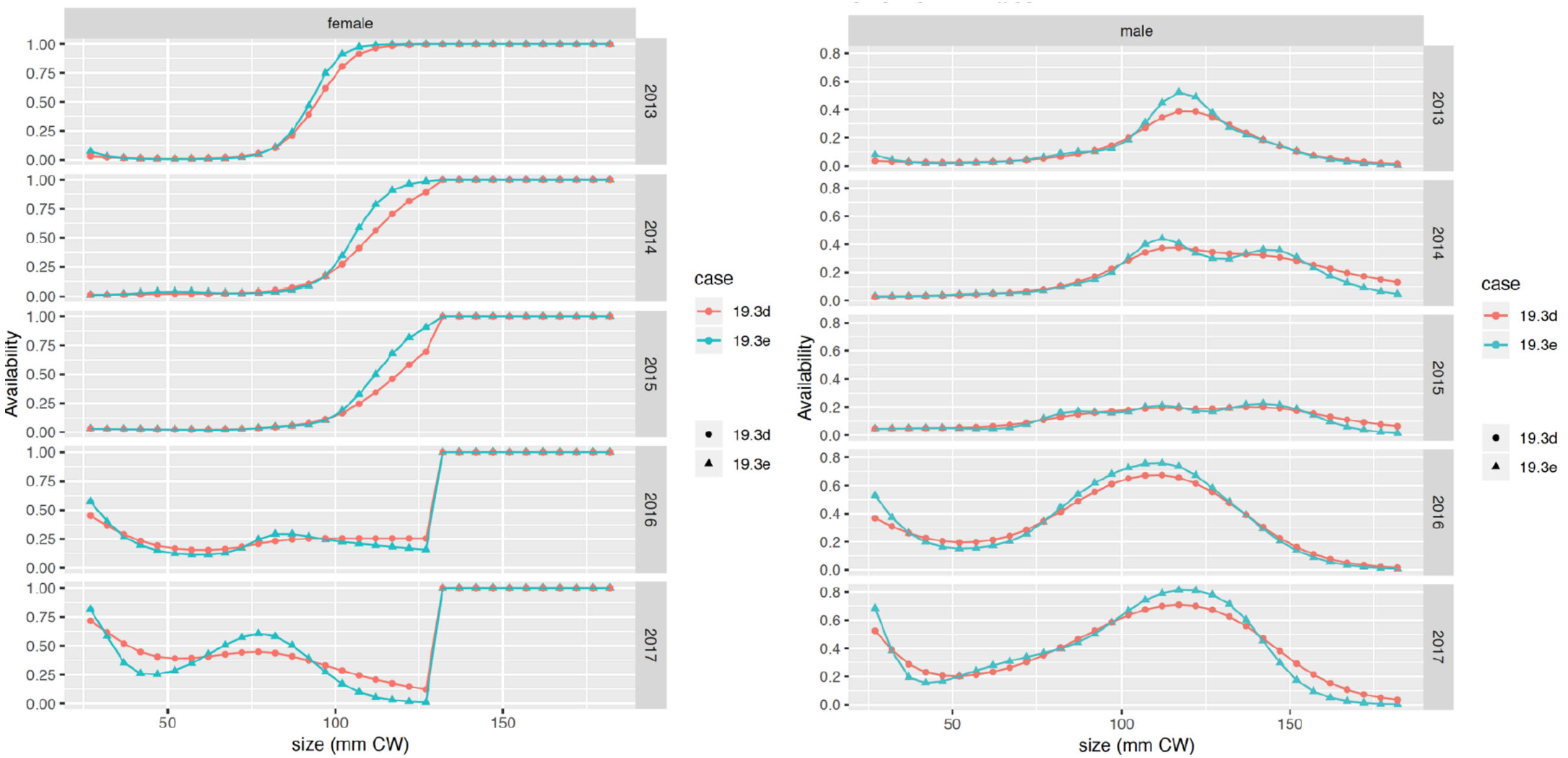
- Compared estimated availability for different smoothing factors
  - all base parameters fixed (265 parameters estimated)
- Scenarios:
  - 19.3c : SMP = 100 (19.0 + all SBS data)
  - 19.3c1: SMP = 10
  - 19.3c2: SMP = 1


female
male
2013
2014
2015
2016
2017
Availability
size (mm CW)
case
19.3c
19.3c1
19.3c2

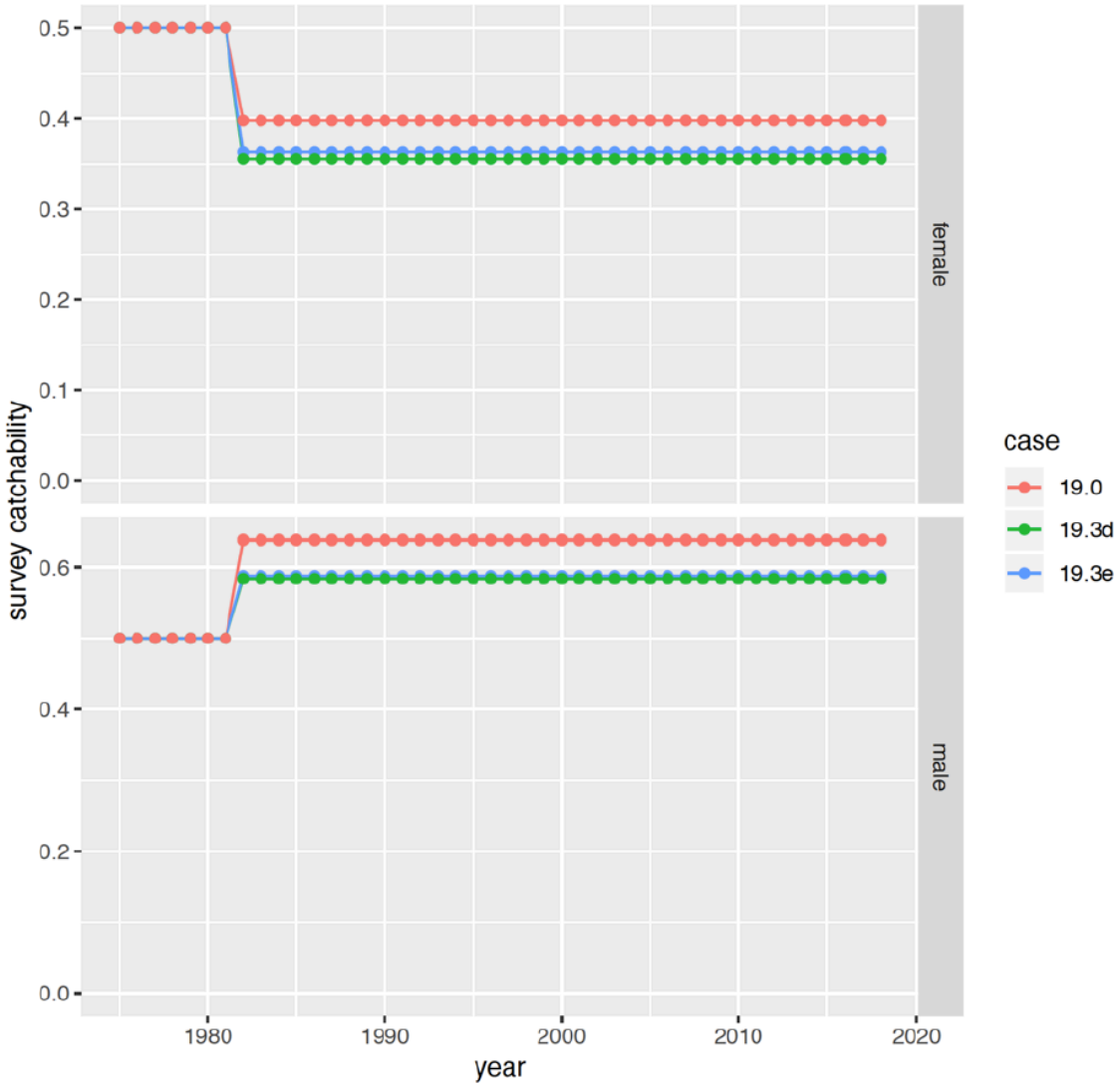
Full parameter estimation

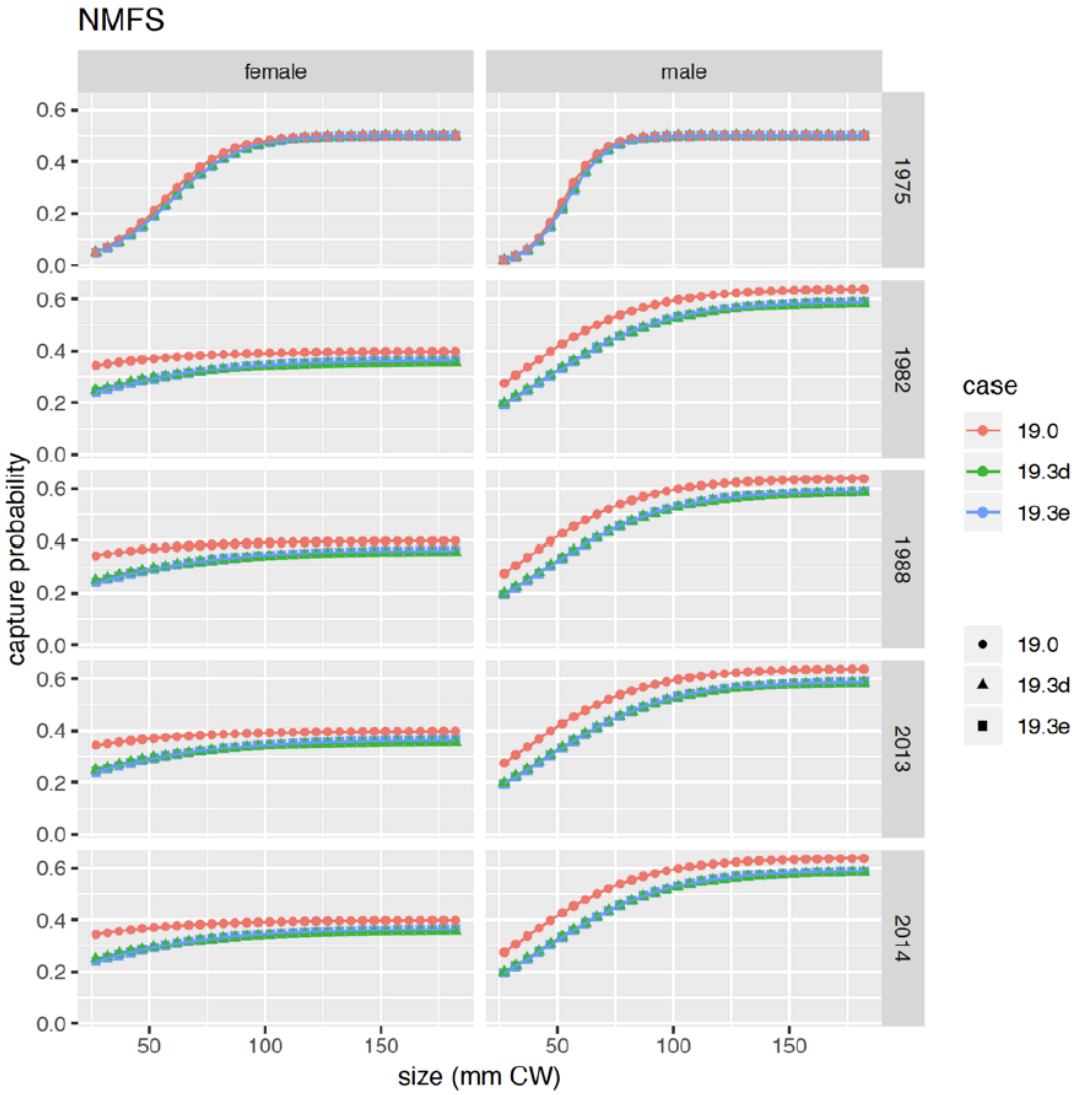
- Compared estimated parameters for SBS integration and different smoothing factors
  - All parameters estimated (base: 357; SBS: 622)
- Scenarios:
  - 19.0 : base model (2018 assessment model, no SBS data)
  - 19.3d: SMP = 10 (19.0 + all SBS data)
  - 19.3e: SMP = 1 (19.0 + all SBS data)

Estimated availability

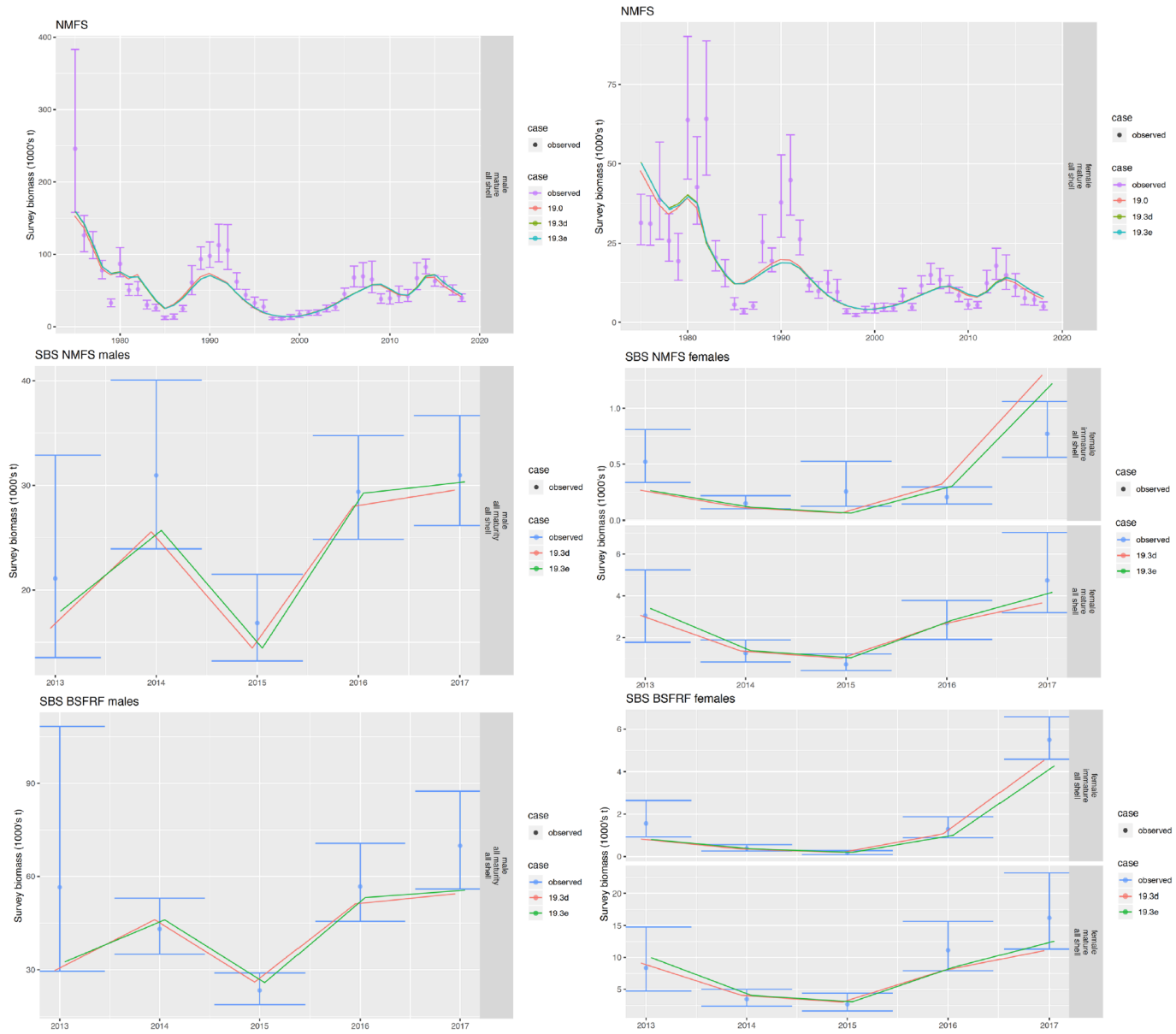


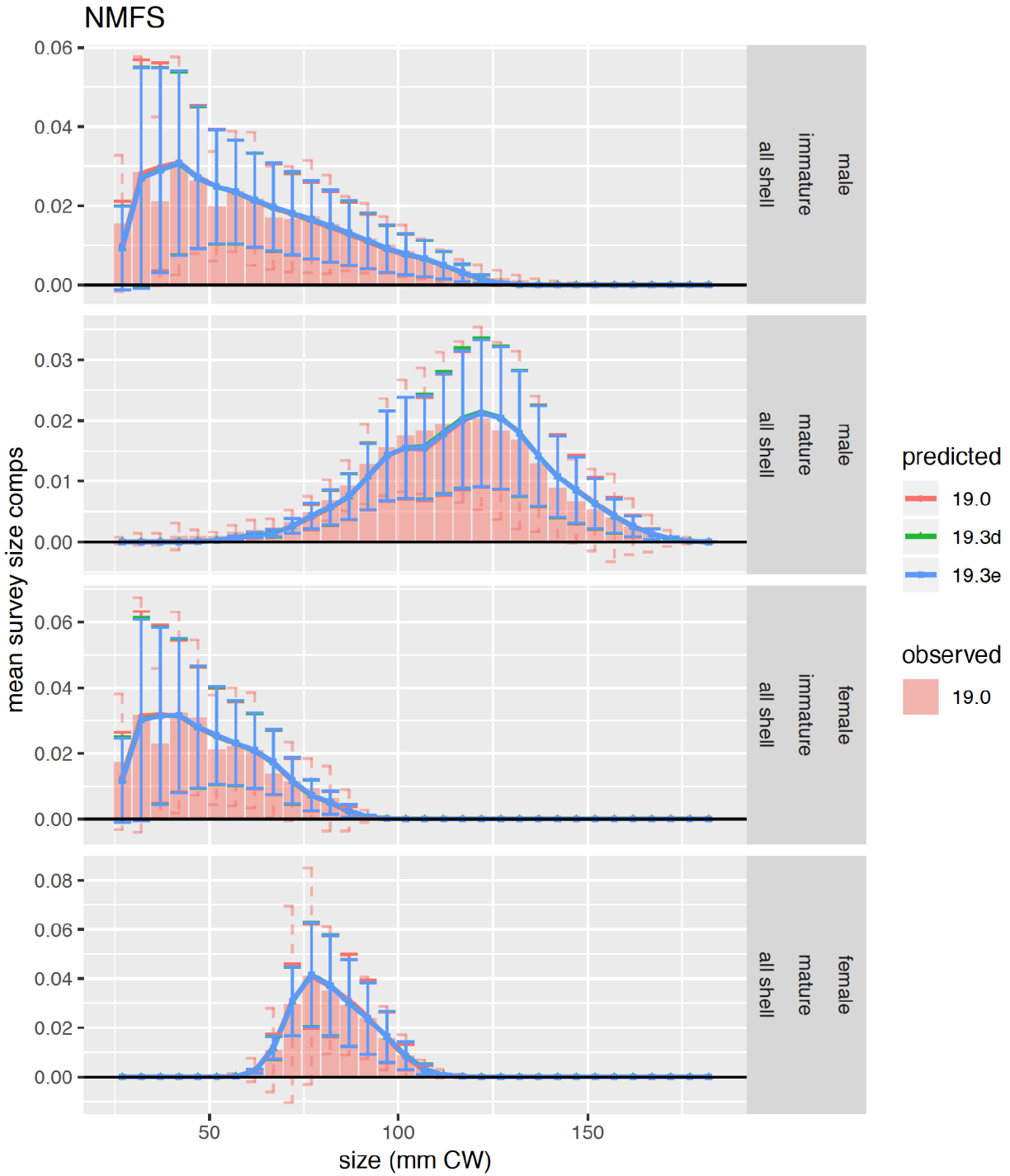
Estimated NMFS survey catchability

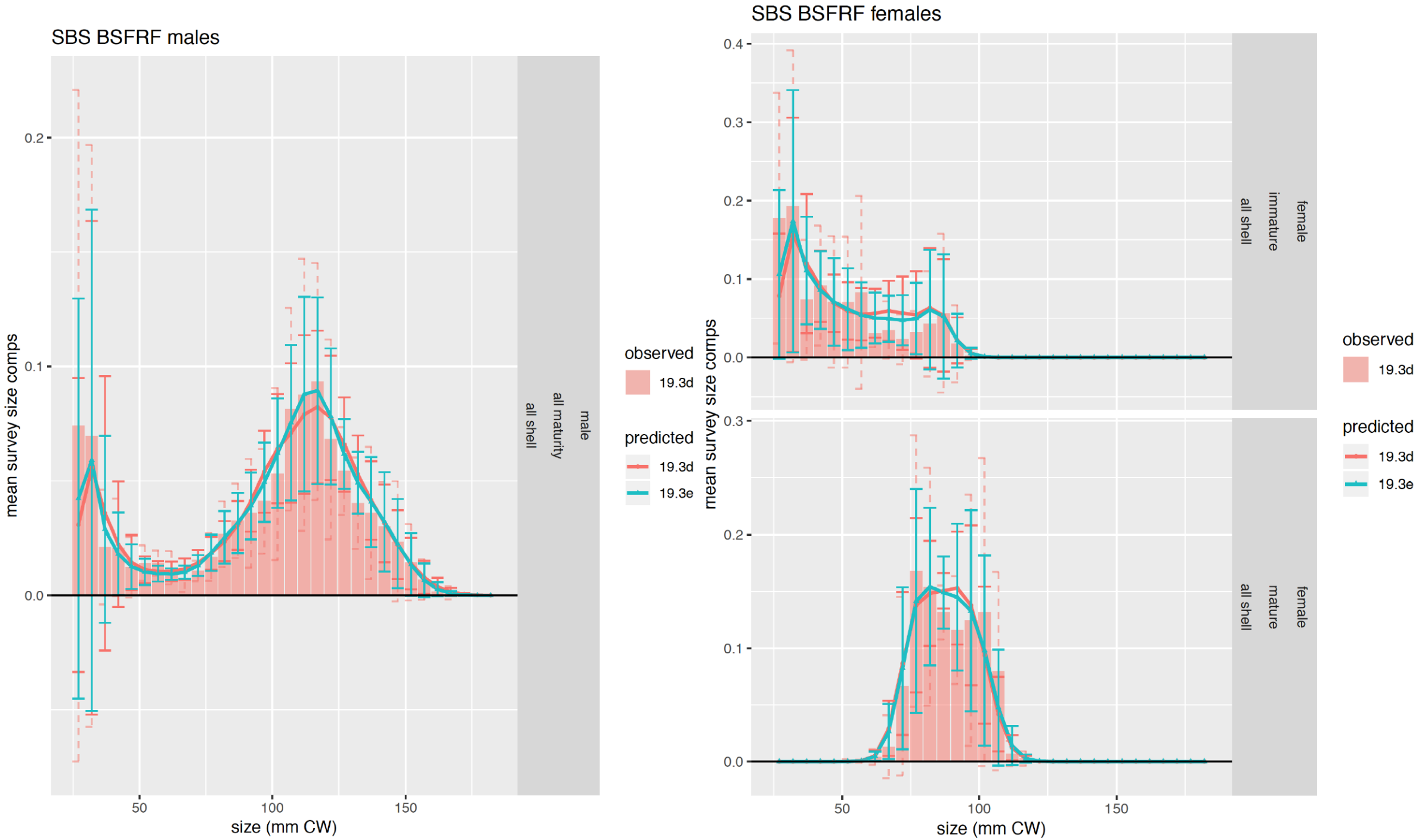


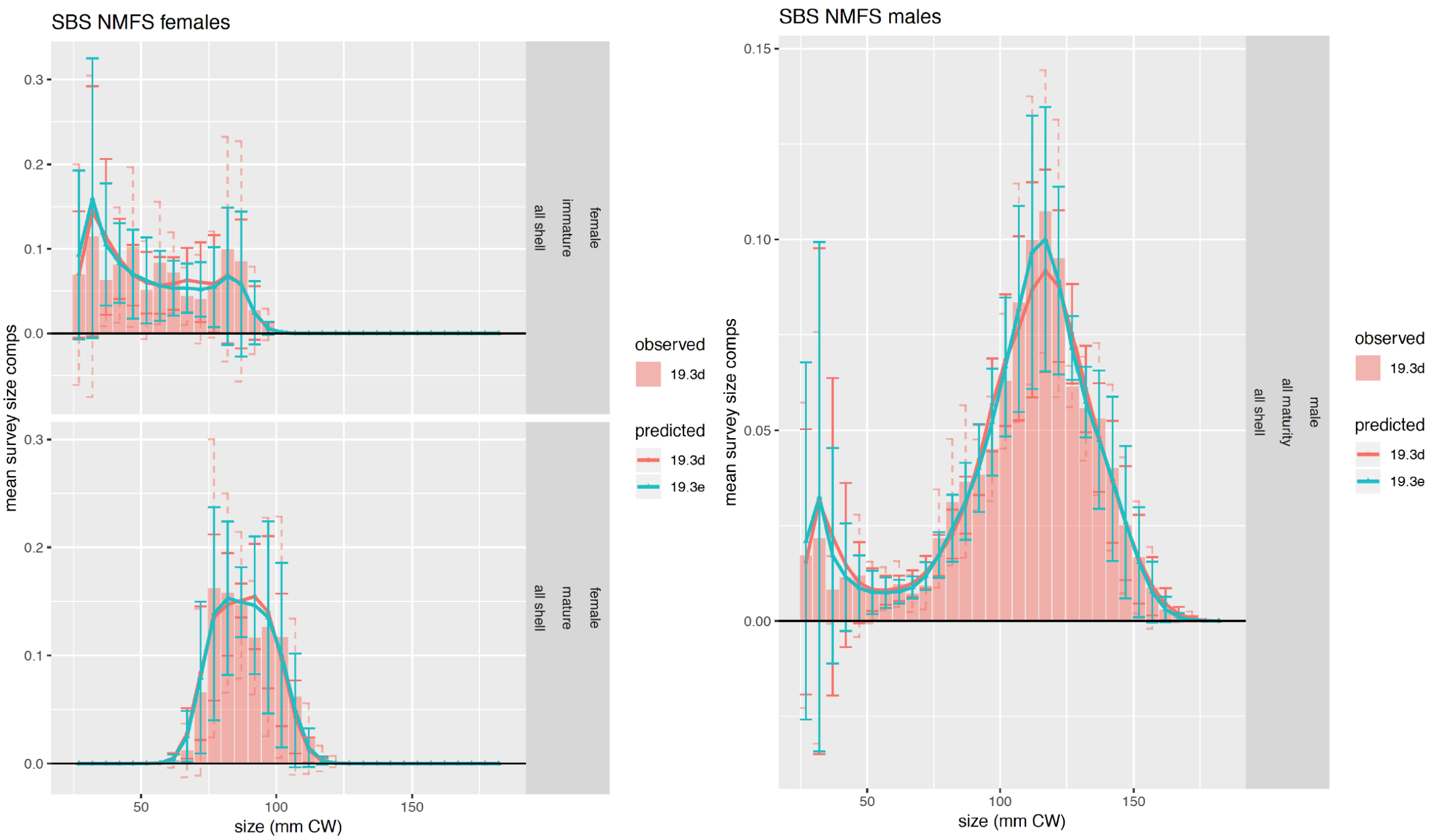


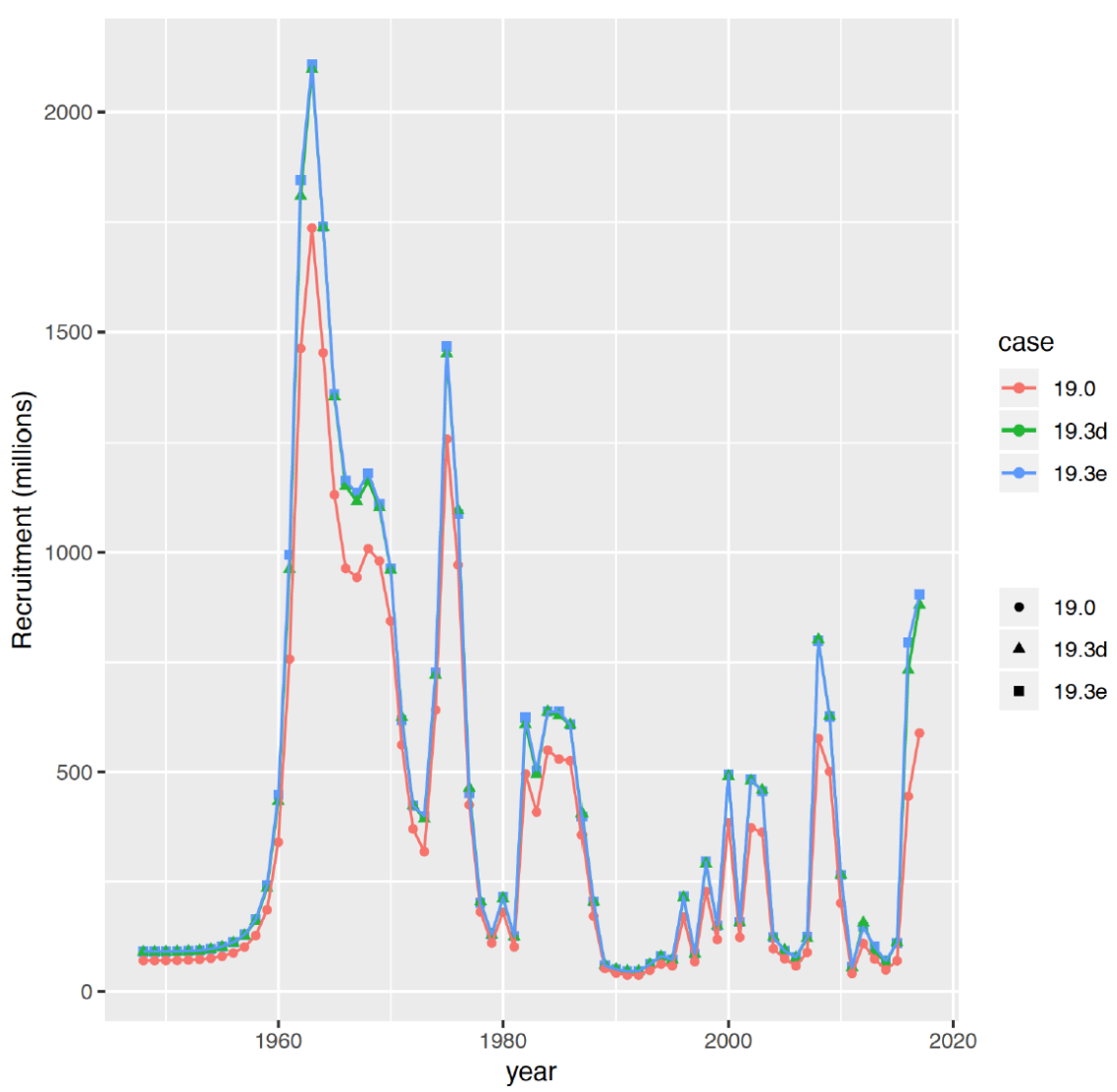
Fits to survey data

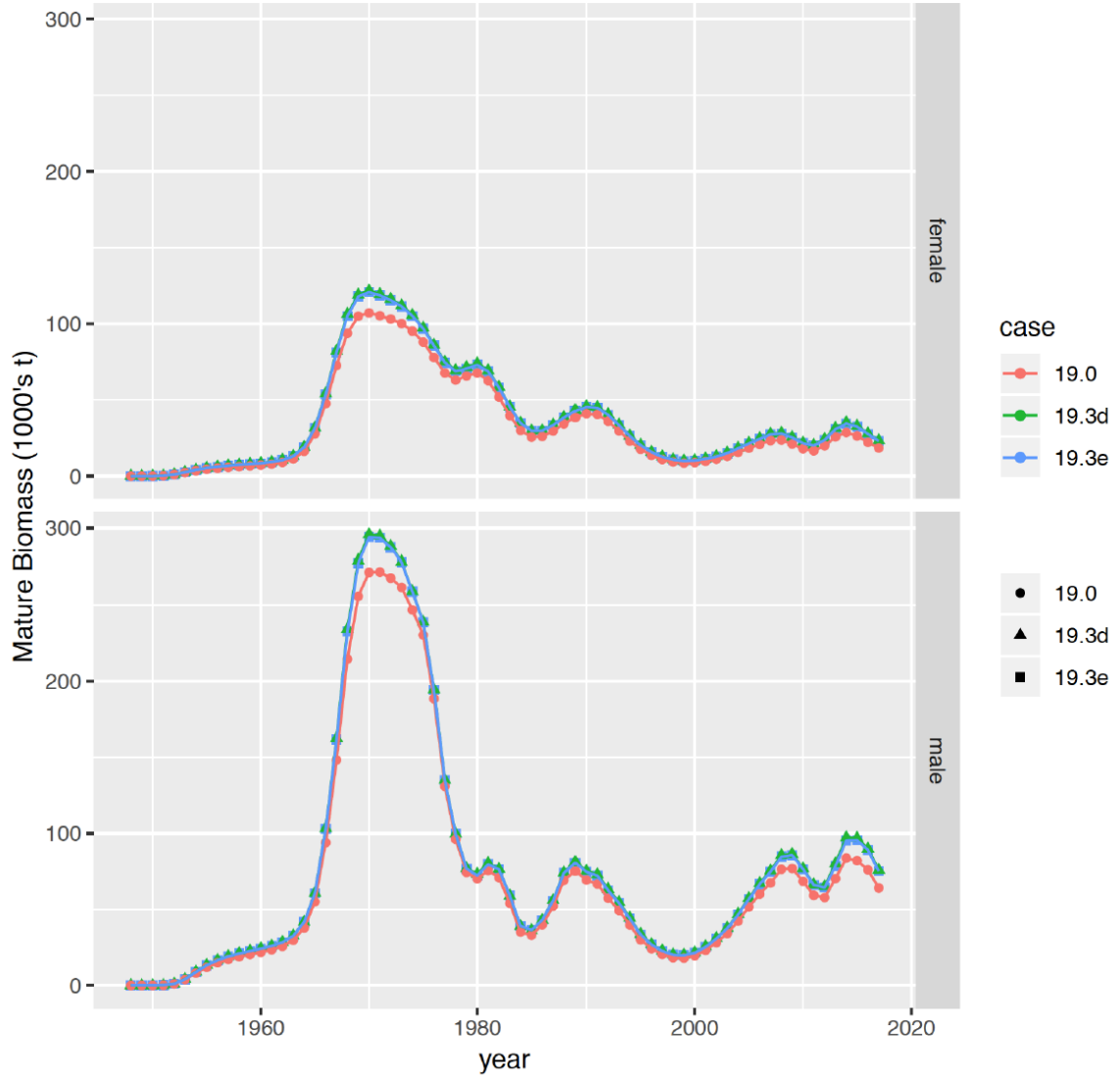



NMFS
mean survey size comps
size (mm CW)
male
immature
all shell
male
mature
all shell
female
immature
all shell
female
mature
all shell
predicted
19.0
19.3d
19.3e
observed
19.0


SBS BSFRF males
mean survey size comps
0.2
0.1
0.0
50
100
150
size (mm CW)
male
all maturity
all shell
SBS BSFRF females
mean survey size comps
0.4
0.3
0.2
0.1
0.0
female
immature
all shell
female
mature
all shell
size (mm CW)
observed
19.3d
predicted
19.3d
19.3e


SBS NMFS females
SBS NMFS males
mean survey size comps
size (mm CW)
female immature all shell
female mature all shell
male all maturity all shell
observed
19.3d
predicted
19.3d
19.3e


Recruitment (millions)
2000
1500
1000
500
0
1960
1980
2000
2020
year
case
19.0
19.3d
19.3e
19.0
19.3d
19.3e

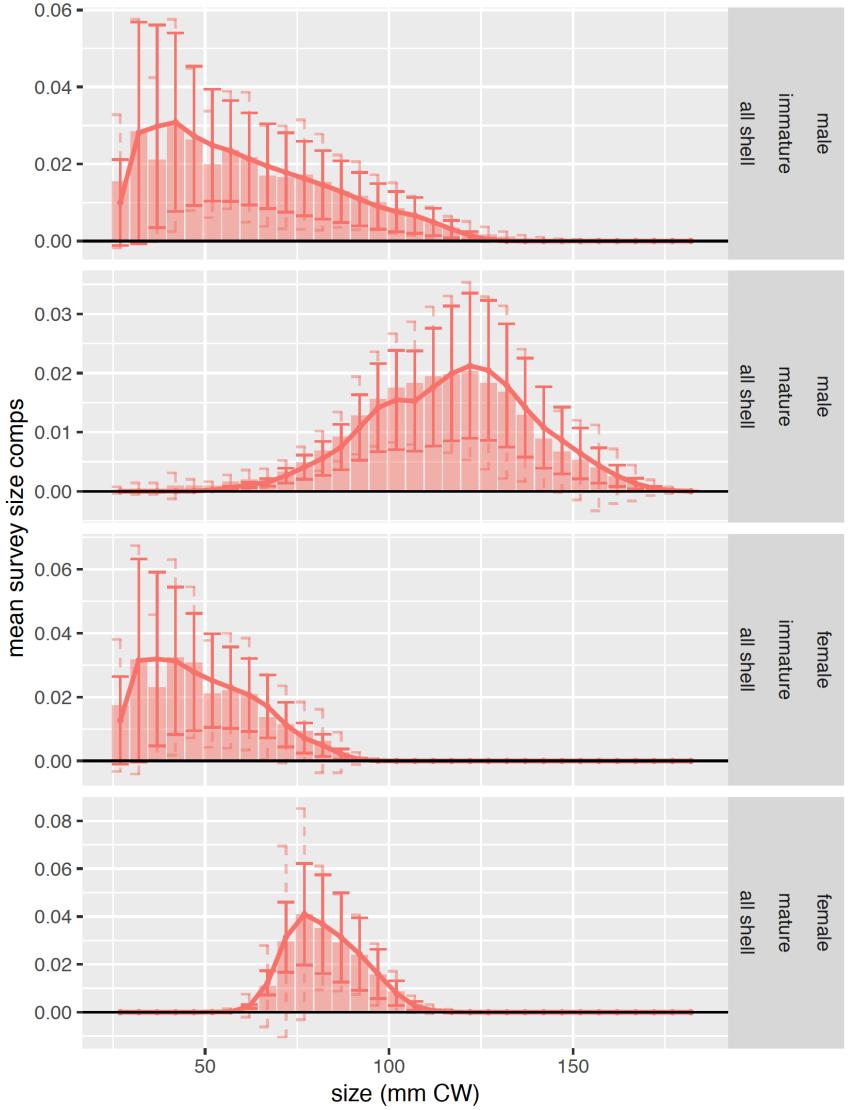

Mature Biomass (1000's t)
300
200
100
0
female
male
1960
1980
2000
2020
year
case
19.0
19.3d
19.3e
19.0
19.3d
19.3e

Management-related quantities

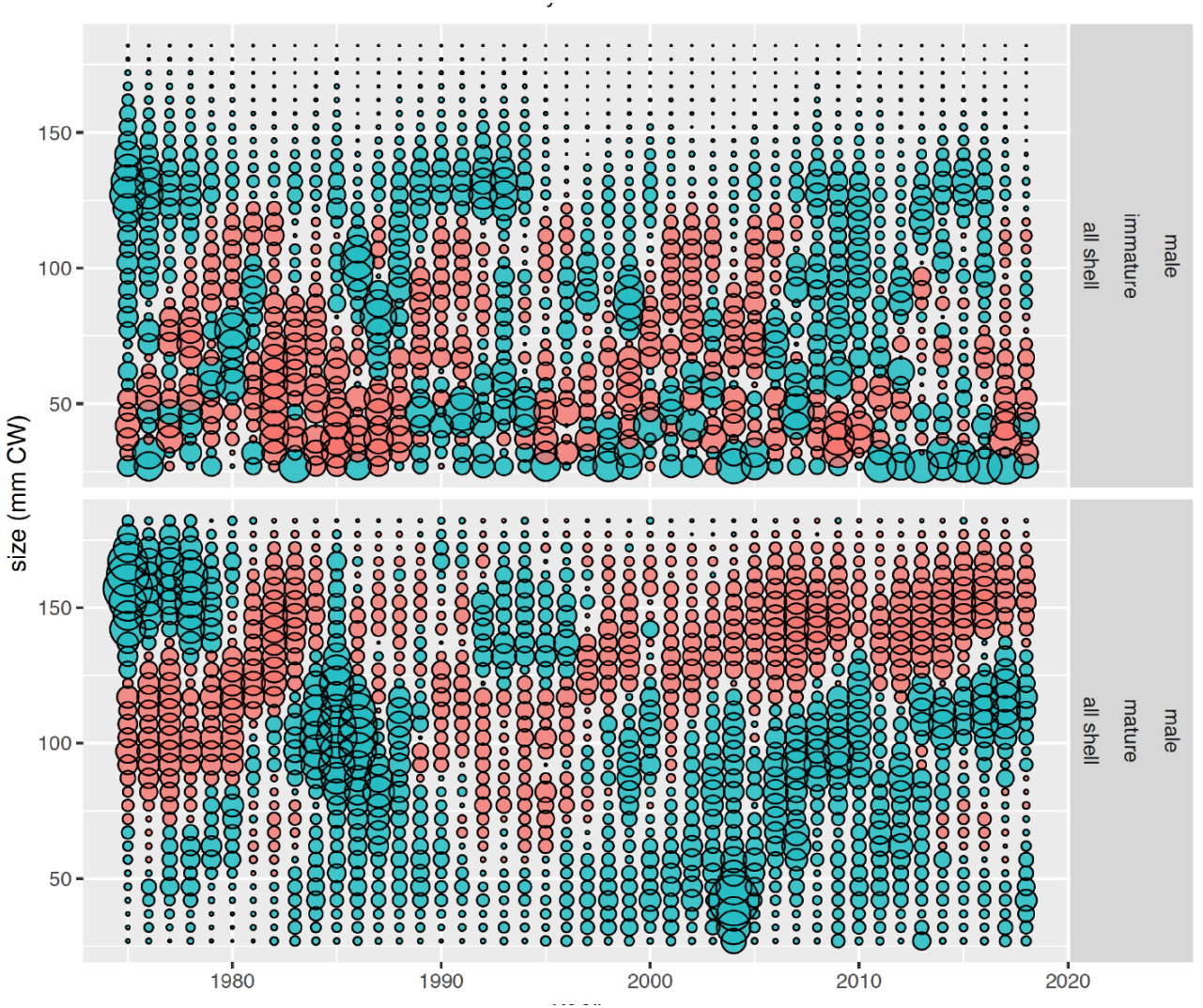
case	OFL	Fofl	prjB	curB	Fmsy	Bmsy	MSY	B100	avgRec
19.0	20.87	0.74	35.95	66.64	0.74	30.29	12.75	86.55	223.63
19.3d	25.86	0.82	41.02	78.97	0.82	33.48	14.63	95.66	287.96
19.3e	25.50	0.81	40.78	78.22	0.81	33.53	14.61	95.80	291.55

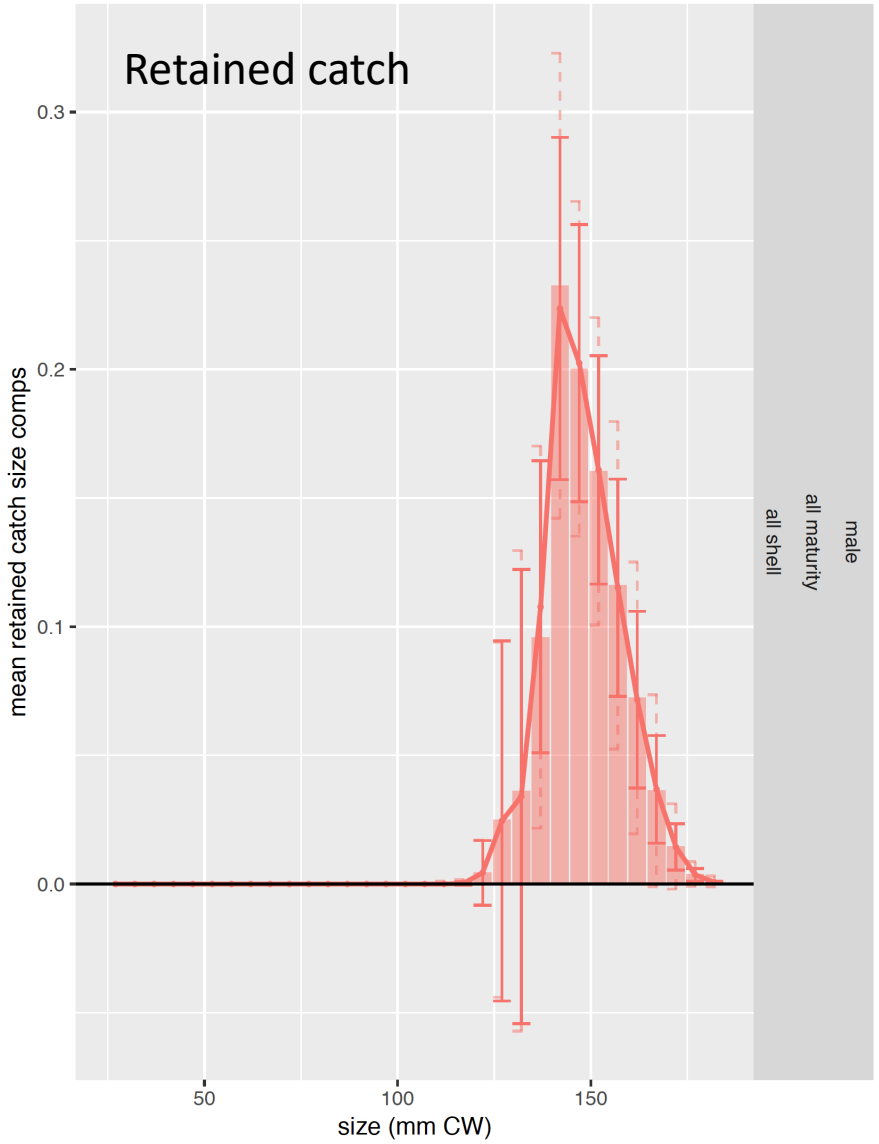
Issues related to overestimation of large crab abundance

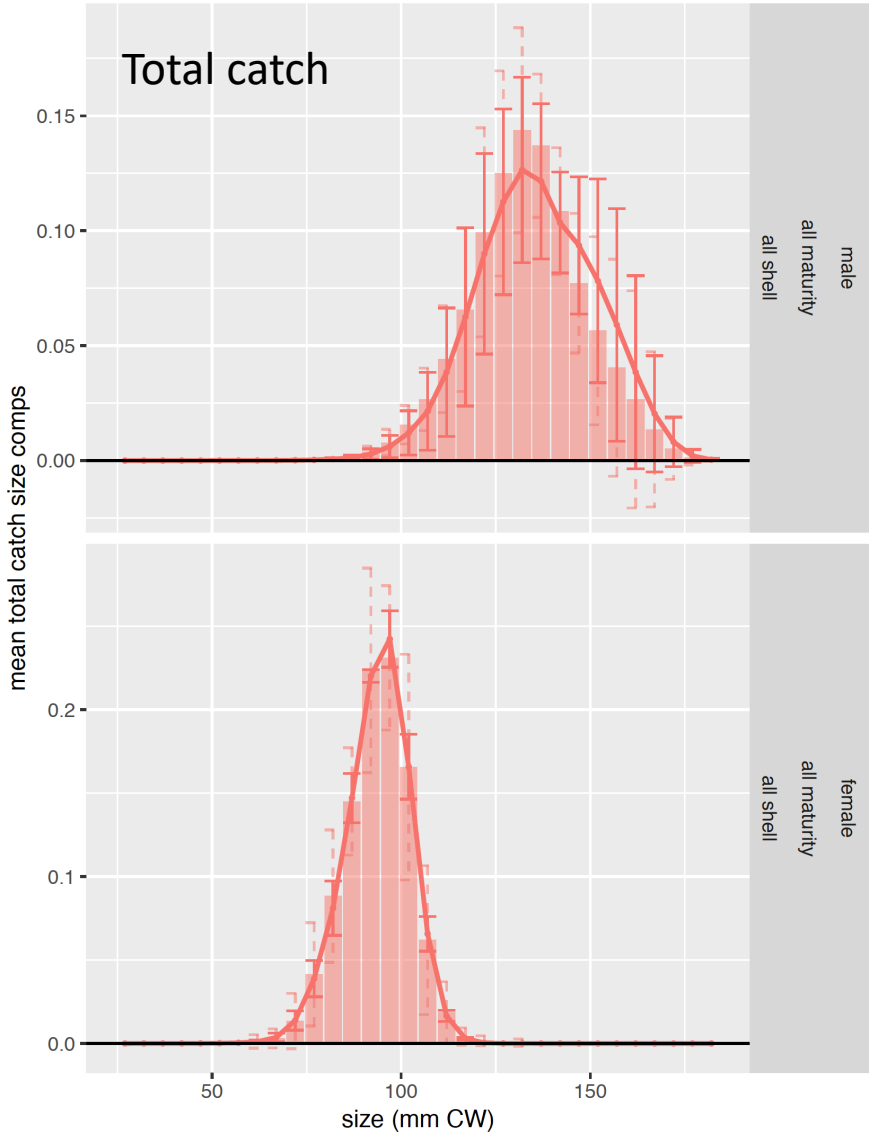
Mean survey size compositions



Survey size composition residuals for males




Retained catch
mean retained catch size comps
0.3
0.2
0.1
0.0
50
100
150
size (mm CW)
male
all maturity
all shell


Total catch
mean total catch size comps
0.15
0.10
0.05
0.00
0.2
0.1
0.0
50
100
150
size (mm CW)
male
all maturity
all shell
female
all maturity
all shell

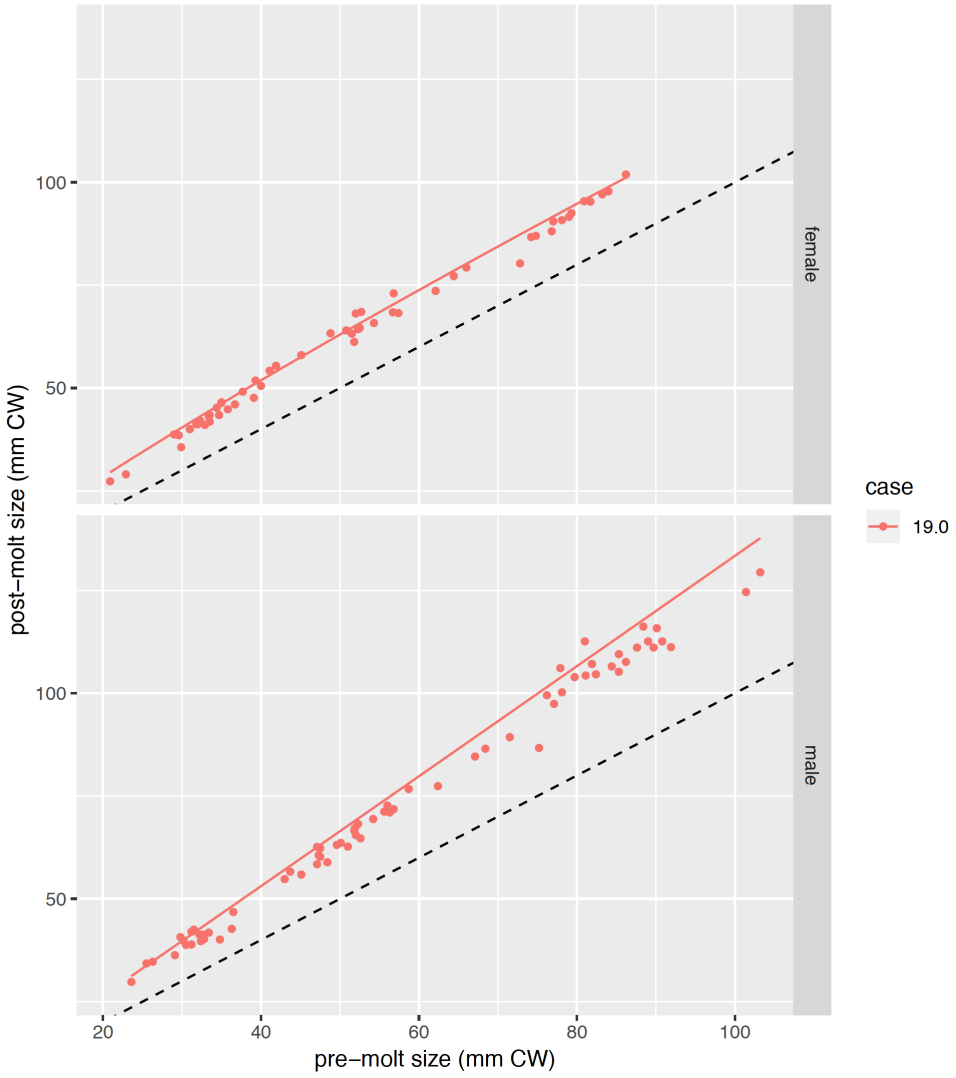
Potential causes of overestimation

- Fishery/survey-related
  - selectivity curves not asymptotic

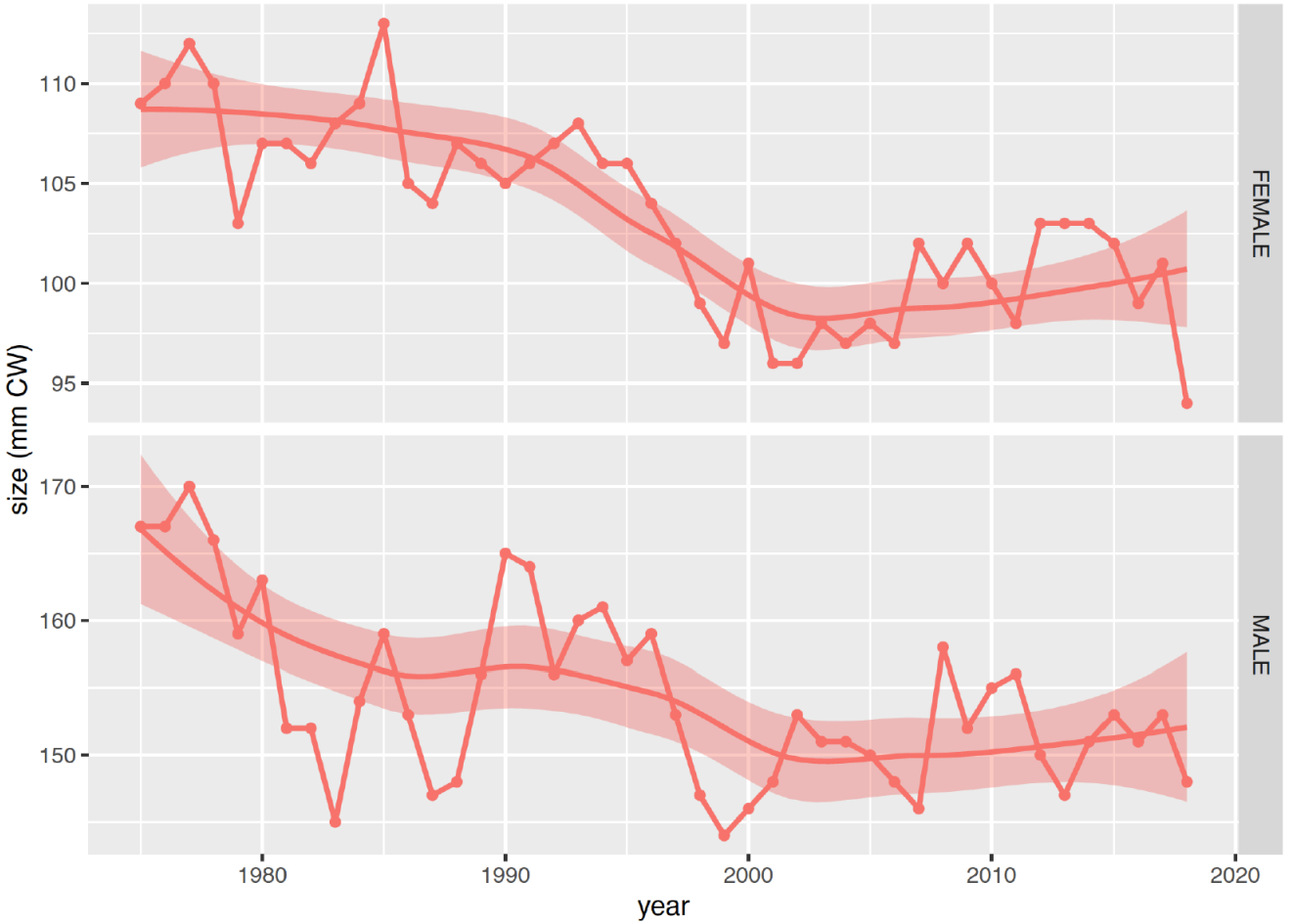
- Biological processes
  - annual molting assumed (no skip molting) [growth too fast]
  - Estimated molt increments to large [growth too fast, too large]
  - Estimated size-at-terminal molt too large [grow too large]
  - Estimated M too small for mature crab

- This study: investigate biological processes
  - Look at growth
  - Developed R Shiny app to look at effects of biological processes on cohort progression (on GitHub at wStockhausen/ShinyTC.CohortProgression)

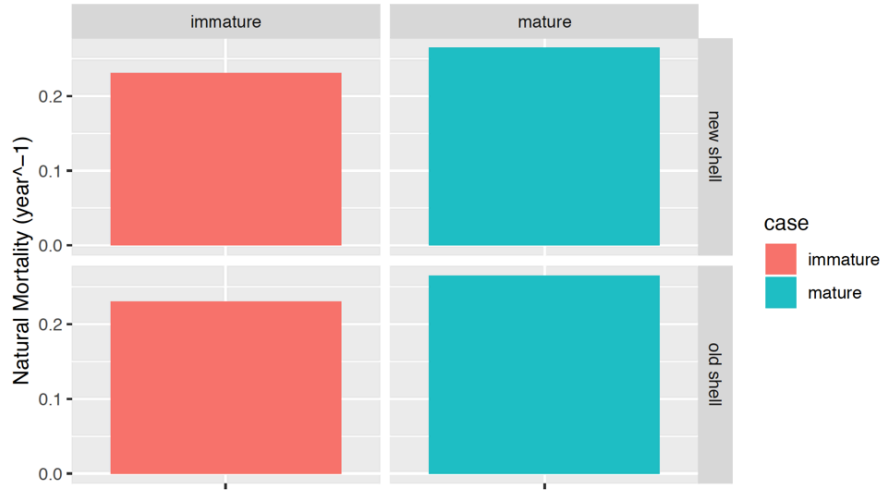
Overestimating male growth: changes in growth with time?

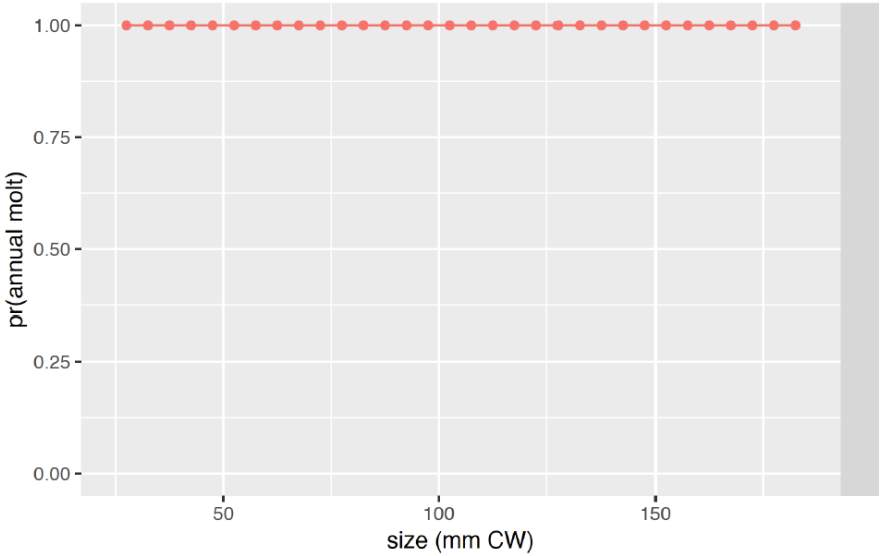


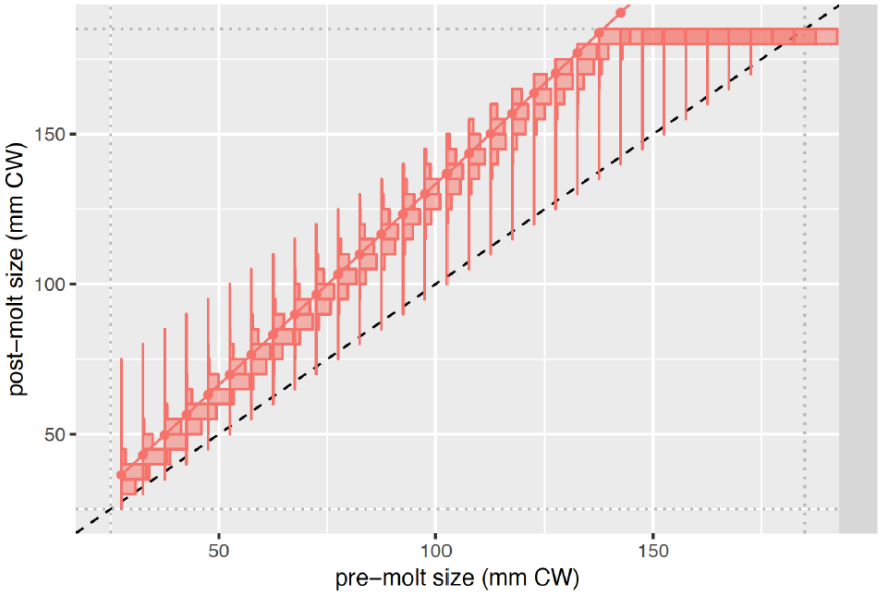
min size of largest 1% of crab
in the NMFS trawl survey

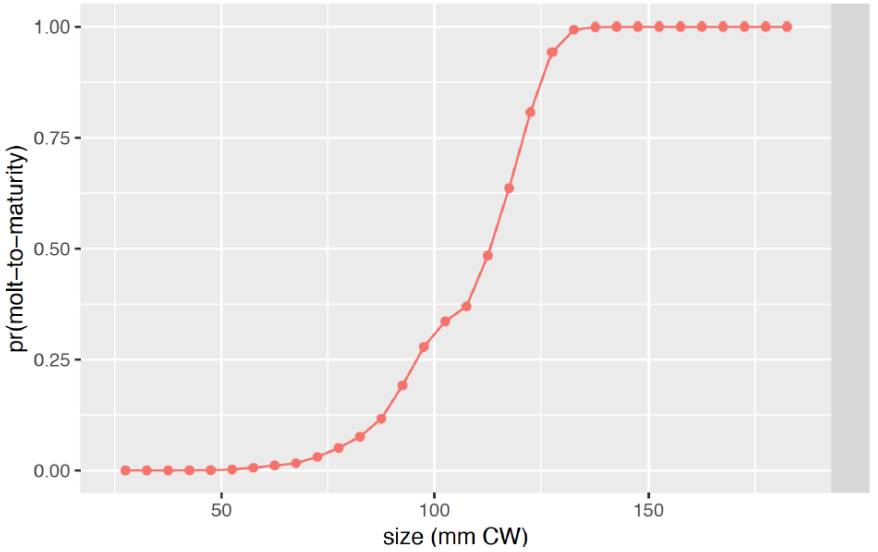


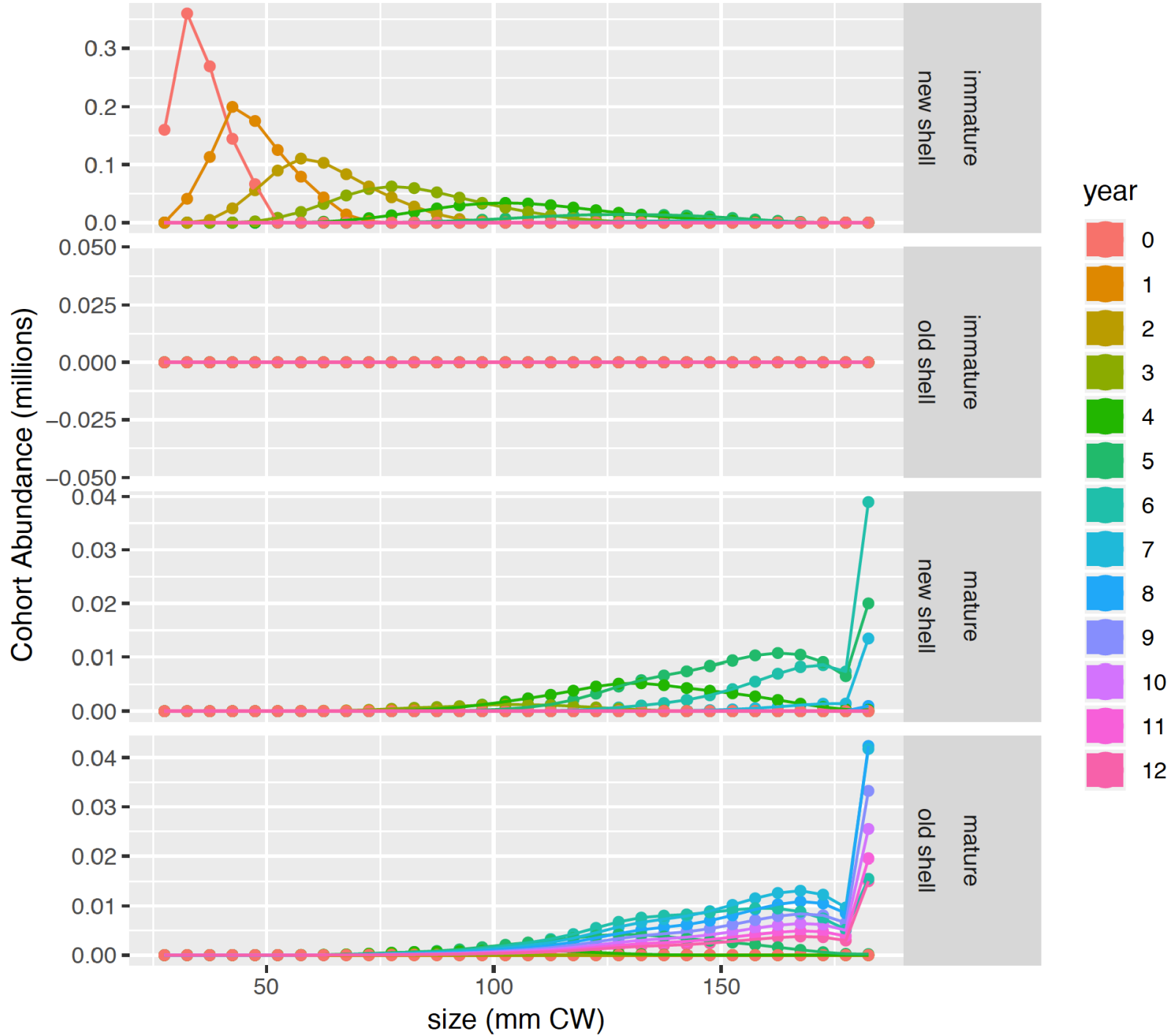
Base model (19.0)





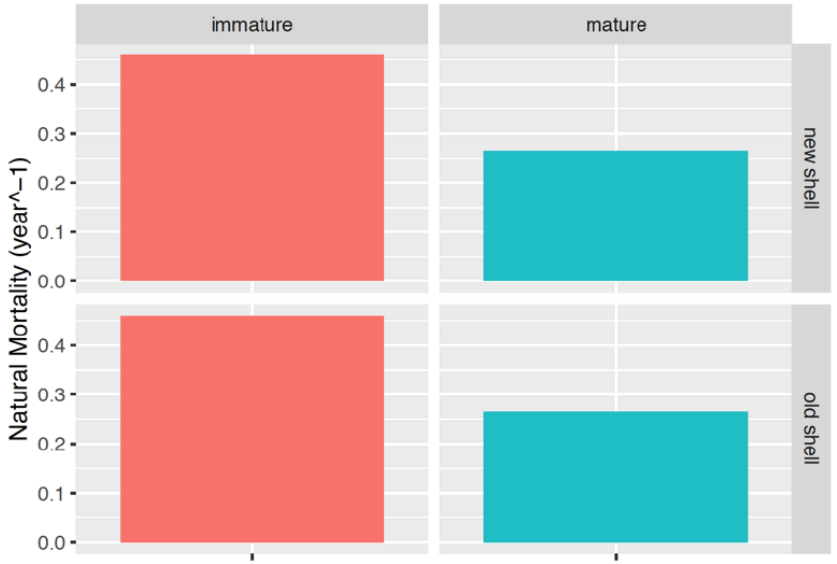




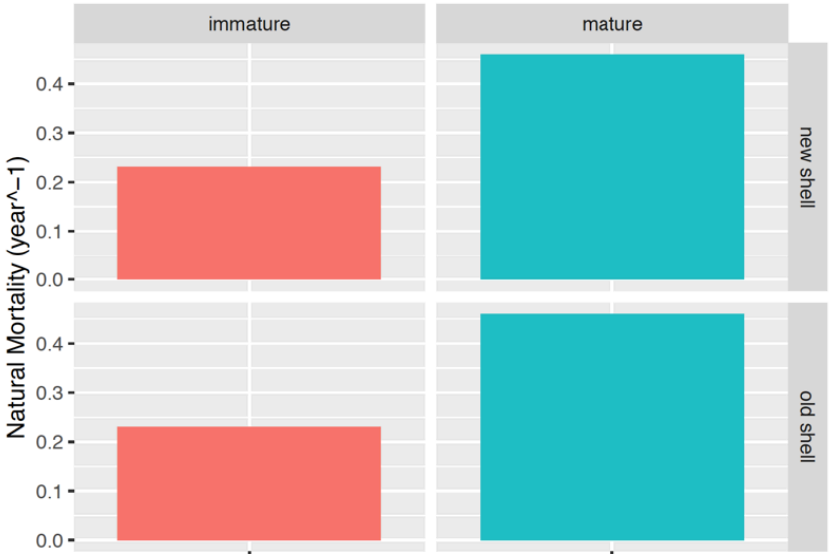

Cohort Abundance (millions)
size (mm CW)
immature new shell
immature old shell
mature new shell
mature old shell
year
0
1
2
3
4
5
6
7
8
9
10
11
12

Perturbation scenarios

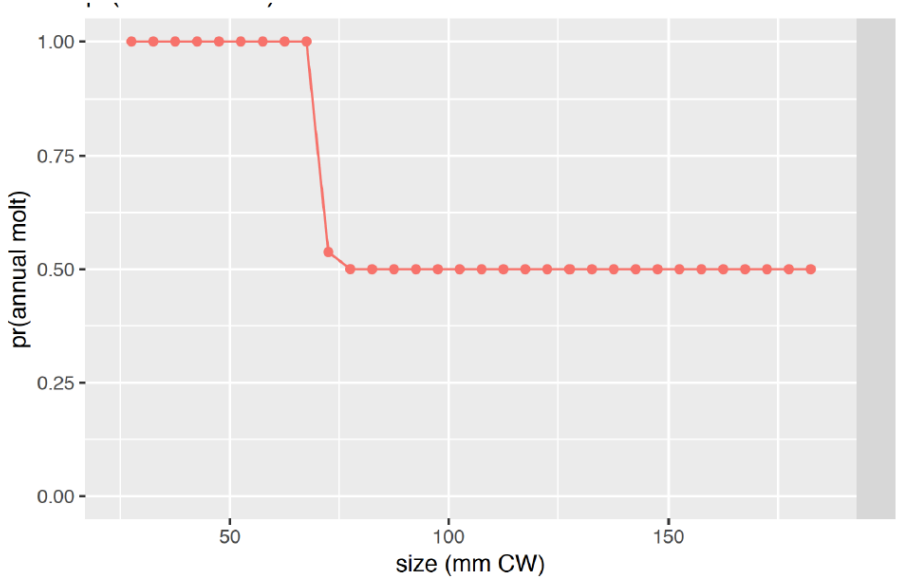
19.4a



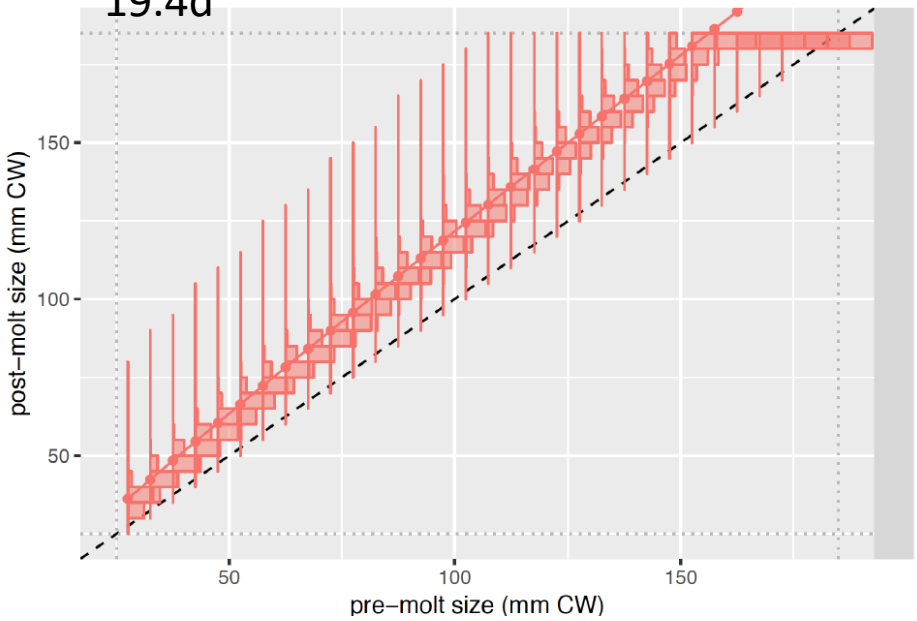
19.4b



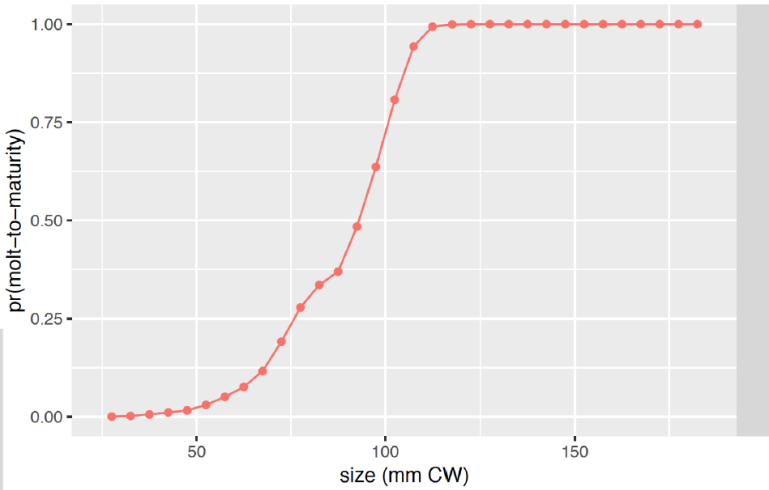
19.4c



19.4d

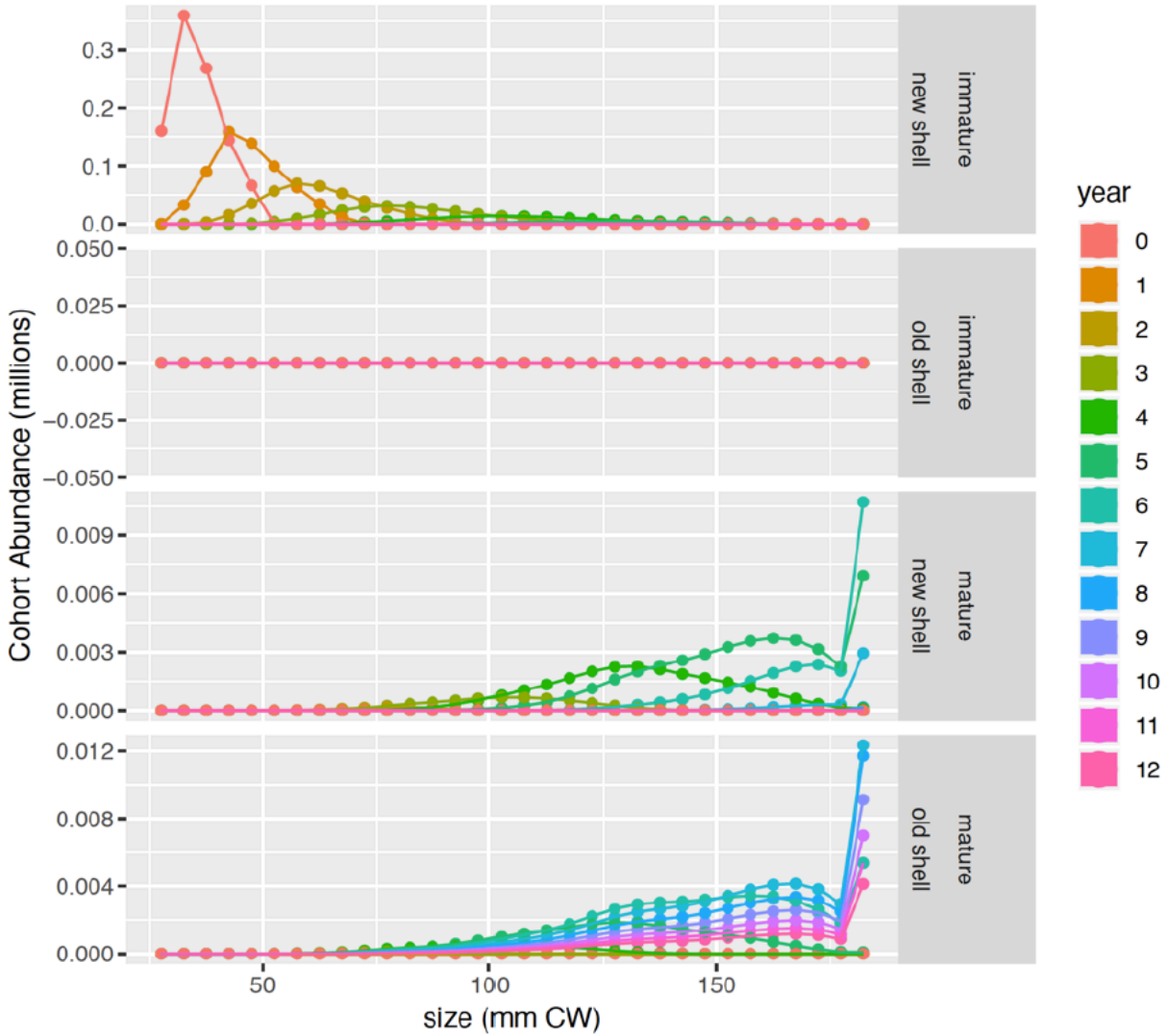


19.4e

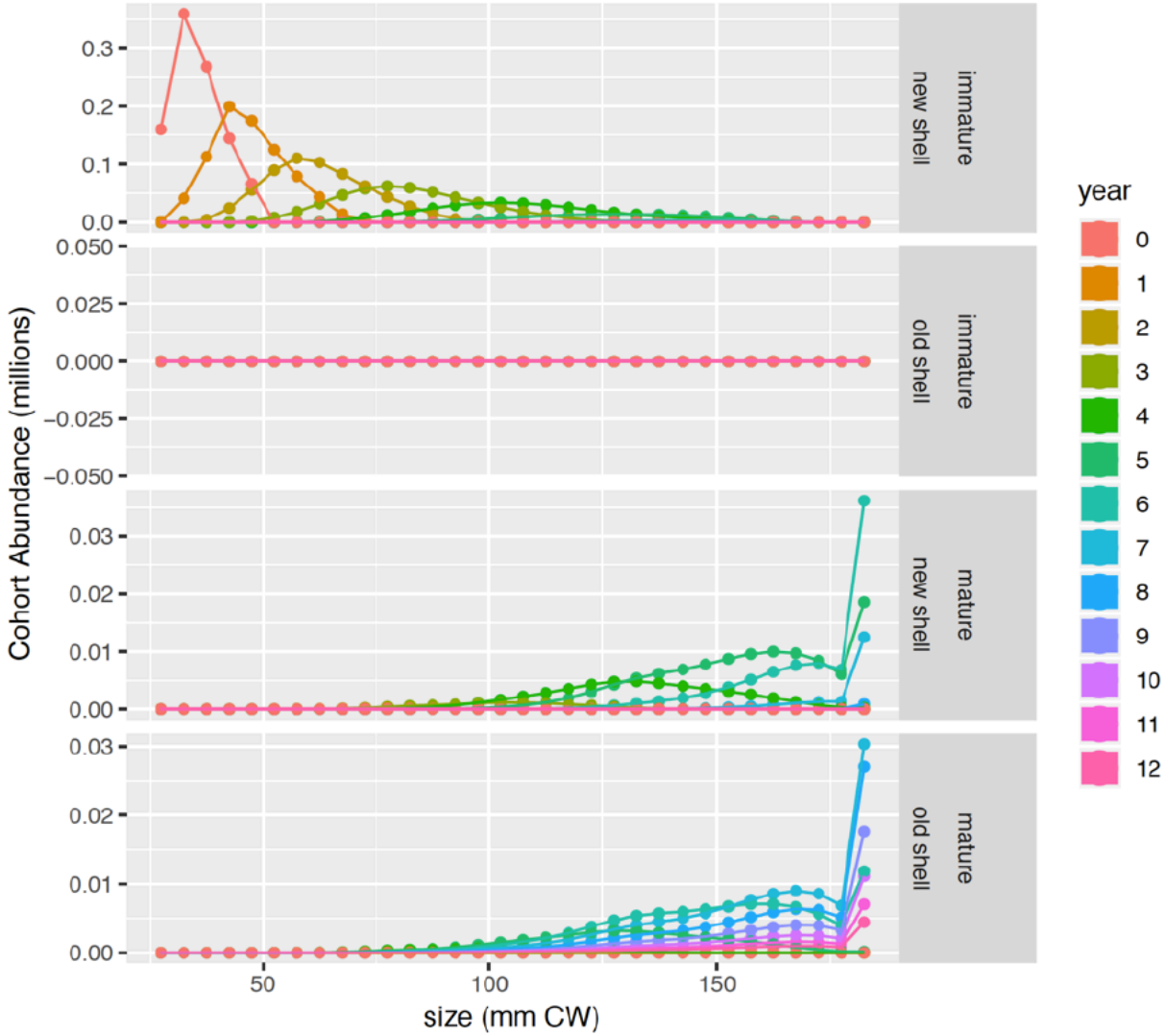


Cohort progressions: 19.4a and 19.4b

19.4a (immature M's increased)

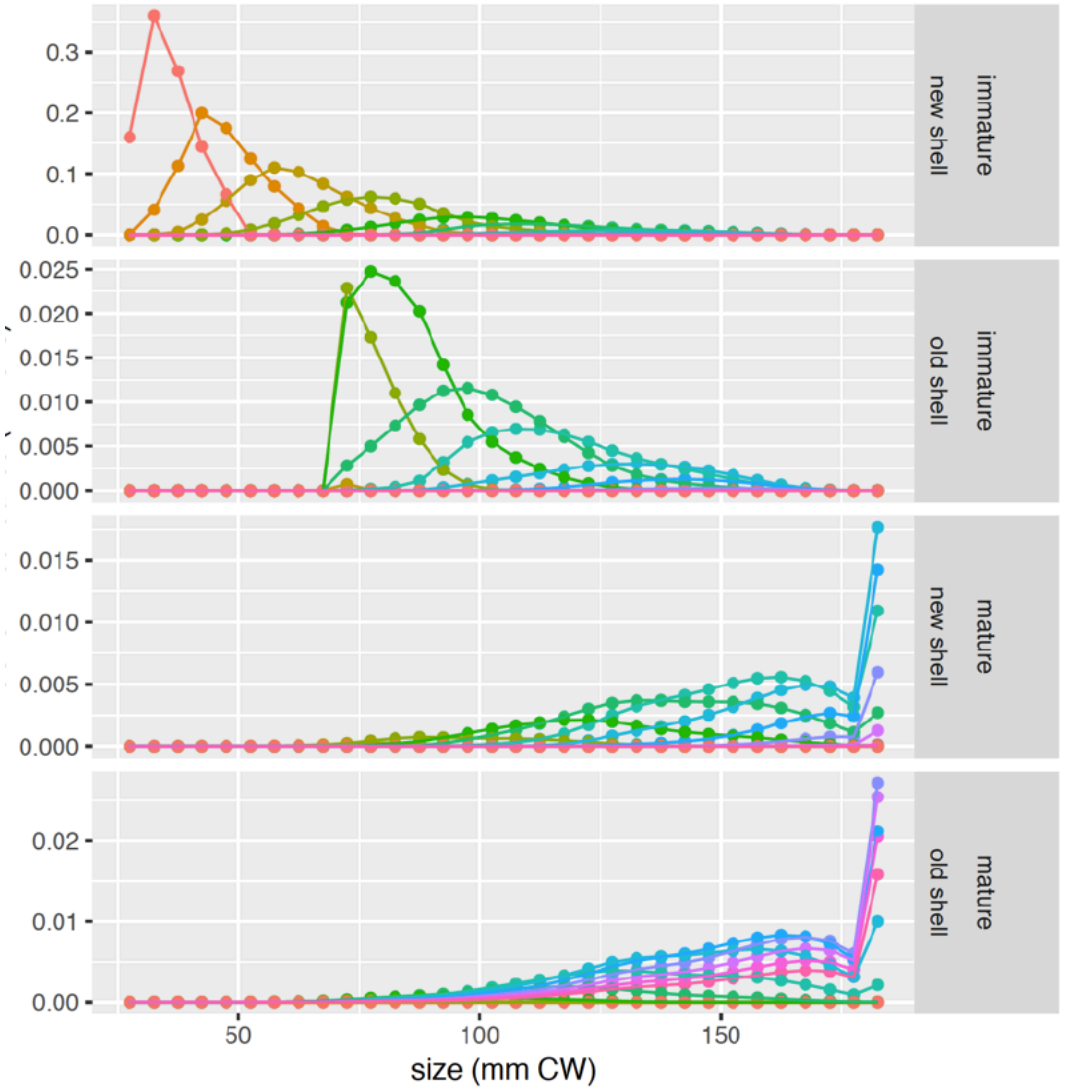


19.4b (mature M's increased)

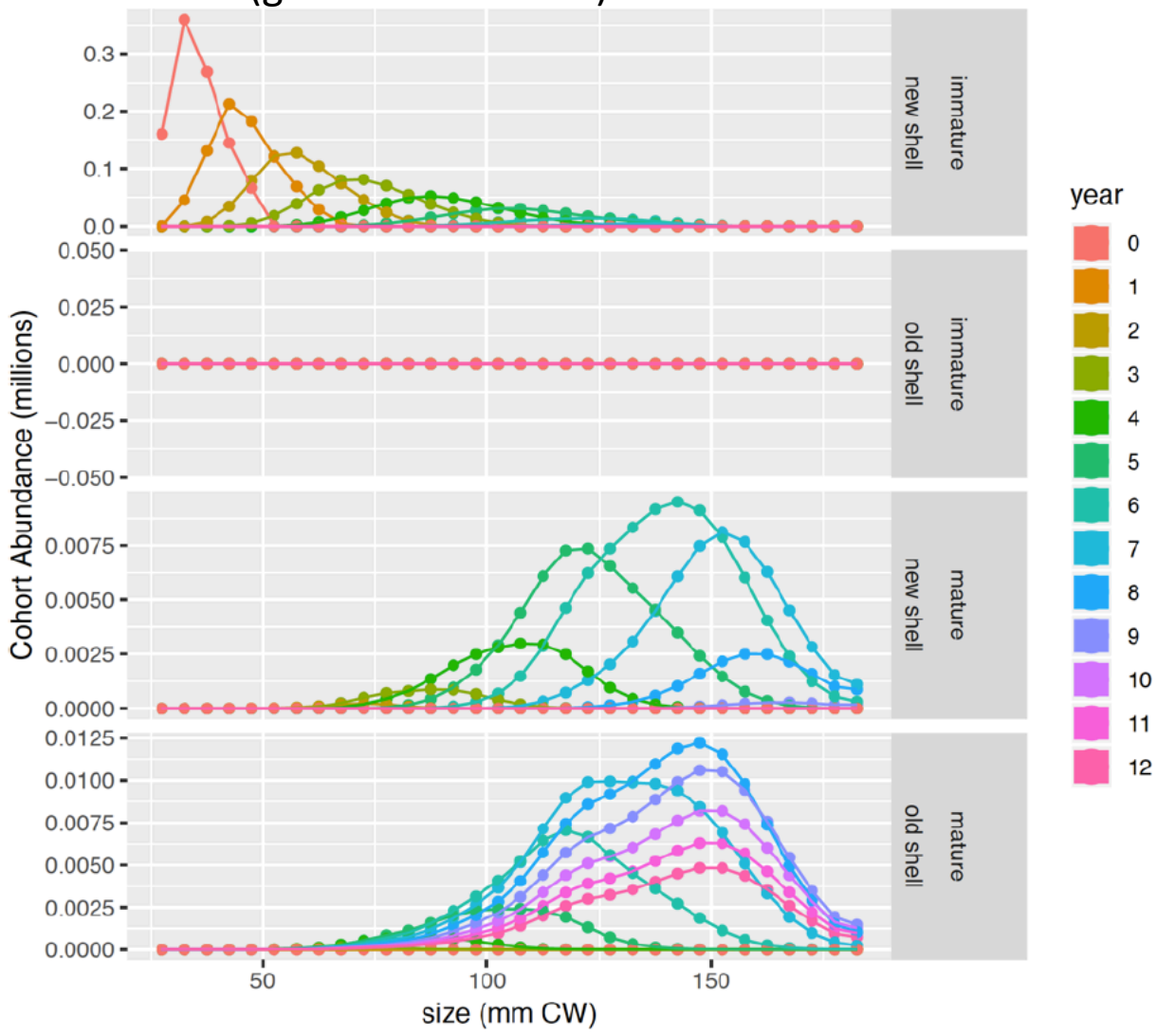


Cohort progressions: 19.4c and 19.4d

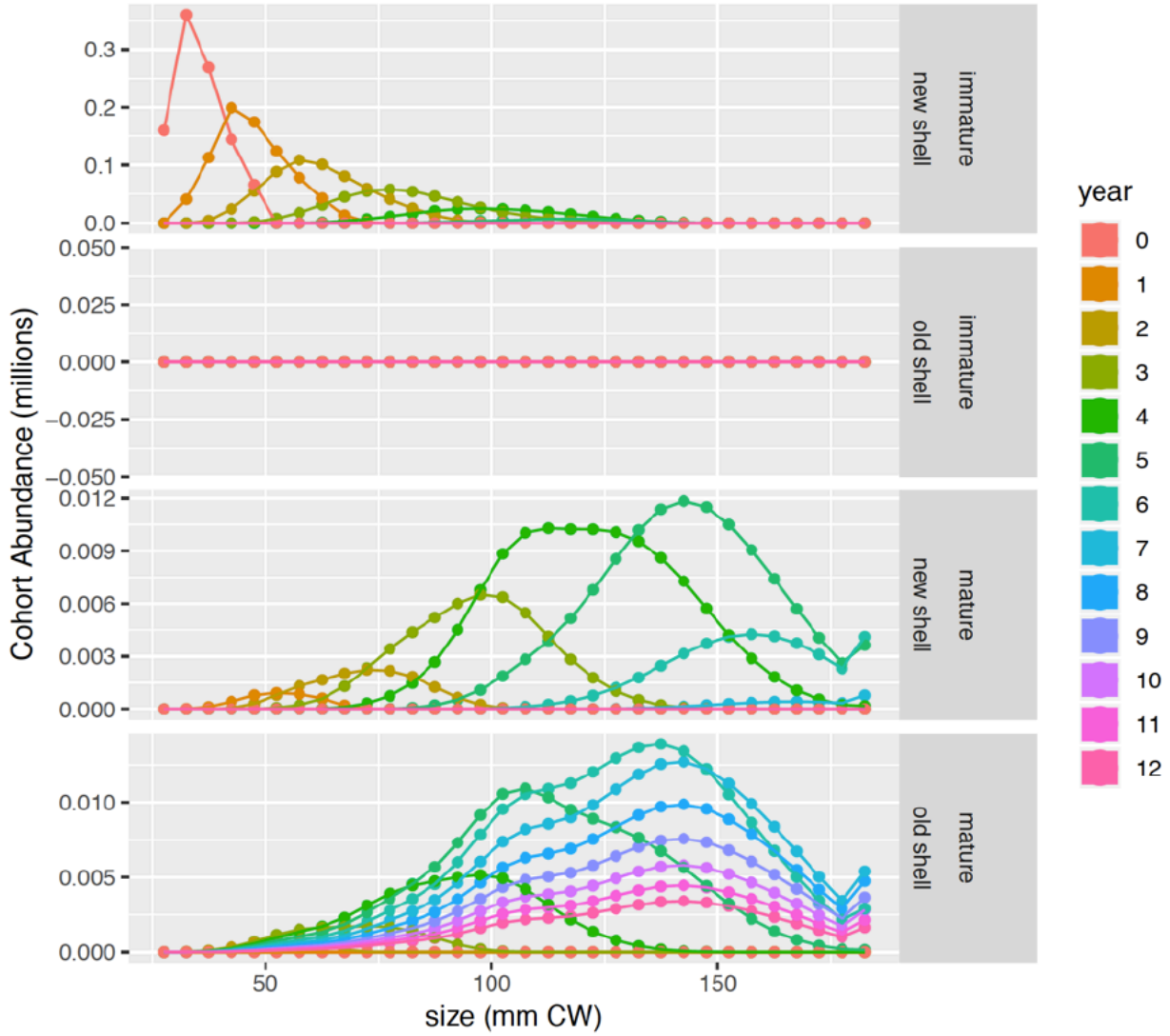
19.4c (skip molting)



19.4d (growth decreased)



Cohort progressions: 19.4e (maturity ogive left-shifted)



Thoughts on overestimation

- Not obvious what the source of the problem is
  - apparent tradeoff between fitting growth data and size compositions
  - growth and terminal molt dynamics

- Potential areas for further research
  - closer look at why model is overestimating molt increments for large crab
  - (re) incorporate male maturity data

Proposed model scenarios for Fall, 2019

Final Scenario	Current Scenario	Description
19F.0	19.0	2018 assessment model as base (18AM17)
19F.0a	19.1b	19F.0 with revised fishery data through 2017/18
19F.1	19.1b+	19F.0a + 2019 NMFS Trawl Survey data, 2018/19 fishery data, 2018 growth data
19F.2		19F.1 + fits to male chela height (maturity ogive) data
19F.3		19F.2 - male maturity classification based on Rugolo and Turnock ogive
19F.4		19.F1 + SBS data incorporation
19F.5		19F.3 + SBS data incorporation

Fishery data issues: total catch revision

- Historical directed fishing effort from 1990/91+ for the Tanner crab, snow crab, and BBRKC fisheries was revised by D. Pengilly based on fish ticket data and landed catch composition to more closely match current methods assigning directed effort to crab fisheries
- Revised effort is substantially different from “historical” effort in the Tanner and snow crab fisheries, in particular
- This impacts the expansion of observed catch to total because it scales with directed effort

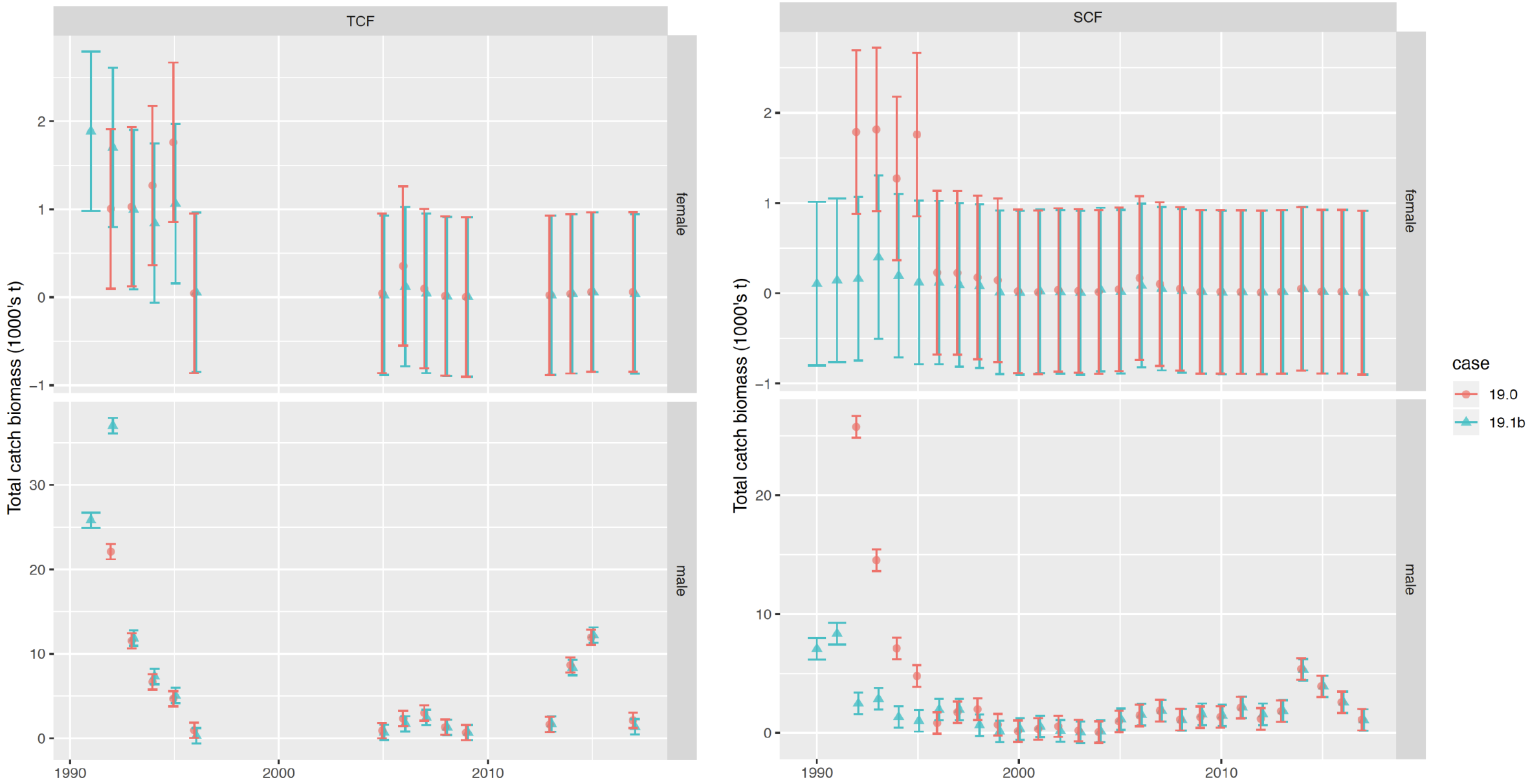
$$A = \frac{n_T}{n_s} \cdot a$$

n_T : directed effort (potlifts)

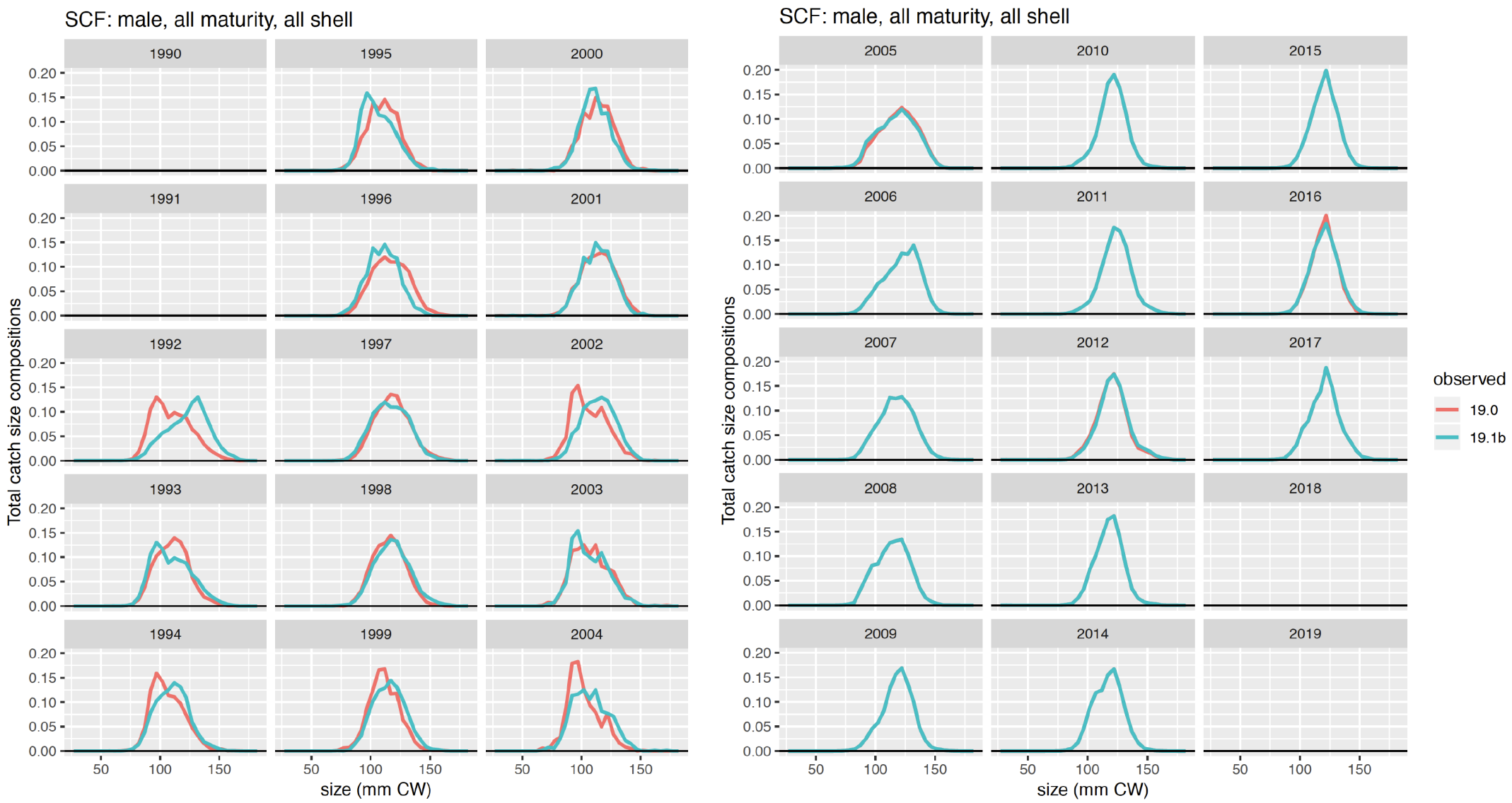
n_s : observer effort (pots sampled)

- Secondarily, this may have resulted in sampling effort (and samples) being re-assigned among fisheries

Total catch biomass of Tanner crab in the directed and snow crab fisheries



Bycatch size compositions in the snow crab fishery



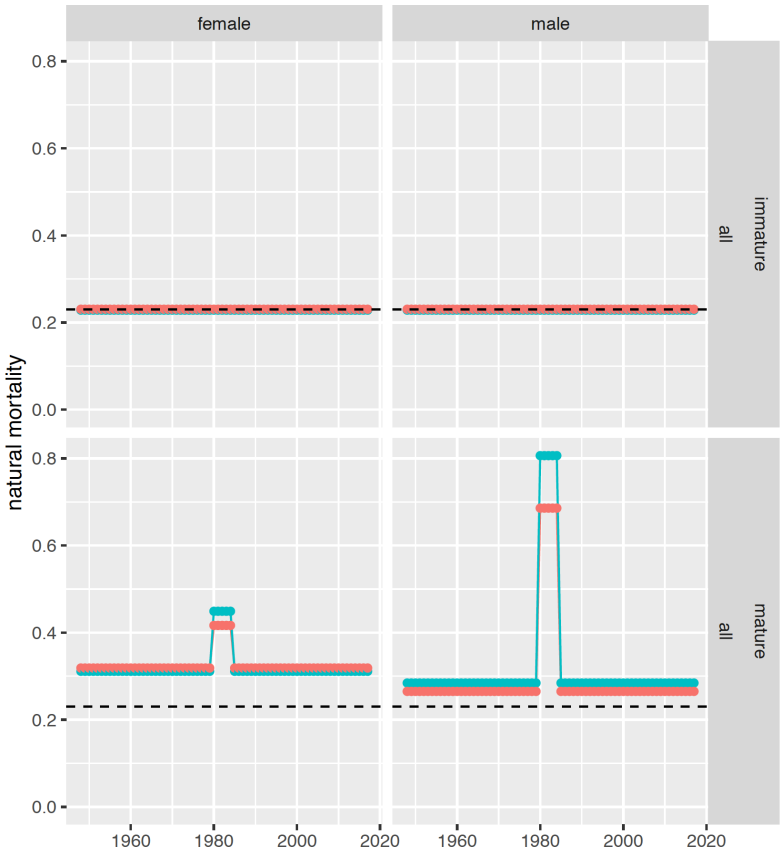
Impact on the 2018 assessment

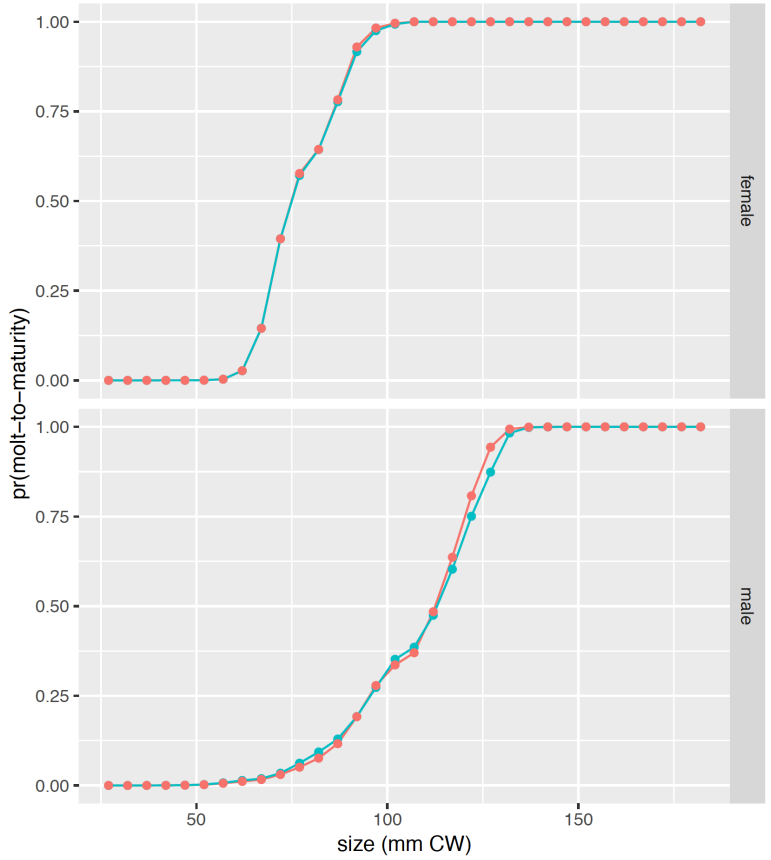
- Attempted to use the revised catch data in the assessment model scenarios
  - Effects on assessment model results were large and were not satisfactorily explained by large changes in catch in the 1990's
  - CPT rejected models based on revised catch data until it could review them and their use among all crab assessments

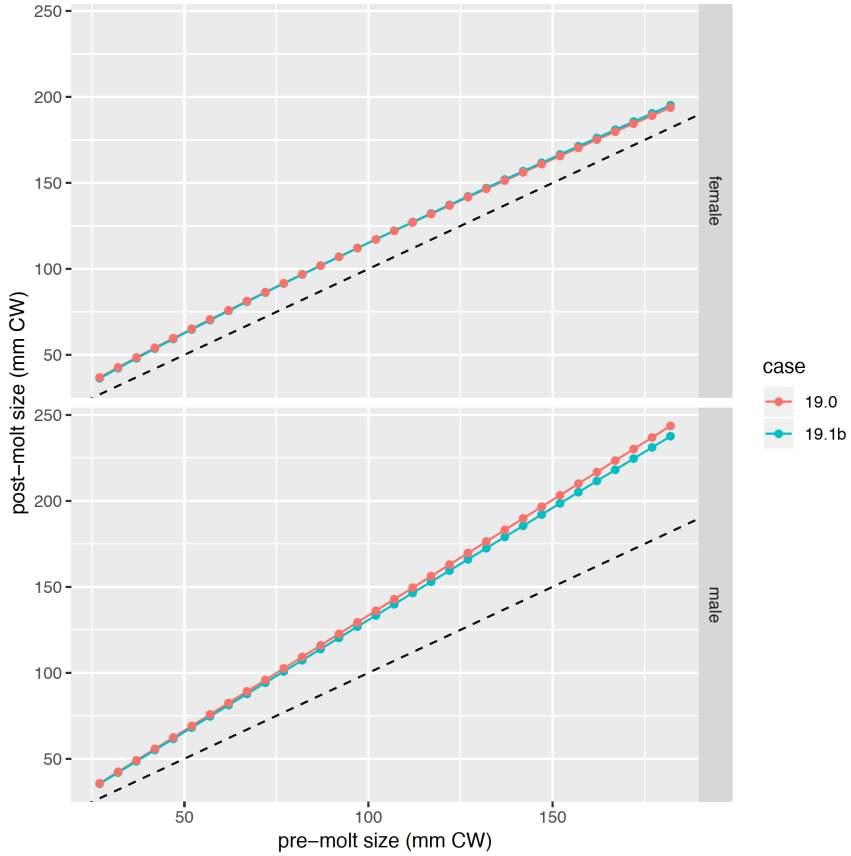
- Good decision by CPT: input sample sizes for updated catch size compositions were incorrectly entered as number of crab sampled

case	OFL	Fofl	prjB	curB	Fmsy	Bmsy	MSY	B100	avgRec
19.0	20.87	0.74	35.95	66.64	0.74	30.29	12.75	86.55	223.63
19.1b	26.09	0.89	38.82	76.90	0.89	31.56	14.08	90.17	271.81
18A	42.01	1.22	53.87	114.10	1.22	42.00	19.24	120.00	391.22

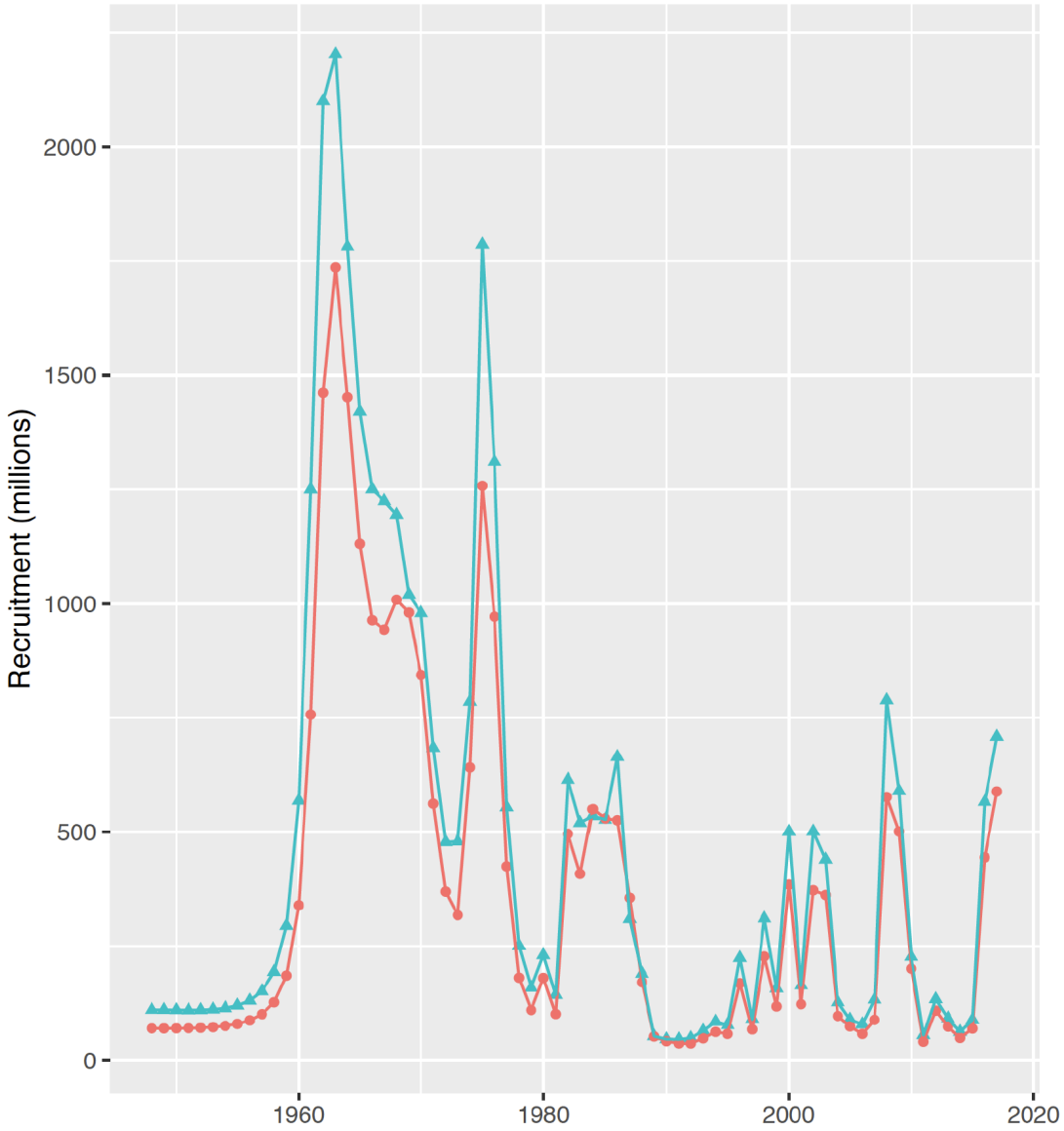
Effects on the assessment (corrected sample sizes)

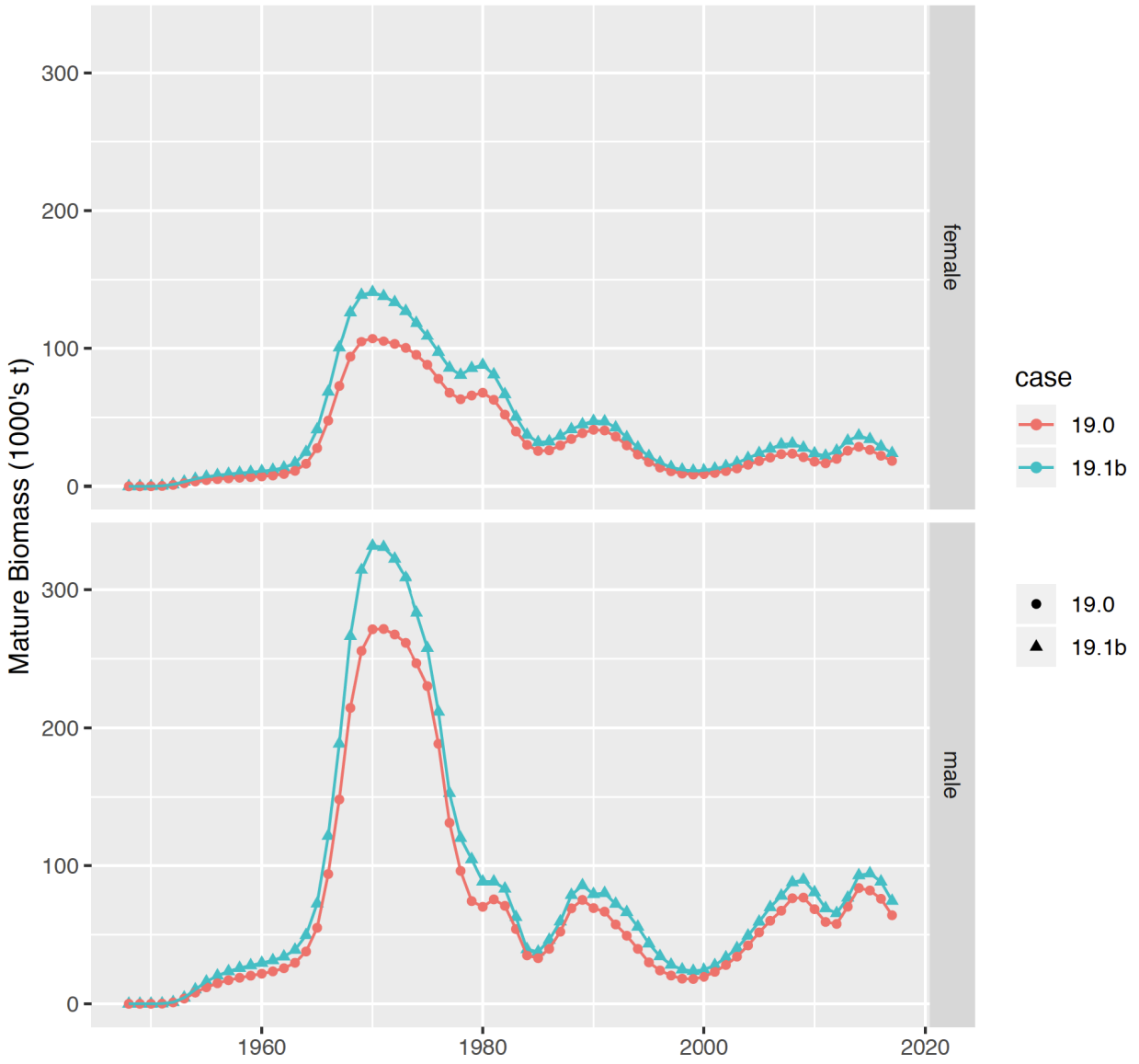






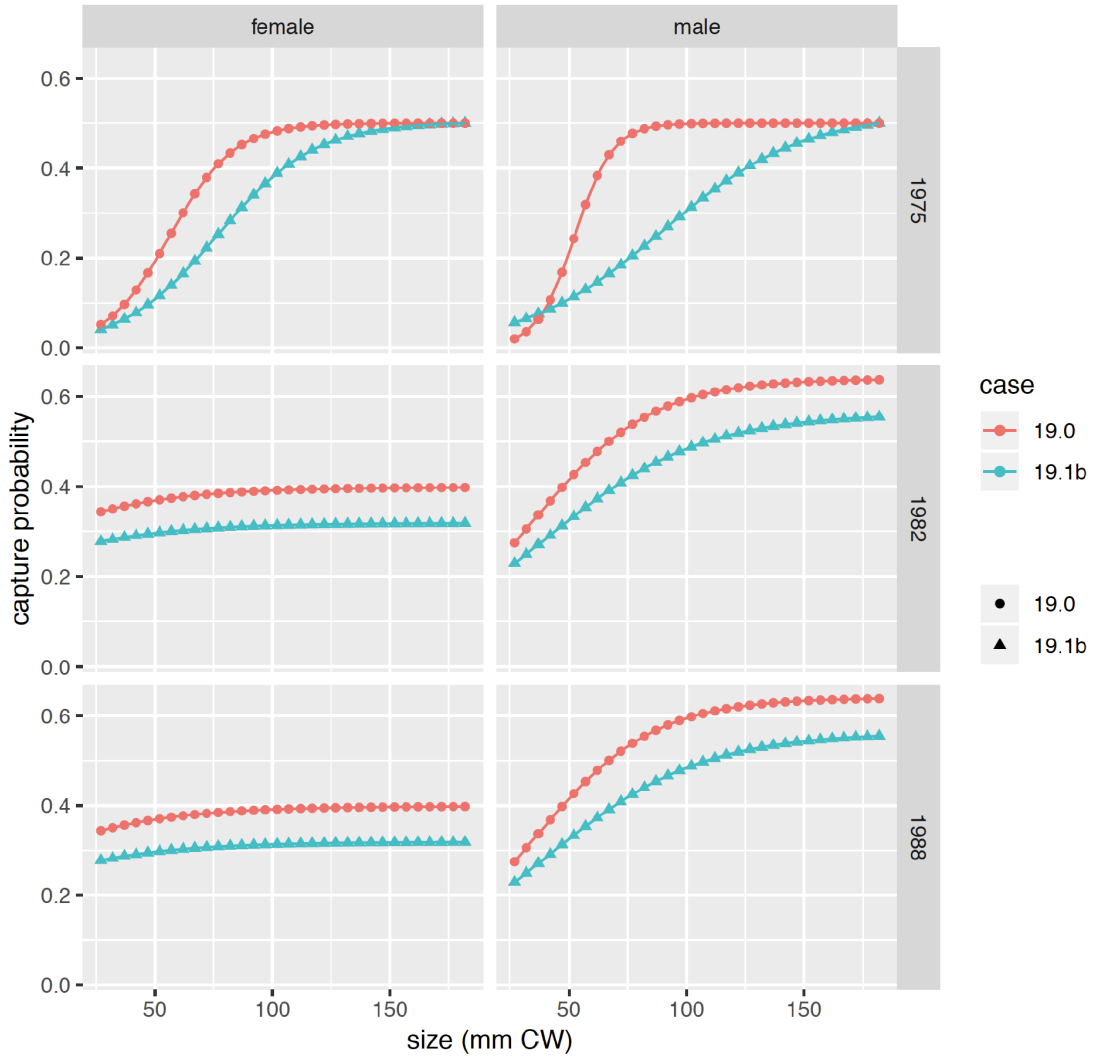
More effects…



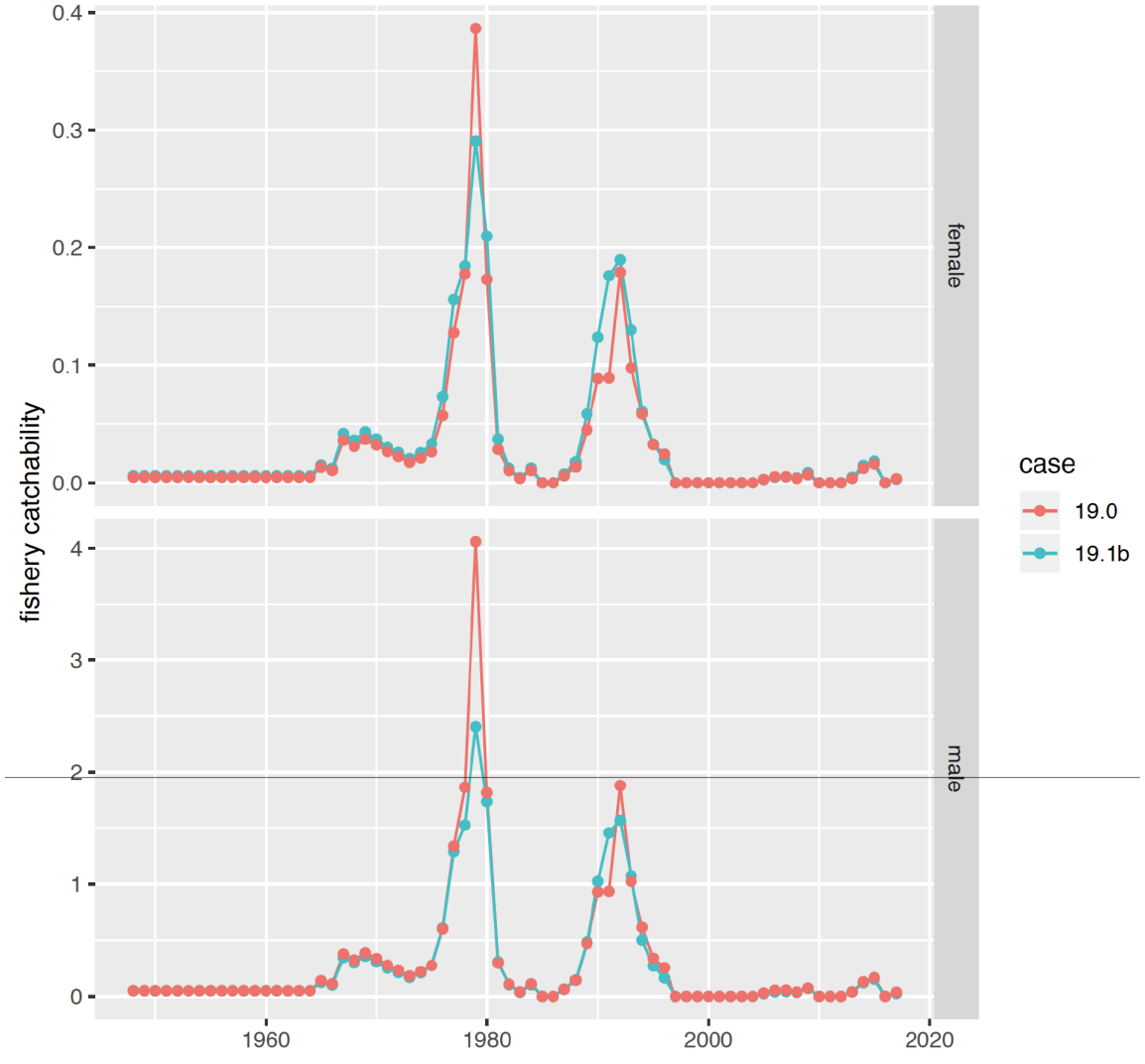


More effects…

Survey catchability

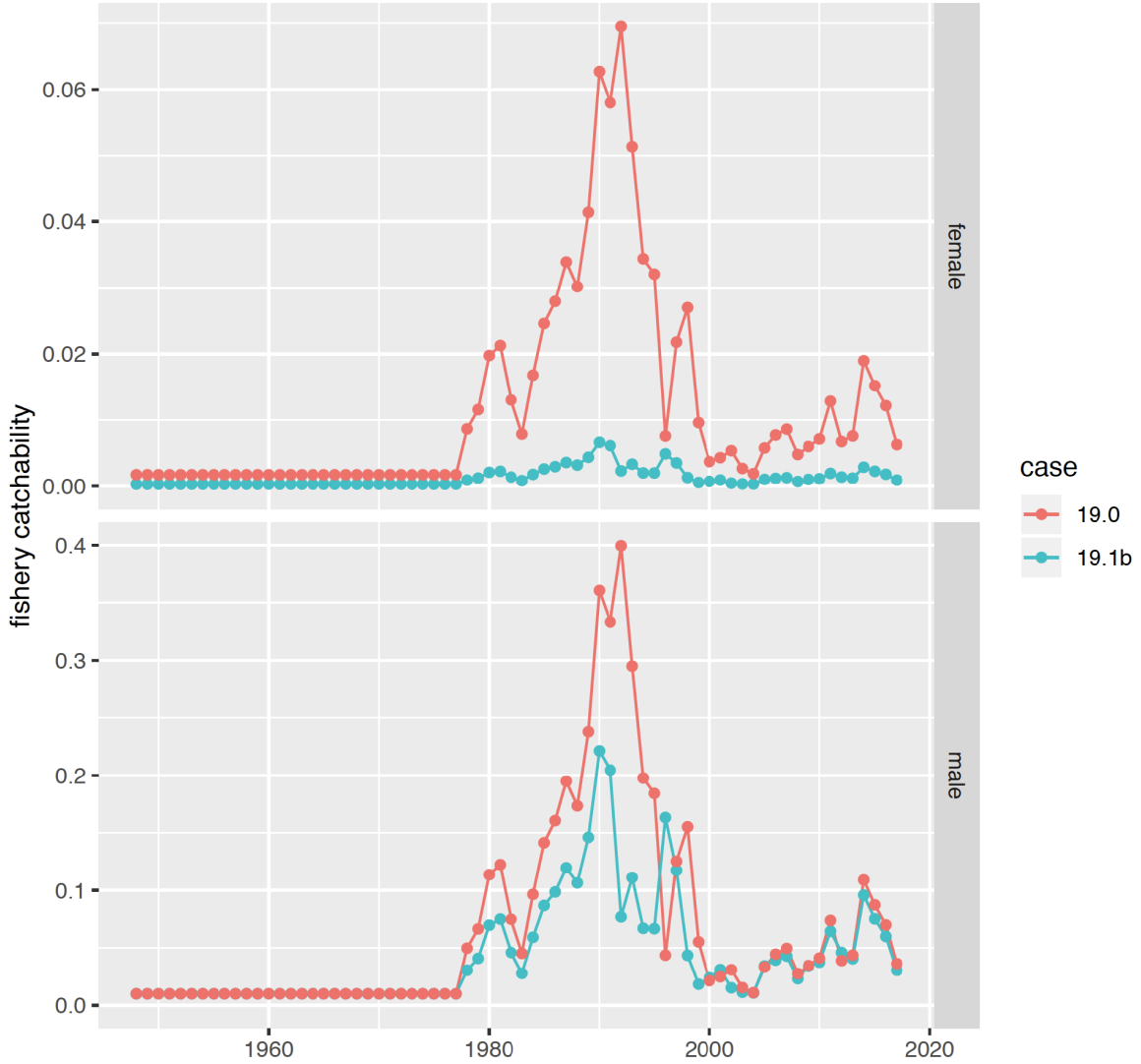


Fully-selected catchability in the directed fishery

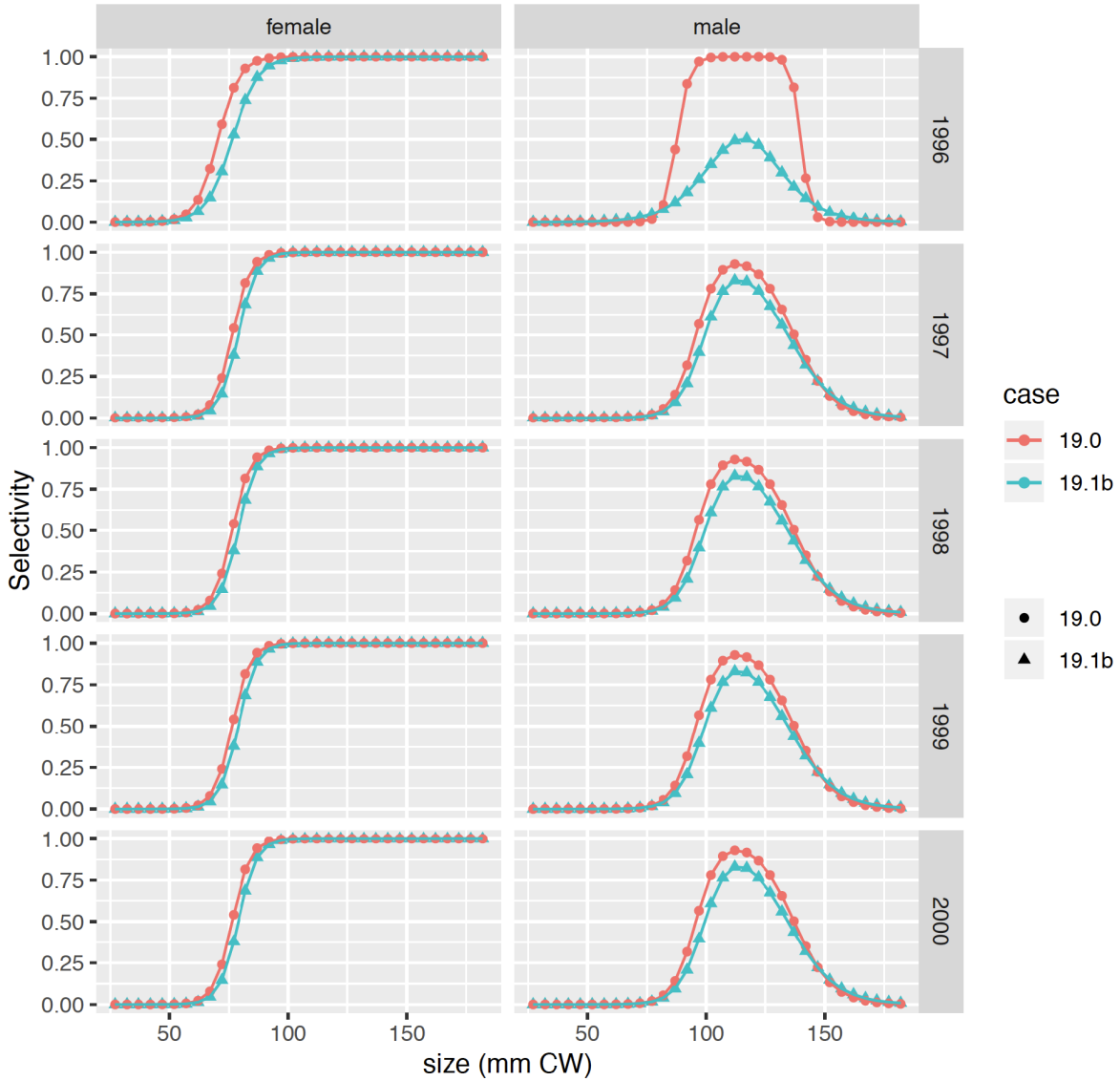


More effects…

Fully-selected catchability in the snow crab fishery



Fully-selected selectivity in the snow crab fishery



Back to management quantities

case	OFL	Fofl	prjB	curB	Fmsy	Bmsy	MSY	B100	avgRec
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