

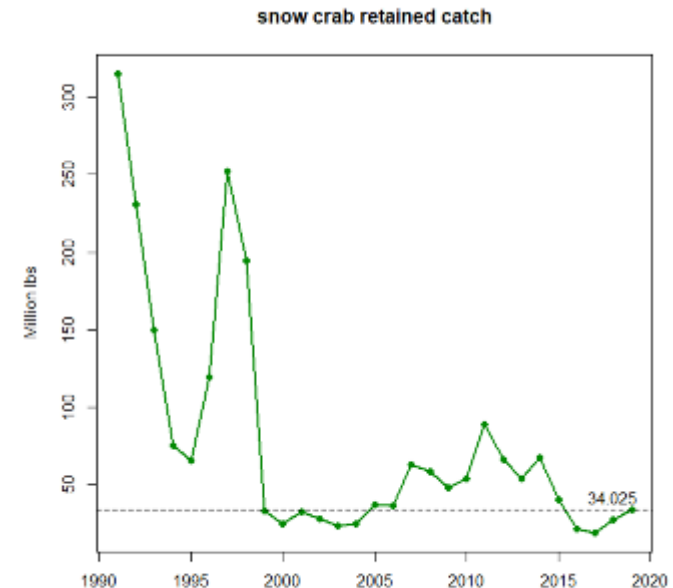
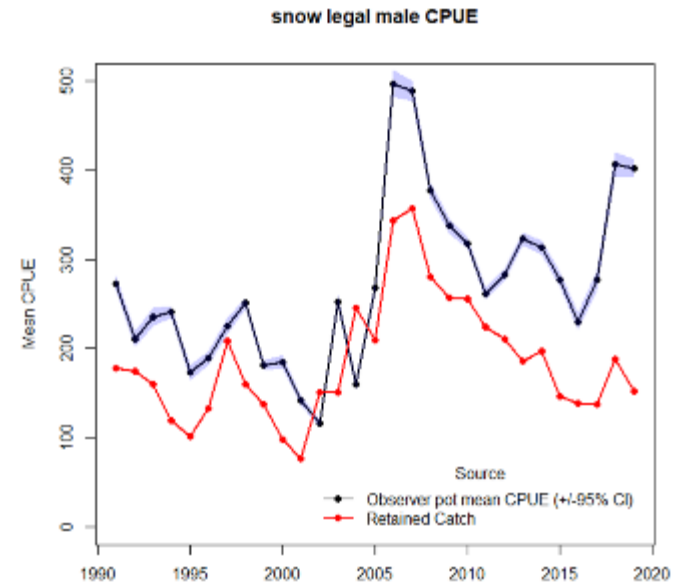


SNOW CRAB

FINAL ASSESSMENT 2020

SNOW CRAB FISHERY UPDATE

- Harvest for 2019/20 34.025 million lb
- Legal male (>3.1 inches) CPUE high in observer sample pots
- Retained catch (industry preferred size) CPUE (≥ 4 inches) was low
- North and west of PI with sea ice limited fishing on northern grounds for first two months of the fishery
- Harvest occurred over 4.5 months
- Heavy sorting on the grounds due to high abundance of legal but not industry preferred size crab
- Increase in average weight of retained catch
- Groundfish bycatch – under 60-ft P.cod pot and yellowfin sole trawl



2

STOCK ASSESSMENT FOR SNOW CRAB IN THE EASTERN BERING SEA

CODY SZUWALSKI, ALASKA FISHERY SCIENCE CENTER



SUMMARY

- Model scenarios and fits
- OFL and projections
- Uncertainty and buffers



MODEL SCENARIOS

- **19.1:** Reference model
- **20.1:** 19.1 fit to updated catch data
- **20.2:** GMACS fit to same data as 20.1
- **20.3:** 20.2 + increased weight on 2010 BSFRF data to force catchability to equal that implied by BSFRF experiments



KEY CHANGES IN MODEL STRUCTURE IN GMACS

Table 12: Differences between GMACS and the status quo model.

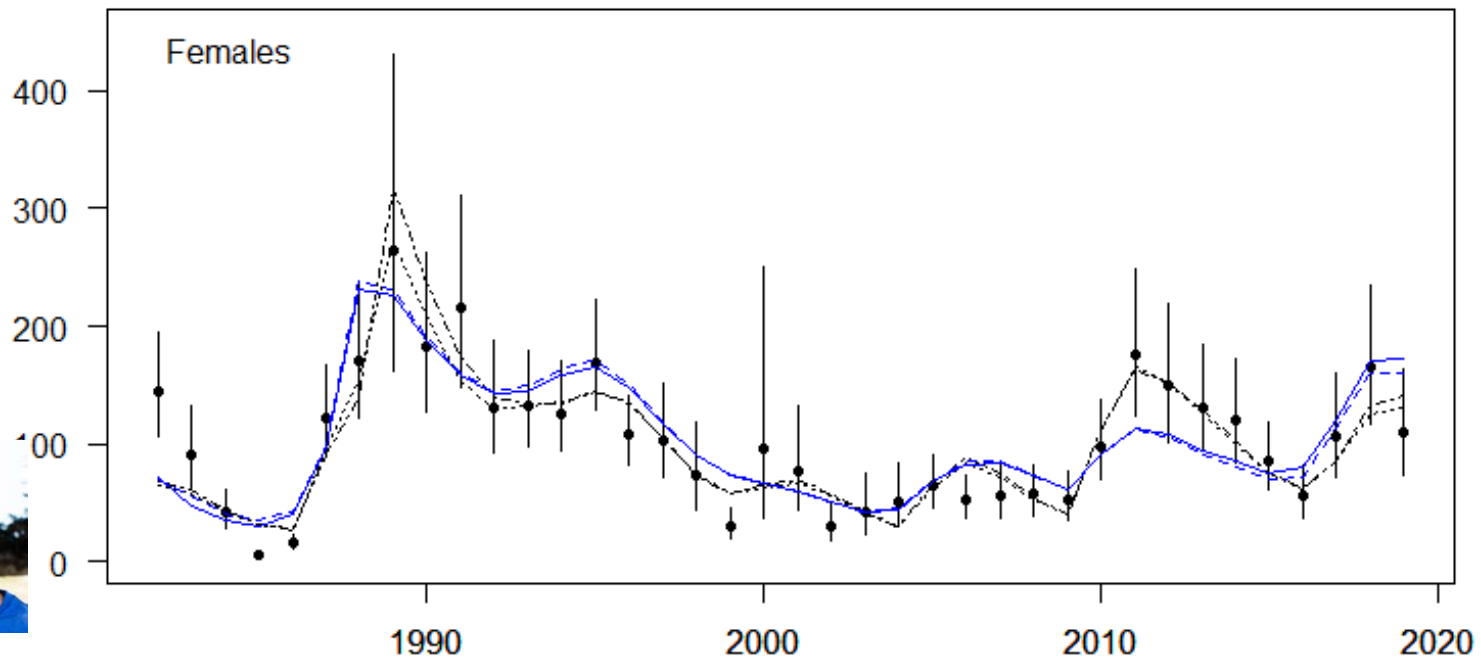
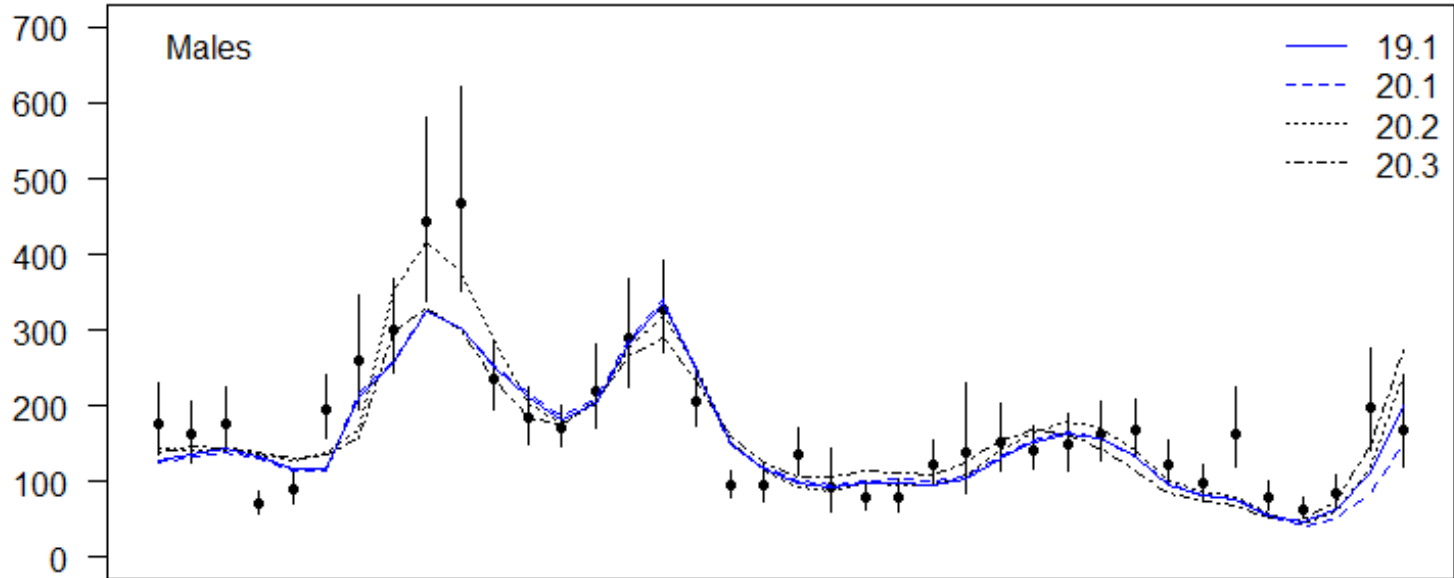
Process	GMACS	Status quo
Recruitment	Yearly recruitment estimate + parameter to divide recruitment between sexes	Separate estimated recruitment deviations and average recruitment for both sexes
Fishing mortality	Total mortality and female discards treated consistently (see May CPT document)	Total mortality and female discards treated inconsistently (see May CPT document)
Growth	Linear growth for both males and females	Linear growth for males; kinked growth for females
BSFRF	Freely estimated availability curves for all sex/year combinations	Logistic availability curves for some sex/year combinations
Natural mortality	Estimated M for mature males, mature females, immature males, immature females (n=4)	Estimated M for mature males, mature females, immature males and females (n=3)



MODEL FITS

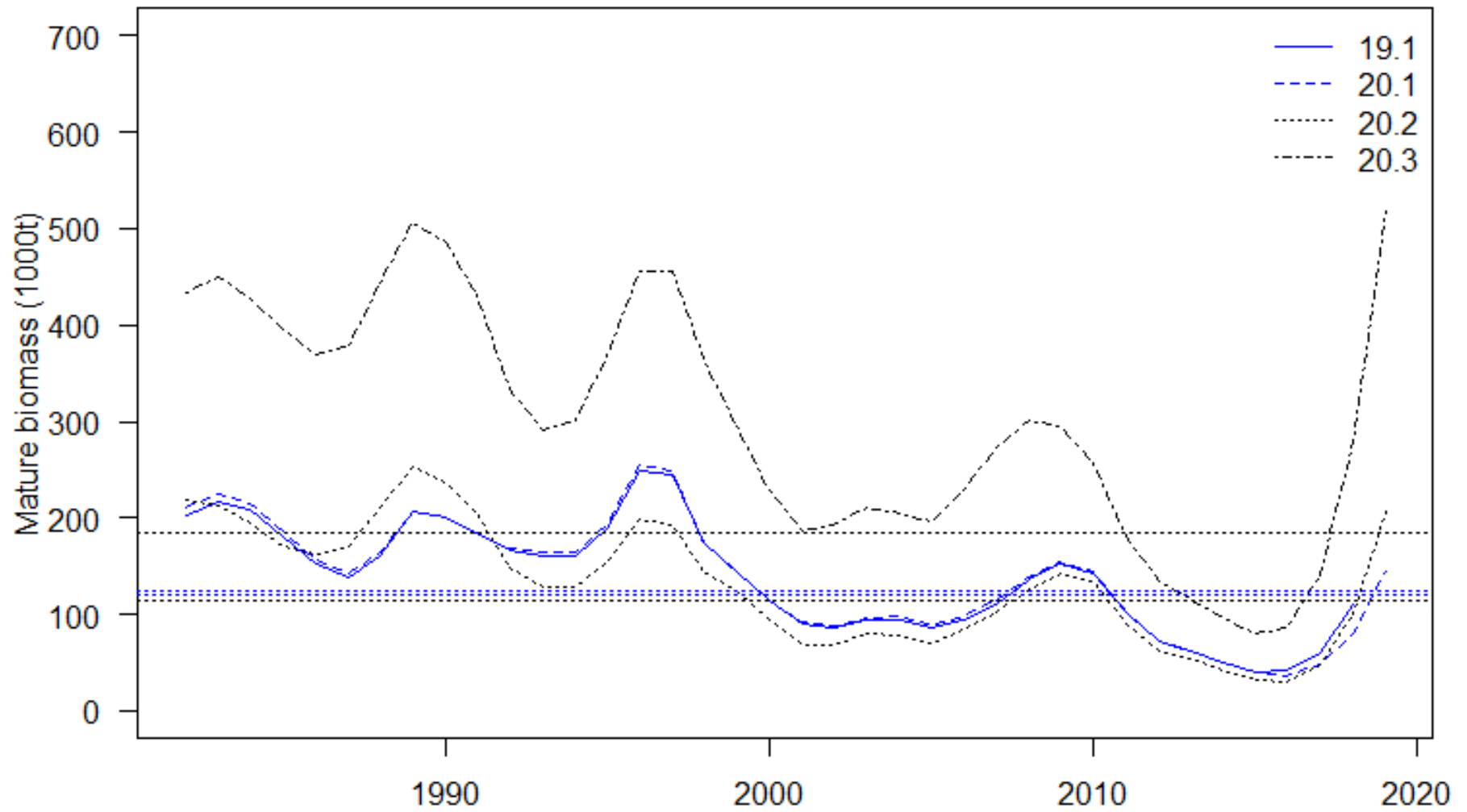
- GMACS fit the data as well (or better) than the status quo in nearly all instances
- Changes in model structure in GMACS are improvements over the status quo



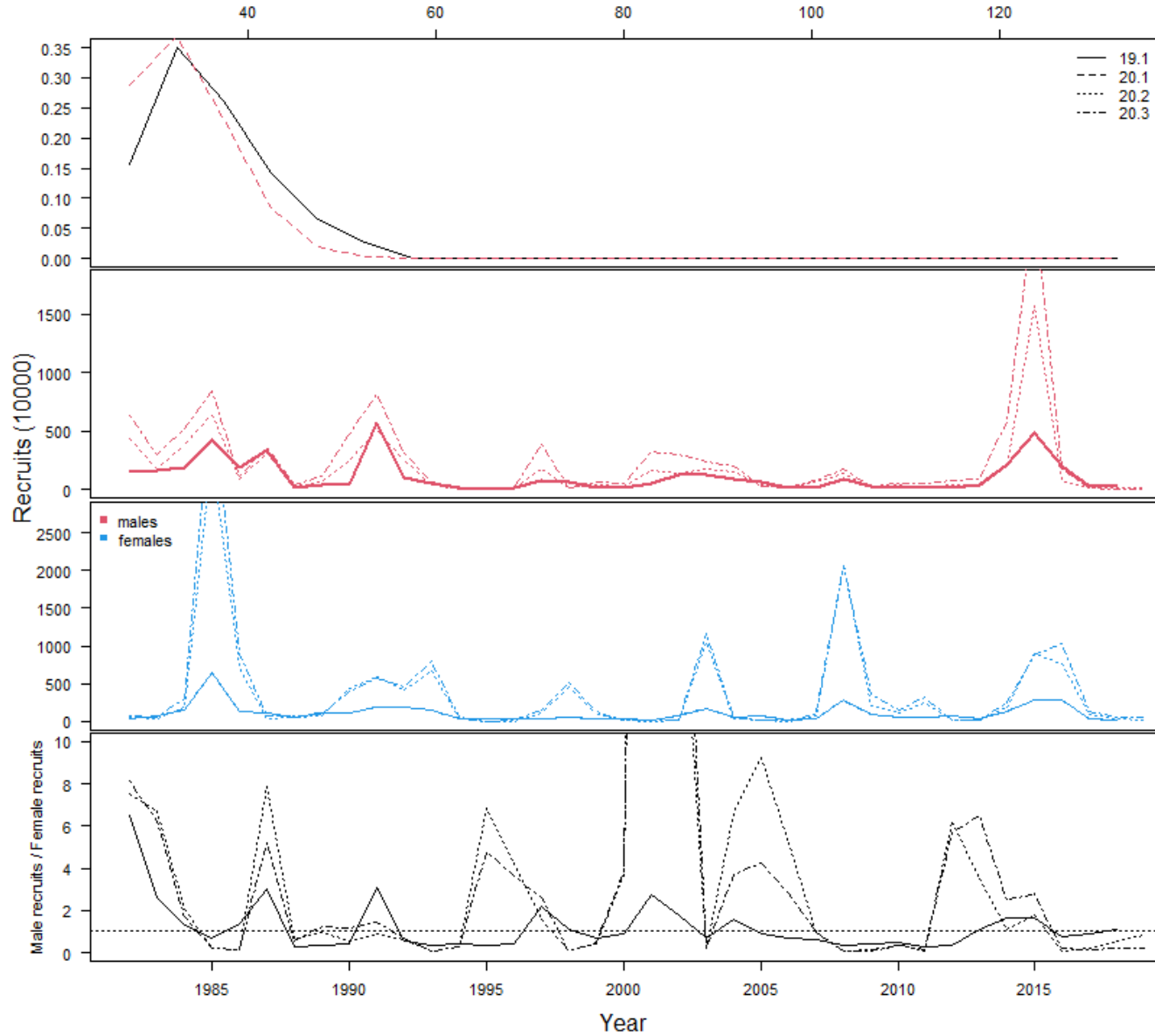


ESTIMATED POPULATION PROCESSES





Length (mm)



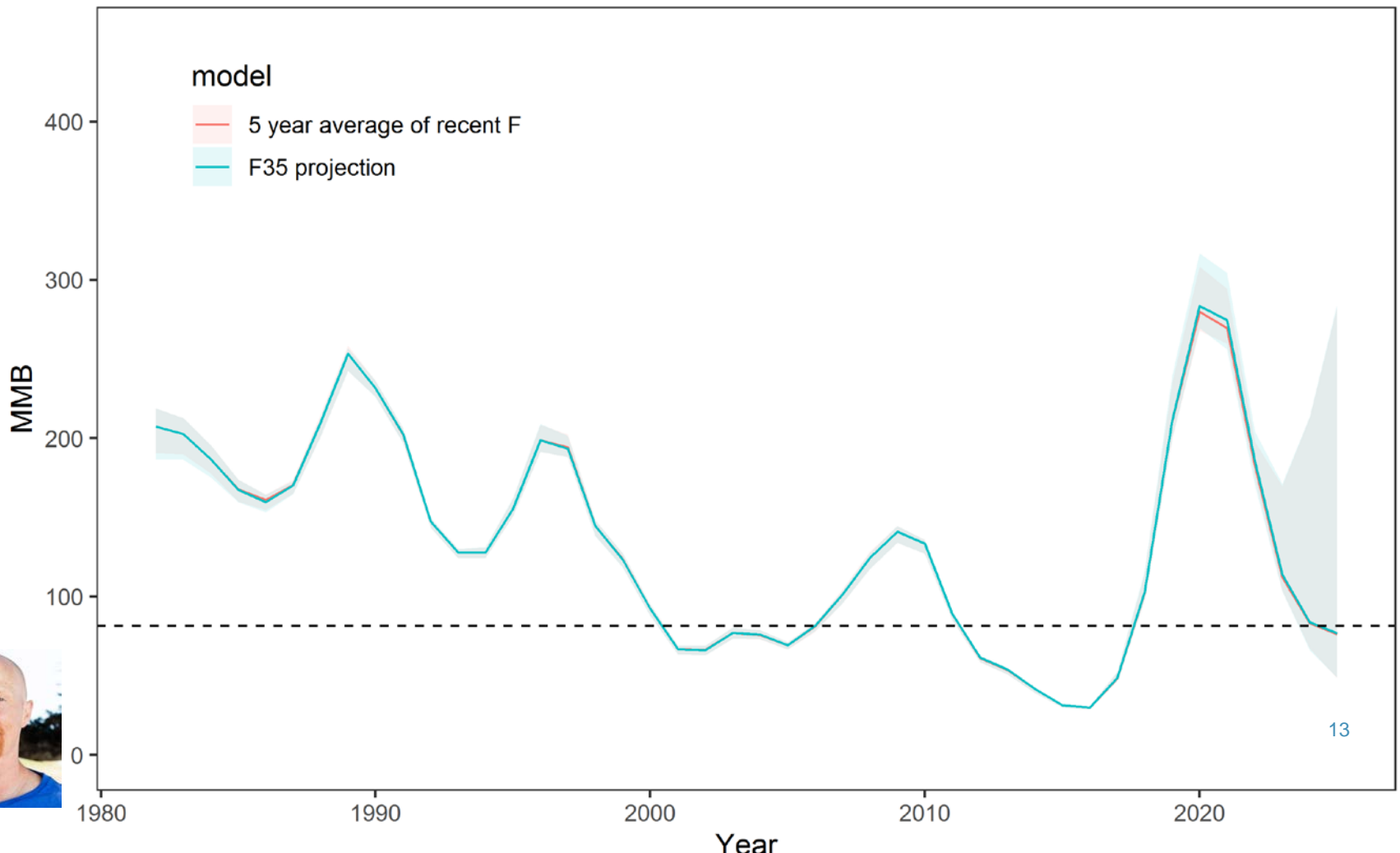
PREFERRED MODEL

- 20.2 (GMACS)
 - Model improvements
 - Comparable model fits and reference points
 - Fit recent years of survey MMB best

Model	MMB	B35	F35	FOFL	OFL	M	avg_rec
19.1	109.56	123.71	1.80	1.80	54.05	0.30	113.68
20.1	144.29	120.51	1.60	1.60	95.40	0.30	109.55
20.2	207.19	113.66	1.65	1.65	184.91	0.36	169.96
20.3	517.13	183.95	2.61	2.61	448.38	0.36	265.31



PROJECTIONS



CPT SUGGESTIONS FOR FUTURE

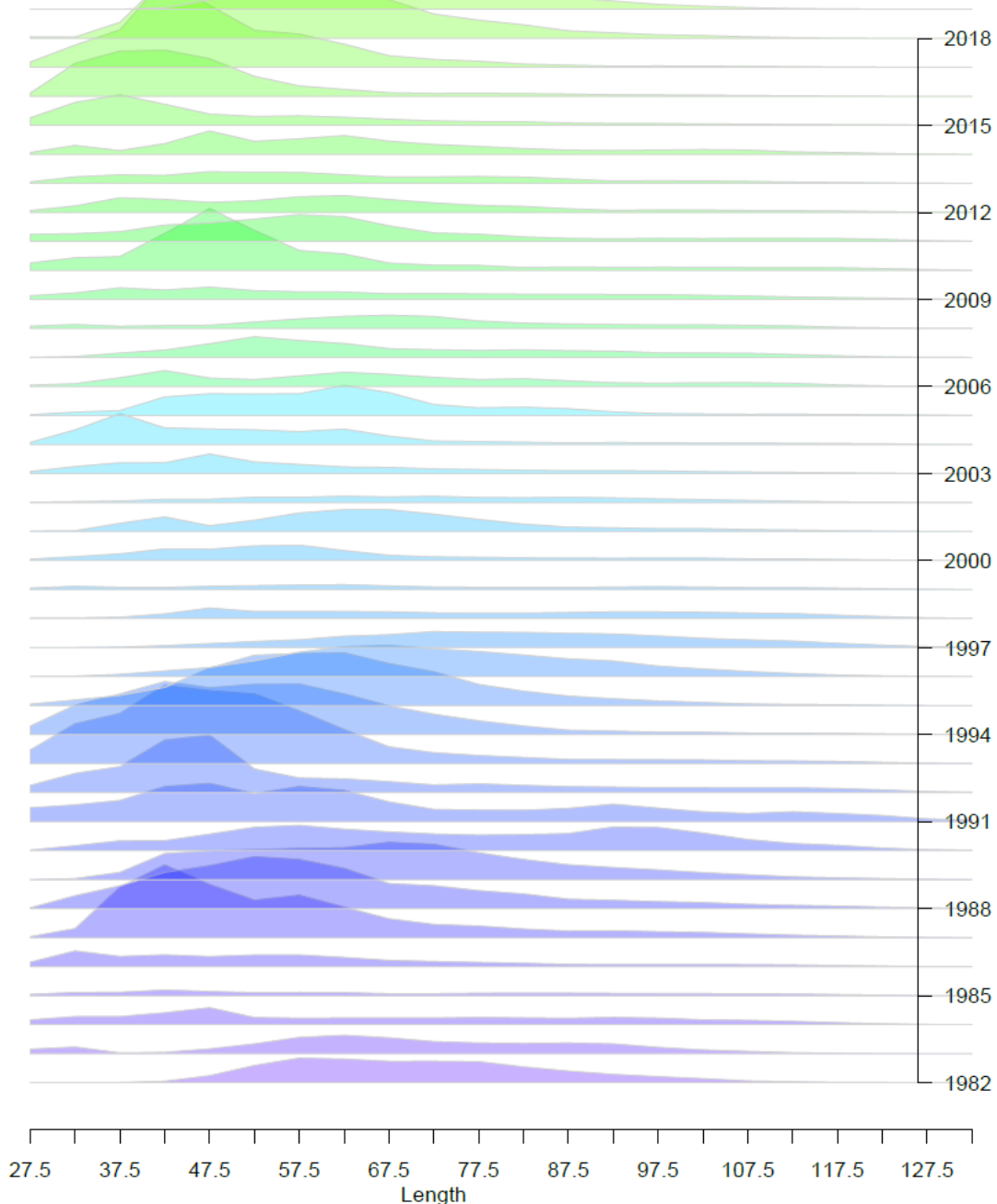
- Review data sources
- Explore implications of different penalties on recruitment deviations
- Explore within-year observer data to determine support for the hypothesis of multiple recaptures of bycaught animals with respect to an assumed pulse fishery
- Modify model to include male maturity data rather than splitting the male data by maturity prior to running the model
- Time-varying retention probability in directed fishery
- Explore data weighting for bycatch size composition
- Jittering in GMACS
- Alternative forms for survey selectivity

UNCERTAINTY IN THE OFL

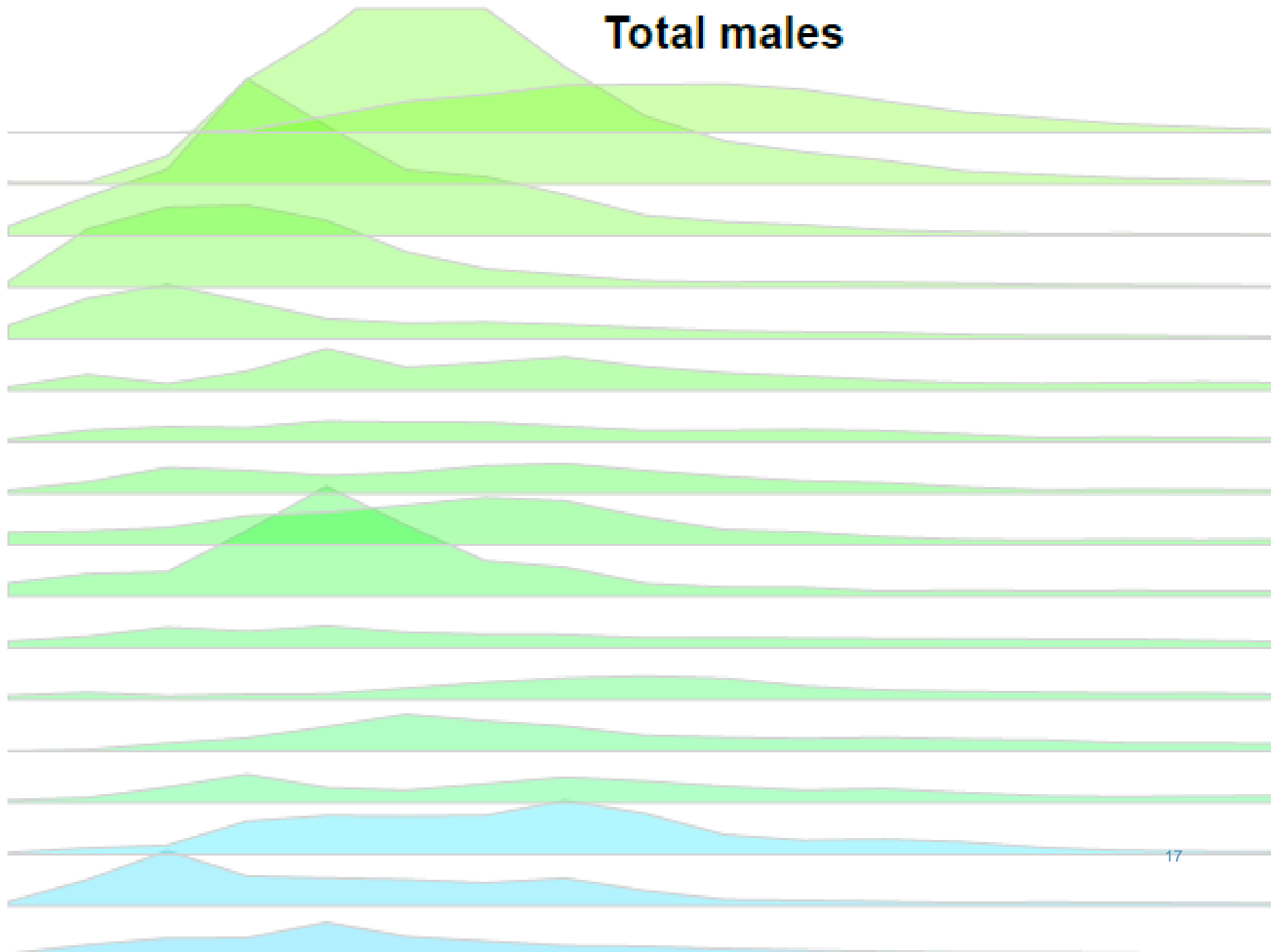
- Missed survey
- Mismatch between the 2018 and 2019 survey data
- Retrospective patterns
- Differences in estimated recruitment from 2019 to 2020

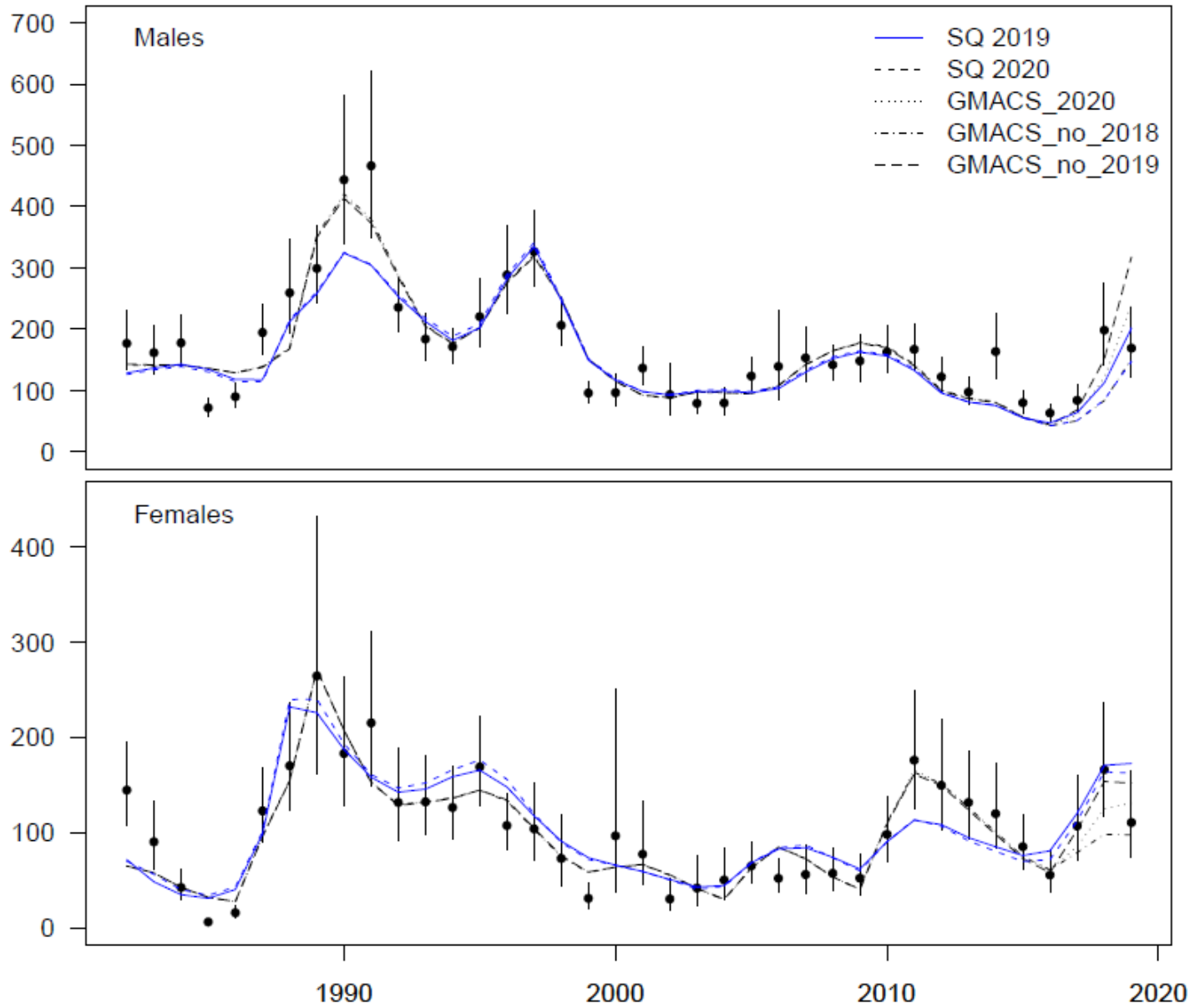


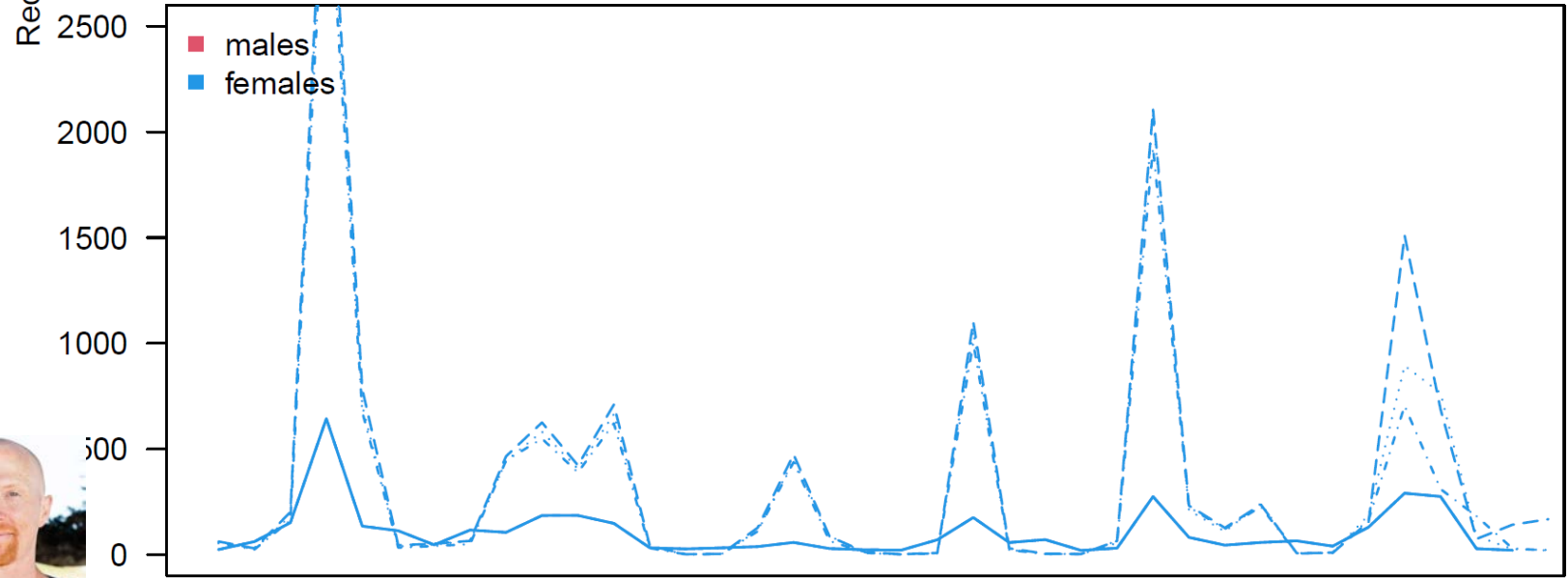
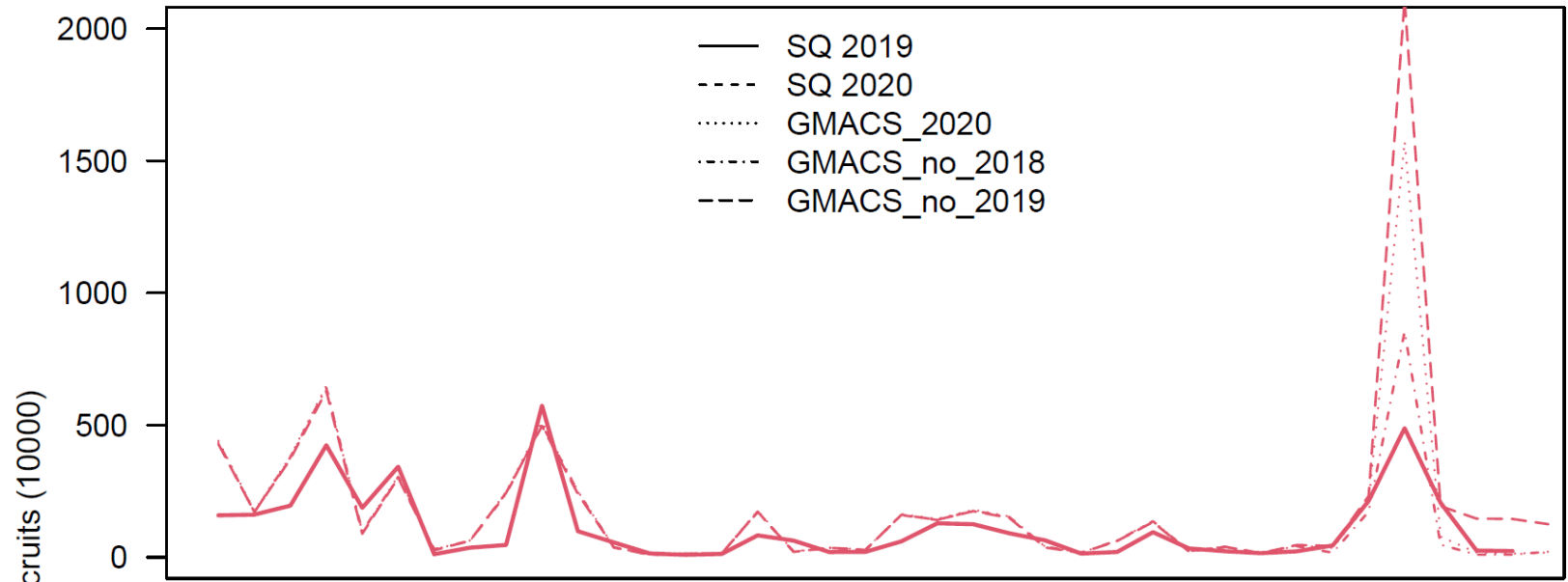
Total males



Total males







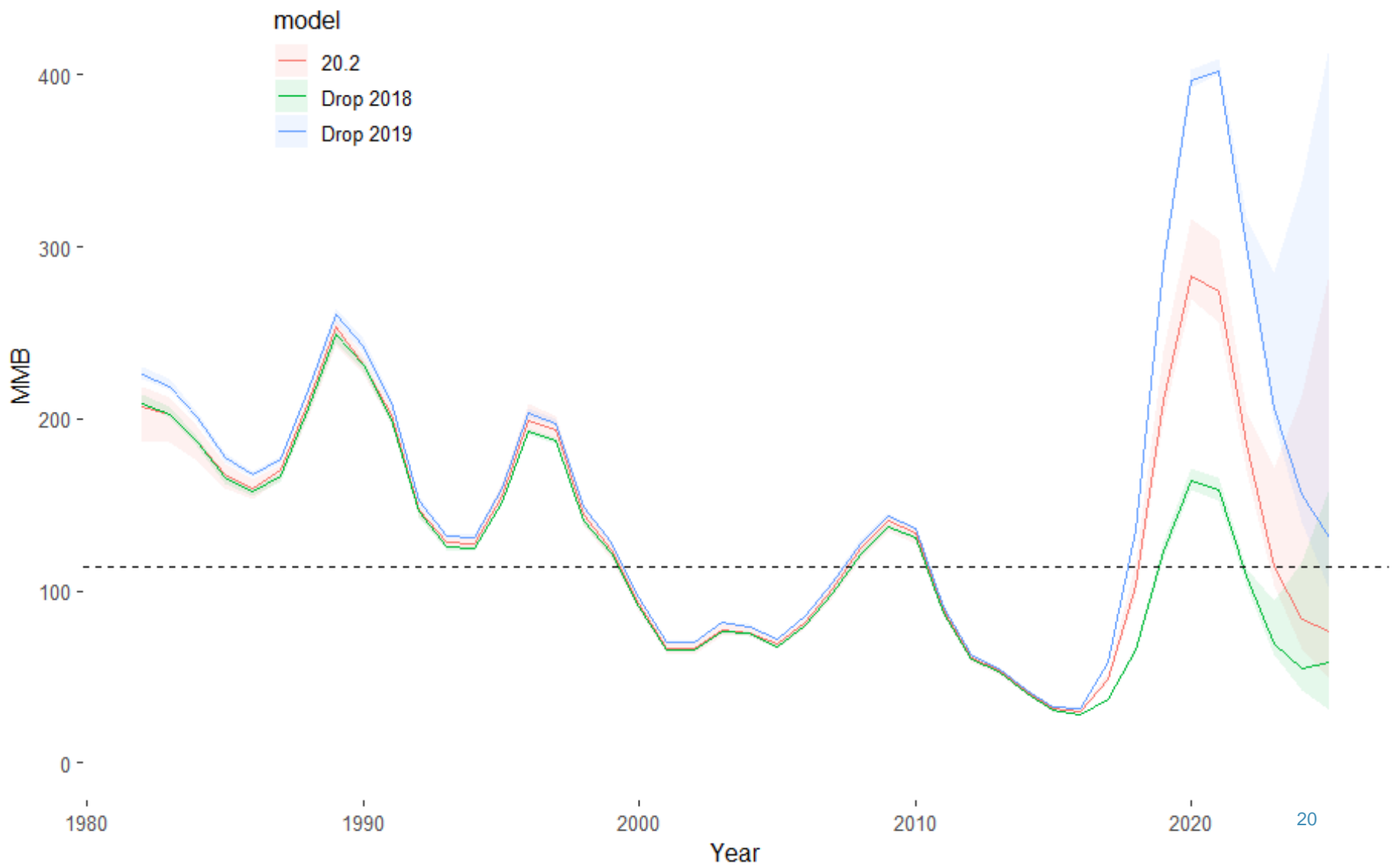


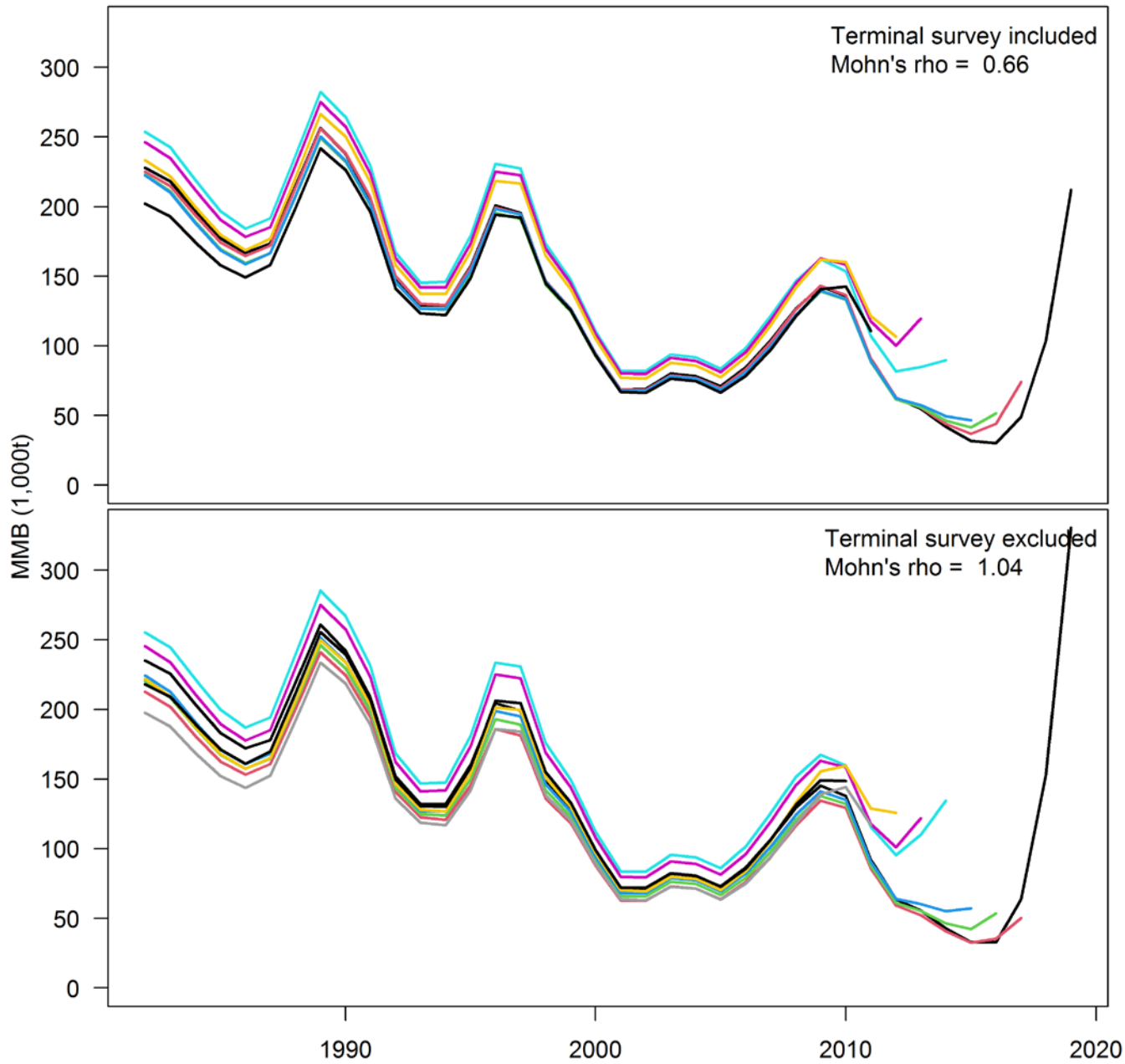
Table 1: Changes in management quantities for each scenario considered. Reported management quantities are derived from maximum likelihood estimates.

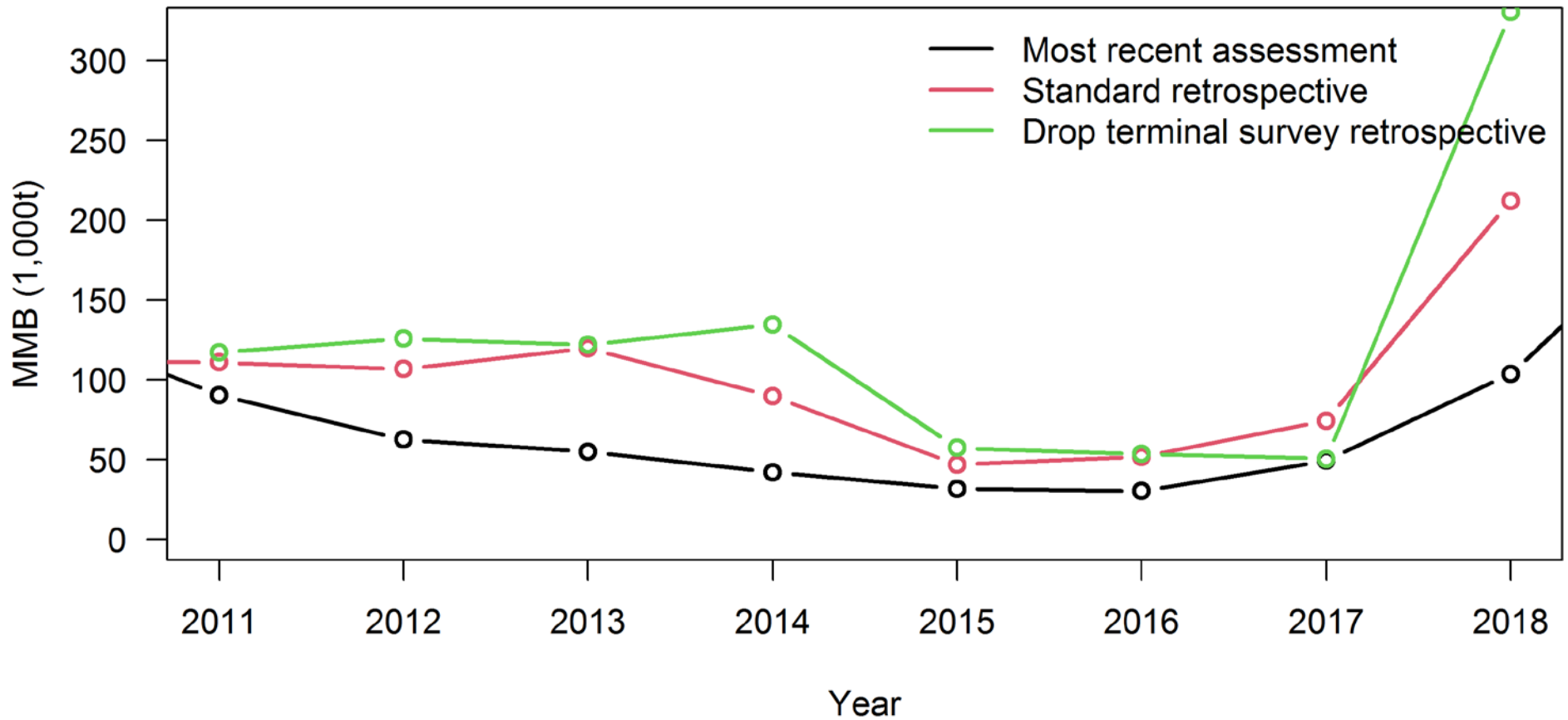
Model	MMB	B35	F35	FOFL	OFL
SQ 2019	109.56	123.71	1.80	1.80	54.05
SQ 2020	142.85	151.25	1.63	1.63	93.63
GMACS__2020	207.19	113.66	1.65	1.65	184.91
GMACS__no__2018	119.68	96.96	1.60	1.60	104.82
GMACS__no__2019	283.66	132.48	1.64	1.64	250.33

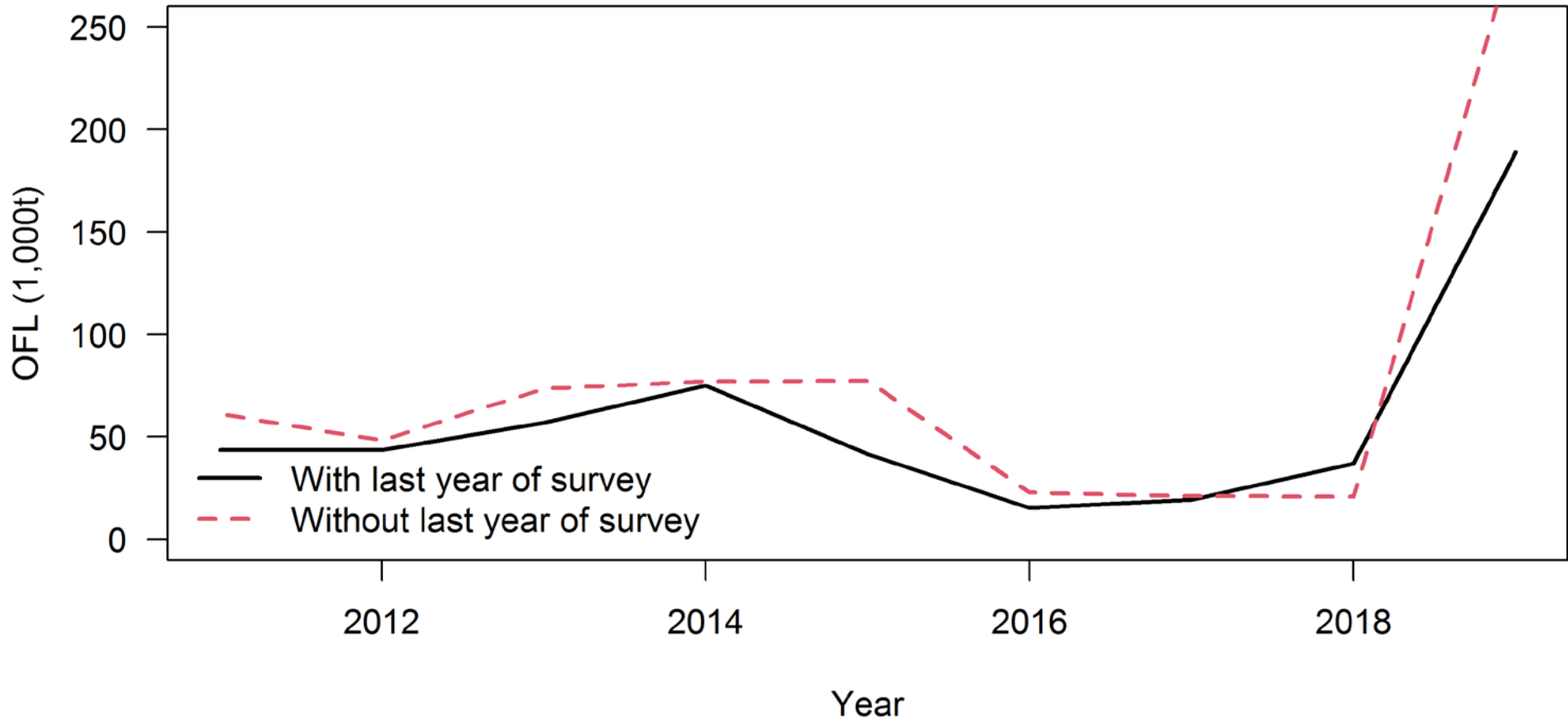


RETROSPECTIVE PATTERNS & MISSING TERMINAL YEAR SURVEY DATA





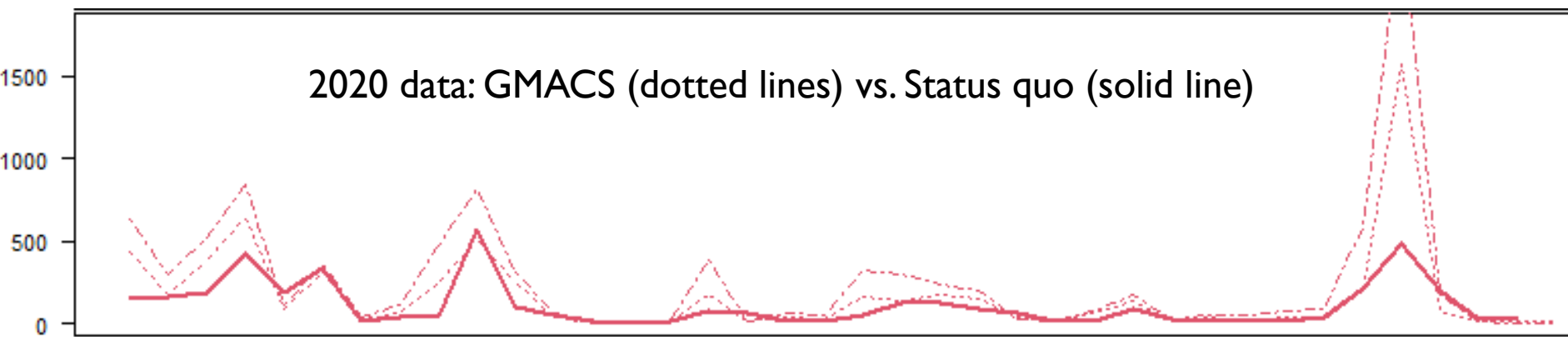
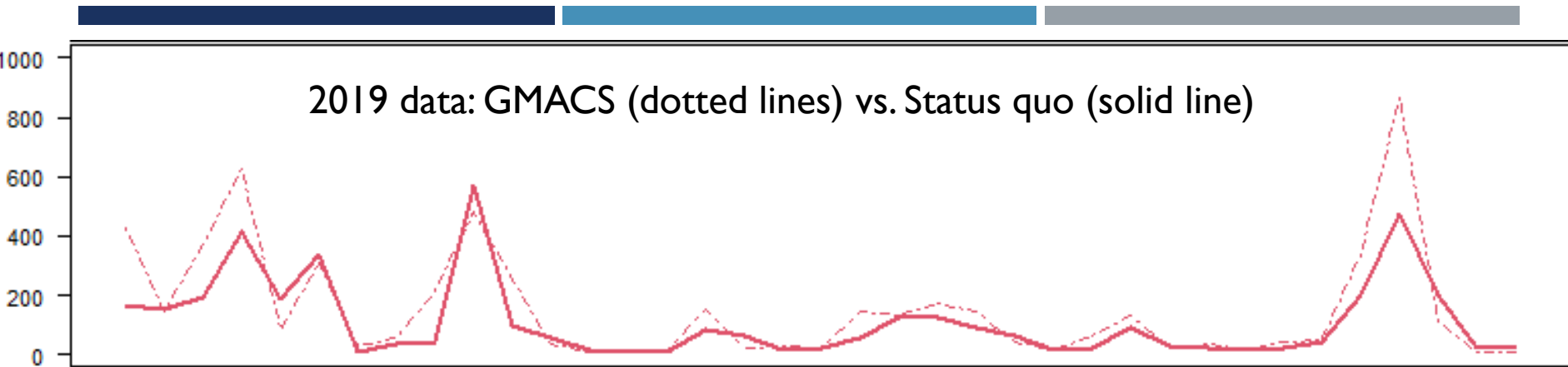




Average difference of +21% in OFL when terminal year of survey is excluded

UNCERTAINTY IN RECRUITMENT





Why would 2015 recruitment be so much higher for GMACS than for SQ with 2019 data?
(recruitment penalties?)

Why would the GMACS recruitment increase so much from 2019 to 2020?
(signal in ratio of discard biomass to retained biomass?)


Why didn't SQ increase with the new data?
(it didn't fit the survey biomass)



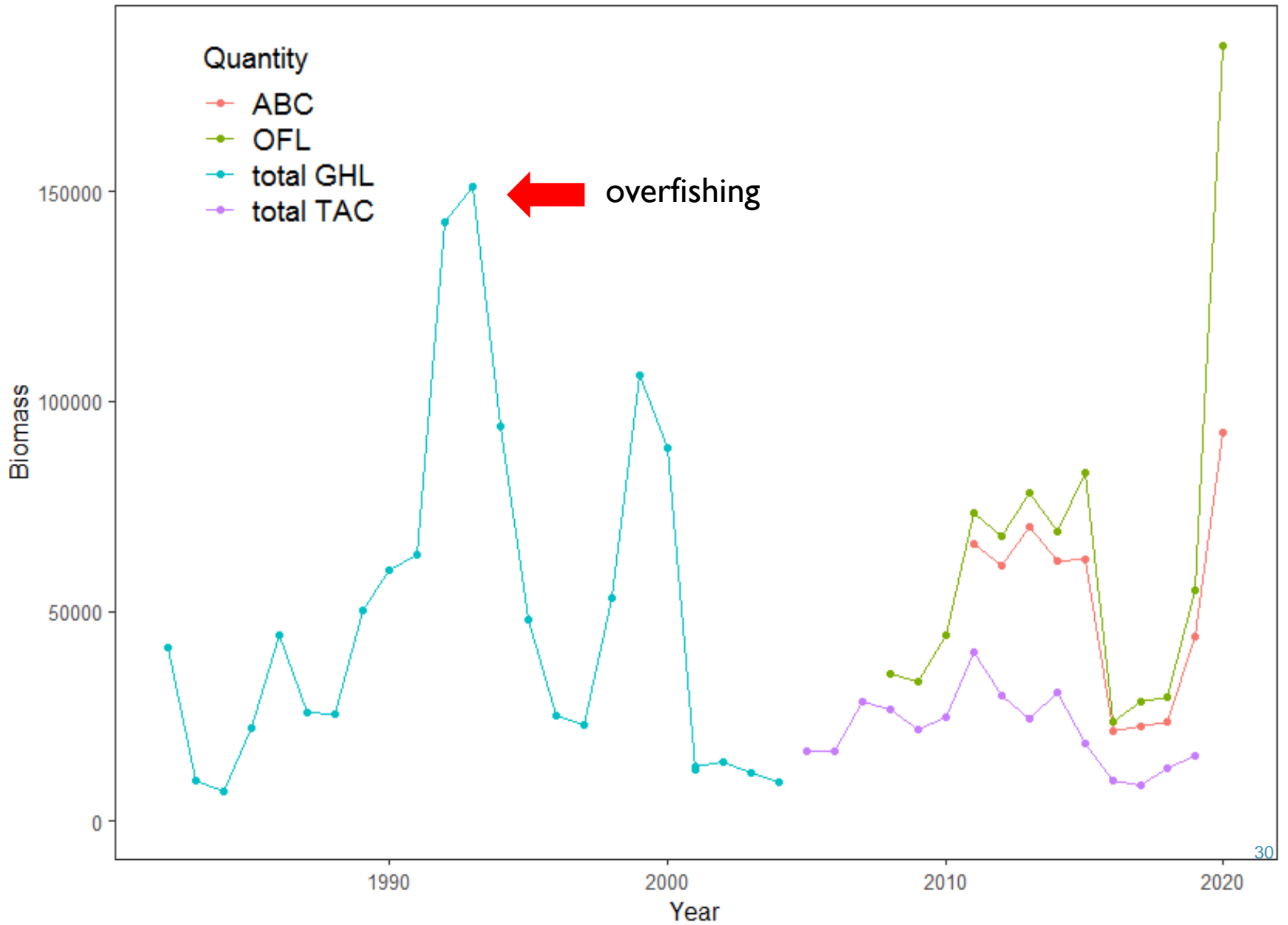
SUMMARY OF CPT DISCUSSION ON ABC BUFFERS FOR SNOW CRAB

- Yearly buffer related to scientific uncertainty
 - 20% → 25%
 - Rationale:
 - Large positive retrospective pattern (20%)
 - New uncertainty in 2015 recruitment (5%)
- Additional buffer related to missing a survey
 - +25%
 - Rationale:
 - Increased positive retrospective pattern when excluding terminal year of survey resulted in 21% higher OFL on average (but with some years much higher than that)
 - Discrepancy in the 2018 and 2019 survey data—the most recent survey data indicated an unexpected drop in numbers and biomass
- Total CPT recommended ABC buffer: 50%

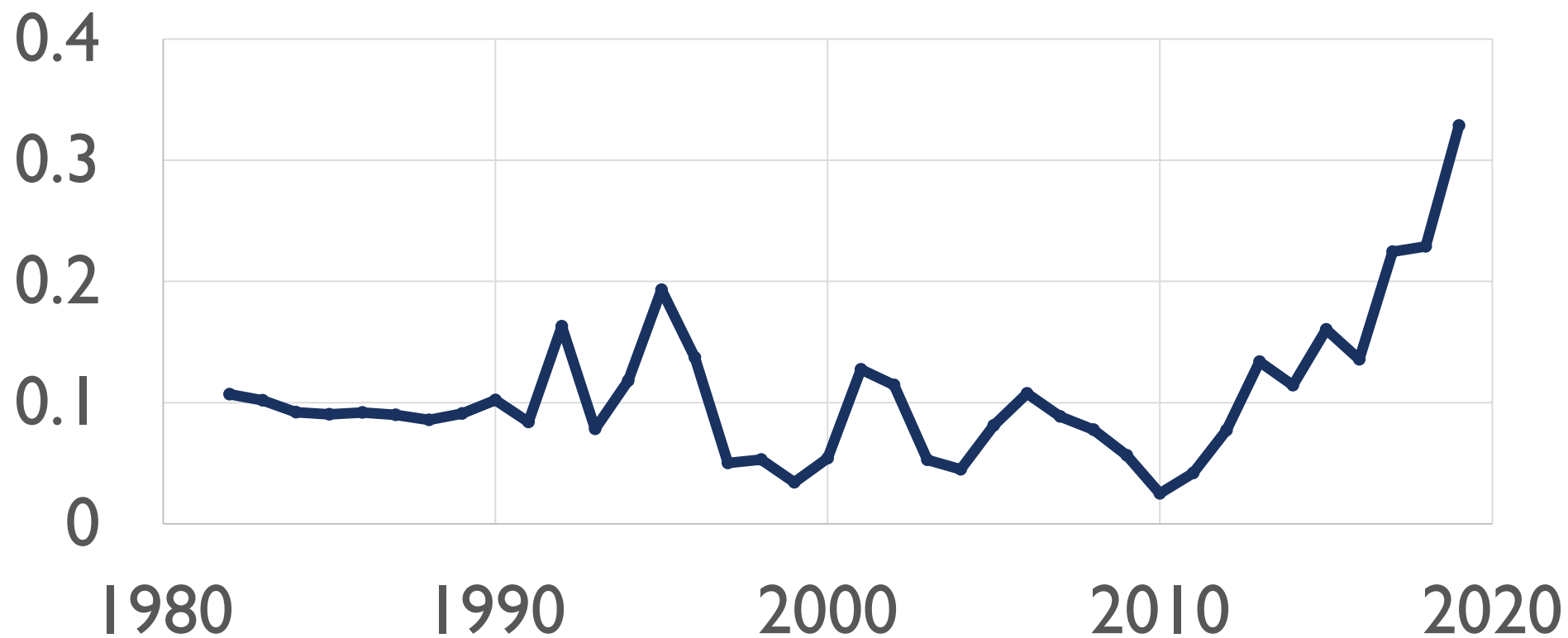


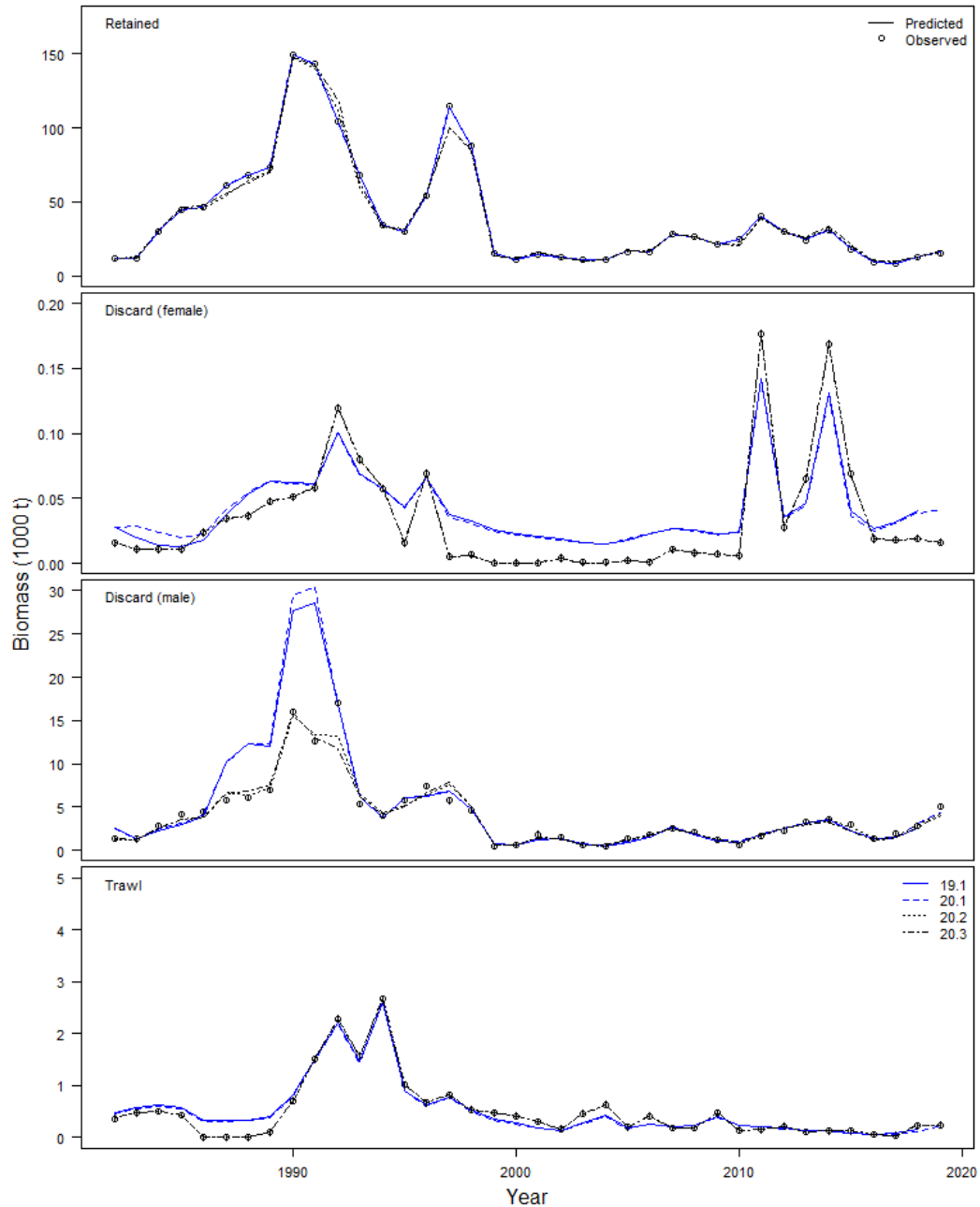


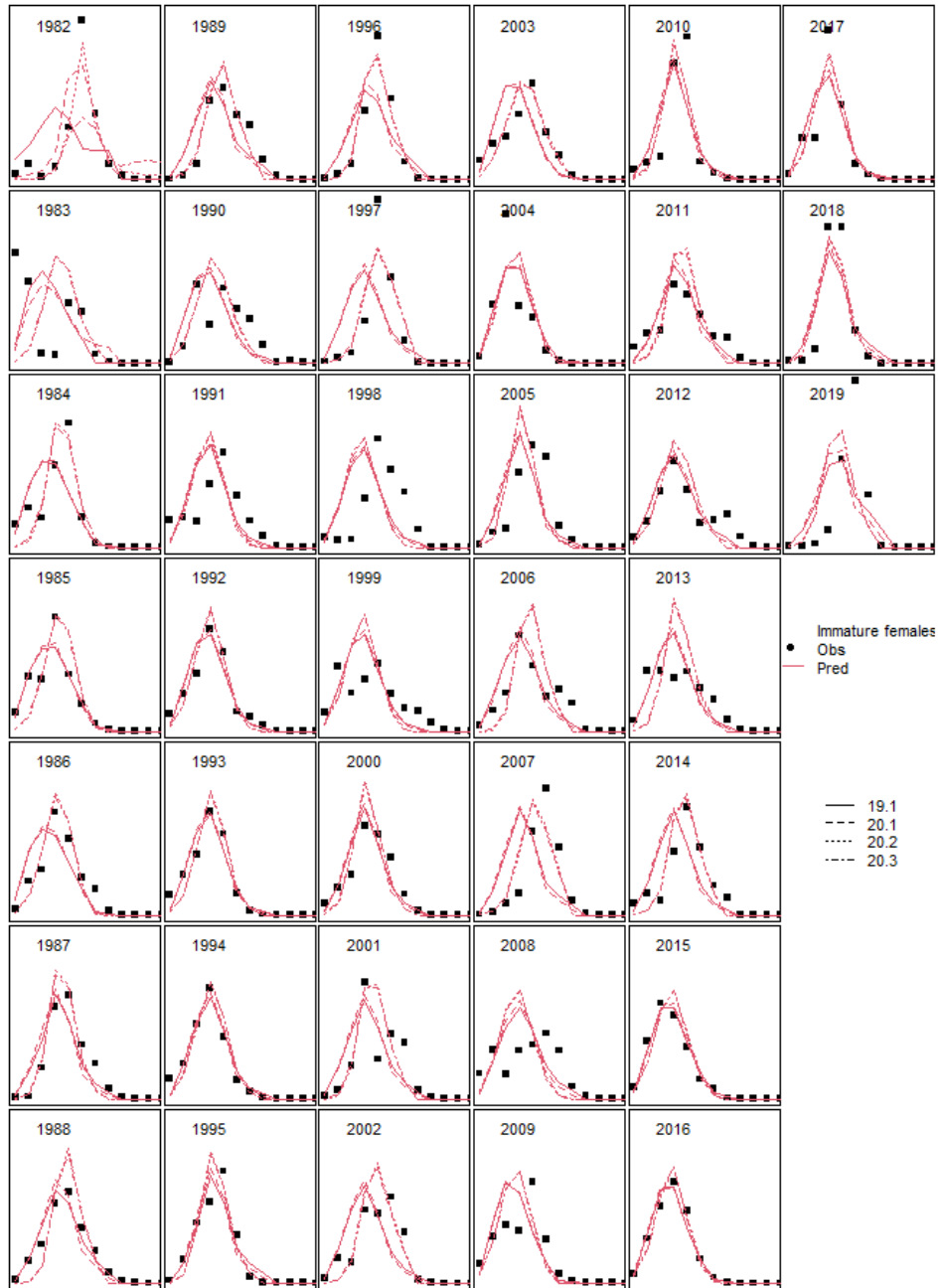
Year	MSST	Biomass (MMB)	TAC	Retained catch	Total catch	OFL	ABC
2015/2016	75.8	91.6	18.4	18.4	21.4	83.1	62.3
2016/2017	69.7	96.1	9.7	9.7	11	23.7	21.3
2017/2018	71.4	99.6	8.6	8.6	10.5	28.4	22.7
2018/2019	63	123.1	12.5	12.5	15.4	29.7	23.8
2019/2020	56.8	167.3	15.4	15.4	20.8	54.9	43.9
2020/2021		276.7				184.9	92.5



Discard biomass mortality / retained biomass







$$MARE = \frac{1}{n} \sum \left| \frac{(pred - obs)}{obs} \right|$$

ZERO IS PERFECT PREDICTION



	20.1	20.2	20.3
Retained	0.00	0.05	0.05
Discard (male)	0.28	0.11	0.14
Discard (female)	7.31	0.00	0.00
Bycatch	195.79	0.00	0.00
Survey MMB era 1	0.34	0.36	0.37
Survey MMB era 2	0.22	0.20	0.22
Survey FMB era 1	1.13	0.88	0.91
Survey FMB era 2	0.28	0.20	0.21
2009 BSFRF MMB	0.03	0.34	0.09
2009 NMFS MMB	0.26	0.23	0.04
2010 BSFRF MMB	0.02	0.36	0.01
2010 NMFS MMB	0.23	0.38	0.01
2009 BSFRF FMB	0.50	0.62	0.58
2009 NMFS FMB	0.04	0.41	0.40
2010 BSFRF FMB	0.48	0.08	0.00
2010 NMFS FMB	0.86	0.08	0.00



$$MAE = \frac{1}{n} \sum |(pred - obs)|$$

ZERO IS PERFECT PREDICTION



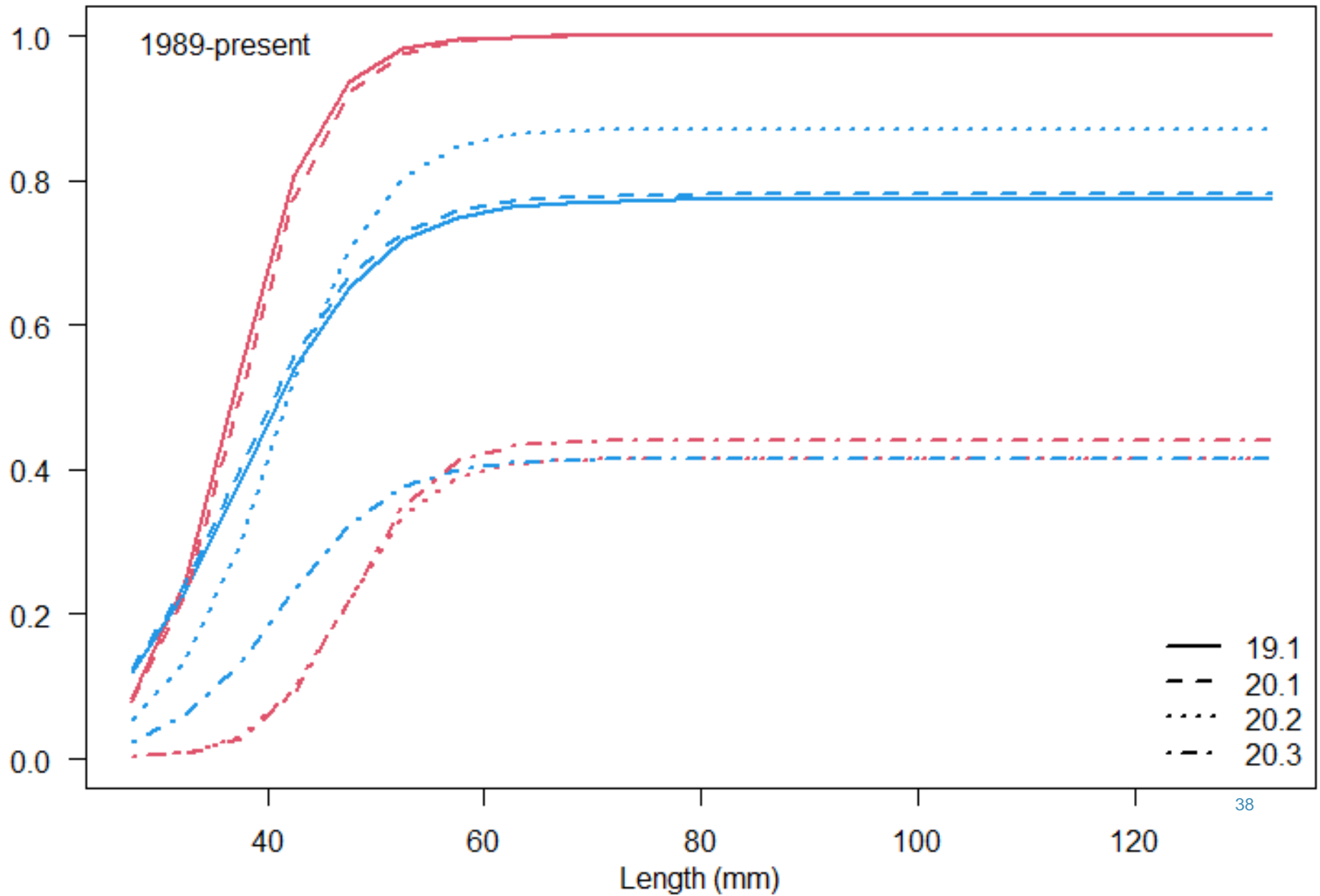


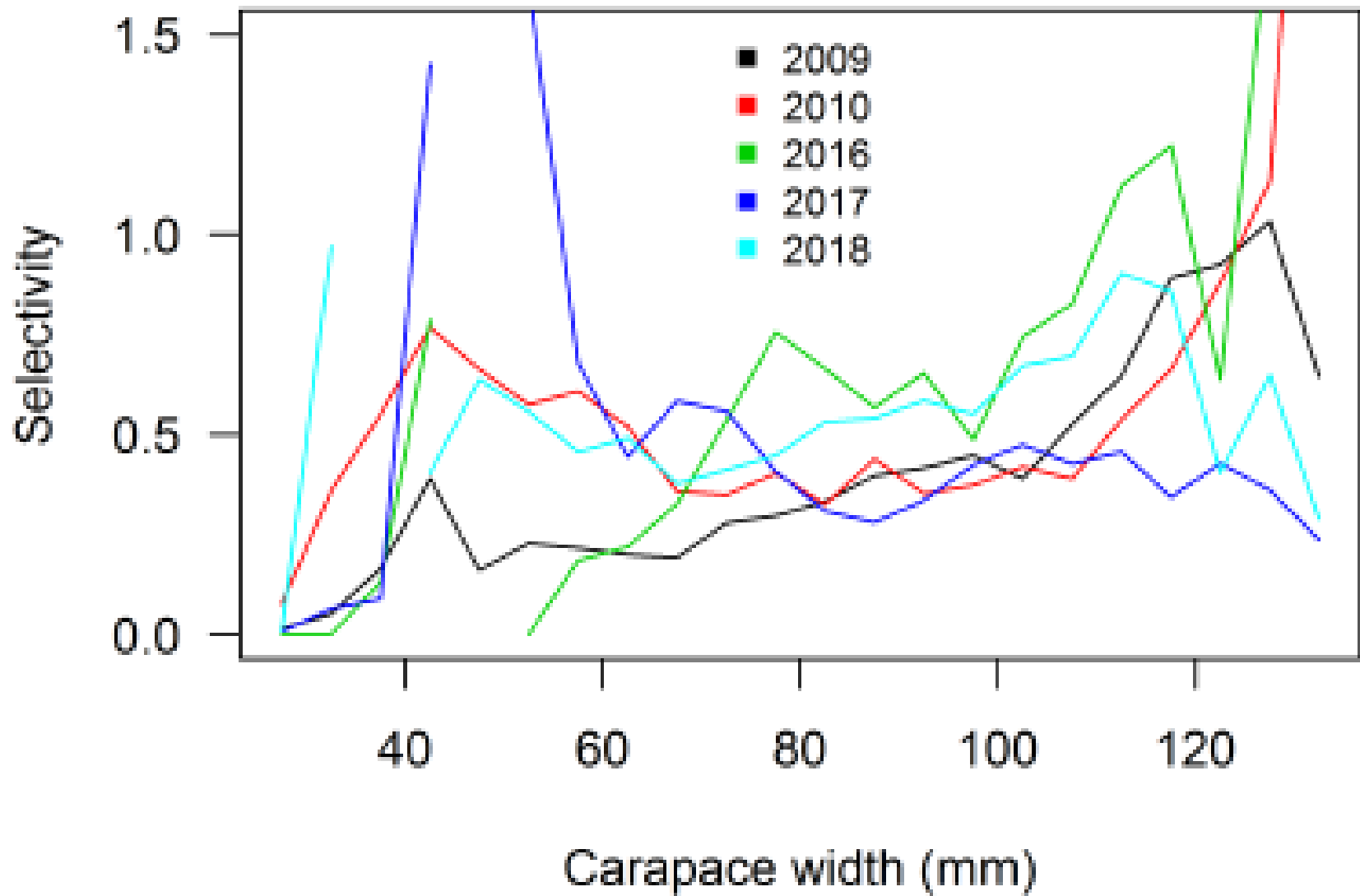
	20.1	20.2	20.3
Directed male	0.009	0.010	0.011
Trawl male	0.019	0.020	0.019
Directed female	0.022	0.024	0.024
Trawl female	0.021	0.021	0.021
NMFS (1982-88) male	0.014	0.014	0.014
NMFS (1989-present) male	0.014	0.013	0.013
BSFRF 2009 male	0.005	0.008	0.008
NMFS 2009 male	0.009	0.009	0.009
BSFRF 2010 male	0.018	0.010	0.012
NMFS 2010 male	0.021	0.014	0.014
NMFS (1982-88) female	0.016	0.016	0.017
NMFS (1989-present) female	0.018	0.016	0.016
BSFRF 2009 female	0.017	0.013	0.013
NMFS 2009 female	0.011	0.007	0.007
BSFRF 2010 female	0.016	0.021	0.007
NMFS 2010 female	0.013	0.011	0.024

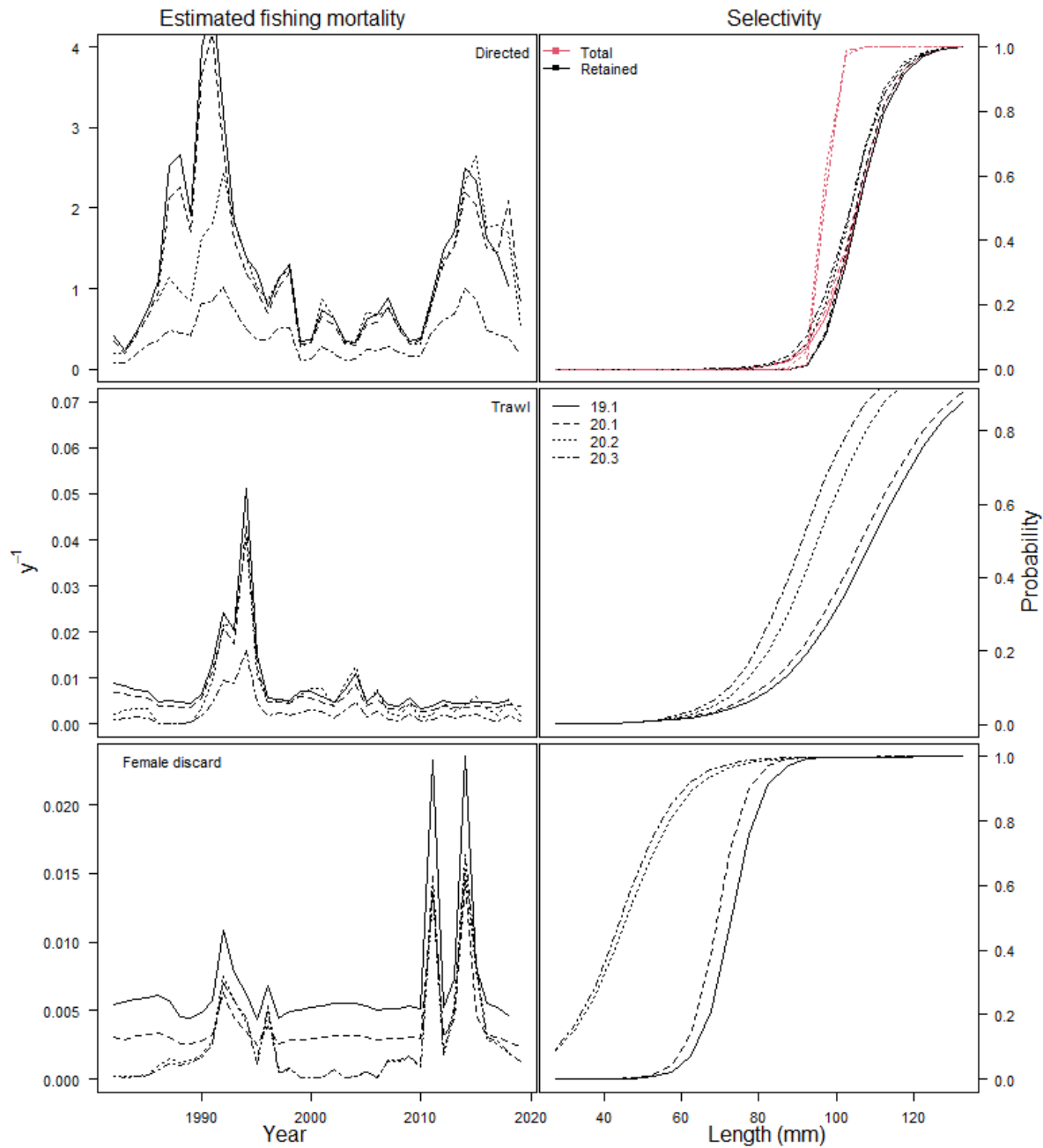




1989-present







Preferred male (biomass t)			
	EBS	NBS	fraction
2010	87099	0	0.0%
2017	20617	38	0.2%
2018	27018	0	0.0%
2019	28955	739	2.5%

Legal male > 78mm (biomass t)			
	EBS	NBS	fraction
2010	134170	8	0.0%
2017	52272	75	0.1%
2018	130474	1195	0.9%
2019	175907	16503	8.6%