ARROWTOOTH FLOUNDER

GOA GROUNDFISH PLAN TEAM, NOV 2021

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FULL ASSESSMENT IN ODD YEARS

TIER 3

- New catch, survey, age/length comps, no model changes
- Data correction, not using non-standard trawl survey sizes
- Projection model
- Recommendations for 2022:
  - OFL 143,100 t
  - ABC 119,779 t (6% decrease from 2021), no reduction recommended

SSC/PT COMMENTS IN GENERAL

- Multiple comments from the SSC as guidance regarding the risk tables:

  Main points are to not change to the risk table language, justify reductions from max ABC and base them on current year data (unless risk factors continue to be present from previous years), produce a risk table for all full assessments if in Tiers 1-3, maintain status quo on providing a recommendation on a reduction (encouraged, not required)

  Risk tables should be specific to the stock, encourage inclusion of LK/TK/S, fishery performance focus on biological status of resources, avoid including stock trends or processes that are in the assessment, postpone the change to three categories until 2022

  - We provide a risk table for GOA Arrowtooth flounder since this is a Tier 3 full assessment and follow the guidelines provided by the SSC

SSC/PT COMMENTS SPECIFIC TO STOCK

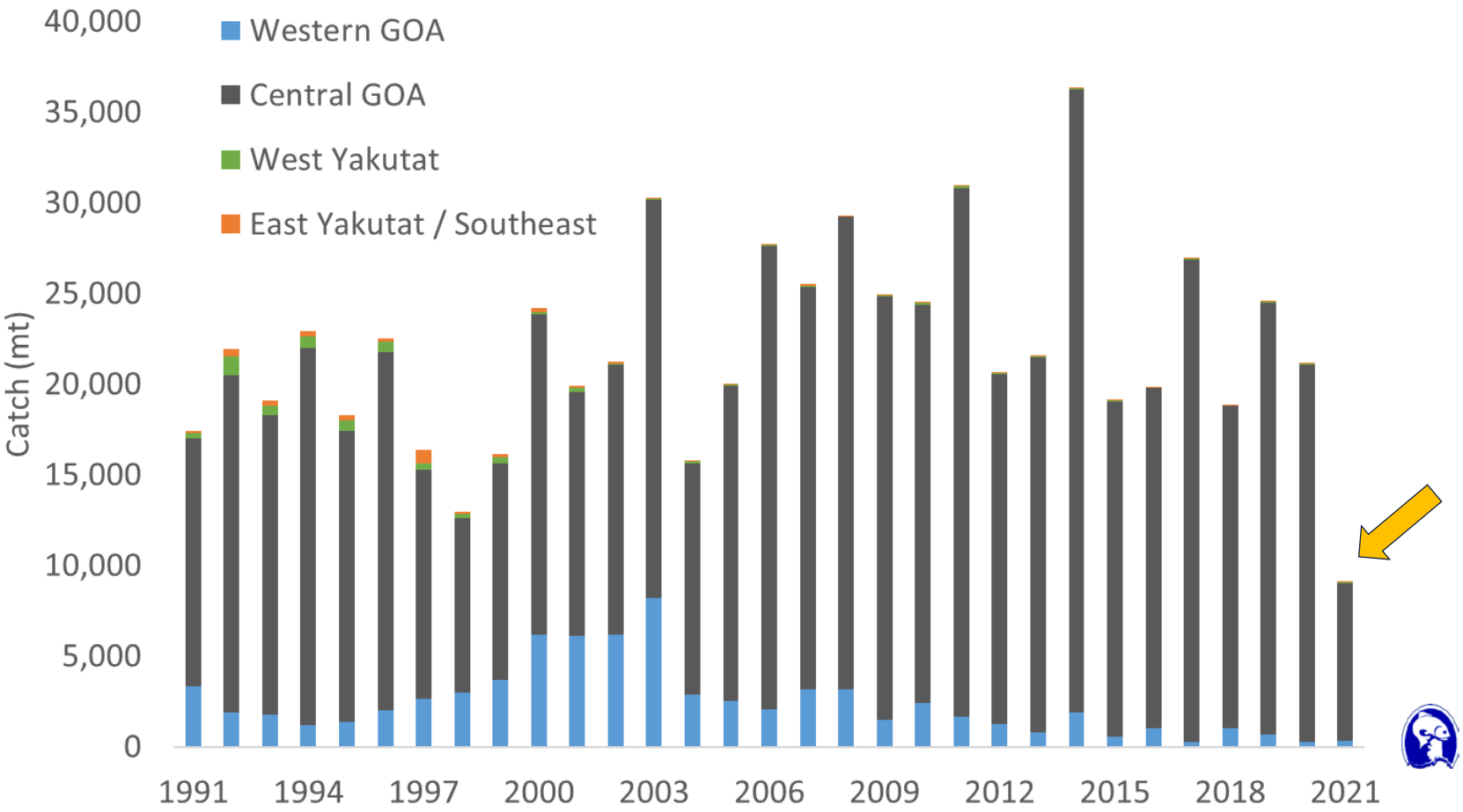
- Plan Team recommends investigating lower recruitment in recent years starting in 2006 and notes that this is before the heatwave
  - We plan to investigate these trends through an ESP in the future. New data in this assessment confirms the 2017 above-average year class which is concurrent with a cooler than average year in the GOA and suggests improved conditions for Arrowtooth in 2017
- Plan Team notes the potential of using the AFSC longline survey data for arrowtooth, SSC requests authors to investigate the IPHC survey data.
  - We provide information regarding the AFSC longline and IPHC longline surveys in the *Data* section and discuss the time series estimates within the document as a start at this investigation. We plan to investigate these two surveys further in the next full assessment.
- Plan Team and SSC request authors investigate whether opportunistically collected length data should be used in this assessment and the SSC requested to investigate whether fishery catch-at-age information is available
  - We provide a sensitivity analysis regarding the non-standard survey length frequency data and explored the availability of fishery ages in the *Data* section of the report

DATA

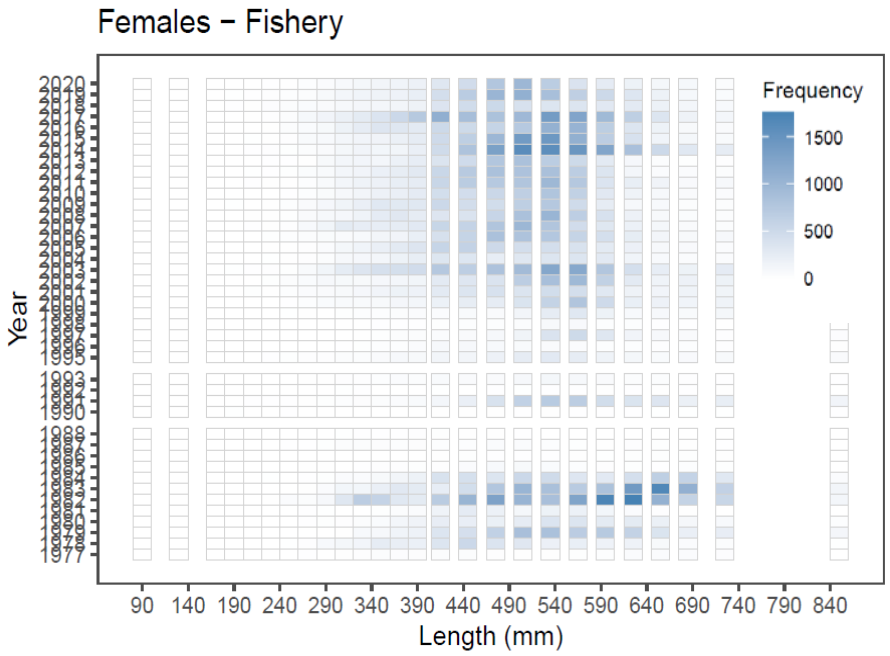
Source	Data	Years
Fishery	Catch Biomass	1977 - **2020, 2021**
	Length composition	1977 - 1993, 1995-**2020**
AFSC GOA bottom trawl survey	Survey biomass and standard error	1984,1987,1990,1993,1996,1999,2001,2003, 2005,2007,2009,2011,2013,2015,2017,2019,**2021**
	Age Composition	1984,1987,1990,1993,1996,1999,2001,2003, 2005,2007,2009,2011,2013,2015,2017,**2019**

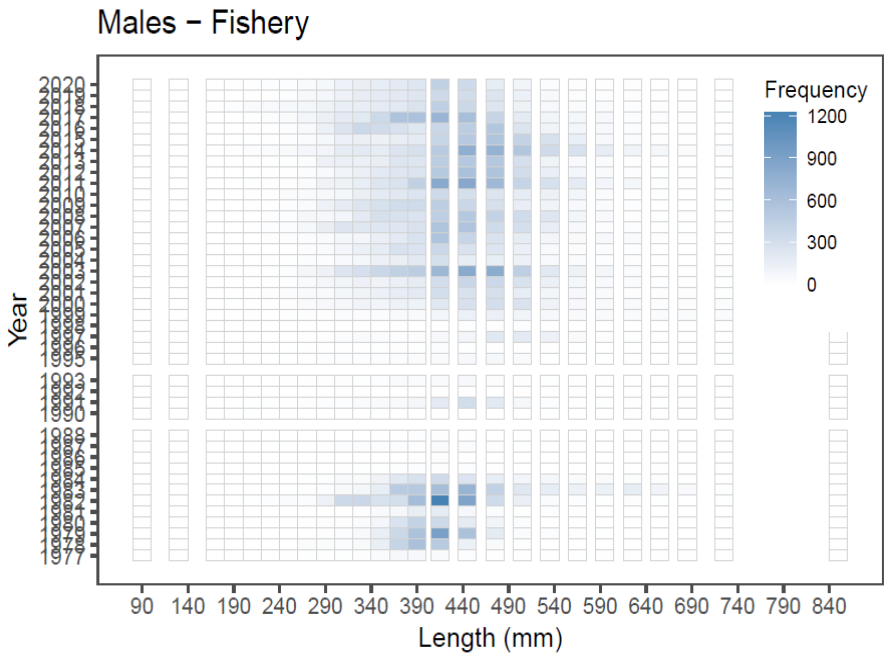
Note new data in bold

CATCH BY AREA



FISHERY LENGTH DATA





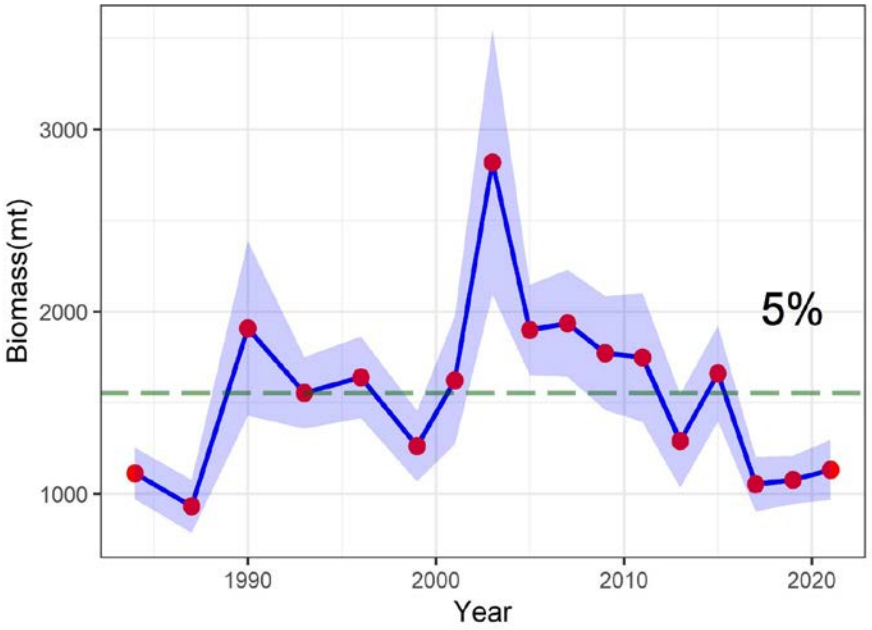
FISHERY AGE DATA

- Otoliths collected sporadically
  - Started in 1982 with a couple years of larger samples sizes
  - Generally low following the start of the Observer Program
- Age and Growth Program
  - Possible to age the years with larger sample sizes with ageing request
  - Would need to be evaluated within the scope of staff time and resources
  - Catch decreasing and samples may stay small for many reasons

Year	BSAI Collected	GOA Collected	Total Collected
1982	1926	912	2838
1983	1213	213	1426
1984	1355	456	1811
1985	1784	228	2012
1986	626	6	632
1987	302	80	382
1991	0	100	100
1995	0	160	160
1997	0	50	50
1999	35	2	37
2000	19	9	28
2001	27	2	29
2002	22	29	51
2003	93	0	93
2004	5	1	6
2005	5	0	5
2006	30	0	30
2007	11	4	15
2008	27	15	42
2010	0	4	4
2011	5	8	13
2012	4	0	4
2018	529	79	608
2019	538	110	648
2020	692	110	802
2021	283	33	316

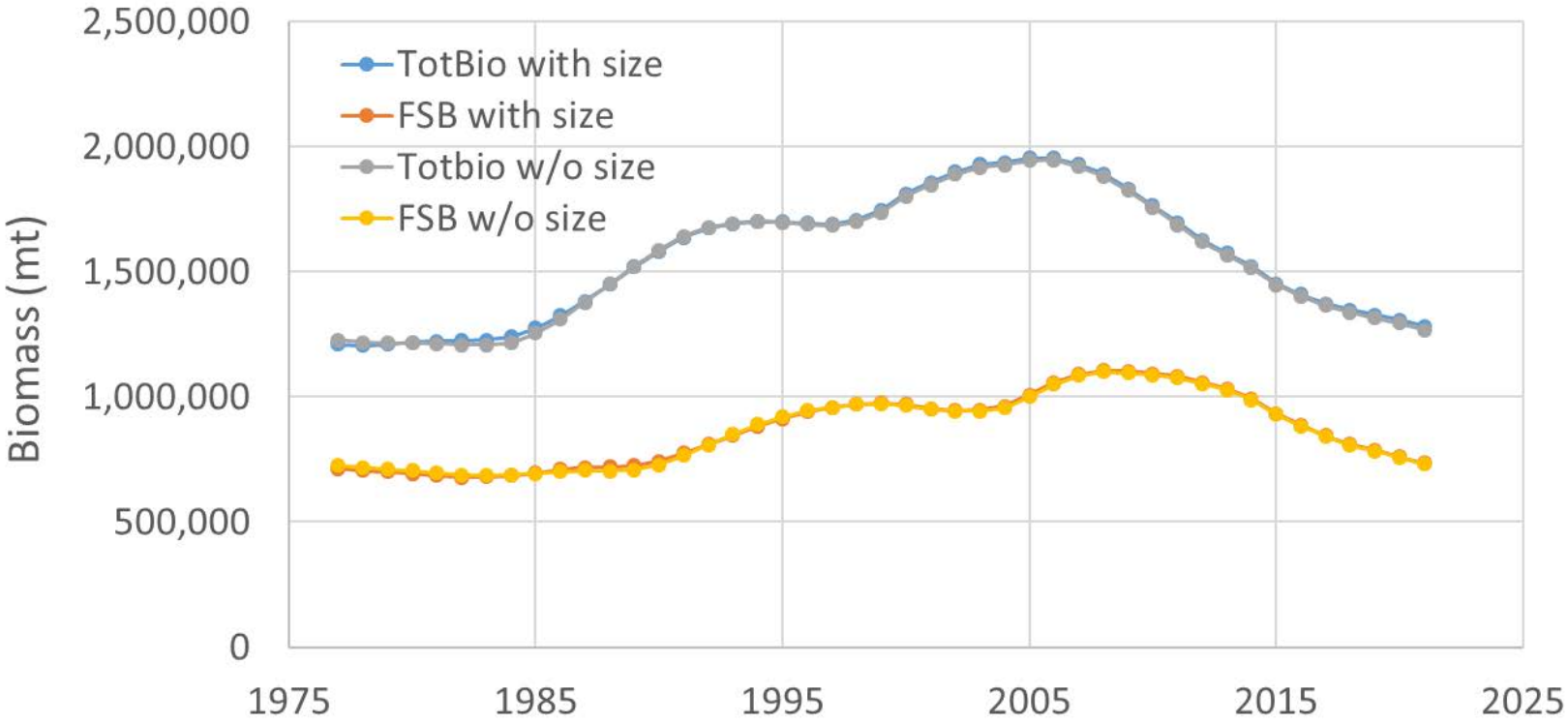
BOTTOM TRAWL SURVEY BIOMASS

- Survey conducted since 1984
  - Design-based estimates used in the model, peak in 2003, general decline
  - 5% increase in 2021, still below avg
  - VAST estimates available, appear very similar to design-based (not in doc)
- Age and Length data available
  - All standard survey years aged so length data not used in model
  - Non-standard survey **length** years of 1985, 1986, and 1989 used in previous model, but sensitivity run without this data show almost no change

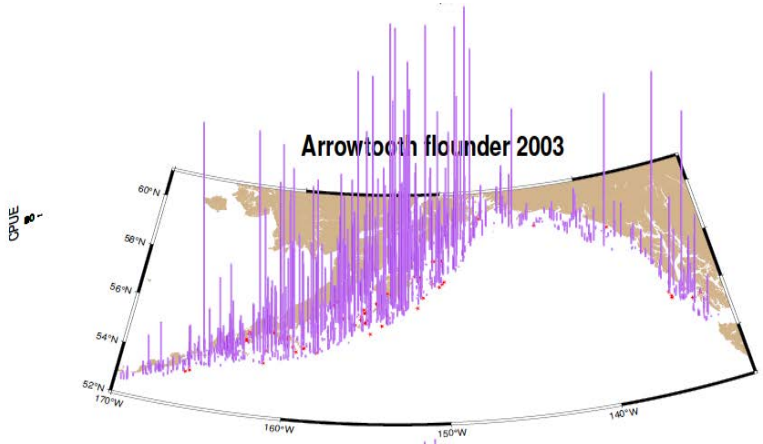


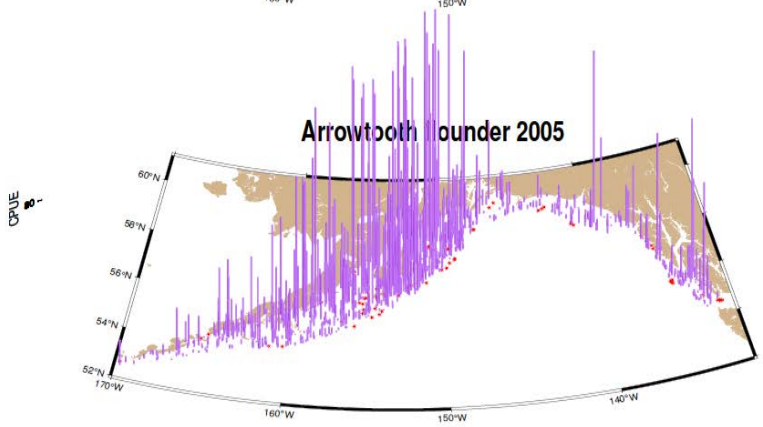
SENSITIVITY TO NON-STANDARD LENGTHS

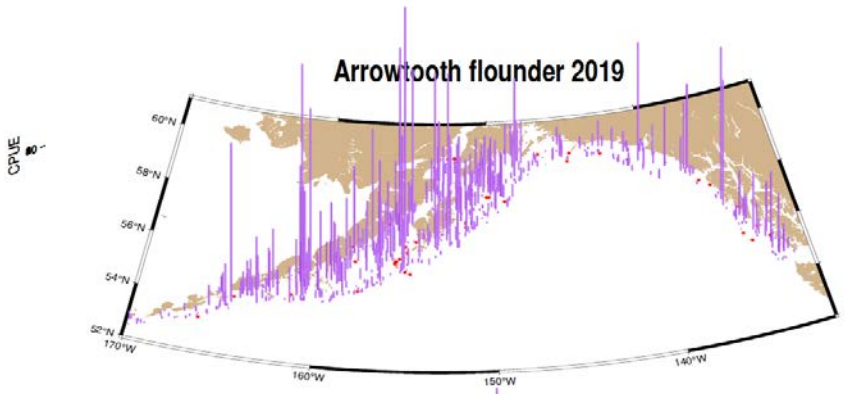
TotBio = Total Biomass, FSB = Female spawning biomass
Average difference spawning biomass = 0.4 % for TotBio, 0.2% for FSB
Determined this was a minor data correction, did not require model evaluation

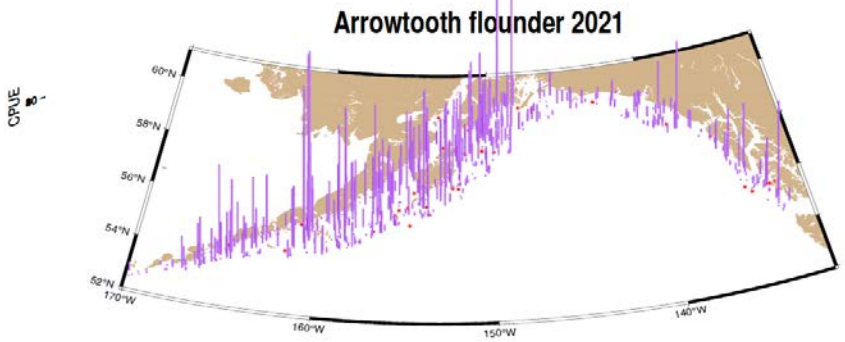


SURVEY DISTRIBUTION (CPUE BY TOW)

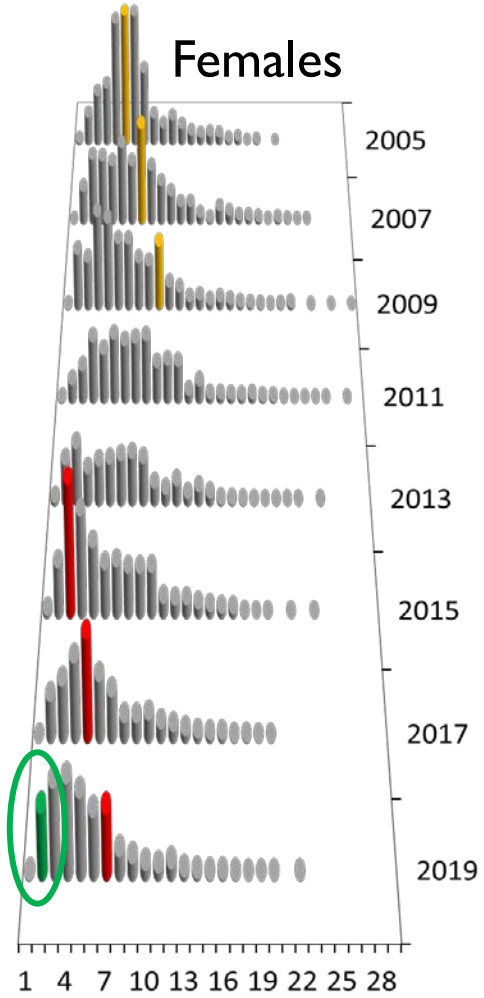


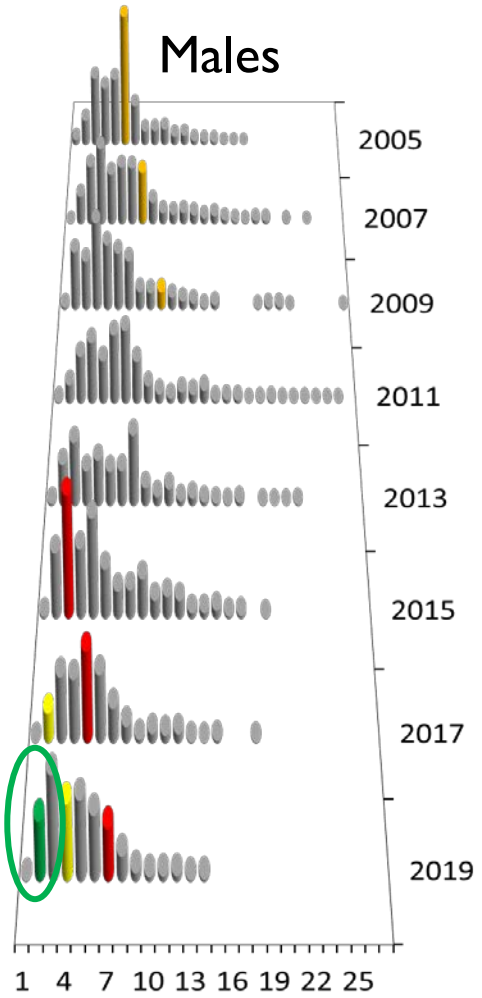




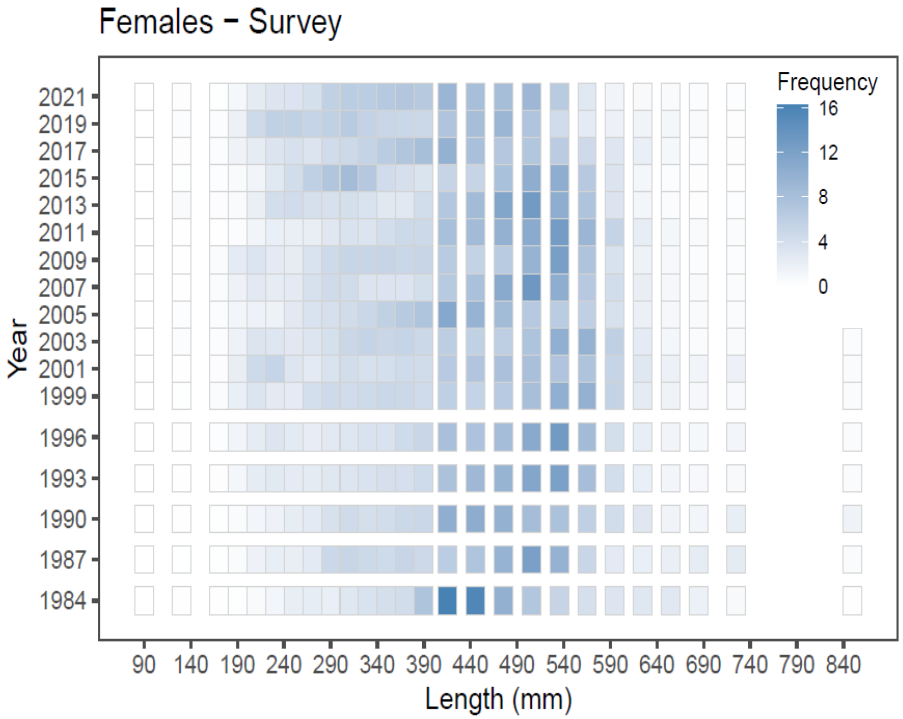


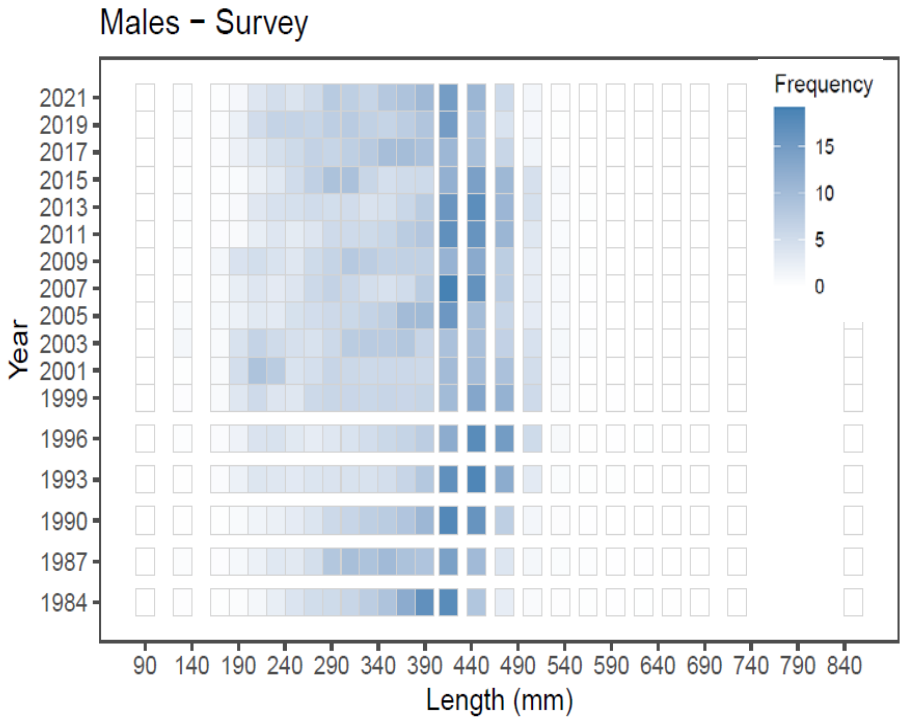
BOTTOM TRAWL SURVEY AGE DATA





BOTTOM TRAWL SURVEY LENGTH DATA*

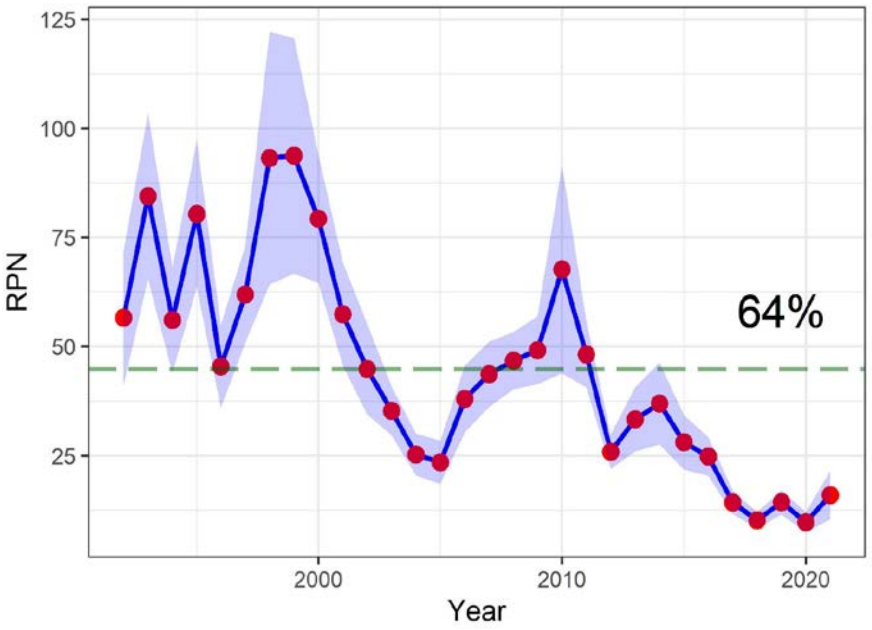




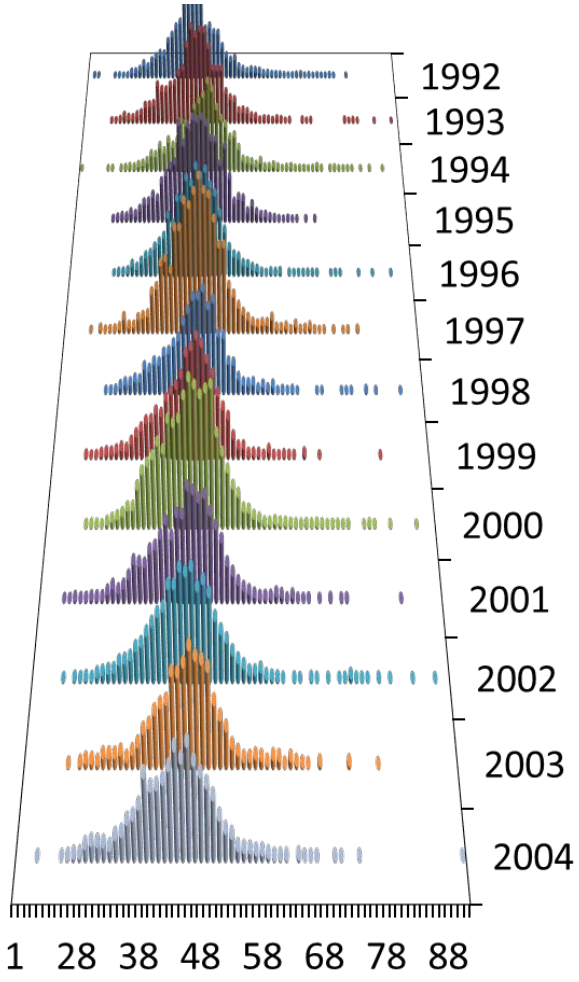
*Not Fit in Model

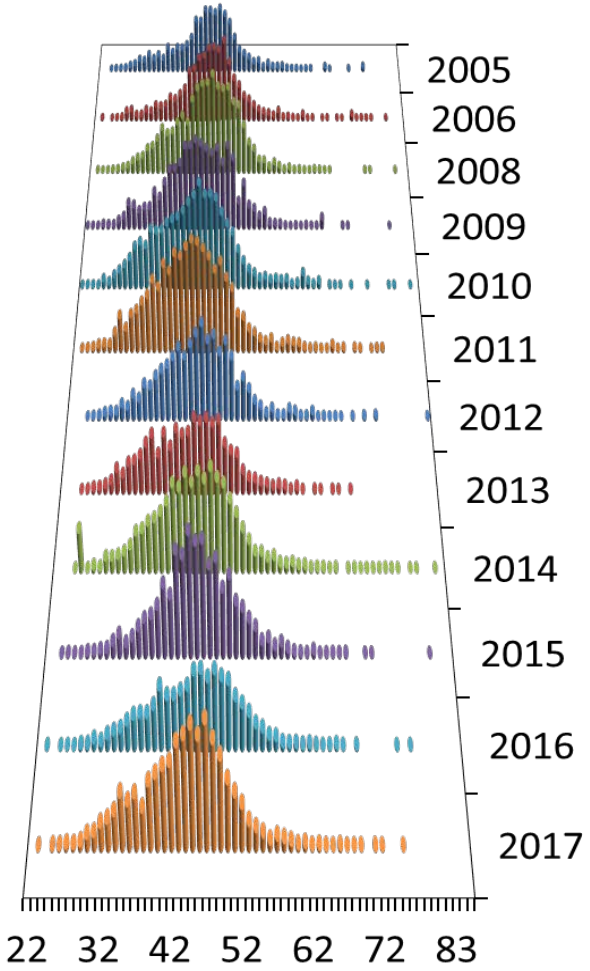
AFSC LONGLINE SURVEY

- Survey conducted since 1988
  - Relative population numbers and weights available since 1992 for Arrowtooth and Kamchatka combined
  - Occurs over shelf and slope (150 to 1000 m), Arrowtooth only in 2019
  - Decadal pattern to 2010, then decline
- Length data also available
  - Compositions available since 1992 for Arrowtooth and Kamchatka combined
  - More smaller sizes in the distribution through time series



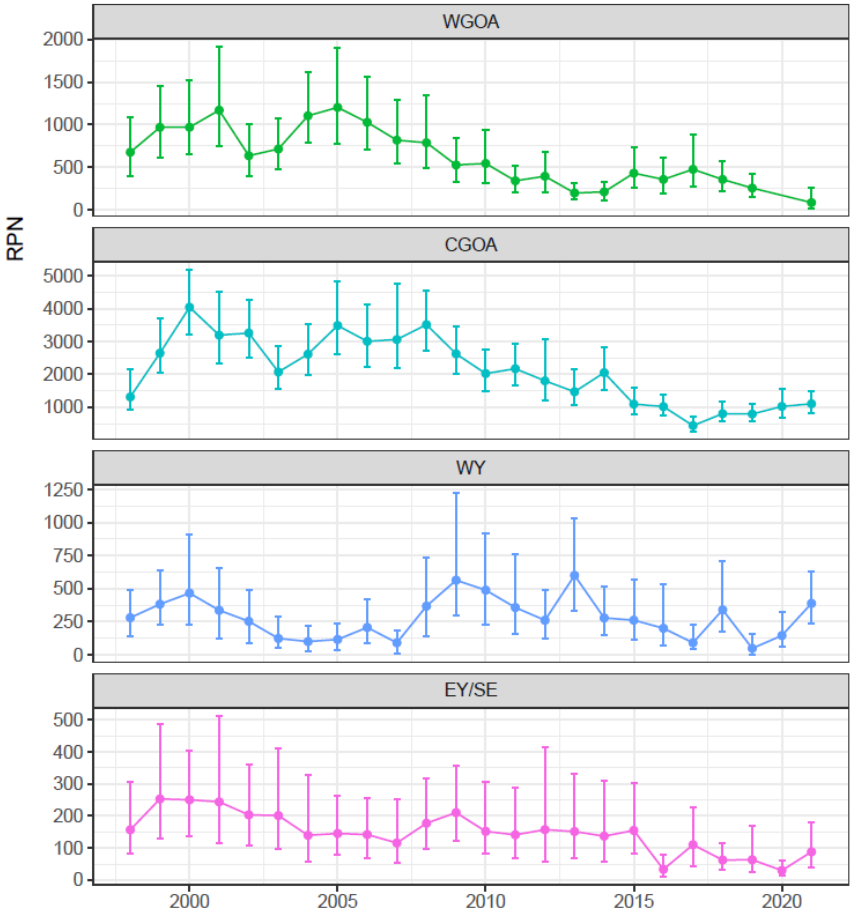
AFSC LONGLINE SURVEY LENGTH DATA





IPHC LONGLINE SURVEY

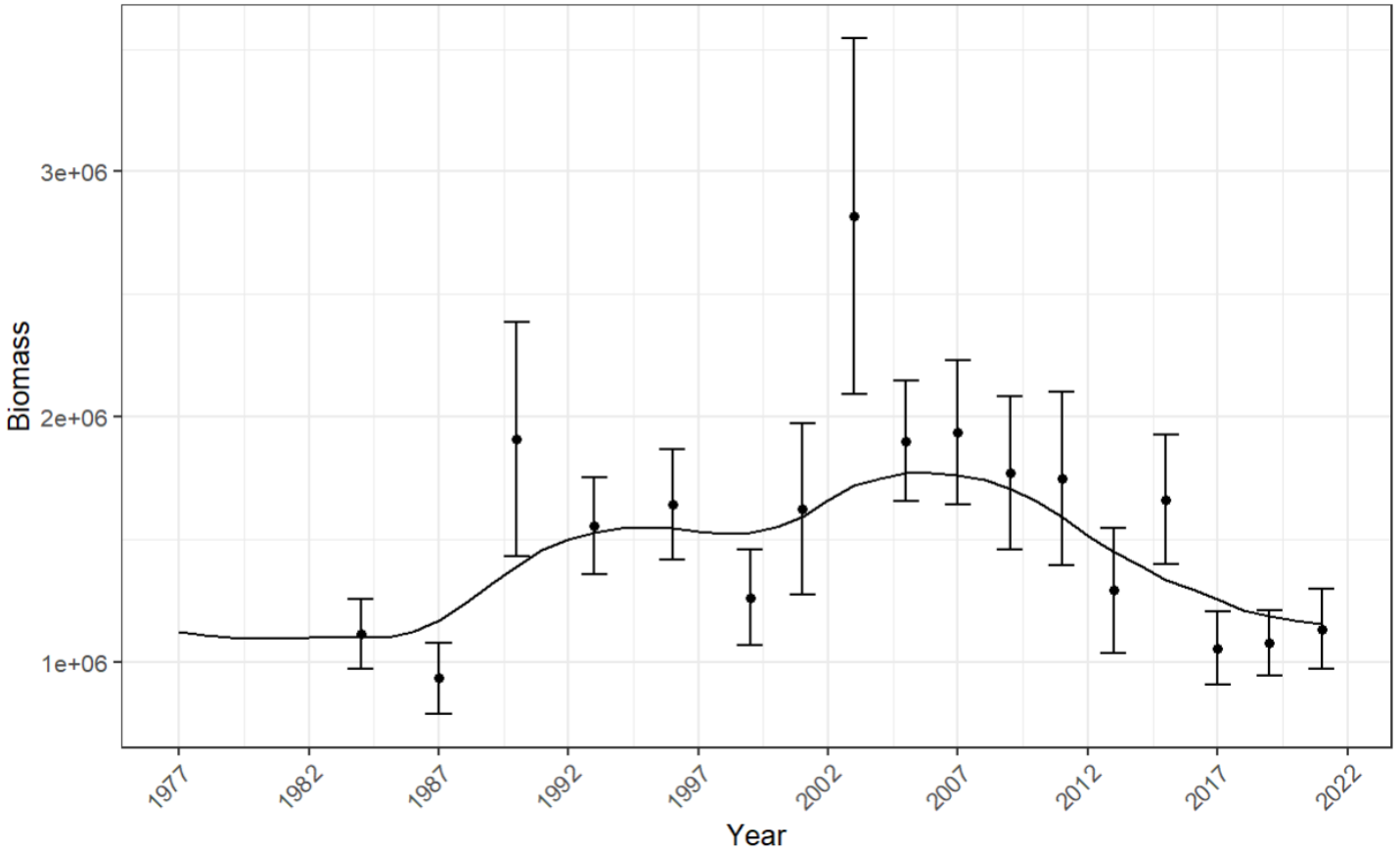
- Standardized grid survey since 1998
  - Relative population numbers available for Arrowtooth
  - Occurs more over shelf (0-500 m) and historical trends similar to AFSC bottom trawl survey since 2005
  - Current year data may be difficult to get in time for assessment
  - Increases in all areas except western GOA in 2021 from 2019, particularly important in CGOA where most of Arrowtooth biomass
- No length data available



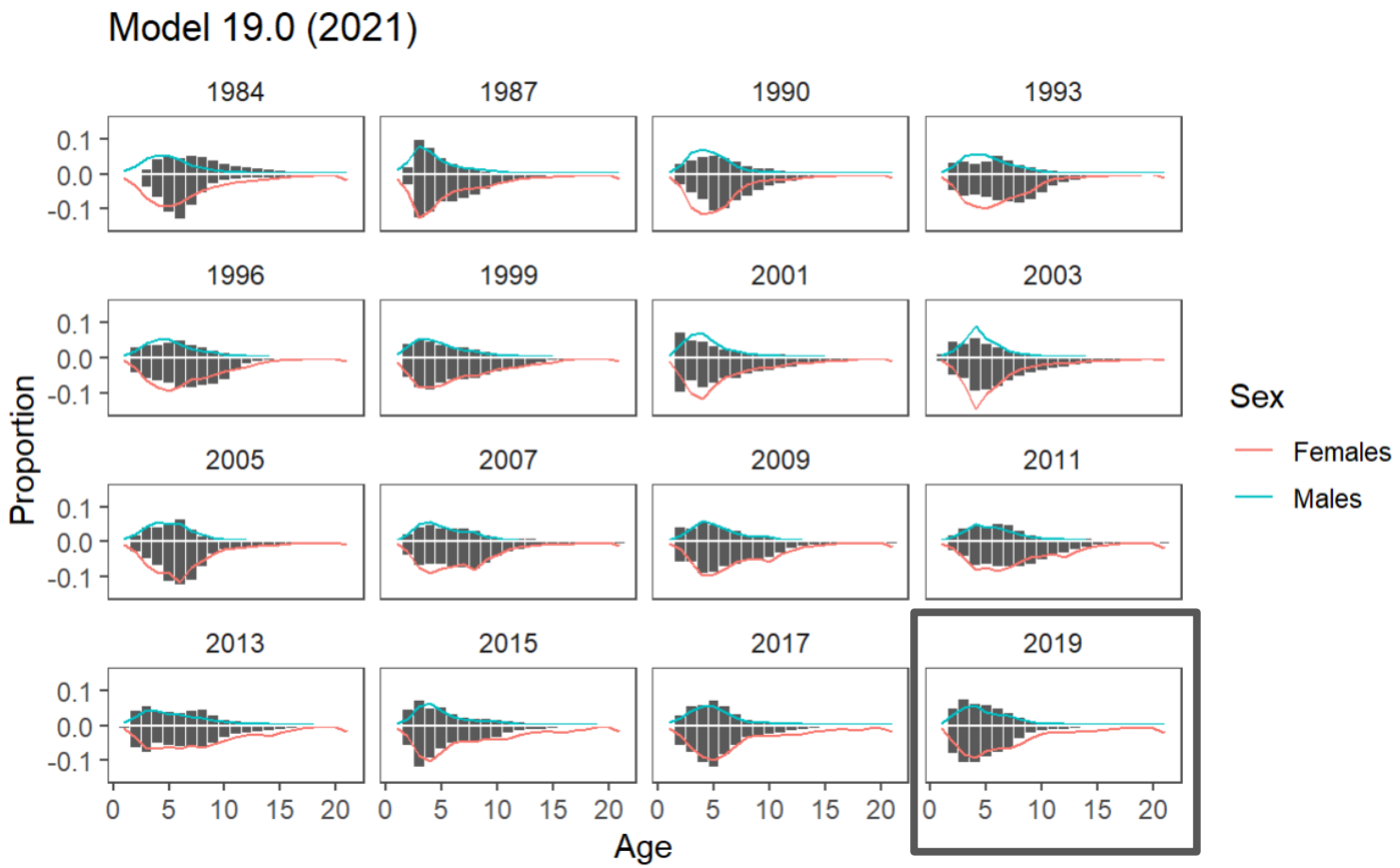
MODEL EVALUATION AND RESULTS

- Model evaluation
  - Same as 2019 model (minus non-standard survey lengths)
  - Generally no major issues, reasonable fits to the data
  - Some years (historic and current) lack of fit for females
  - Small retrospective bias
- Overall results (which we will show next)
  - Spawning biomass and total biomass continue slow decline from mid-2000s peak
  - This is confirmed by survey in the model, and surveys examined outside the model
  - Recruitment generally below average, but 2017 year class above average
  - Catch remains well below ABC (14% of ABC average of last 5 years)

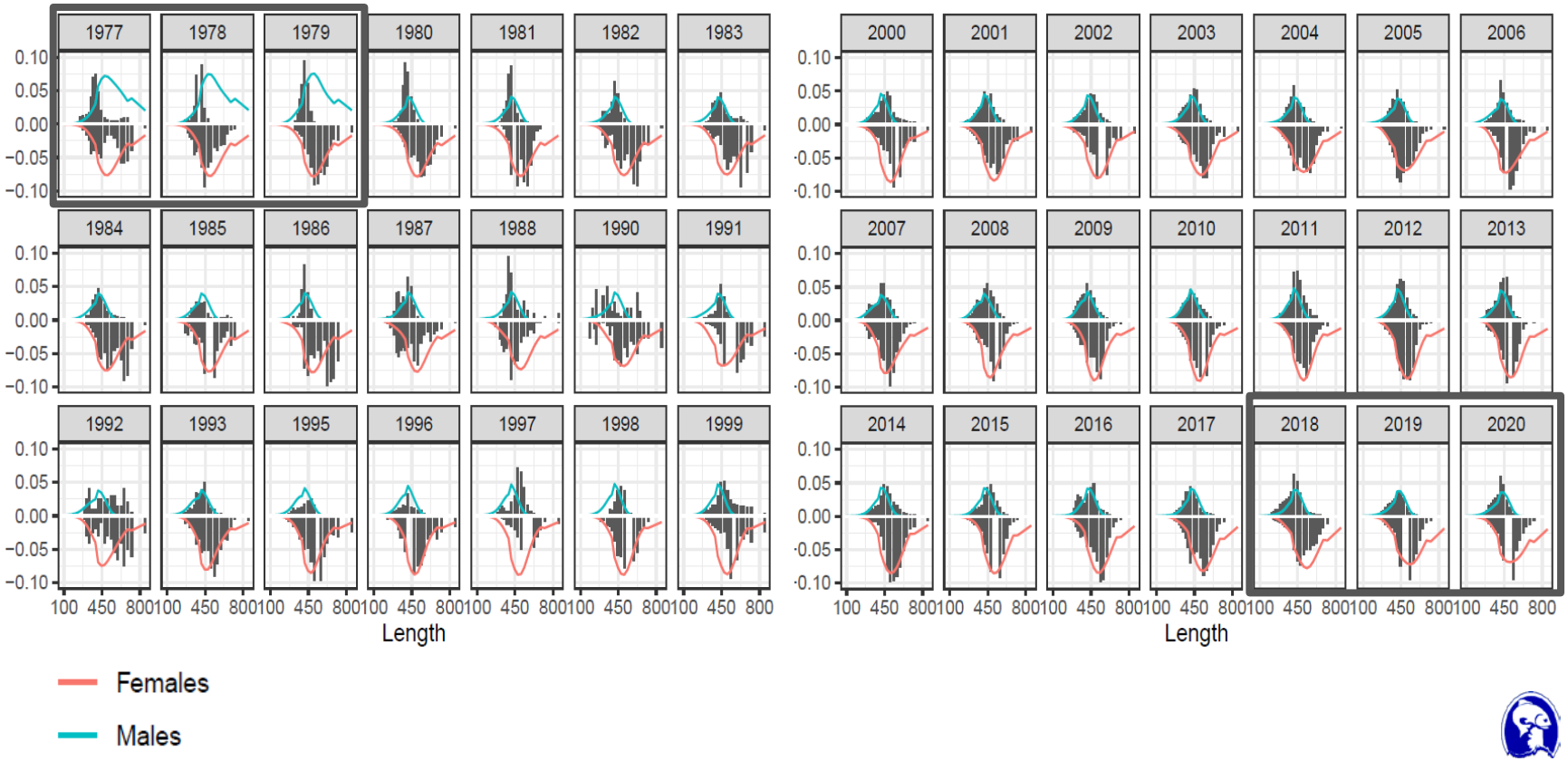
BOTTOM TRAWL SURVEY FIT



STANDARD BOTTOM TRAWL SURVEY AGE COMPOSITIONS

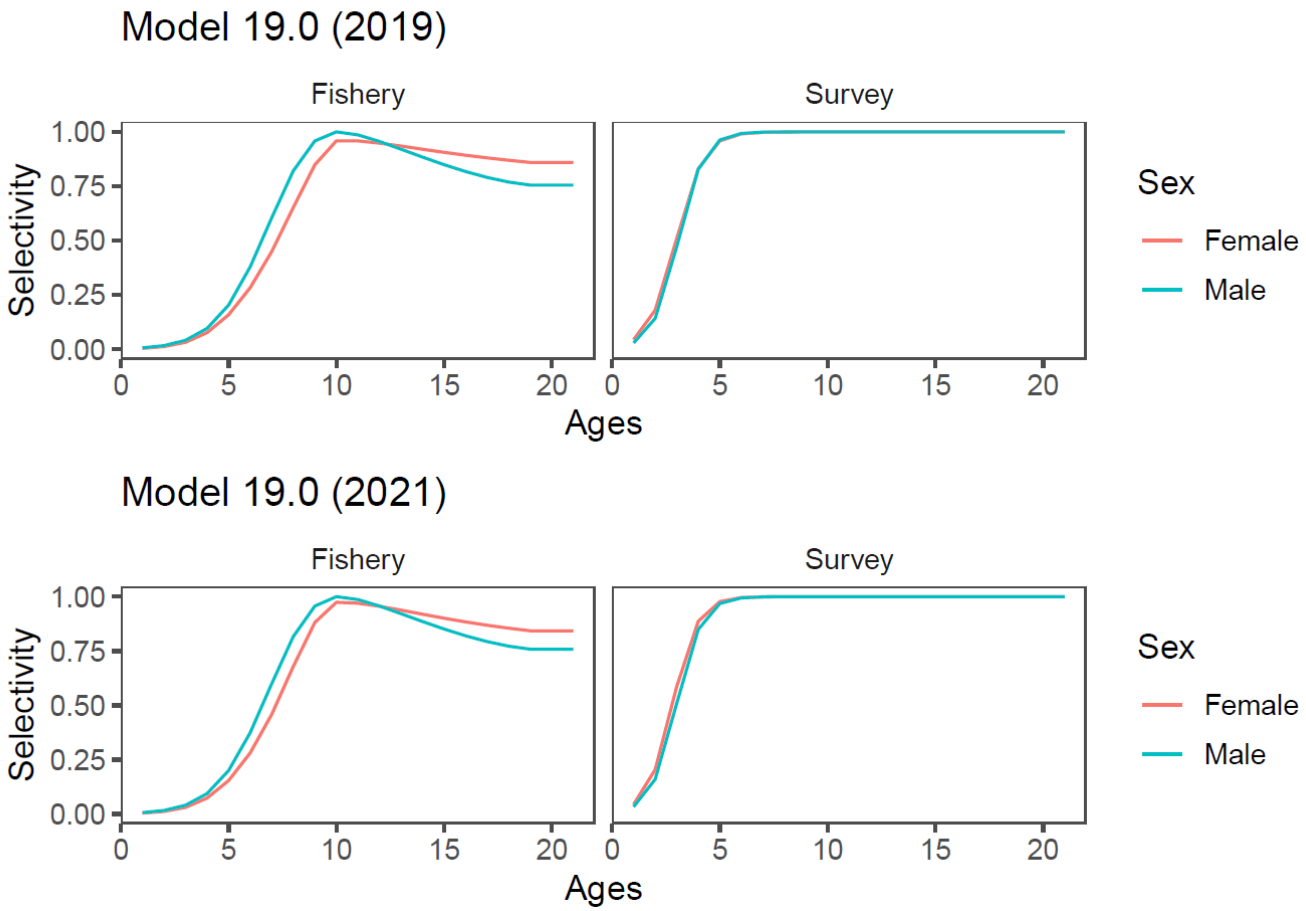


FISHERY LENGTH COMPOSITIONS

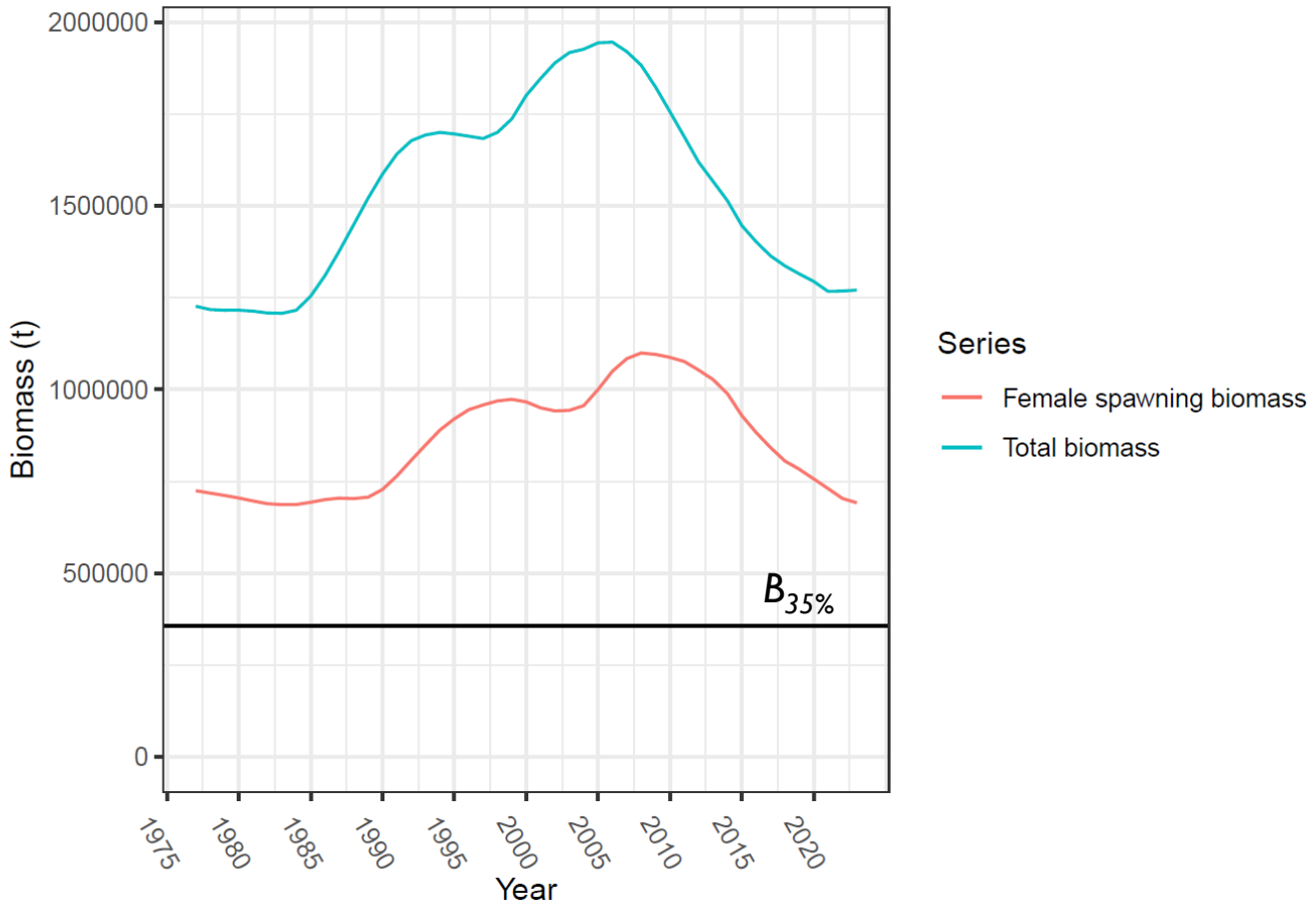


SELECTIVITY

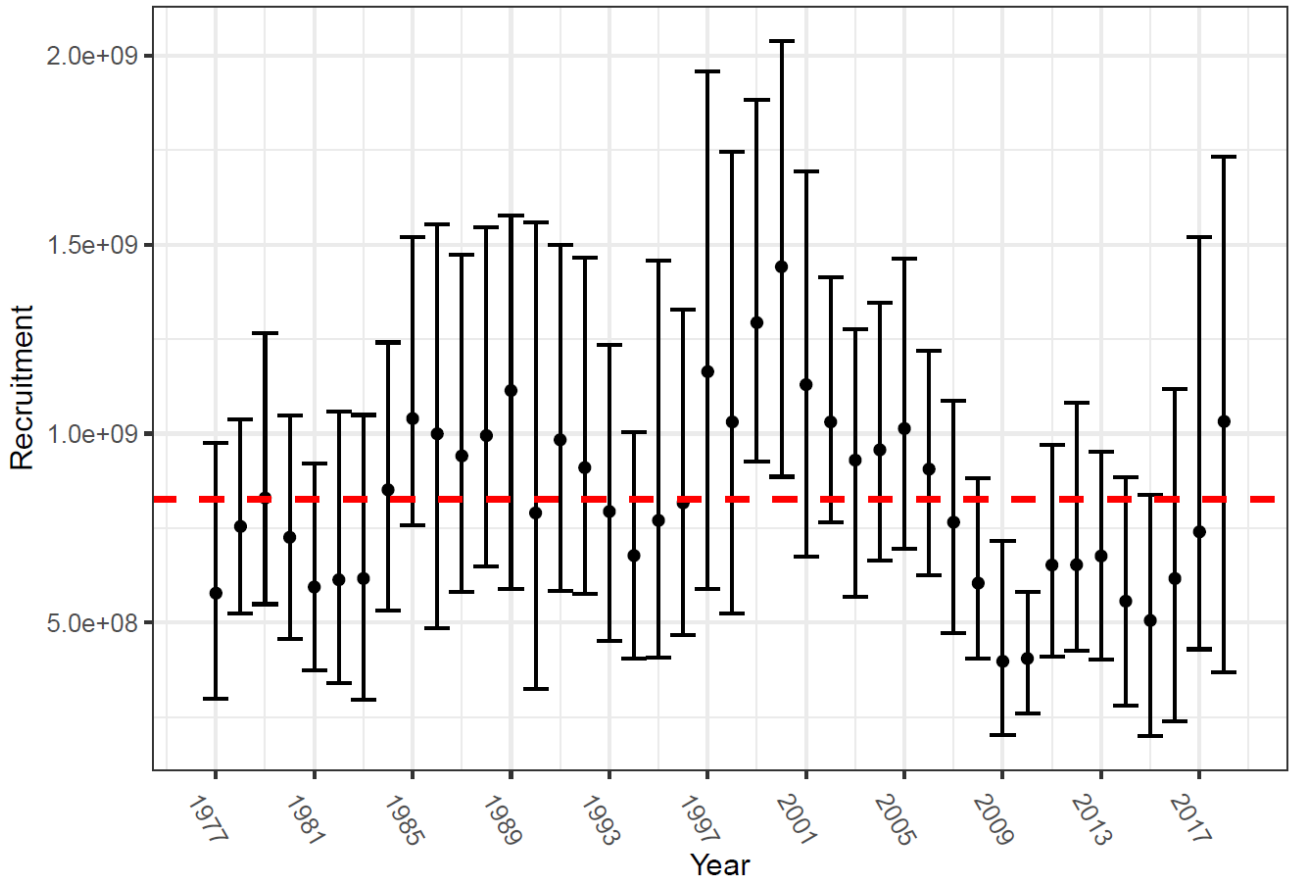
Female and male selectivity are fairly similar, slightly more dome with males in fishery



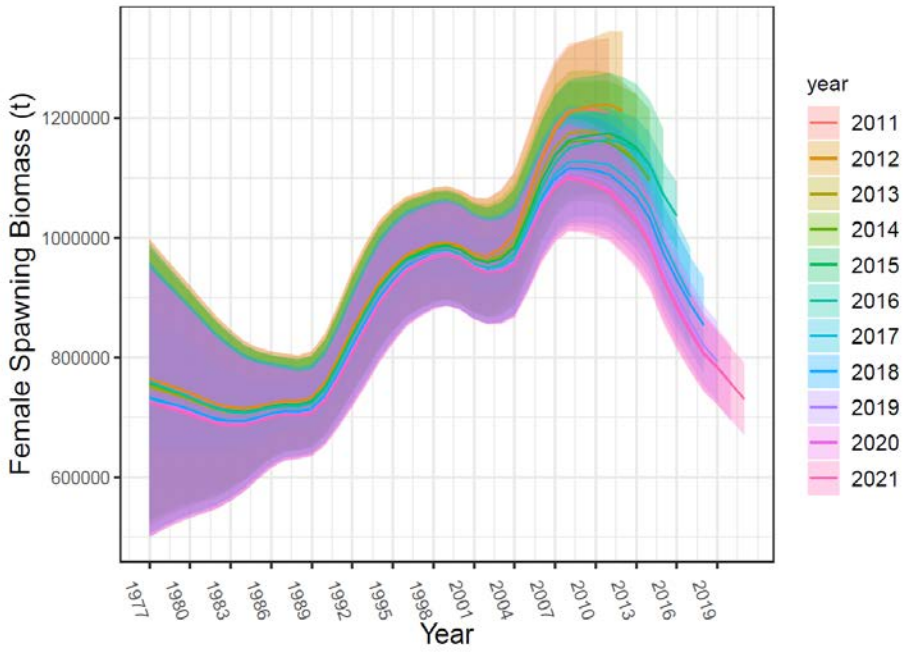
SPAWNING & TOTAL BIOMASS

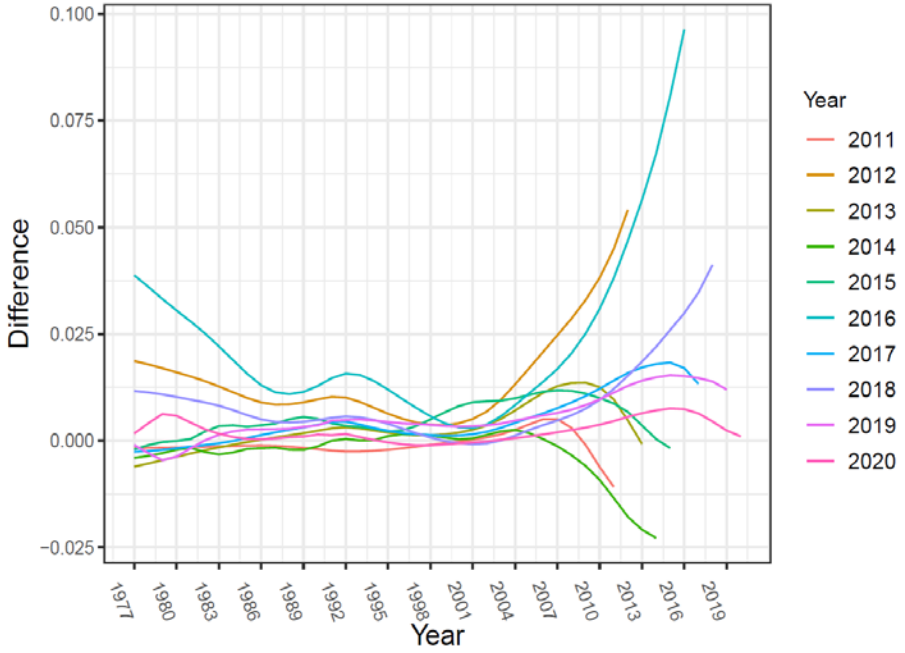


RECRUITMENT (AGE 1)



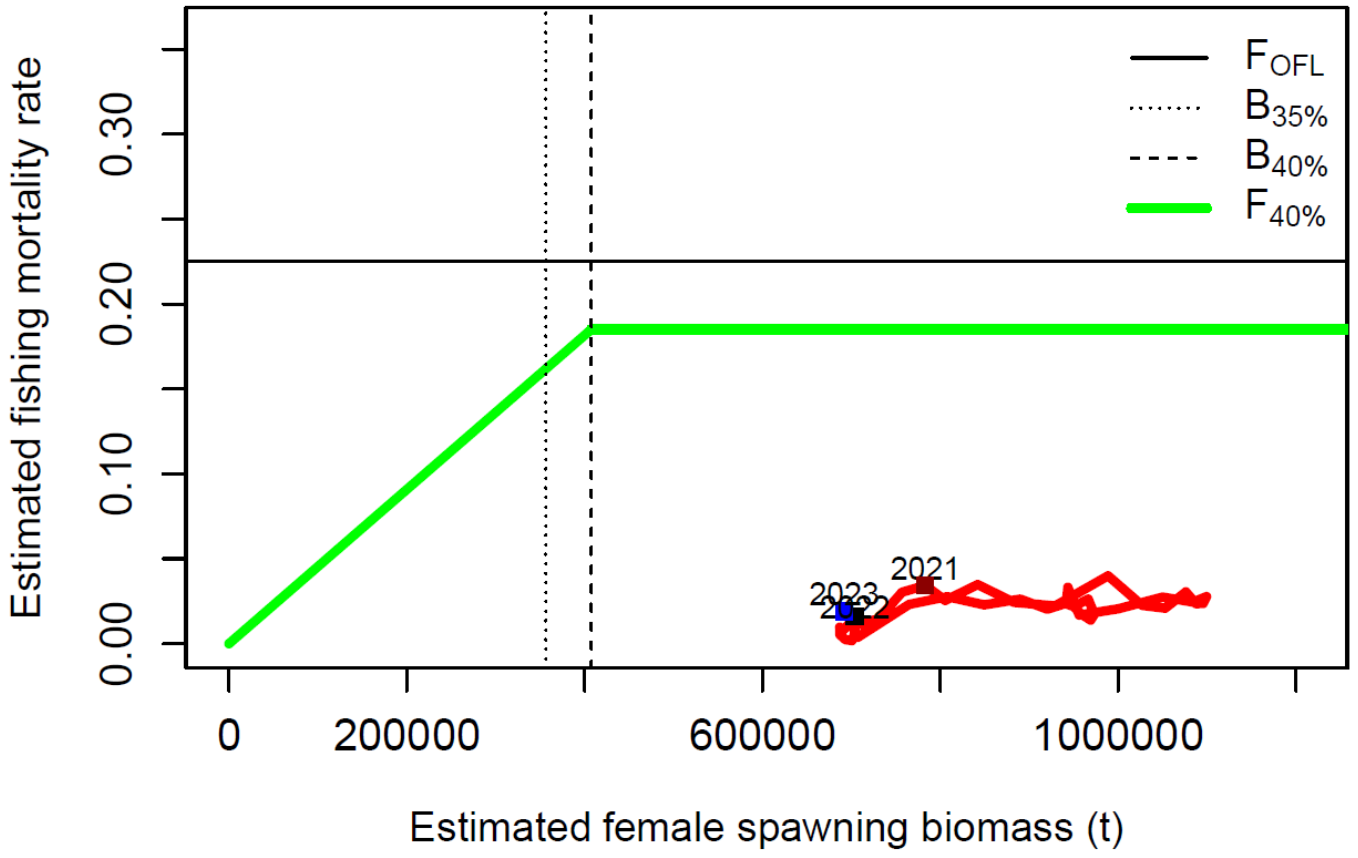
RETROSPECTIVE



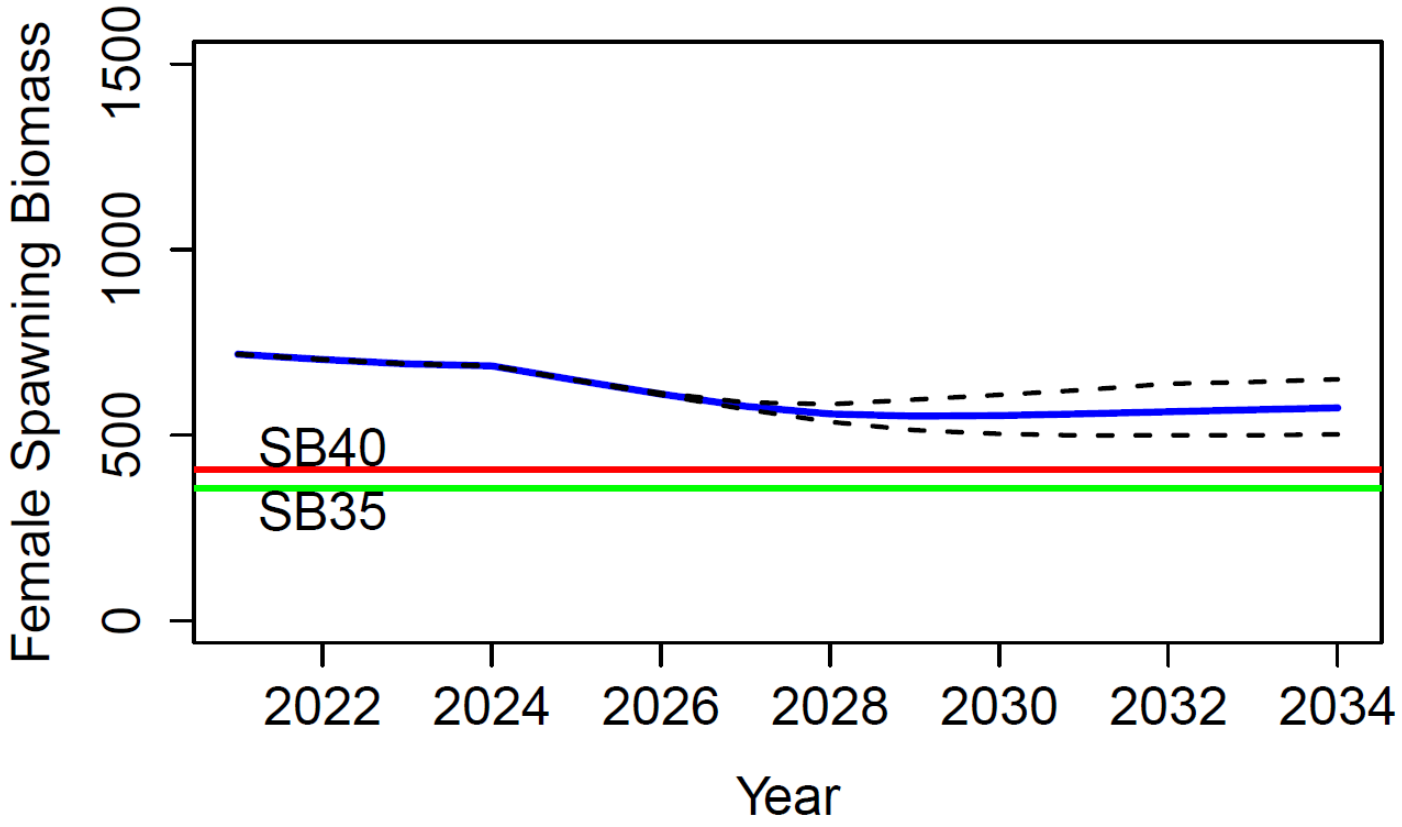


Mohn's Rho = 0.018

PHASE PLANE


Estimated fishing mortality rate
0.00
0.10
0.20
0.30
0
200000
600000
1000000
Estimated female spawning biomass (t)
F_{OFL}
$B_{35\%}$
$B_{40\%}$
$F_{40\%}$
2021
2023
2022

PROJECTION


Female Spawning Biomass
0
500
1000
1500
SB40
SB35
2022
2024
2026
2028
2030
2032
2034
Year

RISK TABLE

Assessment-related considerations	*Population dynamics considerations*	*Environmental/ ecosystem considerations*	*Fishery Performance considerations*
Level 1: No apparent concern	Level 1: No apparent concern	Level 1: No apparent concern	Level 1: No apparent concern

All Level 1 so we do not recommend a reduction from max ABC

Assessment – age structured model with long time series of surveys and ages available for all years, mohn's rho = 0.018, catch recently well below ABC (14%) and below TAC (22%), low concern for odd year bottom trawl surveys as also have annual alternative longline surveys to consider for future use

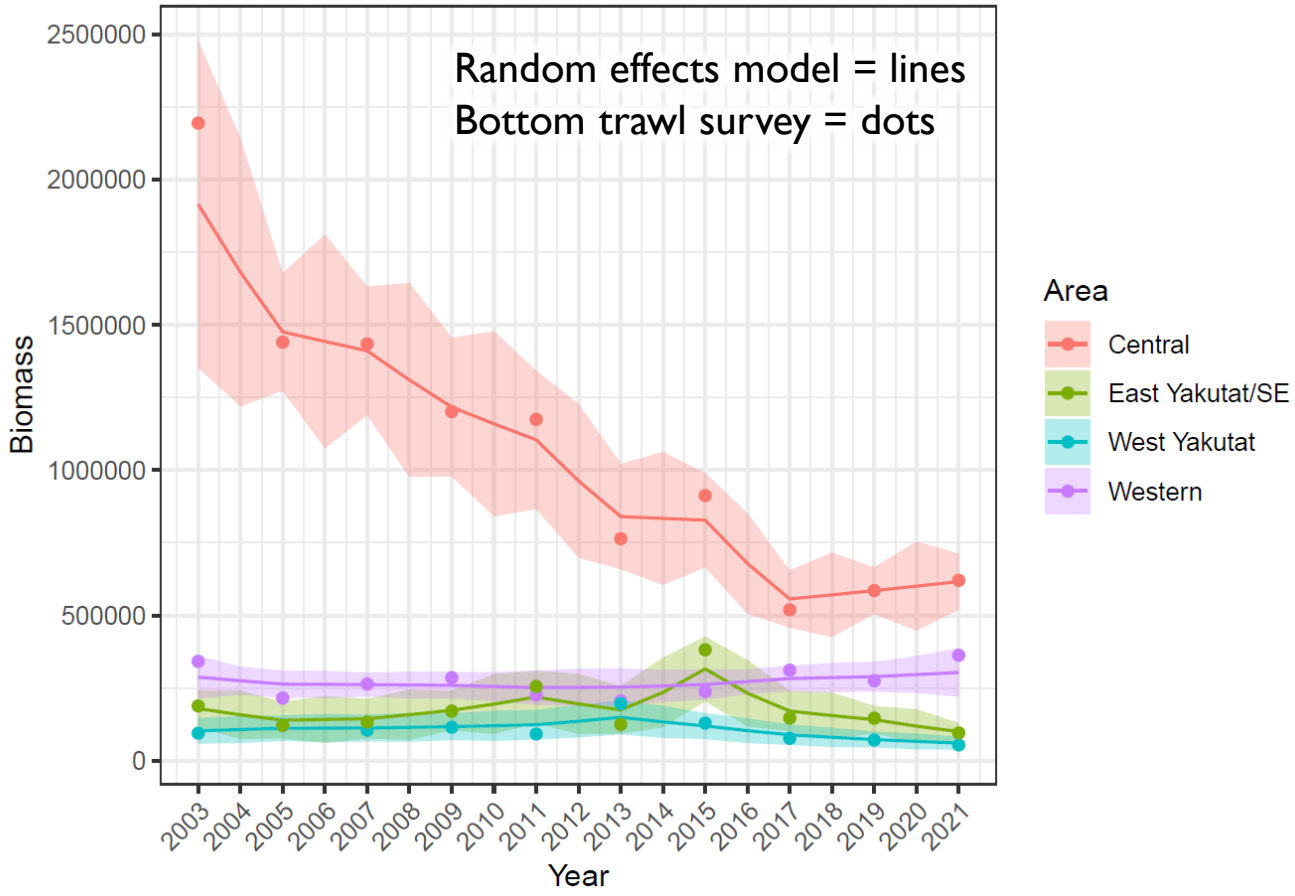
Pop dy and Fishery – SSB and total biomass steadily increased through 80s to peak in 2000s and has been declining over the last 10 years, but SSB well above reference points and recent above average recruitment in 2017, recent low catch due to CV closure, poor markets

Environment (Yasumiishi, Ferriss) – moderate environmental conditions (overall cooling in GOA), limited/mixed data on abundance of prey, predators, and competitors, larval CPUE of arrowtooth was high, condition was near average, forage fish positive trends, piscivorous seabirds average to good reproductive success, lower overlap with sablefish as a competitor

TIER 3A ASSESSMENT FOR ARROWTOOTH (AGE-STRUCTURED ASSESSMENT & PROJECTION MODEL)

Quantity	As estimated or *specified last* year for: 2021	2022	As estimated or *recommended this* year for: 2022	2023
M (natural mortality – Male, Female)	0.35, 0.2	0.35, 0.2	0.35, 0.2	0.35, 0.2
Specified/recommended Tier	3a	3a	3a	3a
Projected total (age 1+) biomass (t)	1,321,700	1,318,860	1,268,140	1,270,850
Female spawning biomass (t)	752,703	724,288	703,853	691,941
Projected				
$B_{100\%}$	1,028,330	1,028,330	1,018,700	1,018,700
$B_{40\%}$	411,331	411,331	407,478	407,478
$B_{35\%}$	359,915	359,915	356,544	356,544
F_{OFL}	0.234	0.234	0.225	0.225
$maxF_{ABC}$ (maximum allowable = $F_{40\%}$)	0.192	0.192	0.185	0.185
Specified/recommended F_{ABC}	0.192	0.192	0.185	0.185
Specified/recommended OFL (t)	151,723	147,515	143,100	141,231
*max*ABC (t)	126,970	123,445	119,779	118,201
Specified/recommended ABC (t)	126,970	123,445	119,779	118,201
Status	As determined *last* year for: 2019	2020	As determined *this* year for: 2020	2021
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No

APPORTIONMENT



APPORTIONMENT

Shift over to the western and central GOA mainly from the East Yakutat / Southeast region

	Western	Central	West Yakutat	East Yakutat/SE	Total
2019 Area Apportionment	25.5%	54.4%	6.6%	13.5%	100%
2021 ABC (t)	32,377	69,072	8,380	17,141	126,970
2022 ABC (t)	31,479	67,154	8,147	16,665	123,445
2021 Area Apportionment	28.1%	57.1%	5.6%	9.2%	100%
2022 ABC (t)	33,658	68,394	6,707	11,020	119,779
2023 ABC (t)	33,214	67,493	6,619	10,874	118,201

SUMMARY

- Recommendation
  - No model changes, only data correction to not use non-standard survey lengths
  - Continued slow decline in biomass with possible 2017 year class emerging (2021 age compositions will help to confirm), all potential surveys show increase in 2021
  - No reduction recommended: ABC = 119,779 t, OFL = 143,100 t
- Data Gaps and Future Research Priorities
  - Investigate lack of fit in female survey age and fishery length compositions, potentially examine interaction between female natural mortality and selectivity
  - Consider exploring incorporating estimates of predation mortality from recent GOA CEATTLE model (G. Adams), include efforts to streamline data pulls and processing between single and multi-species models
  - Re-examine growth assumptions, update age-length conversion matrices, consider alternative surveys and VAST estimates


QUESTIONS
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