

ALASKA SABLEFISH UPDATES

MESA STAFF

MARINE ECOLOGY AND STOCK ASSESSMENT

ALASKA FISHERIES SCIENCE CENTER

JUNEAU, AK

OUTLINE

- Pacific Sablefish Transboundary Assessment Team (PSTAT) Update
- Quick Data Update for 2021
- Proposed Model Updates for 2021
  - Biological
  - Parametrization
  - Data Weighting
  - Proposed Model Results and Comparison to 2020 SAFE Model

PSTAT

Welcome

The Pacific Sablefish Transboundary Assessment Team (PSTAT), in collaboration with the Northwest Fisheries Science Center (NWFSC), Alaska Fisheries Science Center (AFSC), Department of Fisheries and Oceans (DFO), Alaska Department of Fish and Game (ADF&G), Pacific Fishery Management Council (PFMC), and North Pacific Fishery Management Council (NPFMC), is holding a public workshop to solicit feedback on the ongoing range-wide sablefish management strategy evaluation (MSE). The workshop will be held **Tuesday, April 27 through Wednesday, April 28, 2021**. The purpose of the workshop is to engage fishery stakeholders, Alaska Natives and Tribal governments, First Nations, scientists, managers, and Non-governmental organization staff from each region during this two day workshop that will foster discussions among regions about sablefish science and management.

Go to the 2021 MSE Workshop webpage

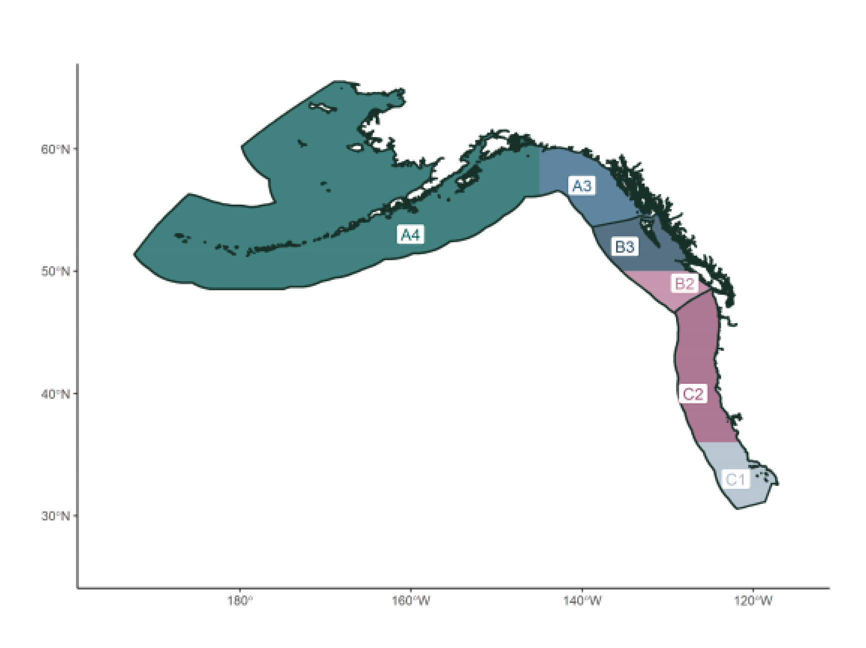
PSTAT

- Pacific Sablefish Transboundary Assessment Team (PSTAT)
- Focus on improving regional scientific advice for sablefish
  - Provide regional management councils with best scientific information possible
  - Better understand range-wide stock dynamics
  - **NOT** aiming to manage sablefish on a NE Pacific-wide basis
- Currently developing a NE Pacific sablefish simulation model

5 SPRING 2021 MSE WORKSHOP

- April 27-28, 2021
- 75+ registered participants and observers, also streamed via YouTube
- Full meeting agenda, presentations, recordings, and summary report available at:
  - https://www.pacificsablefishscience.org/2021-mse-workshop

Six-area spatial stratification in sablefish OM based on data-drive growth rates and regional management areas



MSE WORKSHOP TOPICS

- Mix of presentations and small-group breakout sessions covering:
  - Introduction to MSE and stakeholder engagement
  - Introduction to the NE Pacific sablefish operating model
  - Identify MSE objectives (BOG)
  - Identify MSE performance metrics (BOG)
  - Discussion of proposed MSE management procedures and future management strategies research (BOG)
  - Wrap up and next steps

7 MSE WORKSHOP OUTCOMES

- Report table C.2 is a summary table of the objectives and performance metrics discussed in breakout groups.

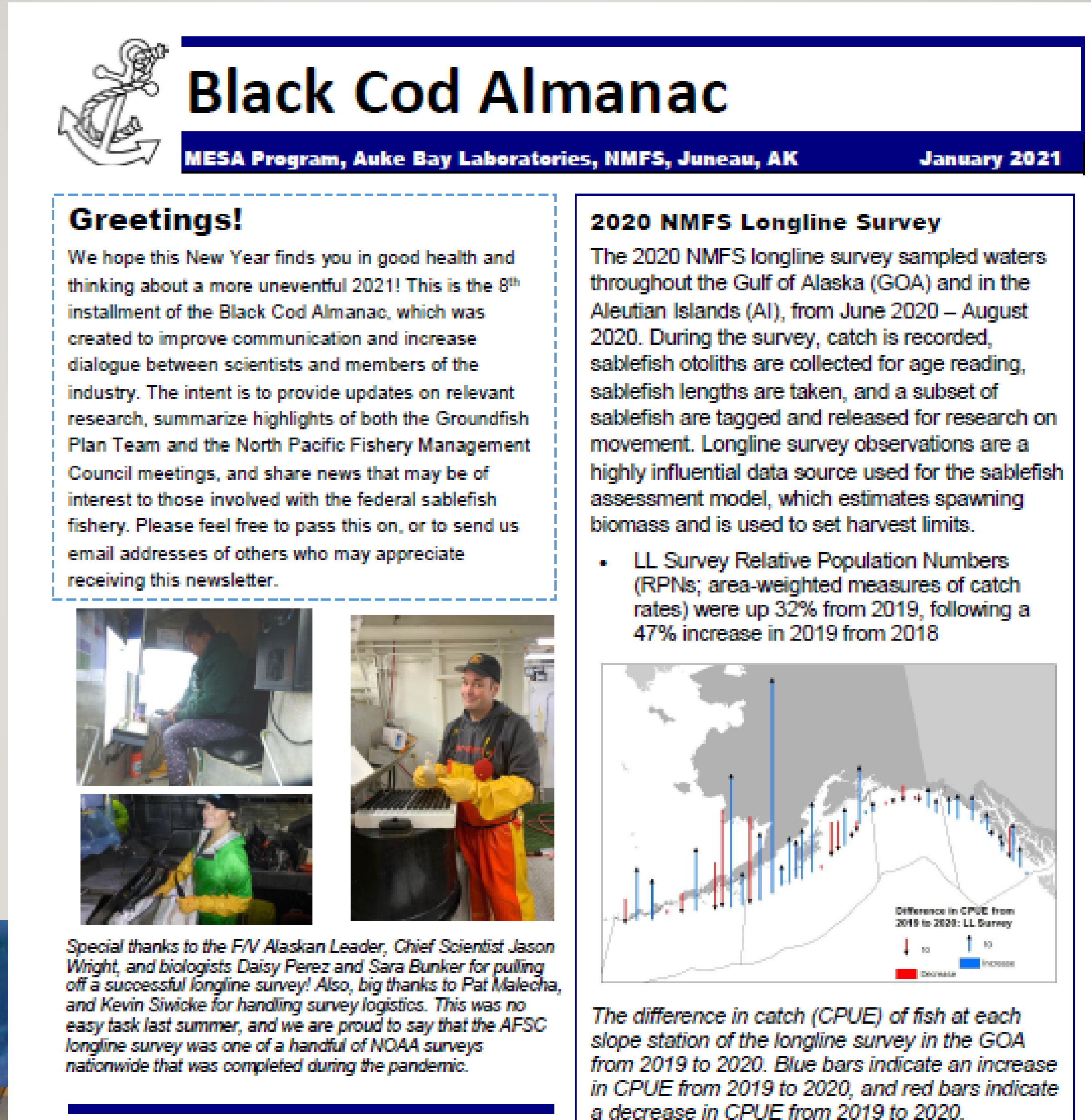
	Objective *What do we care about?*	**Quantity of Interest** *What is measured?*	**Performance Metric** *How do we measure it?*
Phase 1 Objectives & Performance Metrics: Biological	Minimize risk of stock being overfished	Size of spawning biomass	Probability spawning biomass is above 40% of unfished biomass in 50% of the years over a 30-year period
	Maintain stock biomass at or above Bmsy	Size of spawning biomass	Probability spawning biomass is above Bmsy in 50% of the years over a 30-year period
Phase 1 Objectives & Performance Metrics: Economic	Minimize risk of fishery closure	*Number of years the fishery closes, probability of closure in a given 10-year period*	Probability fishery has less than X% chance of closure in any given 30 year period
	Maintain minimum catch level	*Yearly catches*	Number of years in which catch falls below lowest observed (true) catch in each region over 30-year period
	Maximize catch on a regional basis	Sum of catch across all three regions	
	Minimize annual catch variability	Level of catch variability	Coefficient of variation in annual catch over first 10 years of projection; Probability change in ABC / allowable catch between -X% or +Y% for N years over a 30 year period ; Annual catch variation is less than 15%
Phase 2 Objectives*	Maximize long-term profitability profits *	Costs and revenues for each fleet per year	Sum of profits over last N projection years in each fleet and management region
	Encourage price and market stability	Costs and revenues for each fleet per year	Percent change in price is below threshold year-to-year; revenues do not vary more than a given percent year-to-year
	Ensure fair allocation of quota to individual quota holders *	Distribution and variability of quota among quota holders	Probability X% of quota holders receive their expected quota in Y% of years within each management region

8 PSTAT TIMELINE AND NEXT STEPS

Complete Phase 1 in 2023:

- Finish development of 6-area OM, address handling of discard data within the model
- Construct estimation model(s) – one EM that matches management regions, one that matches OM structure. Time permitting – one panmictic EM.
- Report out Phase 1 results to stakeholders and hold discussion about potential work for future phases.
- For more information, see:
  - https://www.pacificsablefishscience.org/2021-mse-workshop

DATA UPDATES



Black Cod Almanac

MESA Program, Auke Bay Laboratories, NMFS, Juneau, AK — January 2021

Greetings!

We hope this New Year finds you in good health and thinking about a more uneventful 2021! This is the 8th installment of the Black Cod Almanac, which was created to improve communication and increase dialogue between scientists and members of the industry. The intent is to provide updates on relevant research, summarize highlights of both the Groundfish Plan Team and the North Pacific Fishery Management Council meetings, and share news that may be of interest to those involved with the federal sablefish fishery. Please feel free to pass this on, or to send us email addresses of others who may appreciate receiving this newsletter.

Special thanks to the F/V Alaskan Leader, Chief Scientist Jason Wright, and biologists Daisy Perez and Sara Bunker for pulling off a successful longline survey! Also, big thanks to Pat Malecha, and Kevin Siwicke for handling survey logistics. This was no easy task last summer, and we are proud to say that the AFSC longline survey was one of a handful of NOAA surveys nationwide that was completed during the pandemic.

INSIDE THIS ISSUE

2020 NMFS Longline Survey

The 2020 NMFS longline survey sampled waters throughout the Gulf of Alaska (GOA) and in the Aleutian Islands (AI), from June 2020 – August 2020. During the survey, catch is recorded, sablefish otoliths are collected for age reading, sablefish lengths are taken, and a subset of sablefish are tagged and released for research on movement. Longline survey observations are a highly influential data source used for the sablefish assessment model, which estimates spawning biomass and is used to set harvest limits.

- LL Survey Relative Population Numbers (RPNs; area-weighted measures of catch rates) were up 32% from 2019, following a 47% increase in 2019 from 2018

The difference in catch (CPUE) of fish at each slope station of the longline survey in the GOA from 2019 to 2020. Blue bars indicate an increase in CPUE from 2019 to 2020, and red bars indicate a decrease in CPUE from 2019 to 2020.

10 DATA UPDATES

- Will have updates for:
  - 2021 longline survey RPN and lengths, 2020 ages
  - 2021 trawl survey biomass and lengths
  - Final 2020 catch and projected 2021 catch with associated whale depredation estimates
  - Fixed gear age and length composition data for 2020
  - Trawl gear length composition data for 2020
- Will likely **not** have:
  - 2020 fixed gear fishery CPUE index data

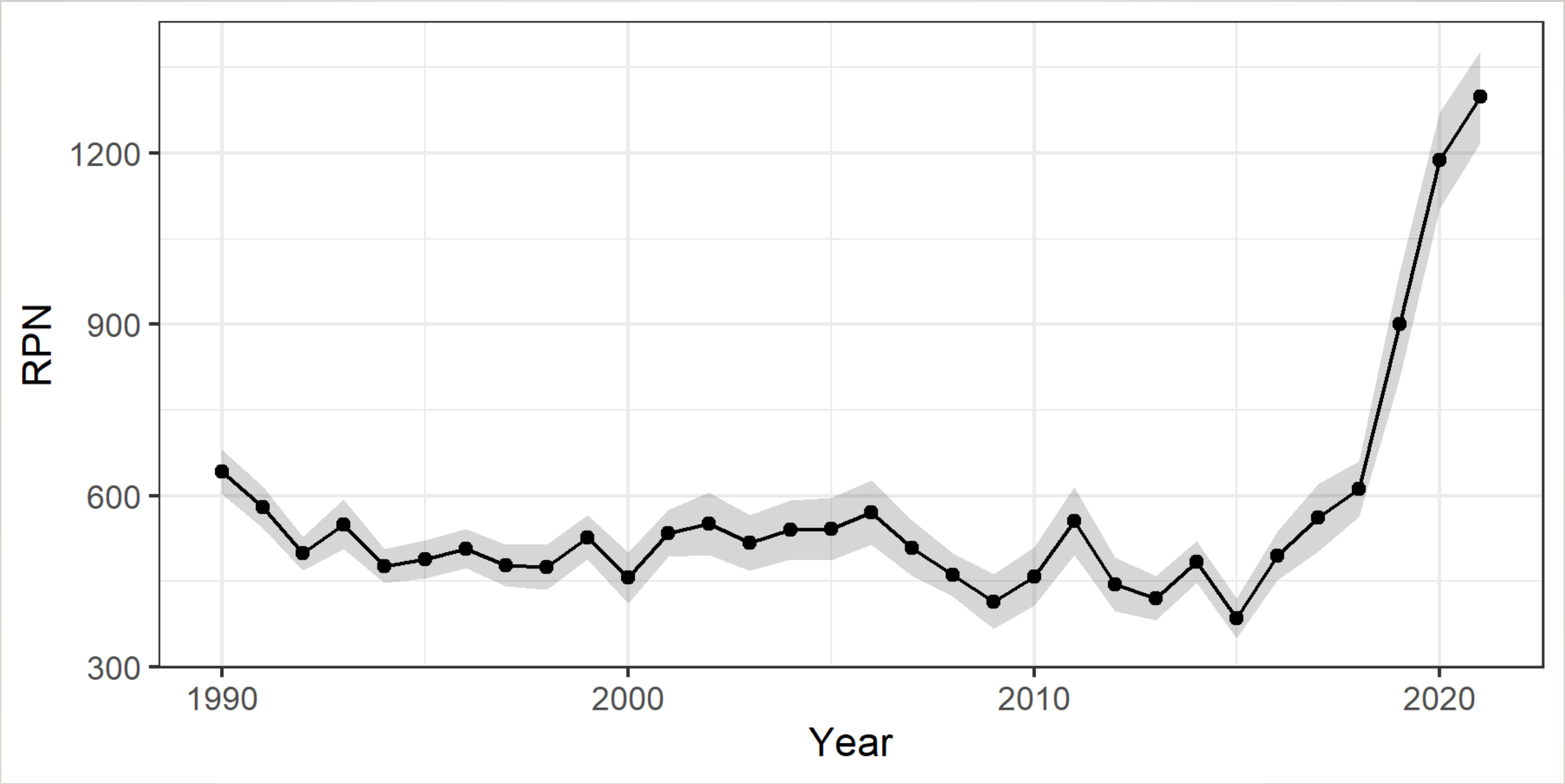
11 CPUE INDEX ISSUES

- CPUE index based on catch rates from the directed longline fishery (no pot gear)
- Combination of observer and logbook data, but logbook sample sizes much higher
- Limited observer coverage in 2020 due to:
  - Increase in pot gear usage and EM
  - Observer deployment plan
  - COVID-19

Year	AI	BS	WG	CG	WY	EY/SE
2016	184	0	251	732	140	228
2017	NA	14	81	389	86	229
2018	NA	NA	108	339	138	188
2019	NA	18	148	344	214	217
2020	0	10	13	90	68	109

- No methods yet available to incorporate electronic monitoring (EM) in the CPUE index
- Voluntary logbook data for 2020 are not available due to limited funding in the IPHC grant that supports collection and keypunching of data

12 SURVEY RPN INCREASED AGAIN



13 APPORTIONMENT

- **Current Apportionment Strategy**: 5-year average of regional survey biomass proportions
  - Balance **tracking regional biomass** vs. **stability in area proportions**
  - *One potential* **biological recommendation**
  - **NOT** static, proportions change based on updated survey biomass distributions
- **Will update with 2021 longline survey RPN distribution by region (increasing relative proportions in BS in 2021)**
- SSC utilized a 25% stair step from previous fixed apportionment to survey proportions in 2020
- No new methods will be presented

FISHERY GEAR CHANGES

- Catch in pot gear has rapidly increased since legalization in GOA in 2017
  - Utilization aided by development of collapsible 'slinky' pots
- Age and length composition from fishery typically sampled in proportion to catch by gear
- Looking at modeling pot gear as a unique fleet in stock assessment (independent selectivity and F)
- UAF student to begin work on improving CPUE index to address pot gear
- Depredation estimates account for gear implicitly based on observer data
  - No depredation in observed pot trips

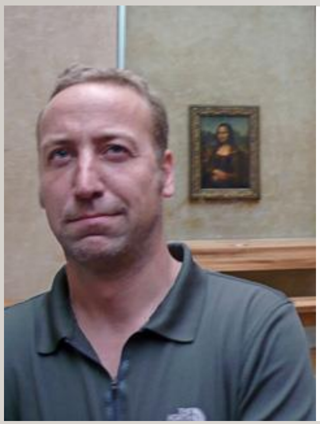
% of Catch, Length, and Age Samples from Pot Gear

Year	Catch	Length Samples	Age Samples
2016	2%	5%	9%
2017	17%	29%	39%
2018	19%	31%	35%
2019	30%	16%	17%
2020	53%	56%	

15 ONGOING RESEARCH

- Future assessment updates to address **changing availability to gears and surveys**, improved formulation of natural mortality, **updated demographics**, **data weighting**, incorporation of tagging data, and modeling of pot gear (1-3 years)
- Improving CPUE index to address shift to pot gear (1-2 years)
- MSE to explore robustness of current management strategies to spasmodic recruitment (2-3 years)
- Ongoing genetics to explore stock structure (1-2 years)
- PSTAT work on a coastwide operating/simulation model (1-3 years)
- Simulation testing robustness of spatial and non-spatial assessments (post-doc; 1-2 years)

PROPOSED MODEL UPDATES

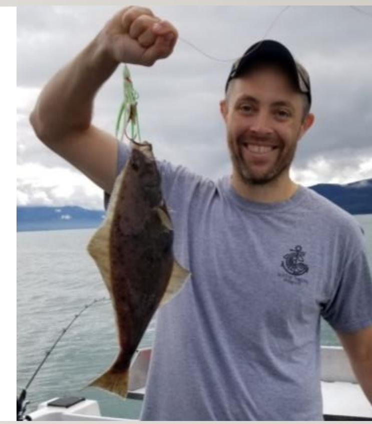


Alaska Sablefish Model Update

Daniel Goethel, Dana Hanselman, Chris Lunsford, Cara Rodgveller,
Ben Williams, Katy Echave, Jane Sullivan, and Pete Hulson

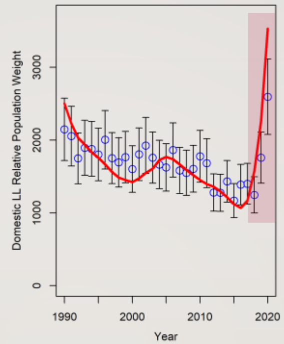
Alaska Fisheries Science Center, Auke Bay Laboratories

September 2021

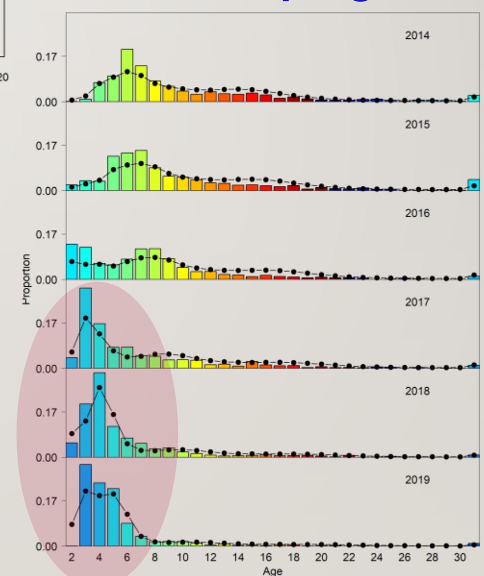


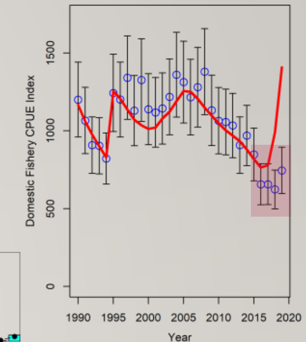
17 TROUBLING MODEL DIAGNOSTICS

- Overestimating longline survey RPNs by >30% in recent years
- Model can't rectify rapid transition to young/small fish since 2016 in composition data, increasing RPNs, and stagnant CPUE
- Emphasis on composition data leading to recruitment estimates that are larger than expected based on RPNs (and CPUE)



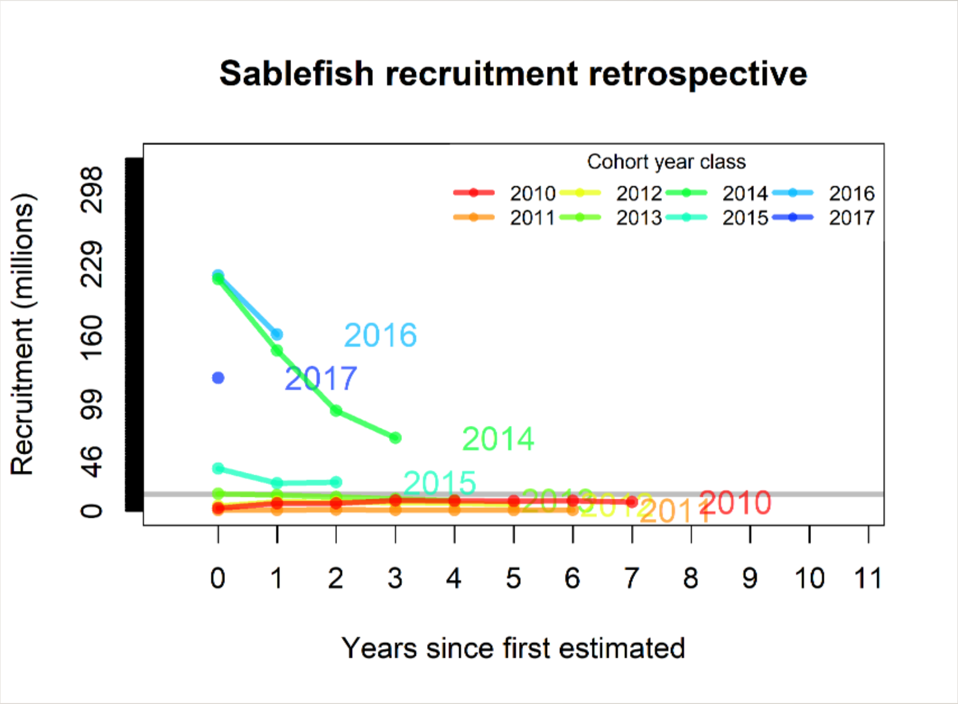
LL Survey Ages





18 TROUBLING MODEL DIAGNOSTICS

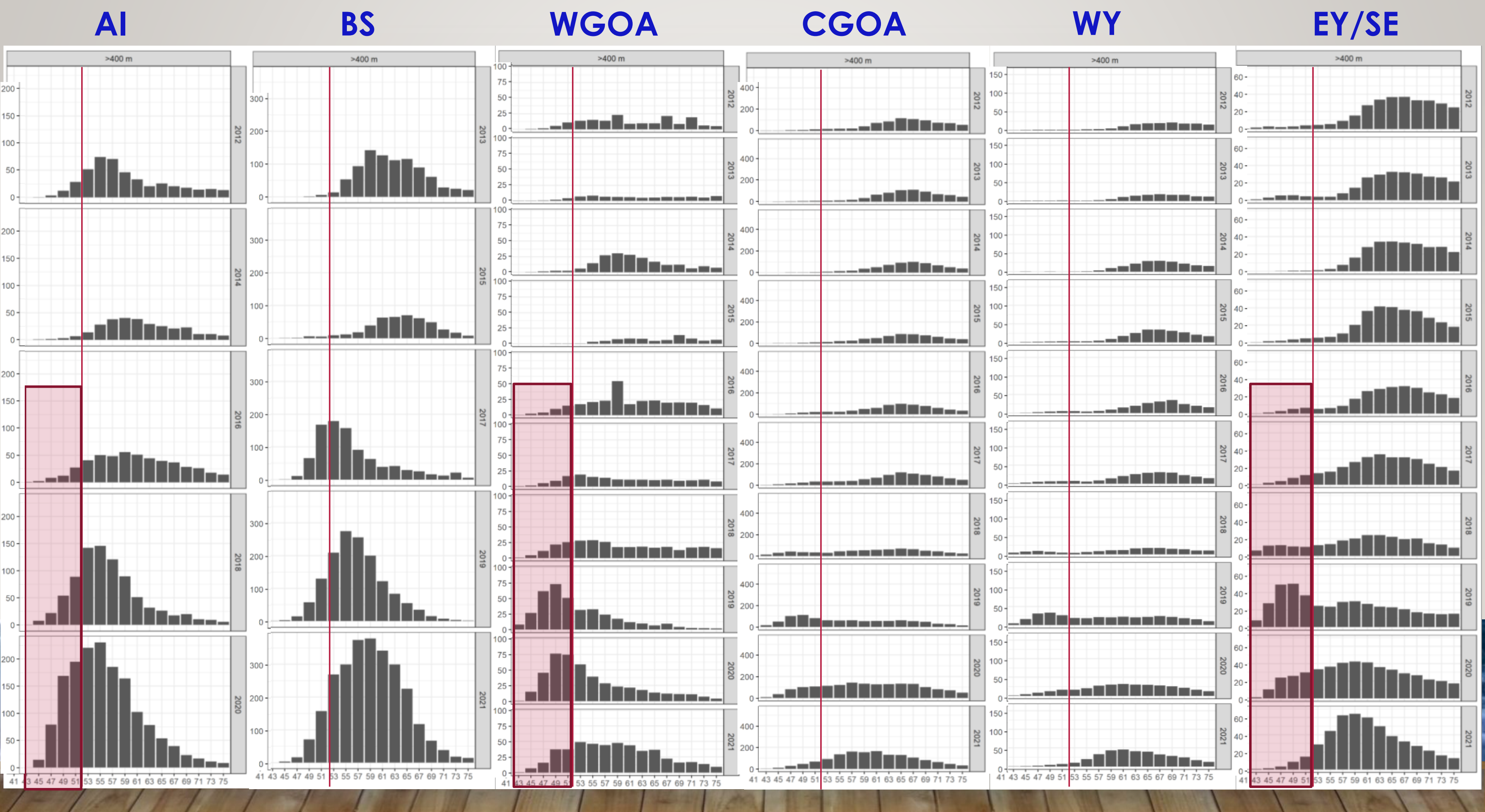
- Large retroactive downgrades in recent recruitment estimates
  - 60% reduction in 2014 year class strength since first estimated
- Fixed data weights may no longer be appropriate



19 CHANGING DYNAMICS

- Fishery rapidly changing due to increasing use of pot gear and potential changes in targeting
- Increase in young/small fish in survey may be factor of increasing availability in deeper strata

20 SMALL FISH GOING DEEPER(?)

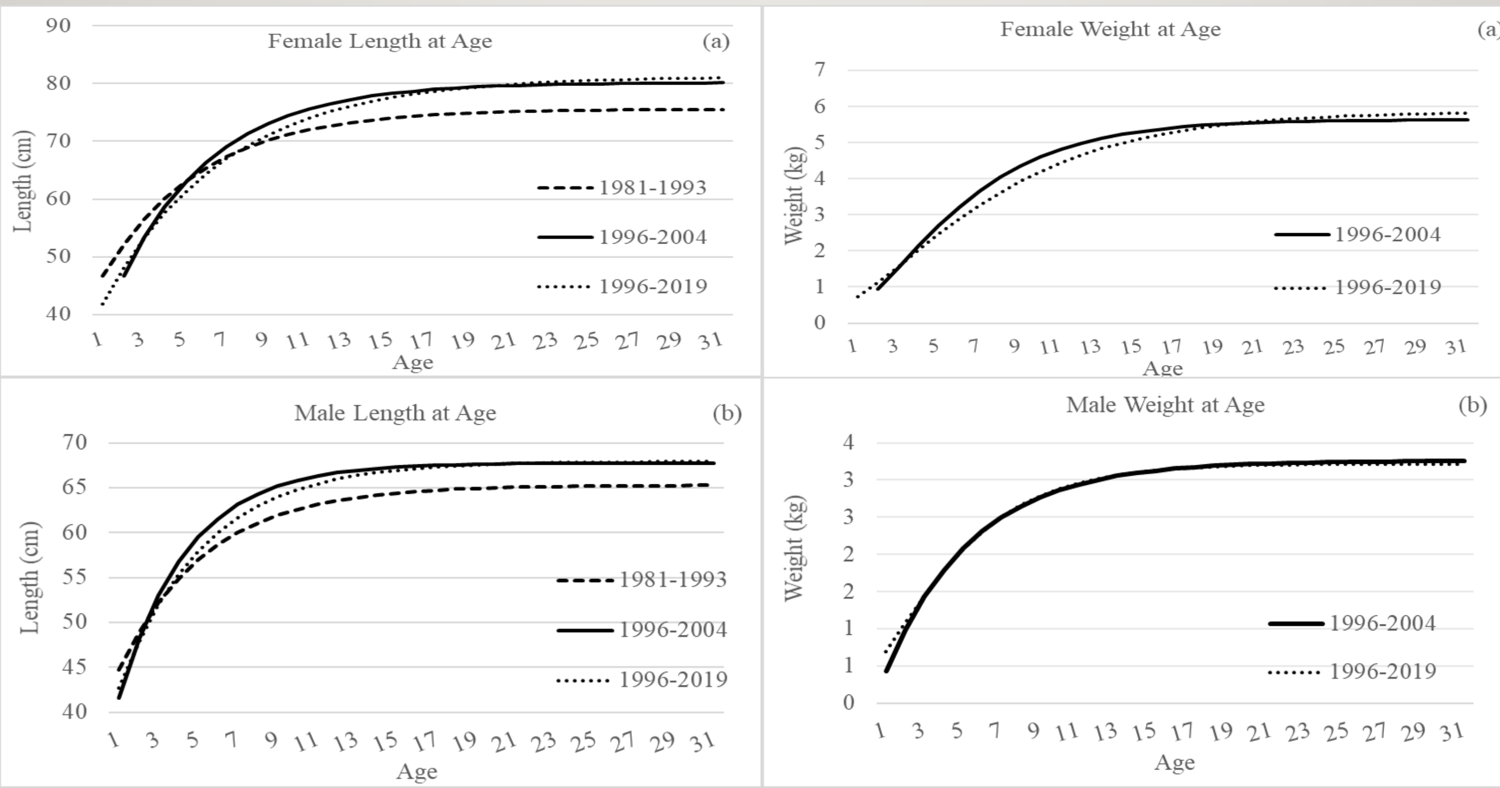


BIOLOGICAL UPDATES

- Maturity has never been updated
  - Utilizes length-based macroscopic data collected in late 1970s and early 1980s, then converted to age from Sasaki (1985)
  - Recently collected histological data more reliable
  - Skipped spawning observed with sablefish, assessment should account for functional maturity
  - GAMs better account for skipped spawning, while age-length based models can better account for maturity processes
- Length and weight have not been updated since 2008
  - Over a decade of new data available to reestimate growth curves and weight-at-age

BIO UPDATES: LENGTH/WEIGHT

- ***21.1_Wt+Grt***: update weight and growth parameters
- Update with all data through 2019 (no change to historic growth)
- Sablefish grow slower, but reach larger max size

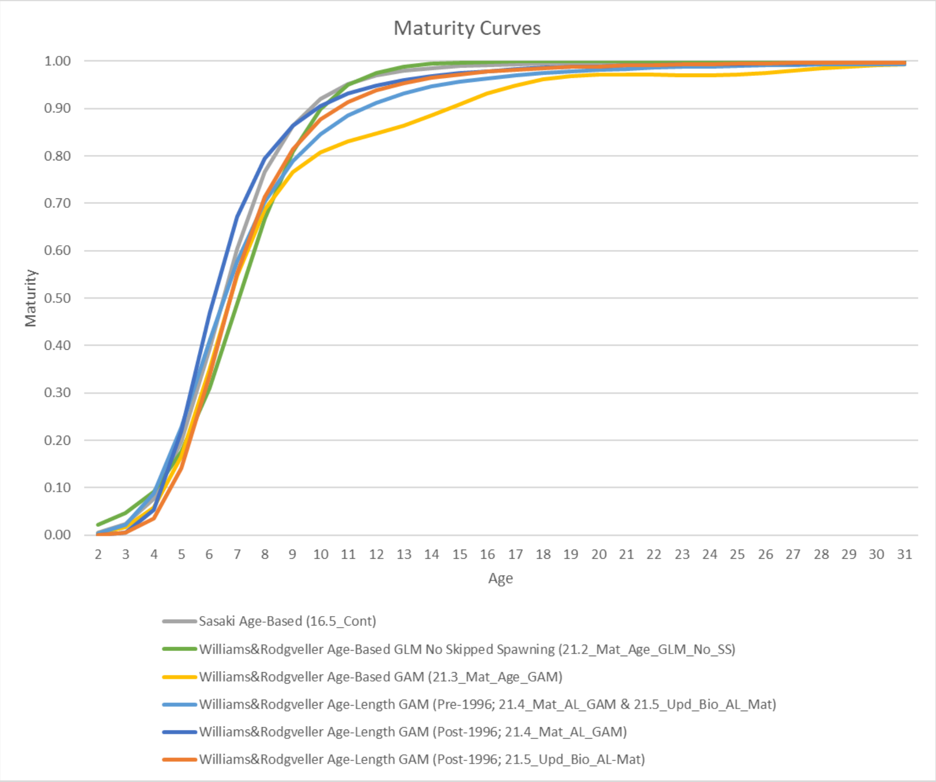


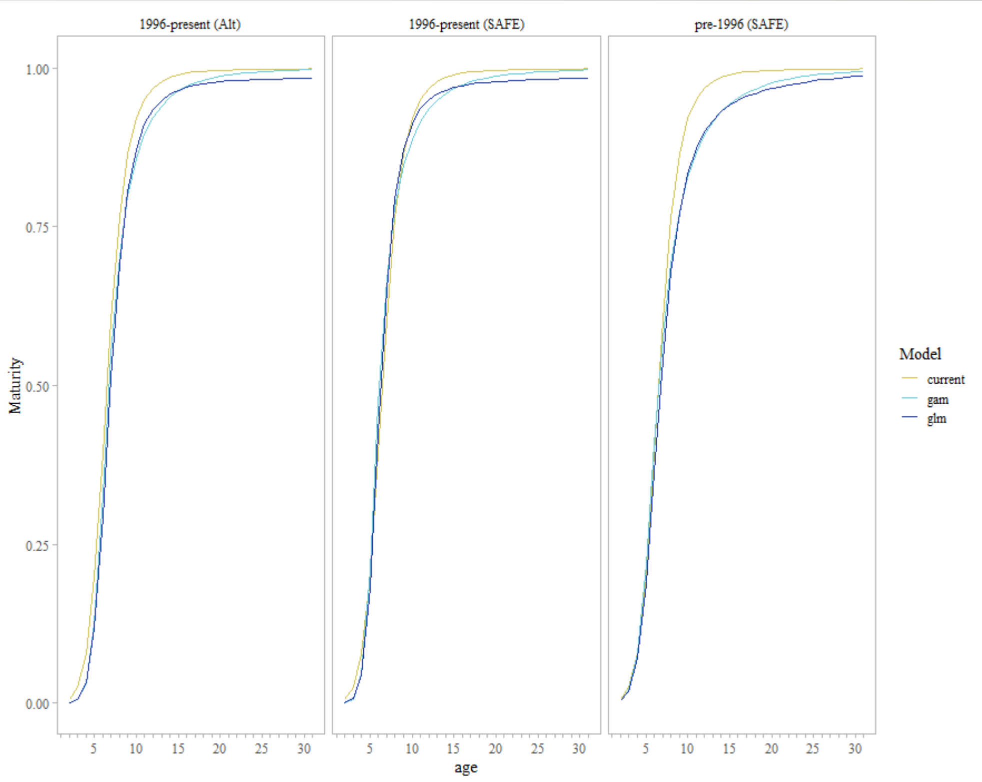
BIO UPDATES: MATURITY

- ***21.2_Mat_Age_GLM_No_SS:*** update maturity using age-based GLM and not accounting for skipped spawning
- ***21.3_Mat_Age_GAM:*** update maturity using age-based GAM and accounting for skipped spawning
- ***21.4_Mat_AL_GAM:*** update maturity using age-length GAM and accounting for skipped spawning
- ***21.5_Upd_Bio_AL_GAM:*** incorporate changes from models *21.1* and *21.4*

24 BIO UPDATES: MATURITY

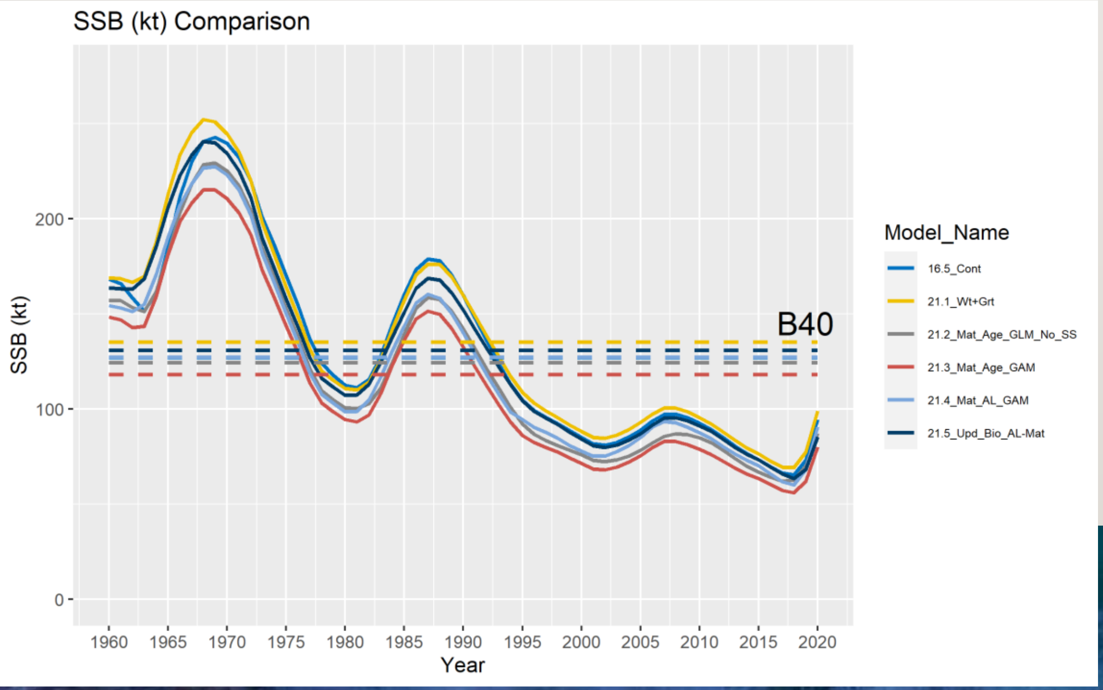
- Maturity differs over time for age-length GAM due to changes in growth (maturity model parameters are constant)
- Recent maturity is decreased for younger and intermediate ages compared to Sasaki (1985)





BIO UPDATES: RESULTS

- Changing biology inputs led to scaling changes, generally reducing SSB
- Combined effect of updating length, weight, and using age-length GAM was to reduce terminal SSB while increasing reference points



Lower maturity at most common ages in current population, but increased B_{40} due to higher maximum sizes and slight increase in recruitment estimates.

Model	2020 SSB (kt)	SSB_40 (kt)	2020 SSB/SSB_40
16.5_Cont	94.43	126.84	0.74
21.1_Wt+Grt	99.1	135.16	0.73
21.2_Mat_Age_GLM_No_SS	87.17	124.22	0.7
21.3_Mat_Age_GAM	79.99	117.98	0.68
21.4_Mat_AL_GAM	90.72	127.17	0.71
21.5_Upd_Bio_AL-Mat	85.31	130.76	0.65

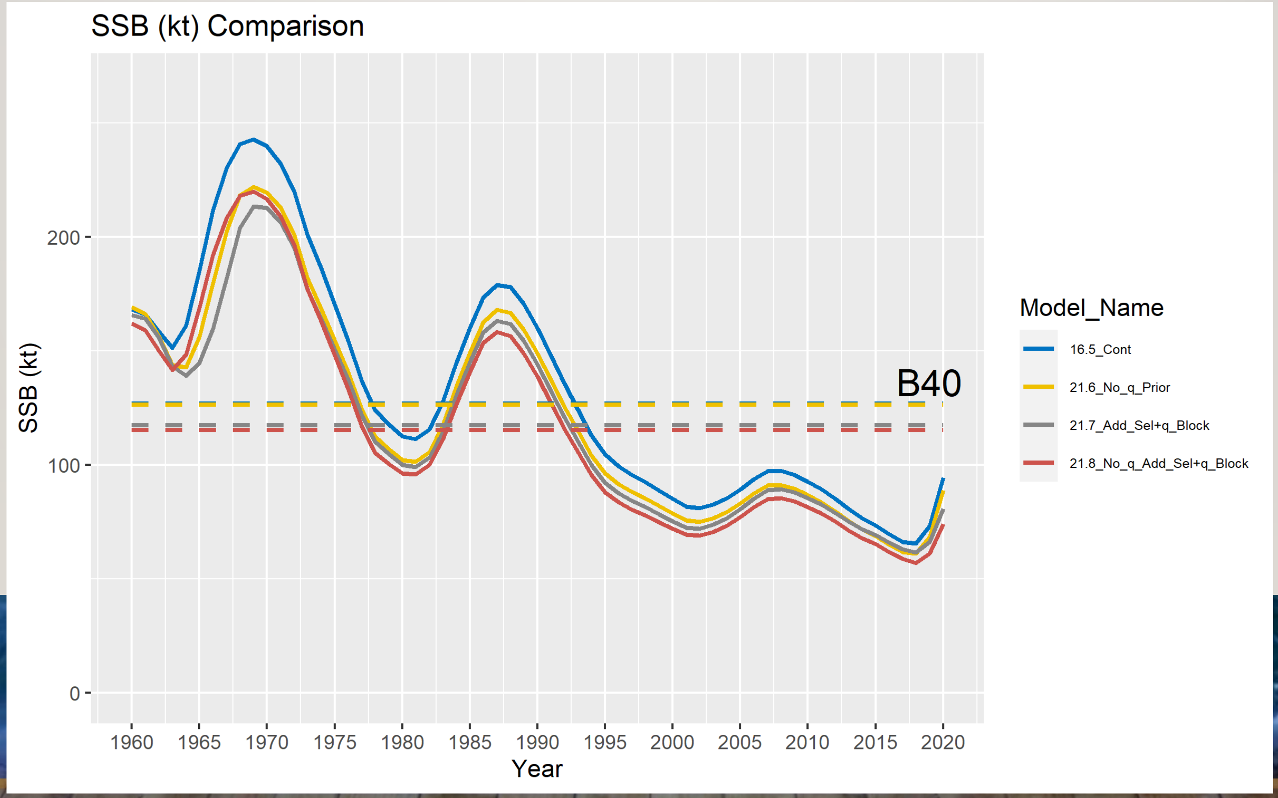
26

PARAMETRIZATION UPDATES

- ***21.6_No_q_Prior***: remove priors on all catchability parameters
  - Best practice to aid internal model scaling
  - "[Catchability priors] seems to use all indices outside the model to develop a prior and then those same indices and prior again in the model. So double-dipping. Plus the outside-model catchability analysis doesn't account for selectivity the same as the model does, so its not clear that catchability priors for the raw indices are useful as a prior on catchability within the age-structured model that is also estimating selectivity differences."—Internal Review
- ***21.7_Add_Sel+q_Block***: add a recent (2016-present) fishery and survey selectivity block along with similar block for fishery CPUE catchability
  - Address abrupt CPUE index decrease around 2016 (catchability) and fishery gear/targeting changes (selectivity)
  - Hypothesize that increase of small/young sablefish may be due to increased availability to survey (selectivity), especially deep survey strata
- ***21.8_No_q_Add_Sel+q_Block***: incorporate changes of models 21.6 and 21.7

27 PARAMETER UPDATES: RESULTS

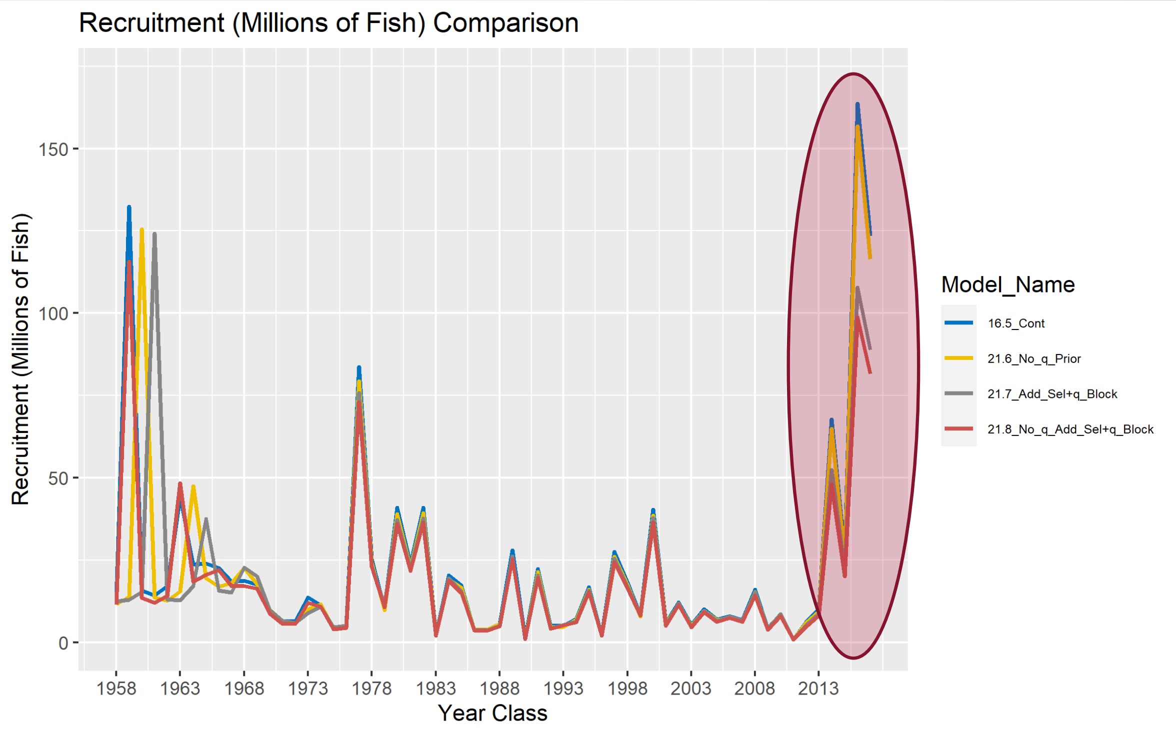
- Changing q and selectivity parametrization led to scaling changes, generally reducing SSB



28 PARAMETER UPDATES: RESULTS

- But, unlike bio updates, reference points also decreased due to large reductions in recent recruitment estimates
- Increased selectivity at younger ages in the recent time block reduces the estimates of recruitment

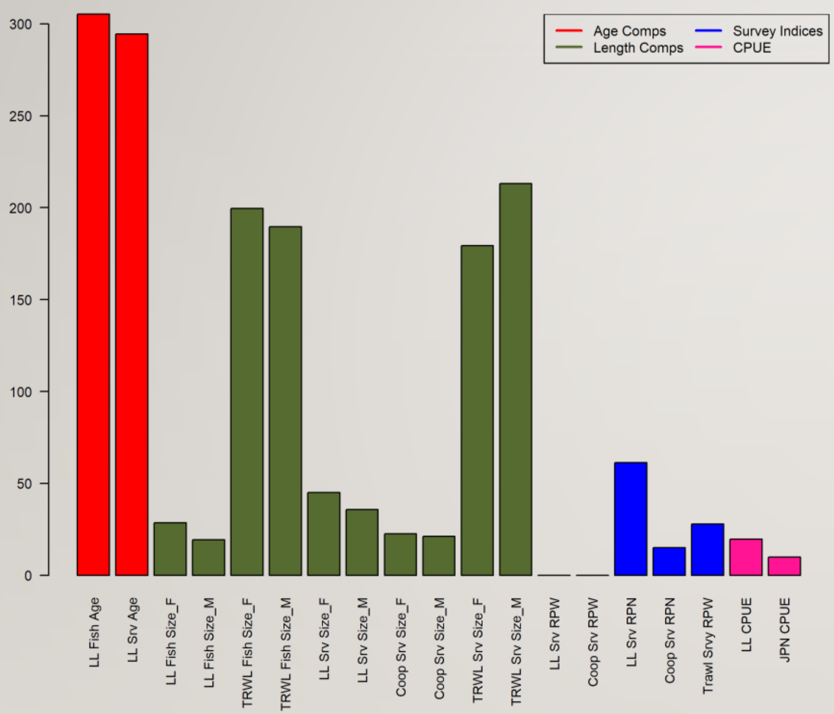
Model	2020 SSB (kt)	SSB_40 (kt)	2020 SSB/SSB_40
16.5_Cont	94.43	126.84	0.74
21.6_No_q_Prior	88.86	126.44	0.7
21.7_Add_Sel+q_Block	80.81	117.4	0.69
21.8_No_q_Add_Sel+q_Block	74.05	115.28	0.64



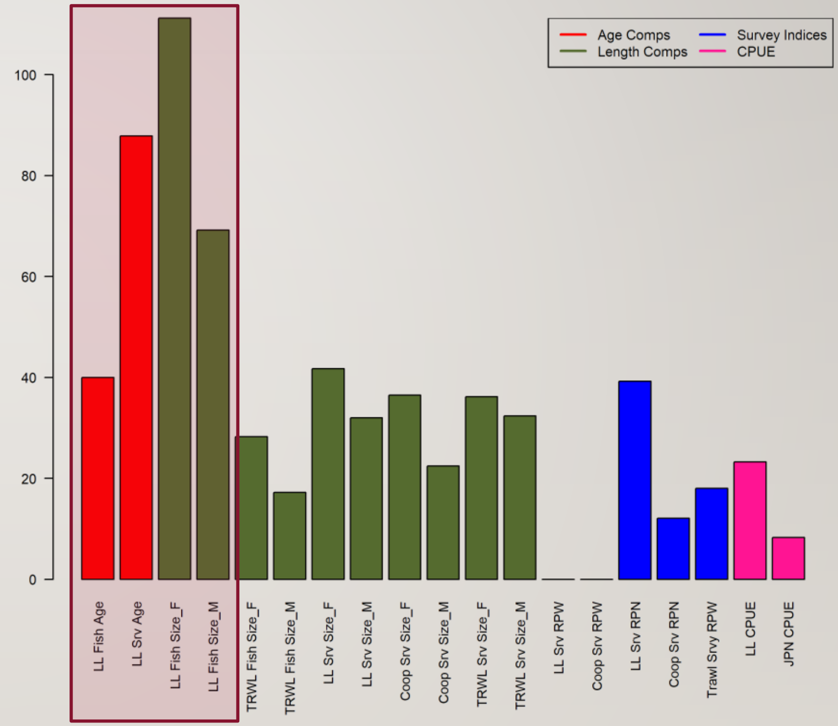
29 DATA WEIGHTING UPDATES

- ***21.9_Cont_Francis***: same as *16.5_Cont* model, but utilizing Francis reweighting
  - Replaces fixed data weights implemented based on recommendations of 2016 CIE review (occurred prior to influx of large recent year classes)
  - Similar to approach explored for other North Pacific species (e.g., GOA pollock and blackspotted/rougheye rockfish)
  - Compositional data weights were adjusted following Method TA1.8 and weighting assumption T3.4 of Francis (2011, Appendix Table A1; i.e., using the assumption of a multinomial distribution and accounting for correlations among ages or length bins)

30 DATA WEIGHTING LIKELIHOODS



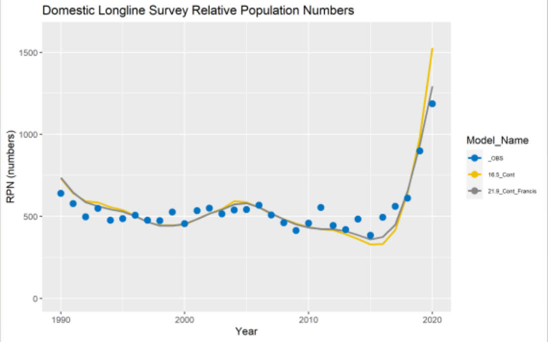
Converged?	Max Grad	nLL	# Pars
TRUE	4.33353878656491e-05	1888.1	240

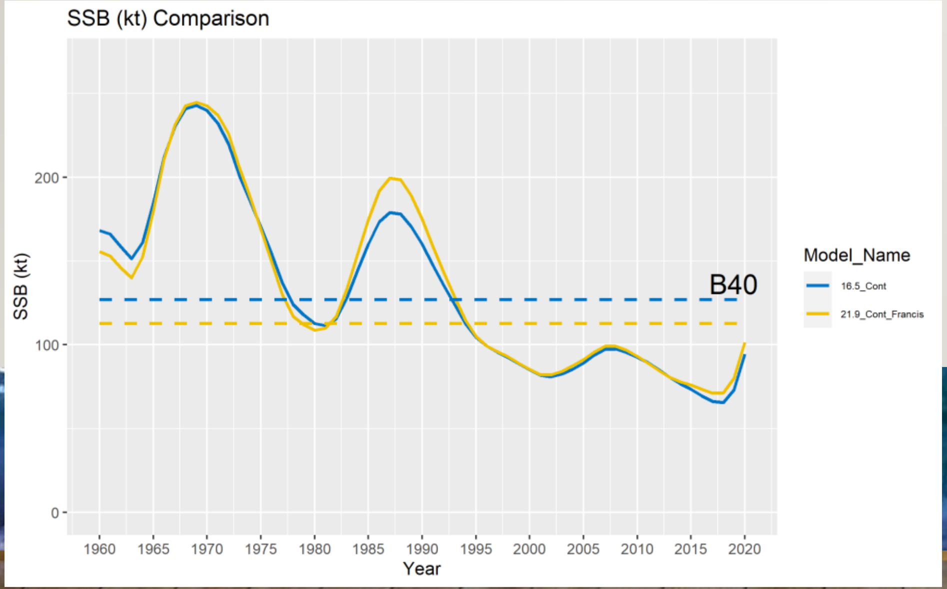


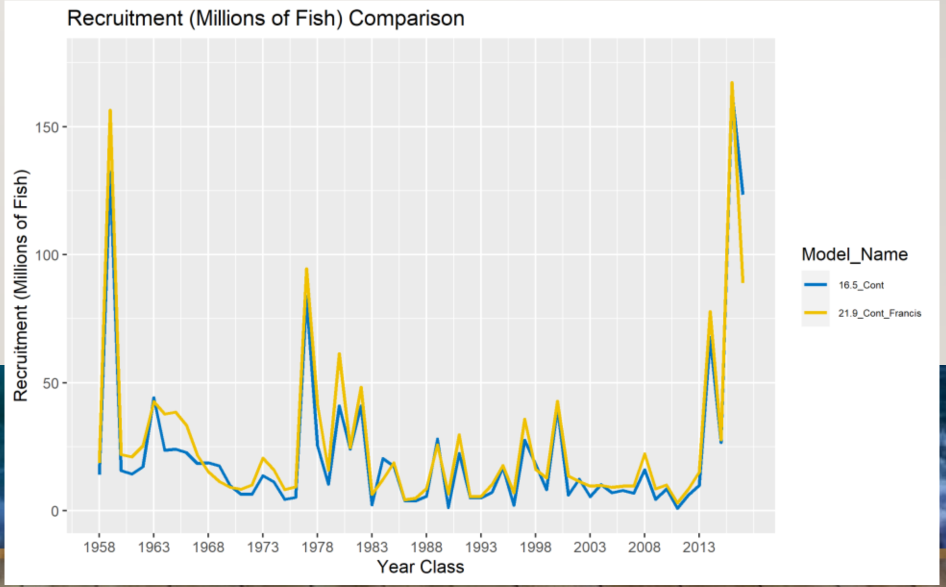
Converged?	Max Grad	nLL	# Pars
TRUE	2.6246219892387e-05	724.48	240

31 DATA WEIGHTING: RESULTS

- Reductions in recent recruitment, more subtle declines in mid-2010s, and better fit to survey RPNs
- Improved retrospective patterns





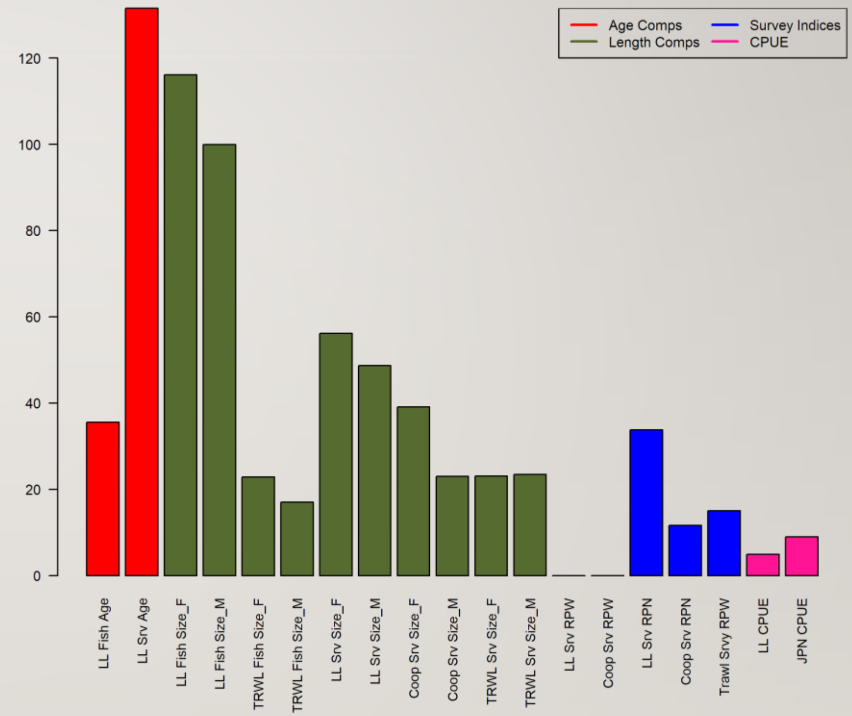


32 21.10_PROPOSED MODEL

- ***21.10_Proposed***: combines results of each model building stage, *21.5_Upd_Bio_AL-Mat* and *21.8_No_q_Add_Sel+q_Block*, then Francis reweighting is applied
  - Updated weight, growth, and maturity (using age-length GAM and accounting for skipped spawning)
  - Removed catchability priors
  - Added a time block starting in 2016 for estimation of fishery catchability and fishery and survey selectivity
  - Applied Francis reweighting

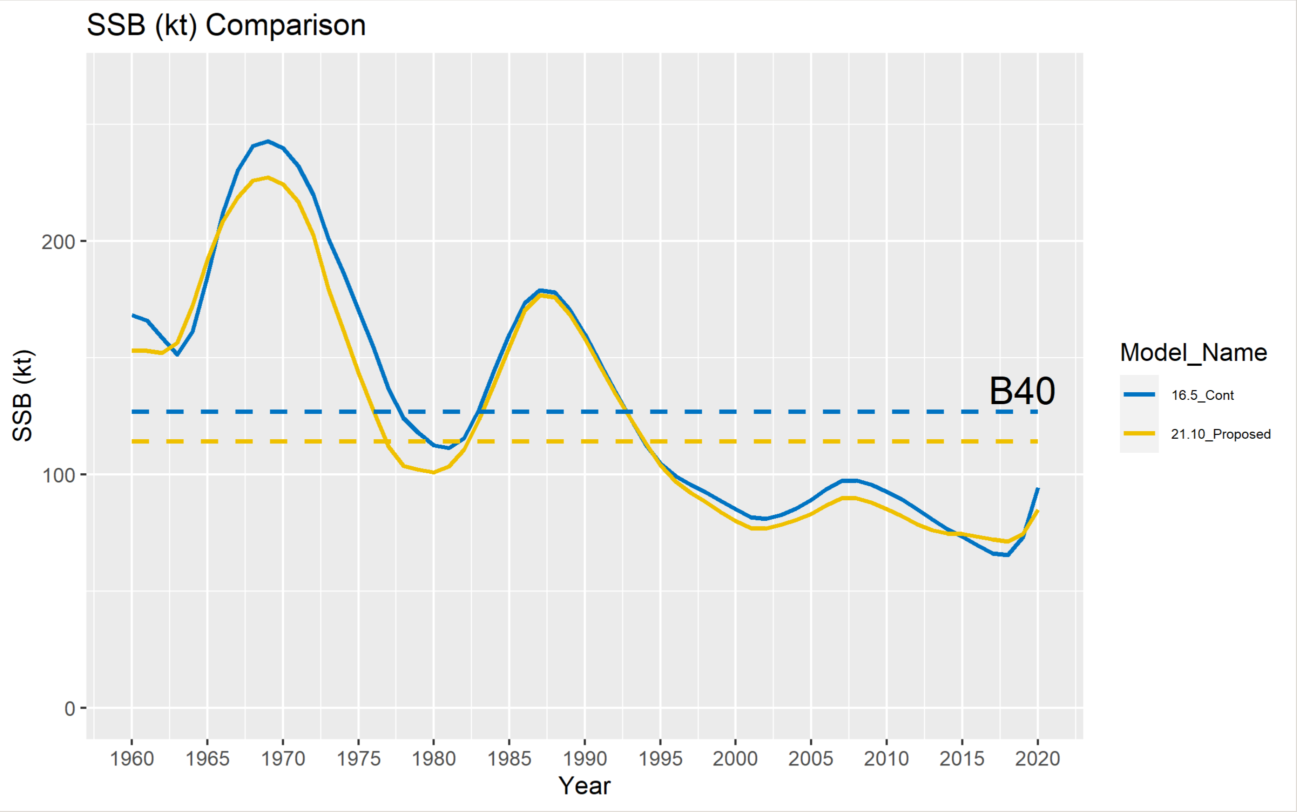
33 LIKELIHOOD COMPONENTS

Data Source	Model *16.5_Cont*	*21.9_Cont_Francis*	*21.10_Proposed*
Fixed Gear Catch	50.000	50.000	50.000
Trawl Catch	50.000	50.000	50.000
Longline Survey RPN	0.448	0.448	0.448
Coop Survey RPN	0.448	0.448	0.448
Fixed Gear Fishery CPUE	0.448	0.448	0.448
Japan Longline Fishery CPUE	0.448	0.448	0.448
Trawl Survey RPW	0.448	0.448	0.448
Fixed Gear Age Composition	7.800	0.817	0.710
Longline Survey Age Composition	7.950	2.297	3.904
Coop Longline Survey Age Composition	1.000	1.123	1.167
Fixed Gear Fishery Length Composition Males	1.000	3.948	5.915
Fixed Gear Fishery Length Composition Females	1.000	4.423	6.223
Trawl Fishery Size Composition Males	4.100	0.324	0.327
Trawl Fishery Size Composition Females	4.100	0.523	0.396
Longline Survey Size Composition Males	1.000	0.904	1.772
Longline Survey Size Composition Females	1.000	0.986	1.885
Coop Survey Size Composition Males	1.000	1.229	1.182
Coop Survey Size Composition Females	1.000	1.923	1.960
Trawl Survey Size Composition Males	7.250	0.954	0.738
Trawl Survey Size Composition Females	7.250	1.274	0.719

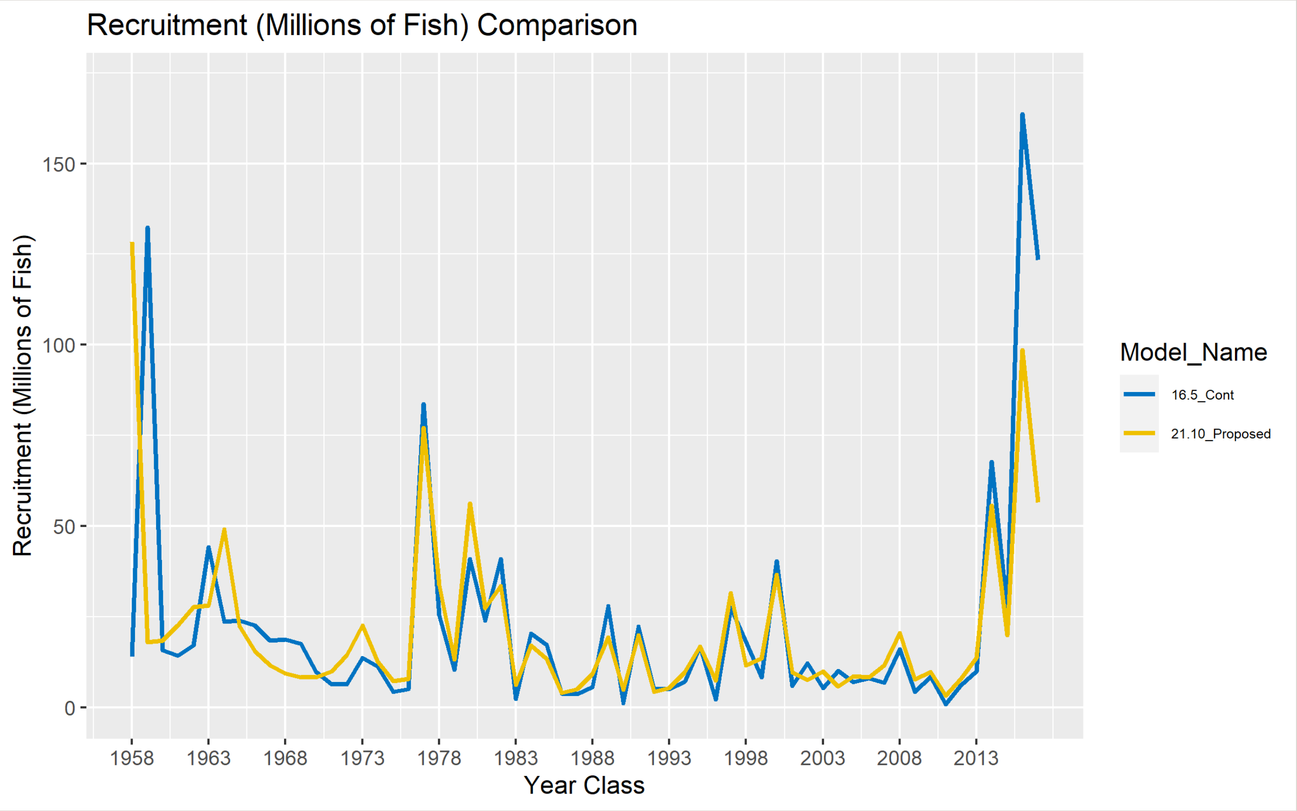


Converged?	Max Grad	nLL	# Pars
TRUE	0.00151063289005471	776.66	244

34 STEADIER RECENT SSB TREND



35 REDUCED RECRUITMENT



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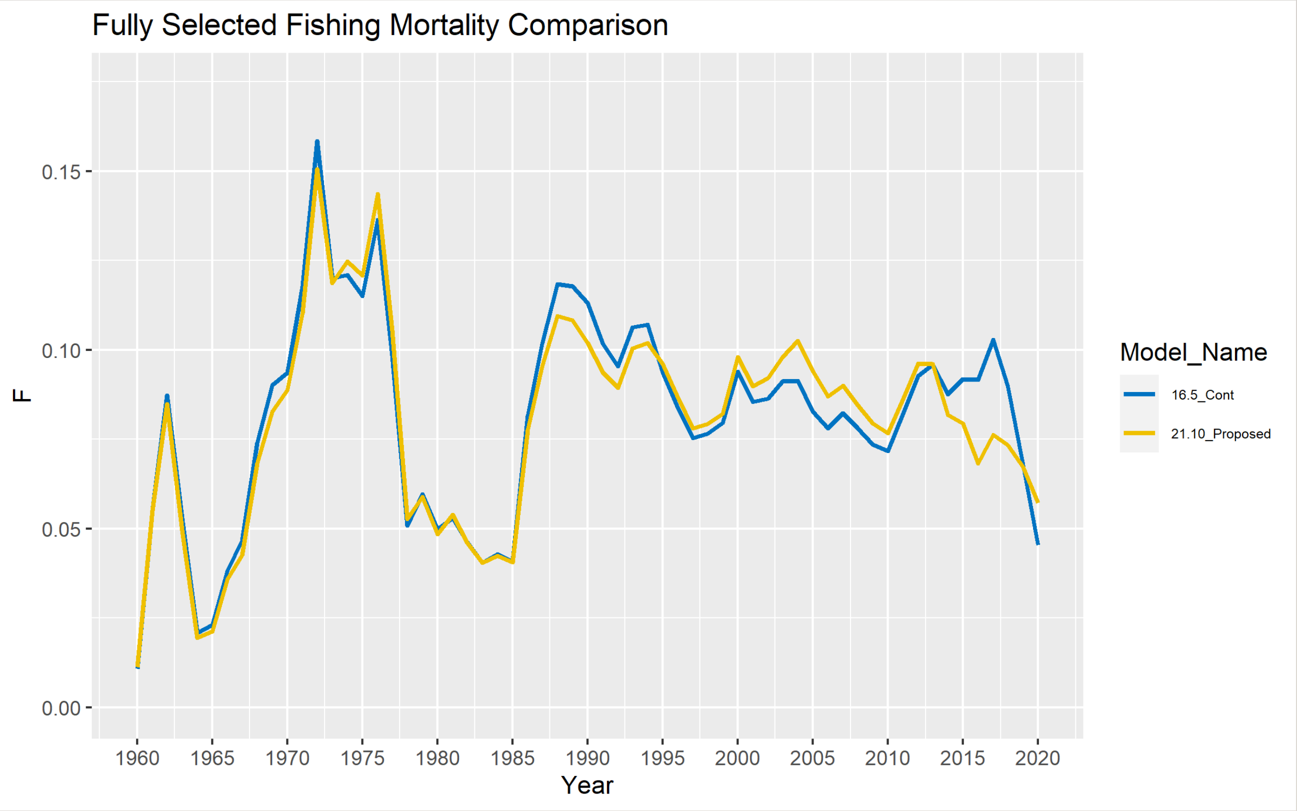
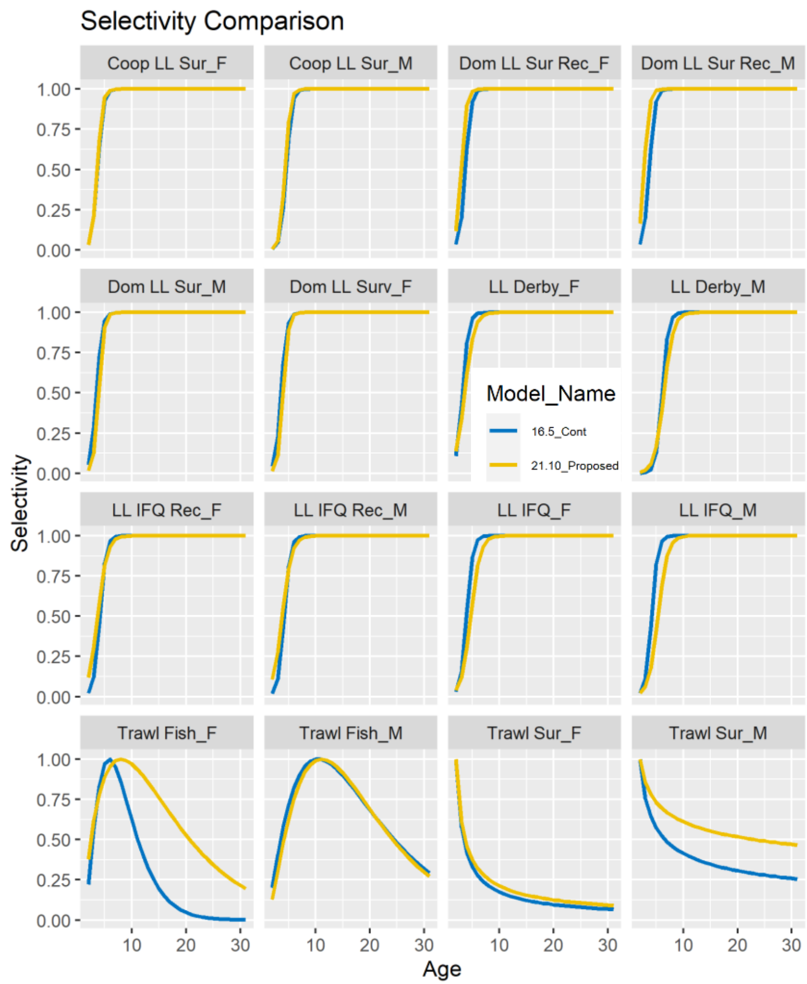
FISHING MORTALITY DECREASING

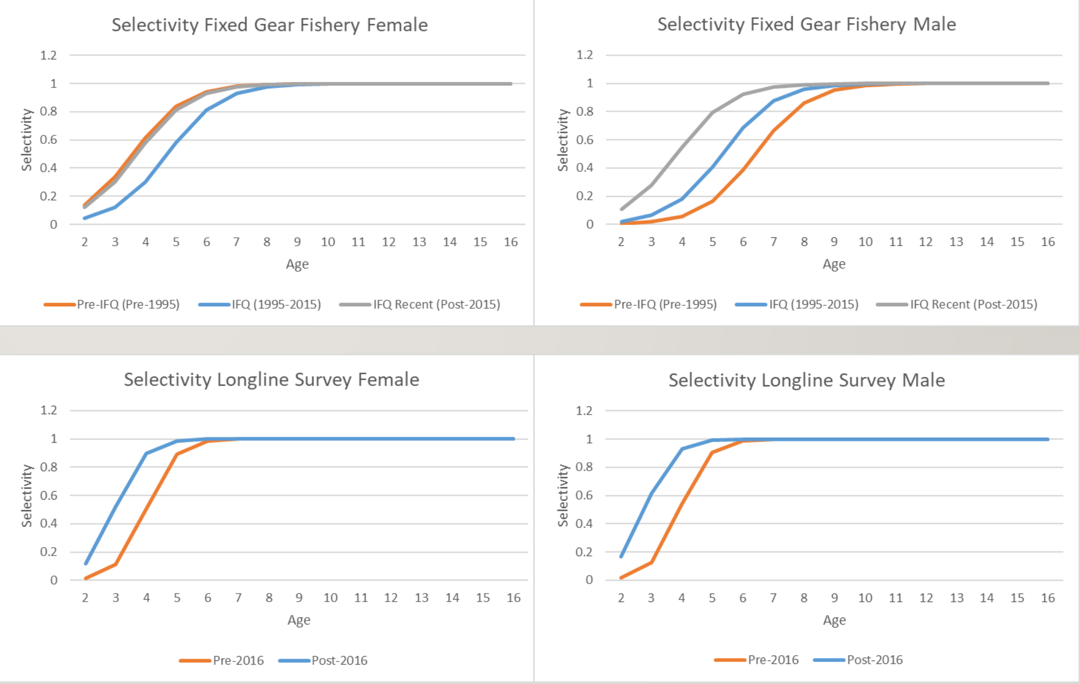


INCREASED SELECTIVITY

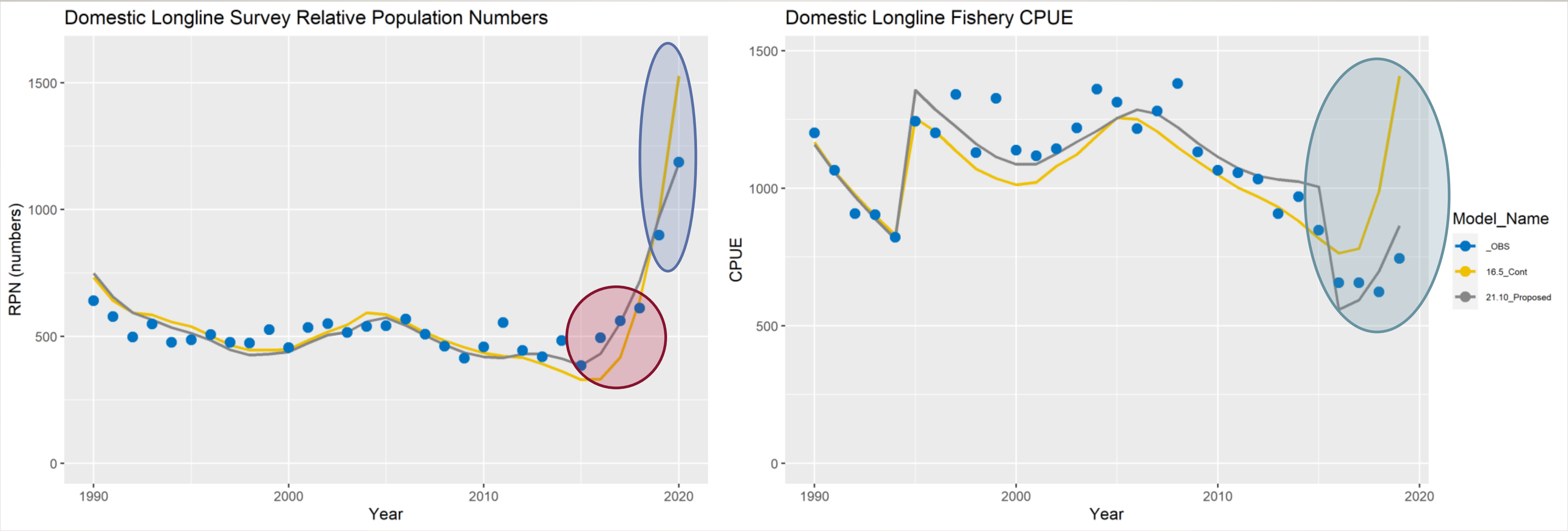


*Note minor change to trawl fishery selectivity parametrization (impacts minor)

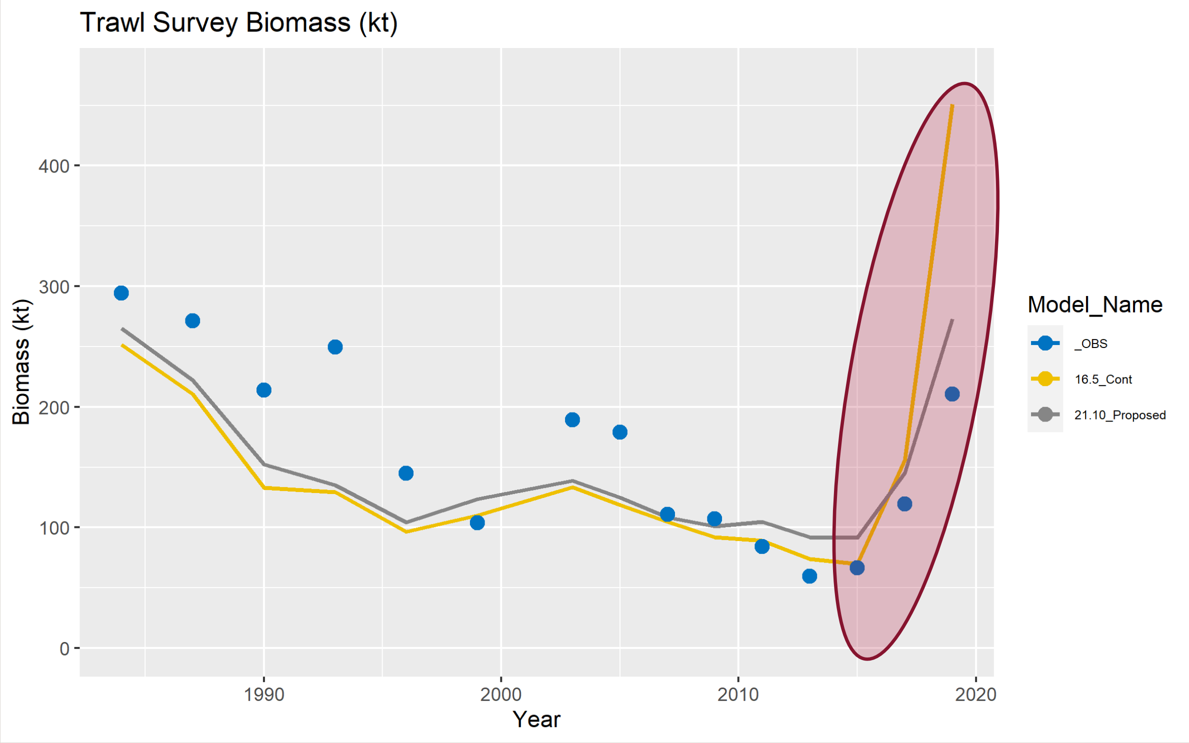
21.10_Proposed Selectivity Estimates



IMPROVED FIT TO RPN AND CPUE

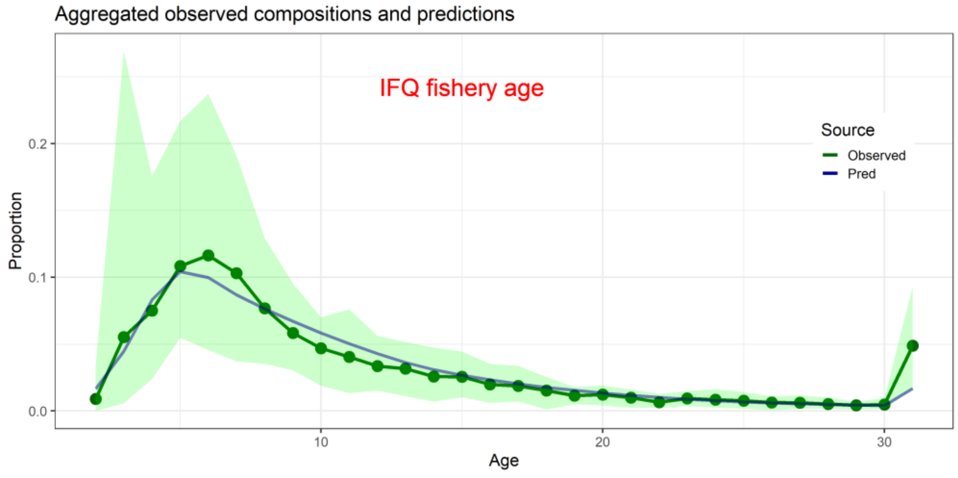


39 IMPROVED FIT TO TRAWL SURVEY

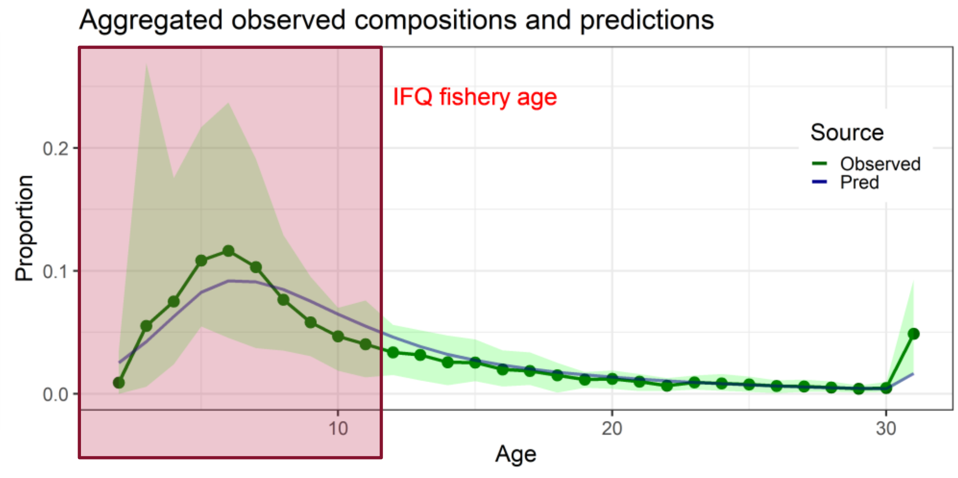


40 DEGRADED FIT TO FISHERY AGE COMPS

16.5_Cont

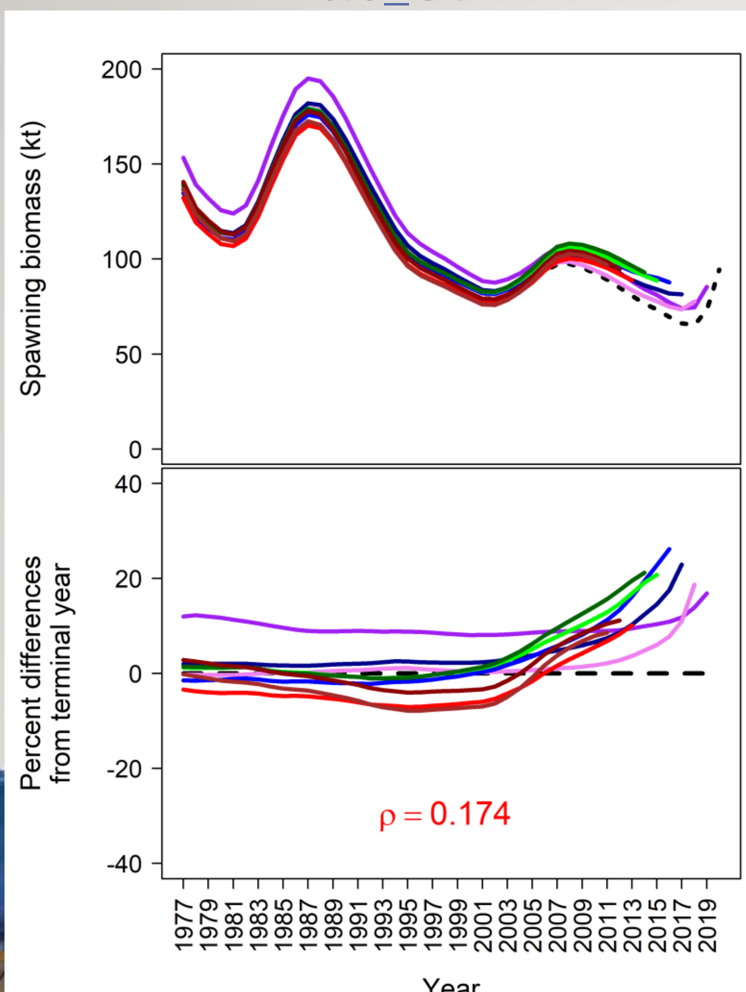


21.10_Proposed

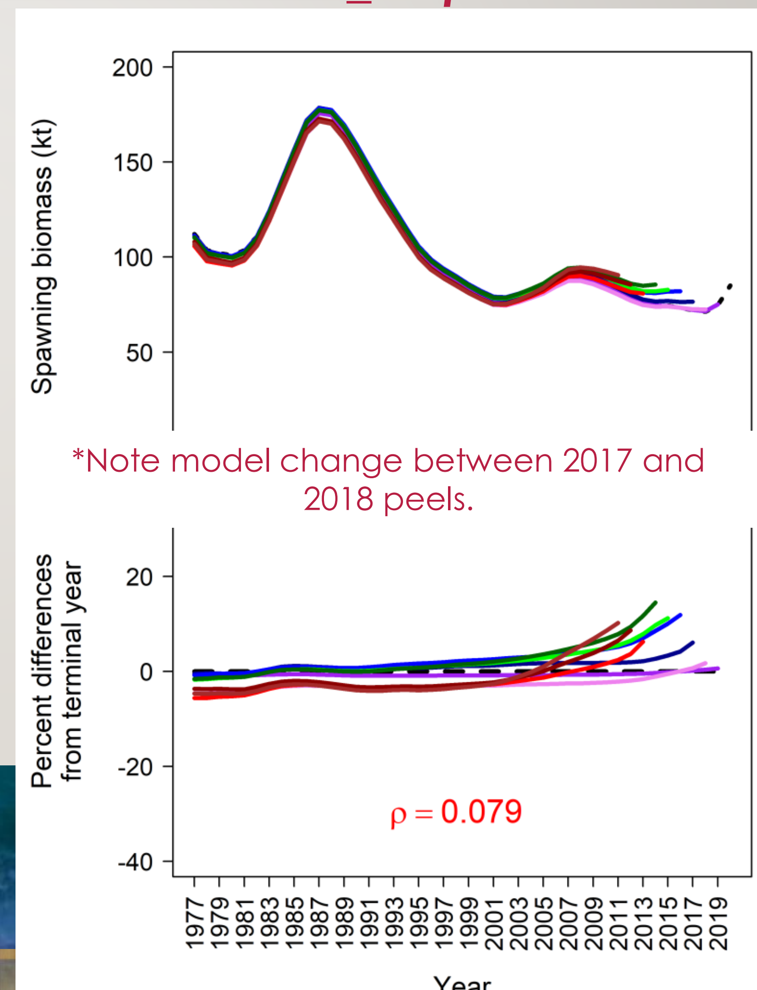


41 REDUCED RETROSPECTIVE TRENDS

16.5_Cont



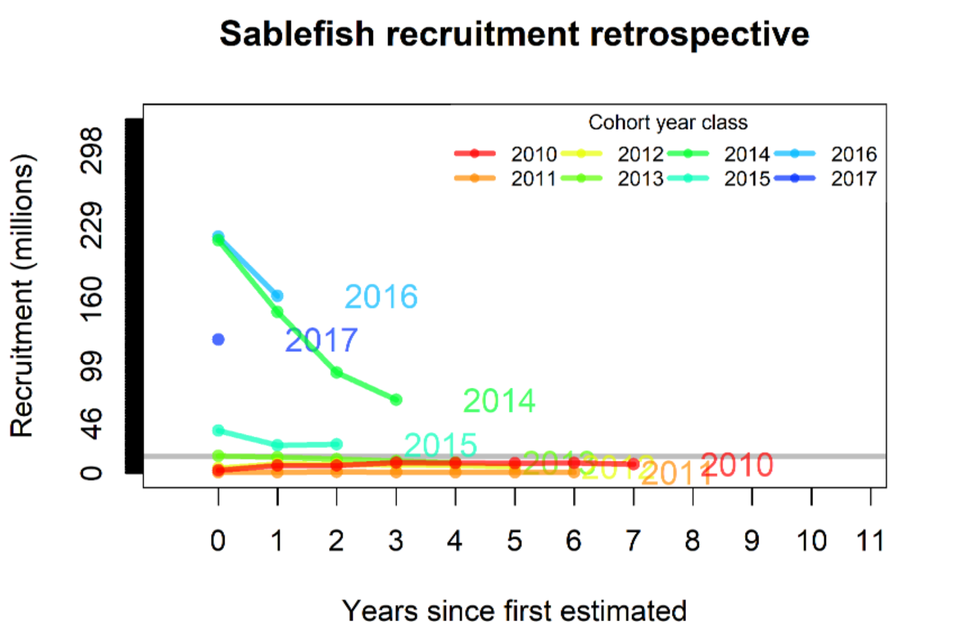
21.10_Proposed



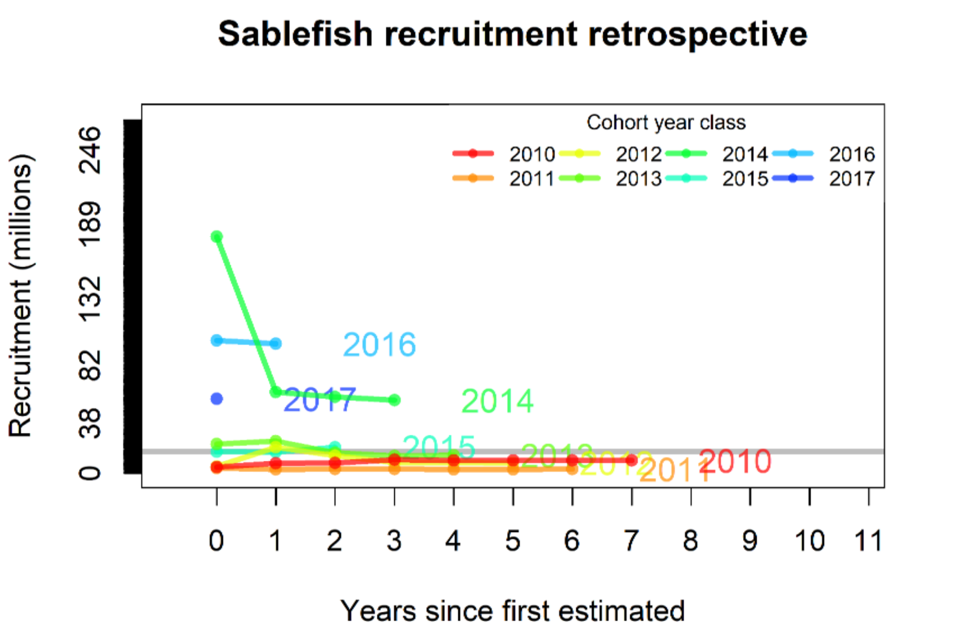
42 CONSISTENT RECRUITMENT

	2014 Year Class		2016 Year Class	
	16.5_Cont	*20.10_Proposed*	*16.5_Cont*	*20.10_Proposed*
2017	210.904	179.989		
2018	165.806	61.6887		
2019	96.9563	58.1246	224.959	101.14
2020	67.7319	55.6527	163.651	98.5237

16.5_Cont



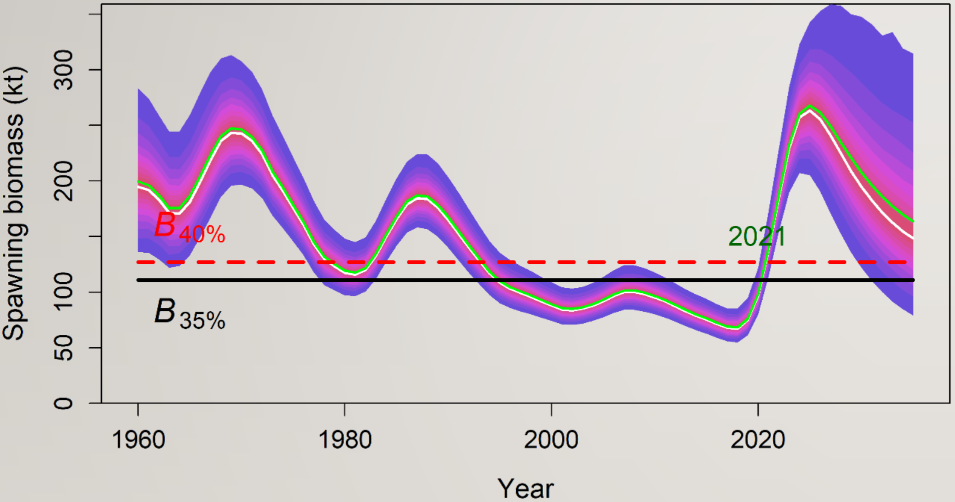
21.10_Proposed



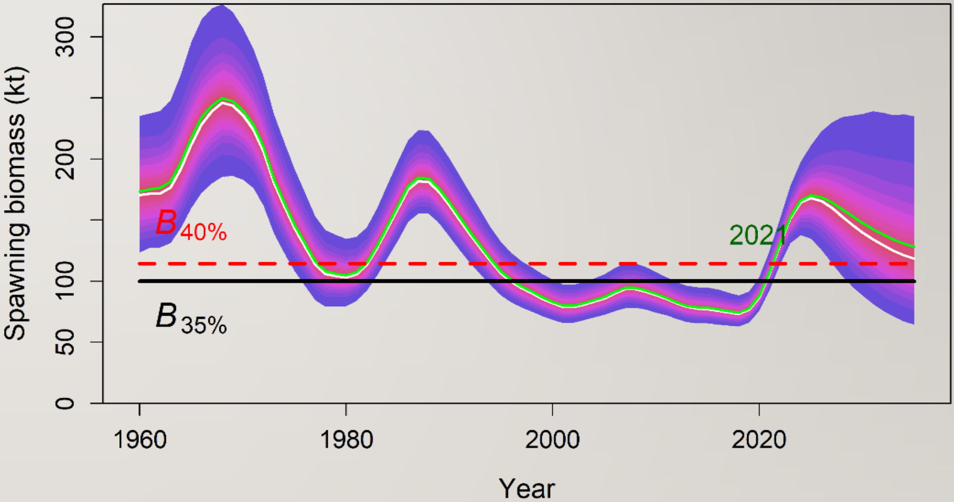
*Note model change between 2017 and 2018 peels.

43 MORE SUBTLE REBUILD

16.5_Cont



21.10_Proposed



REDUCED ABCs

Model	2020 SSB (kt)	SSB_40 (kt)	2020 SSB/SSB_40	2020 F	F_40	2020 F/F_40	F_ABC	2021 ABC (kt)
16.5_Cont	94.43	126.84	0.74	0.05	0.1	0.5	0.1	52.41
21.10_Proposed	85	114.19	0.74	0.06	0.08	0.75	0.08	27.09

			Model	
Year	**Catch (mt)**	**ABC (mt)**	***16.5_Cont***	***21.10_Proposed***
2011	12,978	16,040	14,600	12,750
2012	13,869	17,240	14,400	13,464
2013	13,645	16,230	14,000	13,122
2014	11,588	13,722	12,100	12,042
2015	10,973	13,657	12,700	12,989
2016	10,257	11,795	11,300	11,476
2017	12,270	13,083	11,900	12,241
2018	14,341	14,957	25,700	16,829
2019	16,624	15,068	27,300	12,755
2020	19,006	22,009	43,600	19,914
2021	***13,112***	29,588	52,400	27,086

*Based on retrospective peels. Note model change between 2017 and 2018 peels.

45 SUMMARY

- Population continues to increase based on longline survey RPNs
- No CPUE data expected for 2020
- *21.10_Proposed* is recommended for 2021 SAFE due to improved data fits and diagnostics
  - Population trajectories similar to *16.5_Cont*, but with reduced recent recruitment and more stable SSB trends
  - Reduced retrospective patterns and retroactive downgrades of recent recruitment
  - Improved fit to indices, but at the cost of fit to fishery age composition data

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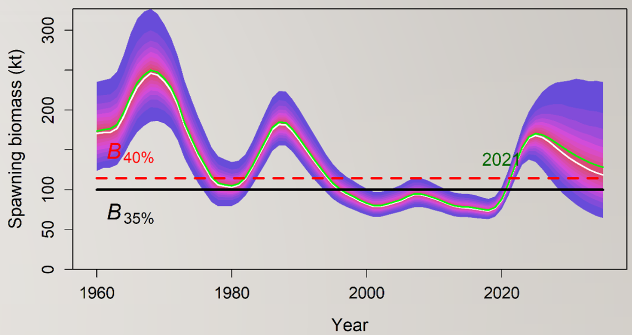
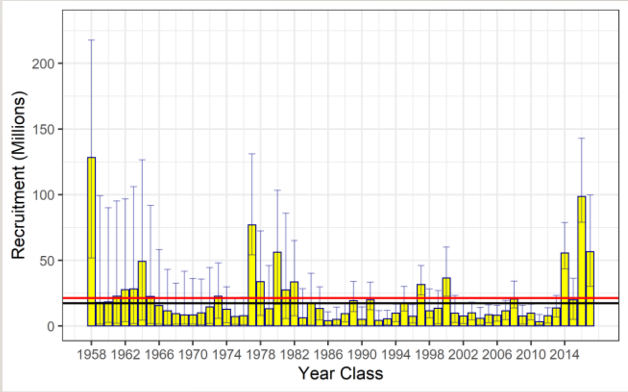
SUMMARY

- Updates are consistent with first principles (i.e., biological updates) or statistical and assessment modeling best practices (i.e., freely estimating catchability parameters and using data reweighting approaches)
- Recent selectivity and catchability block appear reasonable given changes in sablefish dynamics
    - Fishery transitioning towards pot gear and attempting to avoid low value small sablefish
    - Apparent increases in availability of small sablefish in the longline survey in deeper waters may be due to density-dependent spillover from optimal juvenile habitat or warming water temperatures that could be forcing juveniles into deeper, colder slope waters at earlier ages

47 SUMMARY

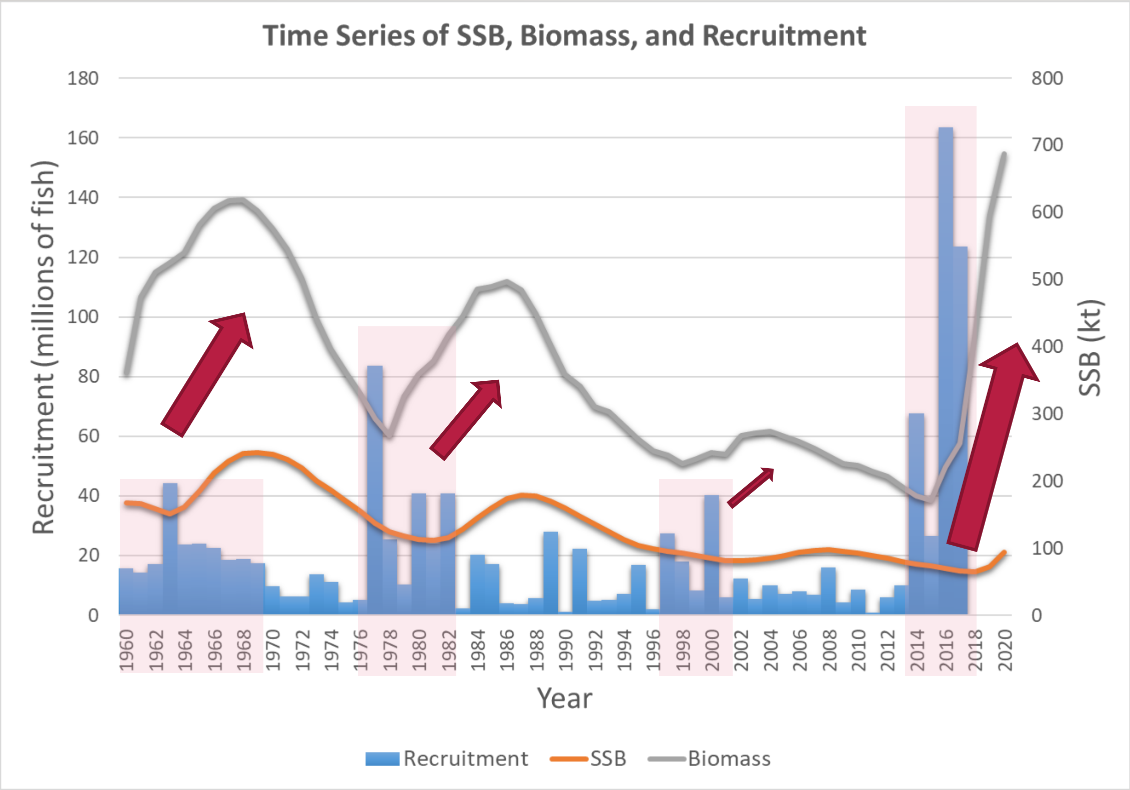
- Rebuilding not as rapid nor does it reach as high a magnitude as in *16.5_Cont*
- Recent recruitment appears to be similar to late 1970s and early 1980s, while 2016 year class may still be largest on record
- Max_ABCs are greatly reduced, because comparatively smaller recruitment events do not support as high an ABC as in model *16.5_Cont*





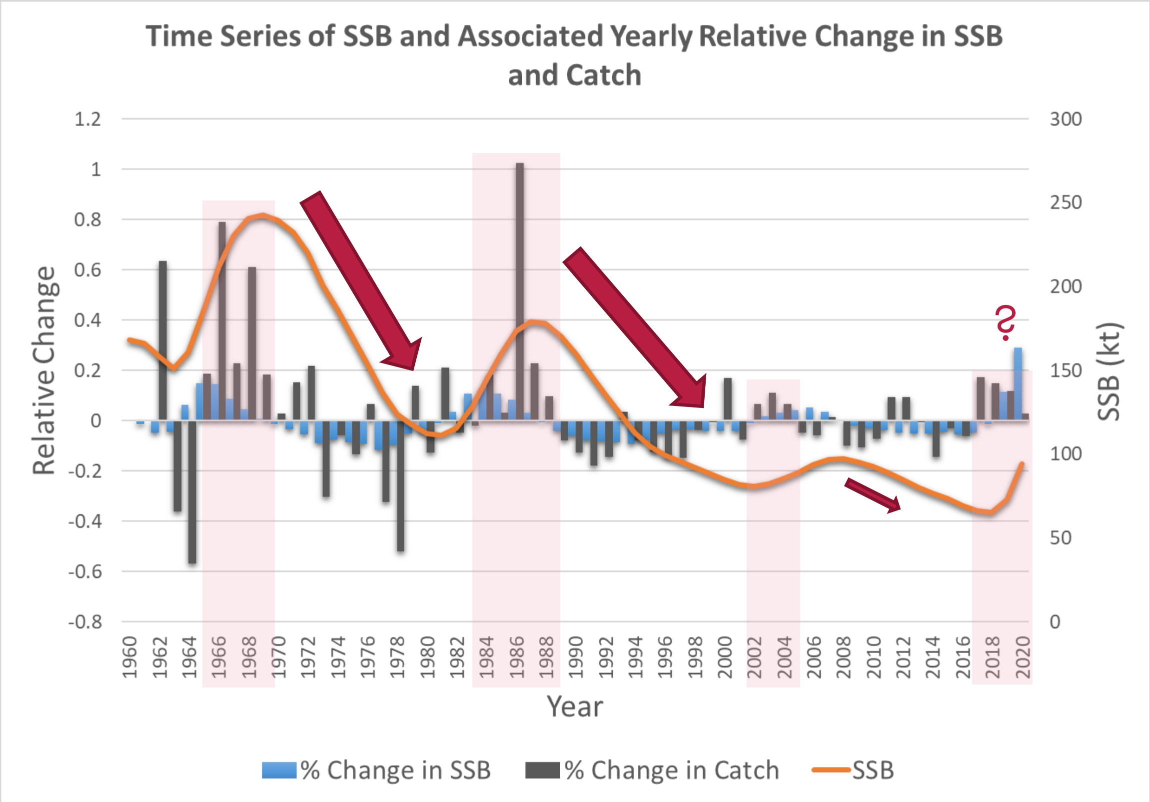
END

49 CYCLICAL SABLEFISH



Large year classes have spurred periodic population growth in the early 1960s, early 1980s, early 2000s, and in last 5 years.

CYCLICAL SABLEFISH



Subsequent population declines have been associated with quotas that increased at rates that outpaced population growth.