



ALASKA SABLEFISH UPDATES

MESA STAFF

MARINE ECOLOGY AND STOCK ASSESSMENT

ALASKA FISHERIES SCIENCE CENTER

JUNEAU, AK



2 OUTLINE

- Quick Data/Research Update
- Biological Updates Summary
- Proposed Model Updates for 2021
 - Biological
 - Parametrization
 - Data Weighting
 - Proposed Model Results and Comparison to 2020 SAFE Model



3 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
- **No** update (or new analyses) for apportionment
 - Will update with 2021 longline survey RPN distribution by region (increasing relative proportions in BS in 2021)



4 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)



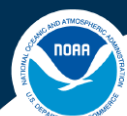
PROPOSED BIOLOGICAL UPDATES

Sablefish Growth

Katy B. Echave, AFSC/ABL



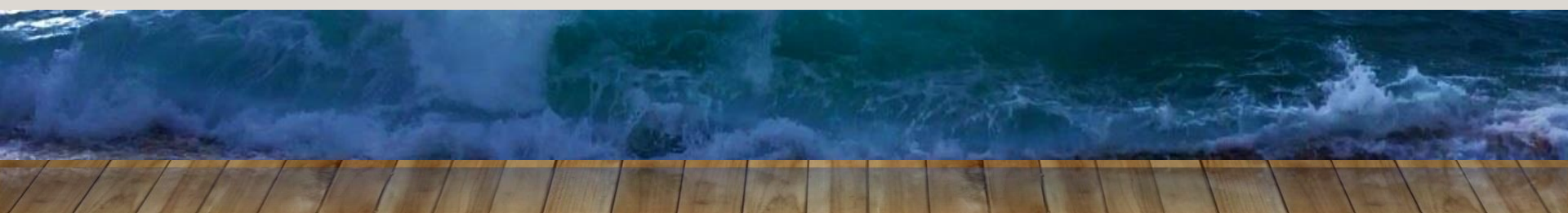
U.S. Department of Commerce | National Oceanic and Atmospheric Administration | National Marine Fisheries Service



**NOAA
FISHERIES**

Updating sablefish maturity in Alaskan waters

Ben Williams and Cara Rodgveller



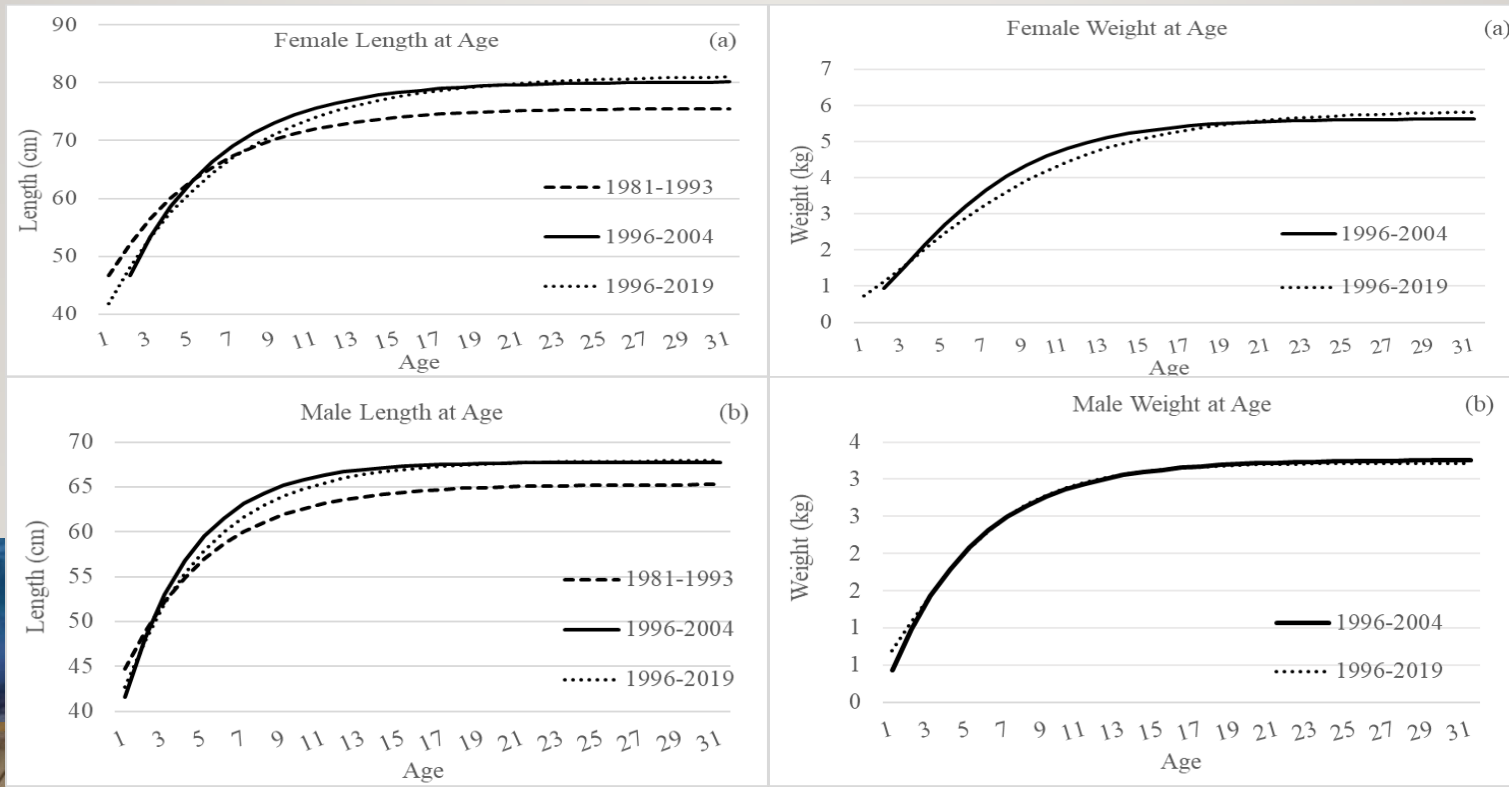
6 BIOLOGICAL UPDATES: GROWTH

- Length and weight have not been updated since 2008
 - Over a decade of new data available to reestimate growth curves and weight-at-age
 - Length, age, and weight data collected on the AFSC longline survey from 1996-2019
 - *No weight data prior to 1996*
- k-means cluster analysis was performed to determine if there were significant time-dependent differences in growth
 - Females showed grouping for both length and weight pre-/post-2004
 - Clusters for males included non-sequential years



7 BIO UPDATES: GROWTH

- **Recommendation:** Update with all data through 2019 (no change to historic growth)
 - Sablefish grow slower, but reach larger max size
- **PT recommendation:** model weight-at-age using same time blocks as length-at-age based on a length-weight relationship for historical period



8 BIOLOGICAL UPDATES: MATURITY

- 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

Biological maturity = physiologically capable of spawning
Functional maturity = potential spawner in a given year

Functional maturity \leq Biological maturity

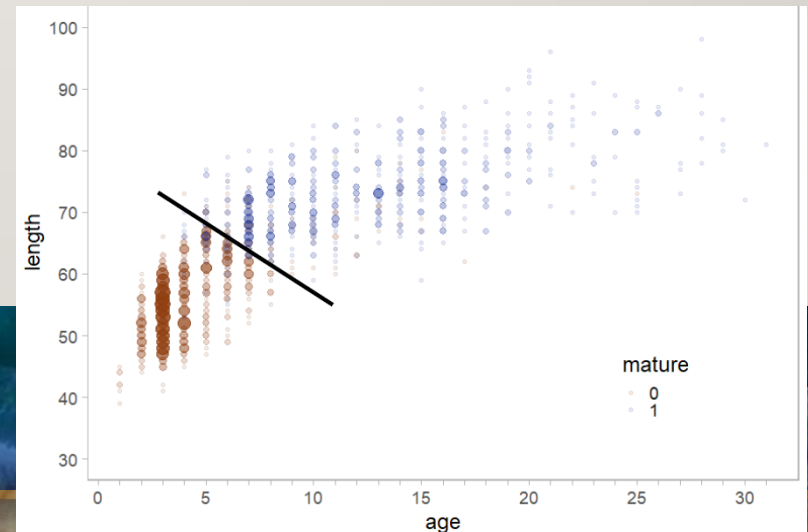
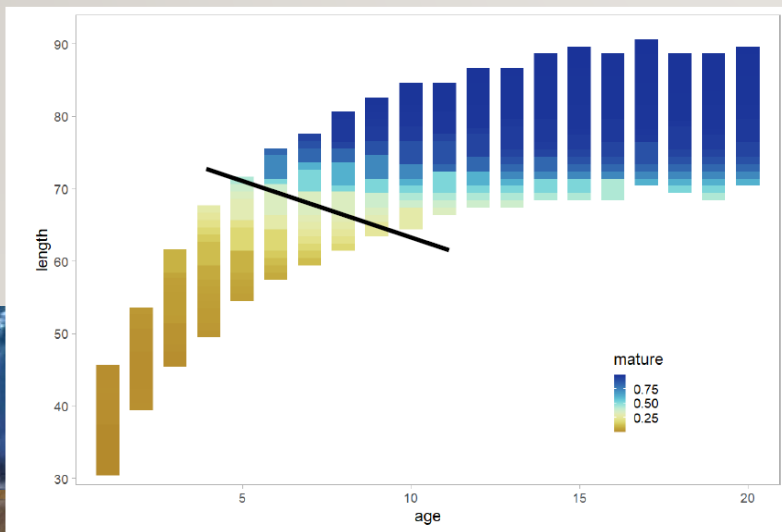
Assessment is concerned with **functional** maturity

- Based on simulation analysis, GAMs better account for skipped spawning
 - Results showed that GLM estimates of maturity can result in large bias, in contrast to GAM estimates



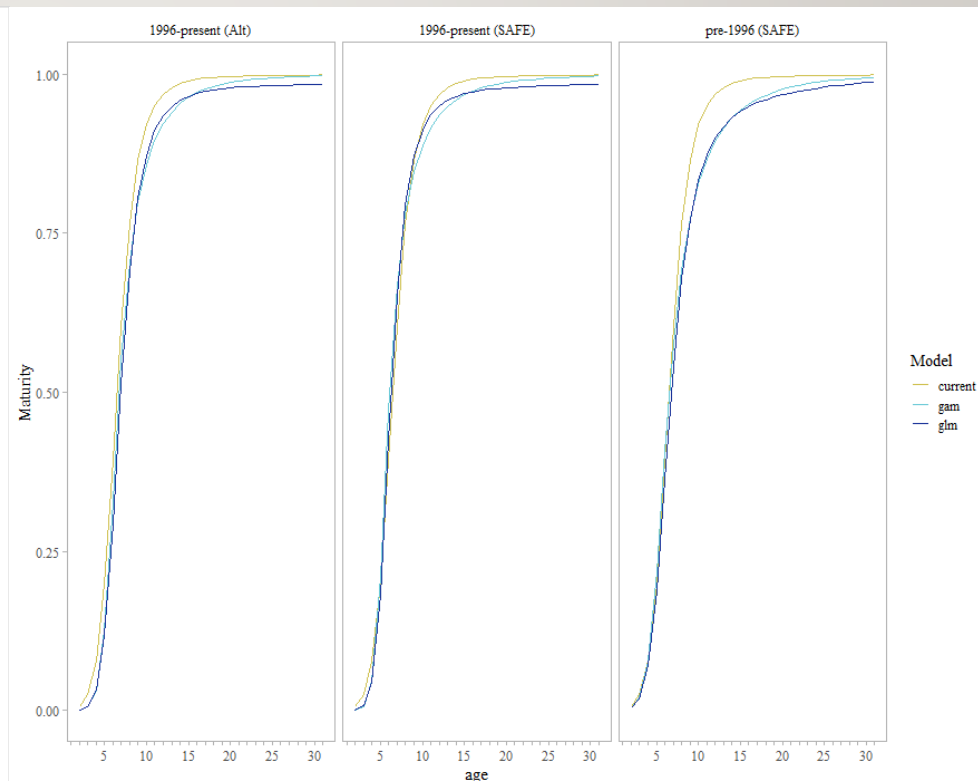
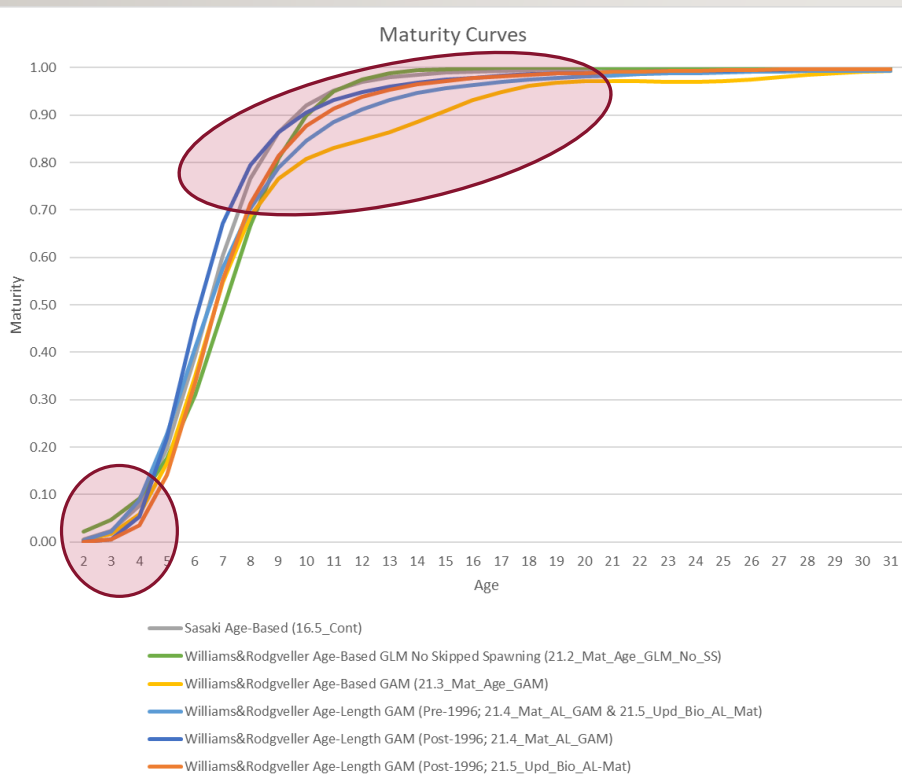
9 BIOLOGICAL UPDATES: MATURITY

- Age-length based models can better account for maturity processes
- **Recommendation:** use a functional maturity curve that accounts for skip spawning based on an age/length-based GAM maturity model



10 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)



PROPOSED MODEL UPDATES



September 2021 Plan Team Draft

sablefish model

Alaska Sablefish Model Update

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

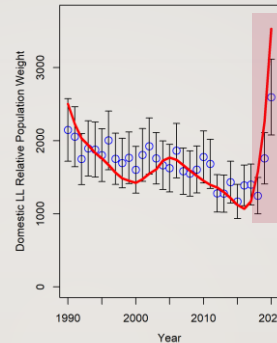
Alaska Fisheries Science Center, Auke Bay Laboratories

September 2021

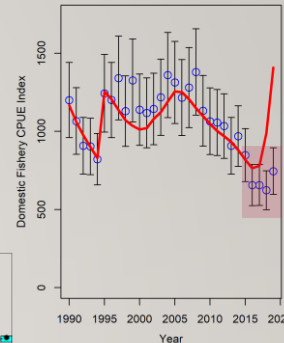
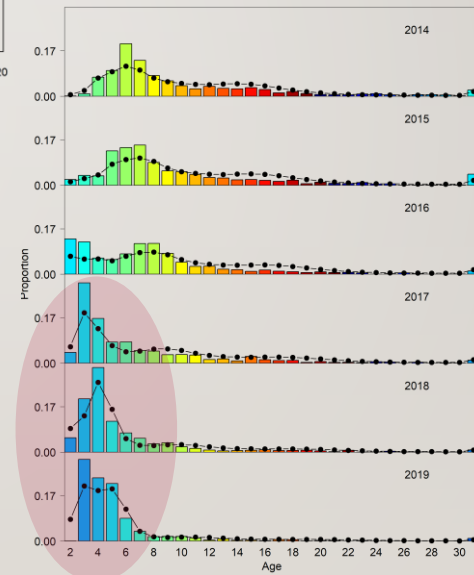


12 TROUBLING MODEL DIAGNOSTICS

- 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)

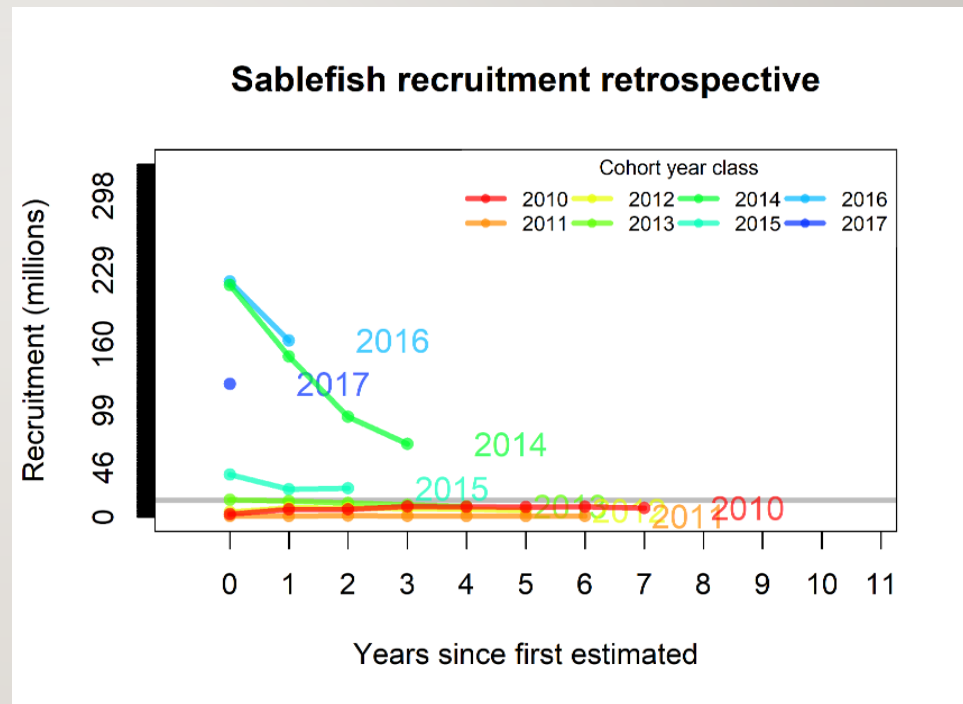


LL Survey Ages



13 TROUBLING MODEL DIAGNOSTICS

- Large retroactive downgrades in recent recruitment estimates
 - 60% reduction in 2014 year class strength since first estimated
- Fixed data weights (based on 2016 CIE) may no longer be appropriate



14 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



15 SMALL FISH GOING DEEPER(?)

RPN by length in the >400m survey depth strata.

AI

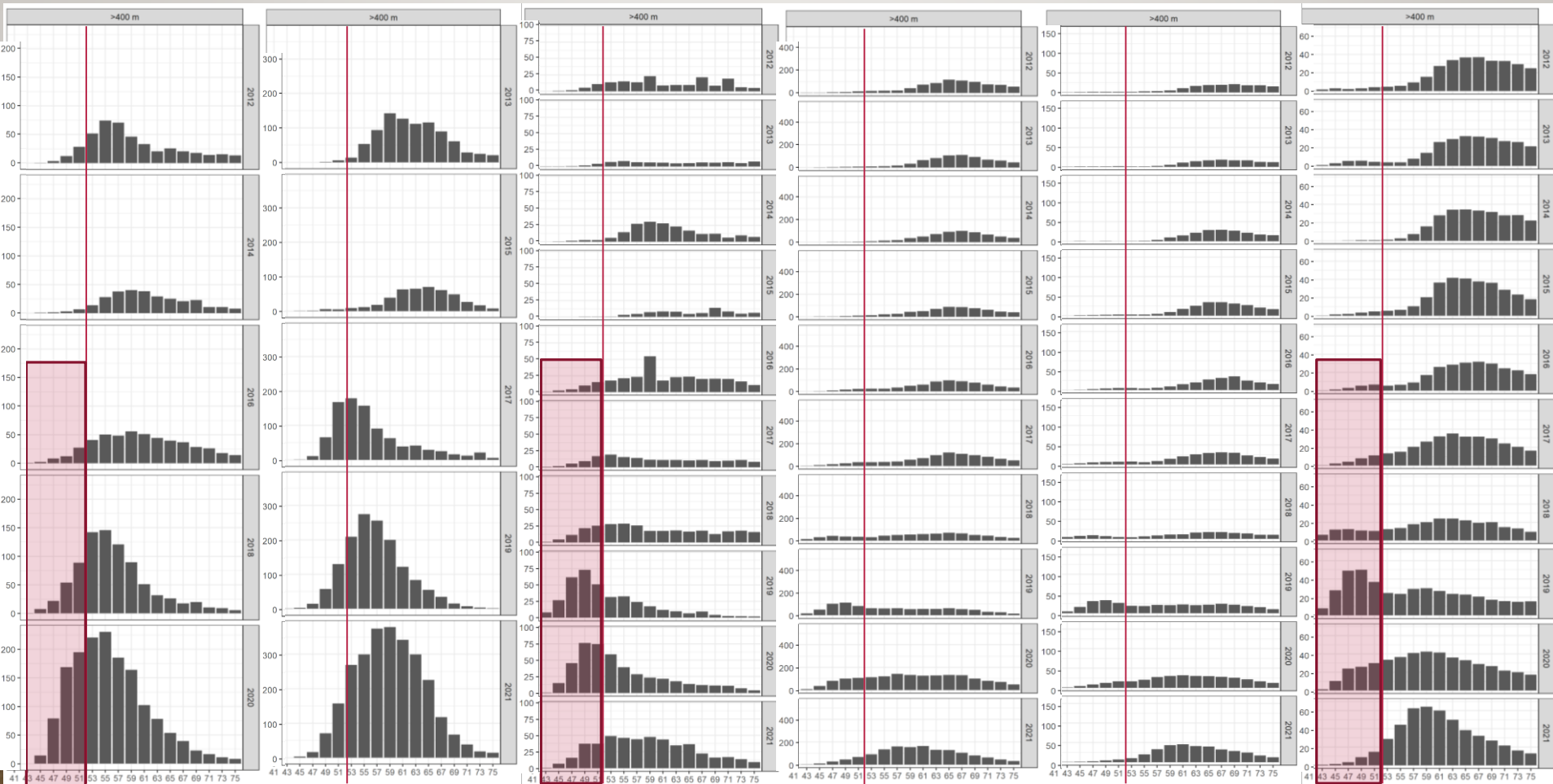
BS

WGOA

CGOA

WY

EY/SE



16 MODEL UPDATES

- 10 new models developed using a quasi-factorial model building approach
- 3 groups of model updates
 - Biological
 - Parametrization
 - Data weighting (not presented)
- Model comparisons made to current model utilized for management advice (2020 SAFE model; **16.5_Cont**)



17 BIO UPDATES: MODELS

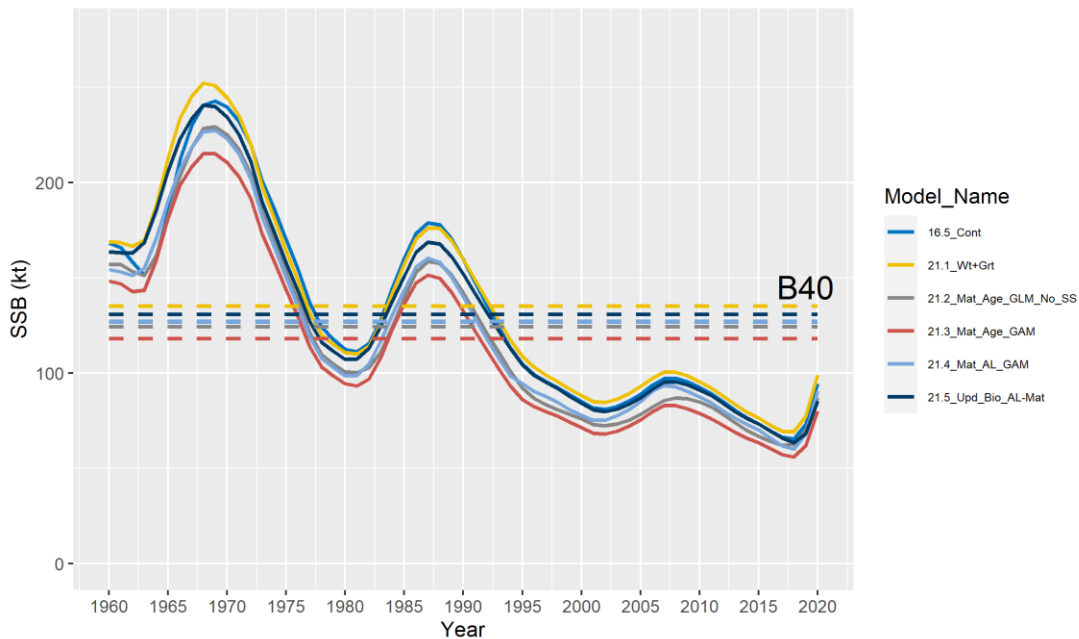
- **21.1_Wt+Grt:** update weight and growth parameters
- **21.2_Mat_Age_GLM_No_SS:** update maturity using age-based GLM and not accounting for skipped spawning
- **21.3_Mat_Age_GAM:** update maturity using age-based GAM and accounting for skipped spawning
- **21.4_Mat_AL_GAM:** update maturity using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



18 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

SSB (kt) Comparison



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

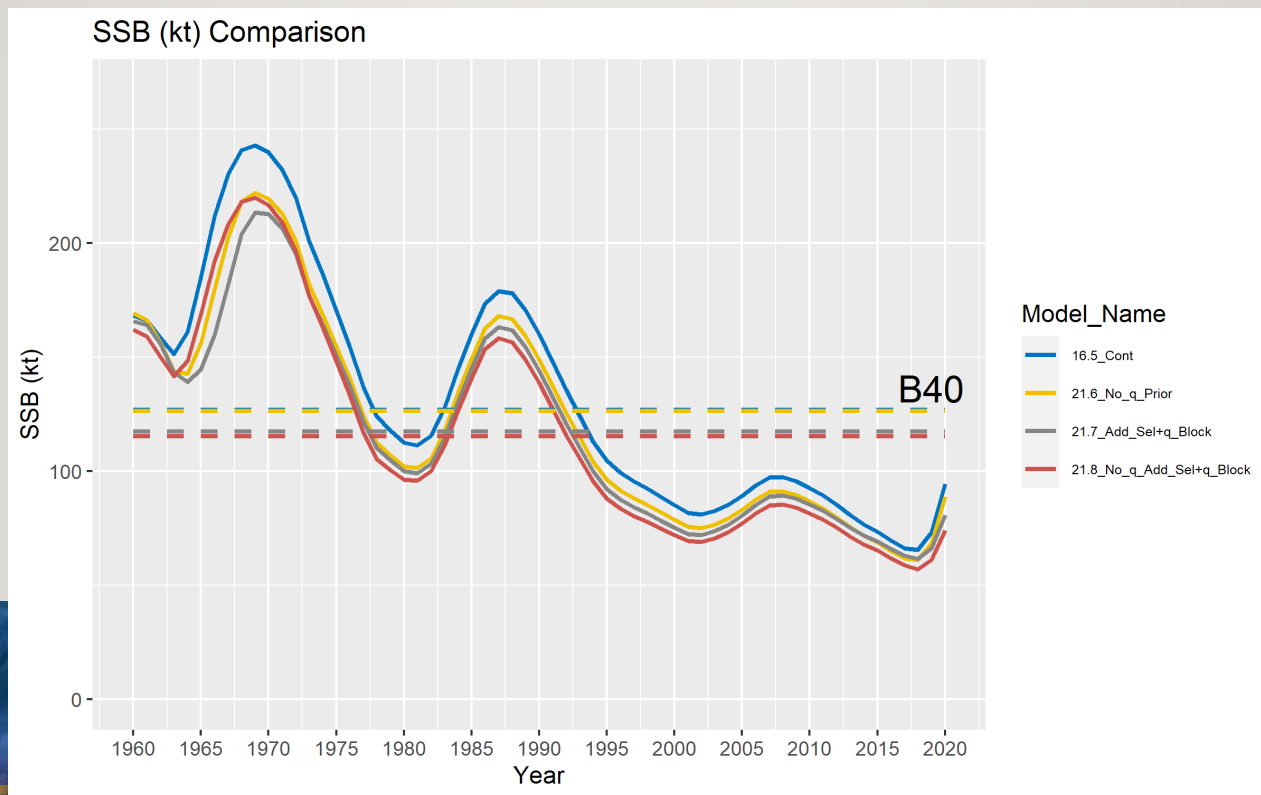
19 PARAMETRIZATION UPDATES

- **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



20 PARAMETER UPDATES: RESULTS

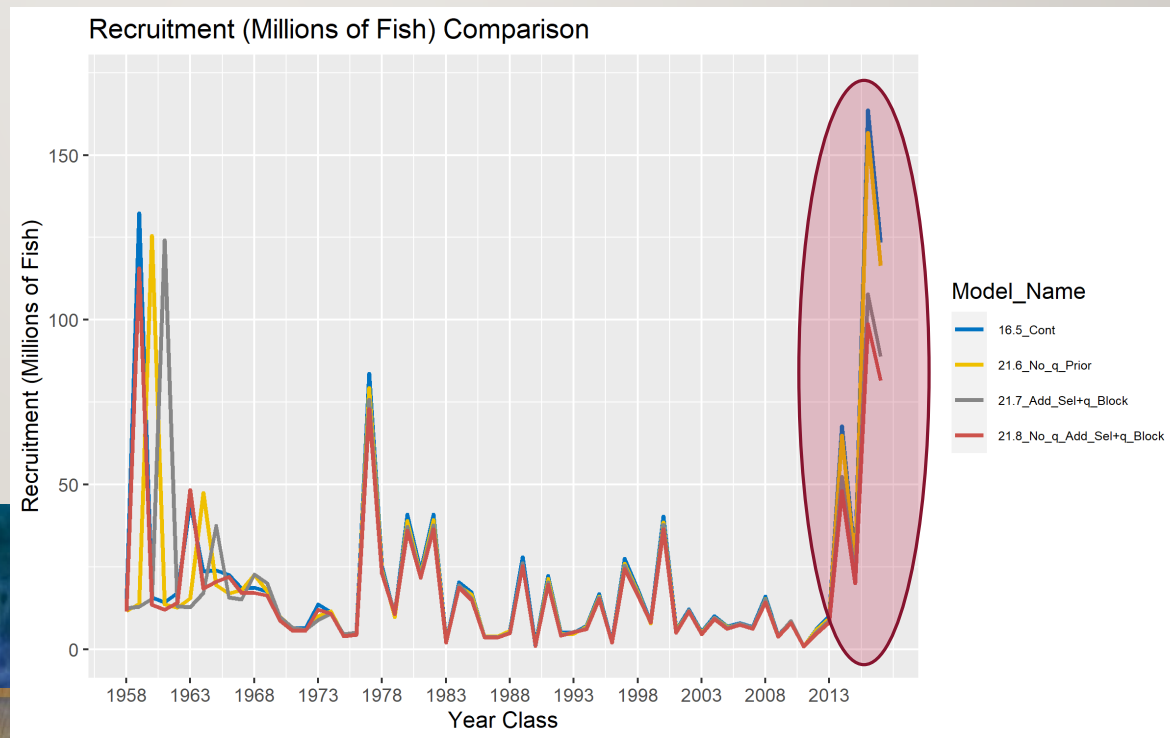
- Changing q and selectivity parametrization led to scaling changes, generally reducing SSB



21 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



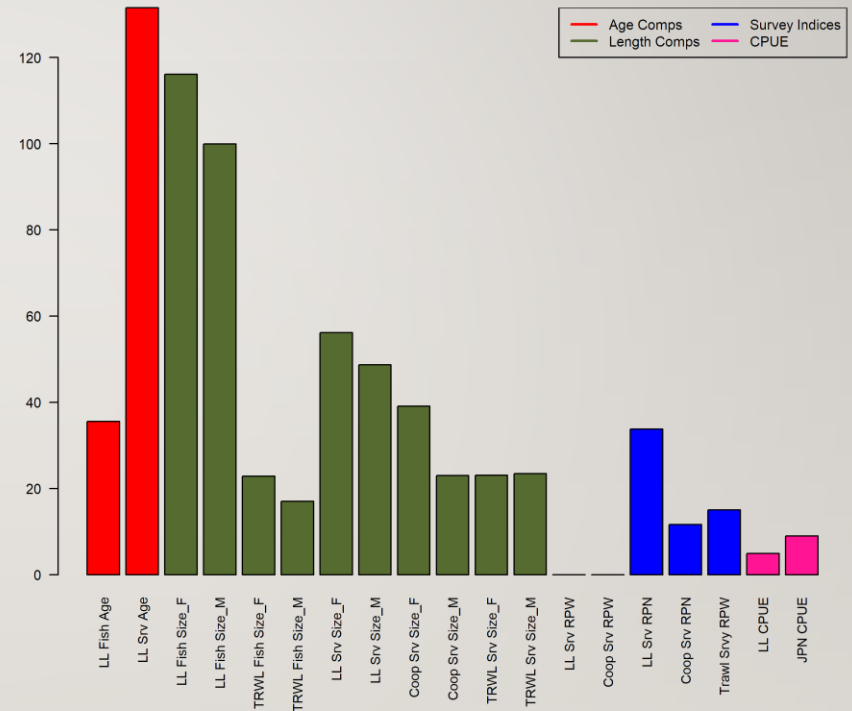
22 21.10_PROPOSED MODEL

- **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



23 DATA REWEIGHTING

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



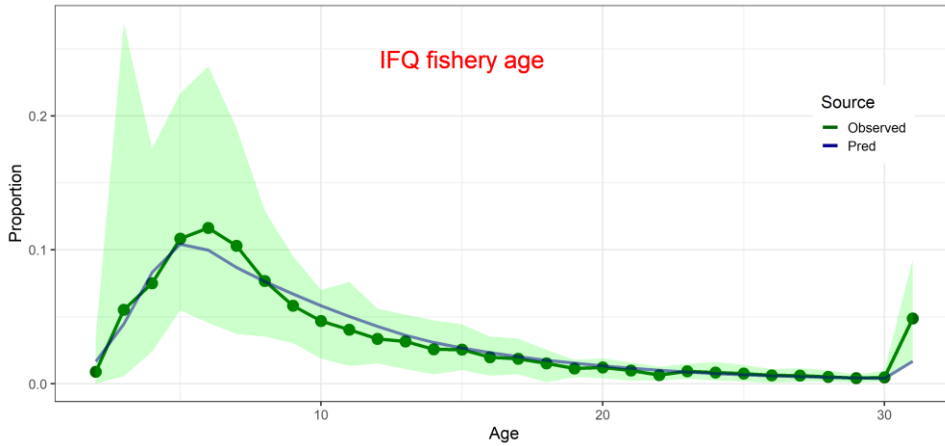
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Pars 244

24

DEGRADED FIT TO FISHERY AGE COMPOSITION DATA

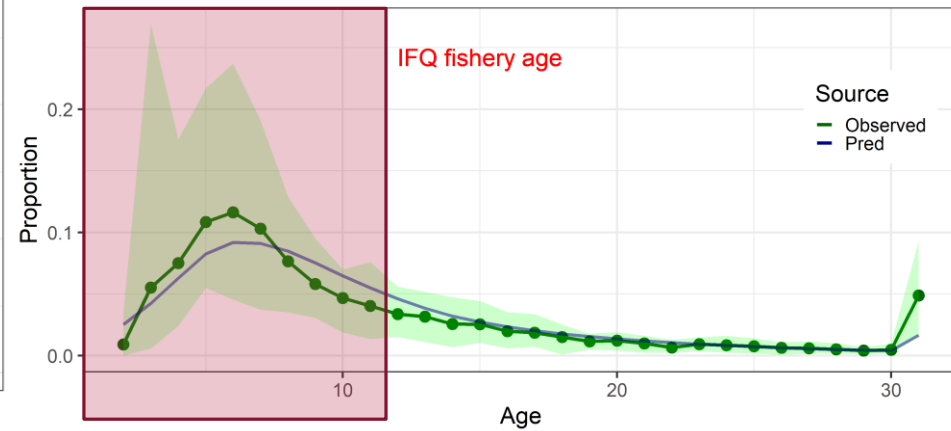
16.5_Cont

Aggregated observed compositions and predictions



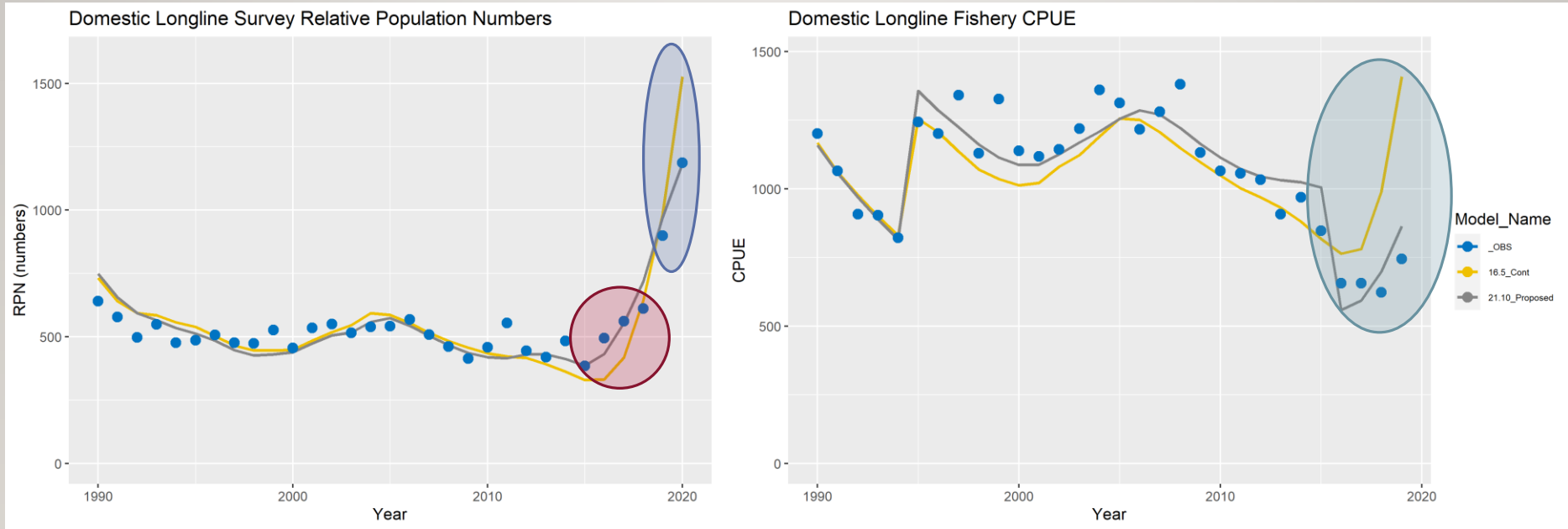
21.10_Proposed

Aggregated observed compositions and predictions



25

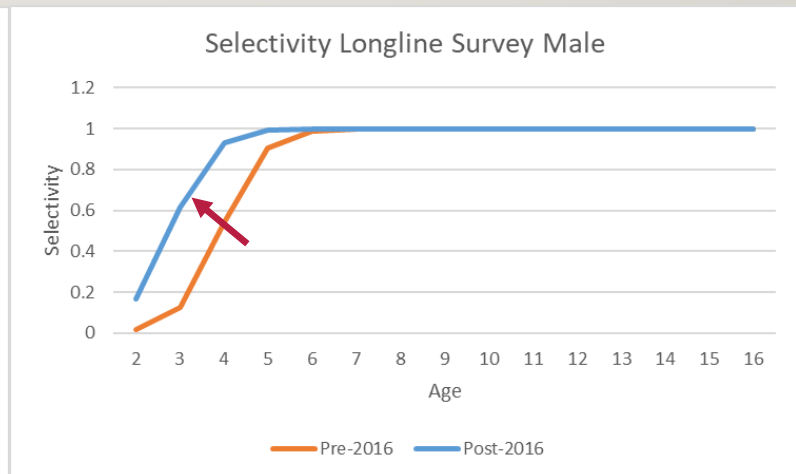
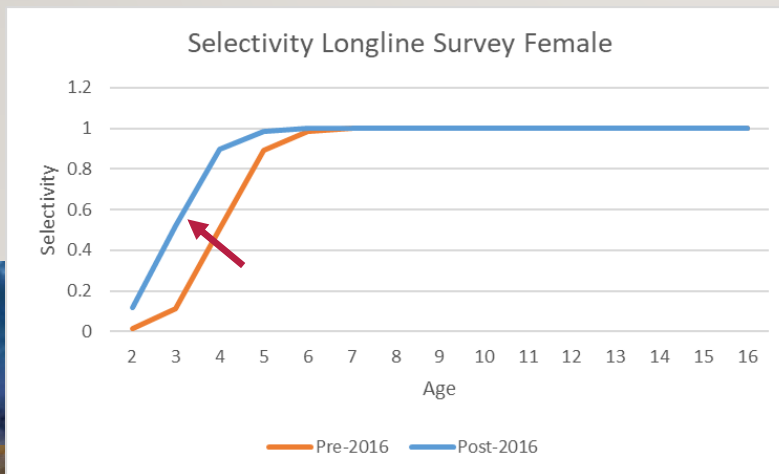
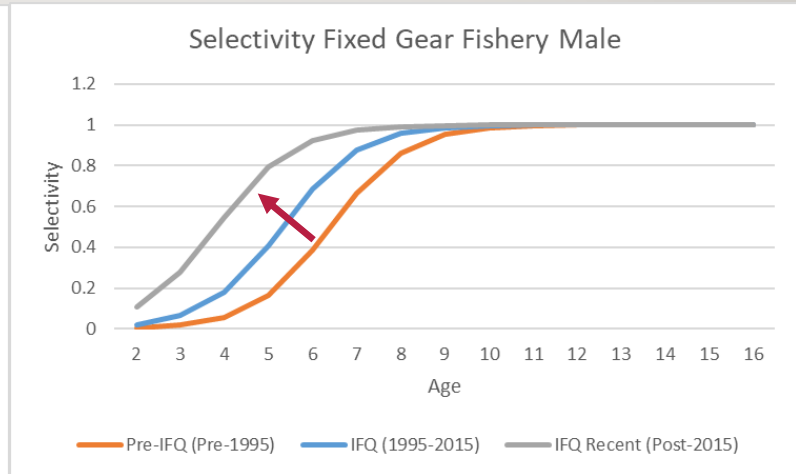
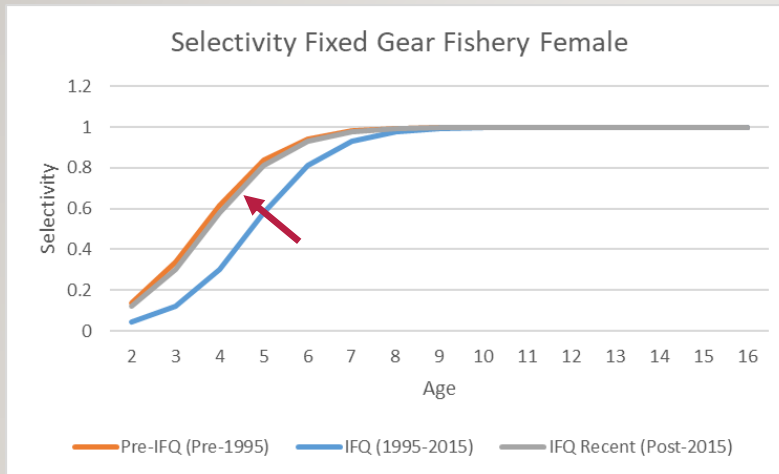
IMPROVED FIT TO LONGLINE SURVEY AND CPUE



26

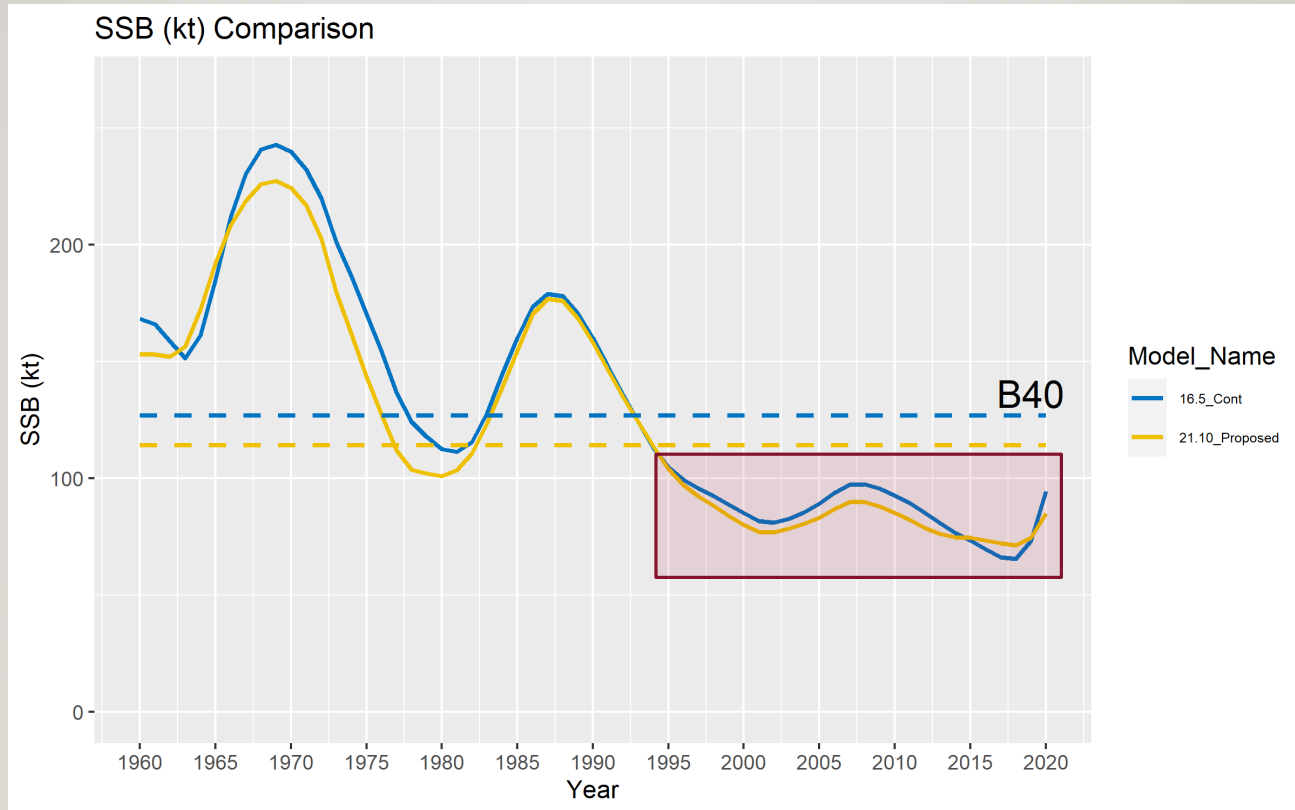
INCREASED SELECTIVITY

21.10_Proposed Selectivity Estimates



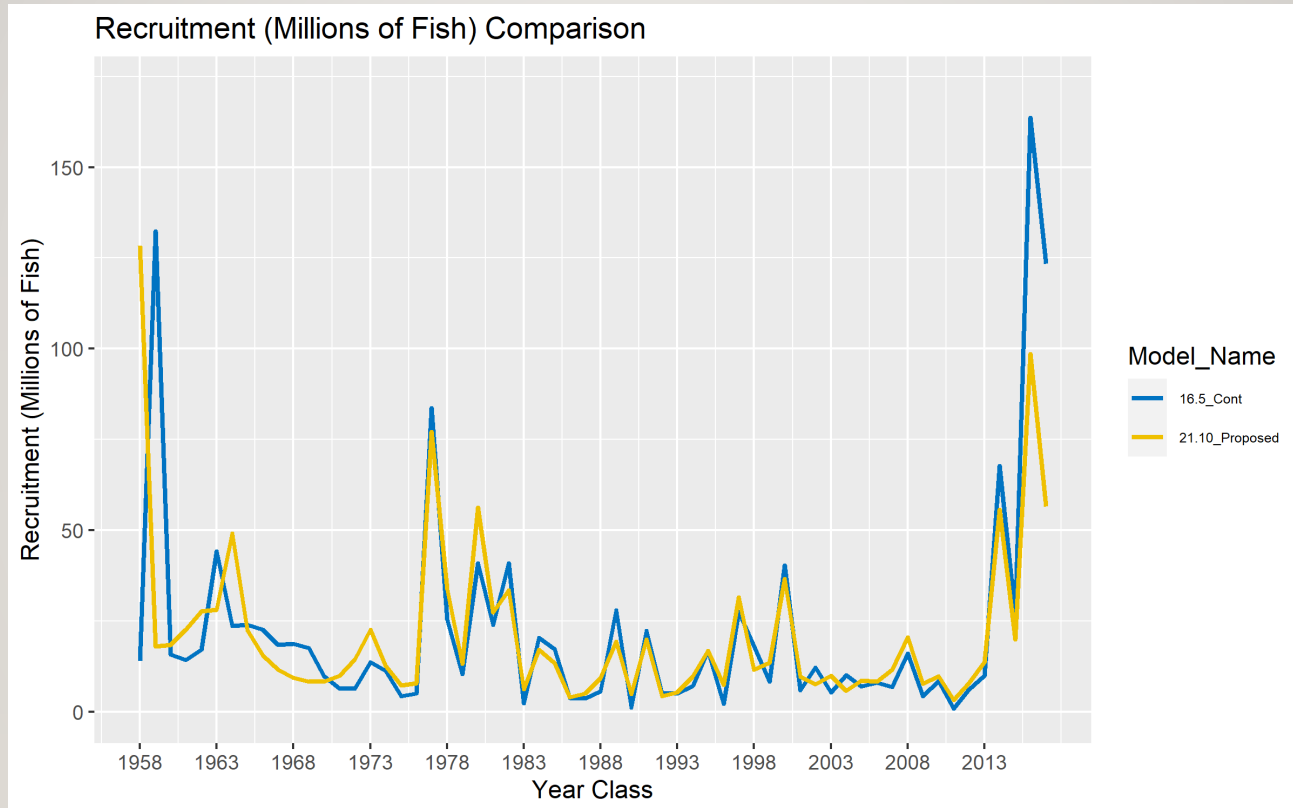
27

STEADIER RECENT SSB TREND



28

REDUCED RECRUITMENT

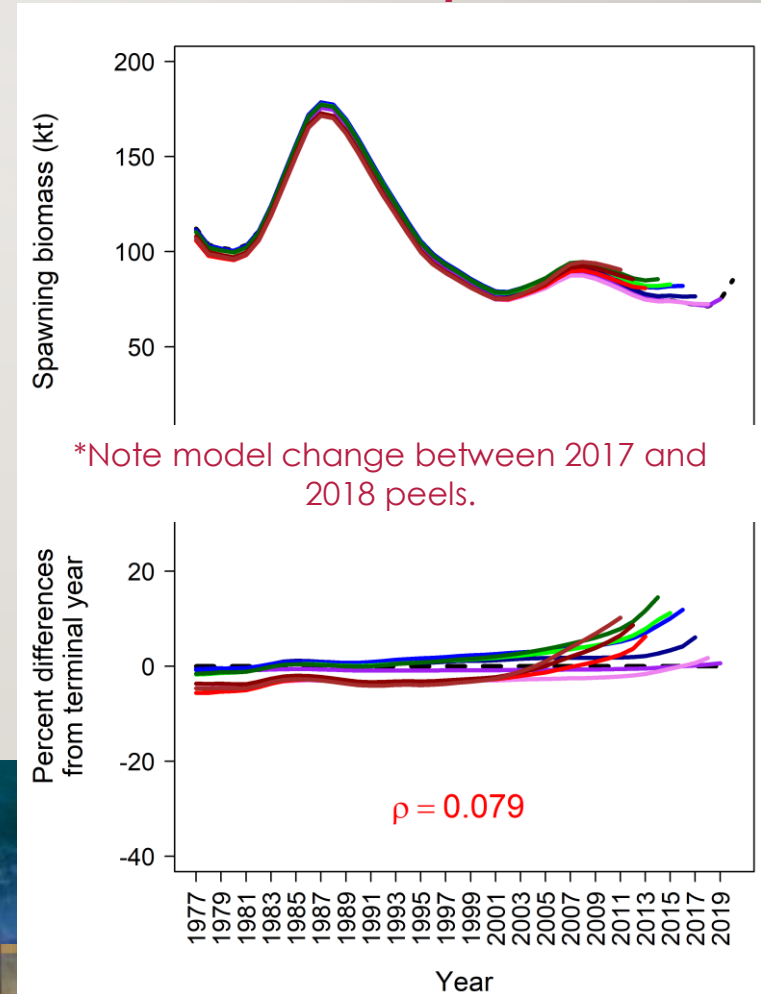
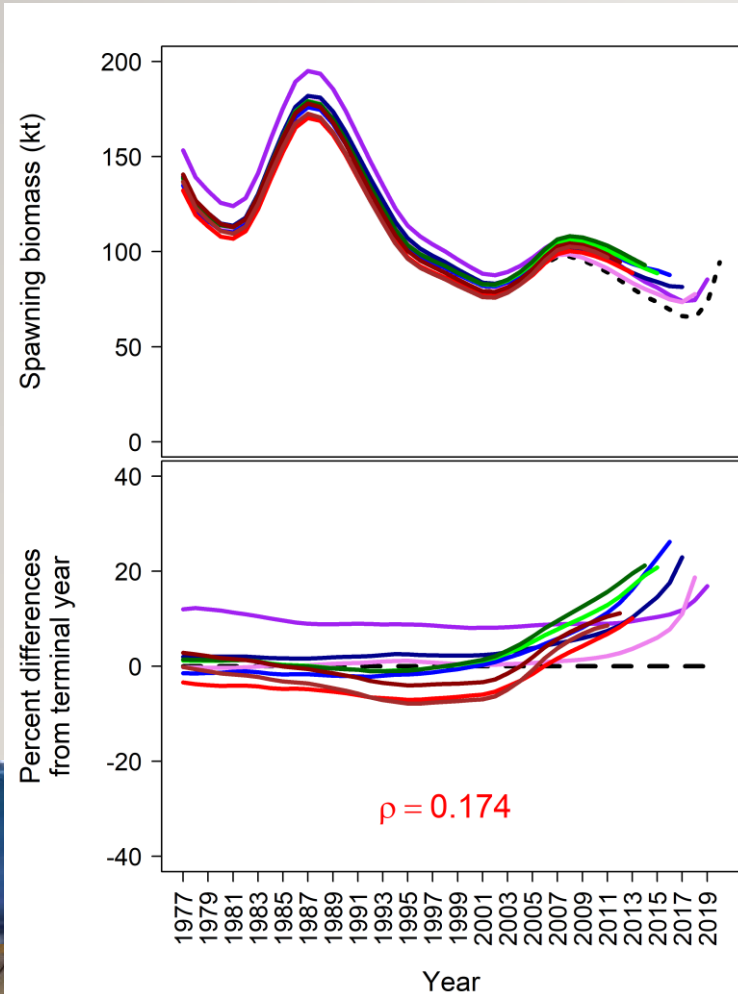


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REDUCED RETROSPECTIVE TRENDS

16.5_Cont

21.10_Proposed



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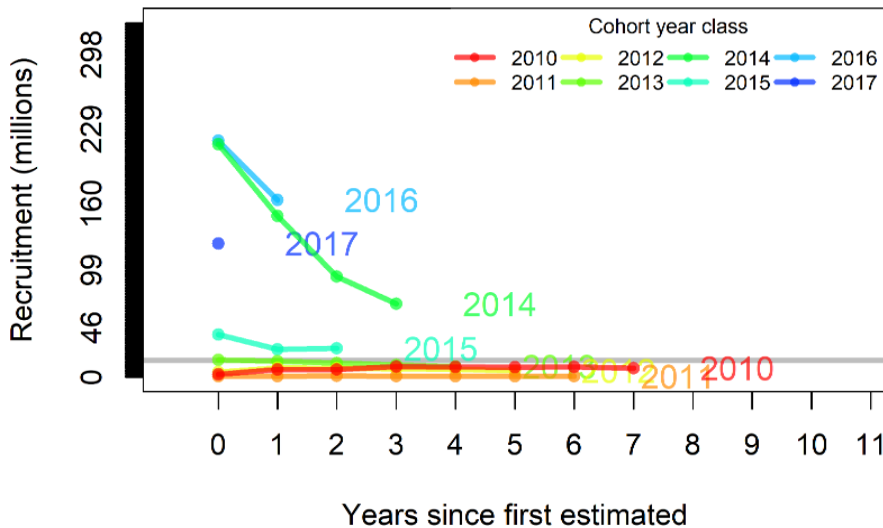
CONSISTENT RECRUITMENT

	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

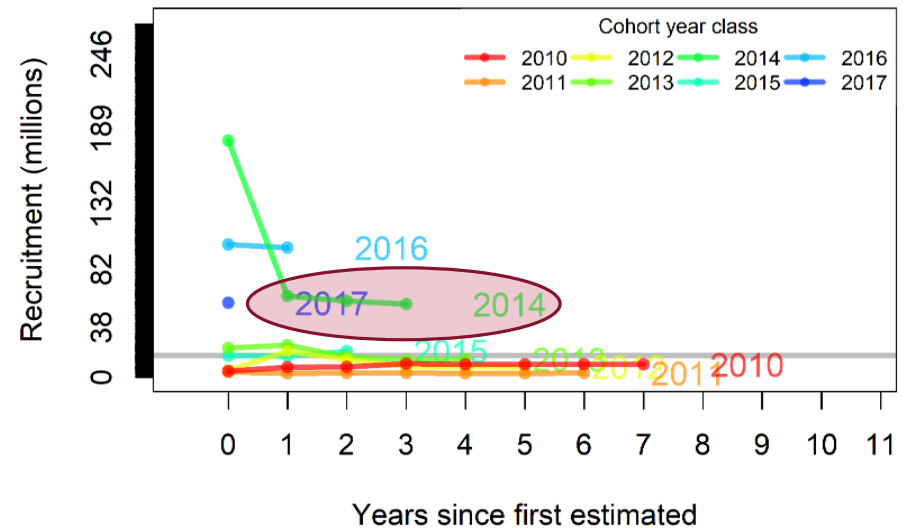
16.5_Cont

21.10_Proposed

Sablefish recruitment retrospective



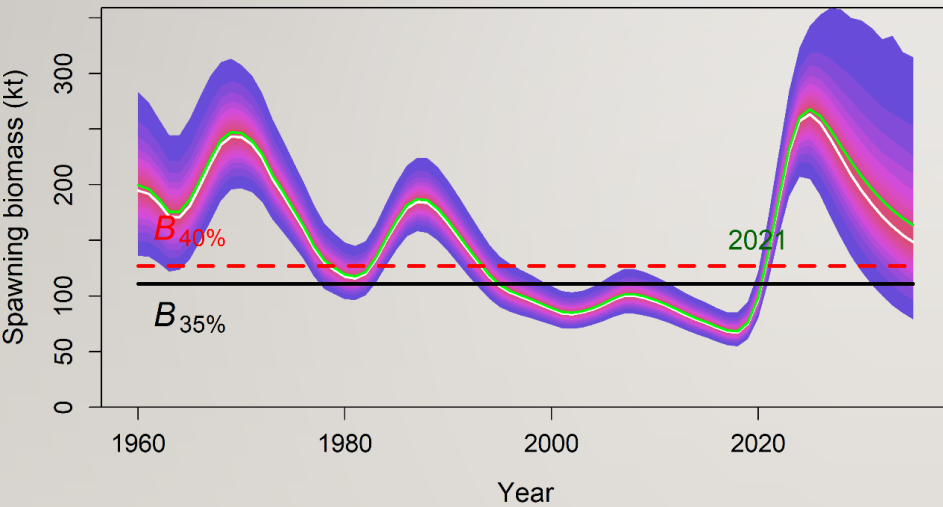
Sablefish recruitment retrospective



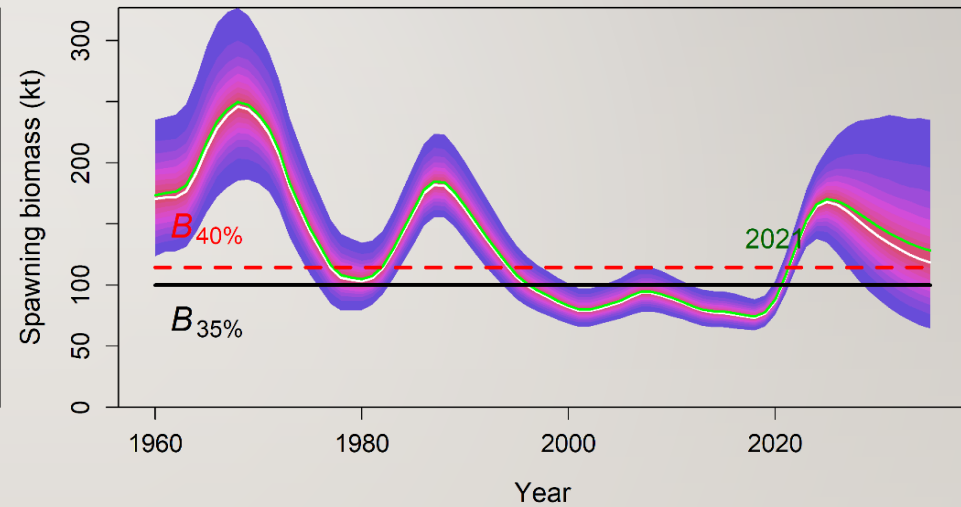
*Note model change between 2017 and 2018 peels.

31 MORE SUBTLE REBUILD

16.5_Cont



21.10_Proposed



32 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

Year	Catch (mt)	ABC (mt)	Model	
			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.

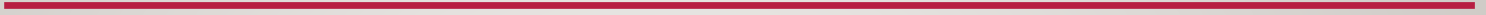
2021 Catch is unofficial, based on AKFIN estimates as of Sept. 1, 2021

33 SUMMARY

- No CPUE data expected for 2020
- *21.10_Proposed* is recommended for 2021 SAFE due to improved data fits and diagnostics
 - Reduced retrospective patterns and retroactive downgrades of recent recruitment
 - Improved fit to indices, but at the cost of fit to fishery age composition data
 - Max_ABCs are greatly reduced, because comparatively smaller recruitment events do not support as high an ABC as in model *16.5_Cont*



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35 EXTRA SLIDES



36 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



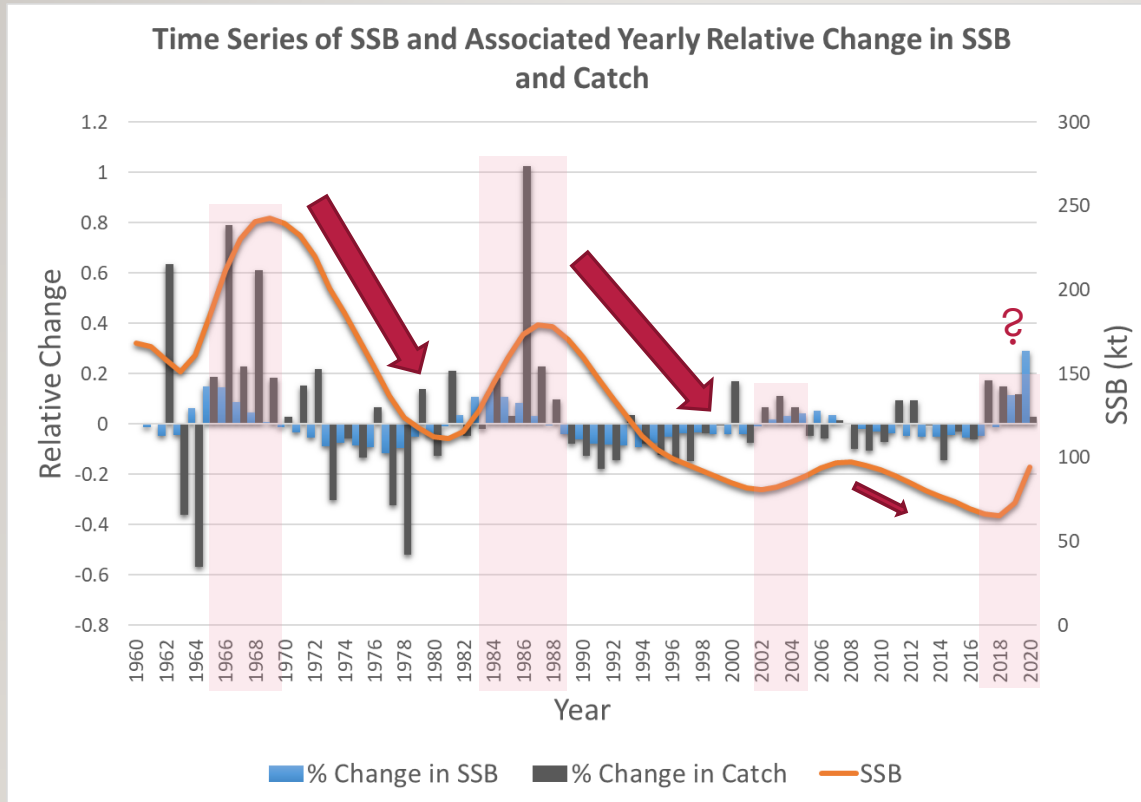
37 FISHERY GEAR CHANGES

- 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

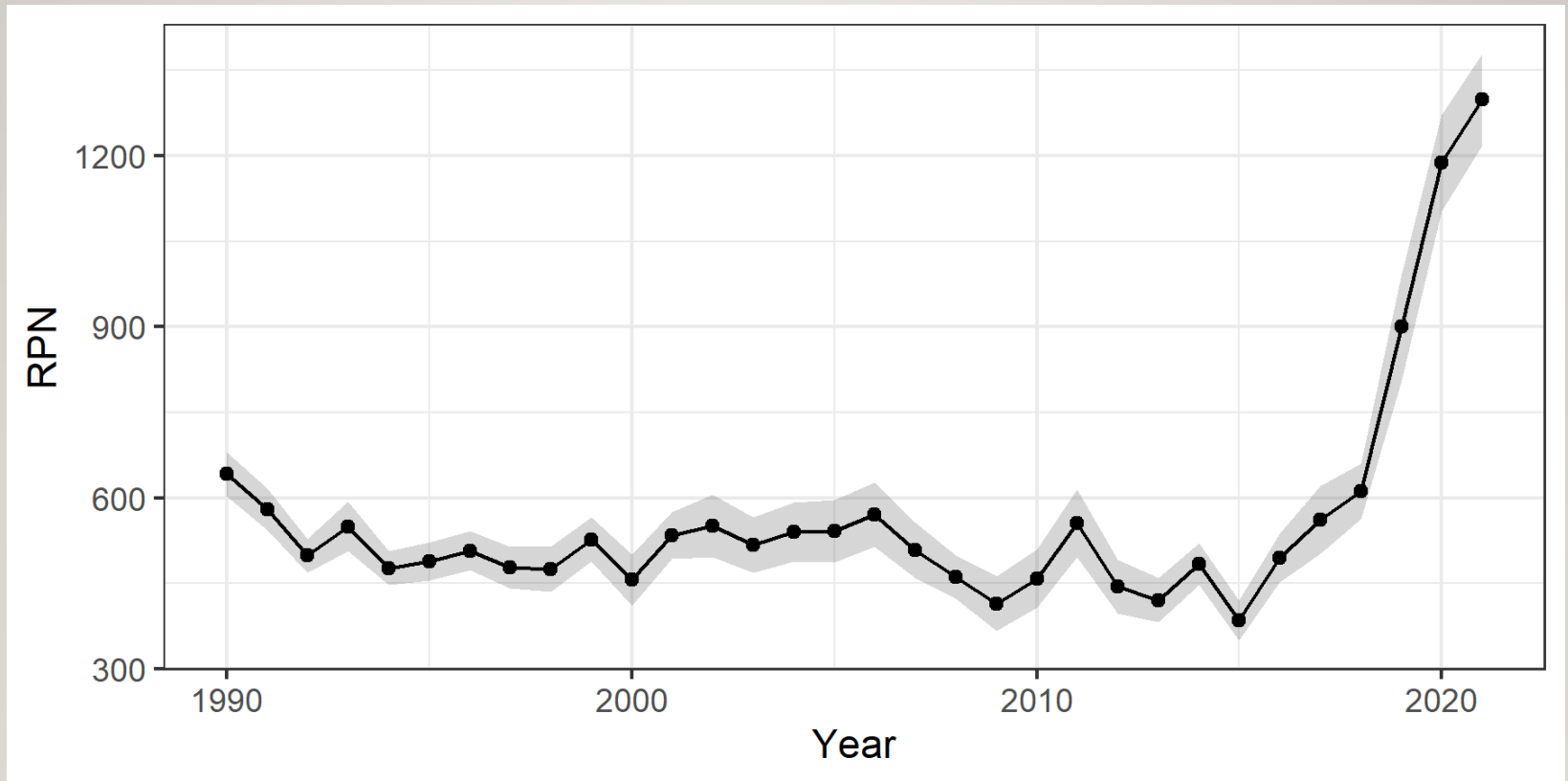
Year	Catch	Length Samples	Age Samples
2016	2%	5%	9%
2017	17%	29%	39%
2018	19%	31%	35%
2019	30%	16%	17%
2020	53%	56%	

38 CYCLICAL SABLEFISH



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

39 SURVEY RPN INCREASED AGAIN



40

MODEL SCENARIOS

Model Group	Scenario Name	Abbreviation	Description
<i>Continuity</i>	16.5. Continuity	<i>16.5_Cont</i>	The 2020 SAFE final model, which utilizes priors on catchability, fixed data weights, and no recent time blocks in the fishery or survey for catchability and selectivity parameter estimation.
<i>Update Biology</i>	21.1. Update Weight and Growth	<i>21.1_Wt+Grt</i>	The continuity model with updated weight and growth parameters based on the full complement of longline survey data from 1996-2019 (as described in Echave, 2021).
	21.2. Update Age-Based Maturity No Skipped Spawning	<i>21.2_Mat_Age_GLM_No_SS</i>	The continuity model with maturity updated using the age-based general linear model (GLM) and ignoring information on skipped spawning (i.e., strict update of maturity based on histological data only) from Williams and Rodgveller (2021).
	21.3. Update Age-Based Maturity	<i>21.3_Mat_Age_GAM</i>	The continuity model with maturity updated using the age-based general additive model (GAM) from Williams and Rodgveller (2021).
	21.4. Update Age-Length Maturity	<i>21.4_Mat_AL_GAM</i>	The continuity model with maturity updated using the age-length based general additive model (GAM) from Williams and Rodgveller (2021).
	21.5. Update Weight, Growth, and Age-Length Maturity	<i>21.5_Upd_Bio_AL-Mat</i>	The continuity model with weight and growth updated based on Echave (2021) and maturity updated using the age-length based general additive model (GAM) from Williams and Rodgveller (2021).
<i>Model Parametrization</i>	21.6. Remove Catchability Priors	<i>21.6_No_q_Prior</i>	The continuity model with all priors on catchability coefficients removed.
	21.7. Incorporate a Recent (post-2016) Time Block for Fishery and Survey Selectivity and Fishery CPUE Catchability Estimation	<i>21.7_Add_Sel+q_Block</i>	The continuity model with a recent time block (2016 - present) added to the longline fishery and longline survey for the estimation of selectivity parameters along with an associated fishery CPUE catchability parameter.
	21.8. Remove Catchability Priors and Add 2016 Selectivity and Fishery CPUE Catchability Time Block	<i>21.8_No_q_Add_Sel+q_Block</i>	The continuity model with all priors on catchability coefficients removed and a recent time block (2016 - present) added to the longline fishery and longline survey for the estimation of selectivity parameters and fishery CPUE catchability.
<i>Data Weighting</i>	21.9. Continuity with Francis Reweighting	<i>21.9_Cont_Francis</i>	The continuity model with data weights updated using the Francis (2011, 2016) reweighting method.
	21.10. Proposed Model	<i>21.10_Proposed</i>	The final proposed model where weight and growth are updated based on Echave (2021), maturity is updated using the age-length based general additive model (GAM) from Williams and Rodgveller (2021), catchability priors are removed, a recent time block (2016 - present) is added to the longline fishery and longline survey for the estimation selectivity parameters and fishery CPUE catchability, and data weights are updated using the Francis (2011, 2016) reweighting method.

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STOCK STATUS COMPARISONS

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
21.1_Wt+Grt	99.1	135.16	0.73	0.04	0.09	0.44	0.09	44.88
21.2_Mat_Age_GLM_No_SS	87.17	124.22	0.7	0.05	0.09	0.56	0.09	44.23
21.3_Mat_Age_GAM	79.99	117.98	0.68	0.05	0.09	0.56	0.09	44.94
21.4_Mat_AL_GAM	90.72	127.17	0.71	0.05	0.09	0.56	0.09	48.35
21.5_Upd_Bio_AL-Mat	85.31	130.76	0.65	0.04	0.08	0.5	0.08	39.75
21.6_No_q_Prior	88.86	126.44	0.7	0.05	0.09	0.56	0.09	47.32
21.7_Add_Sel+q_Block	80.81	117.4	0.69	0.05	0.09	0.56	0.08	34.61
21.8_No_q_Add_Sel+q_Block	74.05	115.28	0.64	0.06	0.09	0.67	0.08	29.1
21.9_Cont_Francis	101.42	112.57	0.9	0.05	0.11	0.45	0.11	51.25
21.10_Proposed	85	114.19	0.74	0.06	0.08	0.75	0.08	27.09

42 DATA WEIGHTING UPDATES

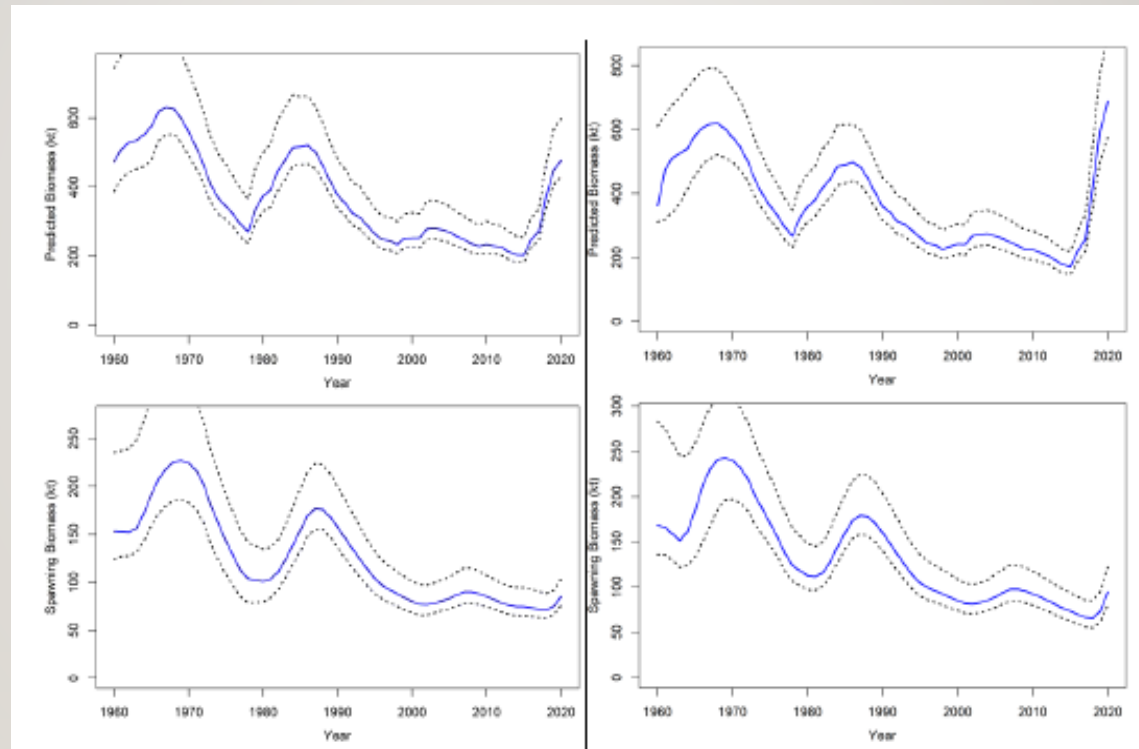
- **21.9_Cont_Francis:** same as *16.5_Cont* model, but utilizing Francis reweighting
 - Replaces fixed data weights implemented based on recommendations of 2016 CIE review (occurred prior to influx of large recent year classes)
 - Similar to approach explored for other North Pacific species (e.g., GOA 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)



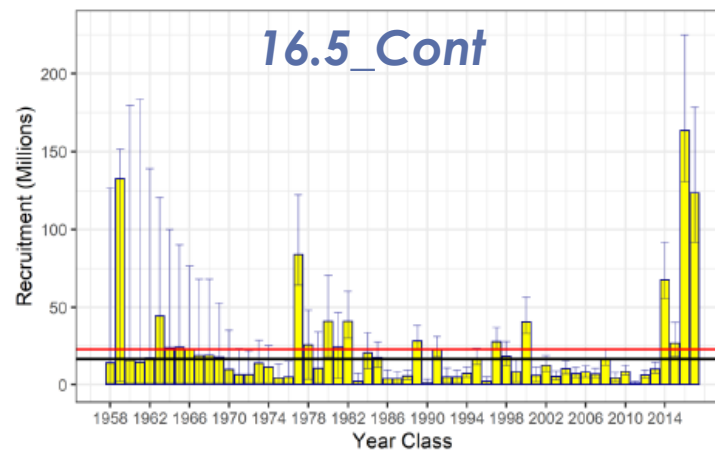
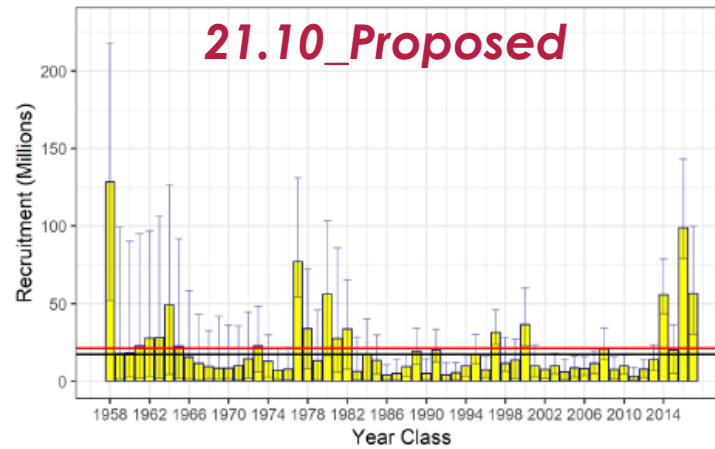
43 BIOMASS COMPARISONS

21.10_Proposed

16.5_Cont

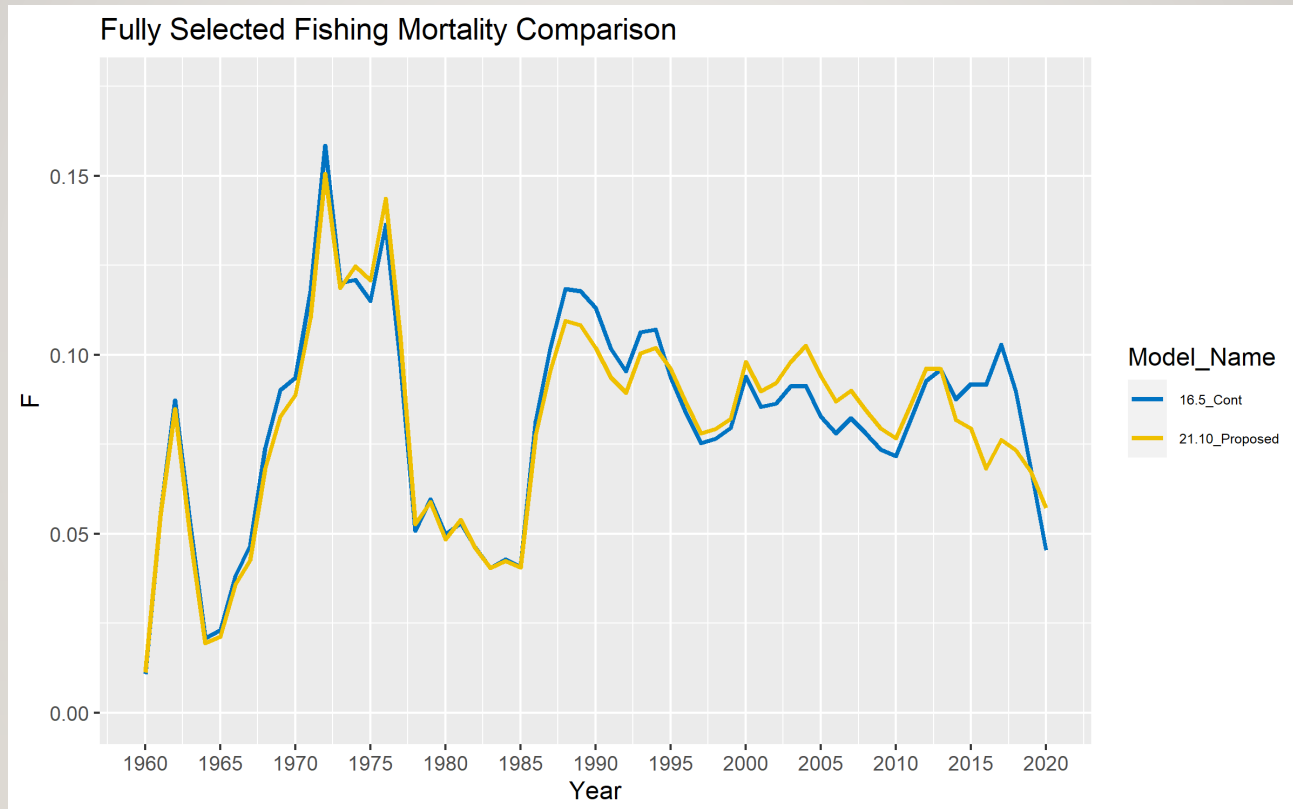


44 RECRUITMENT COMPARISONS



45

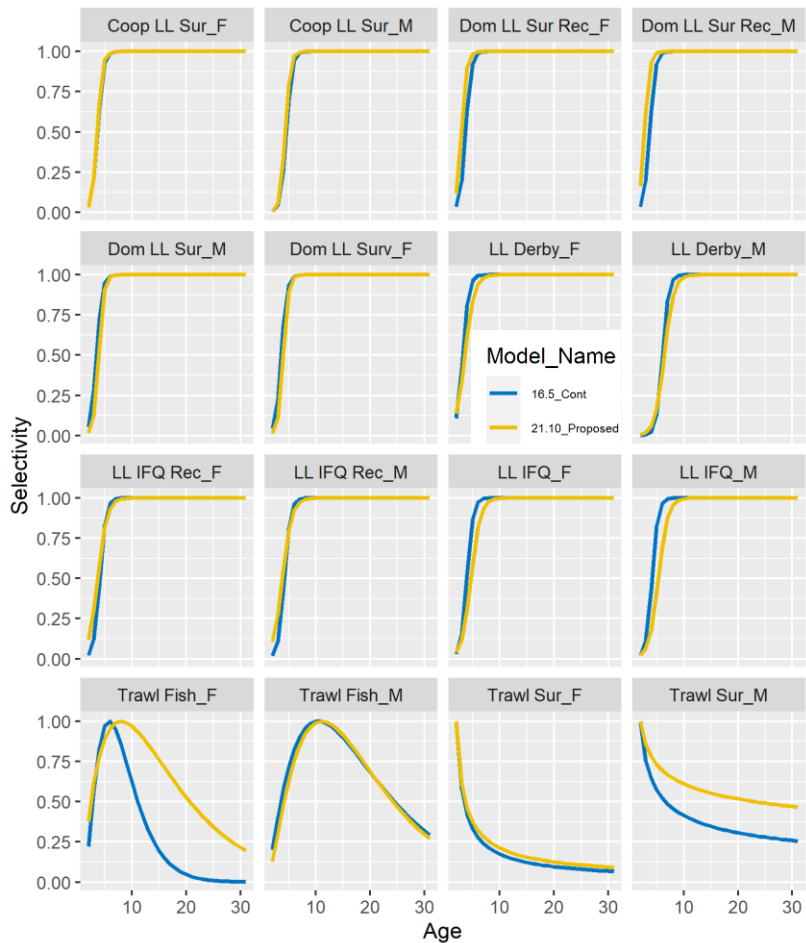
FISHING MORTALITY DECREASING



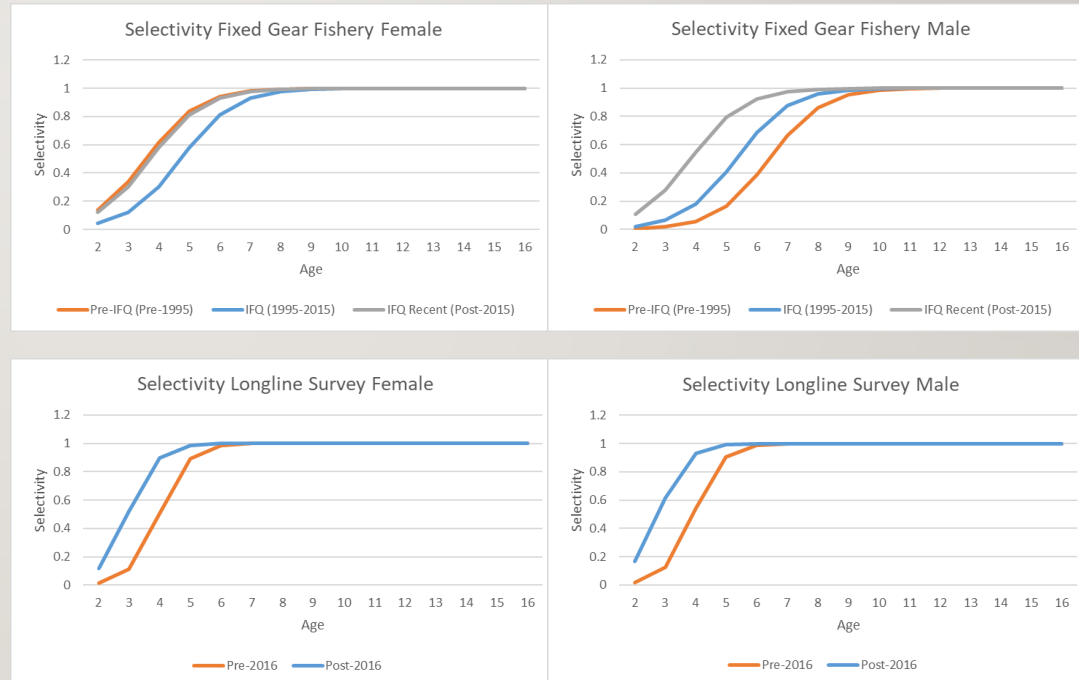
46

INCREASED SELECTIVITY

Selectivity Comparison



21.10_Proposed Selectivity Estimates

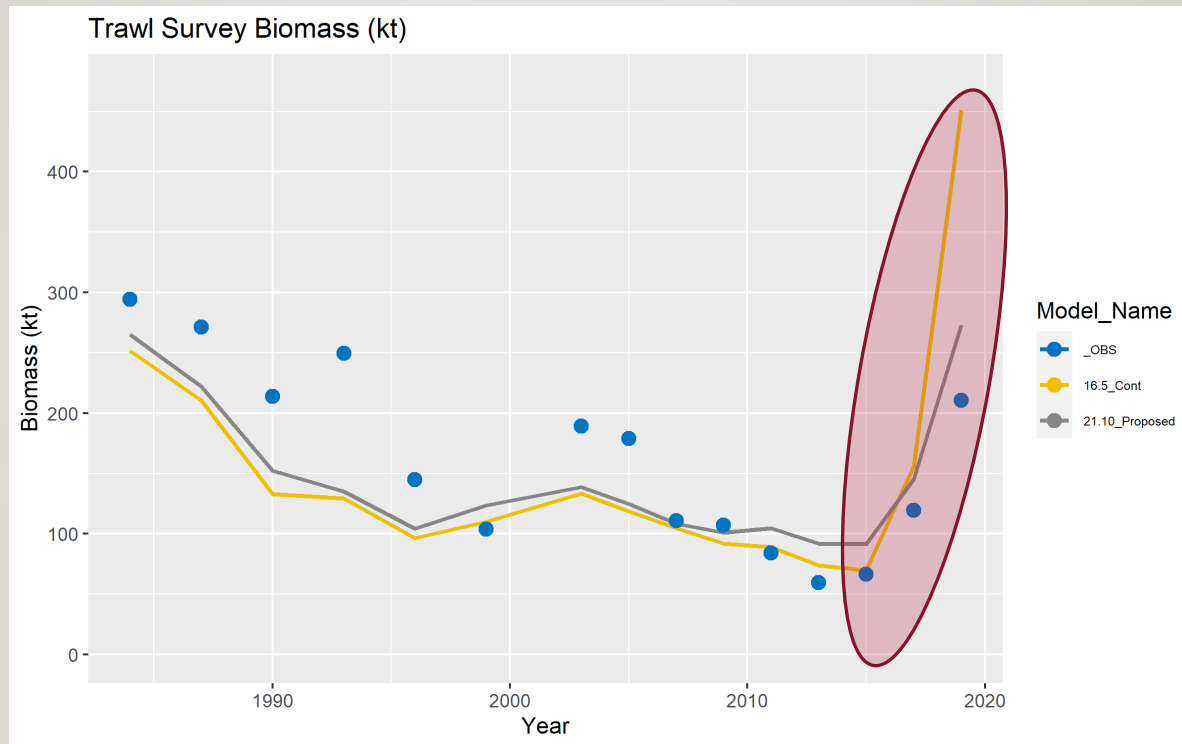


*Note minor change to trawl fishery selectivity parametrization (impacts minor)



47

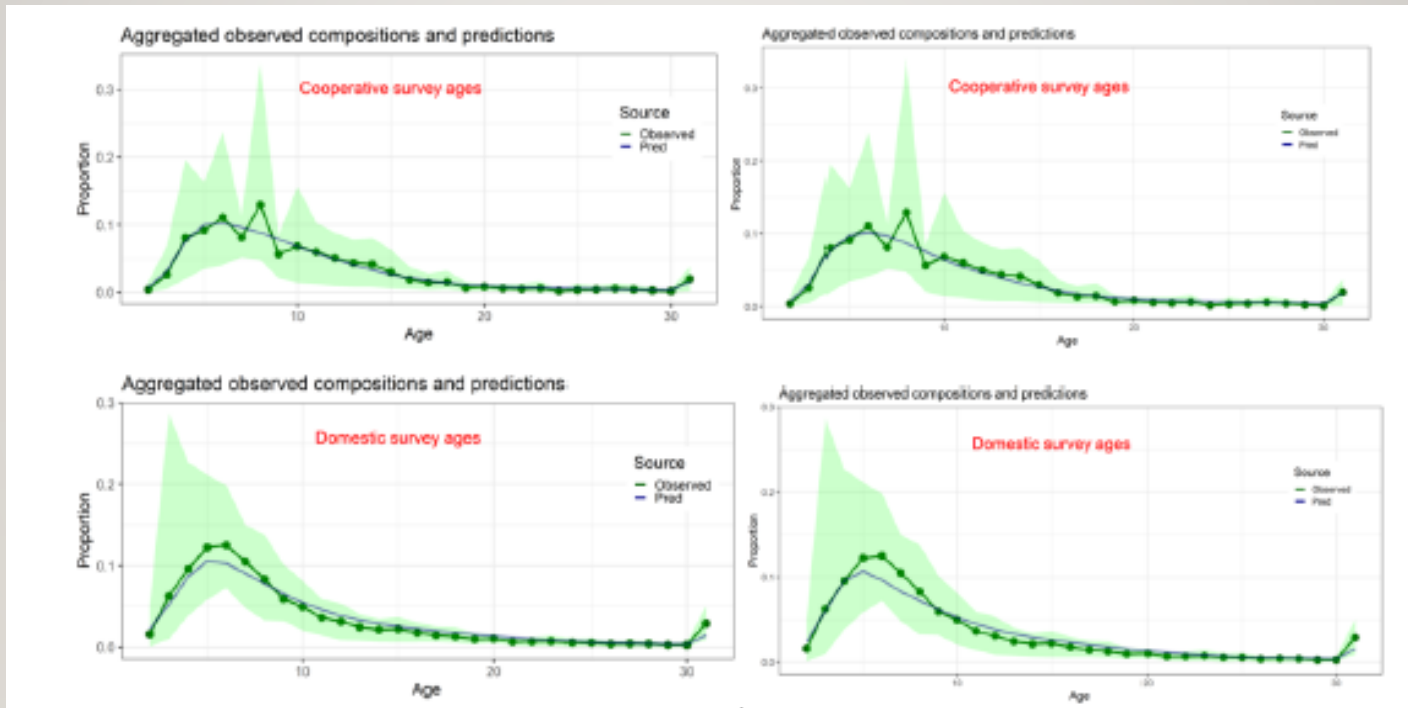
IMPROVED FIT TO TRAWL SURVEY



48 LONGLINE SURVEY AGES

21.10_Proposed

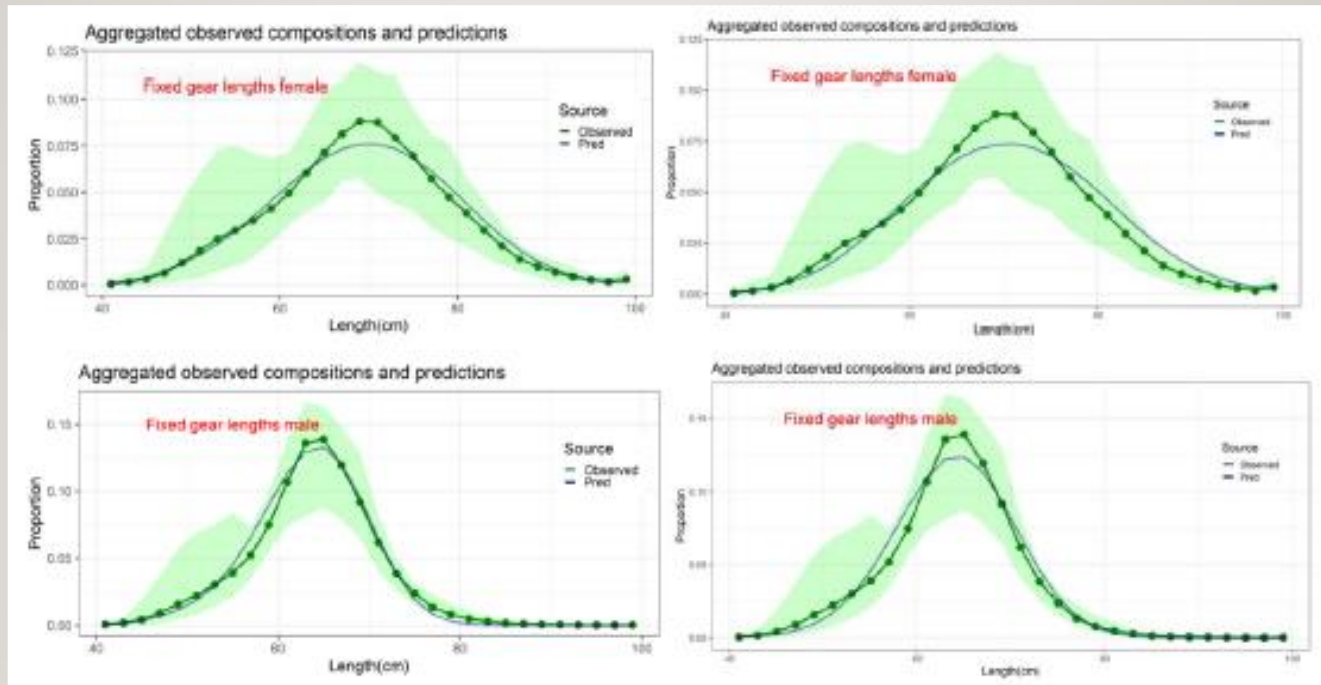
16.5_Cont



FIXED GEAR FISHERY LENGTHS

21.10_Proposed

16.5_Cont



50

DOM LONGLINE SURVEY LENGTHS

21.10_Proposed

16.5_Cont

