ALASKA SABLEFISH

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MARINE ECOLOGY AND STOCK ASSESSMENT

ALASKA FISHERIES SCIENCE CENTER

JUNEAU, AK

2 OUTLINE

- Stock Assessment Overview
    - Review Key Data Inputs
    - Results and Model Fit
    - EBS Trawl Catch Overview
- ABC Projections
    - Caveats and Considerations
- Summary of Assessment and ABC
- Apportionment
    - Retrospective Analyses Results
    - Recommendations

3 BOTTOM LINE

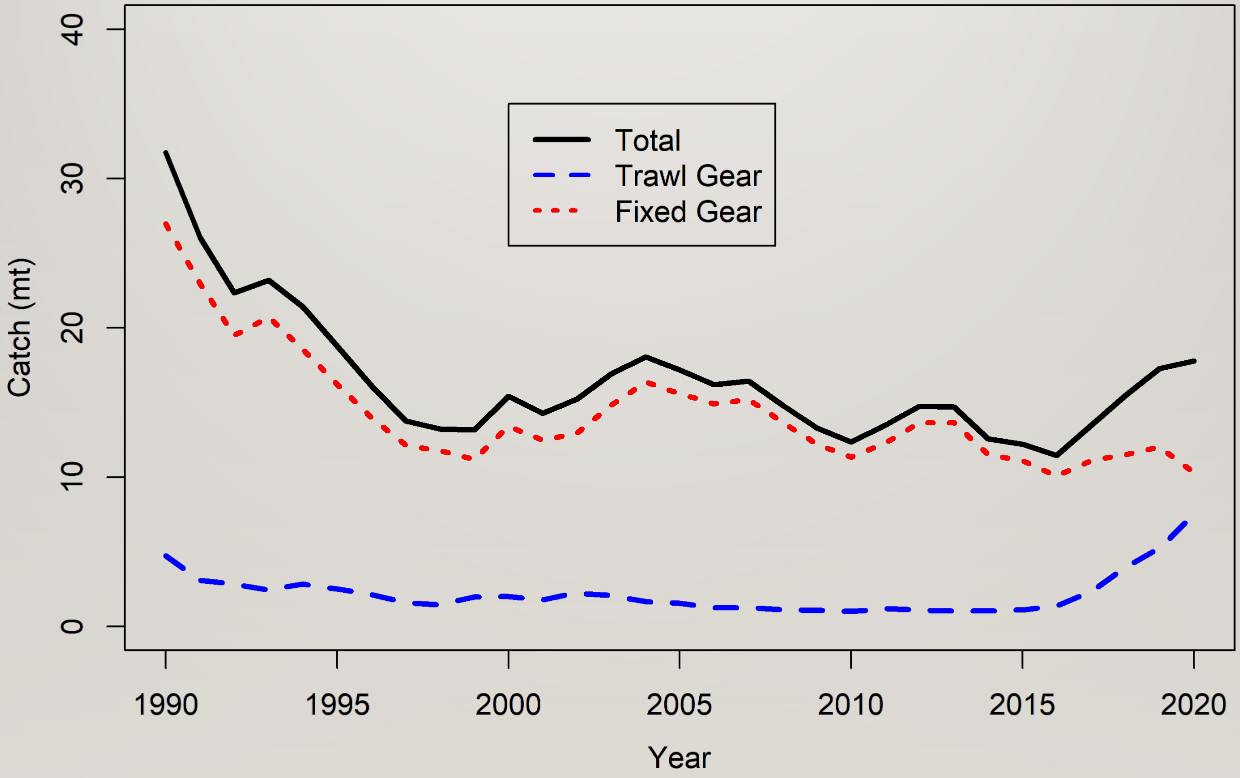
- Biomass increasing, but not as strongly as projected
- Maximum permissible ABC increasing, but projections are overly optimistic due to uncertain recruitment
- ABC % increase outpaced population growth in 2020

Year	SSB (kt)	% Change	Catch (t)	% Change	ABC (t)	% Change
2018	65.4		14,341		14,957	
2019	73.1	12%	16,624	16%	15,068	1%
2020	94.4	29%	18,402	11%	22,009	46%

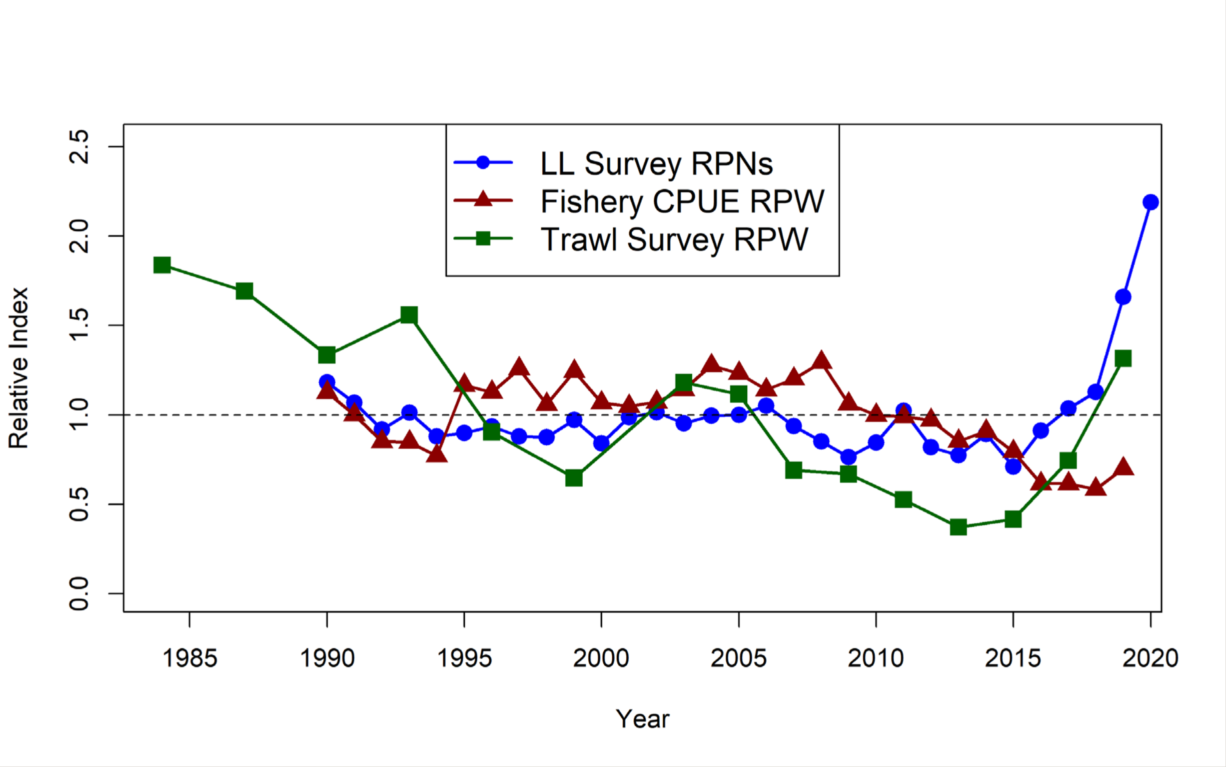
  - 87% increase in ABC since 2016 (smallest), 44% increase in SSB since 2018 (lowest)
- 2021 Author's ABC = 2020 SSC recommended ABC
  - F_ABC_2021 (0.0423) = F_ABC_2020 (0.043) ≈ F_2020 (0.046)
  - **+17% from author's ABC in 2020, because population is rebuilding**

Year	2020	2021	2022
ABC	22,551	22,551	29,723
$\mathbf{ABC_w}$	**22,009**	**22,237**	**29,309**
OFL	51,726	61,319	71,756
$\mathbf{*OFL_w}$	**50,481**	**60,426**	**70,710**

4 RECENT CATCHES



5 INDICES IN THE MODEL

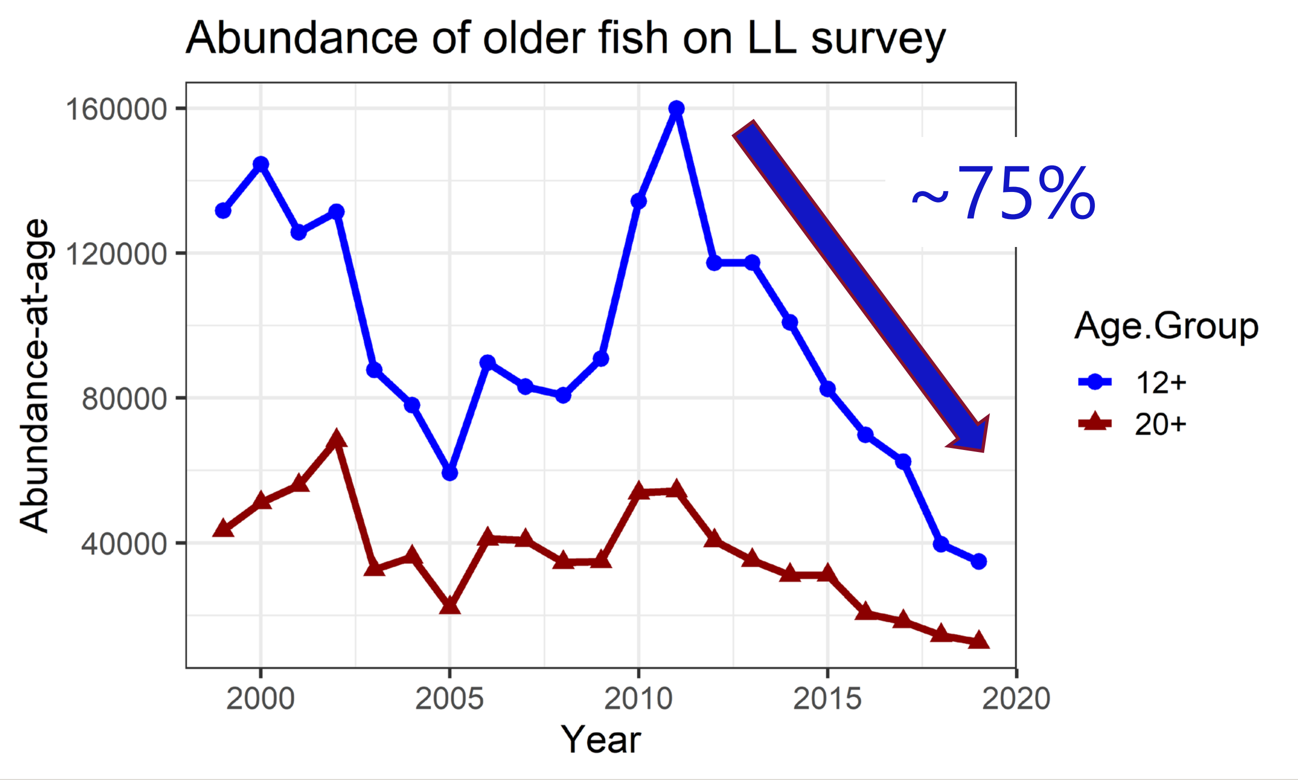


32% Increase

77% Increase

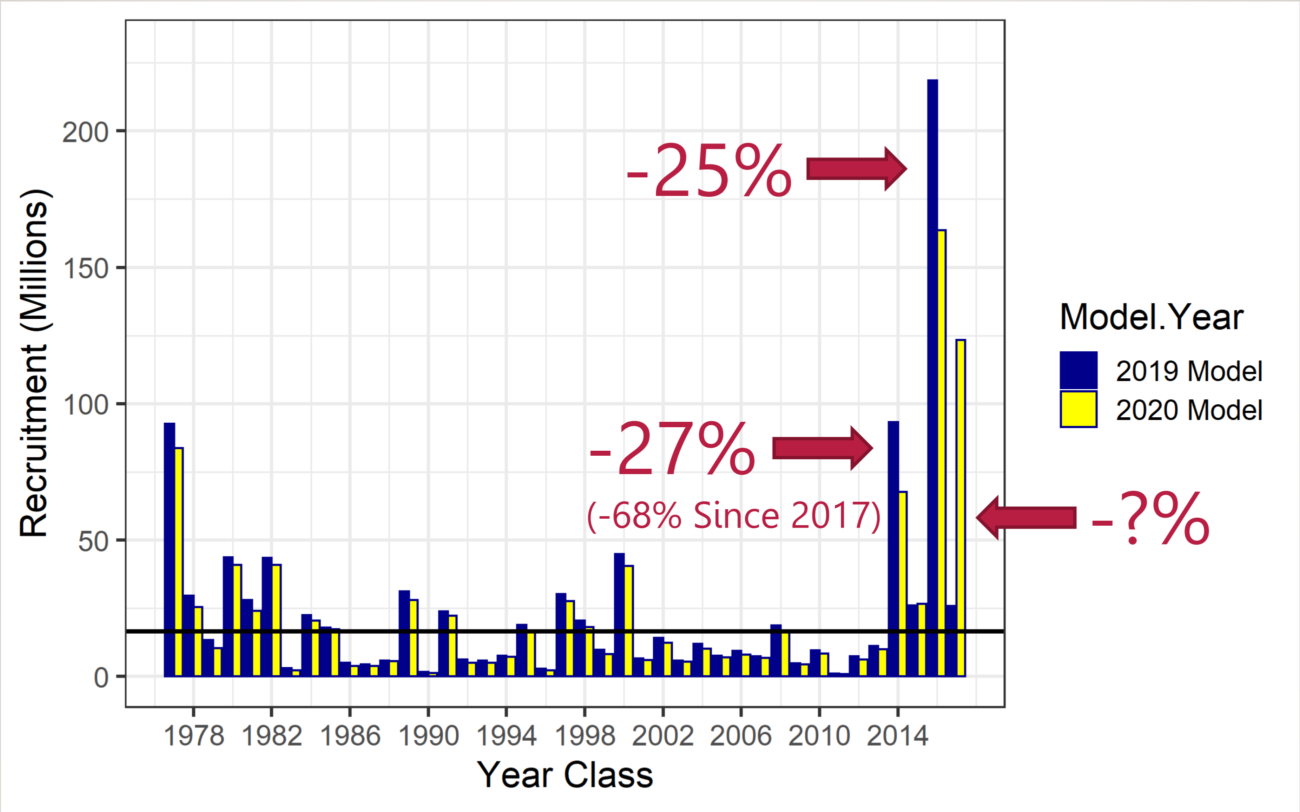
20% Increase

6 GROW UP!

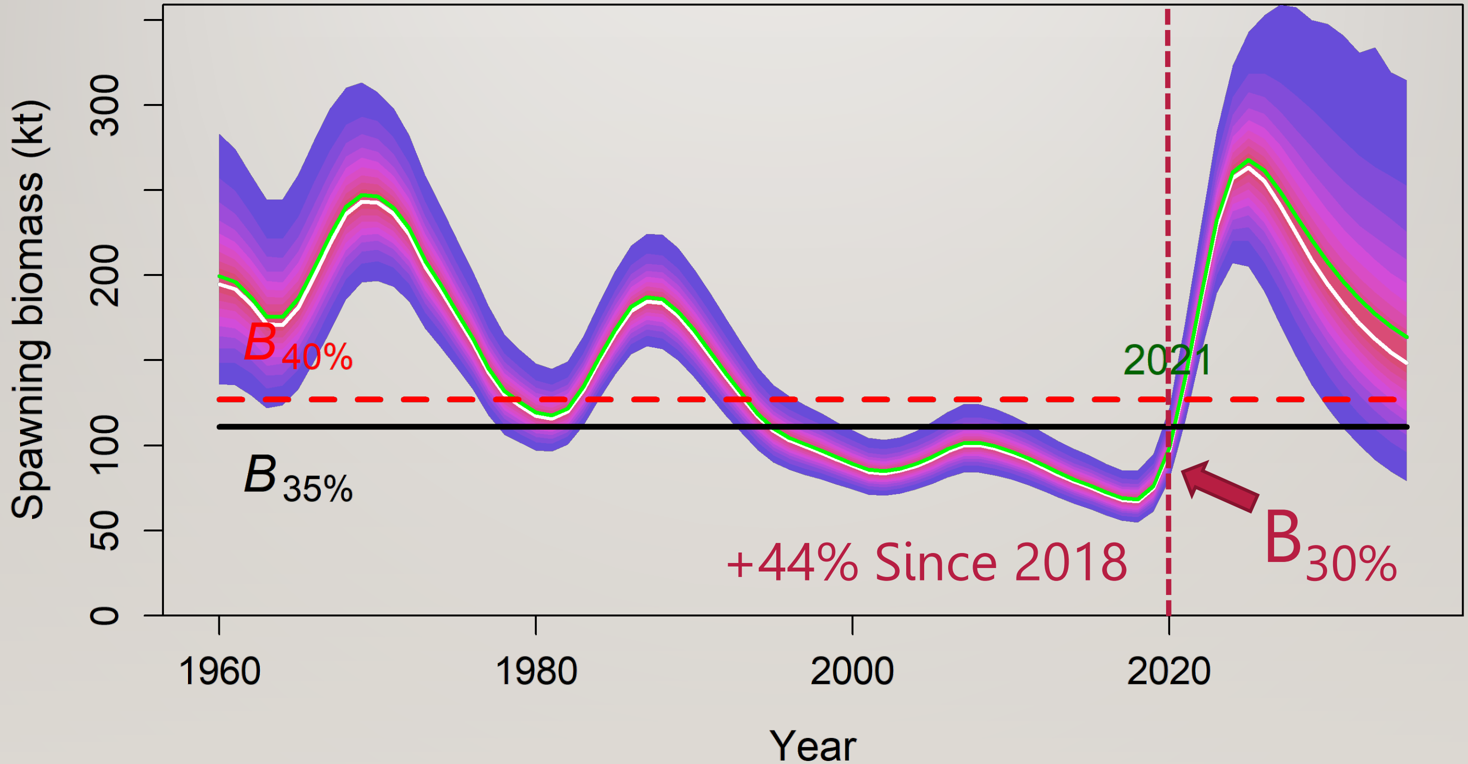


Abundance of older fish on LL survey
160000
120000
80000
40000
Abundance-at-age
2000
2005
2010
2015
2020
Year
~75%
Age.Group
12+
20+

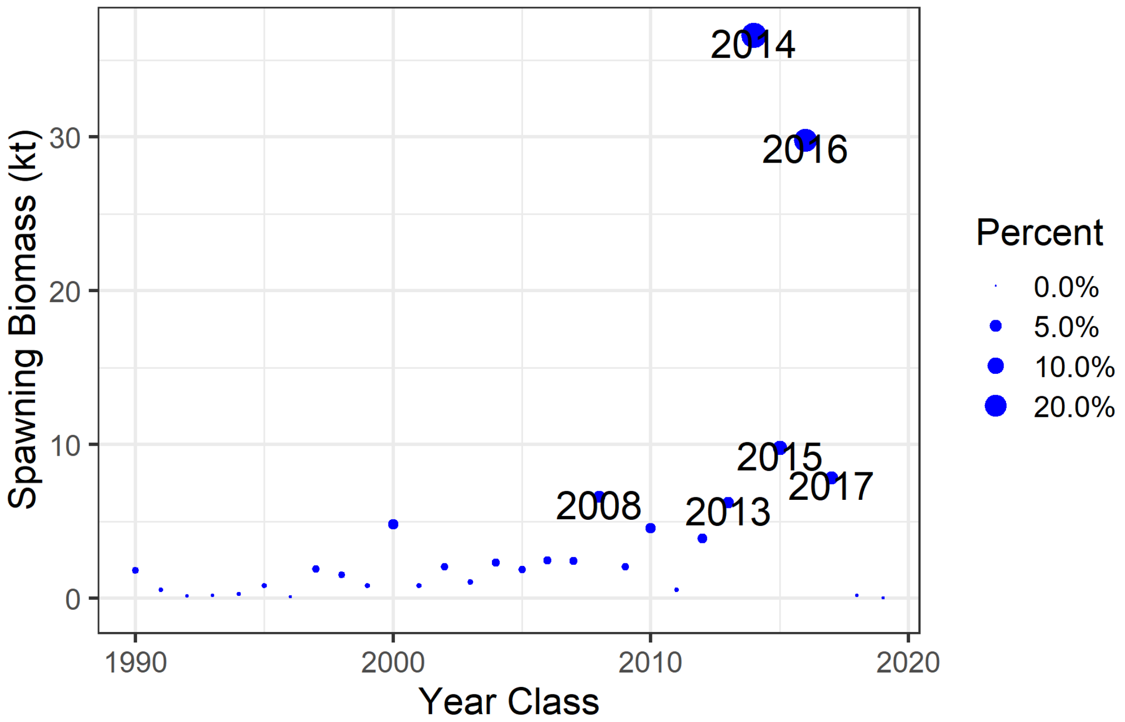
THE 2014 YEAR CLASS DECREASED (AGAIN), 2016 ON SAME TRAJECTORY



SPAWNING BIOMASS INCREASING, BUT STILL LOW

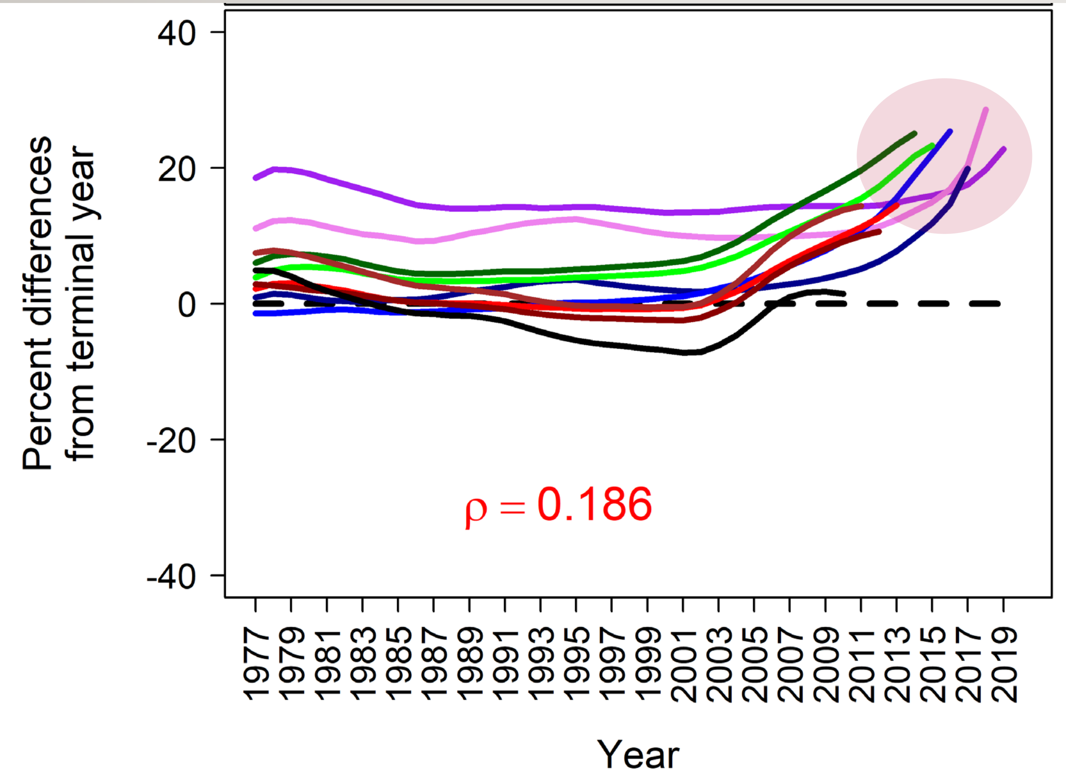


9 NEW KIDS ON THE BLOCK



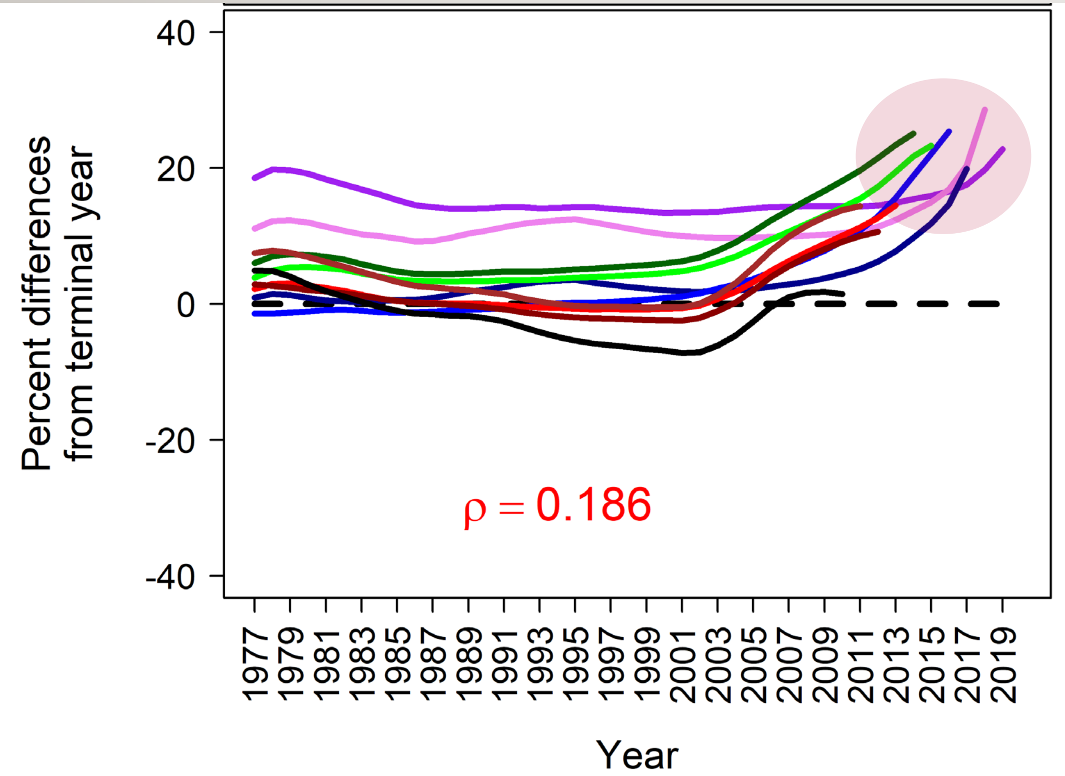
2014 and 2016 Year Classes ~50% of SSB, 60% and 20% Mature, Respectively

10 RETROSPECTIVE BIAS INCREASED

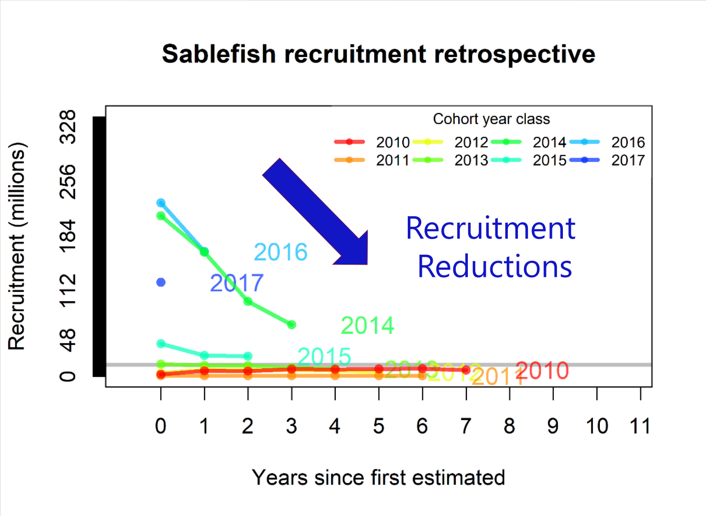


20% reduction in terminal SSB when subsequent year of data is added to model.

11 RETROSPECTIVE BIAS INCREASED



20% reduction in terminal SSB when subsequent year of data is added to model.



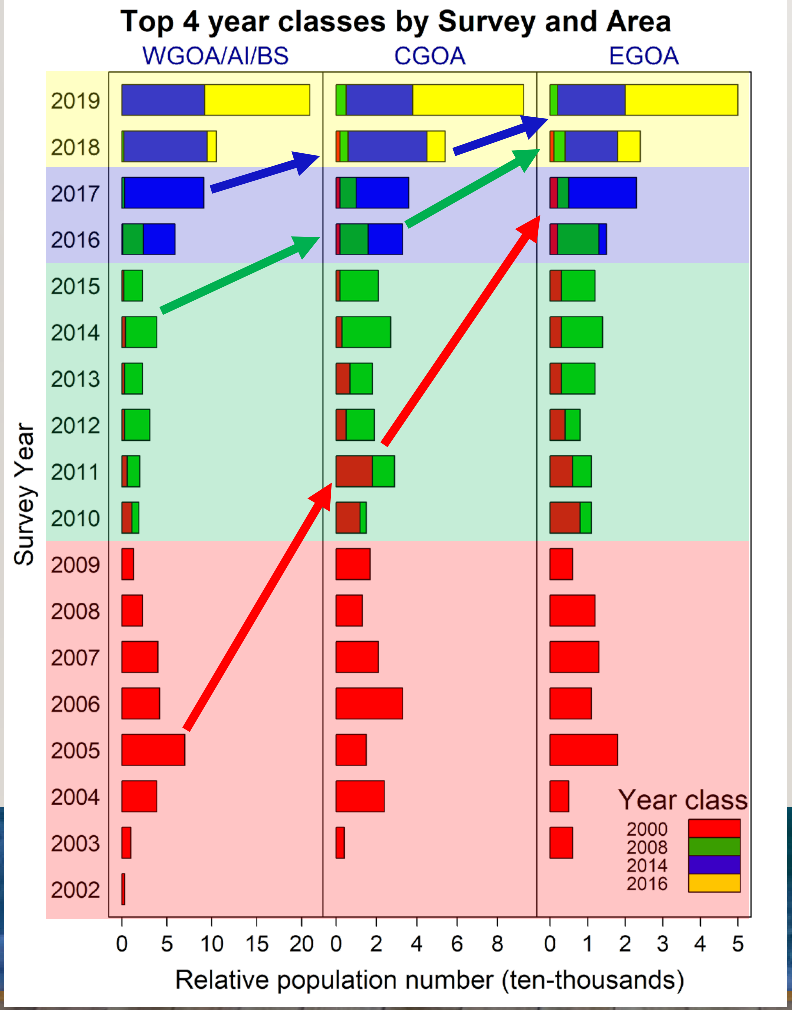
SENSITIVITY RUNS

- Explored nine areas of model sensitivity and/or parametrization
- Focused on allowing new selectivity time blocks and/or time-/age-variation in natural mortality
- Also explored impact of maturity assumptions and data weighting
- Alternate parametrizations and assumptions had strong impact on terminal SSB (ranging from ~49 kt to 136 kt) and ABC

ASSESSMENT SUMMARY

- Model tension between fitting indices and compositional data
- Recent year classes are large, but continue to be downgraded
- SSB increasing rapidly, but still below target rebuilding
- Reference points have increased due to inclusion of 2016 year class
- F is decreasing and well below M
- Retrospective patterns increased and indicate consistent overestimation
- Sensitivity runs indicate that the model may be overestimating SSB and/or underestimating M
- Realized population growth in terminal year SSB from 2019 SAFE to 2020 SAFE was ~10%

JUVENILE DISTRIBUTION



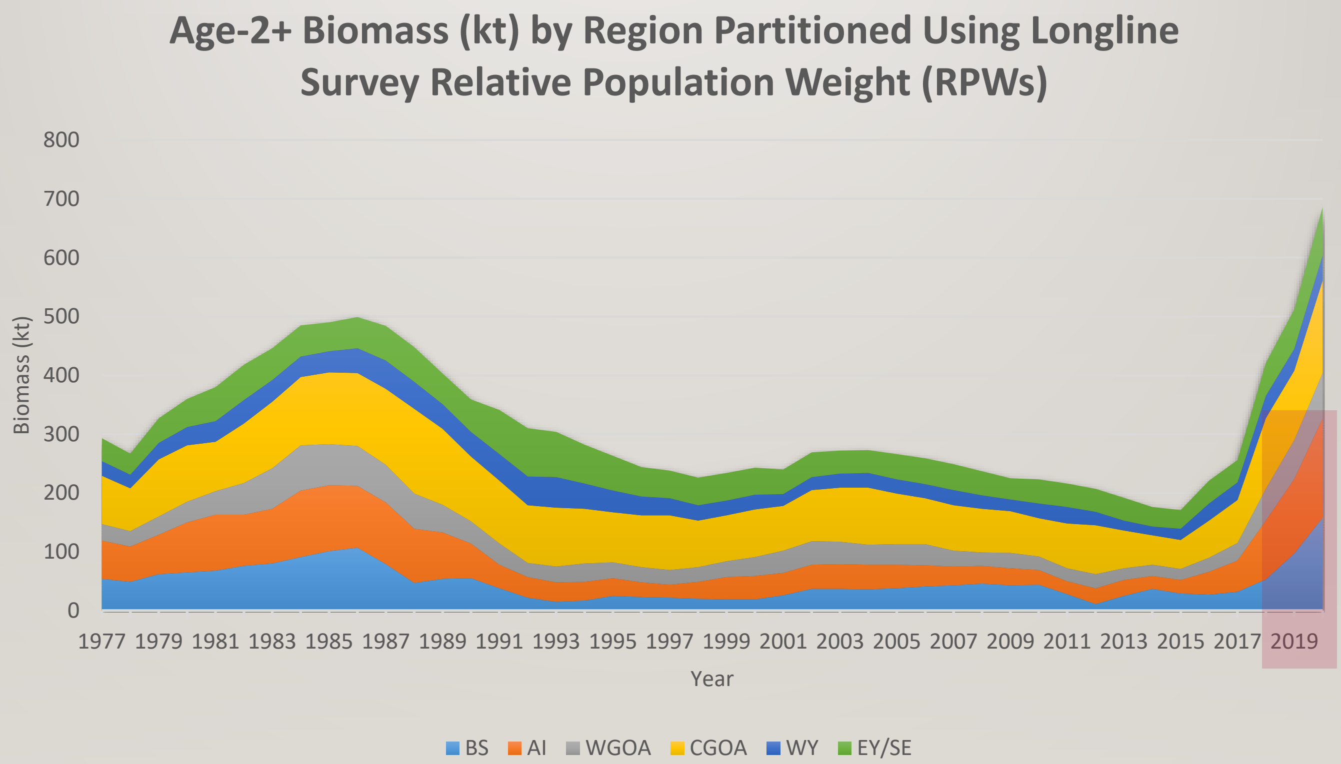
2016 Year Class

2014 Year Class

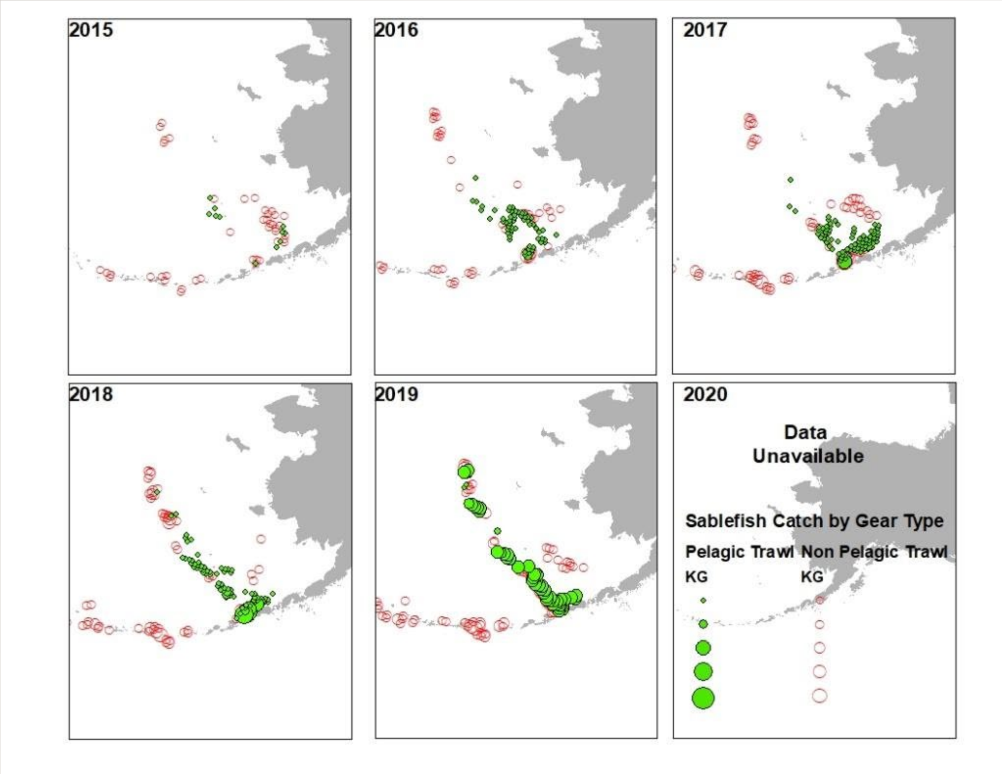
2008 Year Class

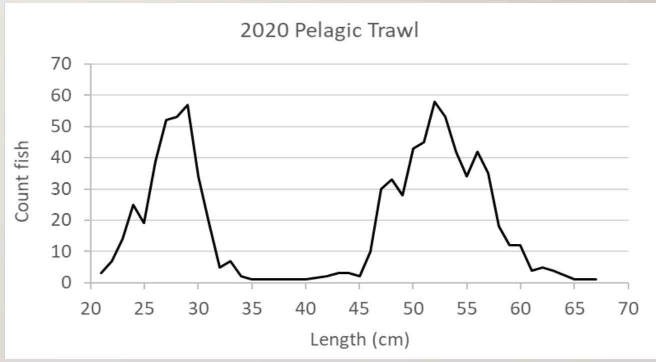
2000 Year Class

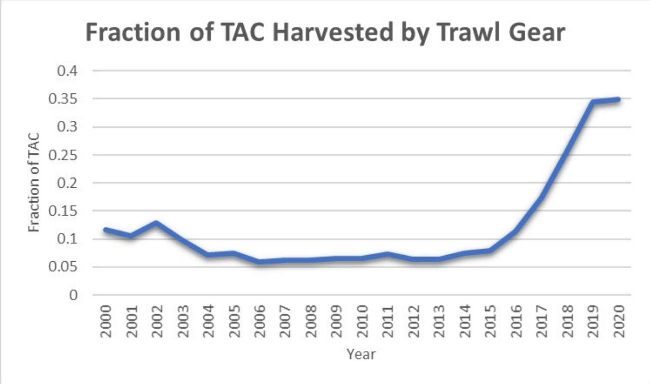
15 APPROXIMATE DISTRIBUTION



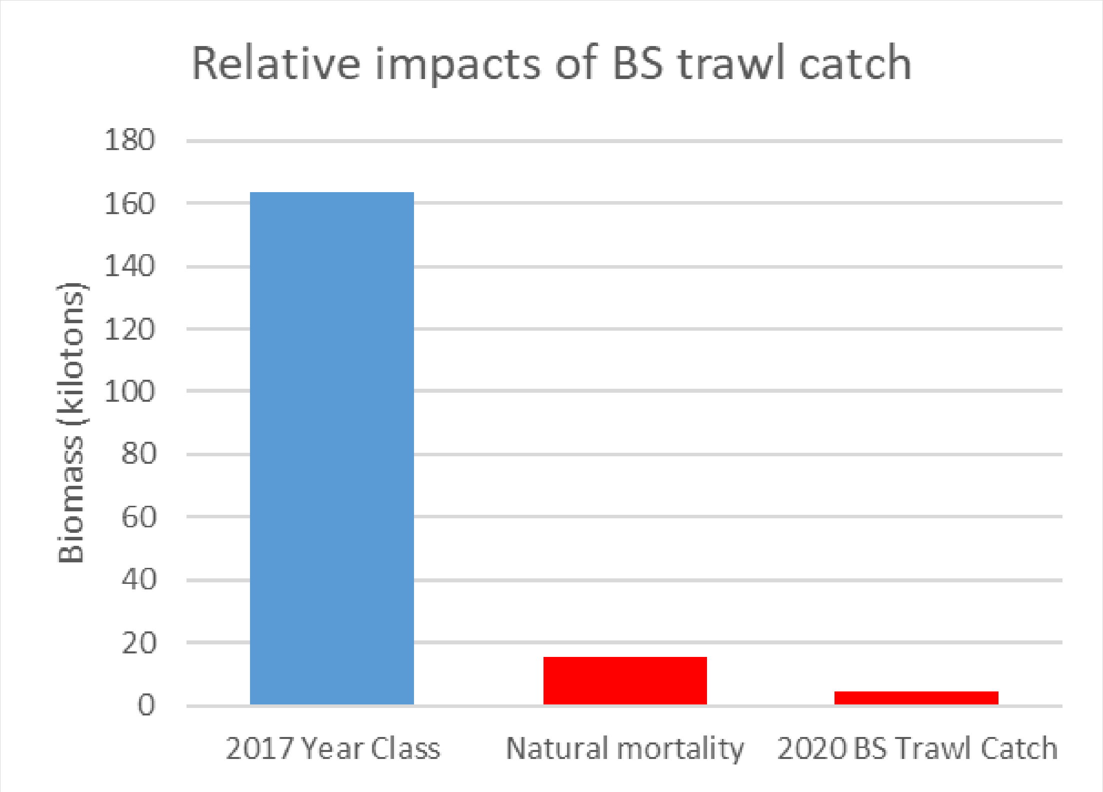
16 EBS TRAWL CATCH





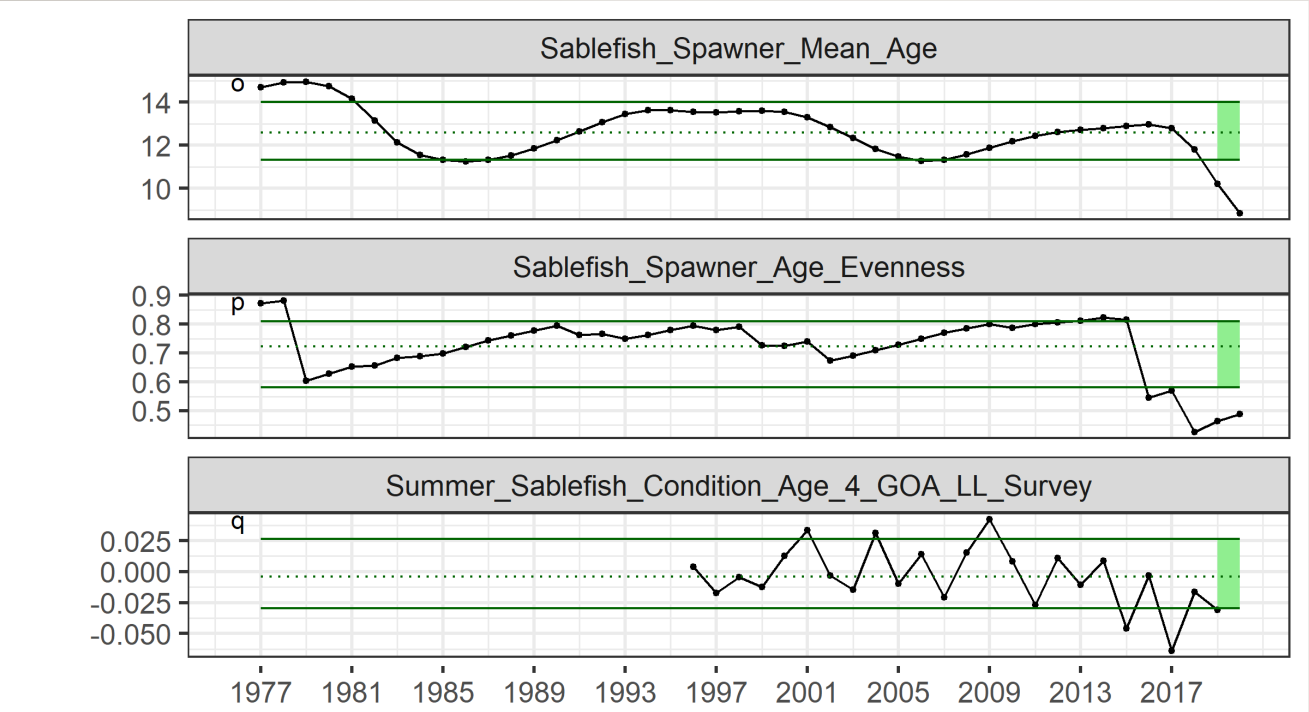


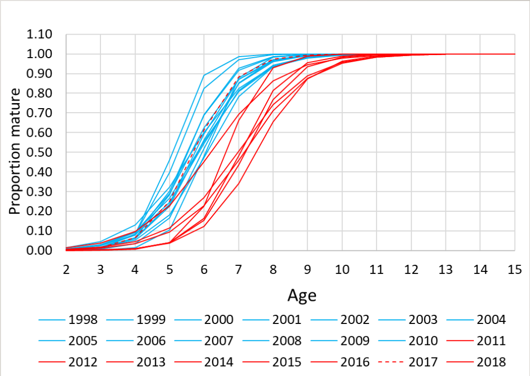
17 TRAWL CATCH

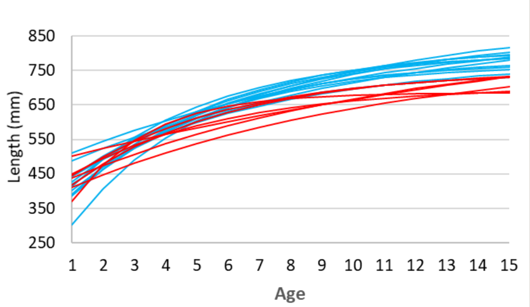


18

POOR CONDITION, CHANGES IN VITAL RATES (ESP)





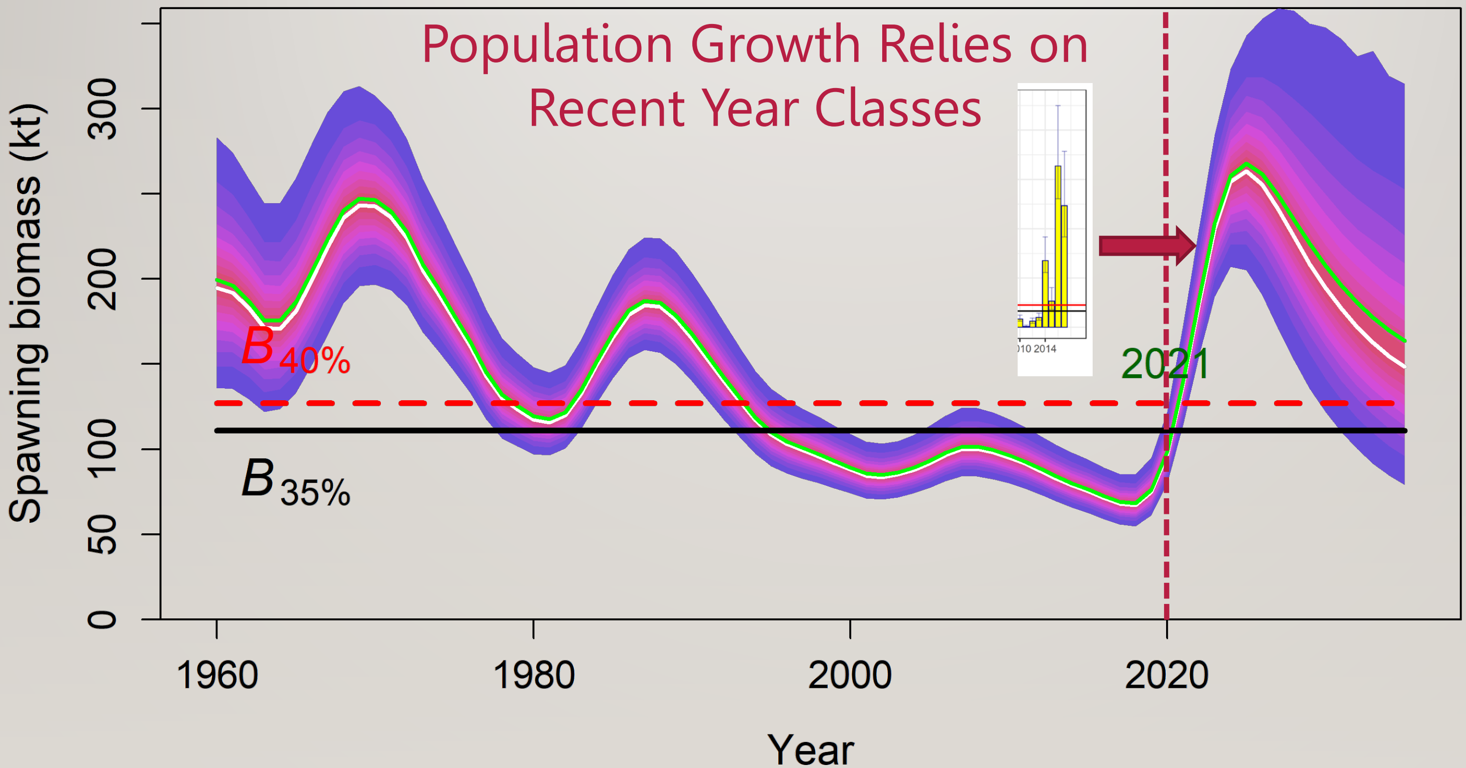


19 RISK TABLE FRAMEWORK

- Assessment model: **3** (major concern)
- Population dynamics: **3** (major concern)
- Ecosystem: **2** (increased concern)
- Fishery performance: **3** (major concern)
- Reduced ABC would aid in more rapidly rebuilding spawning biomass and improving age structure

20

MAX ABC PROJECTIONS



Projected
+94% in SSB
2020 → 2022

REDUCED RECRUITMENT PROJECTION

- Fix uncertain 2016 and 2017 year classes at average levels

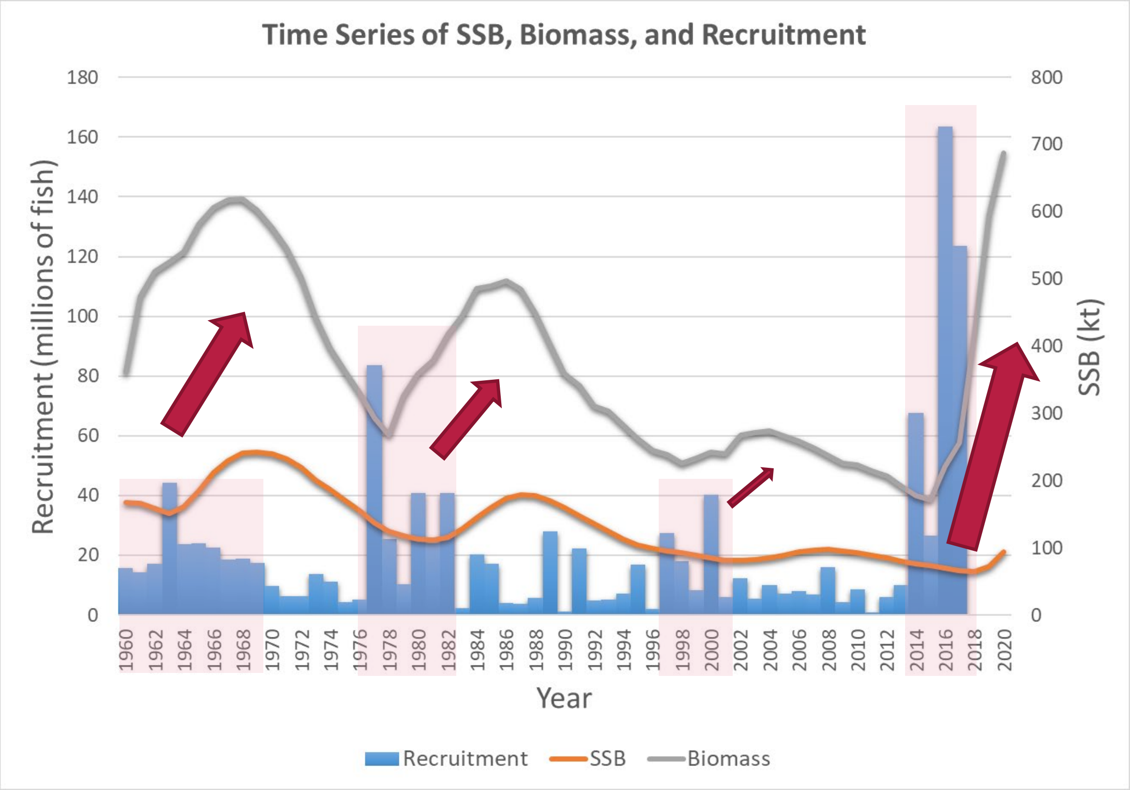
	Max ABC Projection		Avg. Recruitment Projection	
Quantity	**2021**	**2022**	**2021**	**2022**
SSB (t)	134,000	192,000	98,000	109,000
ABC (t)	52,400	61,400	22,100	23,400
OFL (t)	61,300	71,800	25,800	27,400

POPULATION GROWTH COMPARISON

	2019 SAFE to 2020 SAFE 2019 to 2020 Population Growth	Maximum Historical Population Growth	Average Recruitment Projection 2020 to 2021 Population Growth*	2020 SAFE 2019 to 2020 Population Growth	Maximum ABC Projection 2020 to 2021 Population Growth
% Population Growth	10%	15%	17%	30%	43%
SSB (t)	104,000	109,000	98,000	122,000	134,000
ABC (t)	--	--	22,100	--	52,400

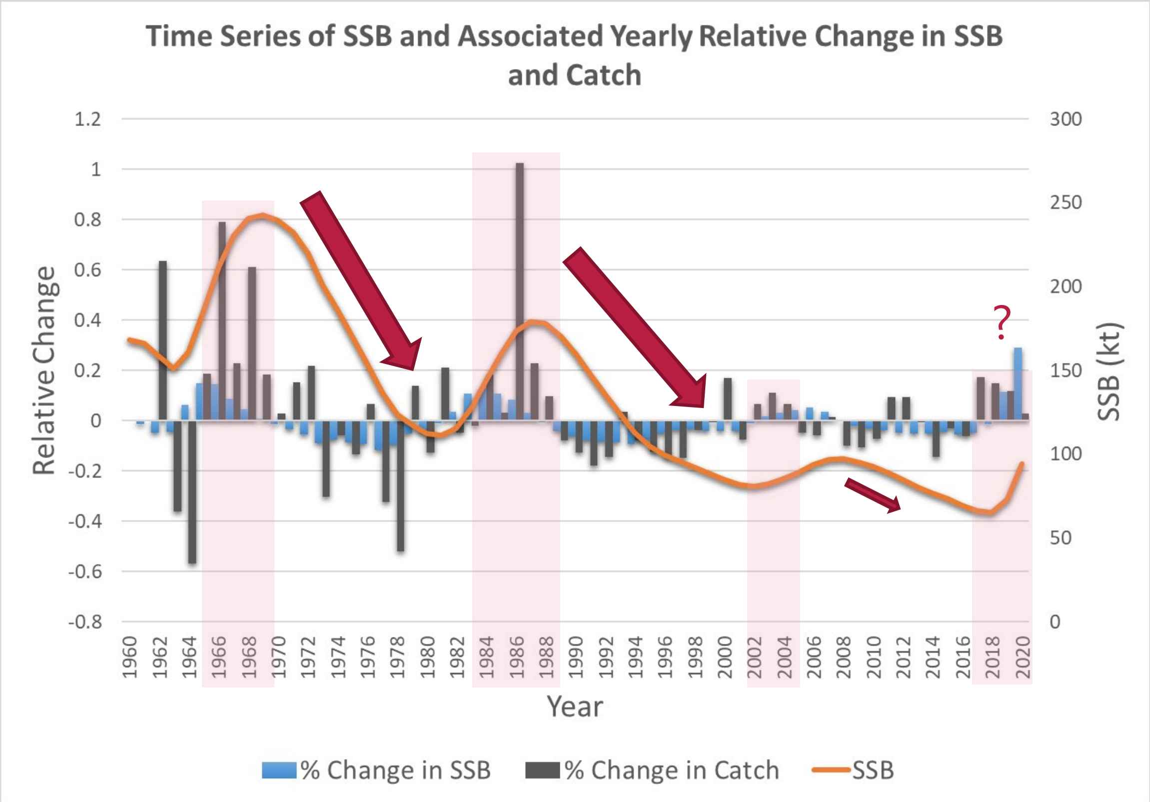
*2020 SSB was 83,000 t

23 CYCLICAL SABLEFISH



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

24 CYCLICAL SABLEFISH



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

25 BOTTOM LINE

- Biomass increasing, but not as strongly as projected
- Maximum permissible ABC increasing, but projections are overly optimistic due to uncertain recruitment
- ABC % increase outpaced population growth in 2020

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2018	65.4		14,341		14,957	
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Year	2020	2021	2022
ABC	22,551	22,551	29,723
ABC_w	**22,009**	**22,237**	**29,309**
OFL	51,726	61,319	71,756
***OFL_w**	**50,481**	**60,426**	**70,710**

ABC SUMMARY

- **Rationale**: maintain F from previous years, because the SSB and age structure have not rebuilt, despite setting conservative ABCs in recent years
- **May need to temper the control rule F**: increases in fishing mortality may not be warranted when large uncertainty exists in the size of recent year classes
- **Strong increases in retrospective patterns** escalate concern that the model may not be adequately capturing changing processes and that projections are overly optimistic
- **The Generic NPFMC HCR may not be robust** to the importance of sablefish SSB age portfolios and boom/bust recruitment dynamics

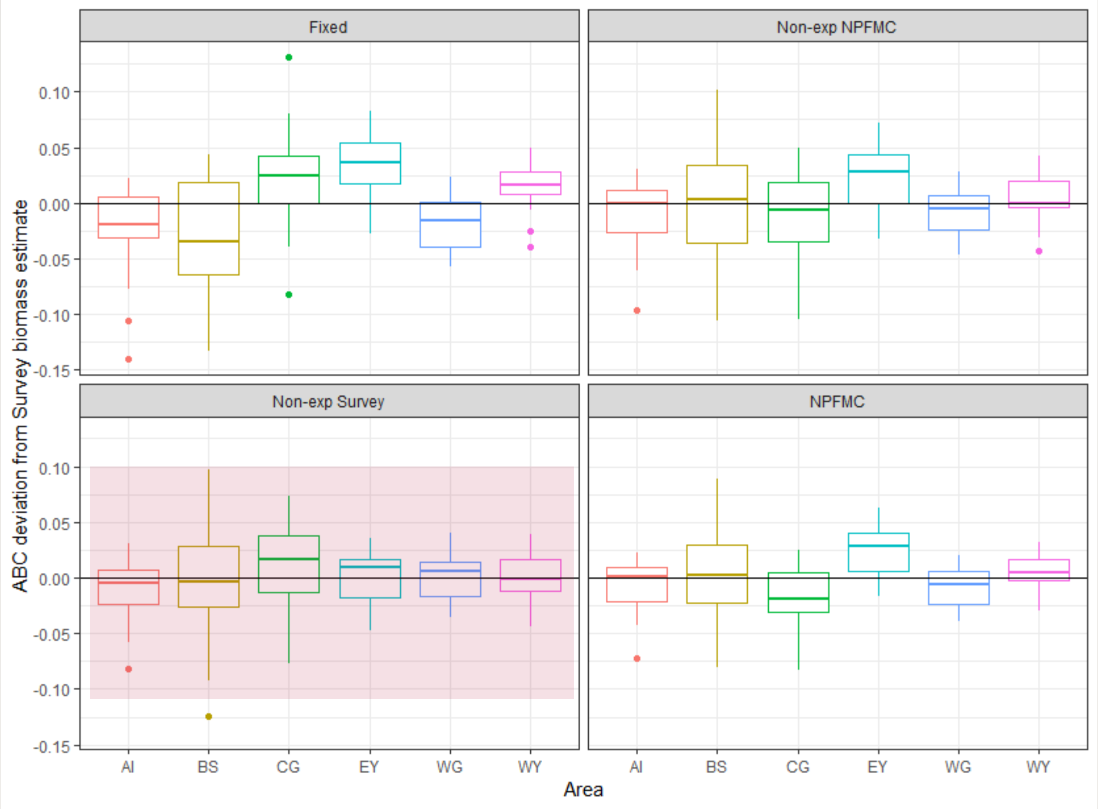
PRIMARY APPORTIONMENT STRATEGIES

- Fixed (status quo)
  - Ignores rapidly changing distribution of biomass
- NPFMC (exponentially weighted survey and fishery data)
  - Limited fishery-dependent data (i.e., BSAI observer and logbook data) along with increased electronic monitoring and use of alternate gear types (e.g., pots)
- Survey (5-year average survey proportions)
  - Best represents biomass distribution

28 SIMULATION LIMITATIONS

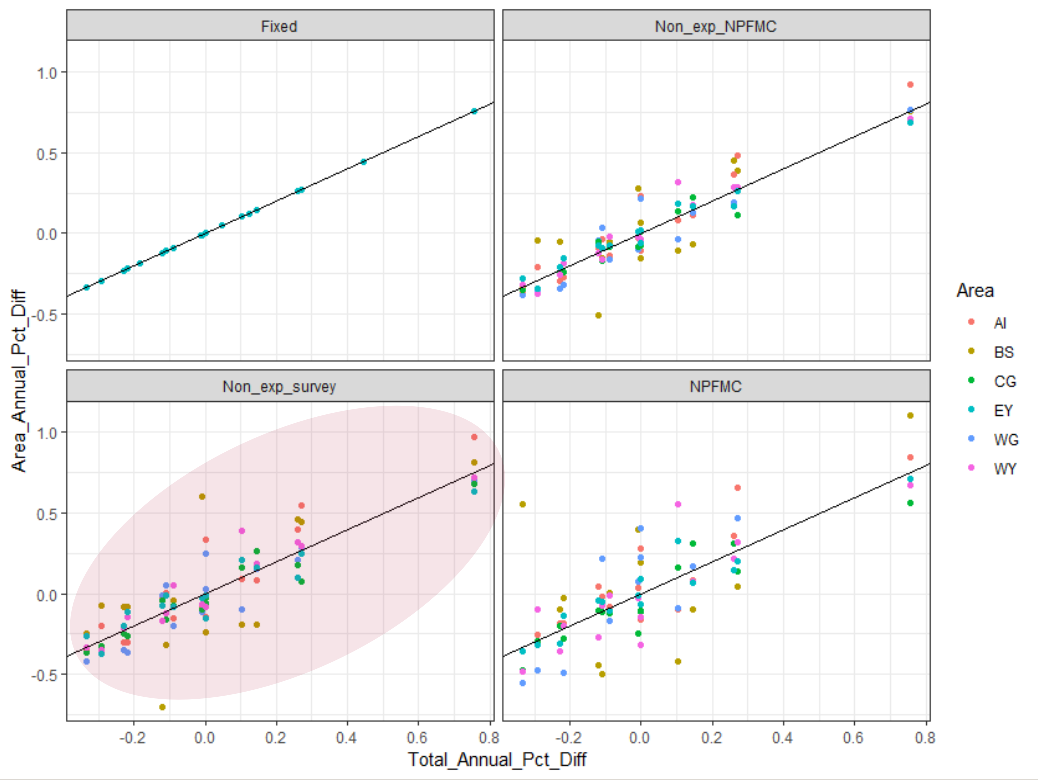
- Many SSC recommendations led to recurring convergence issues
- Expectations/conclusions from MSE work need to be tempered
  - Conditioned on extant dynamics as of ~2018
  - Does not specifically account for current dynamics (i.e., strong year classes and resulting distributional shifts), because we don't have data/knowledge to adequately model these dynamics
  - Have not tested alternate population dynamics or exceptional circumstances for which apportionment strategies might perform poorly
  - Desired SSC results not possible due to limitations in simulation framework

29 RETROSPECTIVE ANALYSIS



How does area ABC differ from biomass proportions by area from LL survey?

30 RETROSPECTIVE ANALYSIS



How does year-to-year variation in area ABCs compare to total ABC ?

APPORTIONMENT CONCLUSIONS

- Goal is to balance tracking **regional biomass** (conservation metric) vs. **stability in area proportions** (economic metric valued by stakeholders)
- Fixed apportionment is not responsive to changing biomass distributions
- BS ABC exceeded by >2,000 t in 2020, but also sharp recent increases in biomass in BS
- Tracking regional biomass or a best proxy thereof is likely the best defense against localized depletion
- Important to protect spawning biomass in all areas and keep fishing mortality on immature fish to reasonable levels

APPORTIONMENT SUGGESTION

- **Suggestion**: 5-year average of regional survey biomass proportions
- Stair step approach is likely warranted to avoid drastic changes in 2021 by area

2021 ABC

Area	AI	BS	WG	CG	WY*	EY*	Total
Fixed	2,975.9	2,200.6	2,432.8	7,692.6	2,587.6	4,661.5	22,551.0
5 Year Avg Survey	5,323.6	3,714.5	2,778.5	5,785.7	1,934.3	3,014.4	22,551.0
2 Year Stair Step	4,149.8	2,957.5	2,605.7	6,739.1	2,261.0	3,837.9	22,551.0
3 Year Stair Step	3,758.5	2,705.2	2,548.0	7,056.9	2,369.9	4,112.5	22,551.0
4 Year Stair Step	3,562.8	2,579.0	2,519.2	7,215.8	2,424.3	4,249.7	22,551.0

Percent Difference from 2020 ABC

Area	AI	BS	WG	CG	WY*	EY*	Total
Fixed	0%	0%	0%	0%	0%	0%	0%
5 Year Avg Survey	79%	69%	14%	-25%	-25%	-35%	0%
2 Year Stair Step	39%	34%	7%	-12%	-13%	-18%	0%
3 Year Stair Step	26%	23%	5%	-8%	-8%	-12%	0%
4 Year Stair Step	20%	17%	4%	-6%	-6%	-9%	0%

APPORTIONMENT SUGGESTION

- This is *one potential* **biological recommendation**, but **socioeconomics cannot be adequately addressed** with our tools
- This is **NOT** a static apportionment, the proportions will change yearly based on changing distributions and updated survey biomass

SUMMARY TABLE

Quantity/Status	As estimated or specified *last* year for: 2020	2021	As estimated or recommended *this* year for: 2021*	2022*
M (natural mortality rate)	0.105	0.105	0.098	0.098
Tier	3a	3a	3a	3a
Projected total (age 2+) biomass (t)	704,683	741,029	753,110	789,584
Projected female spawning biomass (t)	113,368	156,854	134,401	191,503
$B_{100\%}$	264,940	264,940	317,096	317,096
$B_{40\%}$	105,976	105,976	126,389	126,839
$B_{35\%}$	92,729	92,729	110,984	110,984
F_{OFL}	0.121	0.121	0.117	0.117
$maxF_{ABC}$	0.102	0.102	0.100	0.100
F_{ABC}	0.043	0.041	0.042	0.048
OFL (t)	51,726	66,361	61,319	71,756
OFL_w (t)**	**50,481**	**64,765**	**60,426**	**70,710**
max ABC (t)	44,065	56,589	52,427	61,393
ABC (t)	22,551	29,723	22,551	29,723
ABC_w (t)**	22,009	29,008	**22,237**	**29,309**
Status	As determined *last* year for: 2018	2019	As determined *this* year for: 2019	2020
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No

WHALE ADJUSTED AUTHOR ABC

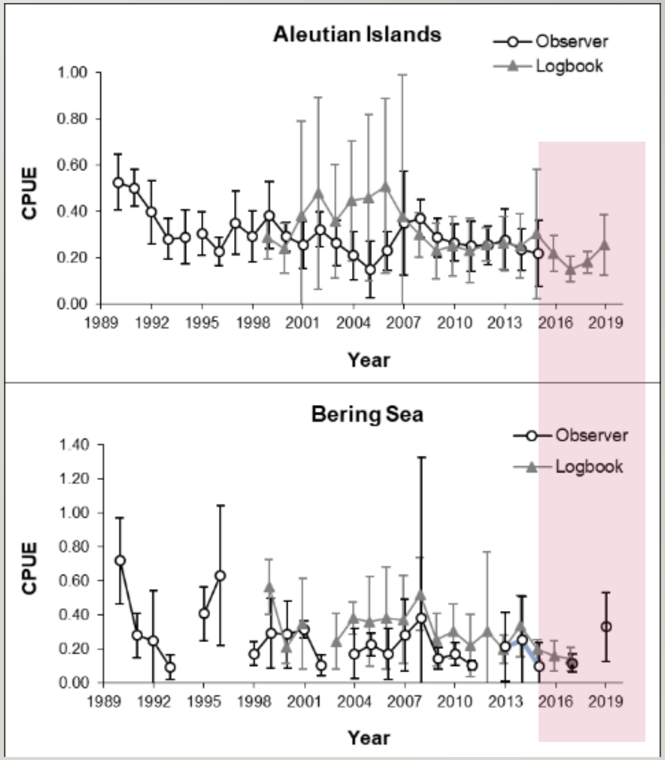
Year	**2020**				**2021**		**2022**	
Region	OFL_w	ABC_w	TAC	Catch*	OFL_w	ABC_w**	OFL_w	ABC_w**
BS	--	2,174	1,861	4,581	--	3,674	--	4,843
AI	--	2,952	2,039	1,104	--	5,294	--	6,978
GOA	--	16,883	14,393	9,208	--	13,269	--	17,489
WGOA	--	2,278	1,942	1,113	--	2,671	--	3,521
CGOA	--	7,560	6,445	4,151	--	5,738	--	7,563
**WYAK	--	2,521	2,343	1,547	--	2,050	--	2,702
**EY/SEO	--	4,524	3,663	2,398	--	2,810	--	3,703
Total	50,481	22,009	18,293	14,894	60,426	22,237	70,710	29,309

WHALE ADJUSTED AUTHOR ABC

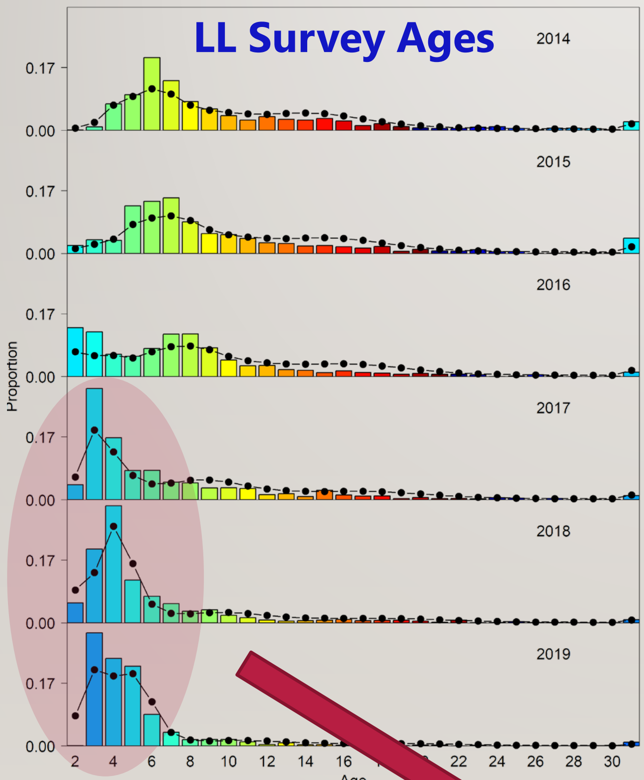
Area	Year	Biomass (4+)	OFL	ABC	TAC	Catch
GOA	2019	264,000	22,703	11,571	11,571	12,772
	2020	387,000	--	16,883	14,393	9,208
	2021	390,000	--	13,269	--	--
	2022	383,000	--	17,489	--	--
BS	2019	52,000	2,887	1,489	1,489	3,191
	2020	116,000	--	2,174	1,861	4,581
	2021	142,000	--	3,674	--	--
	2022	139,000	--	4,843	--	--
AI	2019	98,000	3,917	2,008	2,008	661
	2020	154,000	--	2,952	2,039	1,104
	2021	175,000	--	5,294	--	--
	2022	172,000	--	6,978	--	--

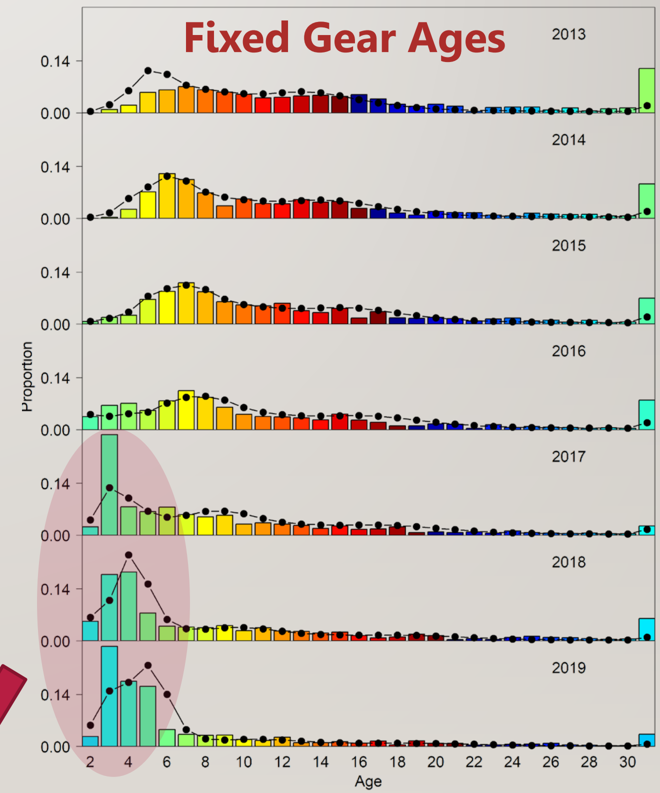
DATA NEEDS

- Fishery-dependent data
  - Low observer coverage on directed trips in BSAI
  - Sablefish are low priority on non-directed trips in EBS
- LL survey occurs every other year in BSAI
- Other surveys poorly sample both juvenile and adult sablefish
- Limited information on juvenile habitat and movement patterns
- Research on large sablefish availability in AI
- Unknown impact of large year classes on condition and survival (e.g., density-dependence)



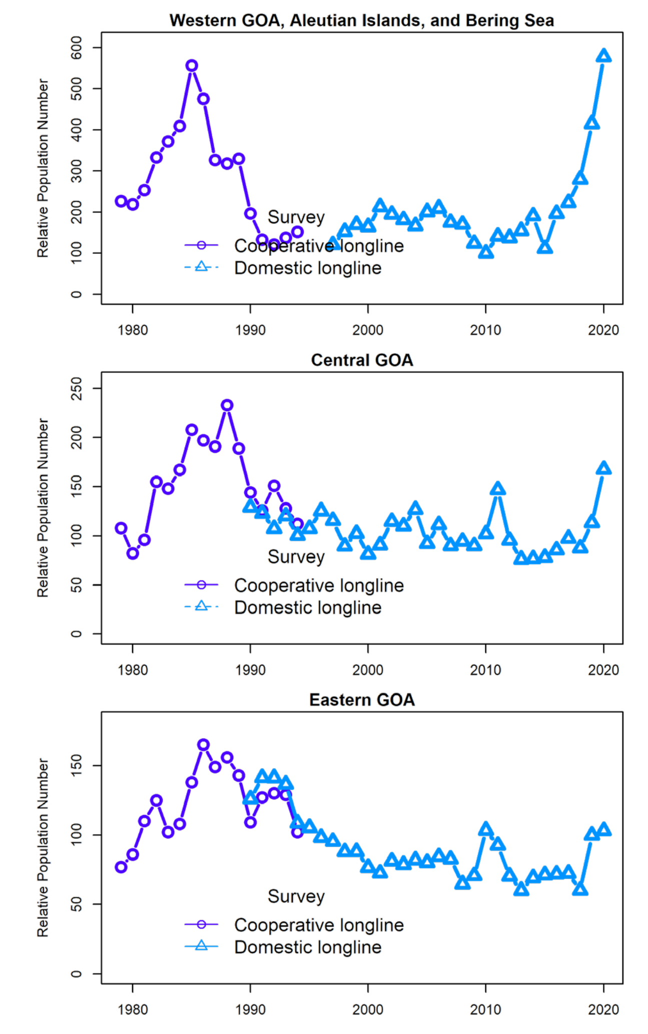
40 GROW UP!

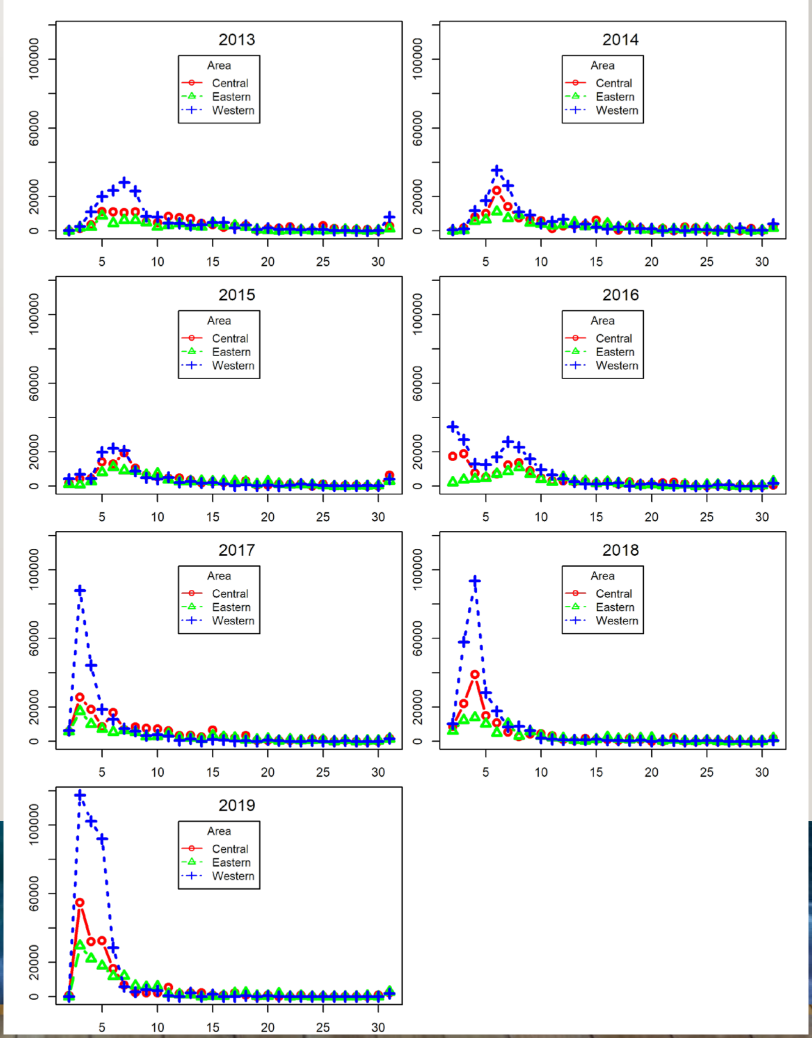




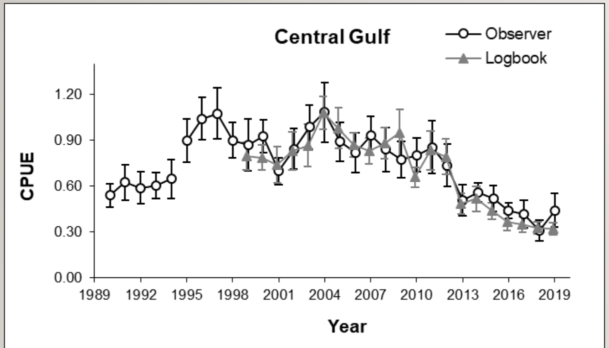
> 50% Age-6 or under

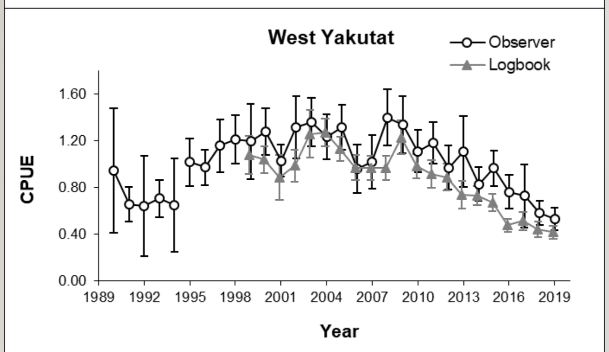
LL SURVEY BY AREA

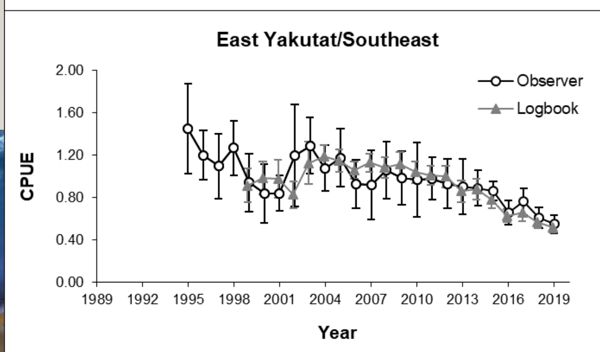


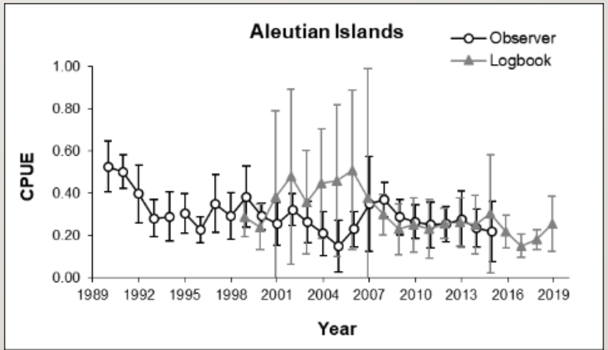


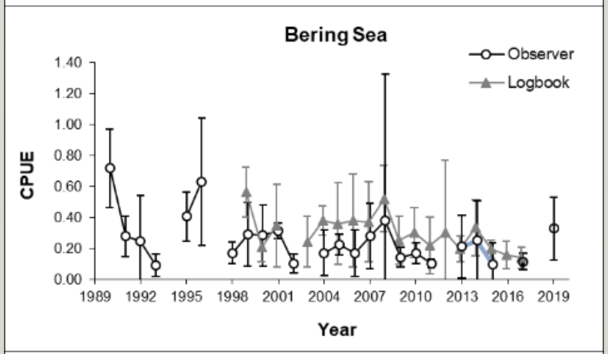
42 FISHERY CPUE BY AREA

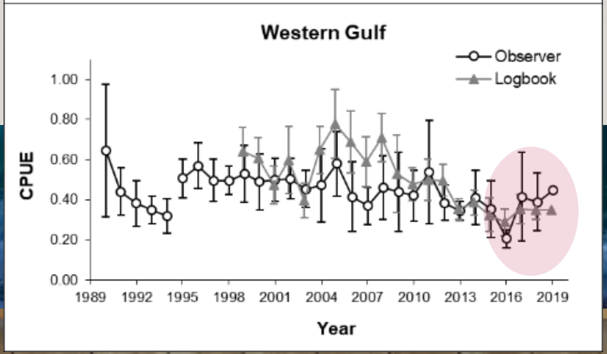








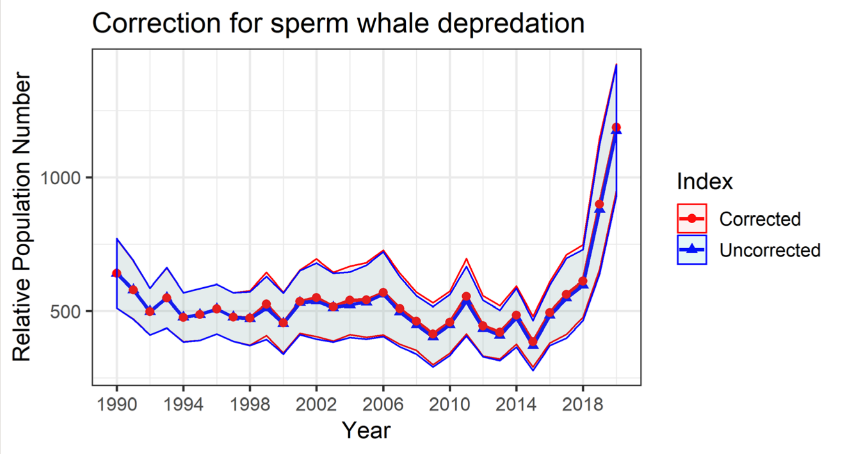


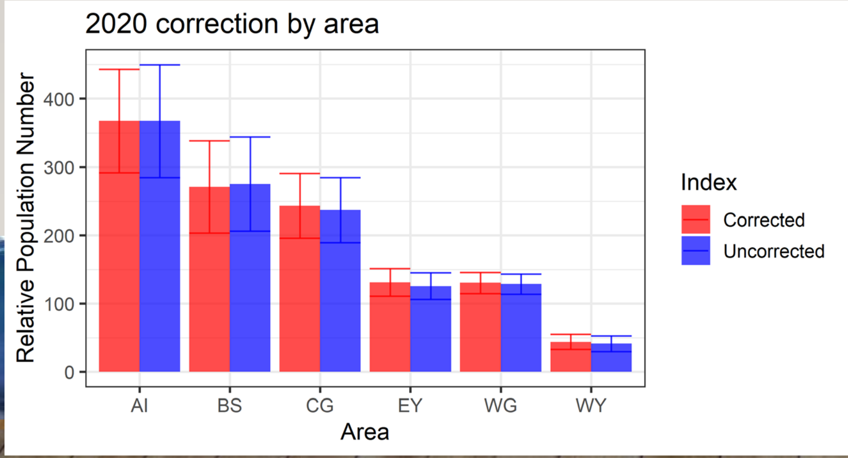


20% increase primarily due to catch rates in western areas

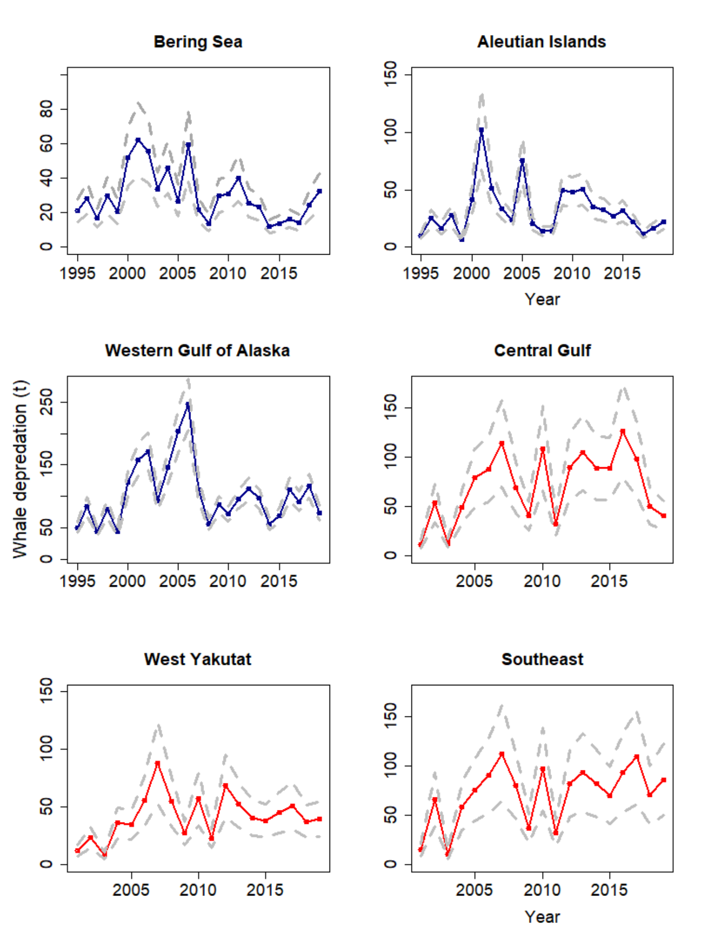
43 WHALE DEPREDATION

Survey Corrections

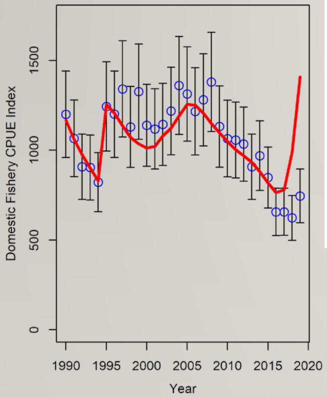




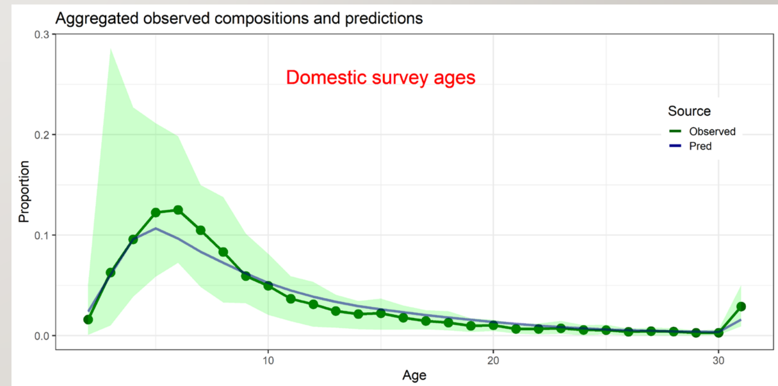
Area Depredation

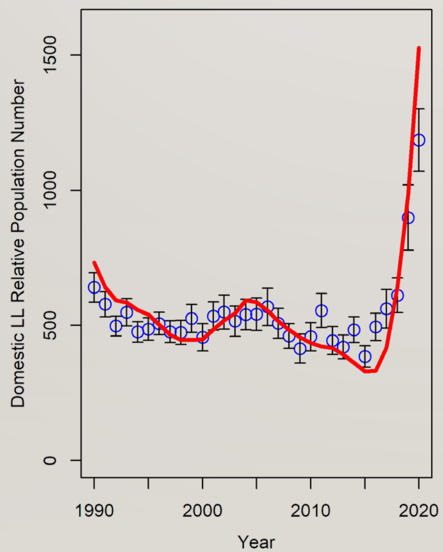


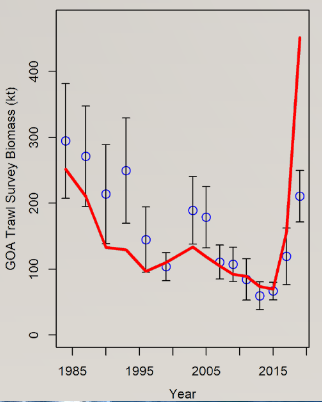
44 MODEL FIT: WHO DO YOU TRUST?

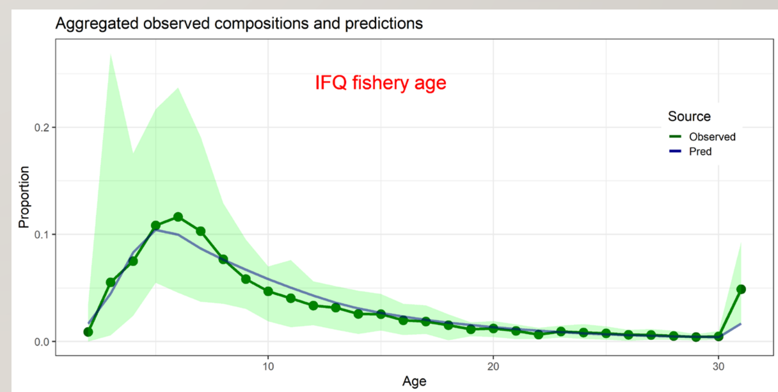


Large year class strength informed by compositional data leads to overpredicting population growth from indices.

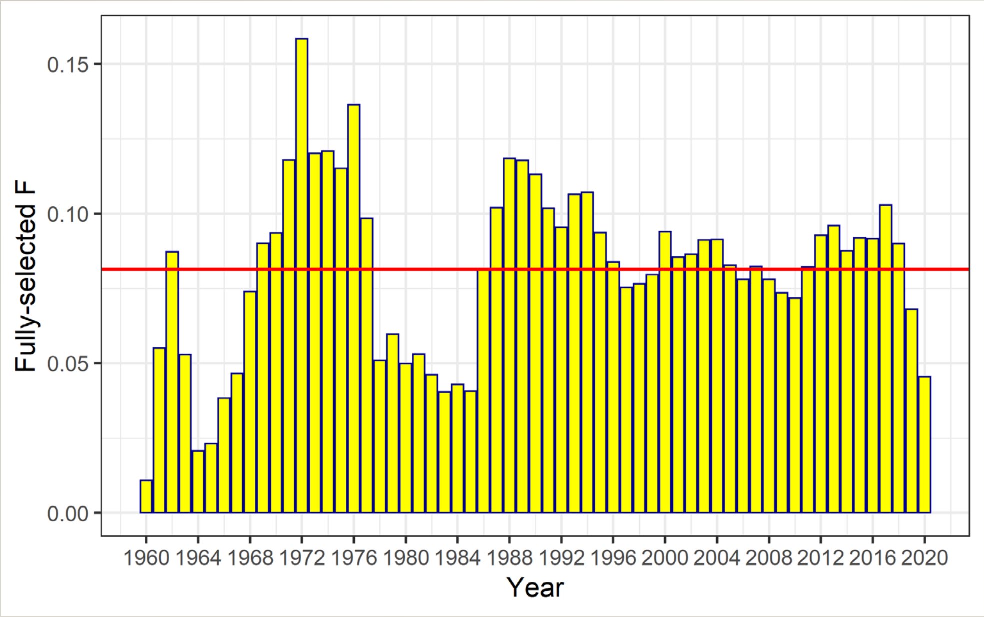


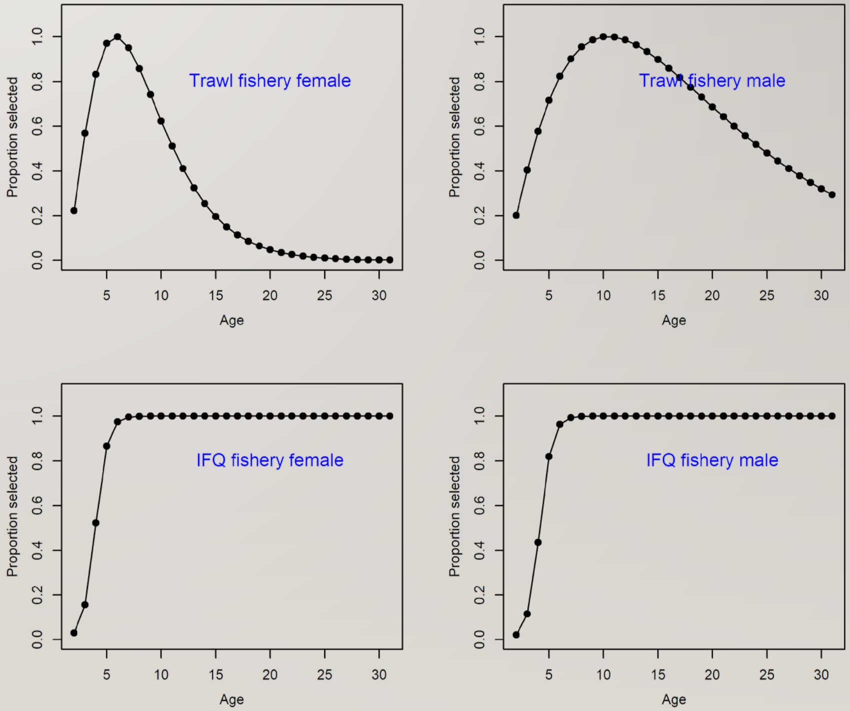




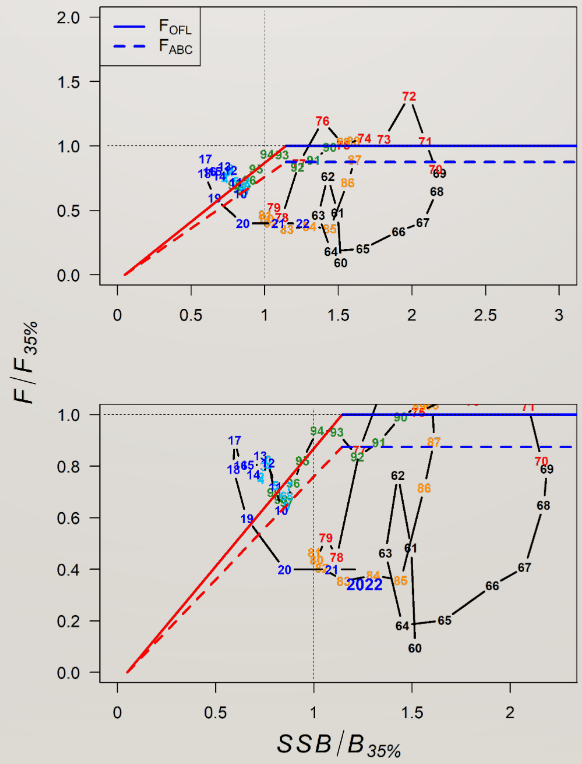


45 DECREASING FISHING MORTALITY

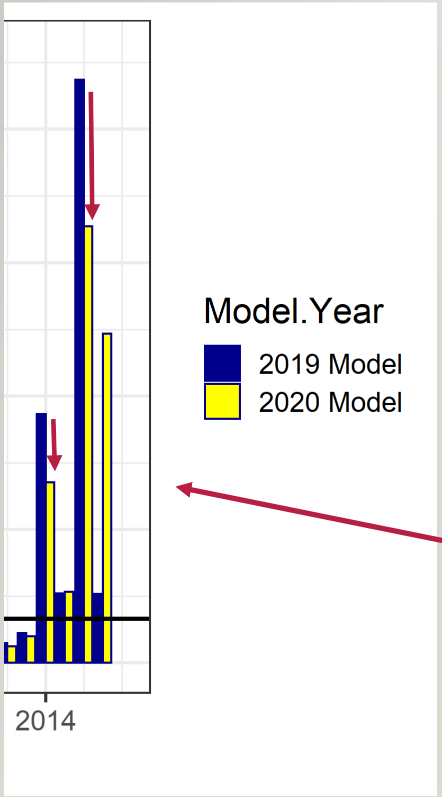


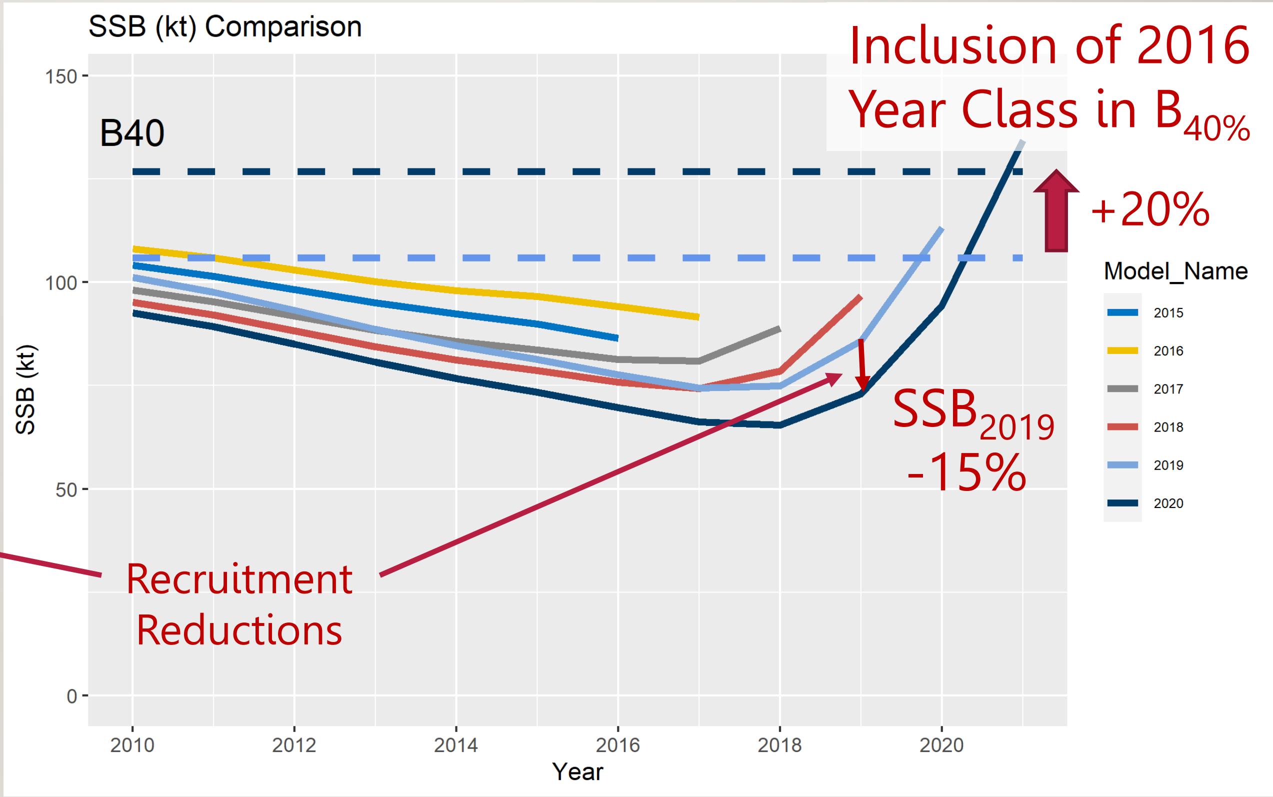


46 # PHASE PLANE DIAGRAM



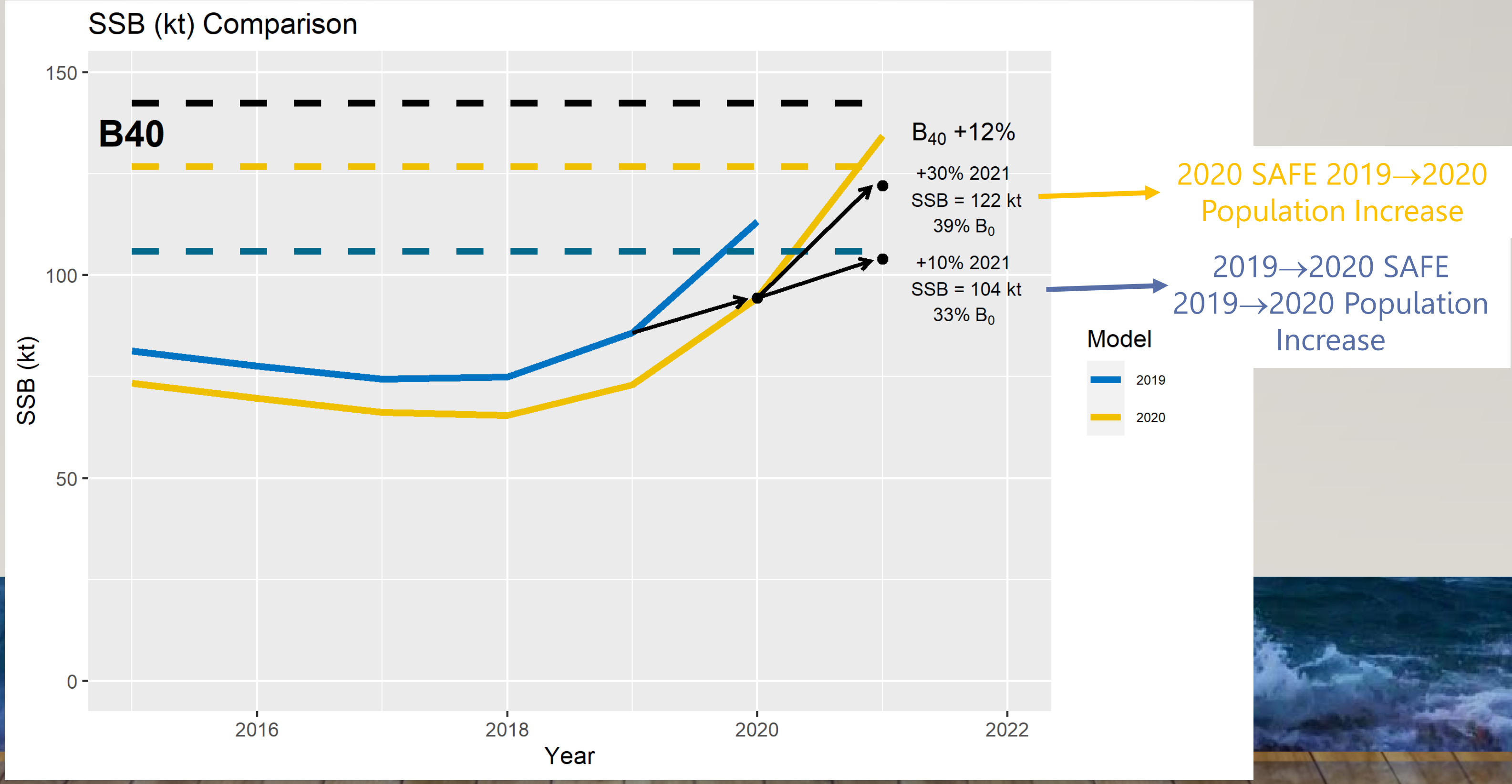
47 SAFE TO SAFE CHANGES



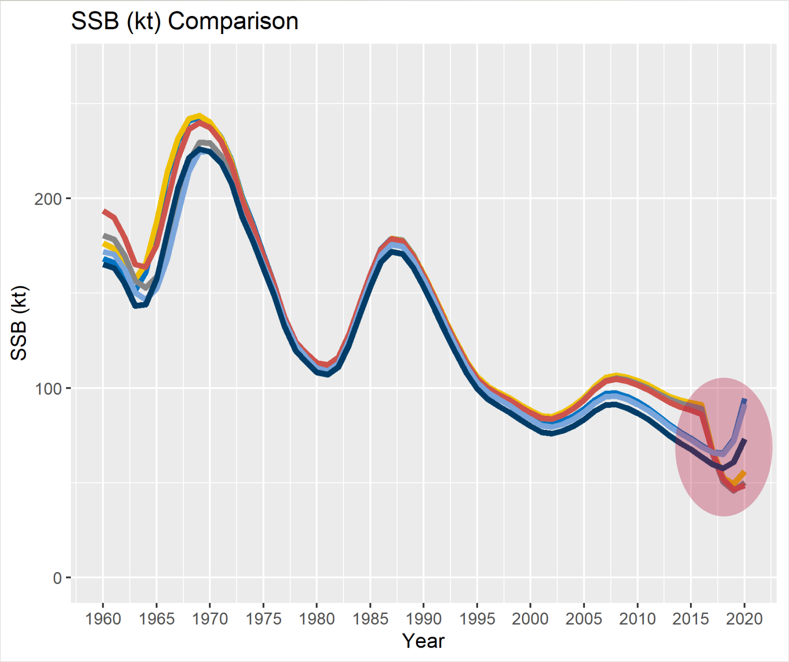


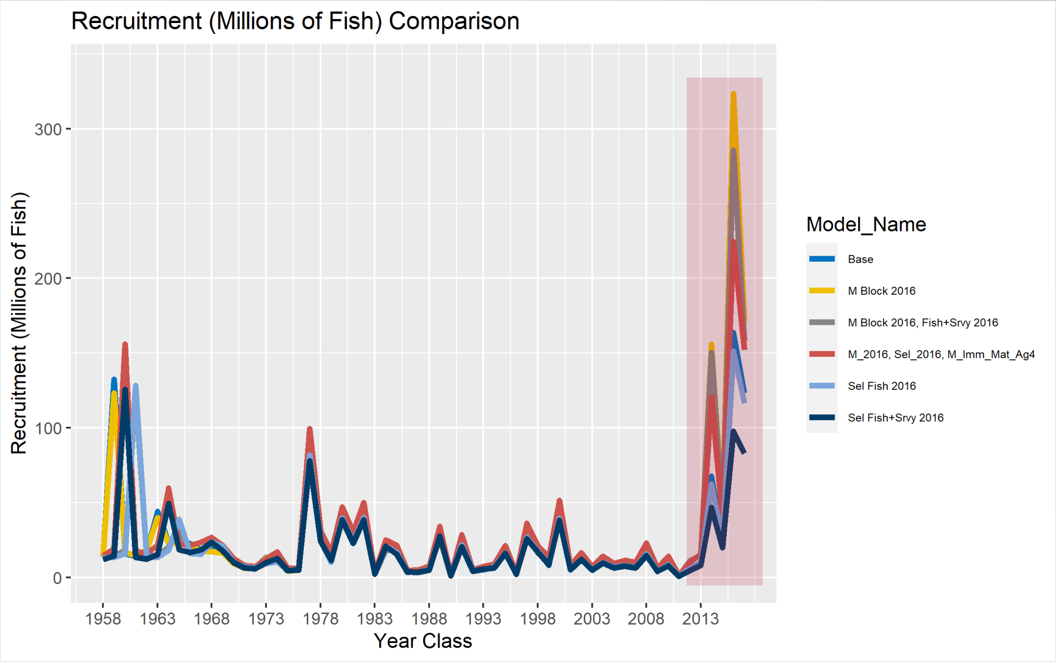
48 EXTRAPOLATED GROWTH

- Assume consistent retrospective patterns and population growth and include 2017 year class in B_{40}

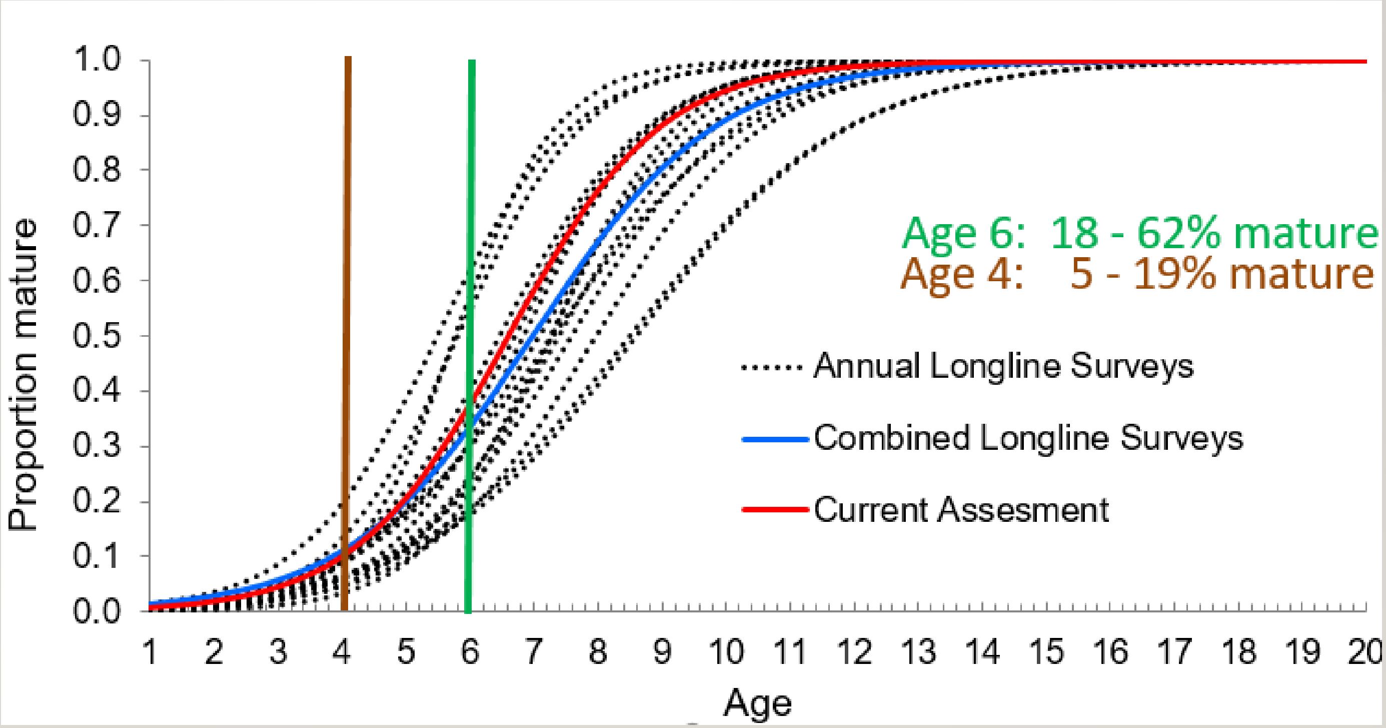


SENSITIVITY RUNS



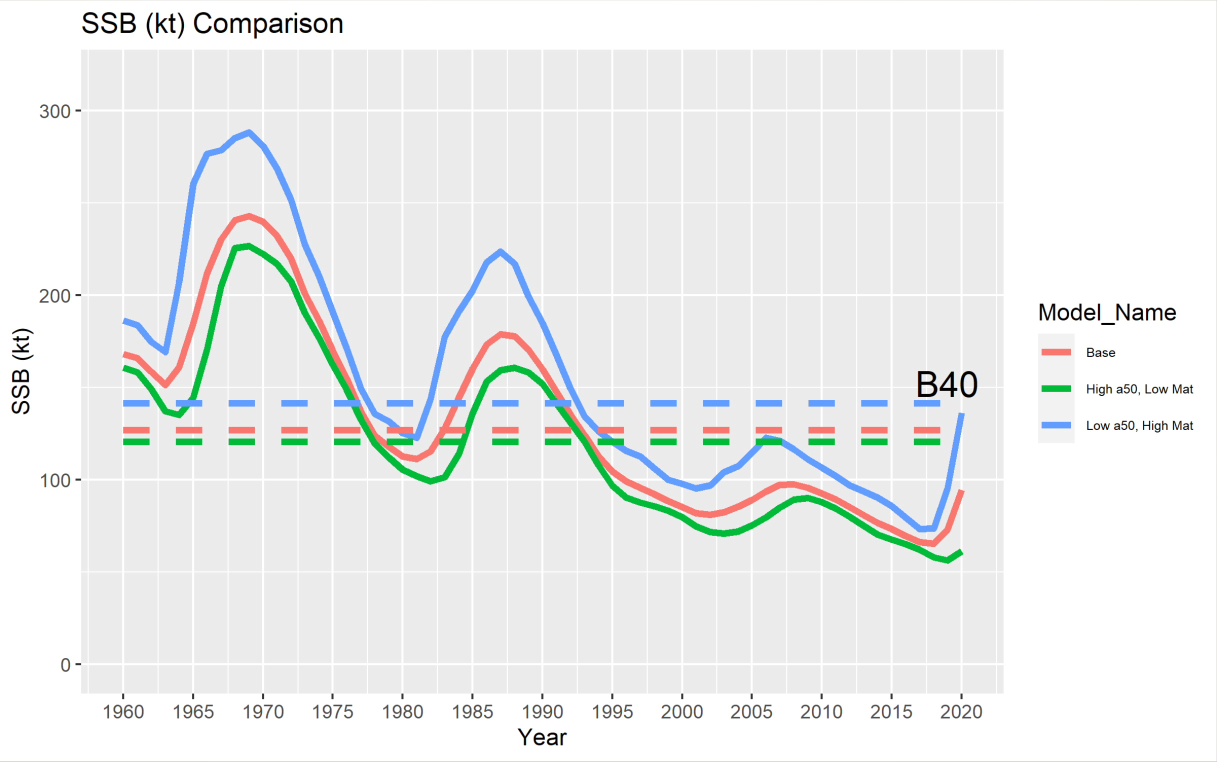


MATURITY


1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Proportion mature
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Age
Age 6: 18 - 62% mature
Age 4: 5 - 19% mature
Annual Longline Surveys
Combined Longline Surveys
Current Assesment

51

SENSITIVITY TO MATURITY RATES



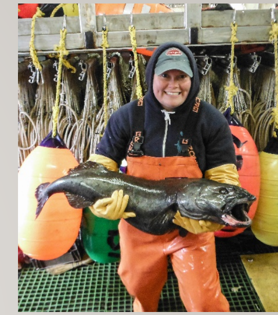
52 WHY CHANGE APPORTIONMENT?

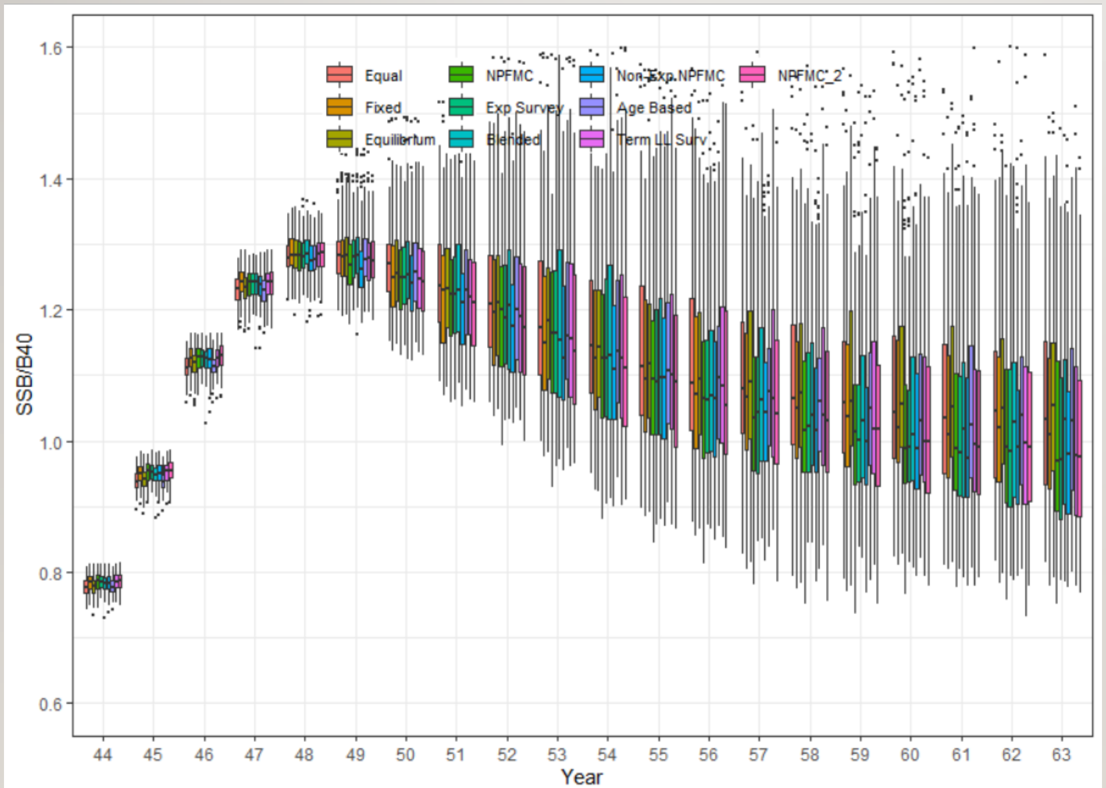
- Biological considerations
  - Changing distributions
  - Age distribution of mortality
- SSC has requested 'resolution' of apportionment
  - Dec 2019: "The SSC notes that the distribution of sablefish has changed considerably since 2013 and there remains a need to resolve how ABC allocations will be derived in the future. The SSC requests that the author finalizes the allocation process no later than September 2020."
  - Dec 2018: "The SSC continues to request that a new apportionment approach be presented next year, noting that the percentages have now been static for many years. The potential for changes in distribution in the fishery and/or the population may become more pronounced with the increasing contribution of the 2014 year class."

ALTERNATE APPORTIONMENTS

- Stakeholders suggested apportioning based on survey distribution of 65+ cm fish
- Used an age-based proxy in simulations
  - Results essentially mimicked Fixed apportionment
- Similar biological concerns as the Fixed strategy
  - Focus removals on diminishing mature cohorts
  - Need to adjust ABC to account for increased removals of older, mature fish (instead of removals from full age/size structure)

54 SIMULATION WORK





ON AVERAGE most apportionment strategies perform similarly given the assumed dynamics.