Alaskan Sablefish Groundfish Joint Plan Team

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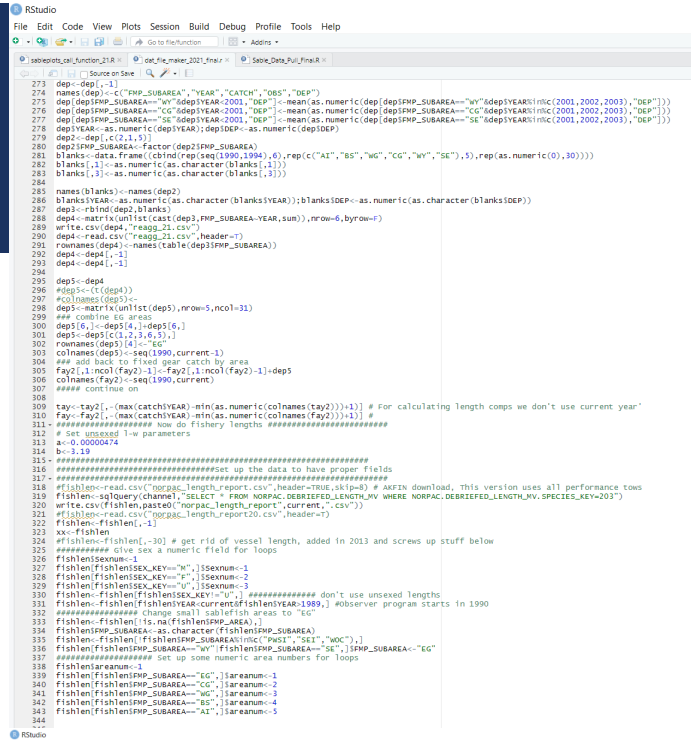
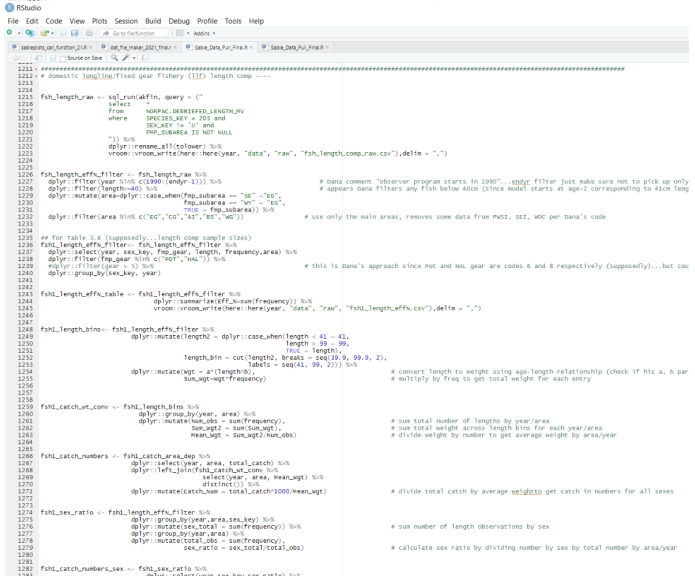
November, 2022

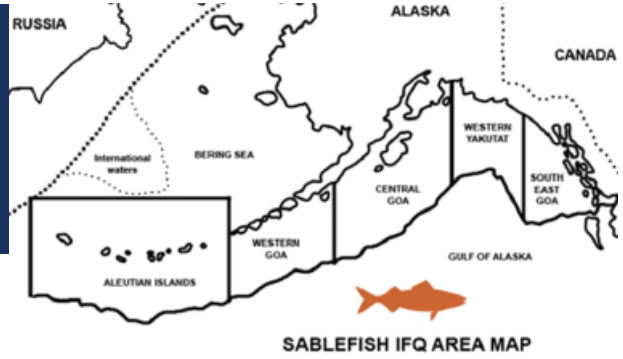
Overview

- Tier: 3a
- Area: Alaska-wide stock (GOA, BS, AI)
- Not overfished, not overfishing, not approaching overfished
- No model changes (SSC accepted model *21.12*)
  - Updated fishery whale depredation time series
  - Reproducibility in data pulls!
  - Logbook data was provided on schedule and the CPUE index was updated through 2021 (not updated for 2021 SAFE)





Summary

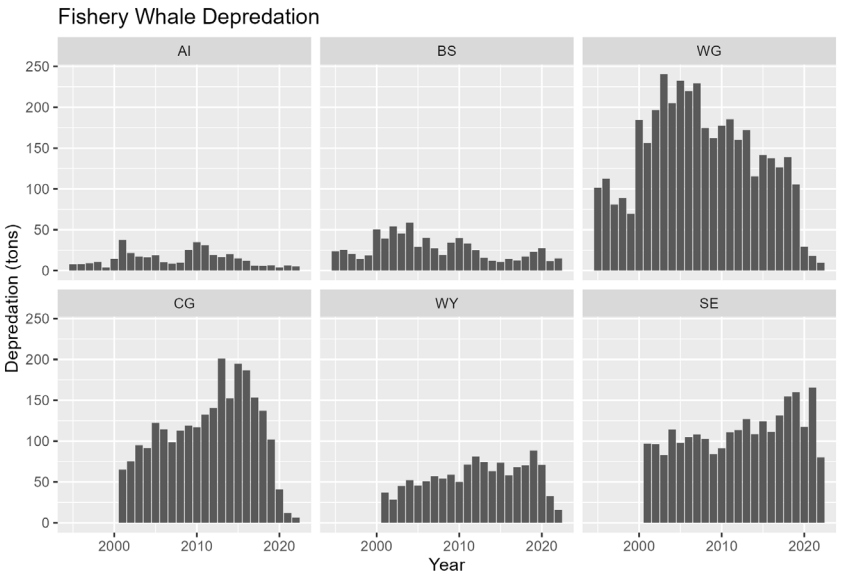


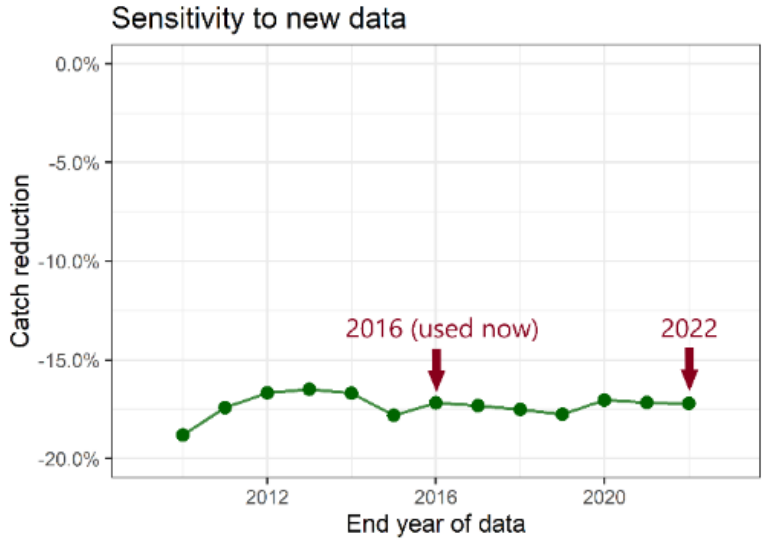
- Continued population growth
  - Spawning stock biomass (SSB) finally demonstrating strong growth
- 2023 Author's ABC = Max ABC = 40,502 t
  - If harvested, this would represent *3rd highest all-time* removals
  - 80 – 90% harvested in recent years, only 65% as of Nov. 8, 2022
- Apportionment based on 5-year average survey biomass proportions by area along with year 3 (75%) of the SSC 4-year stair step in 2023

Year	**2022**				**2023***		**2024***	
Region	OFL_w	ABC_w	TAC	Catch**	OFL_w	ABC_w***	OFL_w	ABC_w***
BS	--	5,264	5,264	4,548	--	8,417	--	10,145
AI	--	6,463	6,463	2,067	--	8,884	--	10,299
GOA	--	22,794	22,794	15,291	--	23,201	--	21,095
WGOA	--	3,727	3,727	2,264	--	4,473	--	4,626
CGOA	--	9,965	9,965	6,294	--	9,921	--	8,819
***WYAK	--	3,437	3,437	2,462	--	3,205	--	2,669
***EY/SEO	--	5,665	5,665	4,271	--	5,602	--	4,981
Total	40,432	34,521	34,521	21,906	47,390	40,502	48,561	41,539

PT and SSC Comments

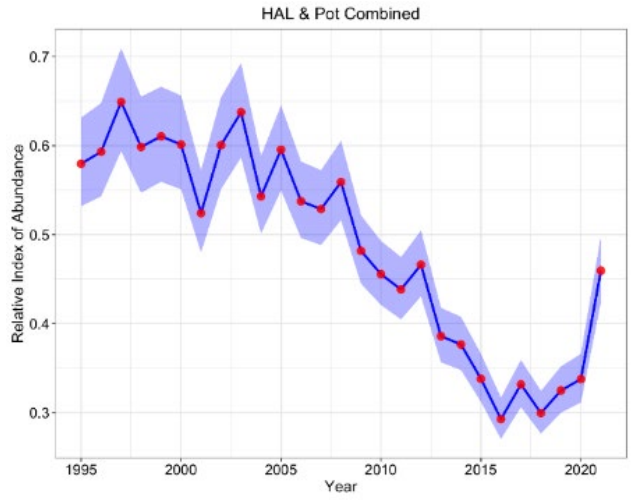
- *The SSC requests that the method for accounting for whale depredation be updated to reflect the additional years of data now available since its development. However, the SSC recognized that the contribution to the overall mortality appears to be low (given current methods) and therefore the priority of this work may be lower than some other issues.*
  - M. Williams (The Ocean Conservancy) updated her work from 2016 on whale depredation and these new estimates were included in the model.
  - D. Hanselman explored the impact of depredation on the longline survey and found no strong time trends; the survey whale correction factor was not updated.
- *This assessment has identified a broad spectrum in the age structure as a biological objective. The SSC suggests that specific hypotheses on why this is the case for sablefish would be helpful to review how important it is and to structure future research.*
  - MSE work is planned, but waiting on search for post-doctoral researcher to be completed.
- *Evaluate what information is available on the sex-ratio of the commercial catch. To the degree that dimorphic growth is present in this species, and the economic incentive to target larger fish, the current assumption of equal sex-ratio in the catch could be improved.*
  - To clarify, sex-specific selectivity in the model results in deviations from equal sex ratio in the catch (though it is assumed equal at recruitment). Further work into sex ratio and sex-specific selectivity is planned in the near future.
- *The Team noted that maturity-at-age, including the influence of skip spawning, should remain a research priority.*
  - C. Rodgveller has continued research on skipped spawning, but funding limitations have limited data collection.





PT and SSC Comments

- *Following the SSC recommendation from October 2021, the SSC requests further consideration of alternative methods for constraining time-varying selectivity as an alternative to a single time-block. In particular, the SSC requests that the authors develop a method (e.g., random walk, autoregressive) that can allow the data to update the model structure and avoid annual evaluation of when bias in selectivity has reached a threshold beyond which it can no longer be ignored. Further, the SSC encourages consideration of adding a fleet to the model or to allow greater flexibility in the shape of the selectivity curve to better represent the growing importance of pot gear.*
  - Ongoing work at UAF (M. Cheng, C. Cunningham) to explore selectivity parametrization and modeling pot gear as a unique fleet.
  - Next year will explore updating CPUE index to include pot gear data and standardization techniques (based on work by M. Cheng).
  - Because pot catch is now > 80% of fixed gear catch, the most parsimonious assessment parametrization may be to retain current fleet structure and 2016 selectivity time block.



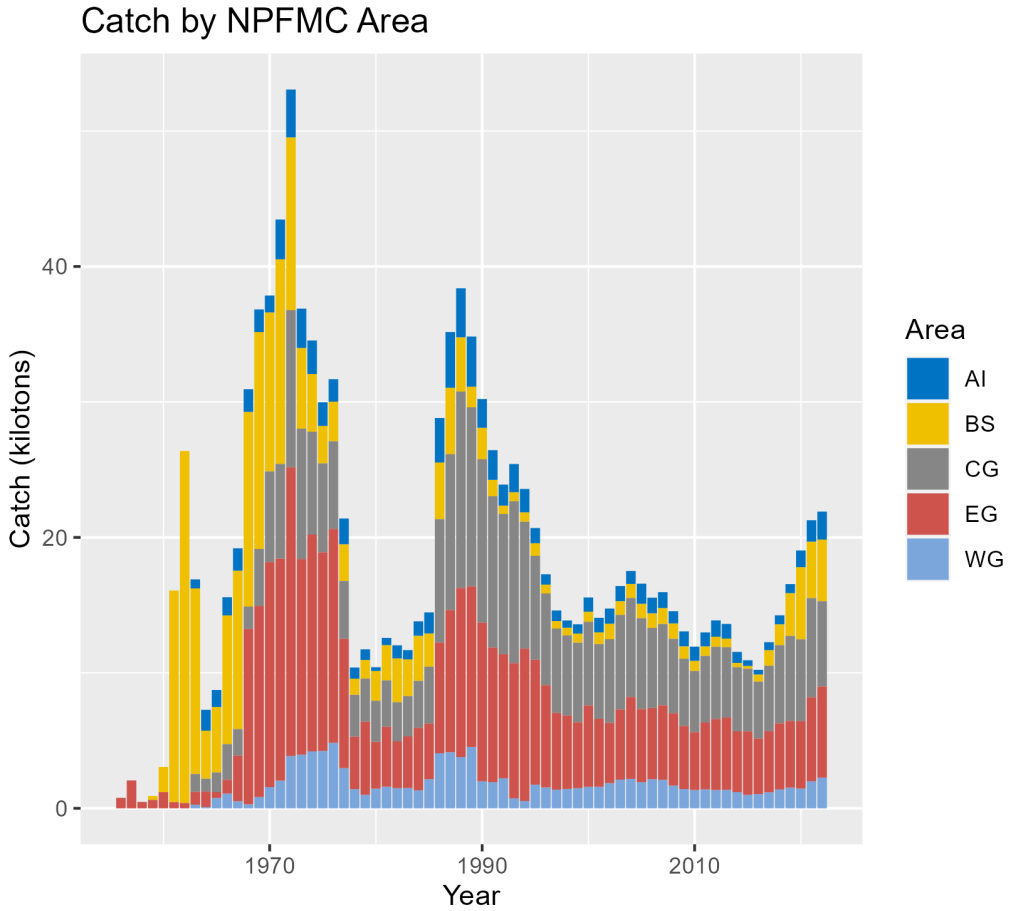
Data Summary

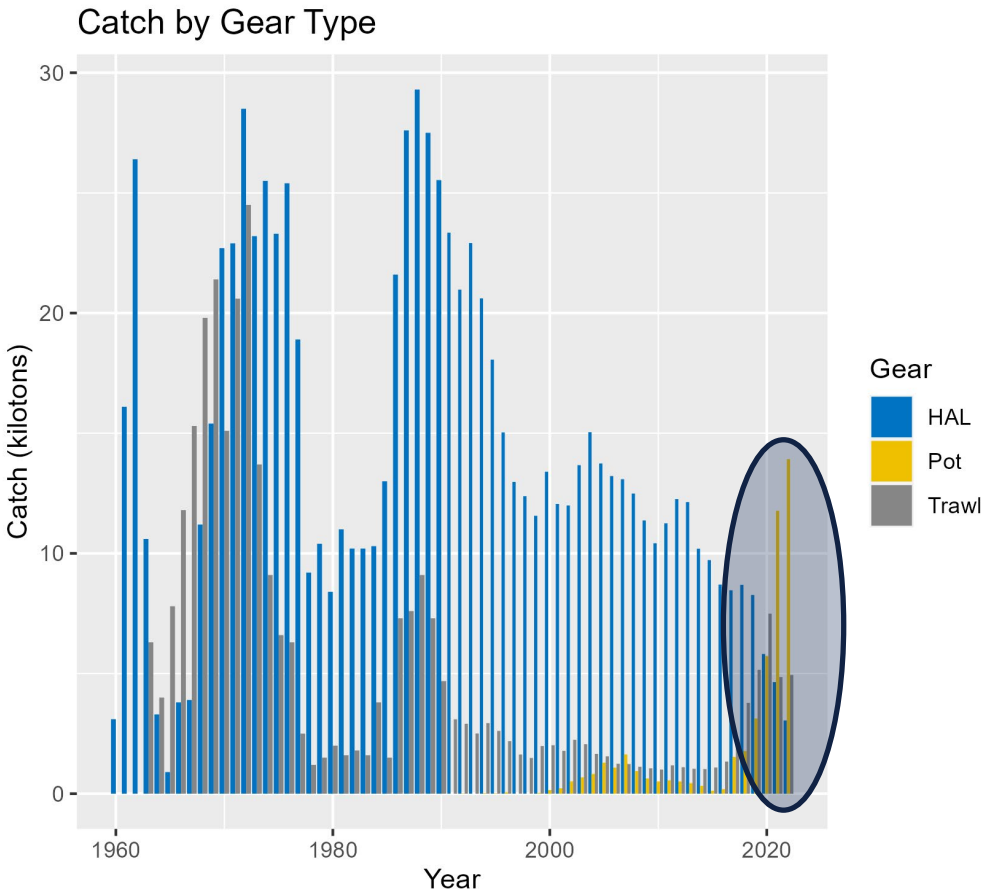
- New data for 2022 in bold

Source	Data	Years
Fixed gear fisheries	Catch	1960 – **2022**
Trawl fisheries	Catch	1960 – **2022**
Japanese longline fishery	Catch-per-unit-effort (CPUE)	1964 – 1981
U.S. fixed gear fishery	CPUE, length	1990 – **2021**
	Age	1999 – **2021**
U.S. trawl fisheries	Length	1990, 1991, 1999, 2005 – **2021**
Japan-U.S. cooperative longline survey	RPNs, length	1979 - 1994
	Age	1981, 1983, 1985, 1987, 1989, 1991, 1993
Domestic longline survey	RPNs, length	1990 – **2022**
	Age	1996 – **2021**
NMFS GOA trawl survey	Biomass index	1984, 1987, 1990, 1993, 1996, 1999, 2003, 2005, 2007, 2009, 2011, 2013, 2015, 2017, 2019, 2021
	Lengths	1984, 1987, 1990, 1993, 1996, 1999, 2003, 2005, 2007, 2009, 2011, 2013, 2015, 2017, 2019, 2021

Catch

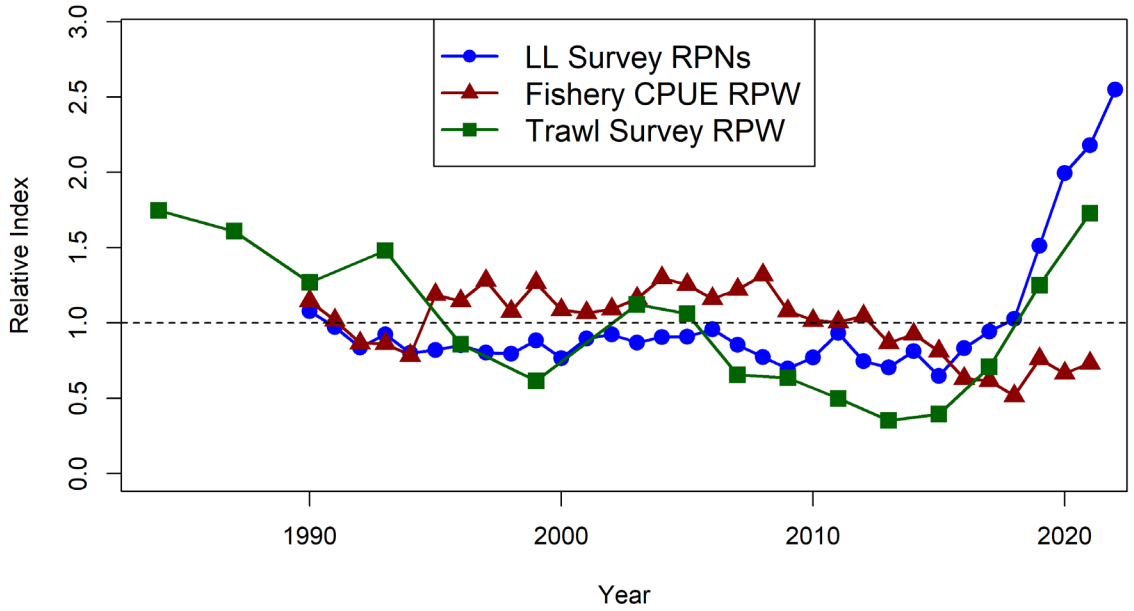
- Catch in pot gear increasing rapidly





Survey

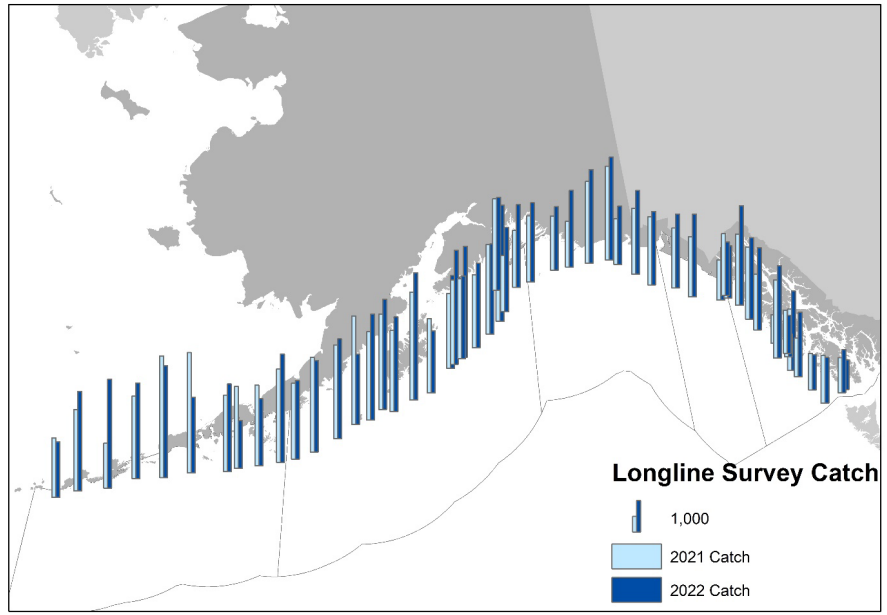
- Longline survey continues to demonstrate strong increases in relative population numbers
- BSAI constitutes > 50% of survey biomass in 2022



17% Increase

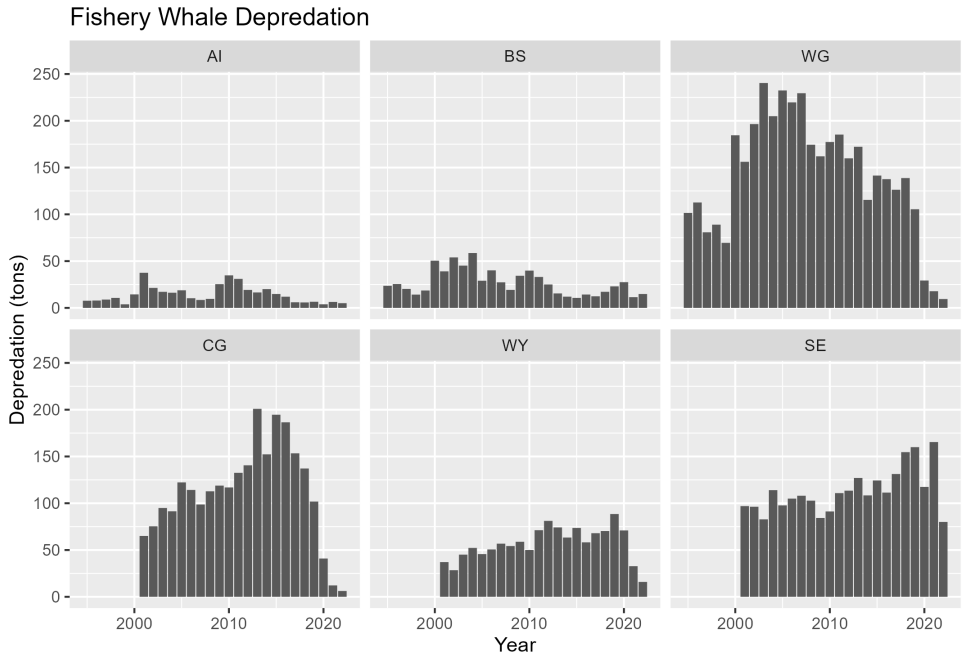
40% Increase (in 2021)

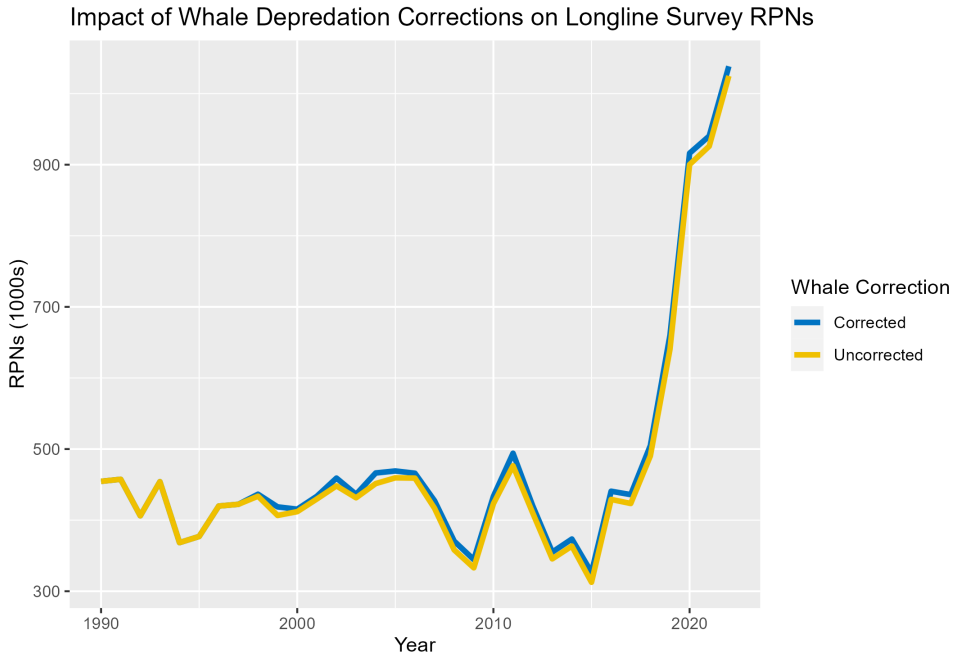
CPUE Increasingly Unreliable due to Increase in Pot Gear



Whale Depredation

- Fishery whale depredation model and time series updated (M. Williams)
  - Increased depredation on remaining hook-and-line gear
  - Overall depredation decreasing, because the majority of fixed gear catch comes from pots
- Depredation on longline survey is limited (13 stations with observed depredation in 2022)



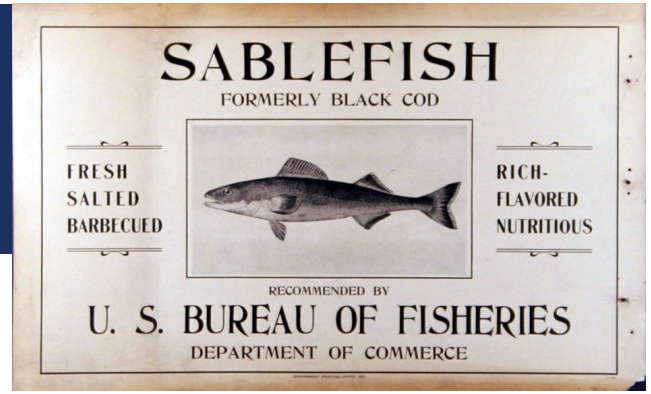


Model Structure (*21.12*)

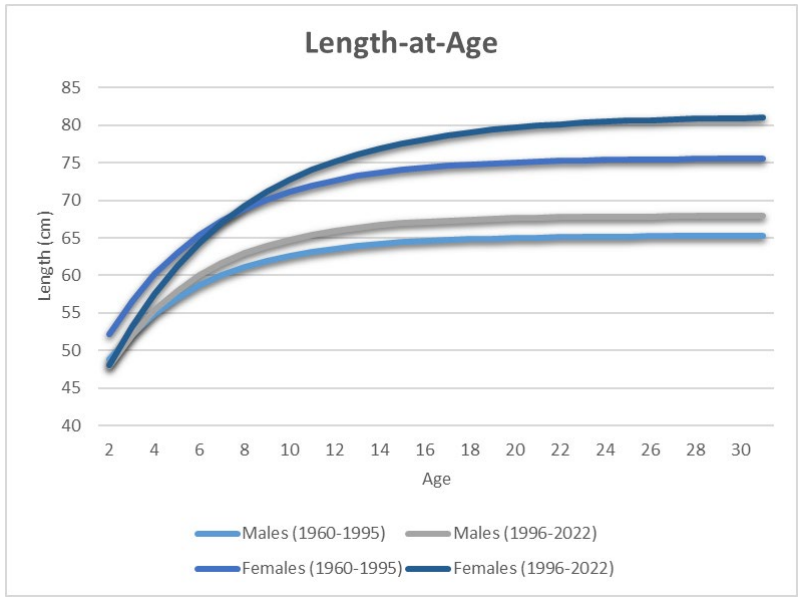
- 1 area, sex-disaggregated, age structured (SCAA in ADMB)
  - Years 1960 to 2022
  - Ages 2 – 31+
- Biological parameters input (length-,weight-, maturity-at-age)
- Natural mortality estimated with prior (time-/age-invariant)
- No stock-recruit functional form, assume yearly deviations from average recruitment
  - Recruitment at age-2, assume a 50:50 sex ratio at birth
  - Terminal year recruitment (2020 year class) fixed at average value
  - Use recruit deviations to estimate initial age structure (i.e., year classes born prior to 1960)
- Each fleet (fishery and survey) has independent, sex-specific selectivity (with some shared parameters across time blocks and sexes)
  - Longline survey and fixed gear fishery assume logistic selectivity with 2016 time block and a post-IFQ (1995) fishery block
  - Trawl survey selectivity assumes power function (exponential decay)
  - Trawl fishery assumes domed selectivity (gamma function)
- Catchability parameters freely estimated for each index (including CPUE)
- Fishing mortality estimated with yearly deviations for each fleet

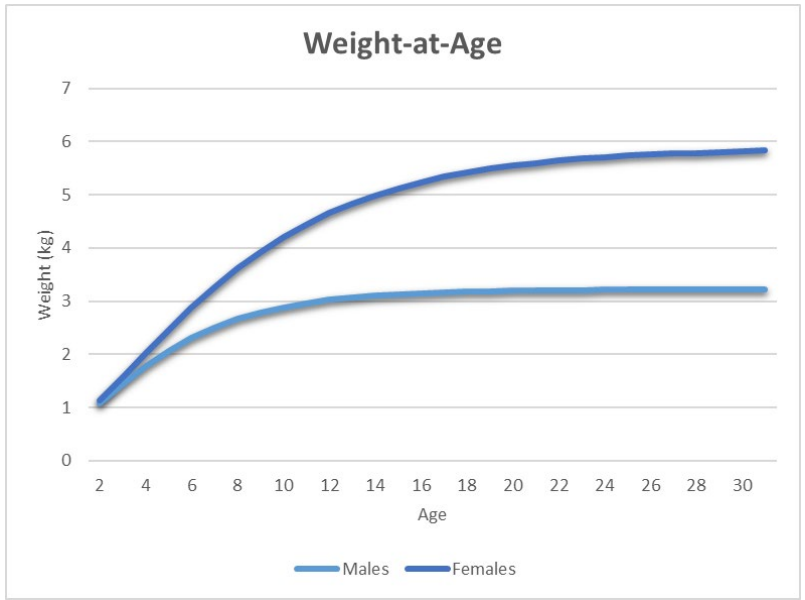
Parameter Name	Symbol	Number of Parameters
Catchability	q	7
Mean recruitment	μ_r	1
Natural mortality	M	1
SSB-per-recruit levels	$F_{35\%}$, $F_{40\%}$, $F_{50\%}$	3
Recruitment deviations	τ_y	90
Average fishing mortality	μ_f	2
Fishing mortality deviations	φ_y	126
Fishery selectivity	fs_a	15
Survey selectivity	ss_a	10
Total		255

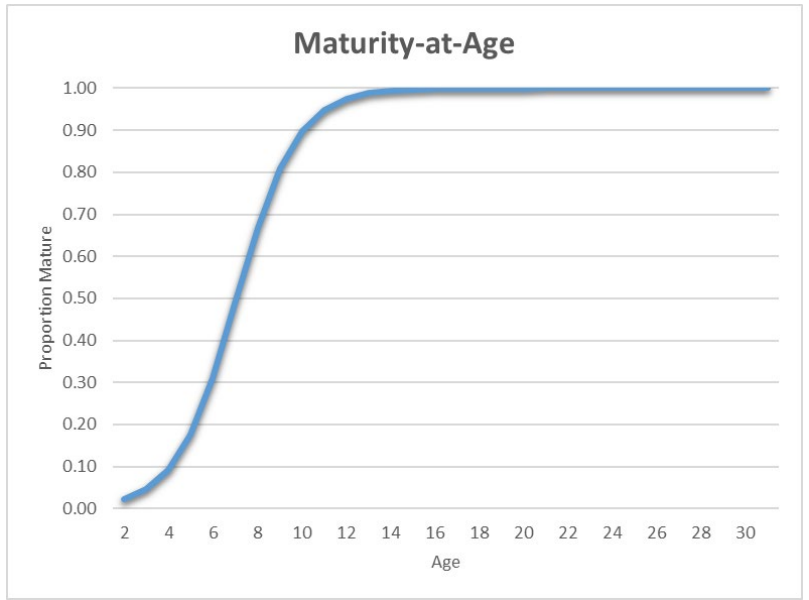
Biological Inputs



- Updated in 2021
  - Two growth time blocks (pre-/post-1995)
  - One weight time block due to unreliable weight data prior to 1996
  - One maturity time block based on histological samples
- Ageing error incorporated based on known-age otoliths
- Internally convert catch-at-age to catch-at-length using input size-at-age conversions



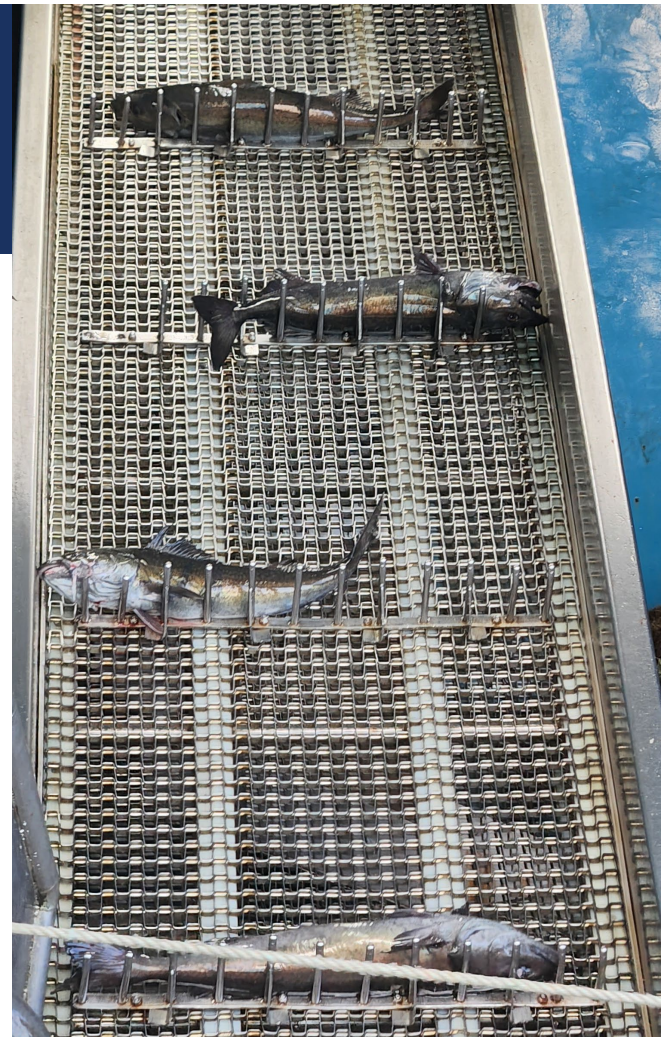




Francis Reweighting

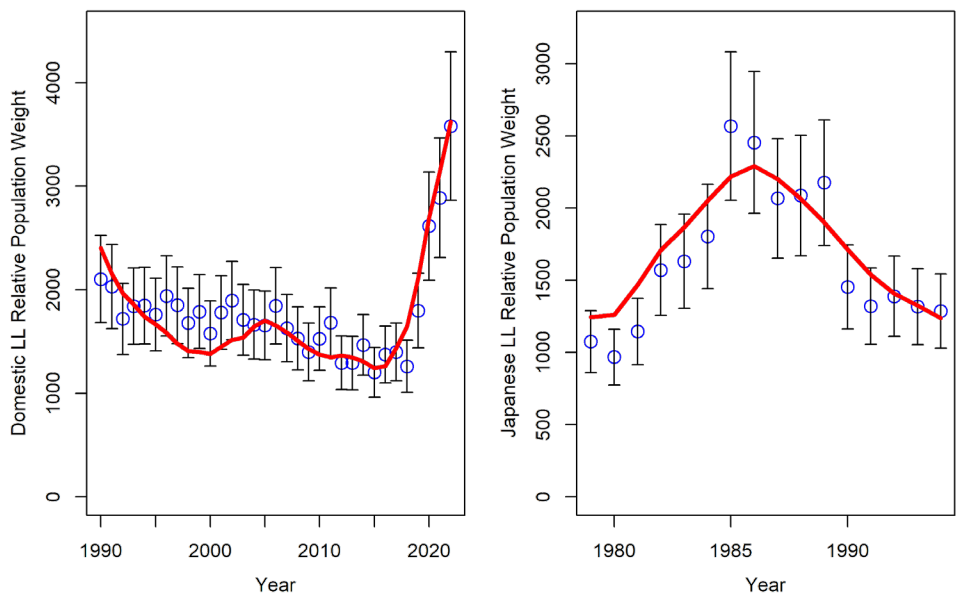
- Francis reweighting run each year when new data added to the model
- Fixed survey weights
- Tends to upweight length compositions at cost of age compositions

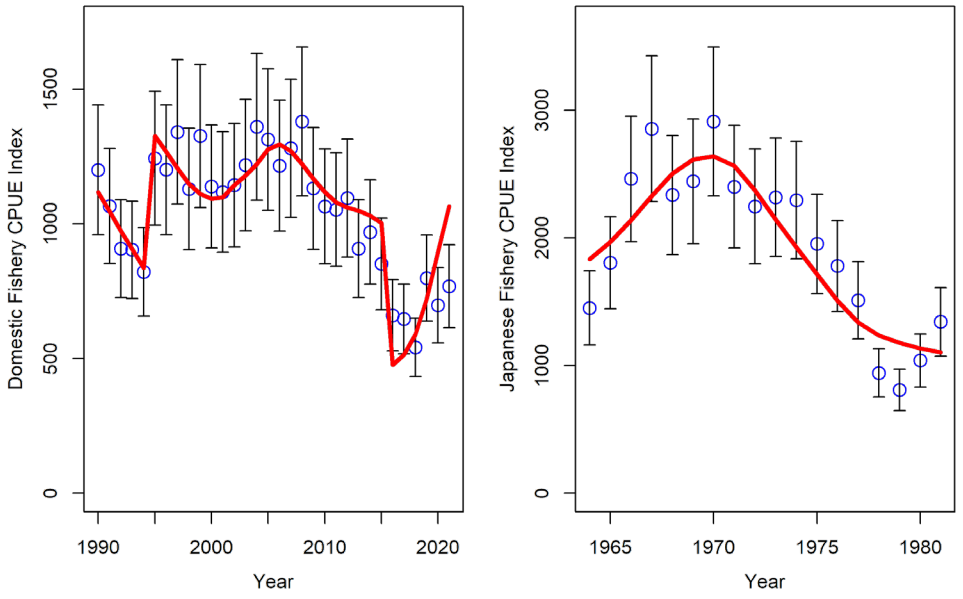
Data Source	2021	2022
Fixed Gear Catch	50.000	50.000
Trawl Catch	50.000	50.000
Longline Survey RPN	0.448	0.448
Coop Survey RPN	0.448	0.448
Fixed Gear Fishery CPUE	0.448	0.448
Japan Longline Fishery CPUE	0.448	0.448
Trawl Survey RPW	0.448	0.448
Fixed Gear Age Composition	0.774	0.799
Longline Survey Age Composition	4.006	3.961
Coop Longline Survey Age Composition	1.209	1.142
Fixed Gear Fishery Length Composition Males	6.078	5.592
Fixed Gear Fishery Length Composition Females	5.340	5.099
Trawl Fishery Size Composition Males	0.299	0.272
Trawl Fishery Size Composition Females	0.383	0.372
Longline Survey Size Composition Males	1.514	1.389
Longline Survey Size Composition Females	1.633	1.658
Coop Survey Size Composition Males	1.070	1.086
Coop Survey Size Composition Females	1.454	1.622
Trawl Survey Size Composition Males	0.372	0.599
Trawl Survey Size Composition Females	0.410	0.773

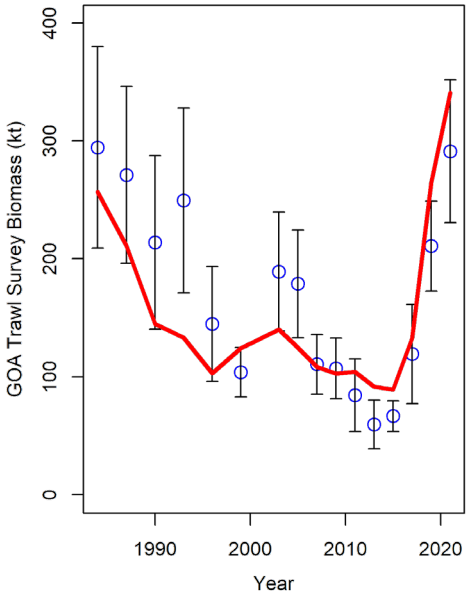


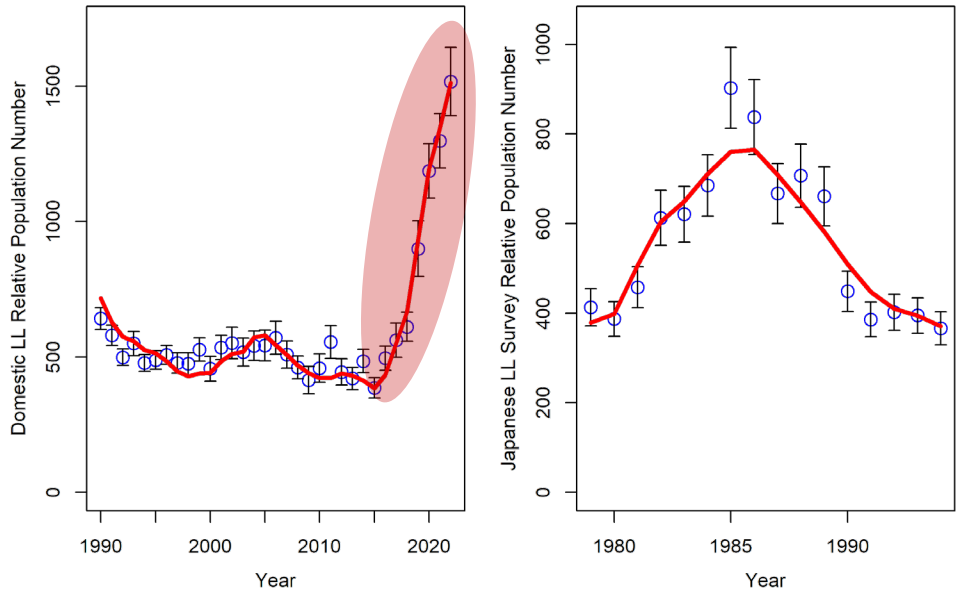
Fit to Indices

- Generally adequate fits to indices of abundance
- CPUE index fit poor in recent years, but may not be reliable given that it does not include pot gear data
- Reduced fit to trawl survey biomass since 2021 SAFE





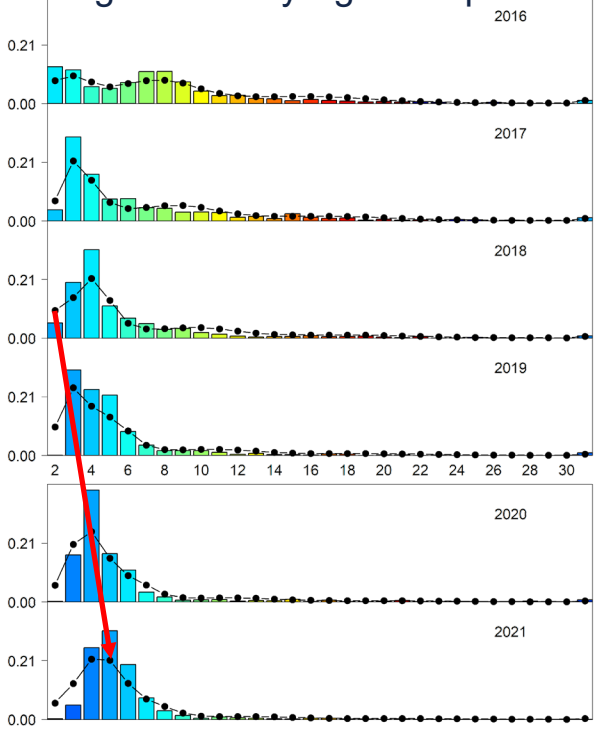


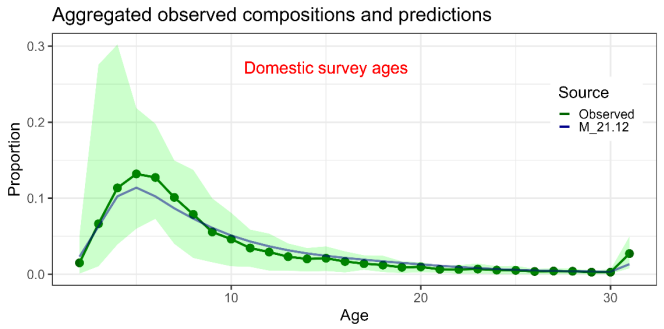


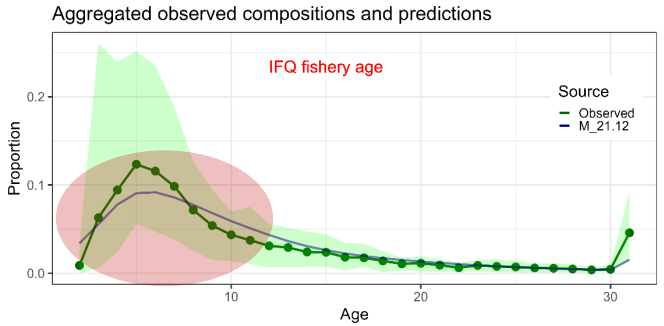
Fit to Compositional Data

- Continued trend of overestimating abundance at age-2 and underestimating at age-4
- Adequately model cohort decay
- Habitually underestimating 2016 year class as it ages

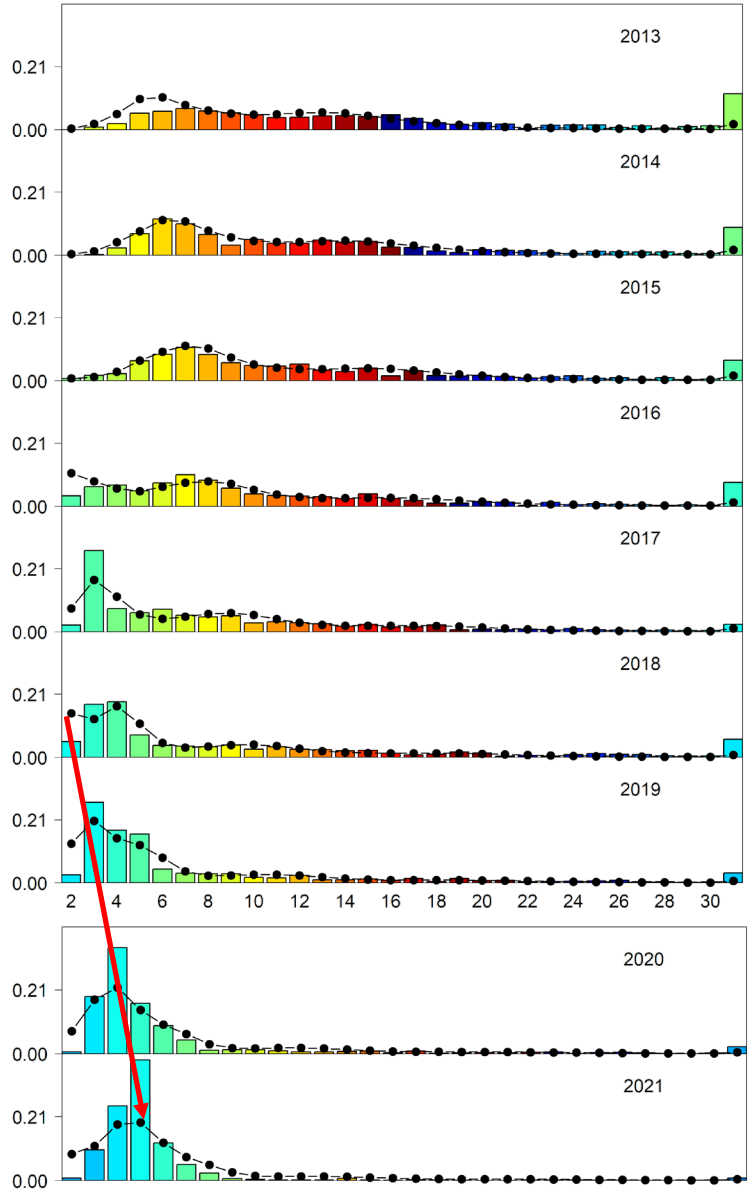
Longline Survey Age Compositions







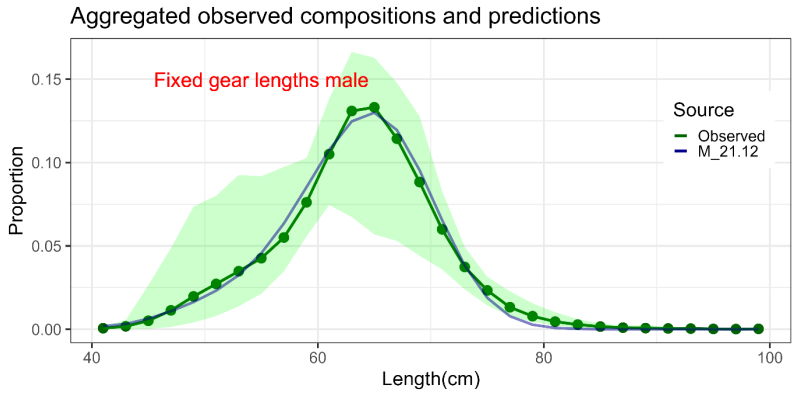
Fixed Gear Fishery Age Compositions

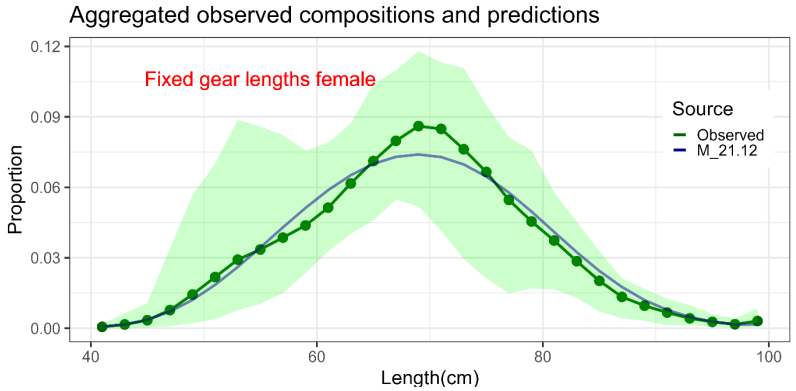


Fit to Compositional Data

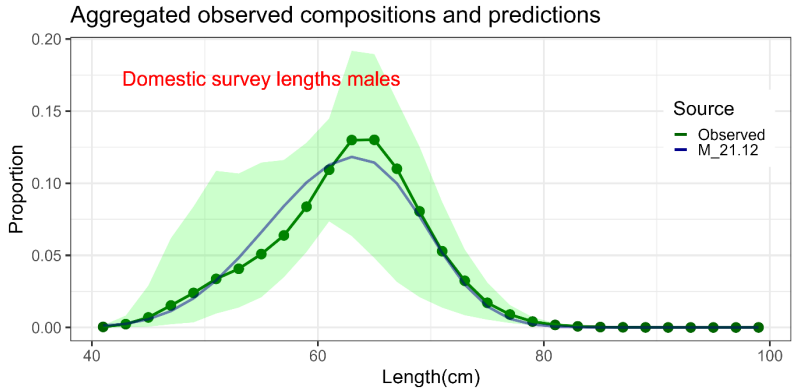
- Likely overfitting fishery length compositions
- Unknown impact of fitting sex-aggregated age compositions compared to sex disaggregated length compositions

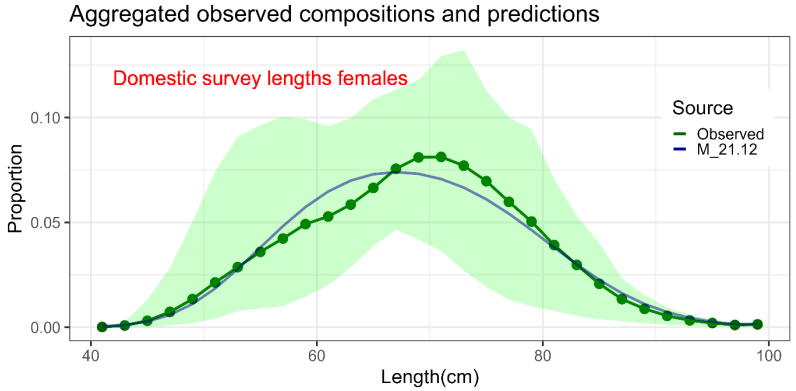
Fixed Gear Fishery





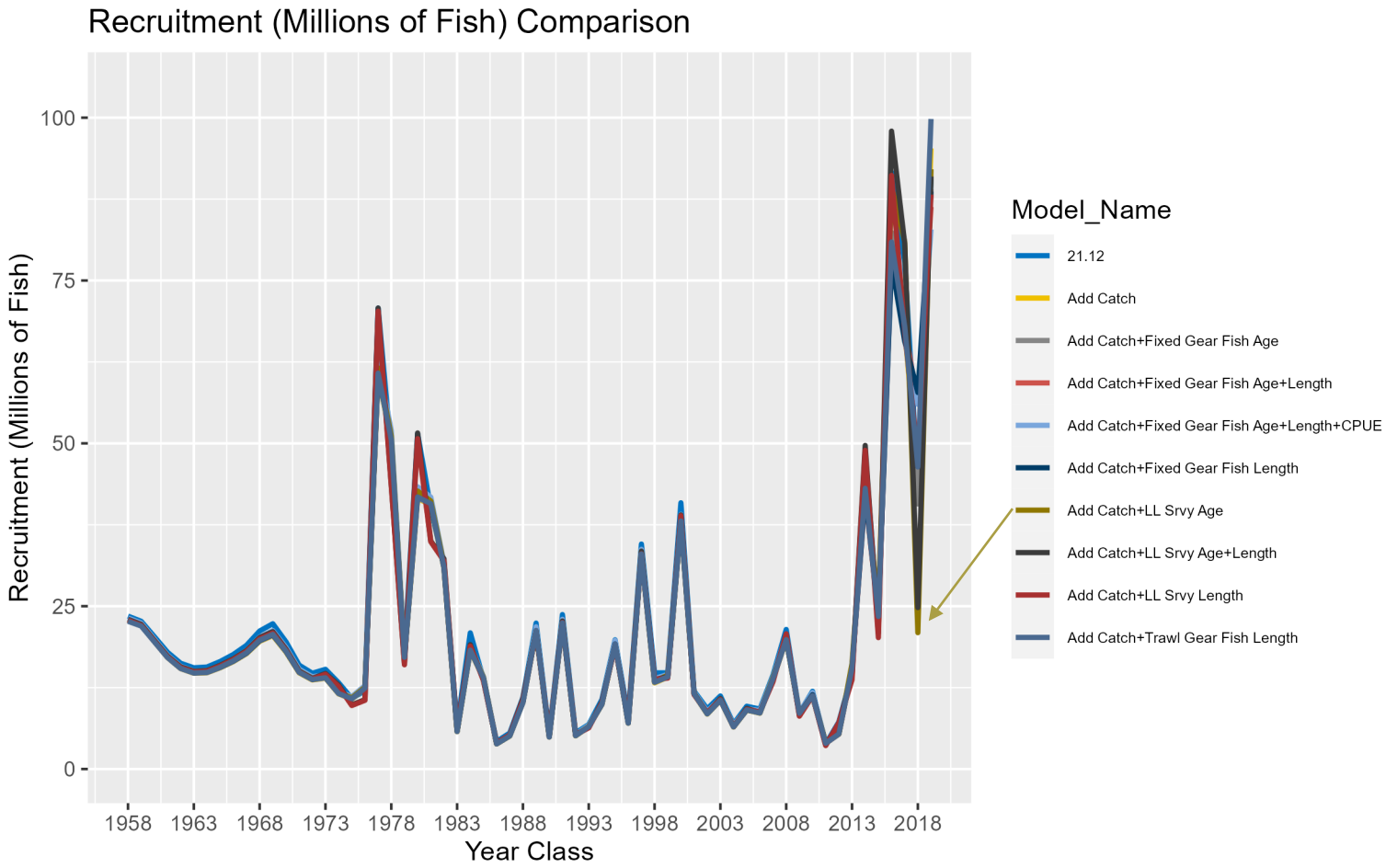
Longline Survey





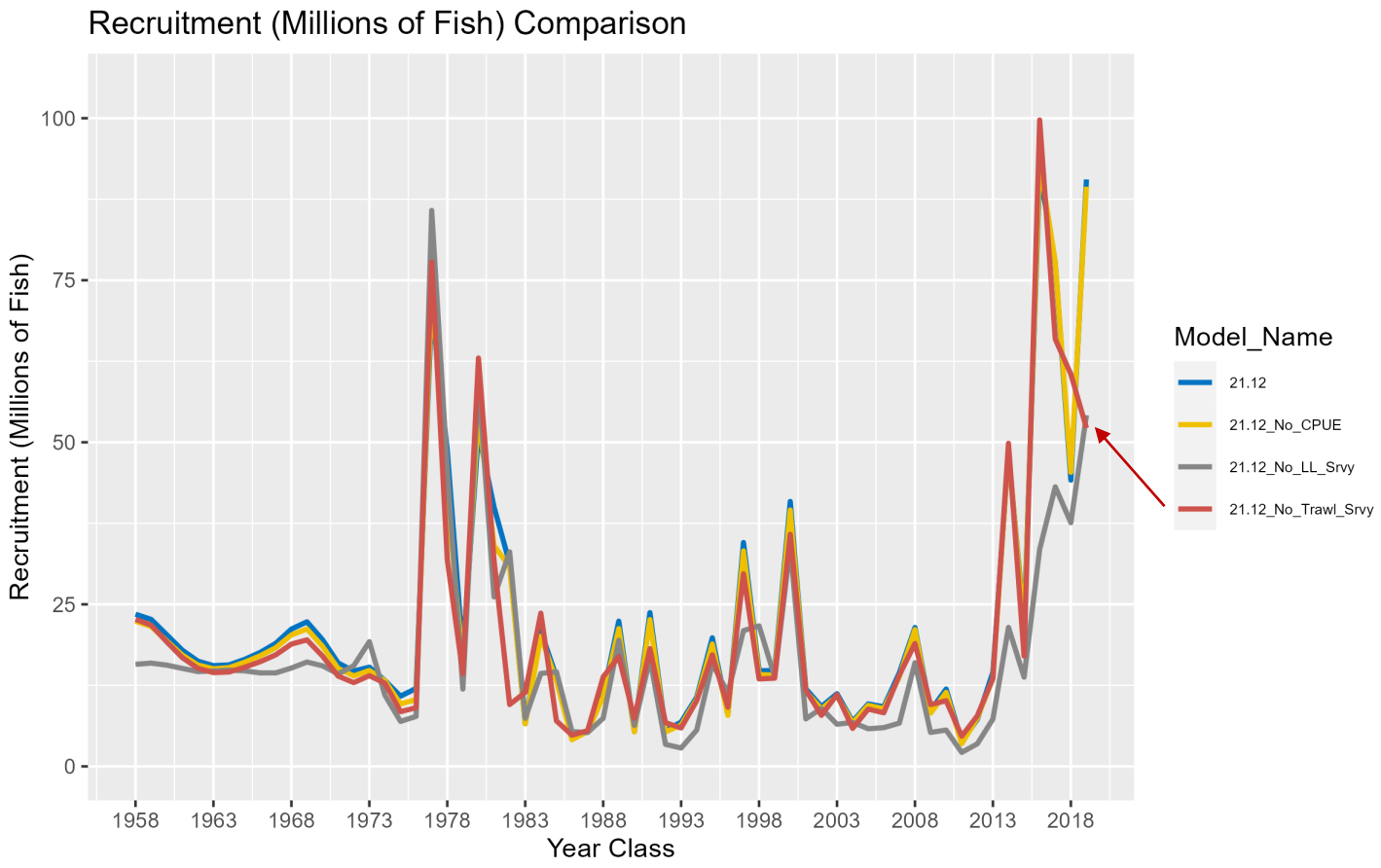
Impact of Data Updates

- Updated LL survey age data suggests reduction in 2018 year class
  - Increase in 2017 year class
  - Predicted in 2021 SAFE
- Considerably stronger agreement regarding the large size of the 2019 year class



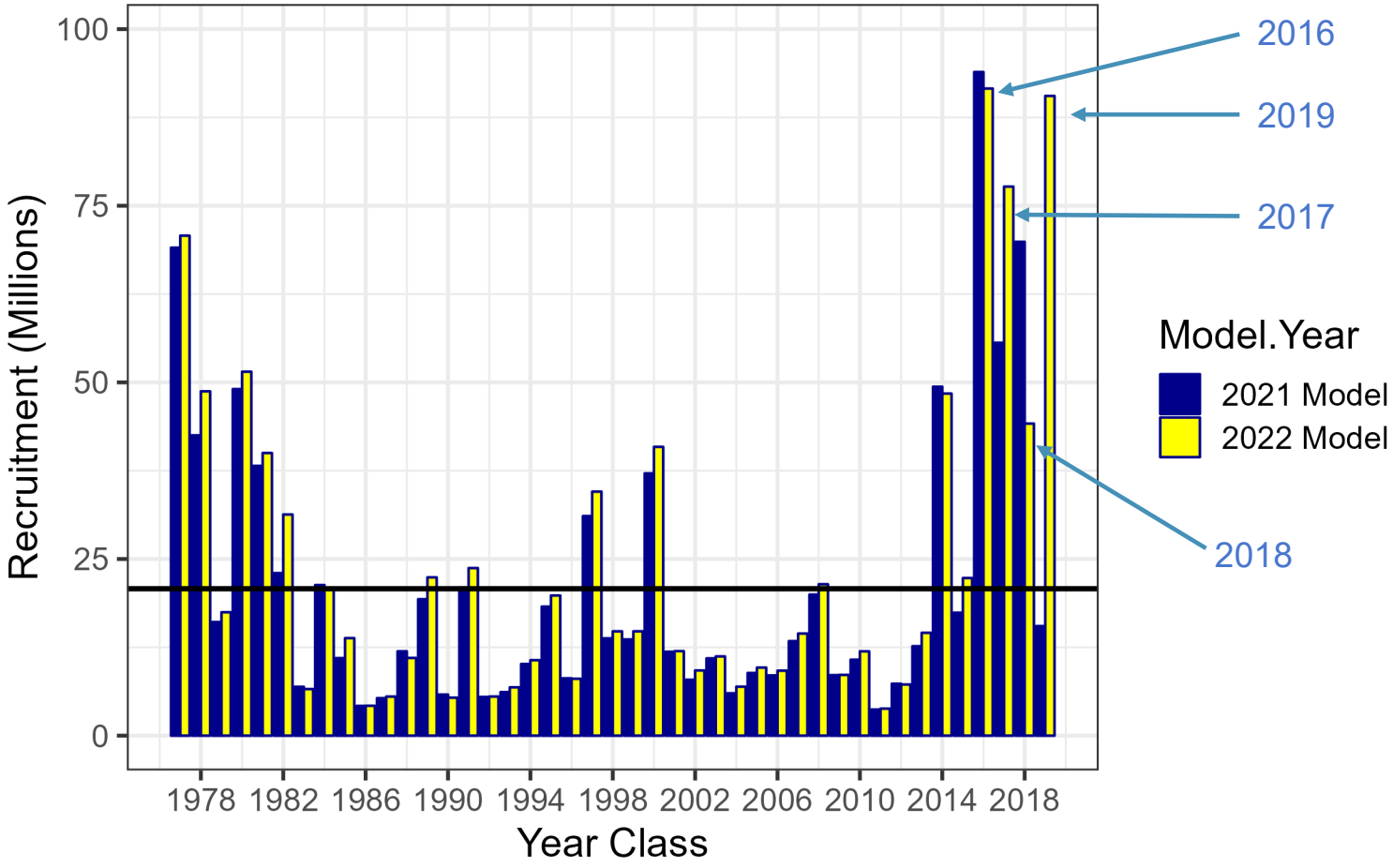
Index Sensitivity

- Longline survey is primary driver of productivity/scale
- Trawl survey is primary driver of recent recruitment
  - Usually around age-4, LL survey age compositions drive recruitment
  - 3 year lag compared to trawl survey length comps, which are available in-year



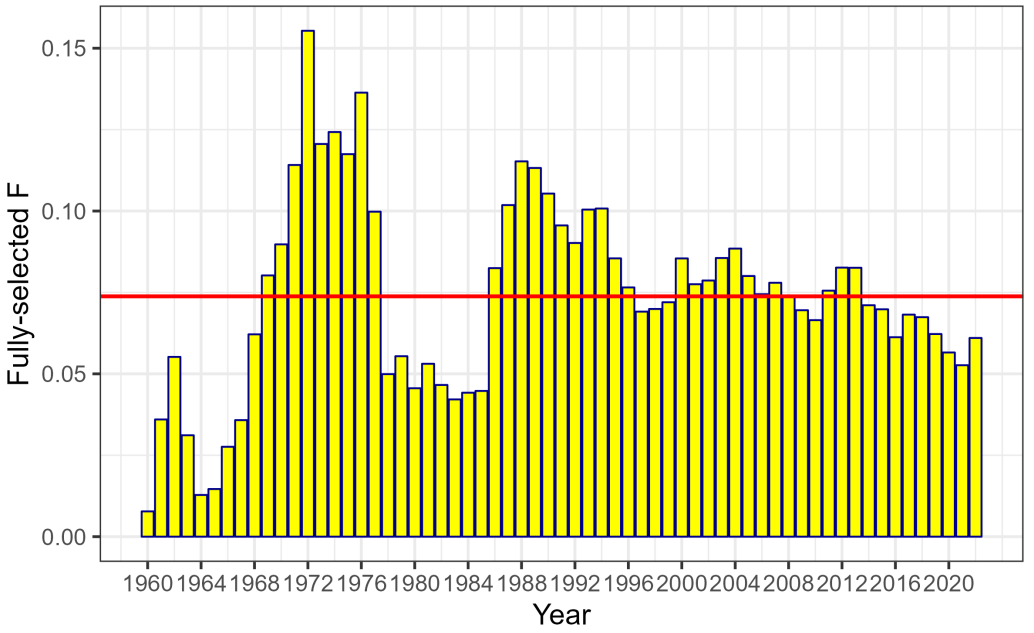
Recruitment

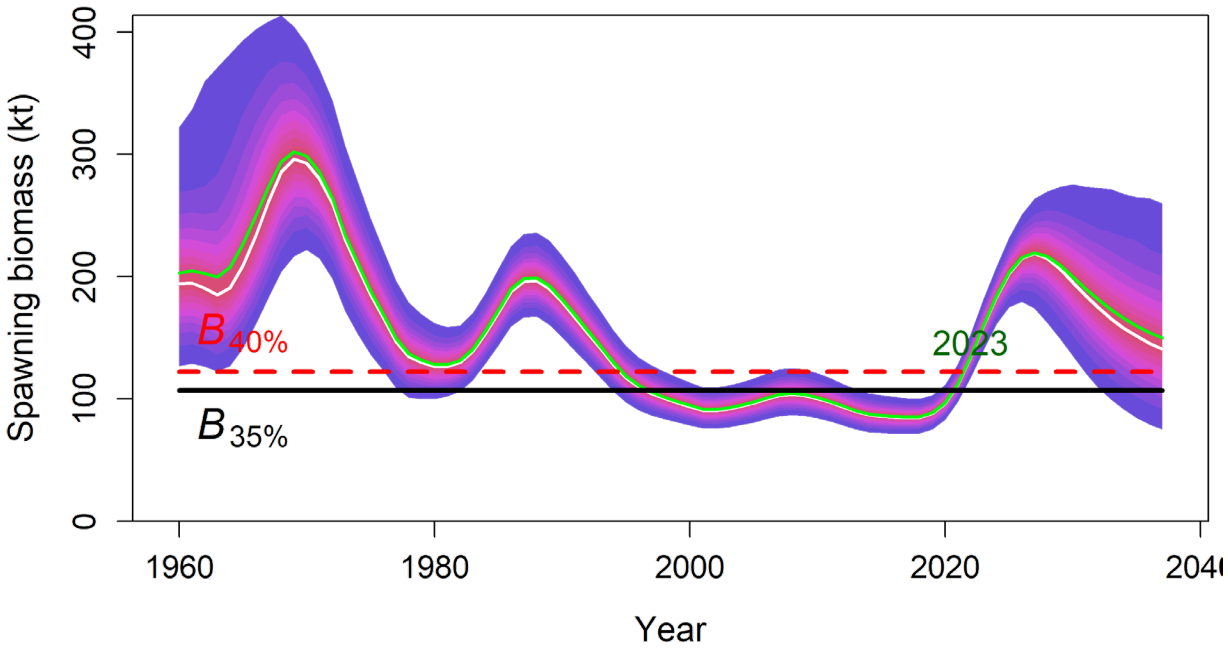
- Increasing agreement/ likelihood that 2016 is the largest year class on record
- ~~2018~~ 2017+2019 appear to be large year classes, as well
  - Uncertainty sorting out exactly which recent year classes are large
- Current series of recruitment emulates late 1970s

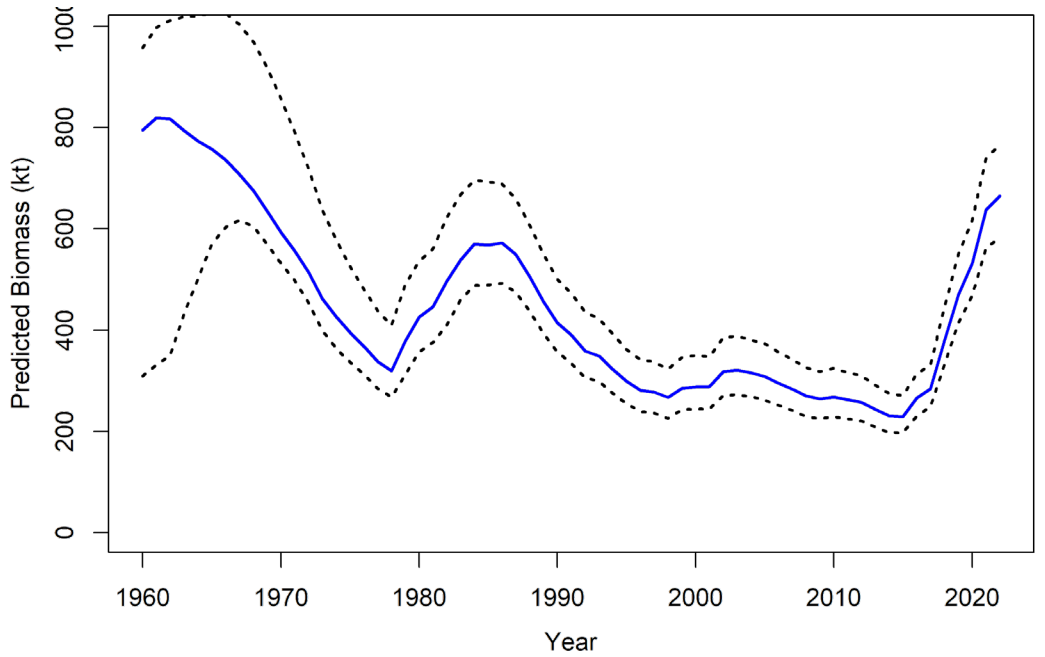


Biomass and Fishing Mortality

- At $B_{44\%}$ in 2022
- Projected to be at $B_{52\%}$ in 2023
- SSB rate of growth increasing rapidly
- Age-2+ biomass growth slowing
- Fishing mortality (0.061) remains at low levels (< F_{ABC})

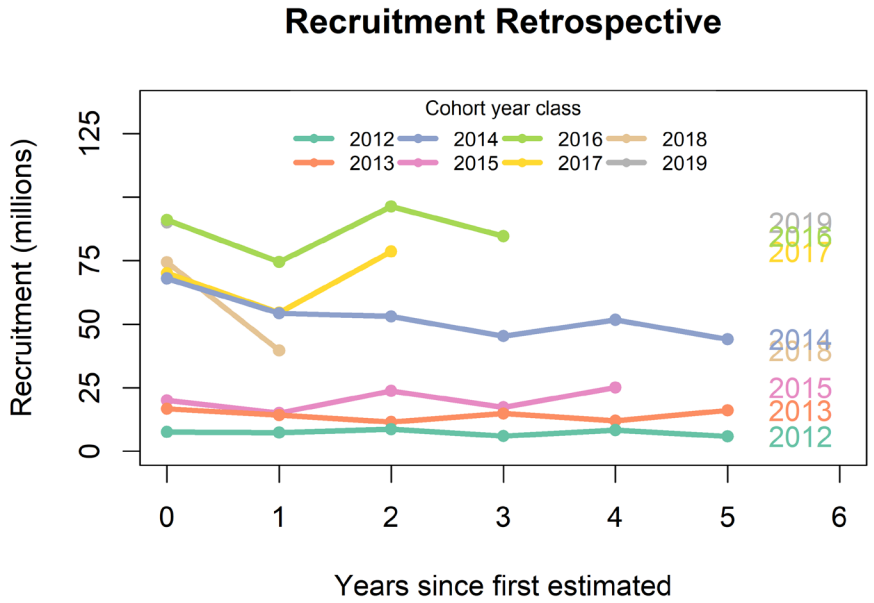


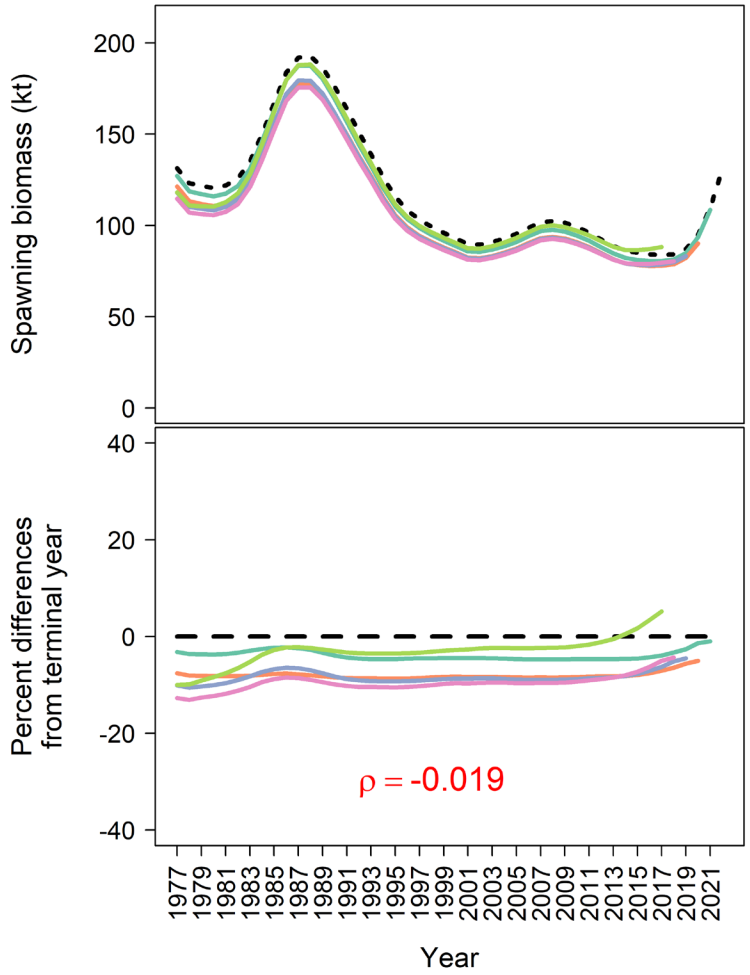




Retrospective Analysis

- Limited retrospective bias
- Slight underestimation of SSB
- Estimation pattern in recent year class (2016, 2017….2018?)
  - Initial estimate is downgraded, then increases around age-4
  - Age when first observed at large numbers in fishery and LL survey ages
  - Pattern not as strong as model *16.5* initial overestimation of recruitment

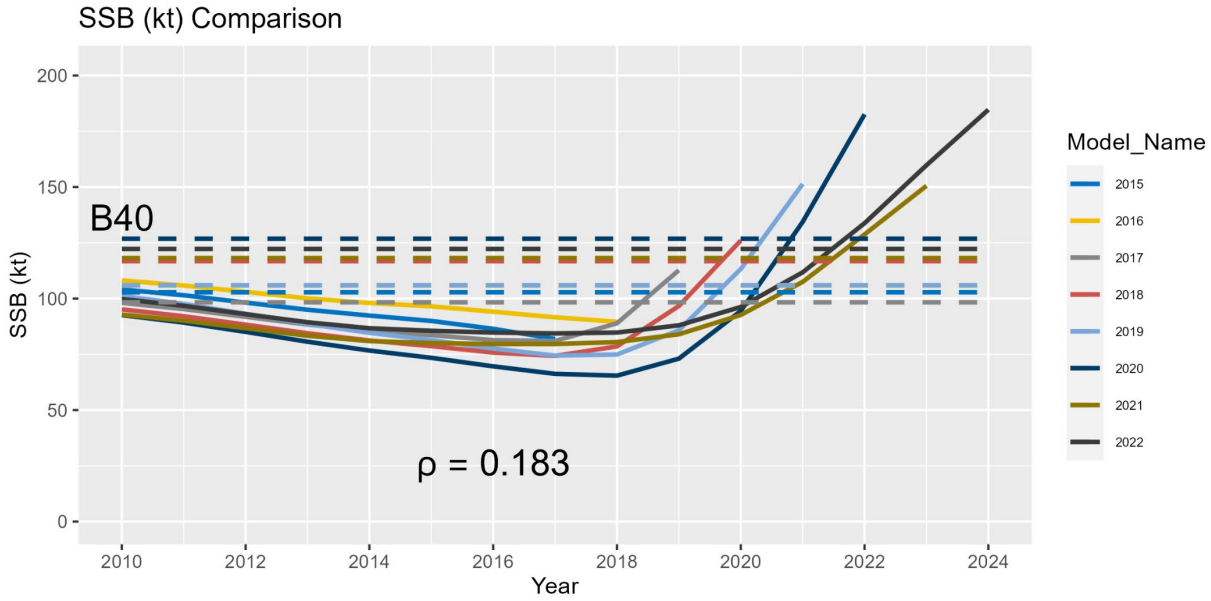




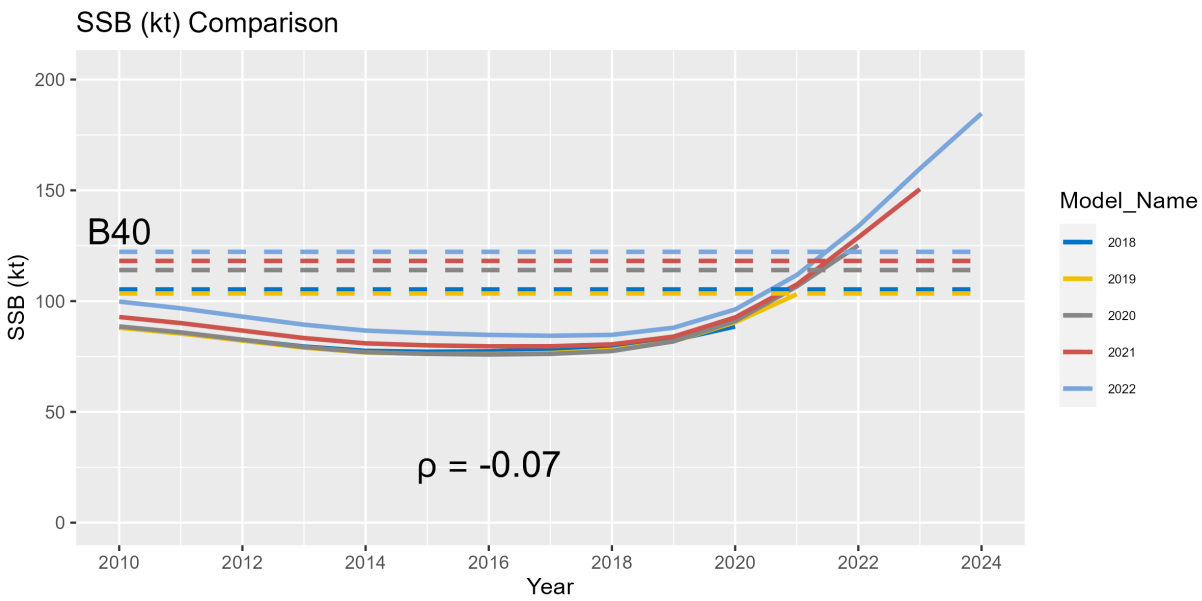
Assessment and Projection Consistency

- Model *21.12* very consistent
- Slight underestimation in SSB as new data added
  - No longer severely overestimating population growth and recruitment (and associated ABCs)

All Models Used For Management Advice

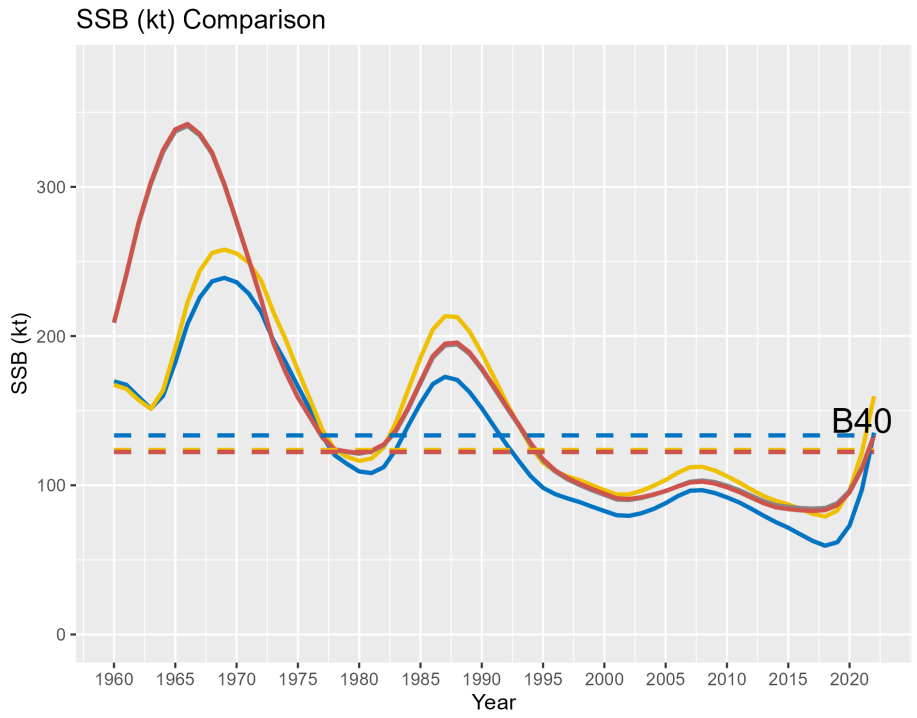


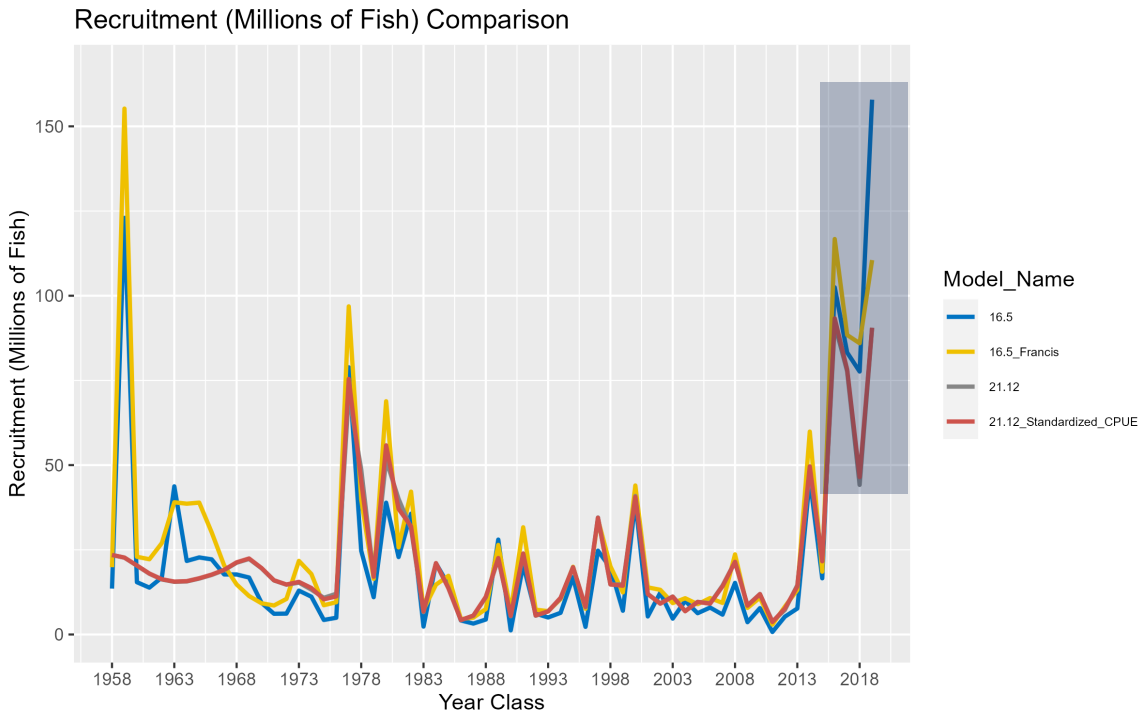
Model *21.12* Only



Sensitivity Runs

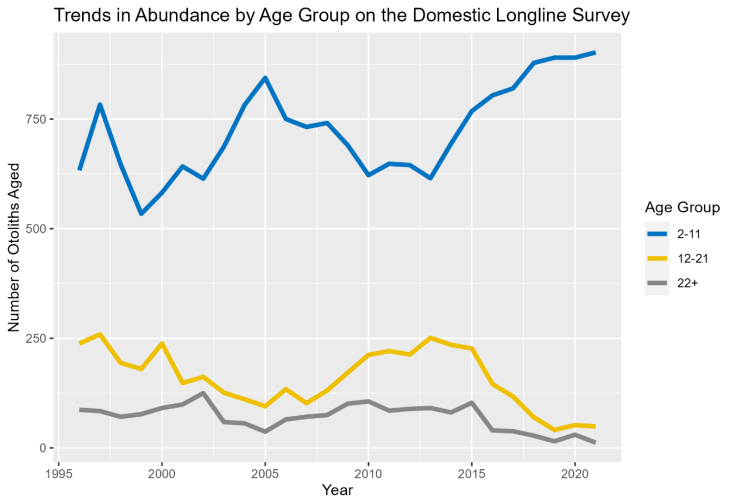
- Replacing the CPUE index with a standardized index (from M. Cheng, UAF) that includes both pot and hook-and-line gear data had minimal impact
- Model *16.5* led to much larger recent year classes, yet more pessimistic stock status
  - ABCs were > 20 kt larger than model *21.12*





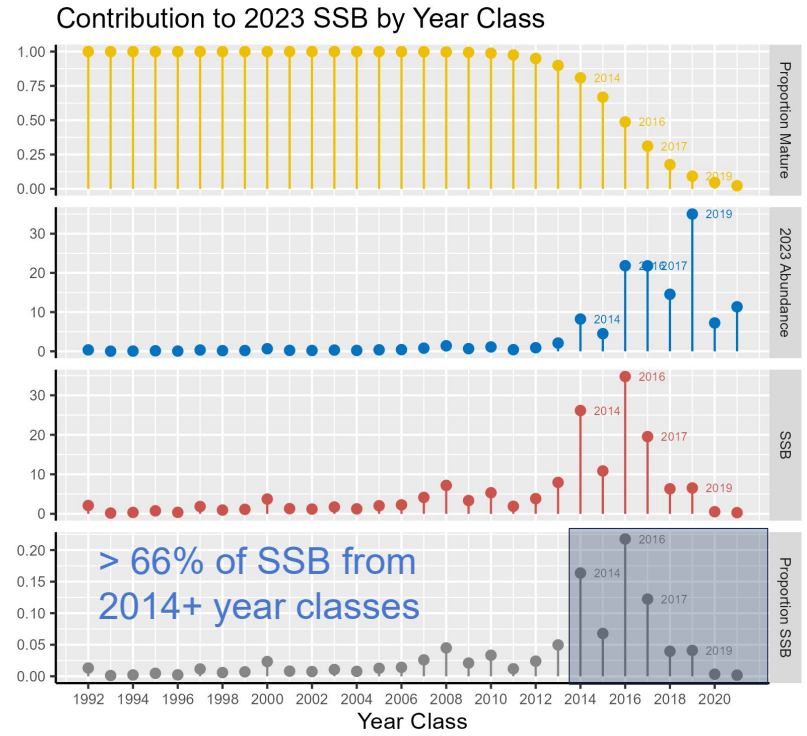
Assessment Summary

- Inherent tension between fitting longline survey RPNs and fishery age compositions
  - Population growth in indices not as rapid as indicated by size of recent cohorts in compositional data
- Assessment model may be slightly underestimating SSB and 2016 year class
- No strong retrospective bias and projections appear consistent
- Population continues to grow rapidly, with SSB lagging biomass increases
- Recent productivity remains high, with 2016 the largest year class on record
- Age structure is slowly expanding
  - Population primarily consists of young, immature fish



Risk Table

- ***No elevated scores***
- **Assessment**: Uncertainty in recent (2017 – 2019) year classes, but no strong retrospective patterns or diagnostic issues
- **Population**: Productivity remains high, but age structure still limited to age classes that are not yet fully mature
- **Ecosystem**: Warm water and above average prey suggest positive influence on young-of-the-year and juvenile sablefish
- **Fishery**: CPUE increasing (when pot gear included), while market conditions remain poor (though expected to improve as population continues to grow into larger market categories)



Assessment Related Considerations	Population Dynamics Considerations	Environmental and Ecosystem Considerations	Fishery Performance Considerations
Level 1: Normal	Level 1: Normal	Level 1: Normal	Level 1: Normal

Appendices

Appendix 3C. Ecosystem and Socioeconomic Profile of the Sablefish stock in Alaska - Report Card

S. Kalei Shotwell, Daniel R. Goethel, Alison Deary, Bridget Ferriss, Katy Echave, Chris Lunsford, Kevin Siwicke, Elizabeth Siddon, Jane Sullivan, Marysia Szymkowiak, and Ben Williams

November 2022

With Contributions from:
Mayumi Arimitsu, Steve Barbeaux, Matt Callahan, Curry Cunningham, Dana Hanselman, Ben Fissel, Jean Lee, Jens Nielsen, Krista Oke, Clare Ostle, Patrick Ressler, Cara Rodgveller, Kally Spalinger, Abigail Tyrell, Jordan Watson, and Sarah Wise

Appendix 3D. Trawl Catches of Small Sablefish in the Eastern Bering Sea

Kevin Siwicke and Katy Echave

October 2022

Appendix 3E. Further Analysis of Fishery Dependent Data

Cara Rodgveller

October 2022

Appendix 3F. Summary of AFSC Sablefish Tagging Database

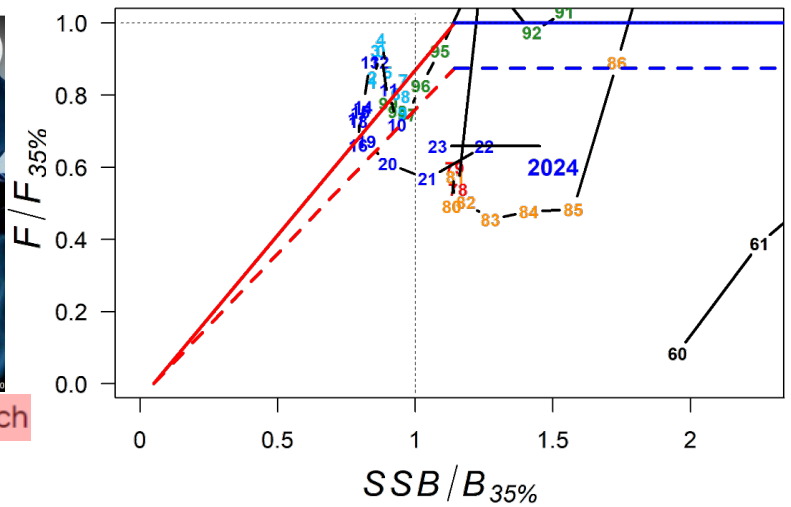
Katy Echave

October 2022

Harvest Recommendations

- 2023 Author's ABC = Max ABC = 40,502 t
  - +17% from 2022 ABC
  - If harvested, it would represent the *3rd largest all-time* removals
  - Quadrupling of quota since 2016 (11,795 t)
  - 80 – 90% harvested in recent years, only 65% as of Nov. 8

The Saga's New Haul: Black Cod? | Deadliest Catch



Quantity/Status	As estimated or specified *last* year for (model 21.12): 2022*	2023*	As estimated or recommended *this* year for (model 21.12): 2023*	2024*
M (natural mortality rate, estimated)	0.100	0.100	0.105	0.105
Tier	3a	3a	3a	3a
Projected total (age 2+) biomass (t)	574,599	582,536	678,562	675,058
Projected female spawning biomass (t)	128,789	153,820	159,788	186,126
$B_{100\%}$	295,351	295,351	305,595	305,595
$B_{40\%}$	118,140	118,140	122,238	122,238
$B_{35\%}$	103,373	103,373	106,958	106,958
F_{OFL}	0.094	0.094	0.096	0.096
$maxF_{ABC}$	0.080	0.080	0.081	0.081
F_{ABC}	0.080	0.080	0.081	0.081
OFL (t)	40,839	42,948	47,857	49,040
OFL_w (t)**	**40,432**	**42,520**	**47,390**	**48,561**
max ABC (t)	34,863	36,670	40,861	41,876
ABC (t)	34,863	36,670	40,861	41,876
ABC_w (t)**	**34,521**	**36,318**	**40,502**	**41,539**

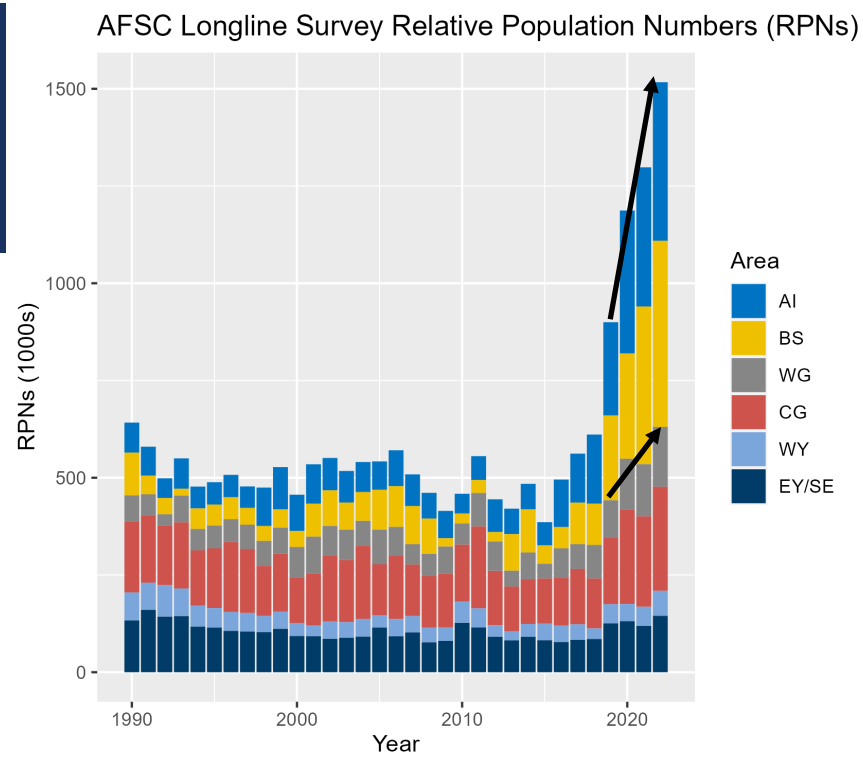
Status	As determined *last* year for: 2020	2021	As determined *this* year for: 2021	2022
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No

Apportionment

- Based on 5-year average of regional longline survey biomass proportions and year 3 (75%) of SSC 4-year stair step
  - Meant to address biological concerns (localized depletion) and avoid extreme fluctuations in regional quotas
  - Updated yearly with new survey data
- BSAI constitutes > 50% of survey biomass in 2022

Year	2022				2023*		2024*	
Region	OFL_w	ABC_w	TAC	Catch**	OFL_w	ABC_w***	OFL_w	ABC_w***
BS	--	5,264	5,264	4,548	--	8,417	--	10,145
AI	--	6,463	6,463	2,067	--	8,884	--	10,299
GOA	--	22,794	22,794	15,291	--	23,201	--	21,095
WGOA	--	3,727	3,727	2,264	--	4,473	--	4,626
CGOA	--	9,965	9,965	6,294	--	9,921	--	8,819
***WYAK	--	3,437	3,437	2,462	--	3,205	--	2,669
***EY/SEO	--	5,665	5,665	4,271	--	5,602	--	4,981
Total	40,432	34,521	34,521	21,906	47,390	40,502	48,561	41,539

After 95:5 fixed:trawl gear split adjustment in the Eastern GOA

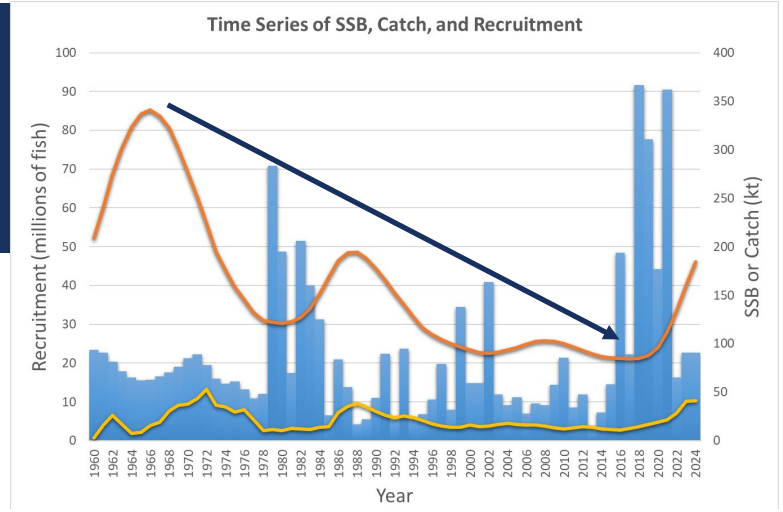


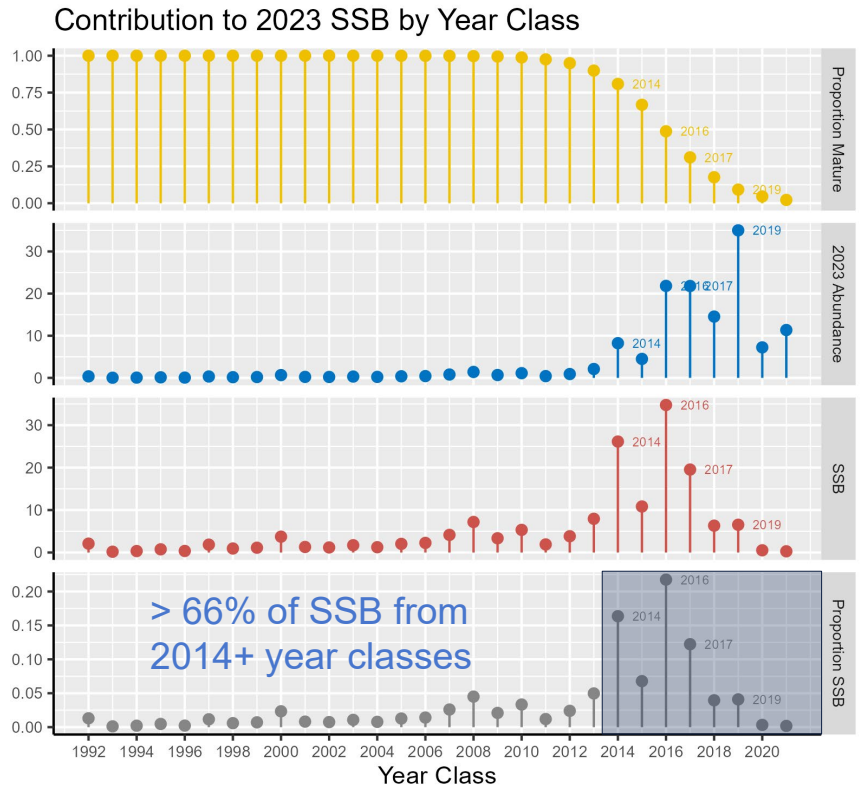
5-year Average Apportionment

Year	AI	BS	WGOA	CGOA	EY/SE	WY
2013	0.13	0.08	0.11	0.34	0.24	0.10
2014	0.13	0.11	0.10	0.32	0.24	0.10
2015	0.13	0.12	0.10	0.32	0.22	0.10
2016	0.15	0.13	0.10	0.29	0.22	0.10
2017	0.17	0.15	0.10	0.28	0.20	0.10
2018	0.19	0.13	0.11	0.27	0.19	0.10
2019	0.21	0.14	0.11	0.26	0.18	0.10
2020	0.24	0.16	0.12	0.25	0.16	0.08
2021	0.24	0.21	0.11	0.23	0.14	0.07
2022	0.25	0.24	0.11	0.21	0.13	0.06

Growing Pains

- If cyclic recruitment dynamics continue, a maximum catch strategy may maintain long-term downward trend
- $B_{40\%}$ harvest control rule is not a one size fits all solution
  - Treats all SSB as equal (despite skipped spawning and maternal effects)
  - Forces population to $B_{40\%}$, but can be difficult to reverse declines
  - Projections assume all future recruitment will be at least average and enables large catch based on 'paper fish'
- Capped management procedures should be considered to **ensure protracted age structure** (allow recent year classes to reach fully mature ages)
- **Alternate SSB metrics could be considered** (e.g., only fully mature age classes) to avoid age truncation



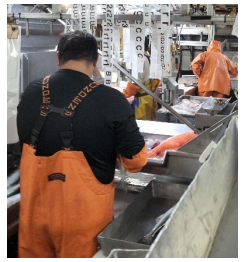


Future Directions

- Explore performance of CPUE standardization, alternate selectivity patterns, fleet structure, and sex-specific selectivity estimation
  - Matt Cheng (UAF Ph.D. Student, Prof. Curry Cunningham) exploring these issues
  - Expect to include standardized, combined gear CPUE index for 2023

- Develop spatially explicit, tag-integrated model to estimate regional biomass and account for movement among areas
  - Kari Fenske recently completed dissertation on a 3 area model
  - Craig Marsh (NRC postdoc) has been hired to extend to a tag-integrated model that estimates movement

- Develop closed-loop simulation model to explore efficacy of the $B_{40\%}$ harvest control rule for sablefish
  - Postdoc being sought through UAF (Curry Cunningham advisor; Ben Williams, Chris Lunsford are co-PIs)



QUESTIONS?

Other PT Tables

Summary Table by Region

Area	Year	Biomass (4+)*	OFL**	ABC#	TAC	Catch^
GOA	2021	390,000	--	21,475	17,992	15,520
	2022	240,600	--	22,794	22,794	15,291
	2023	317,000	--	23,201	--	--
	2024	309,000	--	21,095	--	--
BS	2021	142,000	--	3,396	3,396	4,169
	2022	168,000	--	5,264	5,264	4,548
	2023	151,000	--	8,417	--	--
	2024	147,000	--	10,145	--	--
AI	2021	175,000	--	4,717	4,717	1,578
	2022	121,200	--	6,463	6,463	2,067
	2023	153,000	--	8,884	--	--
	2024	149,000	--	10,299	--	--

*Biomass represents the value projected by the model used to determine the ABC in that year, while regional biomass is based on the longline survey proportions by area in the terminal year of the associated model.
**The OFL is set for the entire Alaska management region, so no area specific OFLs are provided.
#The ABC is based on model *16.5* in 2020 (with reductions from max ABC based on the associated risk table). Model *21.12* and a 50%, 75%, and 100% stair step from fixed apportionment to the 5-year average survey apportionment were utilized, respectively for 2022, 2023, and 2024 ABCs. Also, these values are after the whale depredation adjustments described above.
^As of October 11, 2022 Alaska Fisheries Information Network, (www.akfin.org).

Other PT Tables

Author recommended 2023 ABC (with whale depredation adjustments and assuming a 75% stair step).

Area	AI	BS	WG	CG	WY*	EY*	Total
2022 ABC	6,486	5,305	3,821	10,008	3,179	6,064	34,863
2023 ABC	8,892	8,450	4,533	9,972	2,970	6,044	40,861
2019 - 2021 avg. depredation	6	21	51	52	63	147	340
Ratio 2023:2022 ABC	1.37	1.59	1.19	1.00	0.93	1.00	1.17
Deduct 3 year adjusted average	-8	-33	-60	-51	-60	-147	-359
****2023 ABC_w**	8,884	8,417	4,473	9,921	2,910	5,897	40,502
Change from 2022 ABC_w	37%	60%	20%	0%	-15%	4%	17%

*Before 95:5 hook and line : trawl split between WY and EY/SE shown below.
**ABC_w is the author recommended ABC that accounts for whale depredation.

Author recommended 2024 ABC (with whale depredation adjustments and a 100% stair step).

Area	AI	BS	WG	CG	WY*	EY*	Total
2022 ABC	6,486	5,305	3,821	10,008	3,179	6,064	34,863
2024 ABC	10,308	10,185	4,688	8,865	2,457	5,373	41,876
2019 - 2021 avg. depredation	6	21	51	52	63	147	340
Ratio 2024:2022 ABC	1.59	1.92	1.23	0.89	0.77	0.89	1.20
Deduct 3 year adjusted average	-9	-40	-62	-46	-50	-131	-337
****2024 ABC_w**	10,299	10,145	4,626	8,819	2,407	5,243	41,539
Change from 2022 ABC_w	59%	93%	24%	-12%	-30%	-7%	20%

*Before 95:5 hook and line : trawl split between WY and EY/SE shown below.
**ABC_w is the author recommended ABC that accounts for whale depredation.

Author recommended 2023 – 2024 ABCs by sector in West Yakutat and East Yakutat/Southeast adjusted for the 95:5 hook-and-line : trawl split in the EGOA.

Year	West Yakutat	E. Yakutat/ Southeast
2023	3,205	5,602
2024	2,669	4,981

*ABCs represent total regional ABC across gears, but with the 5% trawl allocation in EY/SE reallocated to WY.

Author recommended 2023 and 2024 OFLs (with whale depredation adjustments).

Year	2023	2024
OFL	47,857	49,040
3-year Avg. Depredation	340	340
Inflation Factor (Projected % Increase)	1.37	1.41
Deduct 3-year Avg.	-467	-479
***OFL_w**	47,390	48,561
% Change from 2022 OFL_w	17%	14%

*OFL_w is the author recommended OFL that accounts for whale depredation.

Selectivity