Assessment of the Sablefish Stock in Alaska

Groundfish Joint Plan Team

Daniel Goethel and Matt Cheng

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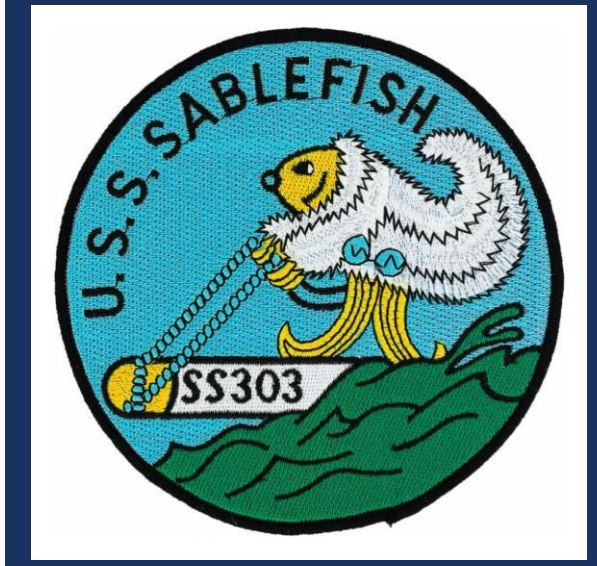
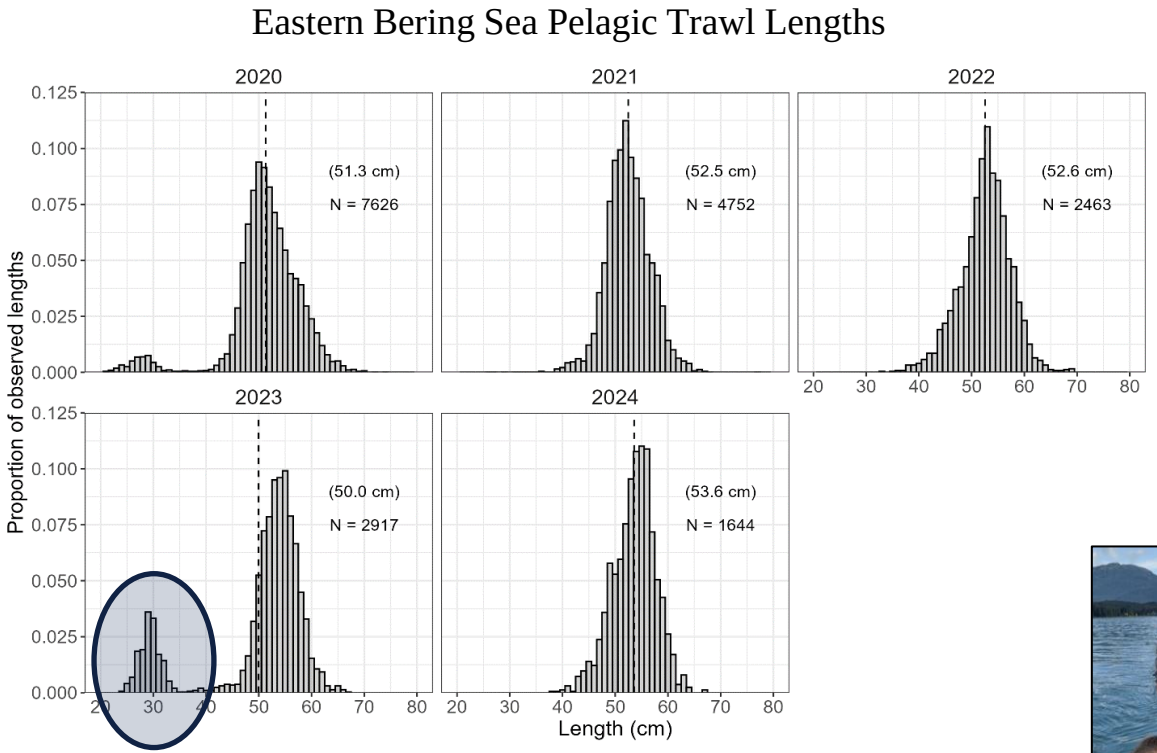
November, 2024



Appendices



Appendix 3D. Ecosystem and Socioeconomic Profile (ESP)

Kalei Shotwell (Editor)

Appendix 3E. Sablefish Bycatch in the Eastern Bering Sea

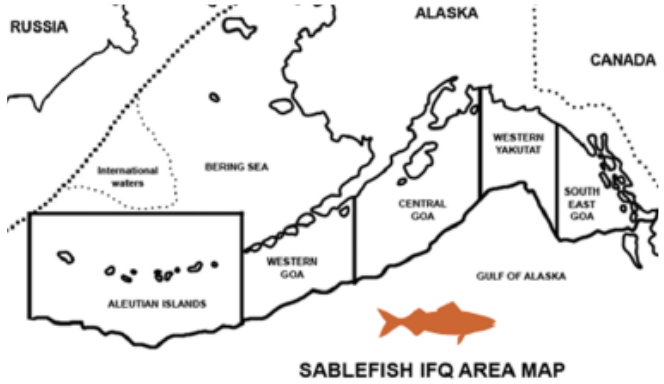
Kevin A. Siwicke and Katy B. Echave

Appendix 3F. Observer Coverage and Sampling of the Sablefish Stock

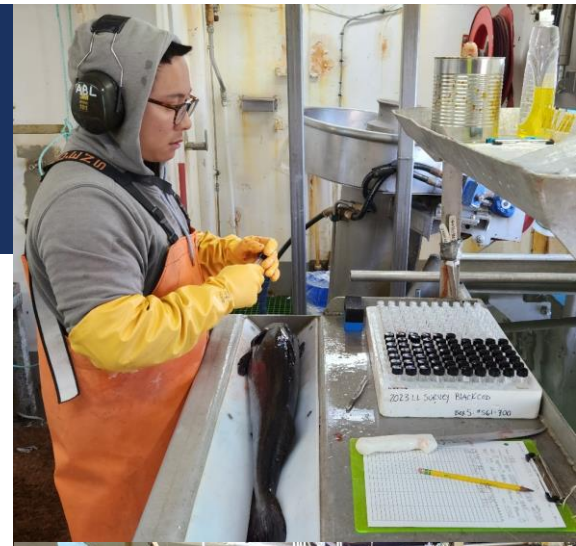
Cindy Tribuzio, Cara Rodgveller, and Matt Callahan

Overview

- Tier: 3a
- Area: Alaska-wide stock (GOA, BS, AI)
- Update assessment
  - No model changes from 2023 SAFE, model *23.5*
- No surveys or indices updated in 2024
  - Longline survey was not conducted due to market conditions (cost recovery survey)
  - Data for CPUE index no longer provided to AFSC
  - Trawl survey was in a scheduled off-year
- Small sablefish release in final action at NPFMC
  - https://shinyfin.psmfc.org/small_sablefish/



SABLEFISH IFQ AREA MAP

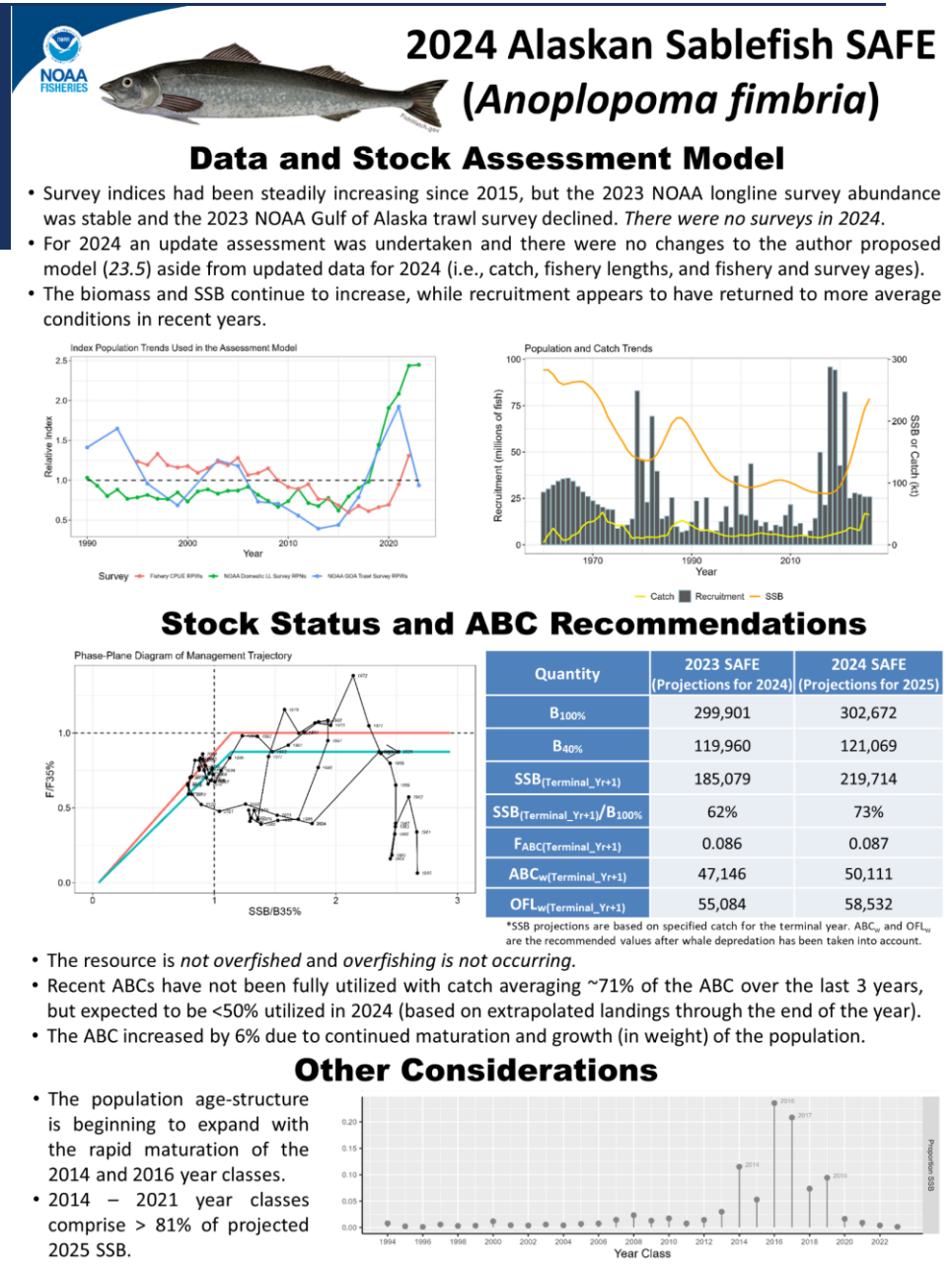


Summary

- Population biomass has slowed, but spawning biomass continues to increase rapidly
- **Max ABC = 50,111 t** (+3,000 t from 2024 ABC)
  - Only ~50% utilization in 2024 (based on extrapolated catch through year end)
- Apportionment based on 5-year average survey biomass proportions by area (no 2024 survey)

Year	2024				2025		2026	
Region	OFL_w	ABC_w	TAC	Catch*	OFL_w	ABC_w**	OFL_w	ABC_w**
BS	--	11,450	7,996	3,940	--	13,898	--	13,723
AI	--	13,100	8,440	1,266	--	12,175	--	12,022
GOA	--	22,596	22,596	13,406	--	24,038	--	23,737
WGOA	--	4,699	4,699	2,101	--	4,996	--	4,934
CGOA	--	9,651	9,651	5,655	--	10,257	--	10,128
**WYAK	--	2,926	2,926	2,172	--	3,125	--	3,086
**EY/SEO	--	5,320	5,320	3,478	--	5,660	--	5,589
Total	55,084	47,146	39,032	18,612	58,532	50,111	57,797	49,482

*As of October 10, 2024 **After 95:5 trawl split and whale depredation



SSC Comments

- *The SSC reiterates that only fishery performance indicators that provide some inference regarding biological status of the stock should be used…The SSC also notes that market-related concerns do not pertain to ABC considerations so should not be in the risk table.*
  - The sablefish fishery performance section of the risk table has been revised to account for inference only related to biology.
- *The SSC supports disaggregating age data by sex as a high priority for the next full assessment to help address residual patterns.*
  - This remains a high priority, but was not undertaken due to this being an 'update' assessment.
- *The SSC suggests that retrospective analysis can be extended to 10 years in line with other stocks, despite the selectivity time block starting in 2017.*
  - This was not done. A 10-year peel will force the model to estimate selectivity in the recent time block with only 1 year of data (in 2016) resulting in an unstable model and providing poor inference. The 'all model' retrospective (i.e., displaying values from the model used for management advice in the given year) has peels back to 2016. By 2026, the sablefish assessment will have a full 10-year peel without having to deal with the uncertainty associated with the recent selectivity time blocks.

SSC Comments

- *Describe the method used for developing input/initial (pre-Francis weighting) sample sizes used for compositional data. Consider using a bootstrapping approach, based on the work by Hulson et al., that is applied in other groundfish stock assessments.*
  - The input sample sizes are set to 20 for each source of compositional data and in each year (Table 3.7). The choice for input sample sizes was originally recommended and implemented during the 2016 CIE when SDNRs were utilized to tune the lambdas for each data source. For 2024, sensitivity runs were conducted to ensure the choice of input sample size was not impacting estimates and results indicate that the model was insensitive to different starting values (Figure 3.53a). As recommended, future sablefish assessment updates will look into using the Hulson and Williams (2024) bootstrapping approach for ISS.
- *Provide further investigation and potential alternative model parameterizations to address the poor fit to the new domestic fishery index that combines longline and pot gear.*
  - *This was not done for the update assessment and is a low priority, given that the index cannot be updated, fits to the sablefish longline survey takes precedence, and fits are only poor when trends do not match those observed in the survey.*

SSC and PT Comments

- *The SSC encourages the use of an appropriate sigma constraining recruitment but notes that the maximum likelihood estimate of a random effects variance is negatively biased…please clarify how the bias correction is treated. (SSC)*
- *Some unknowns remain including how the bias-correction is applied across years with more or less information, how the bias-correction is applied during MCMC, and if estimating sigmaR is reasonable…the bias correction is unnecessary for MCMC evaluations. (JPT)*
  - The treatment (estimated/fixed) of recruitment variance will be explored in the next full assessment.
  - The bias correction term was not utilized during MCMC.
  - As described in Methot and Taylor (2011), the bias correction term is scaled linearly from 0 in data poor years (when there is little information to inform recruitment) to 1.0 in recent data rich years (when there is information to inform recruitment), but then declines near the terminal year to account for lack of information on the most recent recruitment events.
    - For sablefish, the break points for the bias correction term included a start year of 1980 when compositional data starts to become available, a max of 1.0 in 1990 when length composition data become available for most fleets, and a subsequent decline starting in 2019 to account for limited information on recruitment within the last five years of the model terminal year.

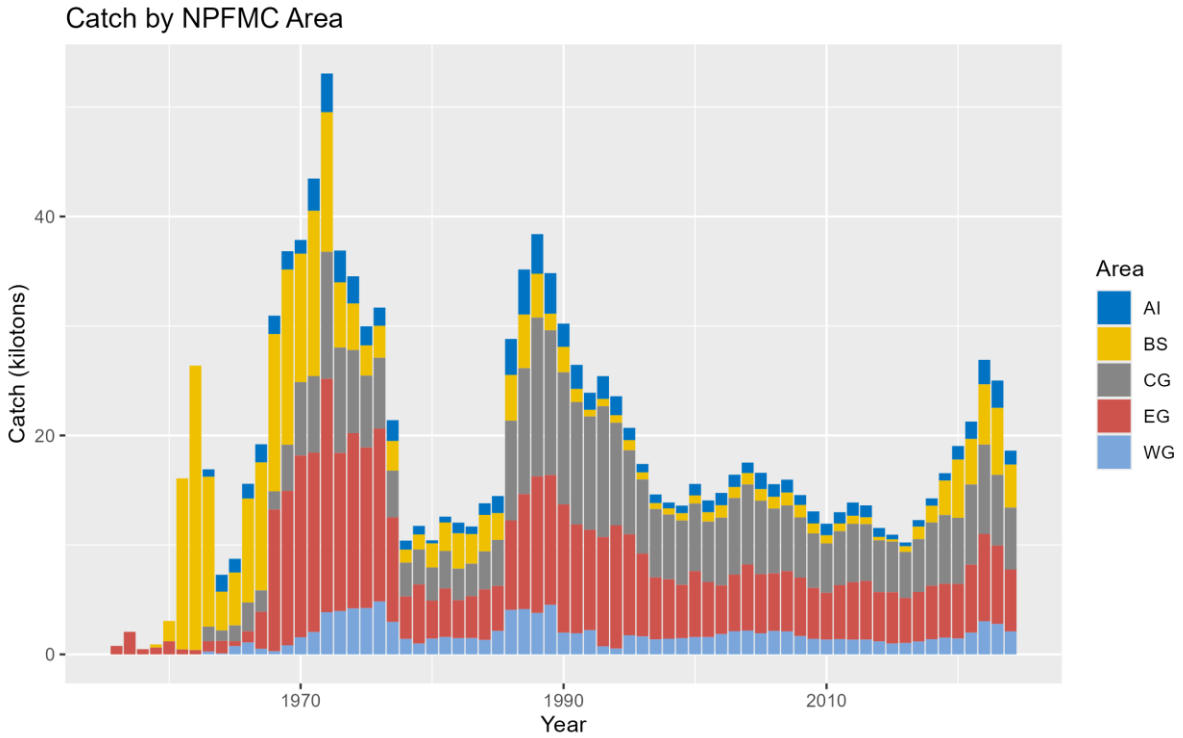
Data Summary

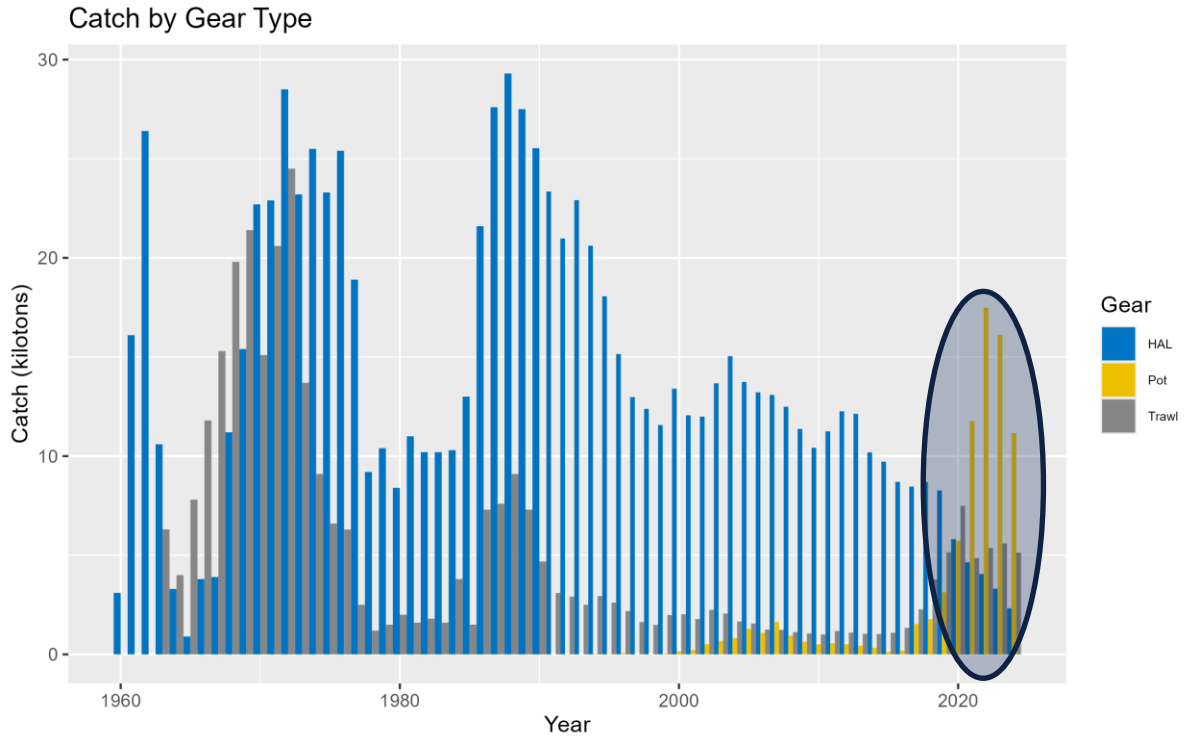
- New data for 2024 in bold
- Whale depredation by area held constant at 2022 levels

Source	Data	Years
Fixed Gear Fisheries	Catch	1960 – **2024**
Trawl Fisheries	Catch	1960 – **2024**
Non-Commercial Catch	Catch	1977 – **2024**
Japanese Longline Fishery	Catch-per-Unit-Effort (CPUE)	1964 – 1981
U.S. Fixed Gear Fisheries	CPUE	1990 – 2022
	Length	1999 – **2023**
	Age	1999 – **2023**
U.S. Trawl Fisheries	Length	1990,1991,1999, 2005 – **2023**
Japan-U.S. Cooperative Longline Survey	RPNs, Length	1979 - 1994
	Age	1981, 1983, 1985, 1987, 1989, 1991, 1993
NOAA Domestic Longline Survey	RPNs, Length	1990 – 2023
	Age	1996 – **2023**
NOAA GOA Trawl Survey	Biomass index	1990, 1993, 1996, 1999, 2003, 2005, 2007, 2009, 2011, 2013, 2015, 2017, 2019, 2021, 2023
	Lengths	1990, 1993, 1996, 1999, 2003, 2005, 2007, 2009, 2011, 2013, 2015, 2017, 2019, 2021, 2023

Catch

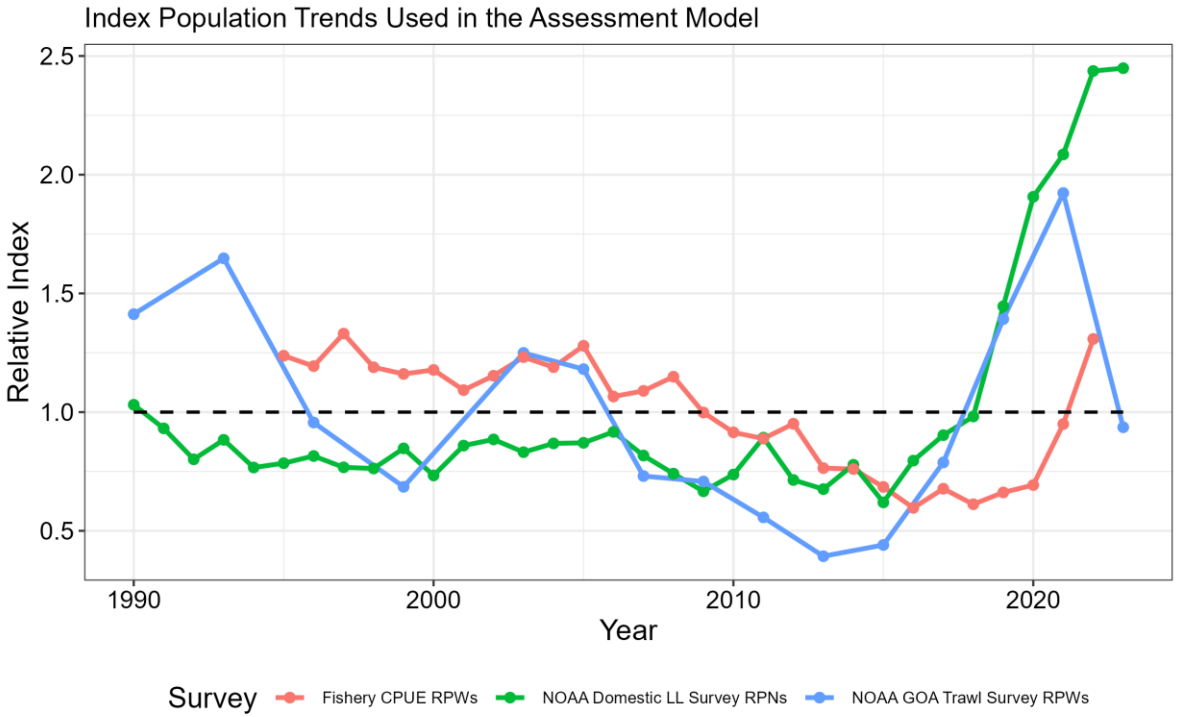
- Catch by pot gear is consistently the primary source of recent removals
  - Pot catch > 80% of fixed gear catch since 2022
- Trawl removals ~20% of total catch in recent years





Indices

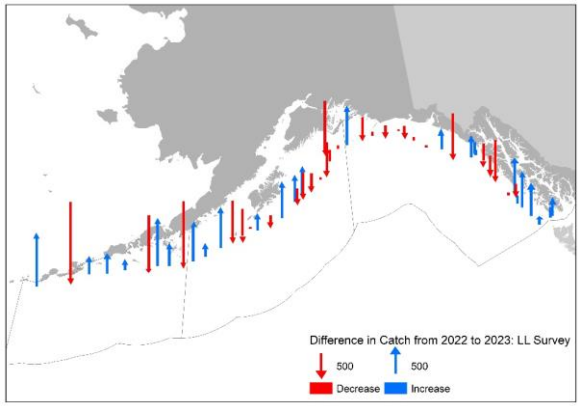
- Longline survey numbers were steady at time series high values in 2023, but trawl survey biomass decreased ~50%
- BSAI constituted > 50% of survey numbers in 2023

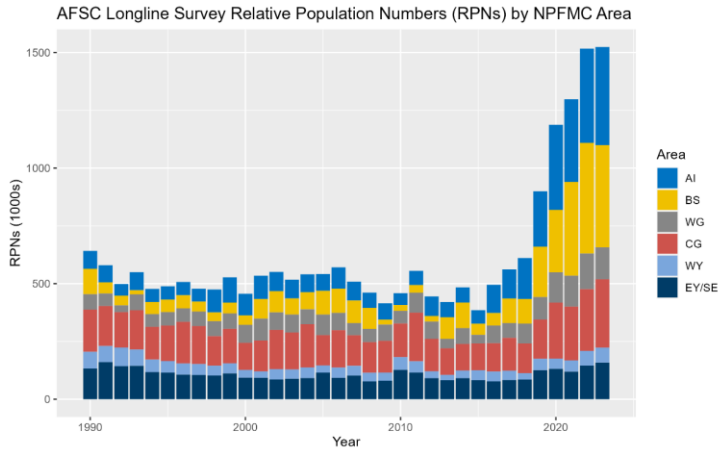


LL Survey: No Survey

CPUE Index: No Update

Trawl Survey: Off-year





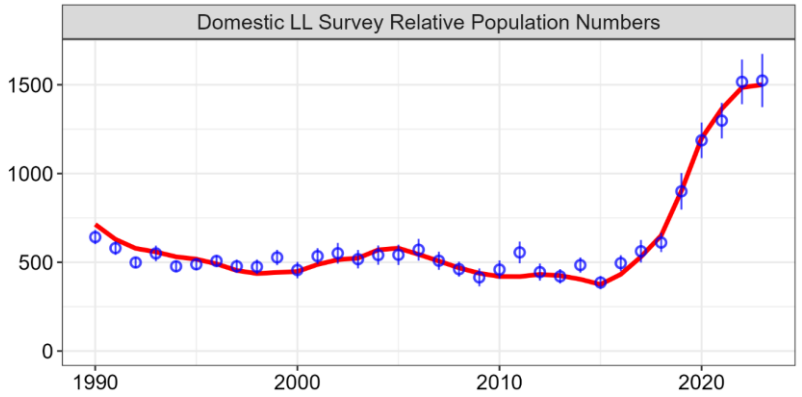
Model Structure (*23.5*)

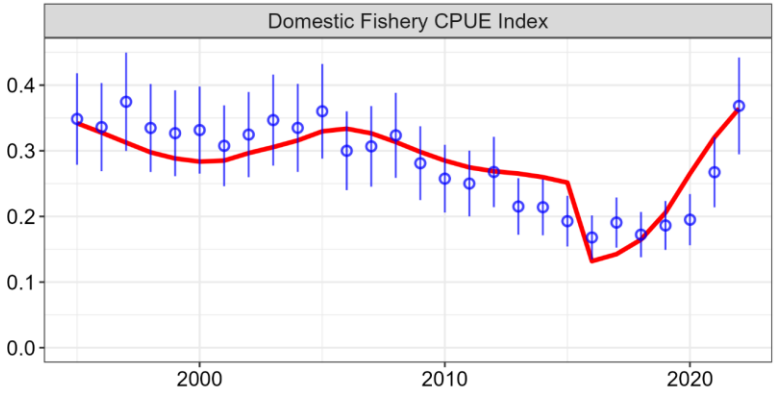
- 1 area, sex-disaggregated, age structured (SCAA in ADMB)
  - Years 1960 to 2024
  - Ages 2 – 31+
- Uses Francis reweighting with composition data input sample size of 20
- Biological parameters input (length-,weight-, maturity-at-age)
- Natural mortality estimated with prior (time-/age-invariant)
- 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 (2022 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

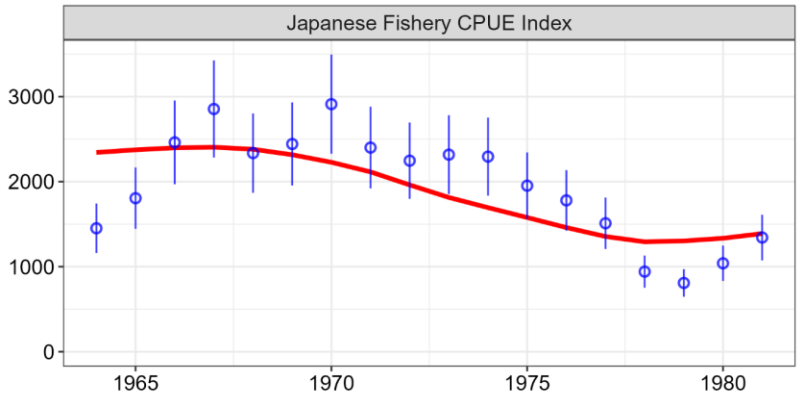
Parameter Name	Symbol	# of Parameters
Catchability	q	7
Mean recruitment	μ_r	1
Recruitment Variance	σ_R	1
Natural mortality	M	1
Recruitment deviations	τ_y	92
Average fishing mortality	μ_f	2
Fishing mortality deviations	φ_y	127
Fishery selectivity	fs_a	14
Survey selectivity	ss_a	8
Total		252

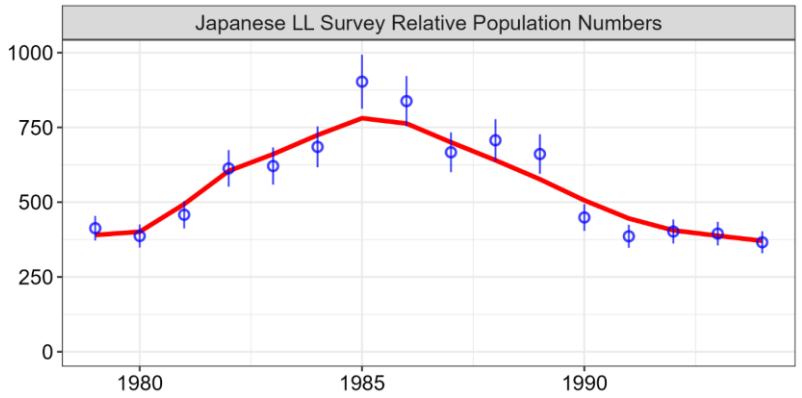
Fit to Indices

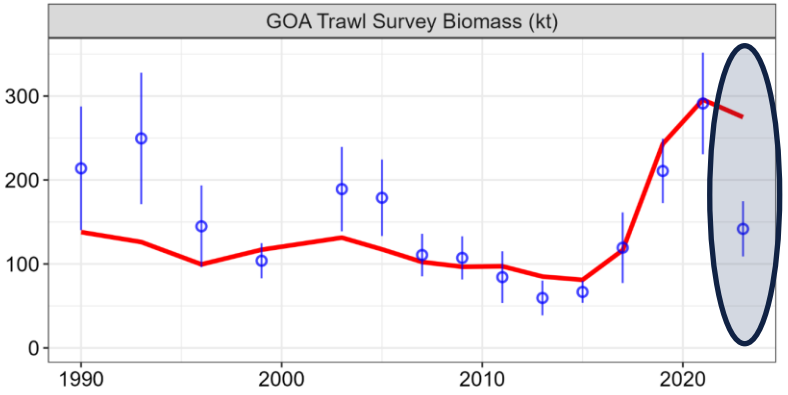
- Generally adequate fits to indices of abundance
- Trouble fitting NOAA GOA trawl survey especially 2023 decline
- CPUE poorly fit when trends do not align with longline survey







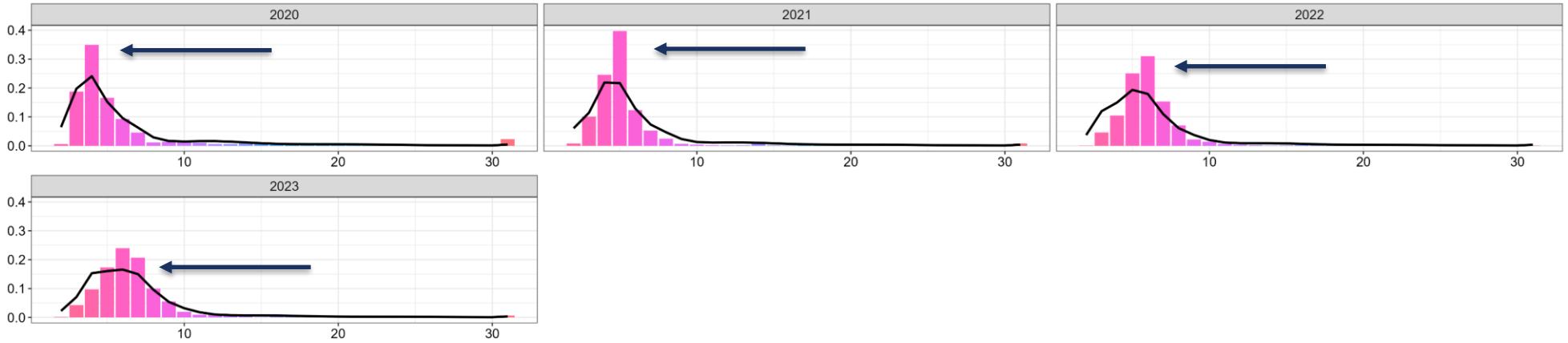




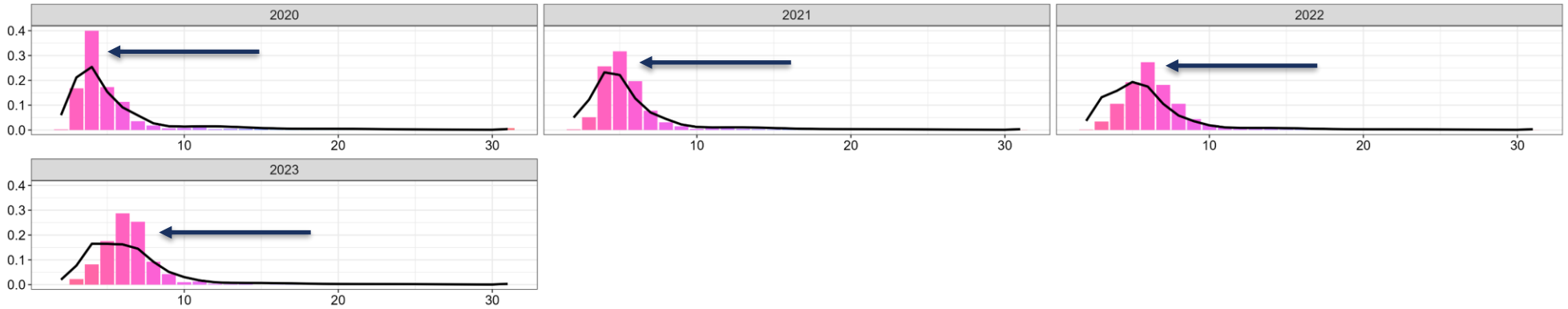
Fit to Compositional Data

- Habitually underestimating 2016 year class as it ages
- For age *data*, continued trend of overestimating abundance for ages 2-3 and underestimating at ages 4 – 6, but…

Fixed Gear Fishery Ages



LL Survey Ages



Fit to Compositional Data

Research Article

'Slim pickings?': Extreme large recruitment events may induce density-dependent reductions in growth for Alaska sablefish (Anoplopoma fimbria) with implications for stock assessment

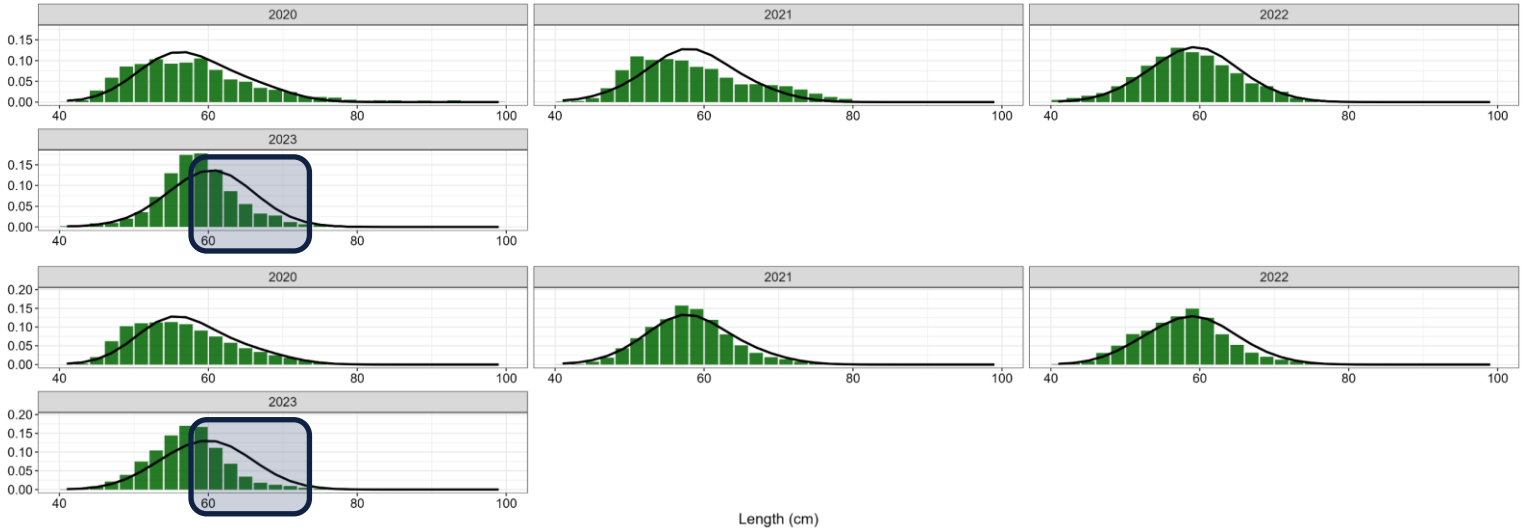
Authors: Matthew Cheng, Daniel R. Goethel, Peter-John F. Hulson, PhD, Katy B Echave, and Curry James Cunningham | AUTHORS INFO & AFFILIATIONS

Publication: Canadian Journal of Fisheries and Aquatic Sciences • 15 October 2024 • https://doi.org/10.1139/cjfas-2024-0228

- …for *length* data, underestimating small/intermediate fish (40-60 cm) and overestimating large fish (60+), but more noticeable for males
  - Based on age compositions and size of 2016 year class, model is expecting higher proportion of 60cm+ fish
  - Related to fitting sex-aggregated age compositions compared to sex disaggregated length compositions(?)
  - Potential process error (DD growth, sex-specific M, not 50:50 sex ratio, aging error)?

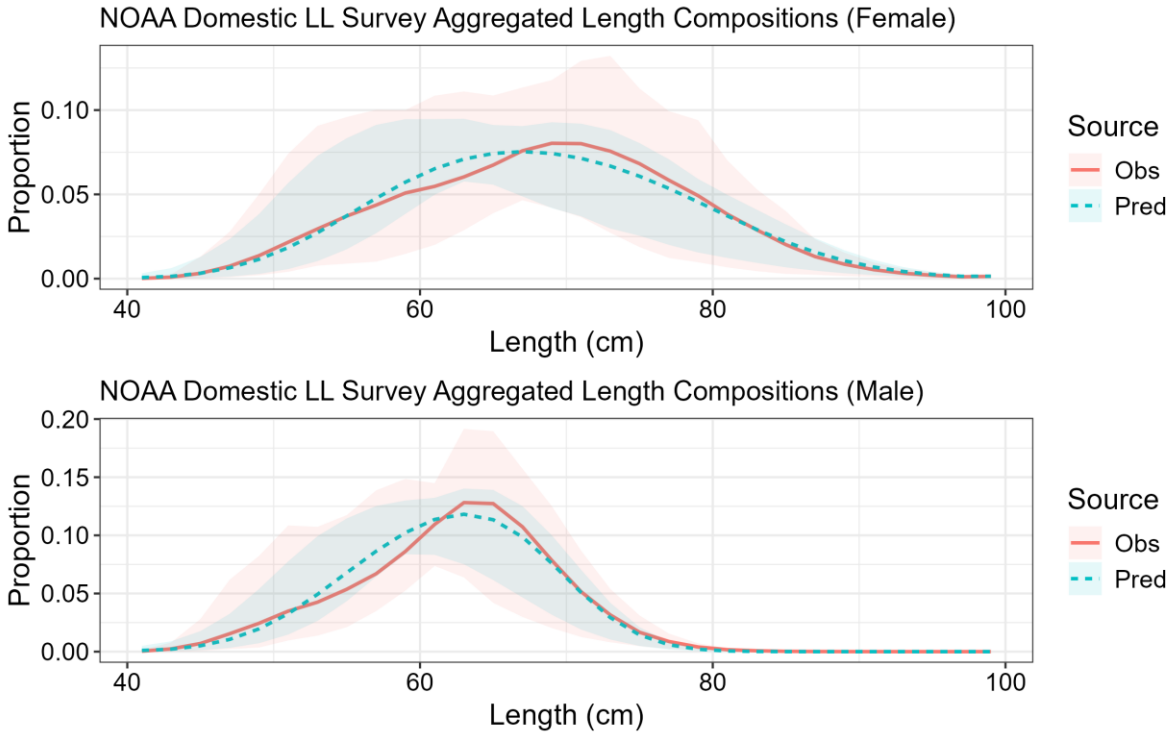
Fixed Gear Fishery Males

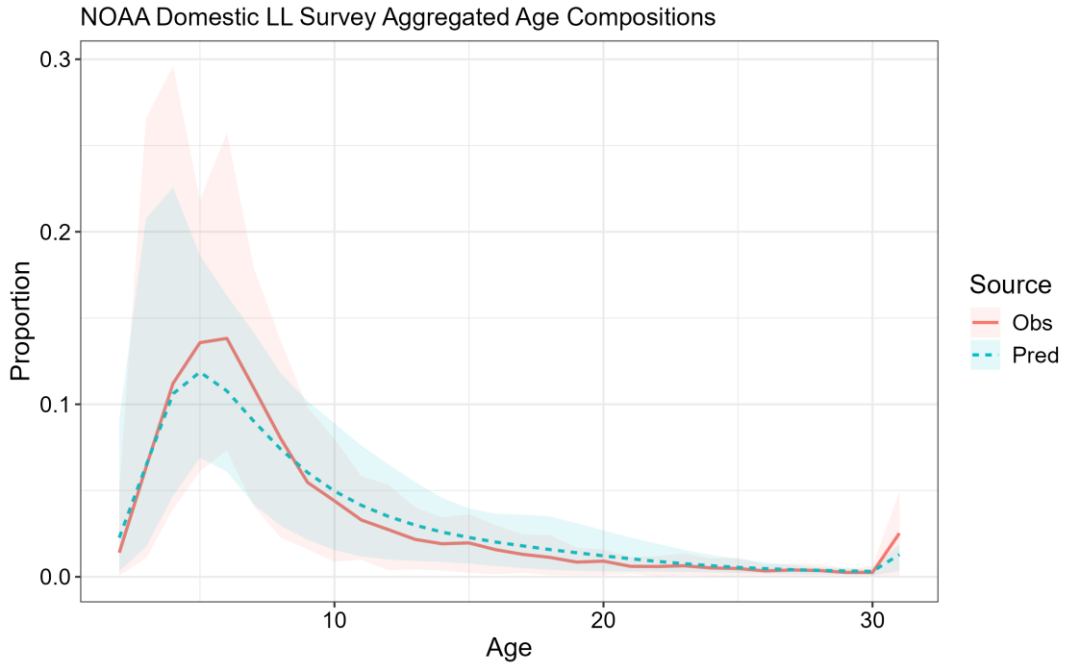
Longline Survey Males



Fit to Compositional Data

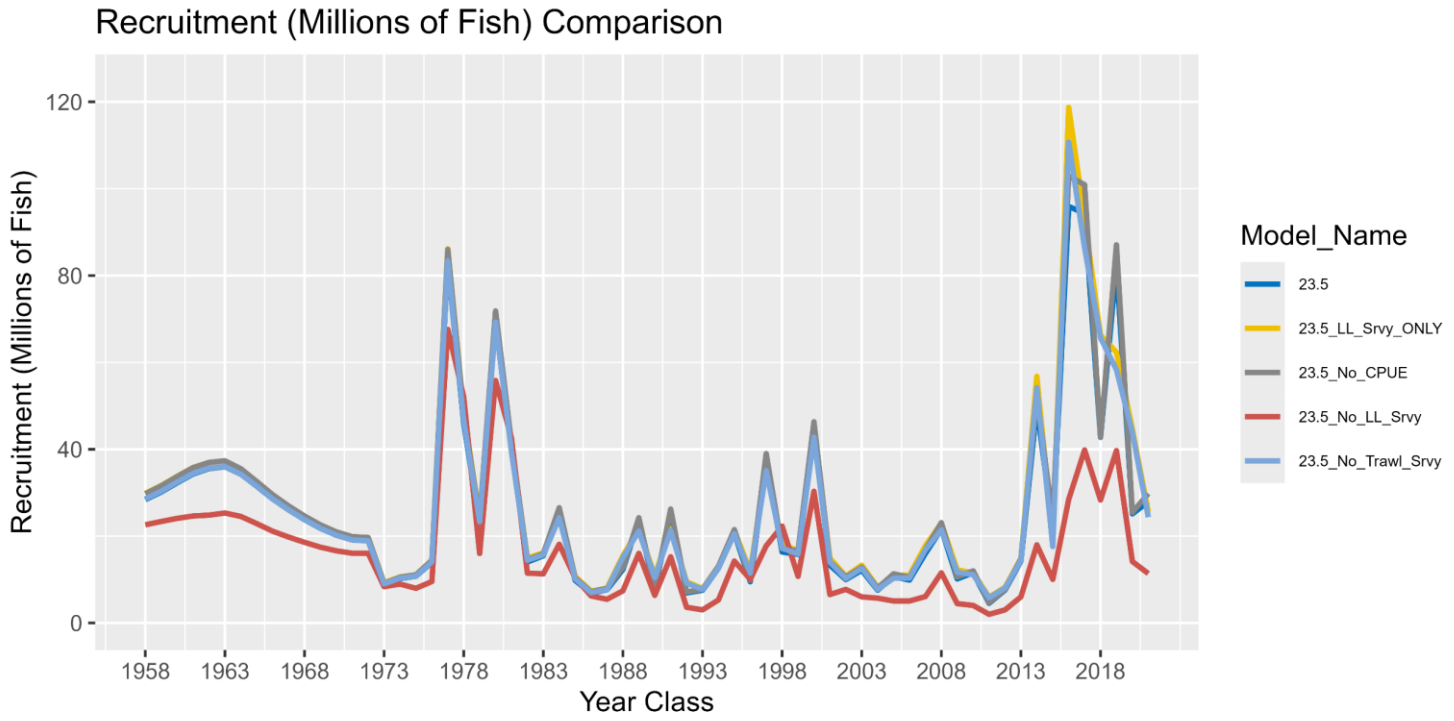
- Aggregate fits across years are adequate
- Likely overfitting length compositions
- Tension due to fitting age and length data simultaneously is a primary model issue





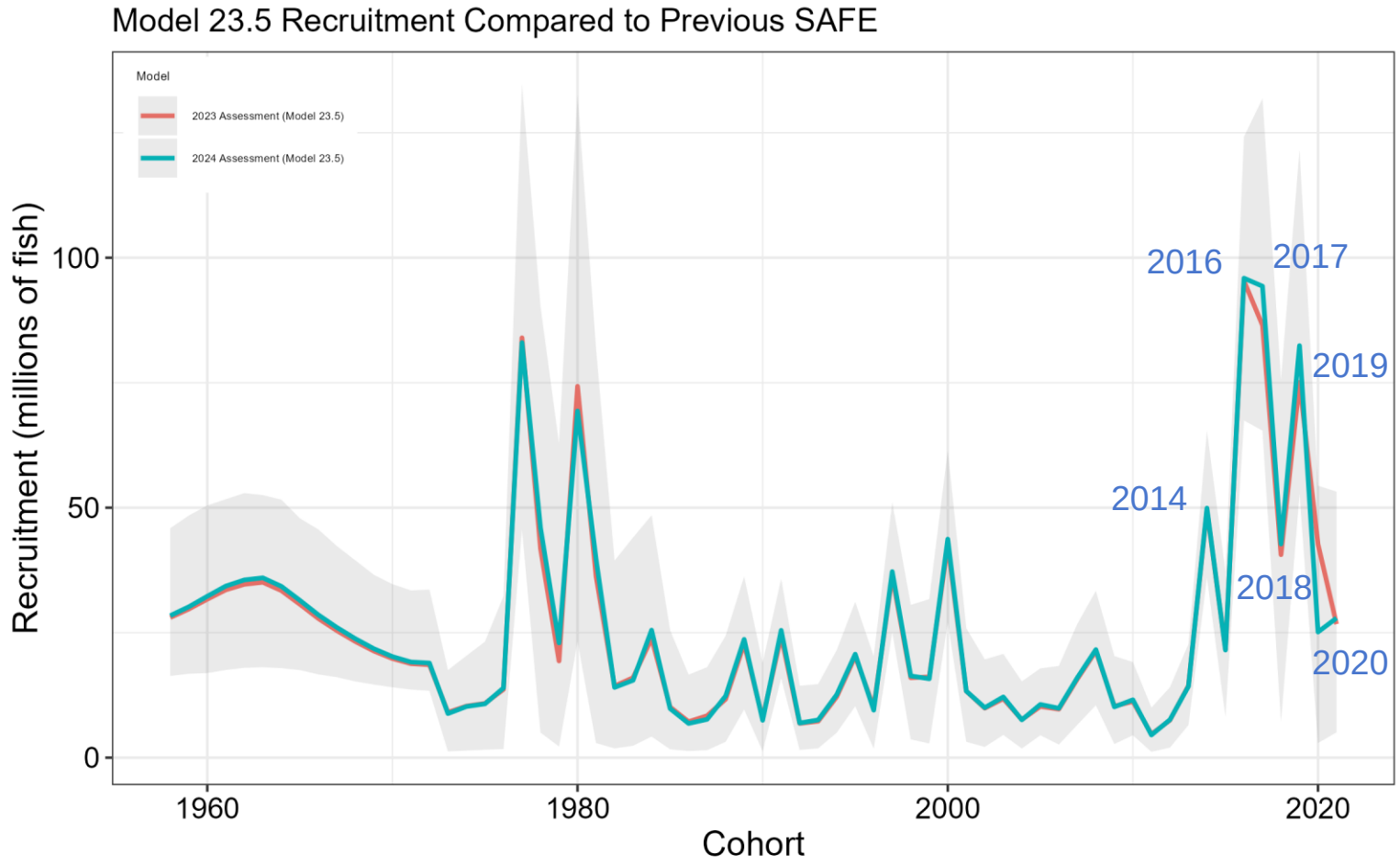
Index Sensitivity

- Longline survey is primary driver of productivity/scale
- Trawl survey is primary driver of recent recruitment
- 2019 year class smaller and 2020 larger when remove trawl survey



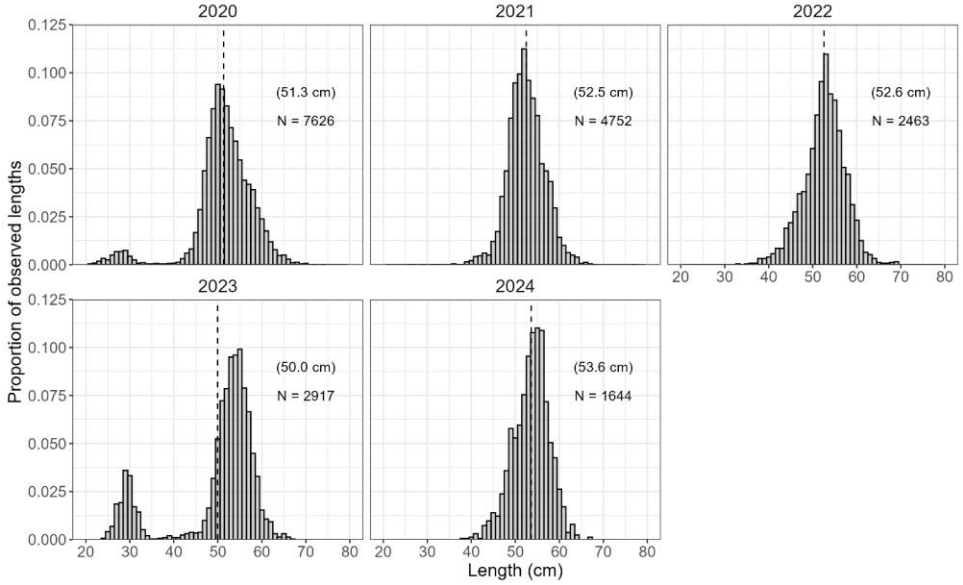
Recruitment

- 2016 likely the largest year class on record
- 2017 and 2019 also appear to be large year classes
- Current series of recruitment emulates late 1970s
- 2020—2021 year classes appear more in line with long-term average



EBS Trawl Catch and Recruitment Signals

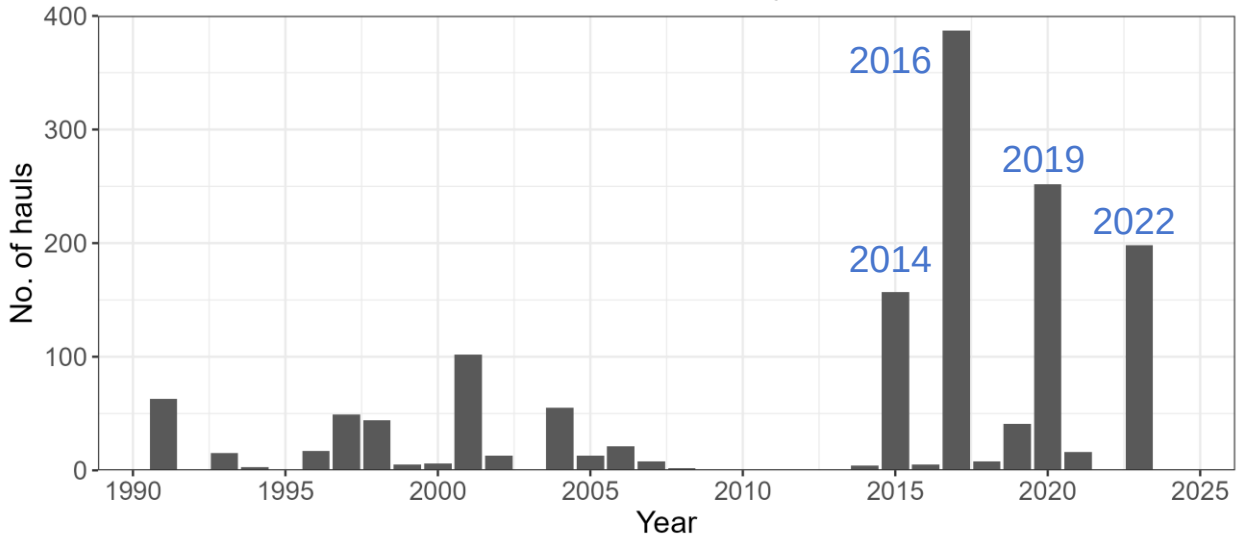
- 2020--2021 year classes small based on length composition data from EBS trawl gears.
- 2022 year class *large* based on 2023 pelagic trawl fishery length comps.



Proportions of sablefish lengths measured by observers in Eastern Bering Sea pelagic trawl fisheries. The vertical dashed line indicates the mean length each year (value shown in parentheses, with sample size, N, below).

Appendix 3E. Sablefish Bycatch in the Eastern Bering Sea

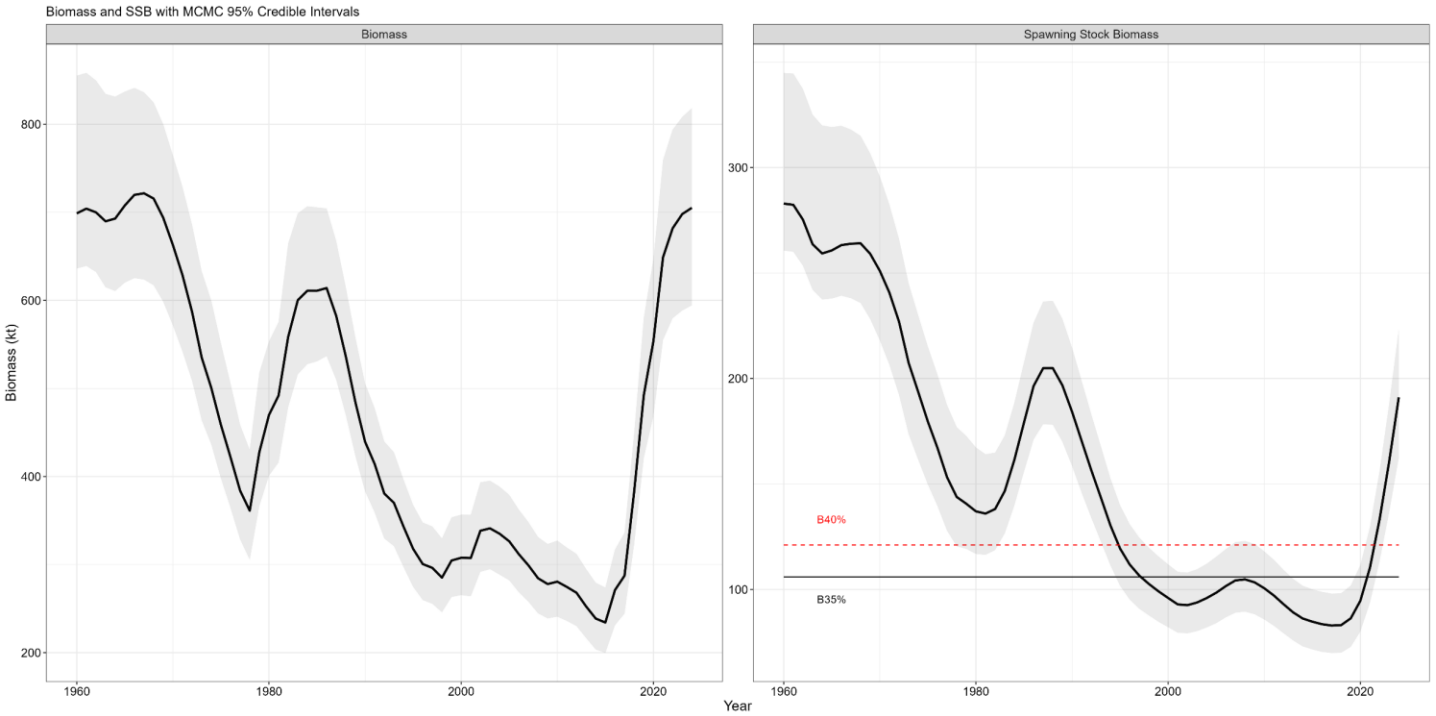
Kevin A. Siwicke and Katy B. Echave

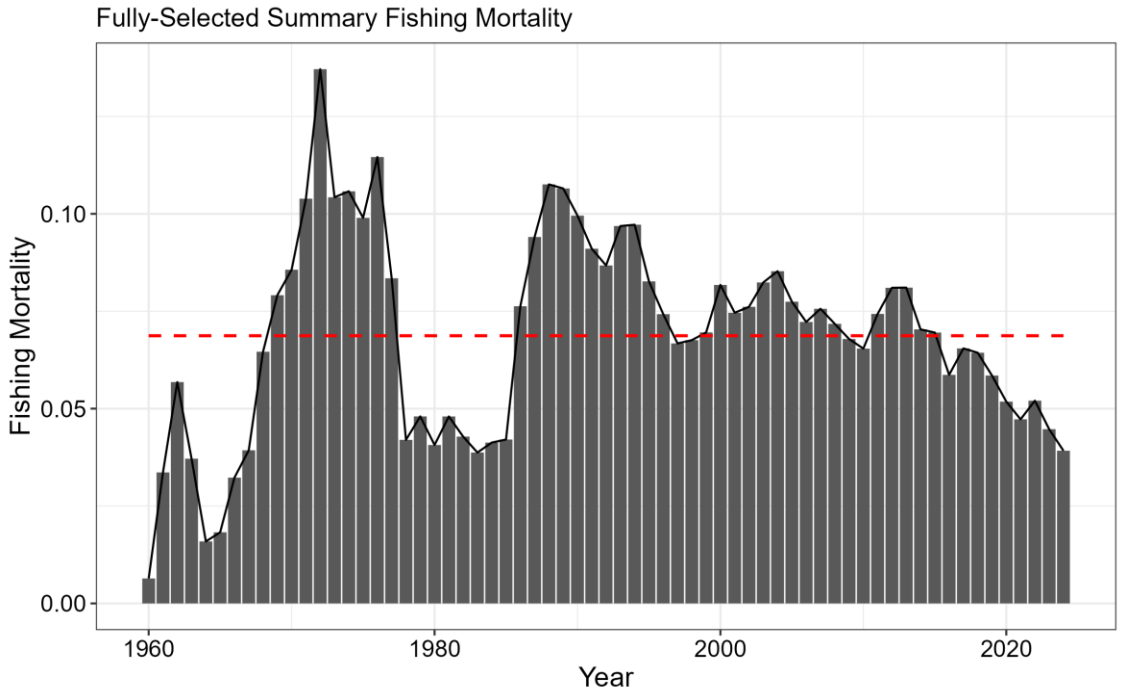


The annual sum of pelagic and non-pelagic trawl hauls fishing from 0 to 100 m where the mean weight of sablefish was < 0.5 kg (i.e., age-1).

Biomass and Fishing Mortality

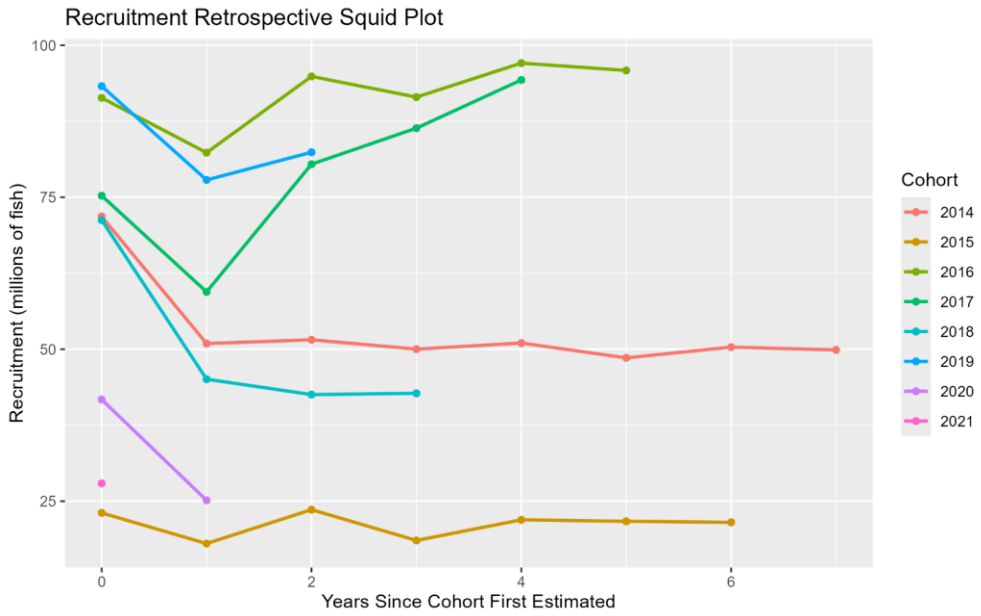
- At $B_{63\%}$ in 2024
- Projected to be at $B_{73\%}$ in 2025
- Fishing mortality remains at low levels ($< F_{ABC}$)

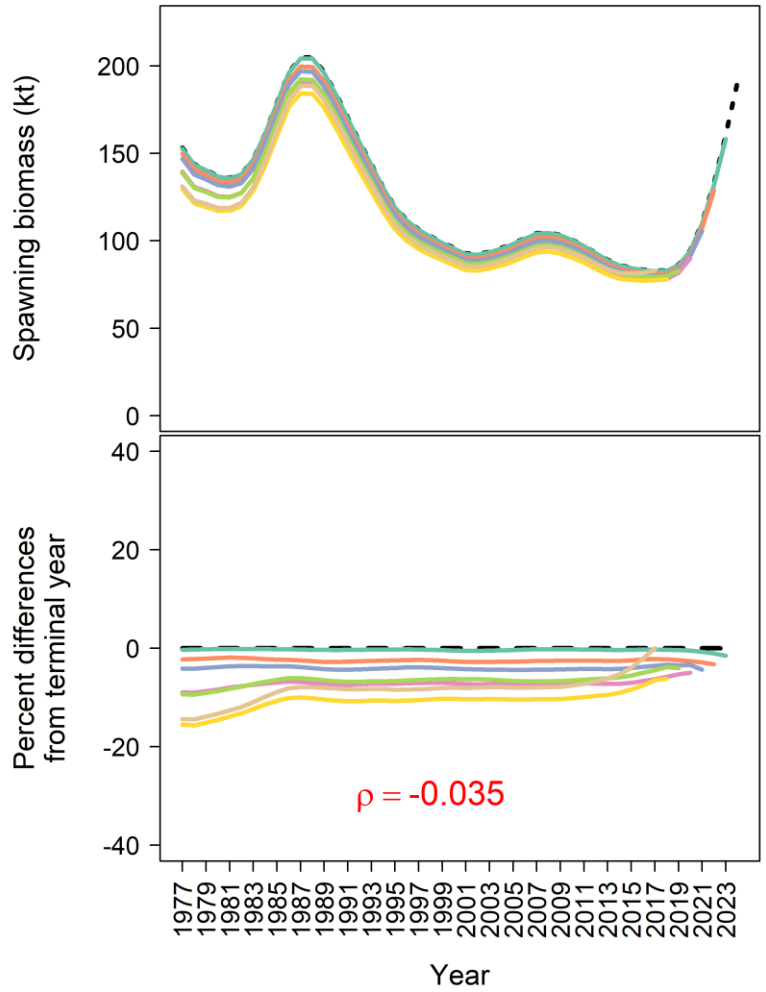




Retrospective Analysis

- Limited retrospective bias
- Slight underestimation of SSB
- Lots of interplay between 2016/2017 cohorts
  - Likely some age smearing due to aging error

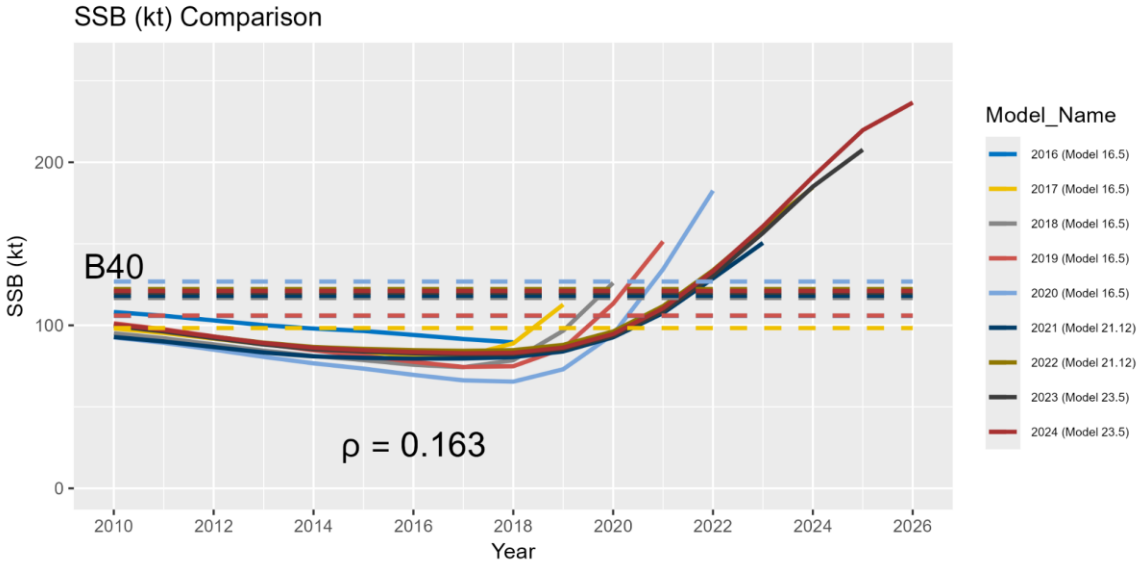




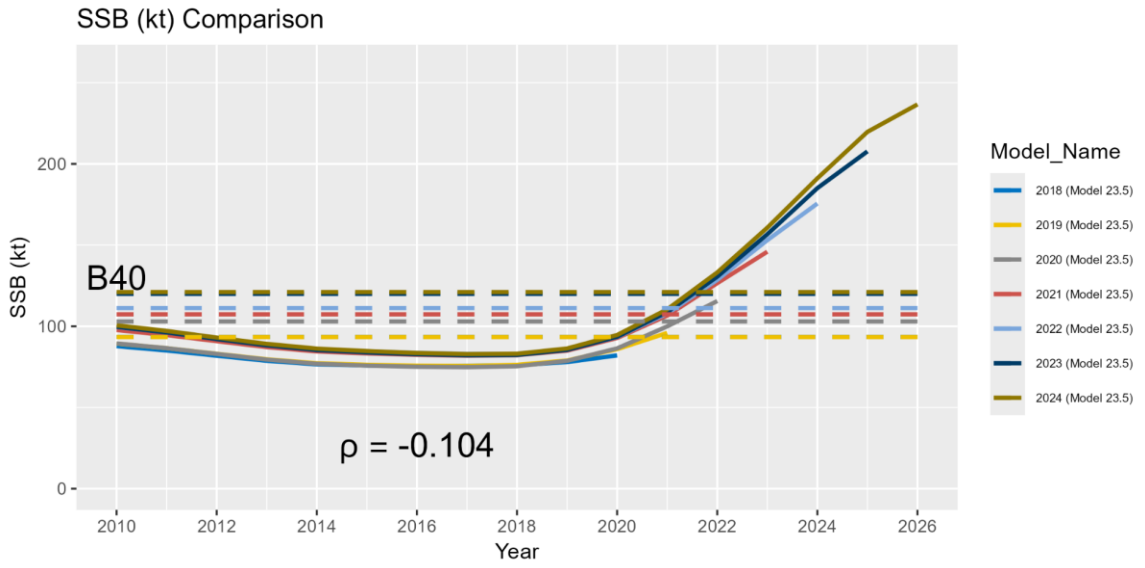
Assessment and Projection Consistency

- Model *23.5* very consistent
- Slight underestimation in SSB, but projections are consistent with realized SSB
  - Interplay with overestimation of assumed %ABC utilized in projections (overly pessimistic projection)

All Models Used For Management Advice



Model *23.5* Only



Assessment Summary

- Model fitting (most) indices well
- Consistently underestimating abundance of large year classes (i.e., 2016-2017) in age compositions and overestimating abundance of large fish in length compositions in recent years
  - Potential that density-dependent growth effects(?) are causing tension in simultaneously fitting age and length composition data
- Spawning population continues to grow rapidly
  - SSB now outpacing biomass growth as recent year classes mature
- Recent productivity is extremely high
  - Recruitment uncertainty due to difficulty differentiating adjacent large recruitment events, given aging error
  - But…no strong retrospective bias and projections appear consistent
- Age structure is slowly expanding
  - Population primarily consists of fish < age-11

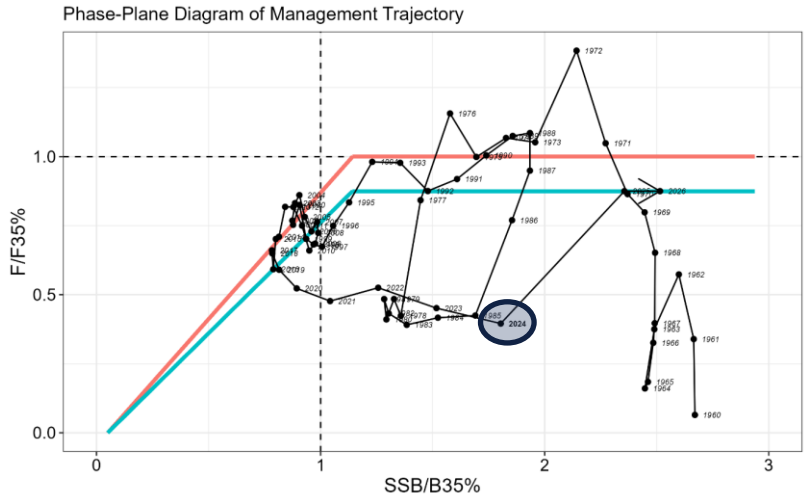
Risk Table

- **Assessment (Level 1)**: Uncertainty in recent year classes, but no retrospective patterns. Lack of a 2024 survey increases uncertainty in recruitment estimates.
- **Population (Level 1)**: SSB rapidly increasing, but age structure remains composed of primarily younger, not fully mature ages classes (recent cohorts > 81% of SSB).
- **Ecosystem (Level 1)**: Temperature and cross shelf transport were potentially favorable for survival and growth of sablefish larvae, adequate foraging for juveniles/adults, decreased competition (pink salmon) and predation.
- **Fishery (Level 1)**: CPUE data indicates positive population trends (not updated since 2023).

Level 1—No Concerns

Harvest Recommendations

- 2025 Author's ABC = Max ABC = **50,111 t**
  - +3,000 t from 2024 ABC
  - If harvested, it would represent the *2nd highest* removals all-time
  - ~40,000 t ↑ in 8 years (2016 ABC was 11,795 t)
  - ABC ~70% harvested in recent years
    - Only 49% extrapolated utilization for 2024



Quantity/Status	As estimated or specified *last* year for (model *23.5*): 2024	2025*	As estimated or recommended *this* year for (model *23.5*): 2025	2026**
M (natural mortality rate, estimated)	0.113	0.113	0.114	0.114
Tier	3a	3a	3a	3a
Projected total (age 2+) biomass (t)	700,353	691,260	704,713	695,681
Projected female spawning biomass (t)	185,079	209,500	219,714	241,217
$B_{100\%}$ #	299,901	299,901	302,672	302,672
$B_{40\%}$ #	119,960	119,960	121,069	121,069
$B_{35\%}$ #	104,965	104,965	105,935	105,935
F_{OFL}	0.101	0.101	0.102	0.102
$maxF_{ABC}$	0.086	0.086	0.087	0.087
F_{ABC}	0.086	0.086	0.087	0.087
OFL (t)	55,385	55,620	58,731	57,993
OFL_w (t)^	**55,084**	**55,317**	**58,532**	**57,797**
max ABC (t)	47,367	47,572	50,283	49,651
ABC (t)	47,367	47,572	50,283	49,651
ABC_w (t)^	**47,146**	**47,350**	**50,111**	**49,482**
Status	As determined *last* year for: 2022	2023	As determined *this* year for: 2023	2024
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No

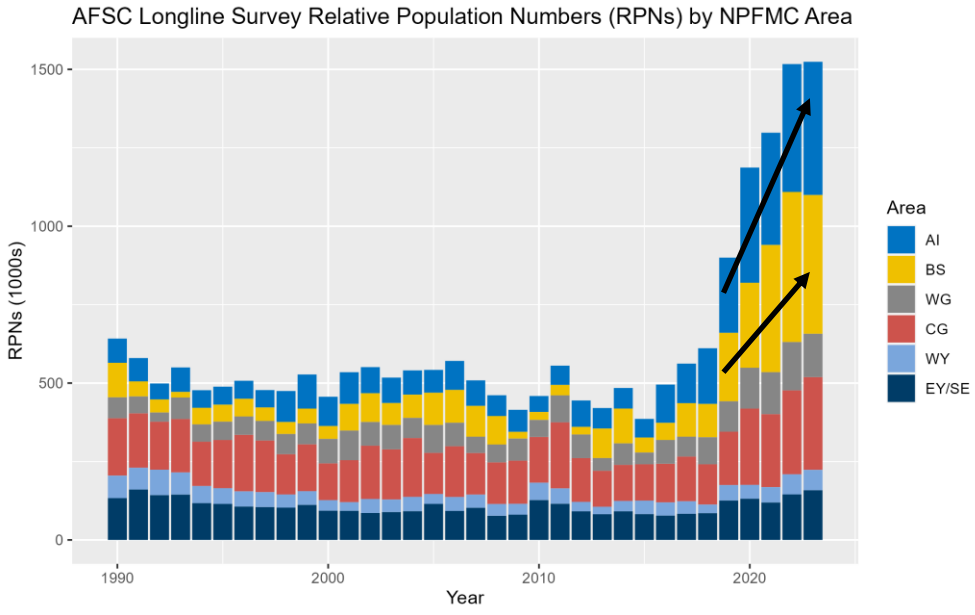
**The 2024 SAFE projections were based on specified catch of 24,692 t in 2025 (a yield ratio of 0.49 was assumed based on a 2024 extrapolated catch of 23,152 t and an ABC of 47,146t).
^ABC_w and OFL_w are the final author recommended ABCs and OFLs after accounting for whale depredation.
#The average recruitment for calculation of biological reference points was 25.9 million fish for the 2024 SAFE and 25.3 million fish for the 2023 SAFE.

Apportionment

- Based on 5-year average of regional longline survey biomass proportions
  - Meant to address biological concerns (localized depletion) and avoid extreme fluctuations in regional quotas
  - Updated yearly with new survey data (no new data for 2024)
- BSAI constitutes > 50% of survey biomass in 2023

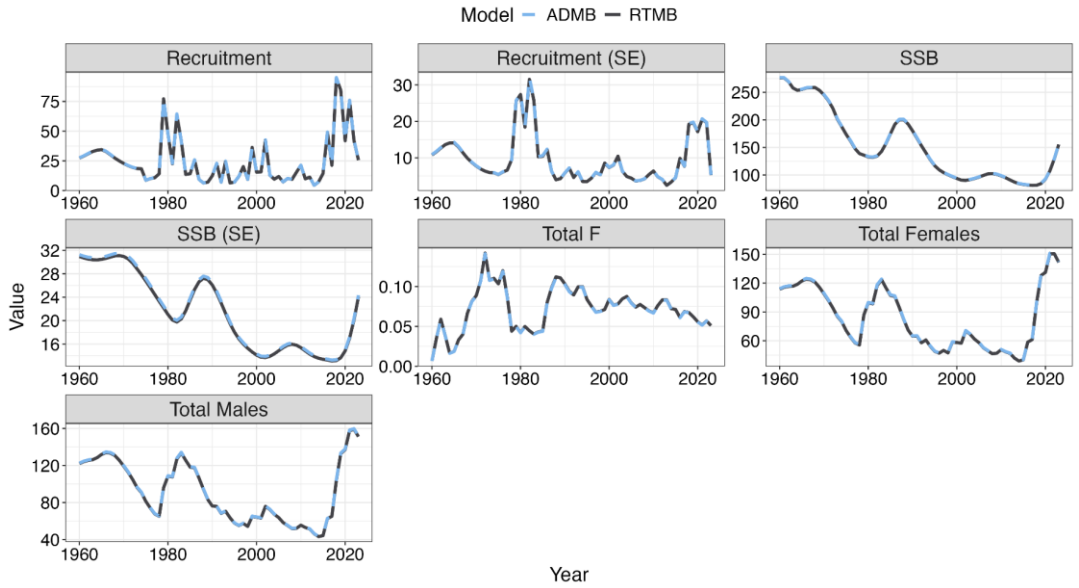
Year	2024				2025		2026	
Region	OFL_w	ABC_w	TAC	Catch*	OFL_w	ABC_w**	OFL_w	ABC_w**
BS	--	11,450	7,996	3,940	--	13,898	--	13,723
AI	--	13,100	8,440	1,266	--	12,175	--	12,022
GOA	--	22,596	22,596	13,406	--	24,038	--	23,737
WGOA	--	4,699	4,699	2,101	--	4,996	--	4,934
CGOA	--	9,651	9,651	5,655	--	10,257	--	10,128
**WYAK	--	2,926	2,926	2,172	--	3,125	--	3,086
**EY/SEO	--	5,320	5,320	3,478	--	5,660	--	5,589
Total	55,084	47,146	39,032	18,612	58,532	50,111	57,797	49,482

*As of October 10, 2024
**After 95:5 trawl split and whale depredation



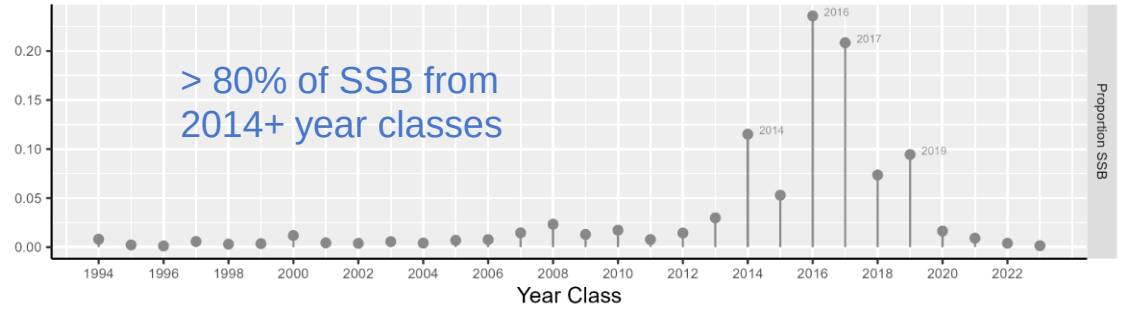
Ongoing Concerns and Future Directions

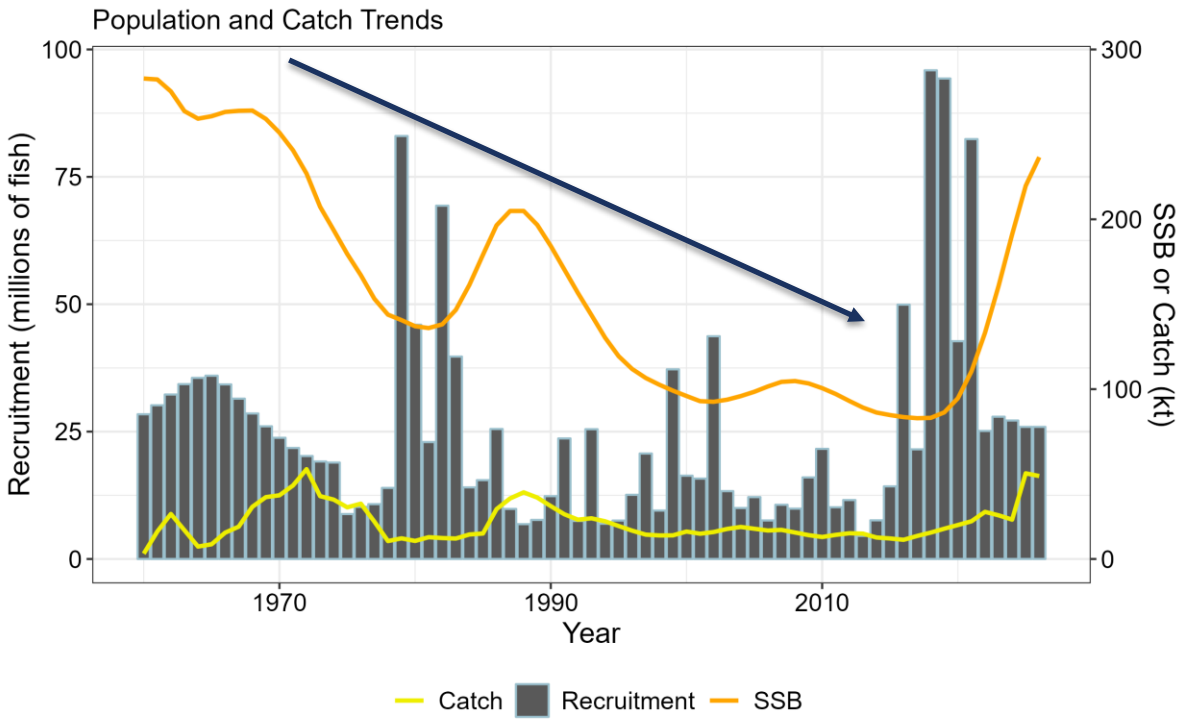
- Rapid transition to pot gear (> 80% of fixed gear catch)
- Influx of small fish
  - NPFMC Small sablefish release action
  - https://shinyfin.psmfc.org/small_sablefish/
- Research:
  - R-TMB version of assessment available (Matt Cheng)
    - Working on integrating sex-specific assessment 'good practices'
  - Spatial model (Matt Cheng)
    - Spatial assessment with age-based movement nearly complete
      - https://github.com/chengmatt/SpatialSabieModel
      - https://craig44.github.io/SableFishResearch/
  - Hidden Markov Model (HMM) and high-resolution tagging/movement STM model to analyze sat tags (Matt Cheng, Kevin Siwicke, Katy Echave)
  - Full life cycle spatial model integrating larval IBM outputs and multistage SRR (Samara Nehemiah, Matt Cheng)



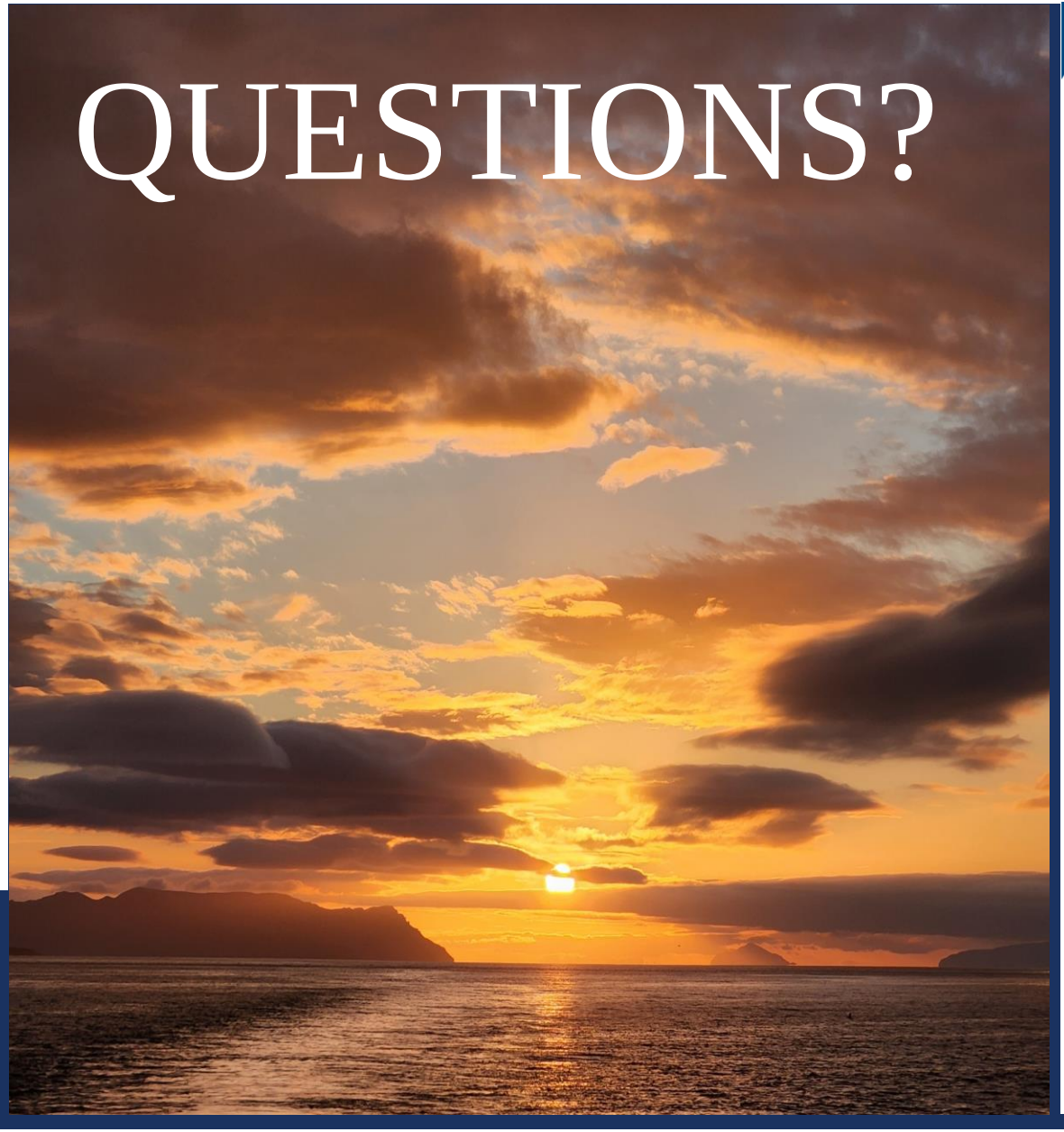
Understanding Management Performance

- Alternate management procedures (e.g., including catch stability constraints) could be considered to help maintain age structure and avoid quota creep
- A sablefish management strategy evaluation (MSE) research tool has been developed to investigate whether the NPFMC F40% harvest control rule (HCR) is adequate for sablefish
  - Being used to explore:
    - Robustness of alternate management options
    - Impact of future recruitment assumptions
    - Tradeoffs in conservation and stakeholder performance metrics
  - Tool complete (https://ovec8hkin.github.io/SablefishMSE/index.html)
    - Developed by Joshua Zahner
  - Two stakeholder outreach meetings held in 2023
    - More planned in 2025
    - Stakeholders can contact the lead author to be added to mailing list





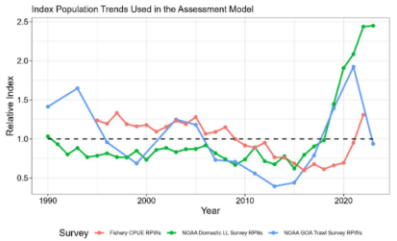
QUESTIONS?

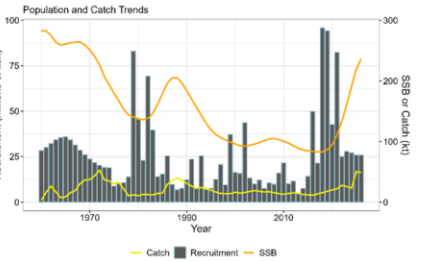


2024 Alaskan Sablefish SAFE (*Anoplopoma fimbria*)

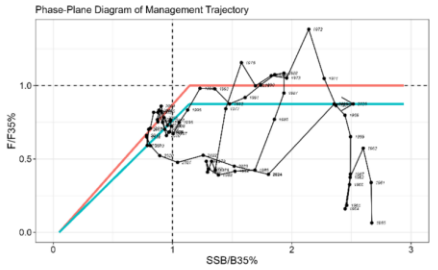
Data and Stock Assessment Model

- Survey indices had been steadily increasing since 2015, but the 2023 NOAA longline survey abundance was stable and the 2023 NOAA Gulf of Alaska trawl survey declined. *There were no surveys in 2024.*
- For 2024 an update assessment was undertaken and there were no changes to the author proposed model (*23.5*) aside from updated data for 2024 (i.e., catch, fishery lengths, and fishery and survey ages).
- The biomass and SSB continue to increase, while recruitment appears to have returned to more average conditions in recent years.





Stock Status and ABC Recommendations



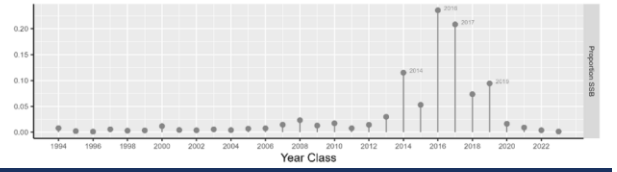
Quantity	2023 SAFE (Projections for 2024)	2024 SAFE (Projections for 2025)
$B_{100\%}$	299,901	302,672
$B_{40\%}$	119,960	121,069
$SSB_{(Terminal\_Yr+1)}$	185,079	219,714
$SSB_{(Terminal\_Yr+1)}/B_{100\%}$	62%	73%
$F_{ABC(Terminal\_Yr+1)}$	0.086	0.087
$ABC_{w(Terminal\_Yr+1)}$	47,146	50,111
$OFL_{w(Terminal\_Yr+1)}$	55,084	58,532

*SSB projections are based on specified catch for the terminal year. ABC_w and OFL_w are the recommended values after whale depredation has been taken into account.

- The resource is *not overfished* and *overfishing is not occurring.*
- Recent ABCs have not been fully utilized with catch averaging ~71% of the ABC over the last 3 years, but expected to be <50% utilized in 2024 (based on extrapolated landings through the end of the year).
- The ABC increased by 6% due to continued maturation and growth (in weight) of the population.

Other Considerations

- The population age-structure is beginning to expand with the rapid maturation of the 2014 and 2016 year classes.
- 2014 – 2021 year classes comprise > 81% of projected 2025 SSB.



Other PT Tables

Area	AI	BS	WG	CG	WY*	EY*	Total
2024 ABC	13,108	11,474	4,718	9,670	2,683	5,714	47,367
2025 ABC	12,180	13,915	5,009	10,265	2,848	6,066	50,283
2021 - 2023 Mean Depredation	5	14	12	8	20	101	160
Ratio 2025:2024 ABC	0.93	1.21	1.06	1.06	1.06	1.06	1.06
Deduct 3-Year Adjusted Mean	-5	-17	-12	-8	-21	-108	-171
****2025 ABC_w**	12,175	13,898	4,996	10,257	2,827	5,958	50,111

Area	AI	BS	WG	CG	WY*	EY*	Total
2024 ABC	13,108	11,474	4,718	9,670	2,683	5,714	47,367
2026 ABC	12,027	13,740	4,946	10,136	2,812	5,989	49,651
2021 - 2023 Mean Depredation	5	14	12	8	20	101	160
Ratio 2026:2024 ABC	0.9	1.2	1.0	1.0	1.0	1.0	1.0
Deduct 3-Year Adjusted Mean	-5	-17	-12	-8	-21	-106	-169
****2026 ABC_w**	12,022	13,723	4,934	10,128	2,791	5,883	49,482

Year	West Yakutat	E. Yakutat/ Southeast
2025	3,125	5,660
2026	3,086	5,589

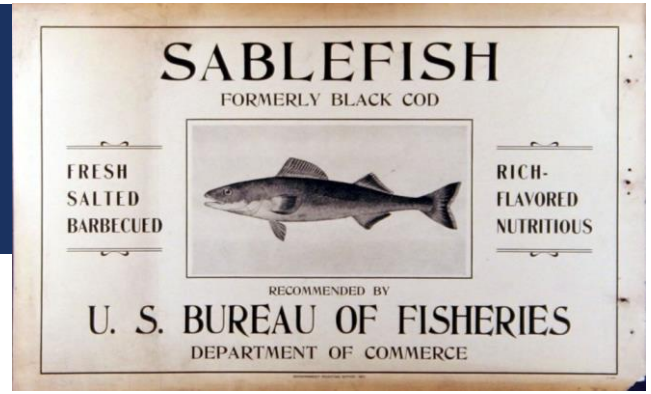
Year	2025	2026
OFL	58,731	57,993
3-Year Mean Depredation	160	160
Depredation Inflation Factor	1.24	1.22
Deduct 3-Year Mean	-199	-196
***OFL_w**	**58,532**	**57,797**

Area	Year	Biomass (4+)*	OFL**	ABC#	TAC	Catch^
GOA	2023	317,000	--	23,201	23,201	13,581
	2024	303,000	--	22,596	22,596	13,406
	2025	305,000	--	24,038	--	--
	2026	299,000	--	23,737	--	--
BS	2023	151,000	--	8,417	7,996	4,851
	2024	174,100	--	11,450	7,996	3,940
	2025	175,000	--	13,898	--	--
	2026	172,000	--	13,723	--	--
AI	2023	153,000	--	8,884	8,440	1,924
	2024	152,000	--	13,100	8,440	1,266
	2025	153,000	--	12,175	--	--
	2026	151,000	--	12,022	--	--

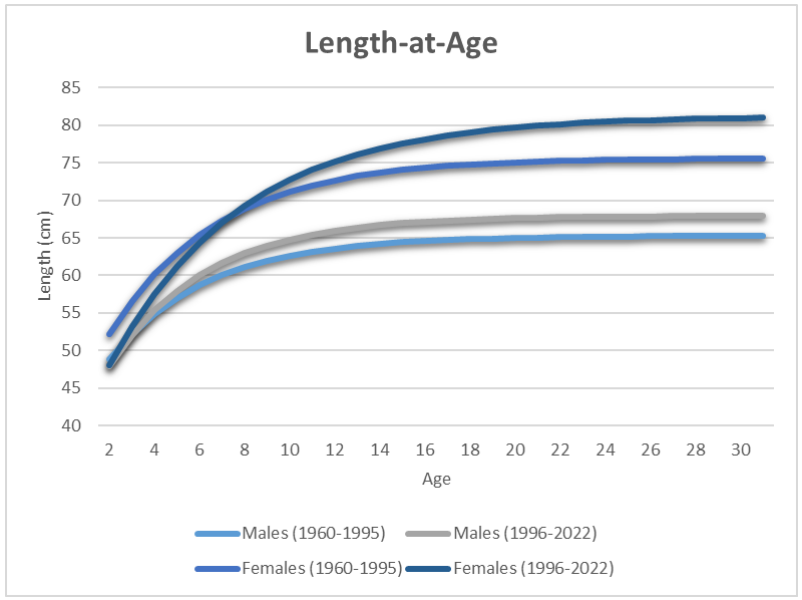
Catch

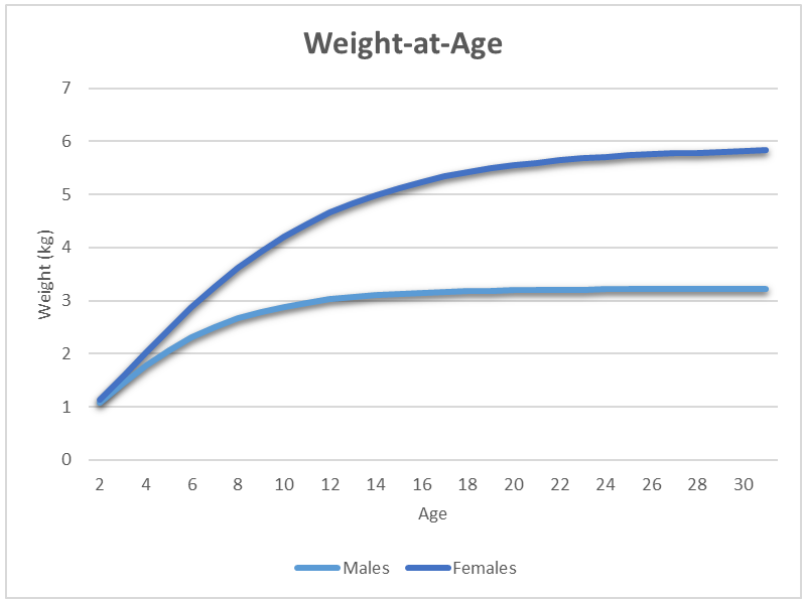
	By Area								By Gear				
Year	Total	AI	BS	WGOA	CGOA	EGOA	WY	EY/SEO	Non-Comm	HAL	Trawl	Pot	% Trawl
2011	13,328	1,027	707	1,395	4,922	4,936	1,902	3,034	341	11,251	1,180	556	9
2012	14,144	1,205	744	1,352	5,328	5,243	2,033	3,210	272	12,259	1,102	511	8
2013	13,851	1,082	635	1,358	5,187	5,349	2,102	3,246	240	12,134	1,037	439	7
2014	11,806	813	314	1,194	4,736	4,489	1,671	2,817	259	10,195	1,025	326	9
2015	11,179	422	210	998	4,626	4,677	1,866	2,811	246	9,721	1,090	122	10
2016	10,472	340	531	1,052	4,195	4,106	1,651	2,455	248	8,701	1,336	187	13
2017	12,552	588	1,150	1,181	4,838	4,510	1,694	2,816	285	8,464	2,272	1,531	18
2018	14,494	664	1,536	1,389	5,778	4,881	1,861	3,019	246	8,690	3,780	1,778	26
2019	16,912	663	3,162	1,533	6,280	4,915	1,802	3,113	360	8,268	5,154	3,130	30
2020	19,416	1,232	5,329	1,462	6,041	4,971	1,835	3,137	381	5,813	7,493	5,730	39
2021	21,748	1,578	4,169	1,994	7,325	6,201	2,329	3,872	481	4,644	4,853	11,771	22
2022	27,420	2,230	5,514	3,028	8,165	7,971	2,750	5,221	512	4,056	5,366	17,485	20
2023	25,493	2,488	6,132	2,789	6,457	7,151	2,453	4,698	476	3,313	5,596	16,107	22
2024	18,682	1,266	3,939	2,101	5,655	5,650	2,172	3,478	71	2,323	5,134	11,155	27

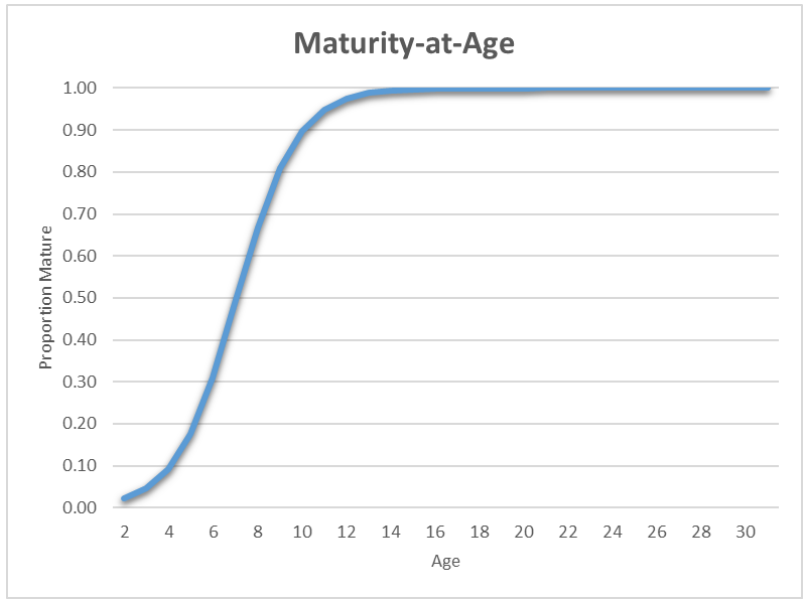
Biological Inputs



- 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

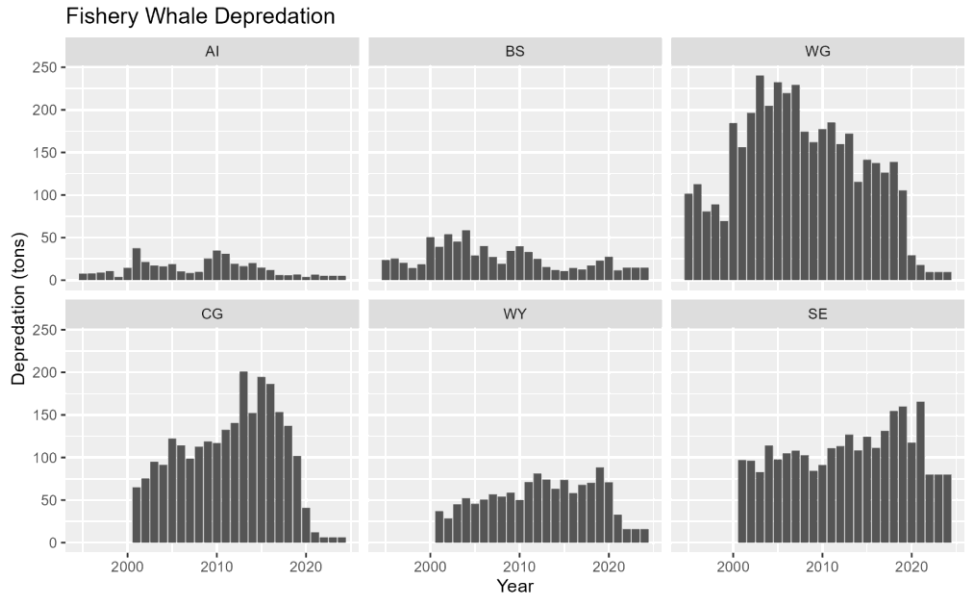


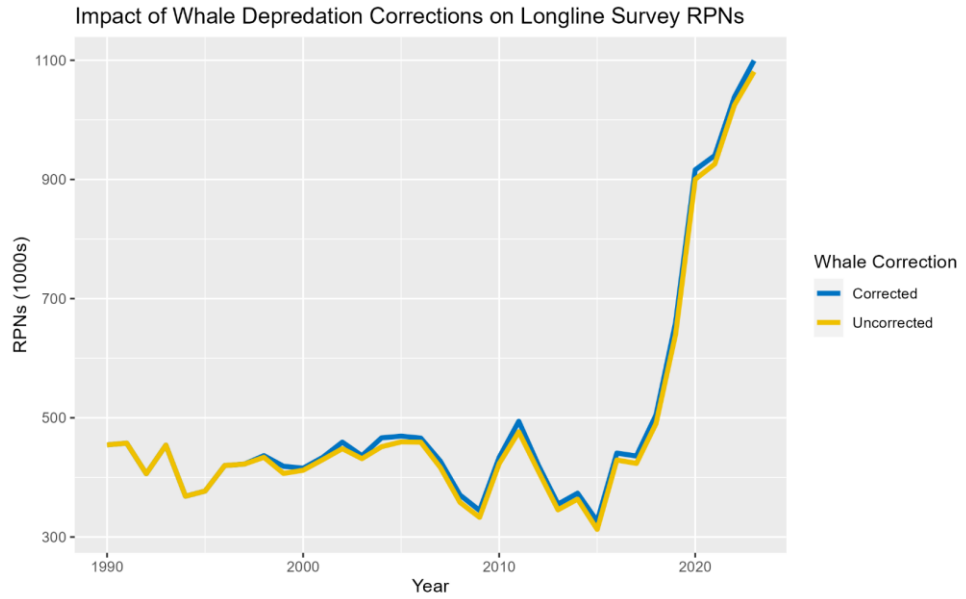




Whale Depredation

- Fishery whale depredation not updated (full update in 2022)
  - Limited depredation due to rapid transition to pot gear (no assumed depredation)
- Depredation on longline survey is low (28 stations with observed depredation in 2023)





*Note figure does not include non-surveyed area interpolations

Age Structure

- Age truncation still an issue, but recent cohorts are beginning to fill out the age structure
- Compared to historic age structure, there are still fewer fish > age-10