

INTERNATIONAL PACIFIC



HALIBUT COMMISSION

Summary of the 2021 data and stock assessment, and decision table for 2022

Agenda items 5.4, 5.5

IPHC-2022-AM098-10



Summary

- Indices were up in 2021 with younger fish from the 2012 year-class increasingly important
- Stock distribution is trending back toward Biological Region 3
- Spawning biomass trend is nearly flat with little projected change at $F_{43\%}$
- Projections rely on the 2012 year-class maturing over the next ~3 years, but the scale and biology of this cohort remain uncertain

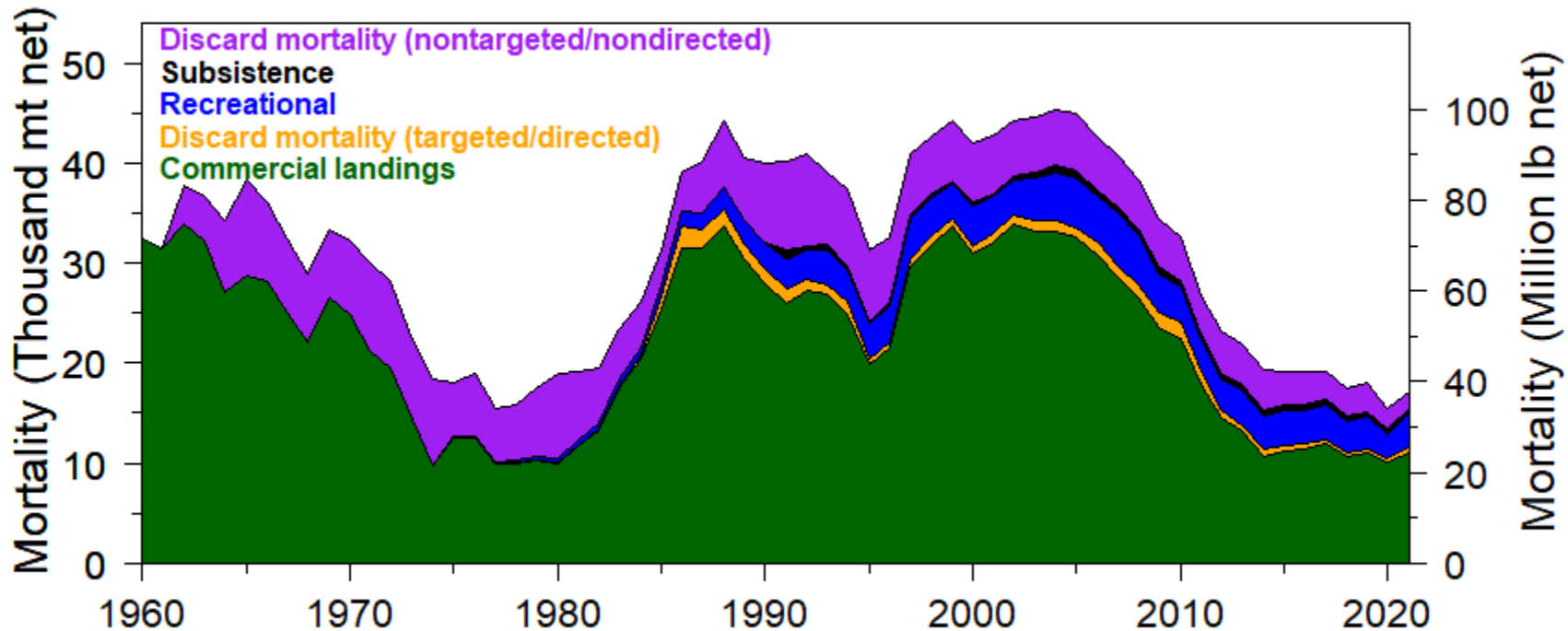


Outline

- Data sources
- Modelling results
- Projections and decision table
- Interim management procedure results



Historical mortality



2021 Mortality

Projected from AM097

Year	Commercial Landings	Commercial discards	Recreational	Subsistence	Non-directed discards	Total
2021	25.70	0.88	6.83	1.06	5.78	40.25

(3-yr avg.)



2021 Mortality

Projected from AM097

Year	Commercial Landings	Commercial discards	Recreational	Subsistence	Non-directed discards	Total
2021	25.70	0.88	6.83	1.06	5.78	40.25

(3-yr avg.)

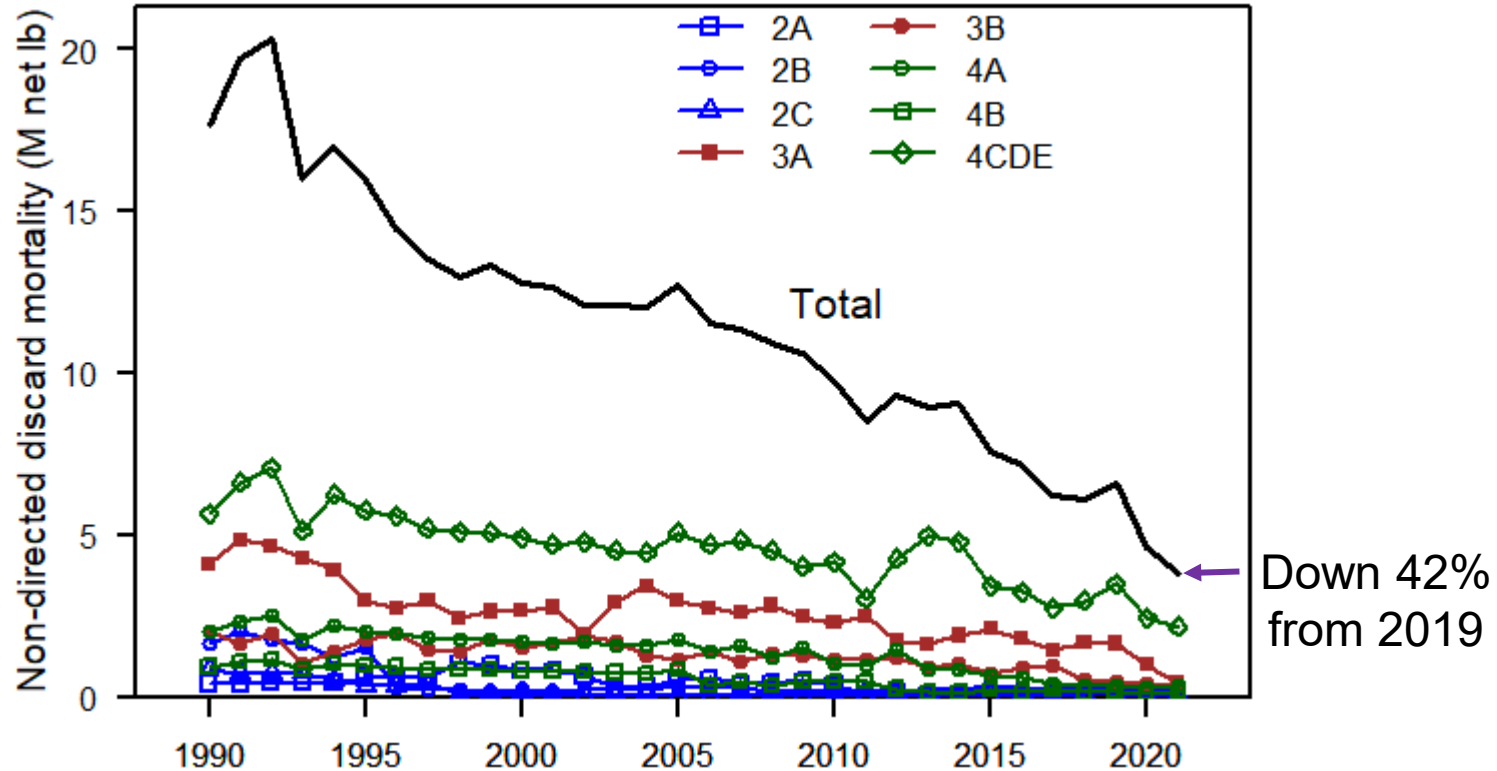
Estimated for this year's stock assessment analysis

Year	Commercial Landings	Commercial discards	Recreational	Subsistence	Non-directed discards	Total
2021	24.49	1.02	7.65	0.97	3.76	37.89

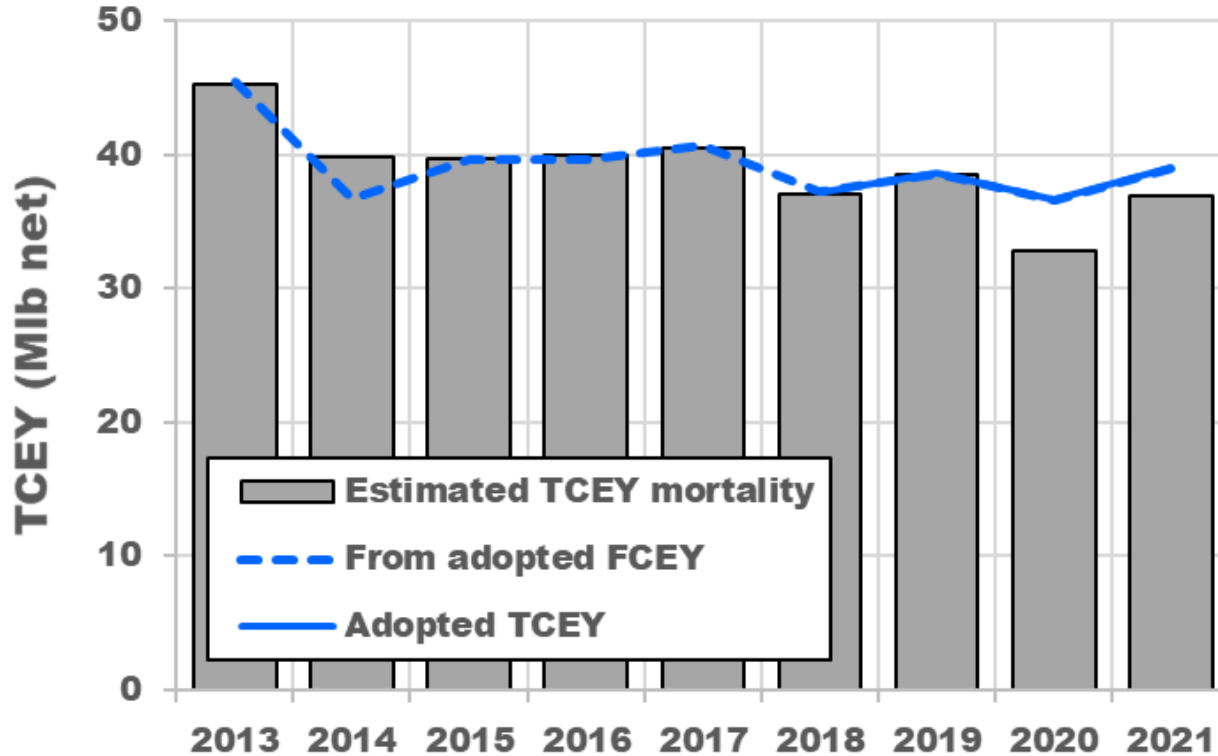
3-yr avg. = 4.98



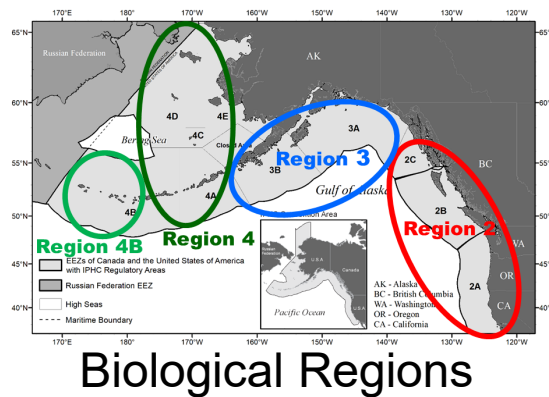
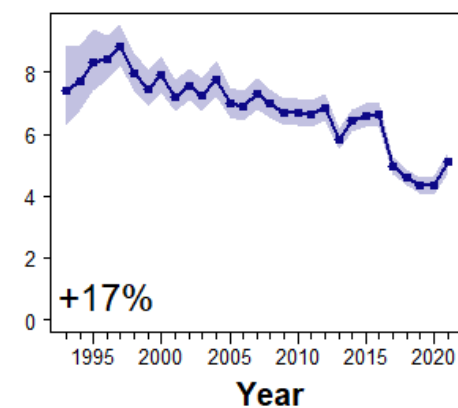
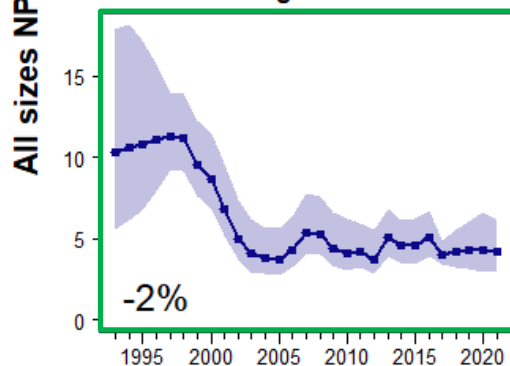
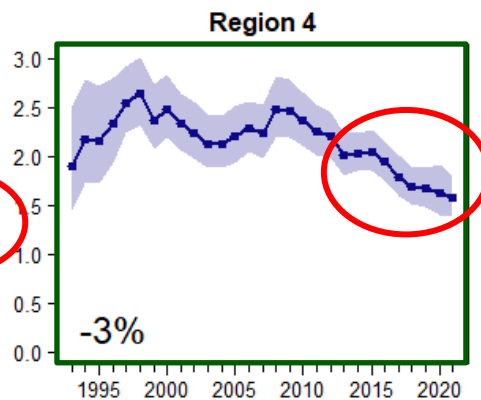
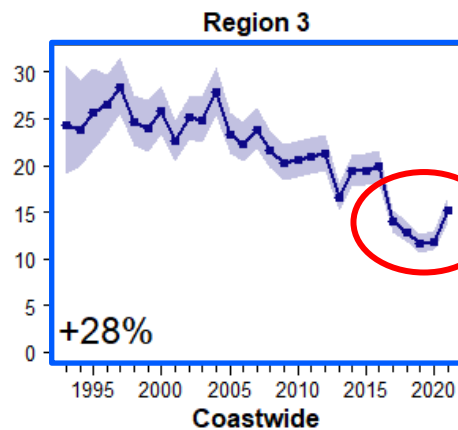
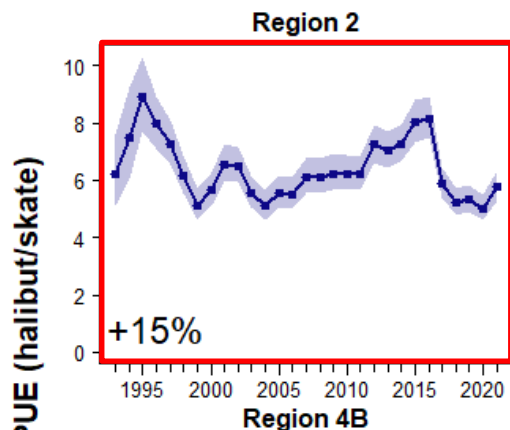
Recent non-directed discard mortality



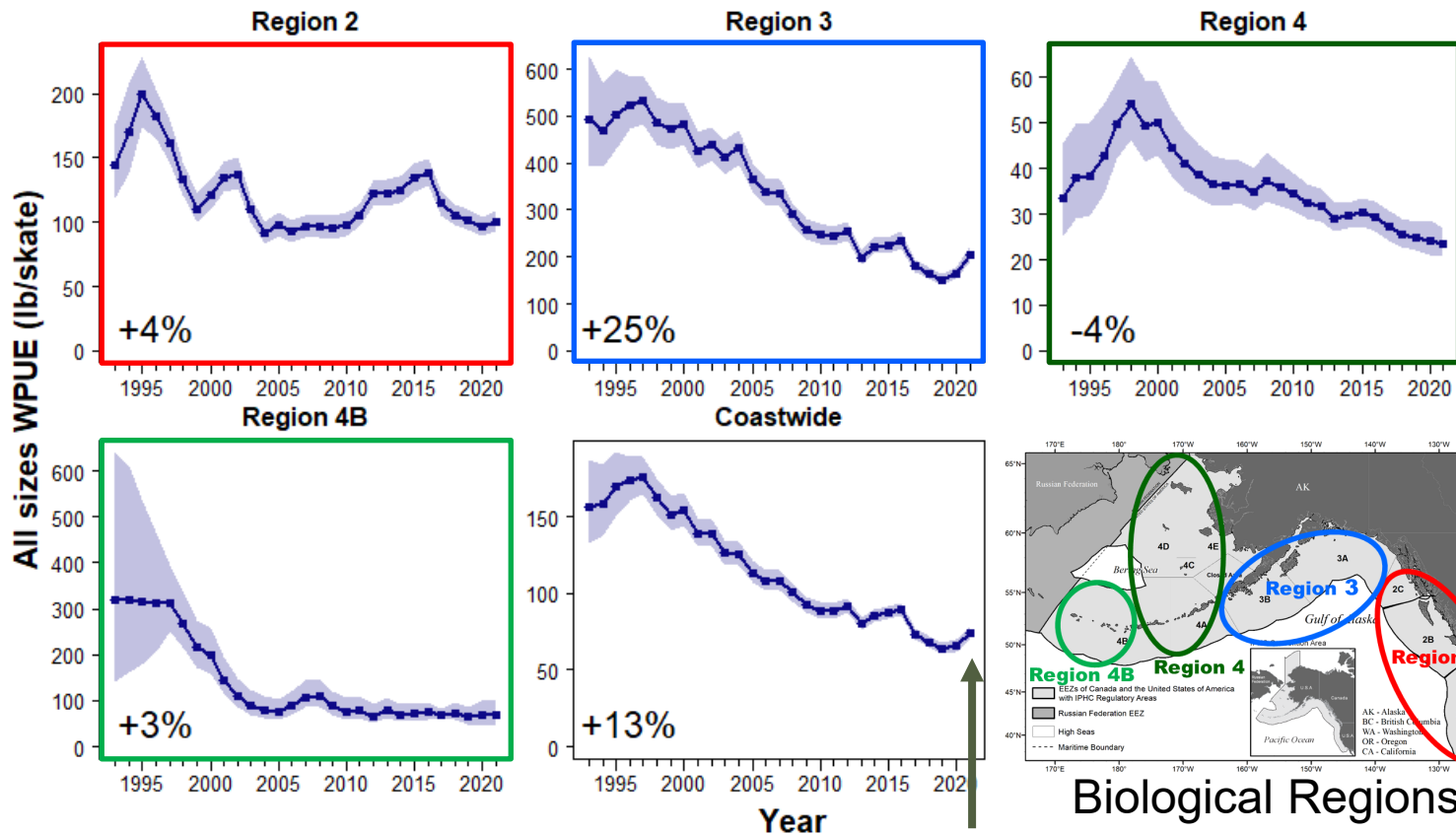
TCEY comparison



Modelled survey trends (Numbers)



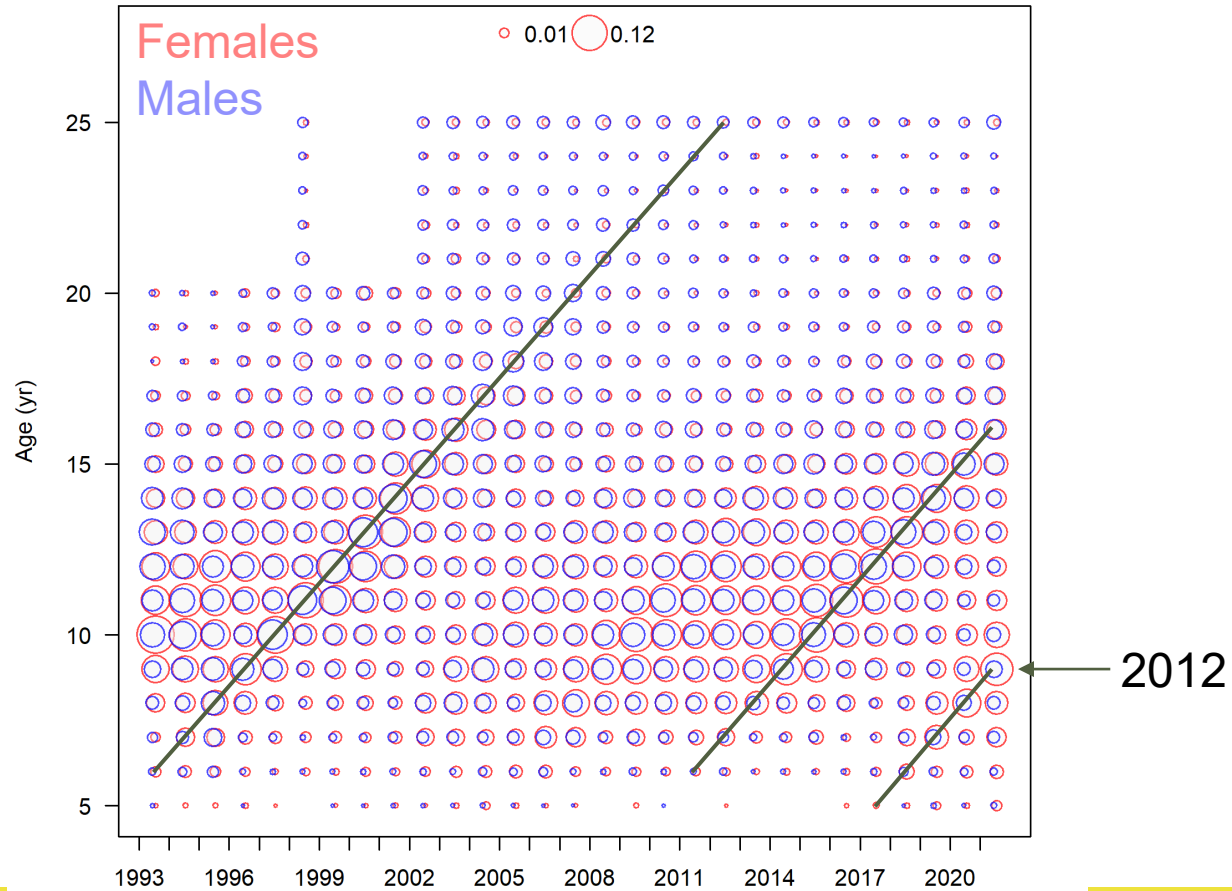
Modelled survey trends (all sizes WPUE)



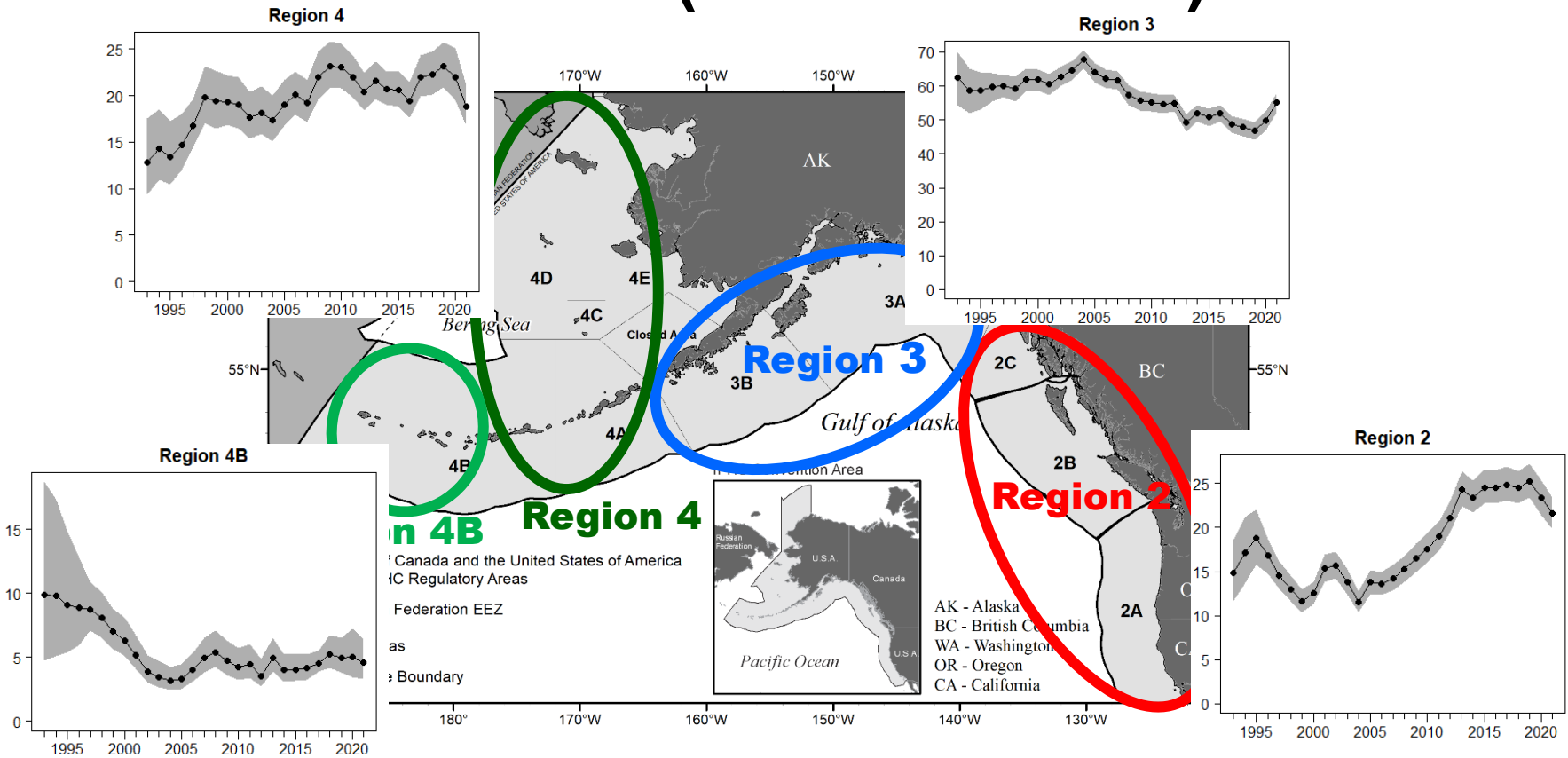
Indicates less productivity from growth than recruitment



Recent FISS ages



Stock distribution (% of biomass)



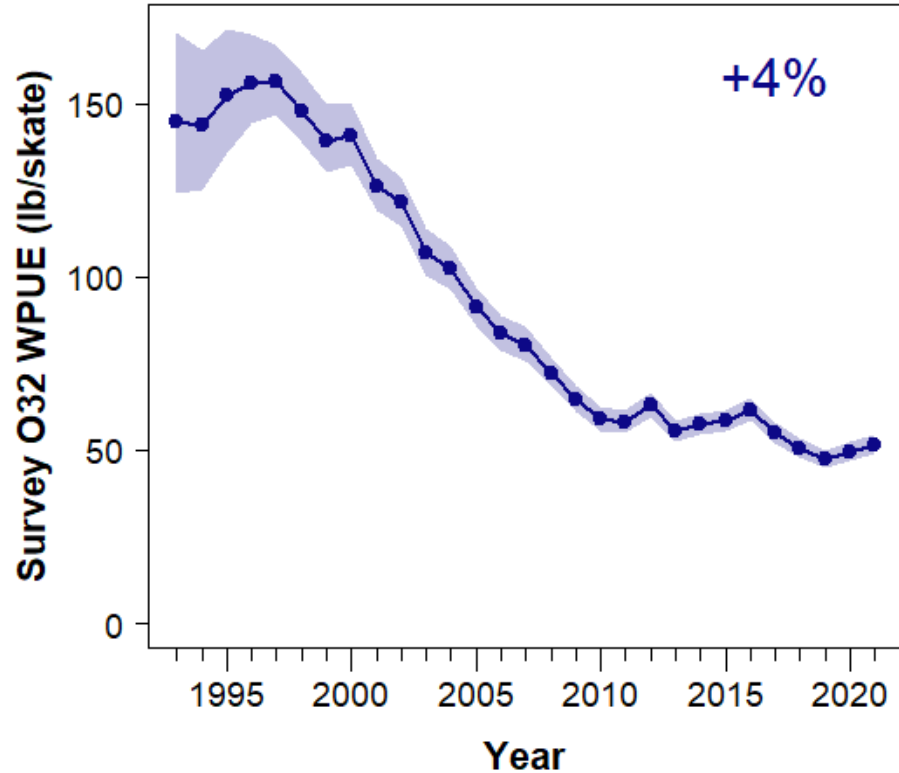
O32 WPUE (lb/standardized skate) trends

- Most direct comparison between FISS and fishery observations
- Fishery WPUE fit in the stock assessment models
- FISS O32 WPUE: basis for current Management Procedure (distribution of TCEY)

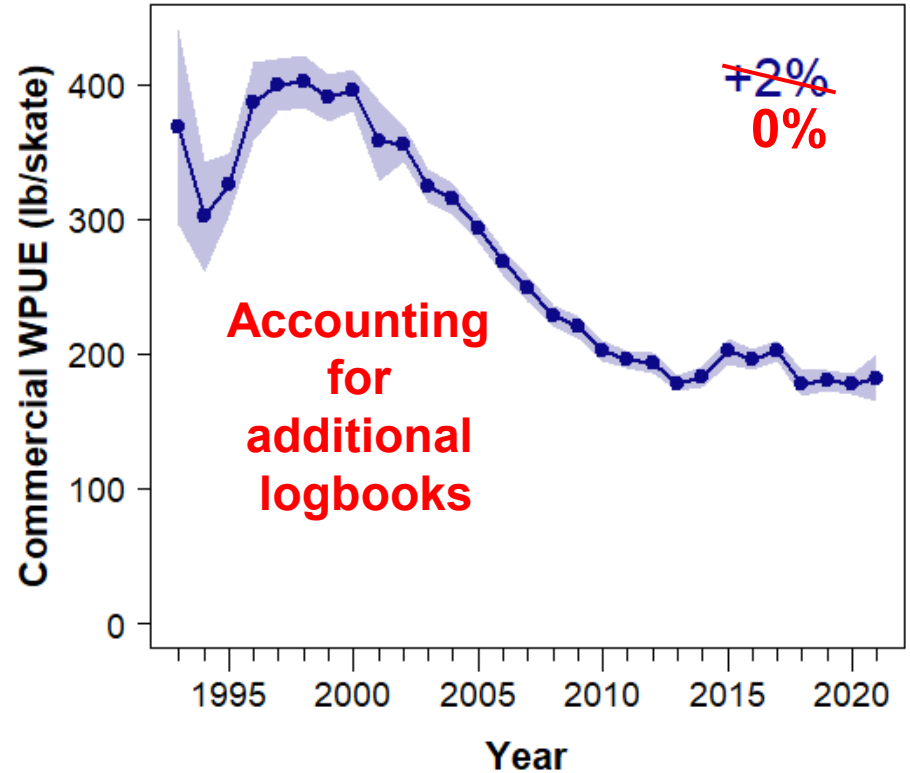


O32 WPUE (lb/skate) trends (1993+)

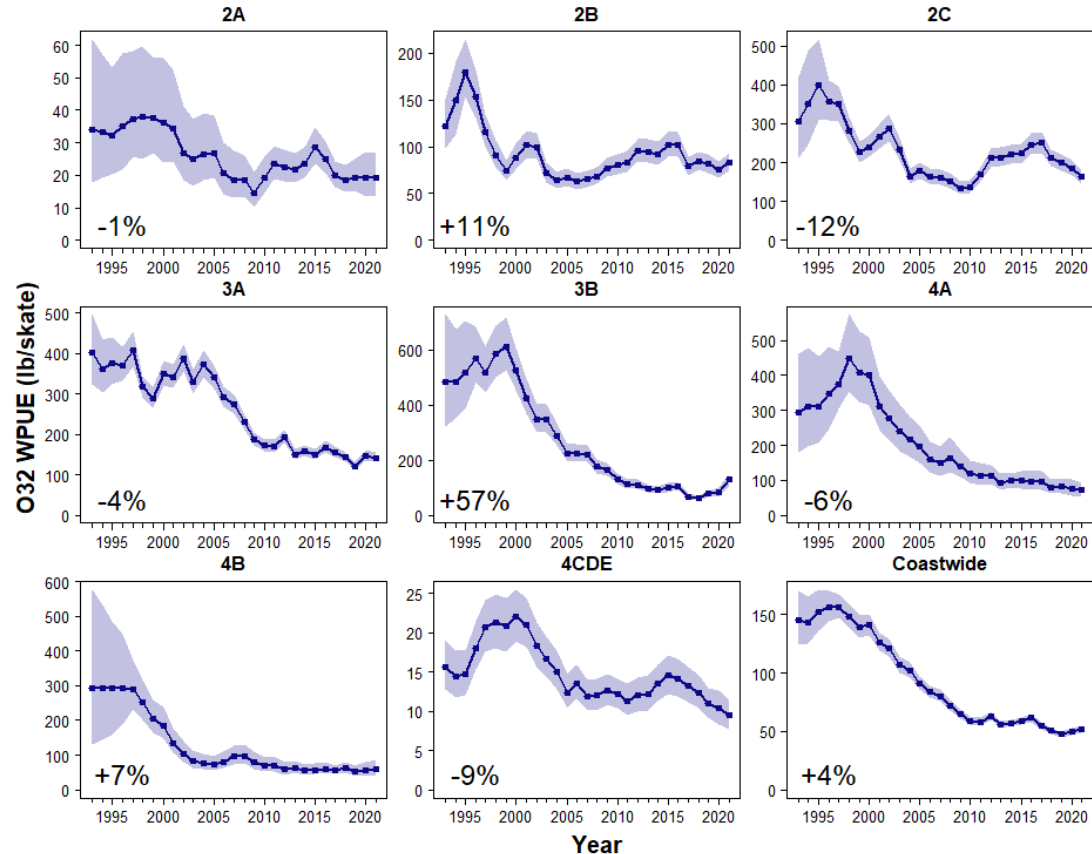
Coastwide survey



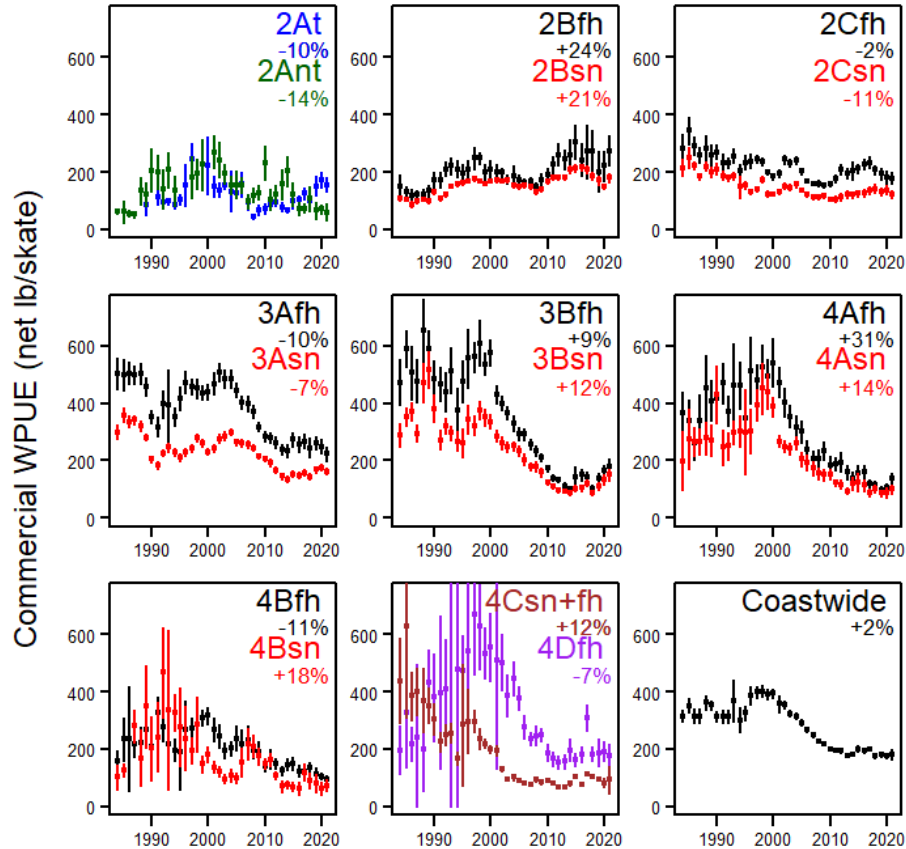
Coastwide commercial



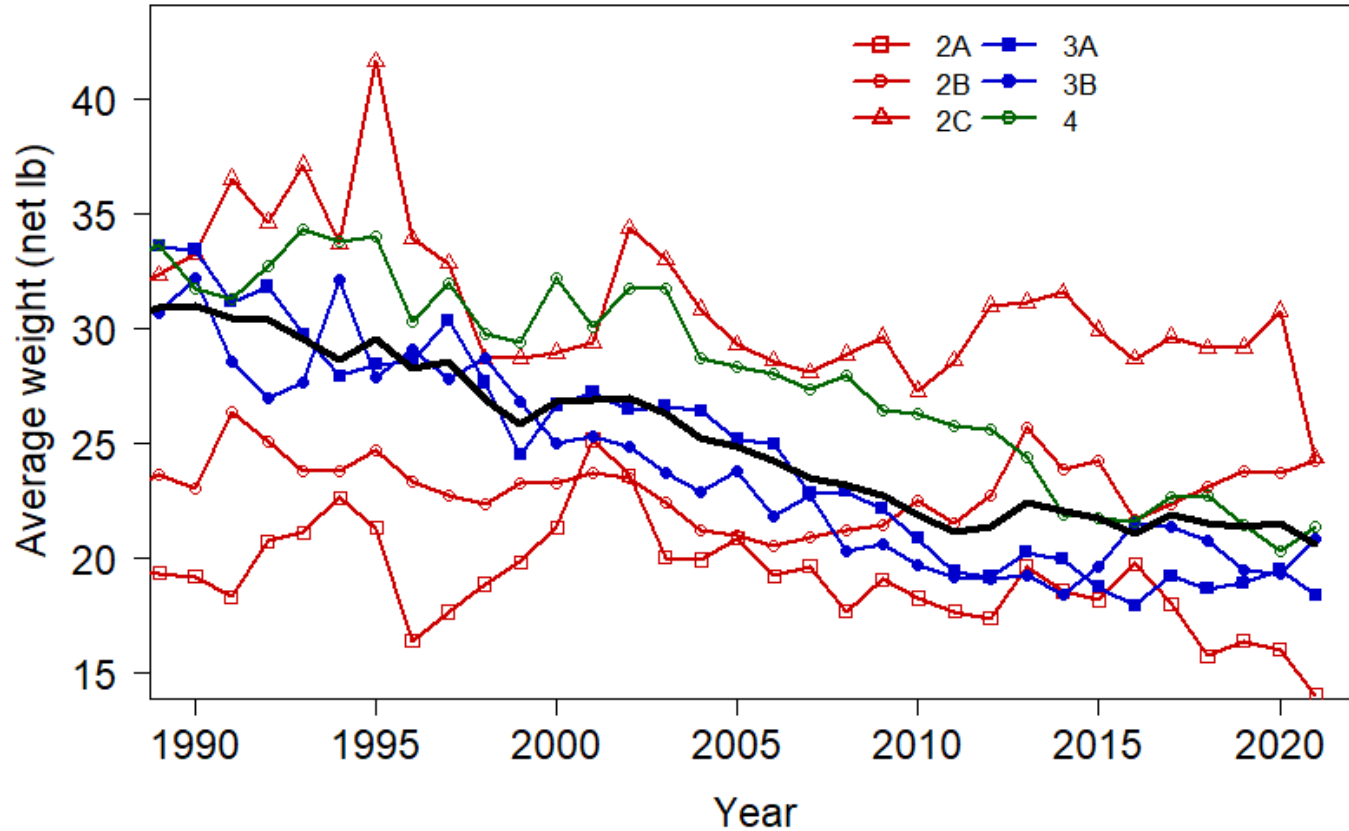
FISS O32 WPUE by IPHC Regulatory Area



Fishery O32 WPUE by IPHC Regulatory Area



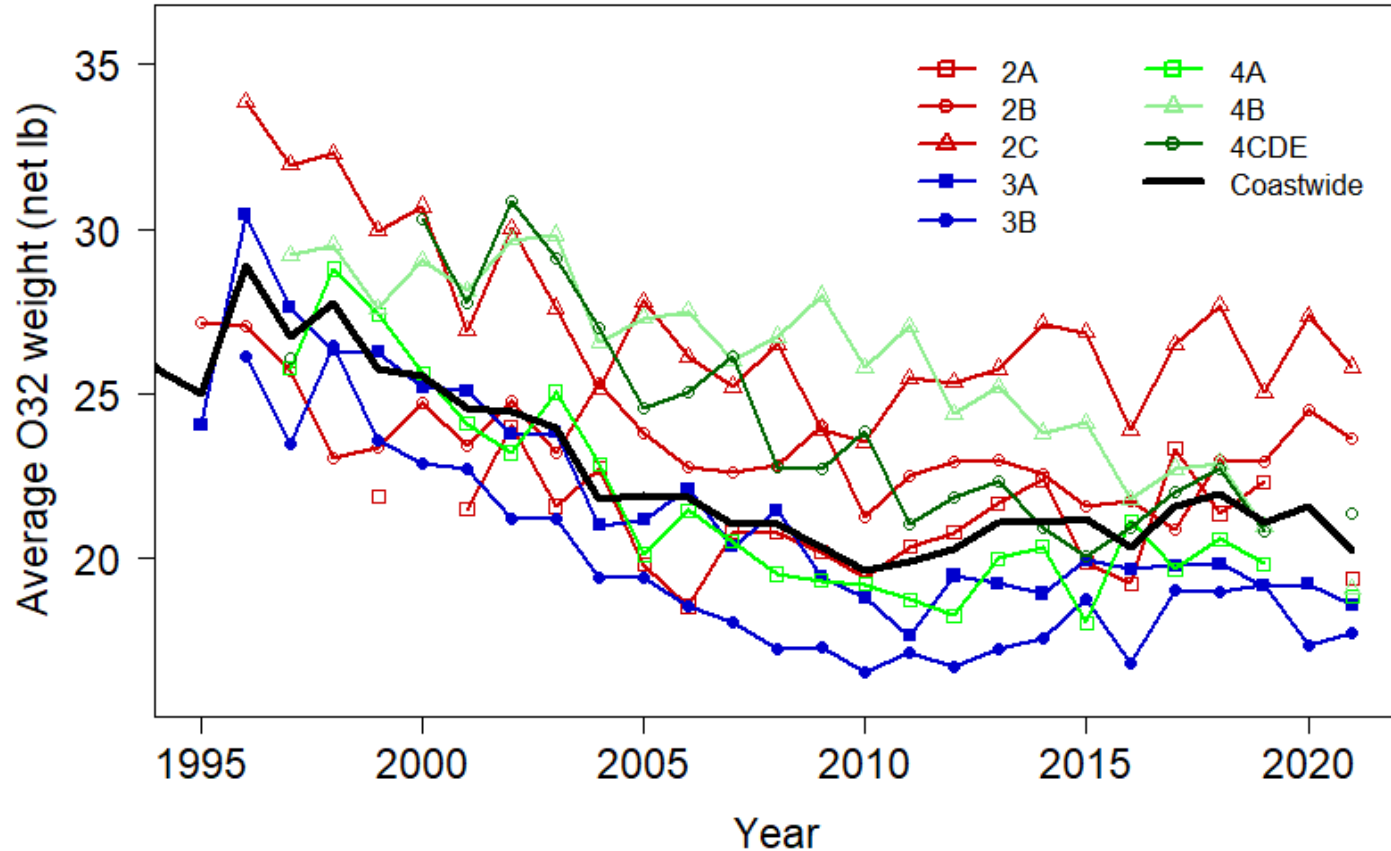
Average weight of landed fish



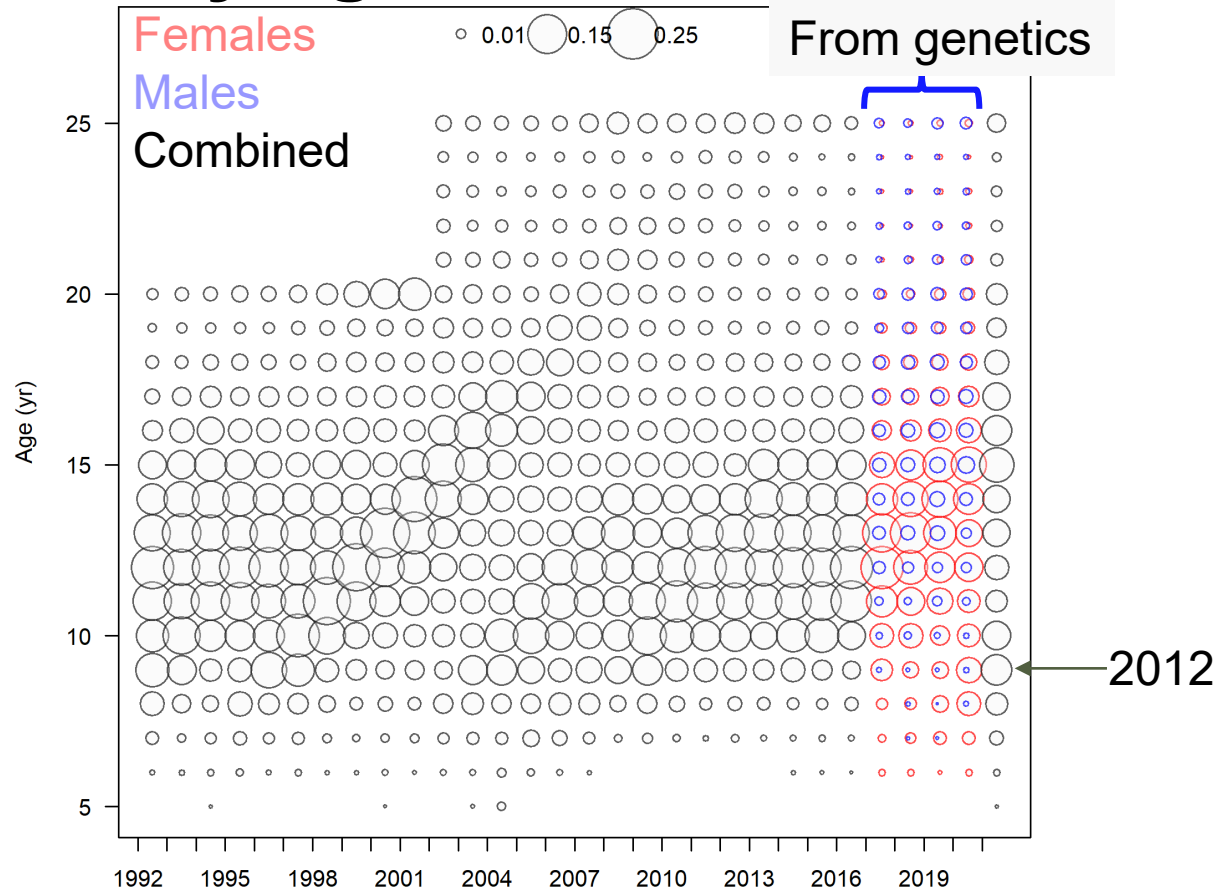
Coastwide



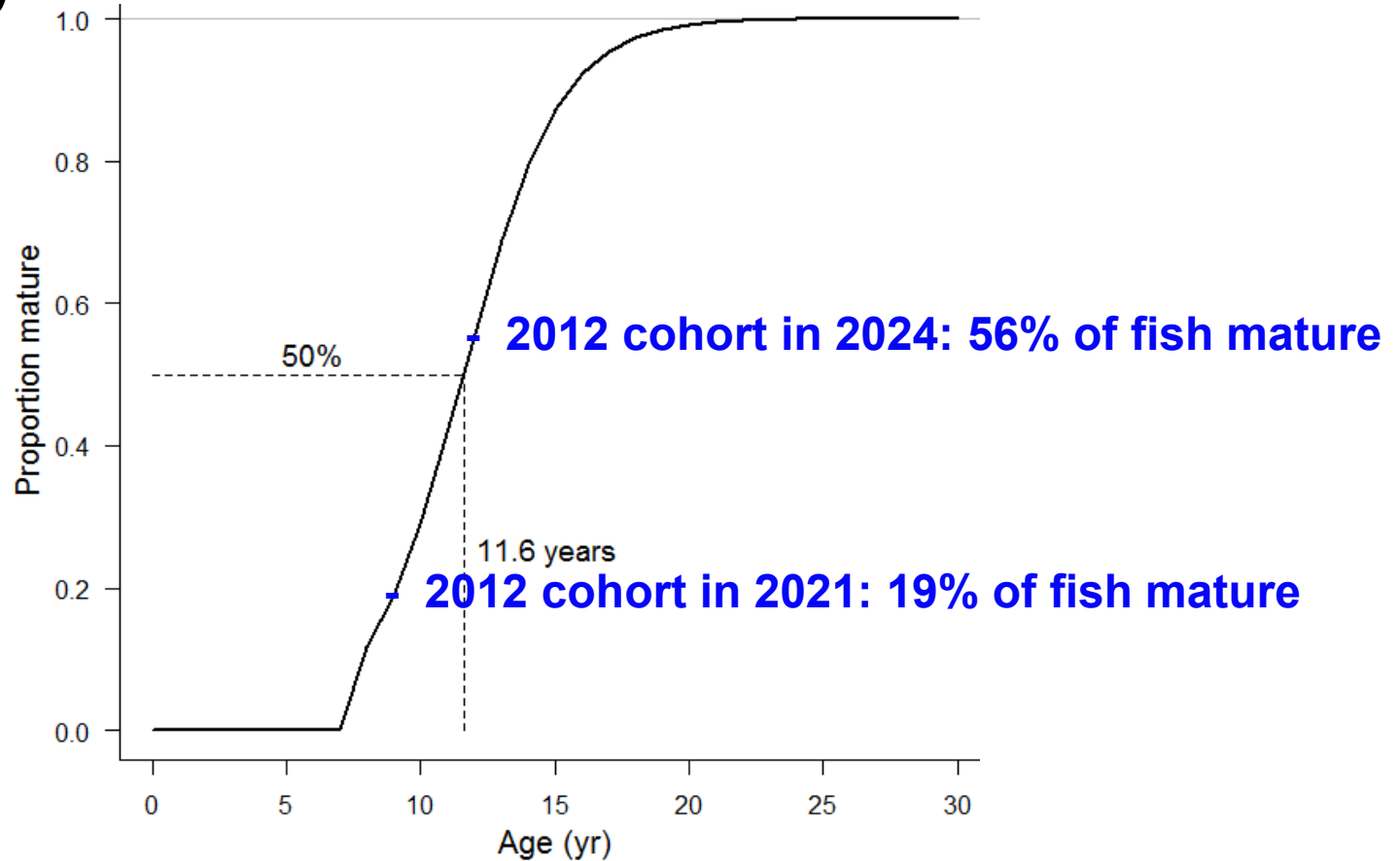
Average weight of FISS O32 fish



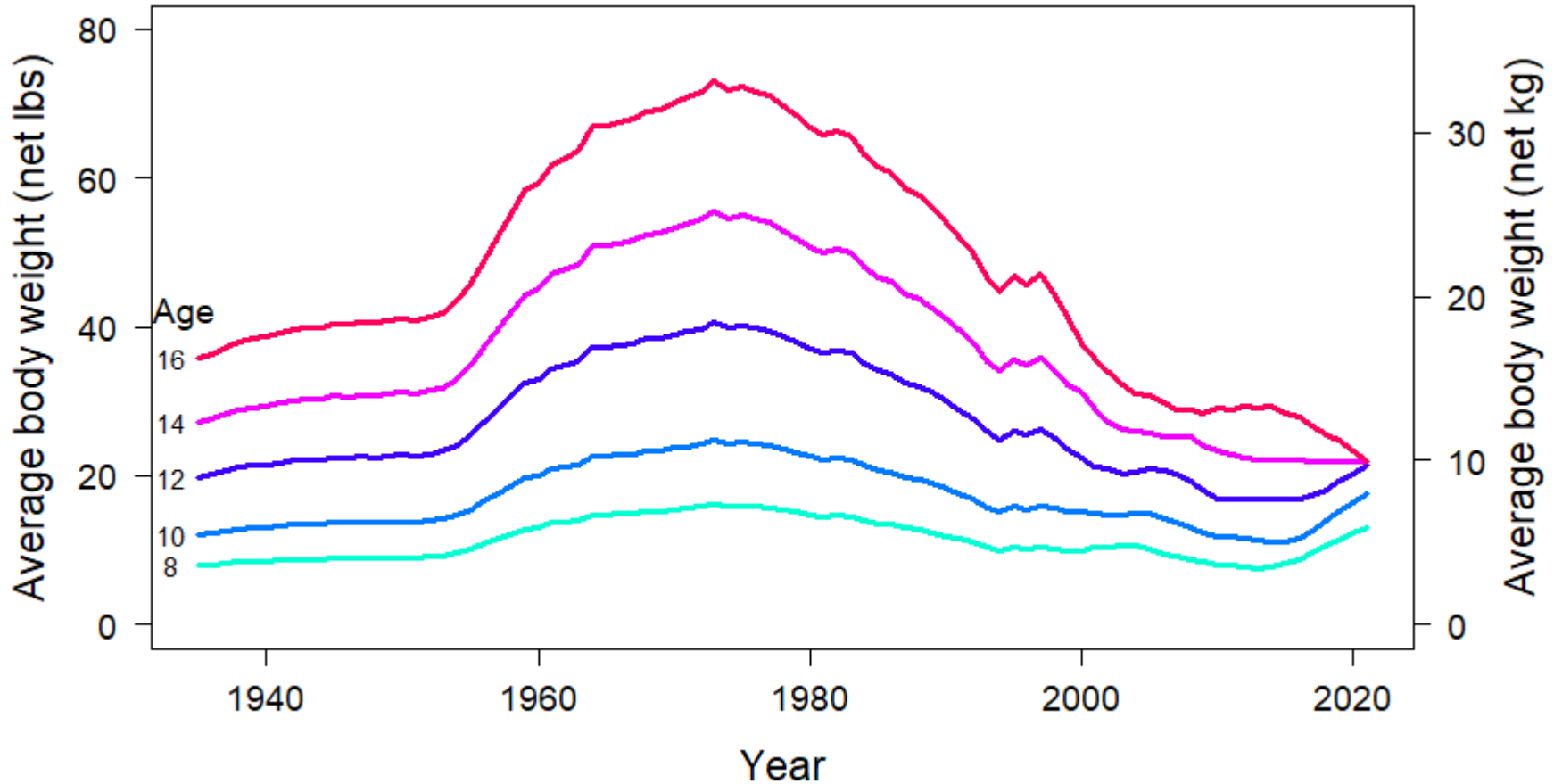
Recent fishery ages



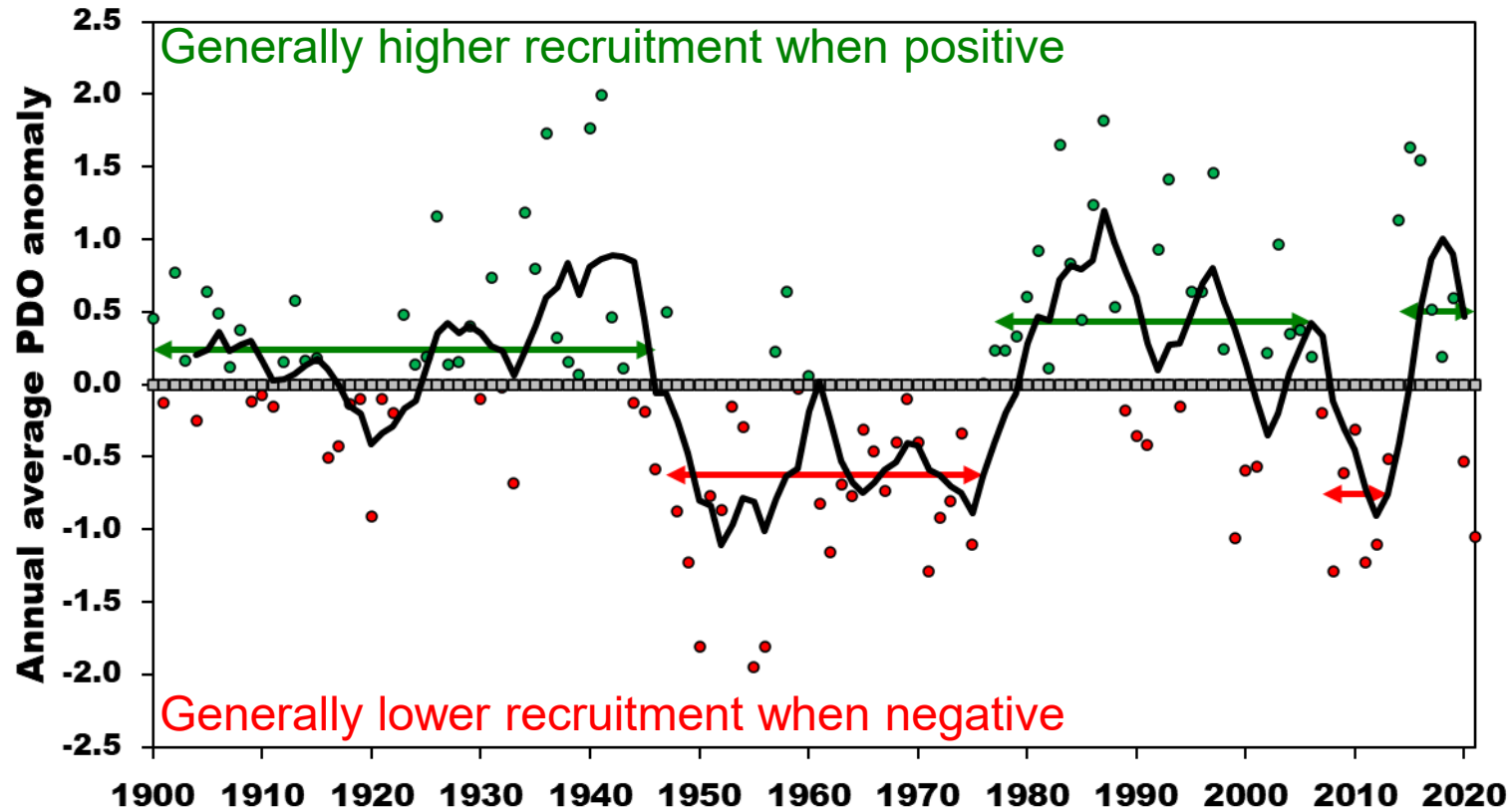
Maturity



Historical coastwide female weight-at-age



Ecosystem conditions: Pacific Decadal Oscillation



Ecosystem conditions

- Bering Sea (2021): warmer since 2014, large drop in crab abundance, near normal ice cover
- Aleutian Islands (2021): mixed trends, somewhat reduced productivity
- GOA (2021): some residual effects from 2014-2016 and 2019 heatwaves
- B.C. (2020): salmon productivity low
- California current (2020): cooler conditions, shifting toward increased productivity, some hypoxia

References (most recent reports):

[Bering Sea](#), [Gulf of Alaska](#), [Aleutian Islands](#), [B.C.](#), [California current](#)



Ecosystem conditions

- Are IPHC data and assessment methods robust to climate change?
- Climate change responsive:
 - *Stock trend and distribution estimates*
 - FISS design and analysis accounts for shifts
 - *Weight-at-age*: extensive annual monitoring
 - *Recruitment*: annual estimates, informed by data
 - *Reference points*: dynamic calculations accounting for current biology and productivity
- Needing research:
 - Static maturity and fecundity estimates – monitoring over space and time
 - Factors affecting weight-at-age, movement and distribution (all life stages)
 - Fishery dynamics



Outline

- Data sources
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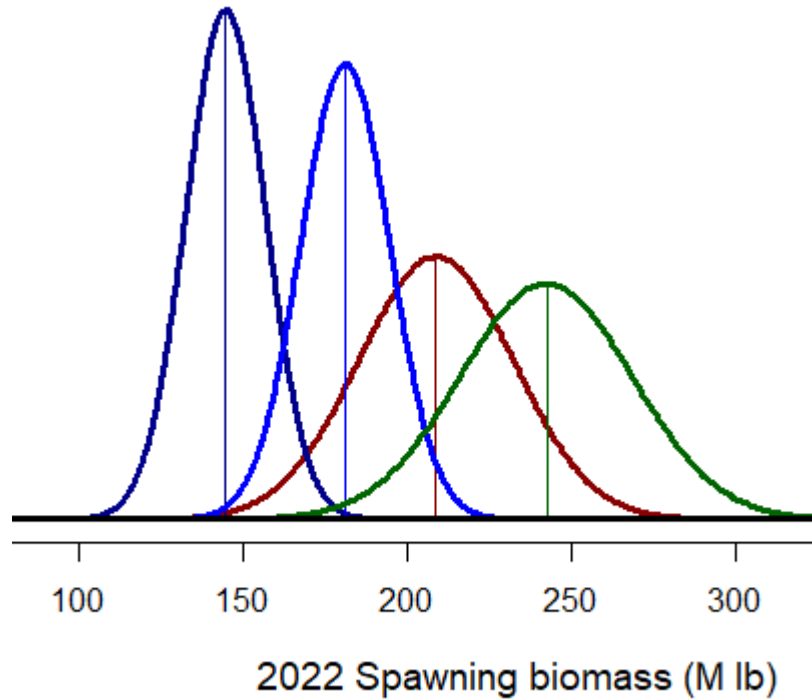


The 2021 assessment

- 2nd update to the full assessment in 2019 (full assessment coming in 2022)
- No major changes in structure or methods
- Incremental changes reviewed by the SRB in June and September
- All data updated for 2020 (where needed) and added for 2021



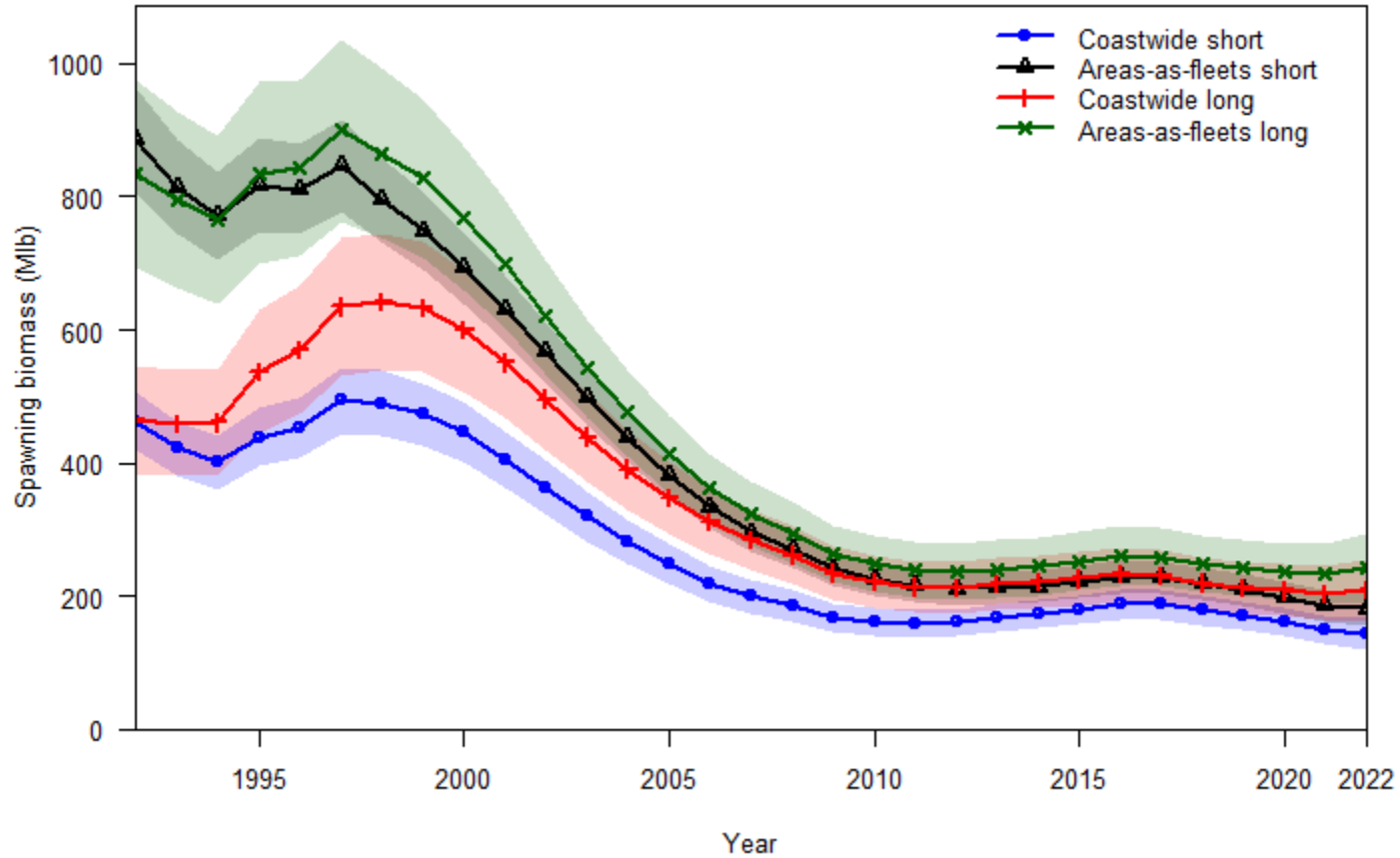
Modelling summary: four individual models



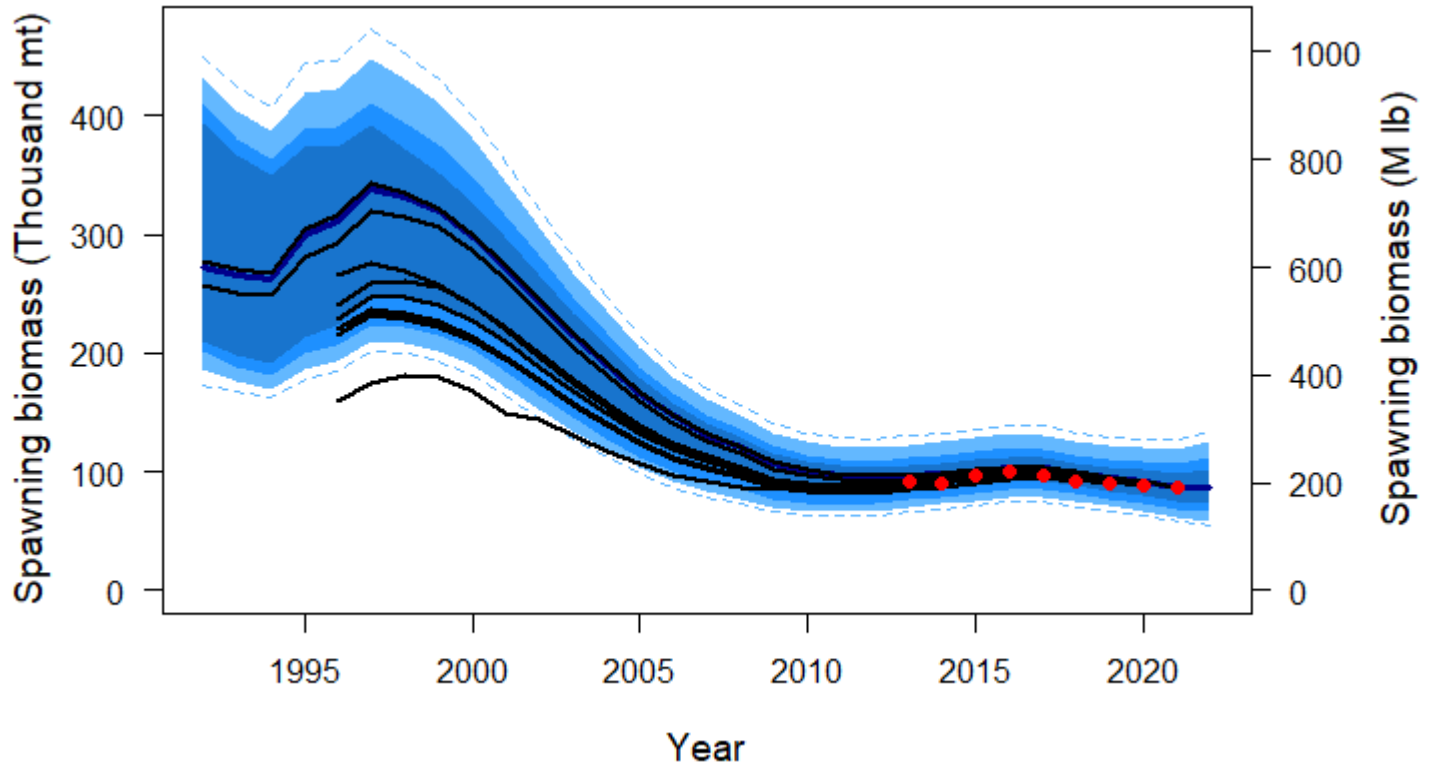
- Four ways to aggregate the data
- Respond differently to trend and age data by Region
- Provide stability from year to year as individual model results change



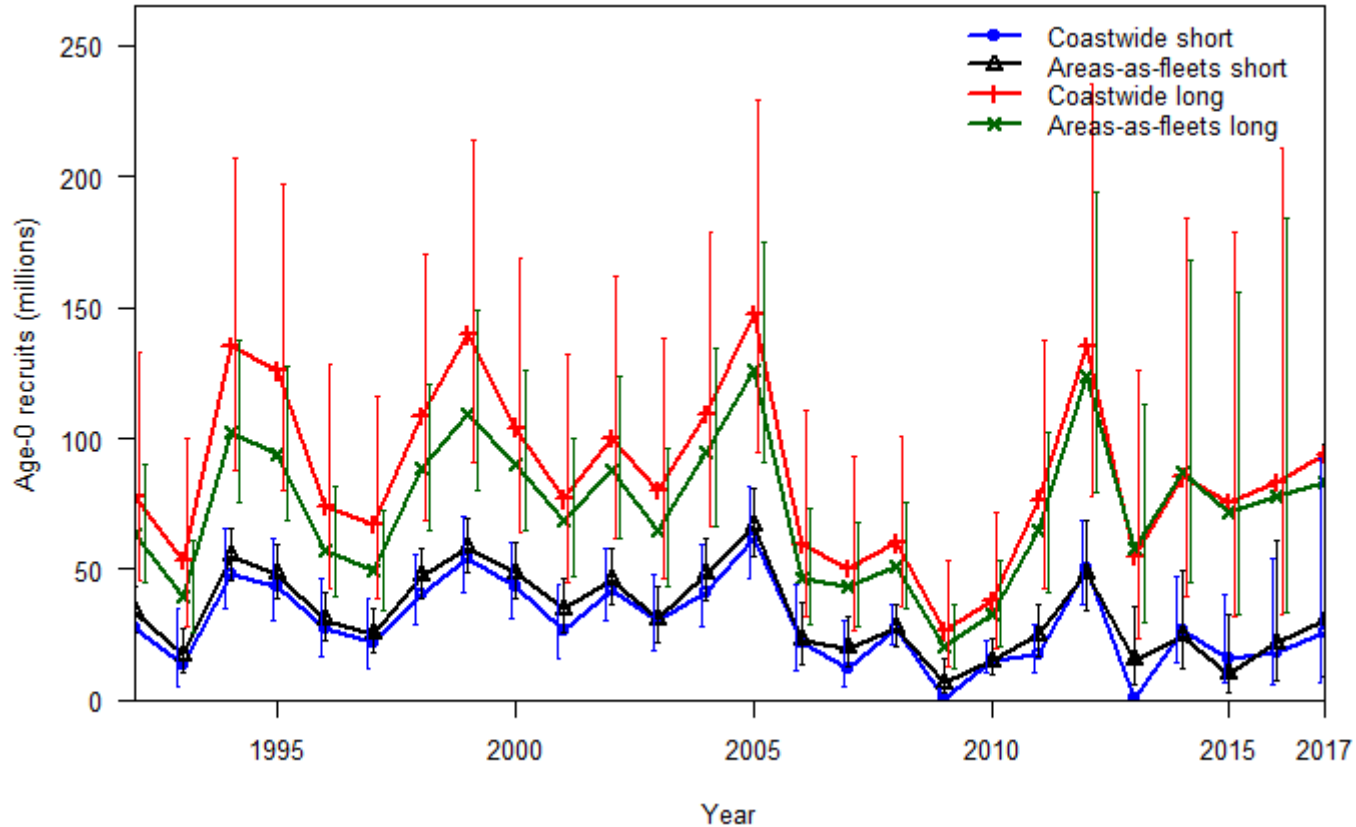
Modelling summary: four individual models



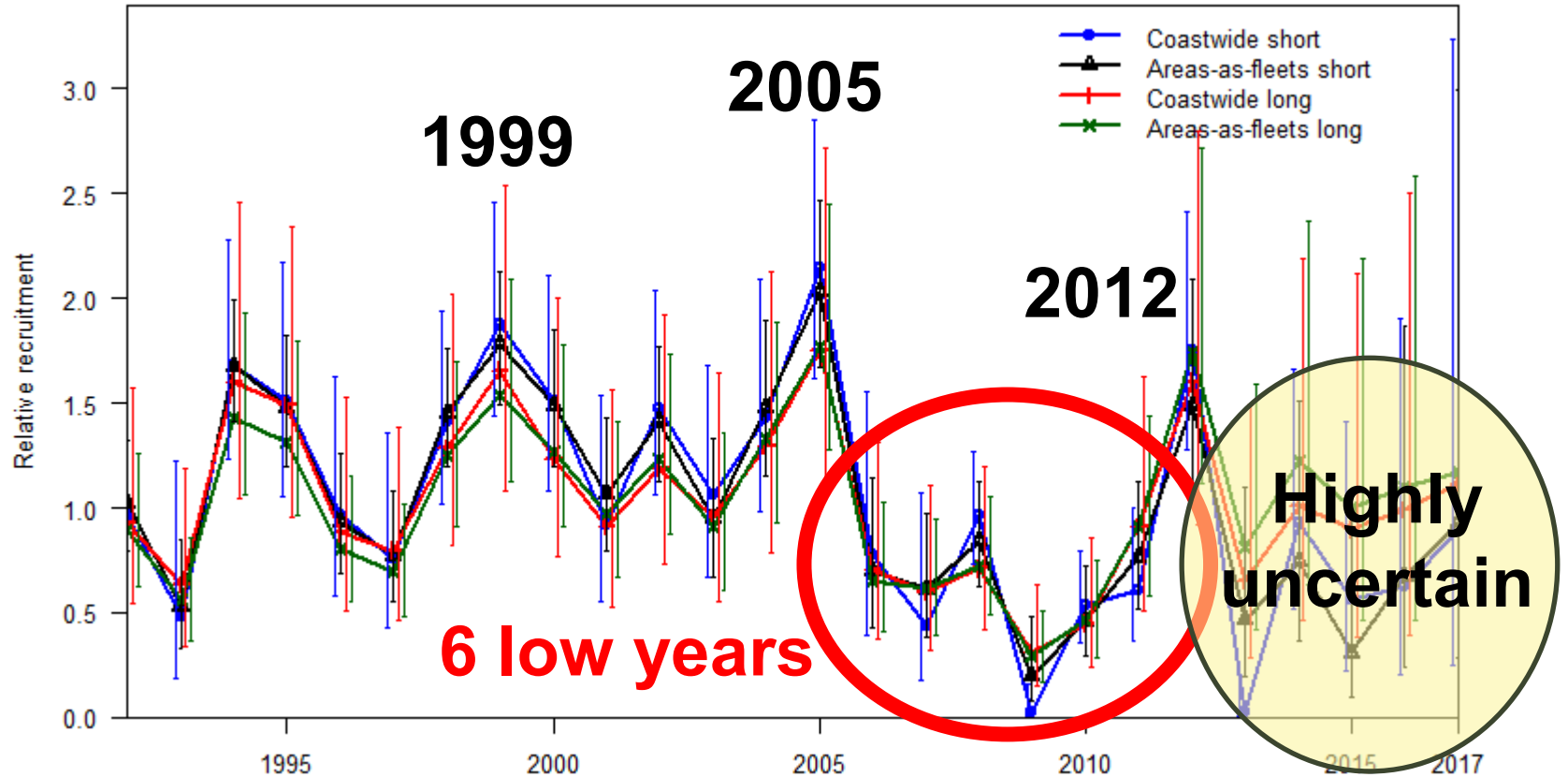
Comparison with previous assessments



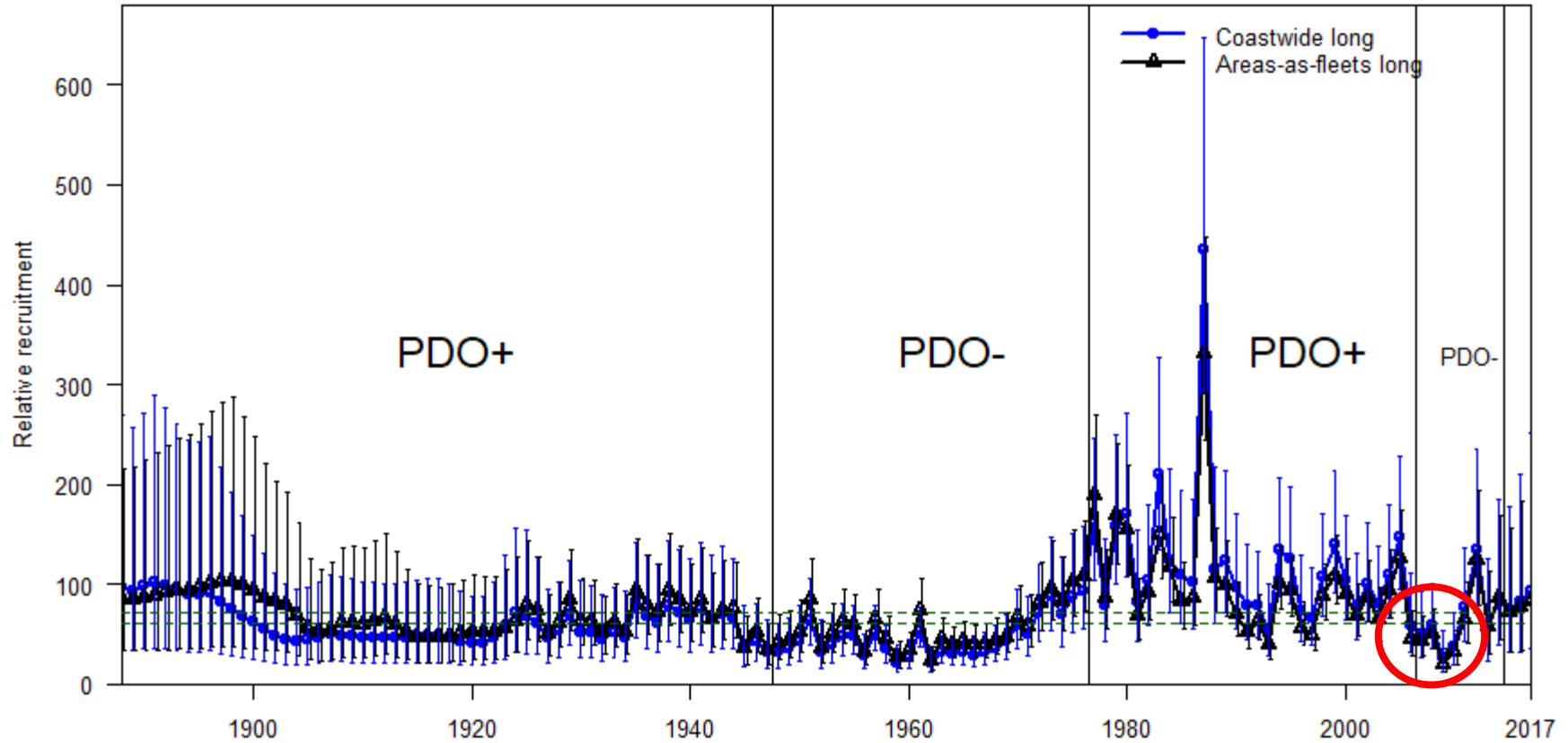
Recruitment estimates



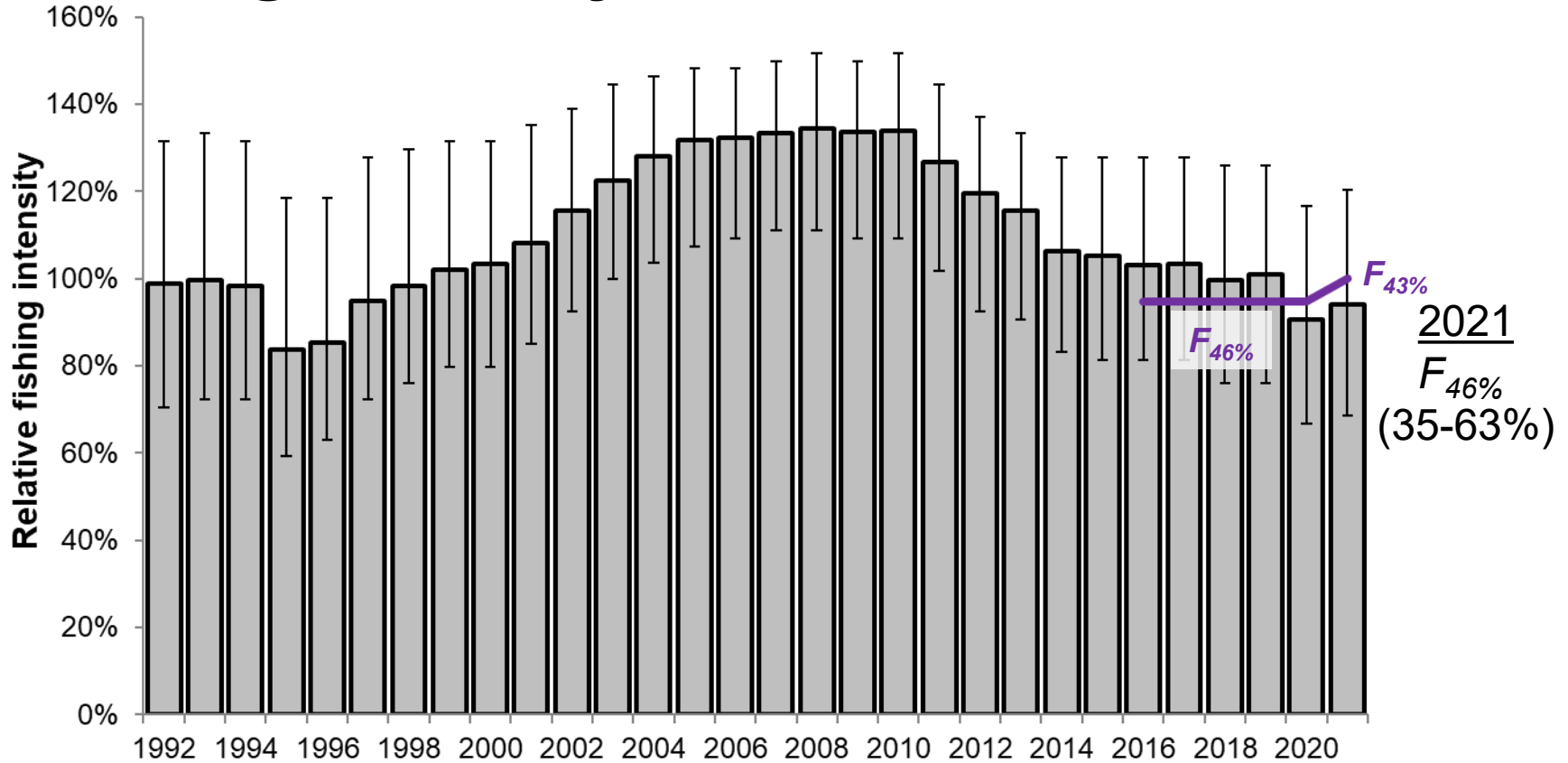
Relative recruitment estimates



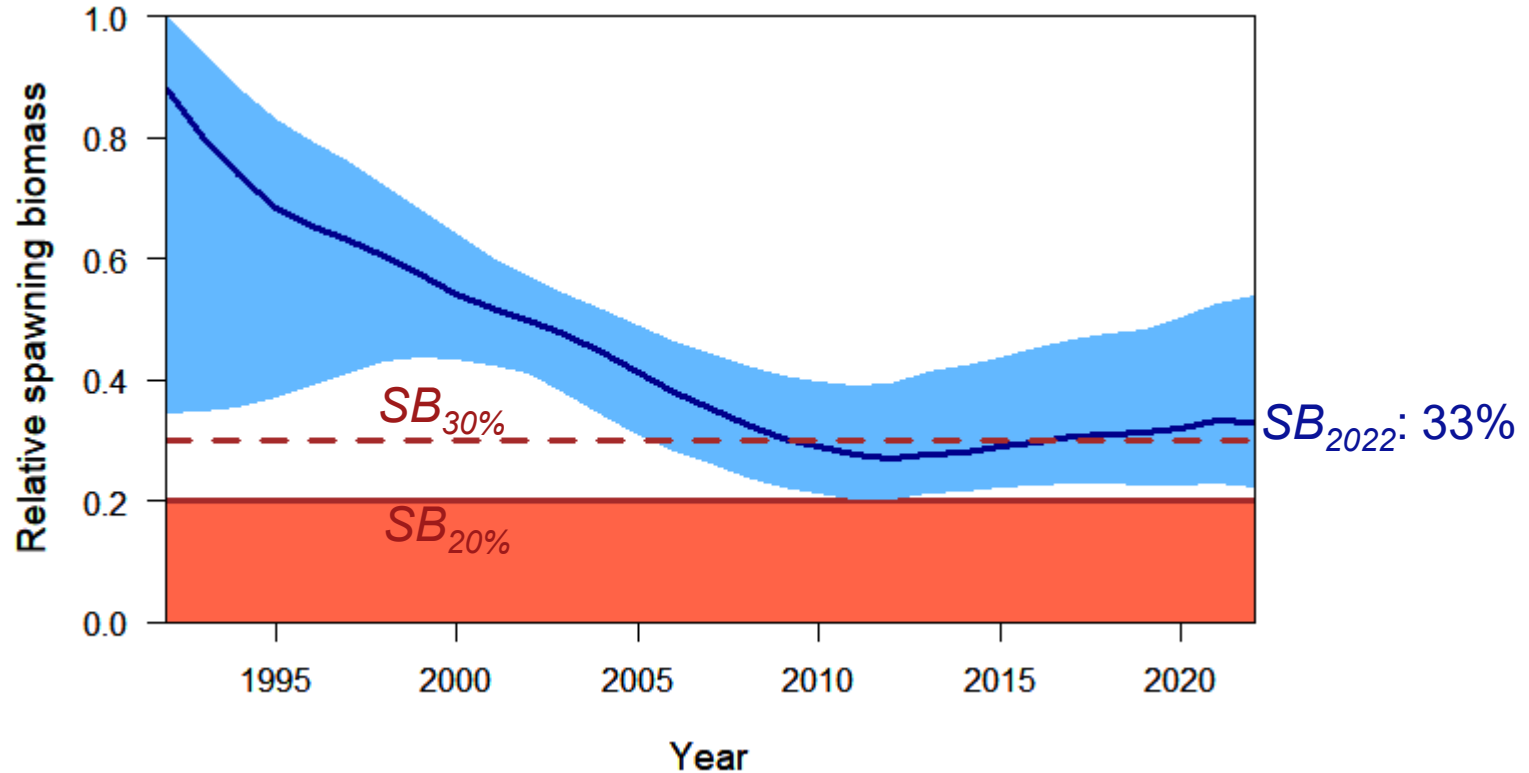
Historical recruitment (2 models)



Fishing intensity



Spawning biomass relative to unfished



Assessment summary table

Indicators	Values	Trends	Status
BIOLOGICAL			
SPR ₂₀₂₁ : P(SPR<43%): P(SPR<limit):	46% (35-63%) 47% LIMIT NOT SPECIFIED	FISHING INTENSITY INCREASED FROM 2020 TO 2021	FISHING INTENSITY BELOW REFERENCE LEVEL
SB ₂₀₂₂ (Mlb): SB ₂₀₂₂ /SB ₀ : P(SB ₂₀₂₂ <SB ₃₀): P(SB ₂₀₂₂ <SB ₂₀):	191 (129–277) MLBS 33% (22-54%) 45% <1%	SB DECREASED 17% FROM 2016 TO 2022	NOT OVERFISHED
Biological stock distribution:	SEE TABLES AND FIGURES	REGION 3 INCREASING	WITHIN HISTORICAL RANGES
FISHERY CONTEXT			
Total mortality 2021: Percent retained 2021: Average mortality 2017-21:	37.66 MLBS, 17,084 T 88% 38.48 MLBS, 17,456 T	MORTALITY INCREASED FROM 2020 TO 2021	2021 MORTALITY NEAR 100-YEAR LOW



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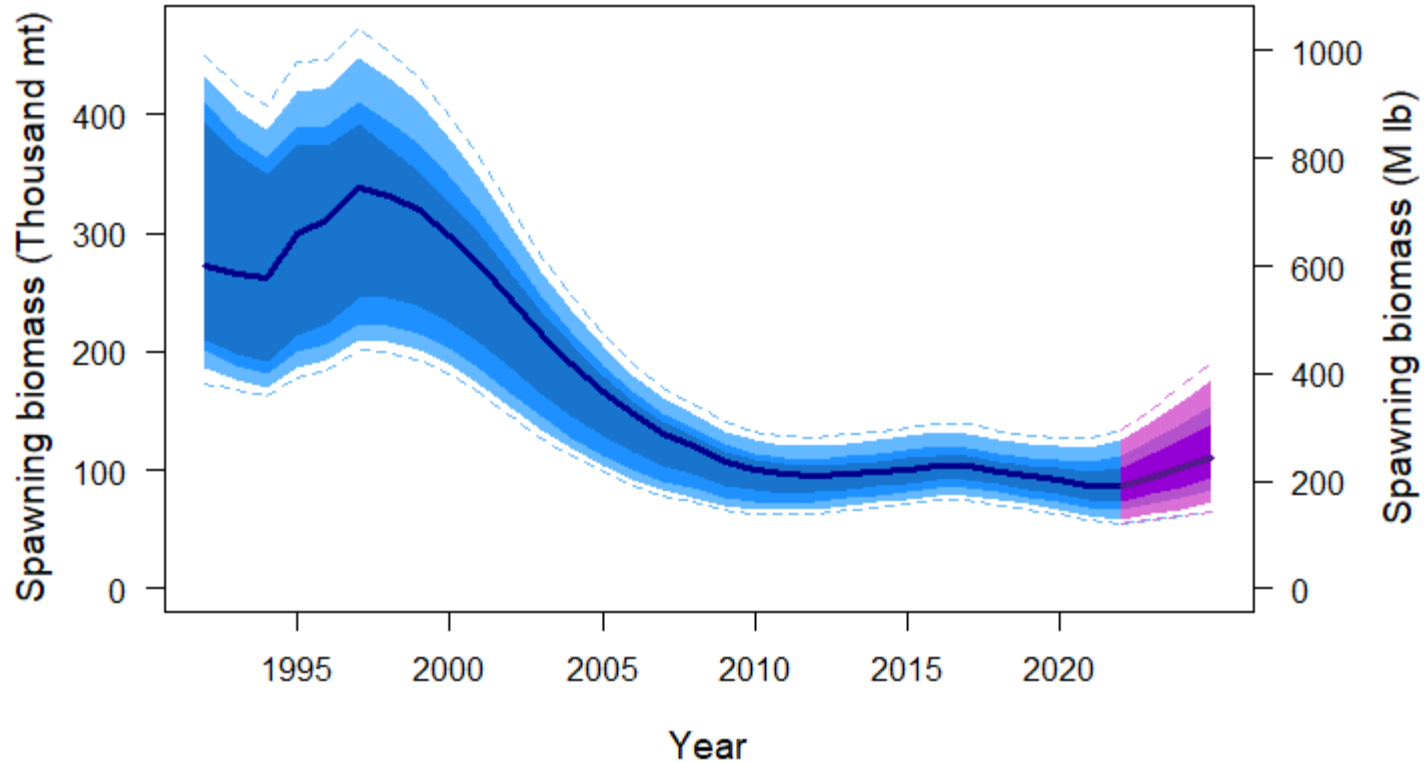


Projections and decision table

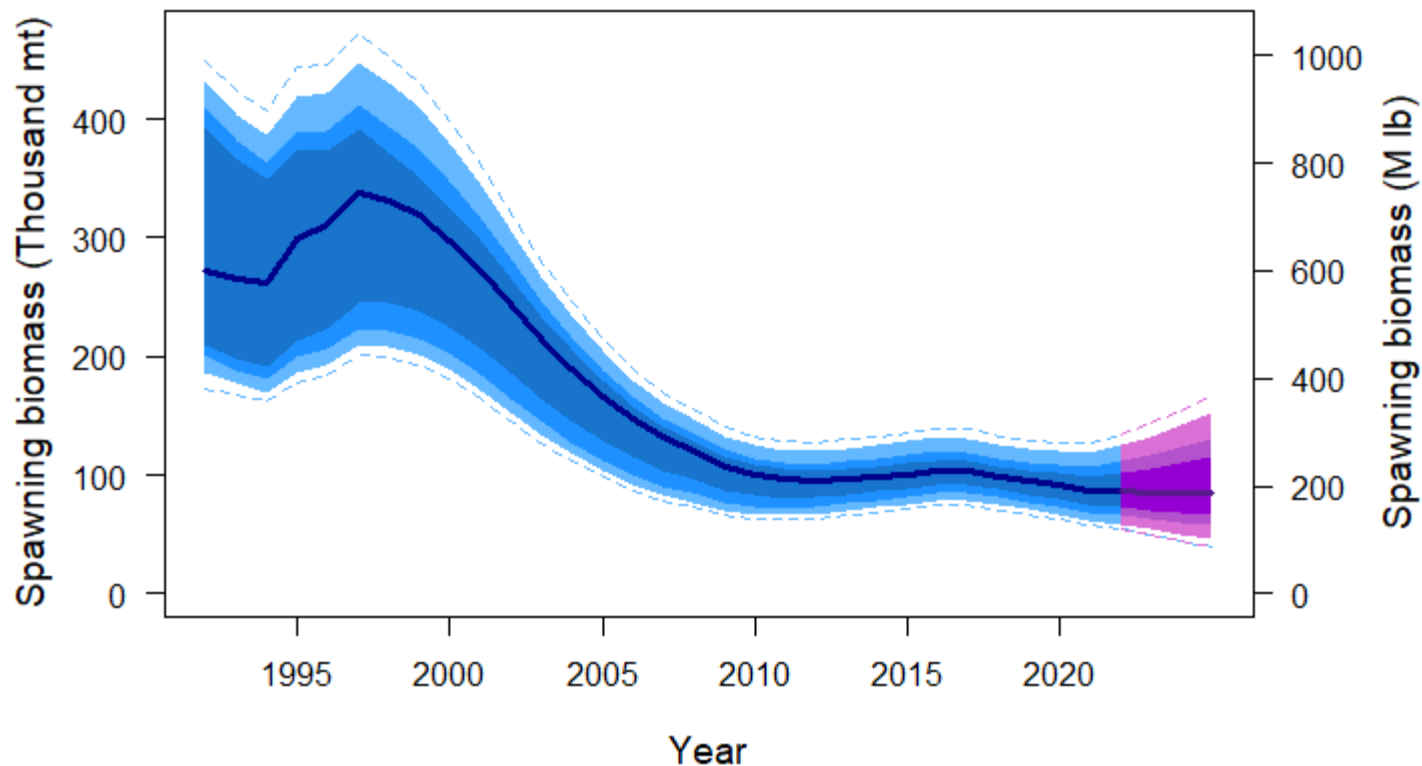
- Constant TCEY for the next three years
- Range of mortality, from no fishing mortality to 60 Mlb TCEY, additional detail from $F_{40\%}$ - $F_{46\%}$
- 3 specific projections:
 - 3-year surplus: 50% odds of spawning biomass dropping below 2022 estimate by 2025
 - *Status quo* (39 Mlb)
 - Reference level: 2022 TCEY estimated to result in $F_{43\%}$



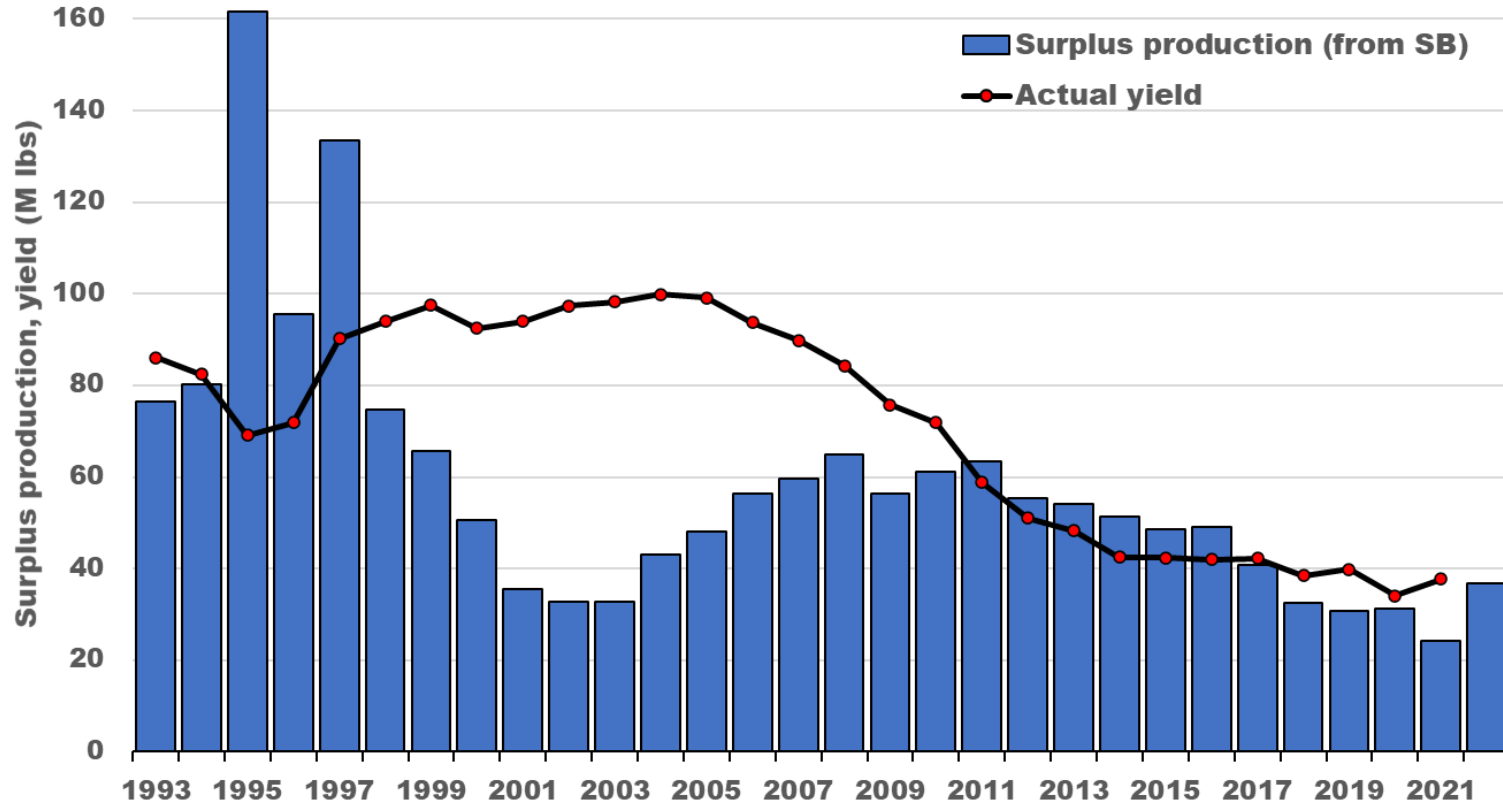
Projections: no fishing mortality



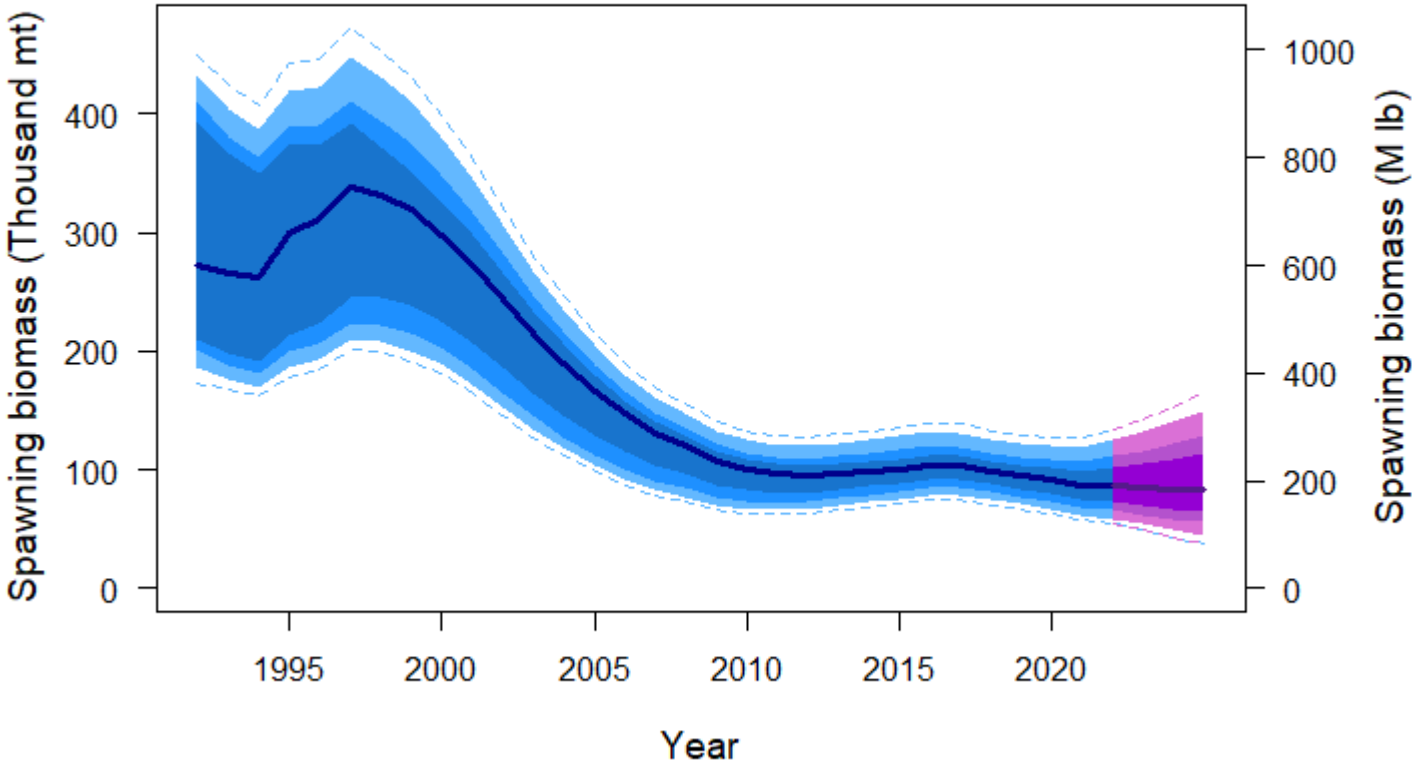
Projections: 3-yr surplus production (38.0 Mlb TCEY)



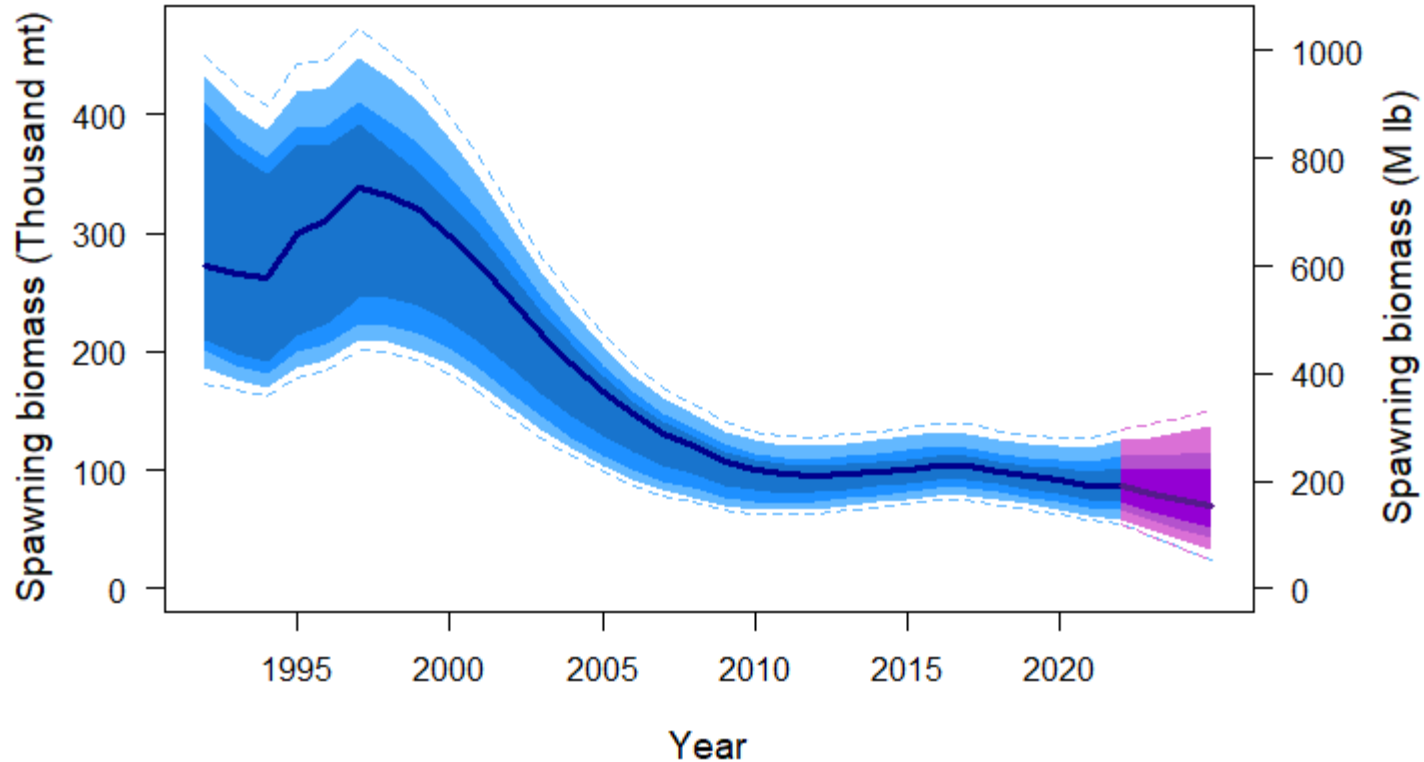
Recent surplus production



Projections: reference level (41.2 Mlb TCEY)



Projections: 60 Mlb TCEY



Decision table

- Risk-benefit trade-offs:
 - Yield vs. probability of stock and fishery trend and status decreases
- Metrics relative to the interim management procedure: $F_{43\%}$ with an $SB_{30\%}:SB_{20\%}$ control rule



Decision table: Yield options

2022 Alternative			3-Year Surplus		Status quo		Reference $F_{43\%}$					
Total mortality (M lb)	0.0	31.2	38.7	39.2	39.9	40.2	41.1	42.4	43.8	45.2	46.6	61.2
TCEY (M lb)	0.0	30.0	37.5	38.0	38.7	39.0	39.9	41.2	42.6	44.0	45.4	60.0
2022 fishing intensity	$F_{100\%}$	$F_{53\%}$	$F_{46\%}$	$F_{46\%}$	$F_{45\%}$	$F_{45\%}$	$F_{44\%}$	$F_{43\%}$	$F_{42\%}$	$F_{41\%}$	$F_{40\%}$	$F_{32\%}$
Fishing intensity interval	--	38-69%	32-64%	32-63%	32-63%	31-63%	31-62%	30-61%	29-60%	28-59%	28-59%	21-51%



Decision table: Stock trend

2022 Alternative		3-Year Surplus			Status quo		Reference $F_{43\%}$					
Total mortality (M lb)	0.0	31.2	38.7	39.2	39.9	40.2	41.1	42.4	43.8	45.2	46.6	61.2
TCEY (M lb)	0.0	30.0	37.5	38.0	38.7	39.0	39.9	41.2	42.6	44.0	45.4	60.0
2022 fishing intensity	F _{100%}	F _{53%}	F _{46%}	F _{46%}	F _{45%}	F _{45%}	F _{44%}	F _{43%}	F _{42%}	F _{41%}	F _{40%}	F _{32%}
Fishing intensity interval	--	38-69%	32-64%	32-63%	32-63%	31-63%	31-62%	30-61%	29-60%	28-59%	28-59%	21-51%

Stock Trend (spawning biomass)	in 2023	is less than 2022	<1	39	55	55	56	57	58	59	61	63	64	84
		is 5% less than 2022	<1	3	14	16	18	19	21	25	30	34	37	58
	in 2024	is less than 2022	<1	39	53	54	55	55	56	58	59	61	62	80
		is 5% less than 2022	<1	16	37	39	40	41	43	46	48	50	52	66
	in 2025	is less than 2022	<1	33	49	50	51	52	53	55	56	58	60	77
		is 5% less than 2022	<1	18	38	39	41	42	43	46	48	50	52	67



Decision table: Stock trend

2022 Alternative		3-Year Surplus			Status quo		Reference $F_{43\%}$					
Total mortality (M lb)	0.0	31.2	38.7	39.2	39.9	40.2	41.1	42.4	43.8	45.2	46.6	61.2
TCEY (M lb)	0.0	30.0	37.5	38.0	38.7	39.0	39.9	41.2	42.6	44.0	45.4	60.0
2022 fishing intensity	F _{100%}	F _{53%}	F _{46%}	F _{46%}	F _{45%}	F _{45%}	F _{44%}	F _{43%}	F _{42%}	F _{41%}	F _{40%}	F _{32%}
Fishing intensity interval	--	38-69%	32-64%	32-63%	32-63%	31-63%	31-62%	30-61%	29-60%	28-59%	28-59%	21-51%

Stock Trend (spawning biomass)	in 2023	is less than 2022	<1	39	55	55	56	57	58	59	61	63	64	84
		is 5% less than 2022	<1	3	14	16	18	19	21	25	30	34	37	58
	in 2024	is less than 2022	<1	39	53	54	55	55	56	58	59	61	62	80
		is 5% less than 2022	<1	16	37	39	40	41	43	46	48	50	52	66
	in 2025	is less than 2022	<1	33	49	50	51	52	53	55	56	58	60	77
		is 5% less than 2022	<1	18	38	39	41	42	43	46	48	50	52	67



Decision table: Stock status

2022 Alternative			3-Year Surplus			Status quo		Reference $F_{43\%}$				
Total mortality (M lb)	0.0	31.2	38.7	39.2	39.9	40.2	41.1	42.4	43.8	45.2	46.6	61.2
TCEY (M lb)	0.0	30.0	37.5	38.0	38.7	39.0	39.9	41.2	42.6	44.0	45.4	60.0
2022 fishing intensity	F_{100%}	F_{53%}	F_{46%}	F_{46%}	F_{45%}	F_{45%}	F_{44%}	F_{43%}	F_{42%}	F_{41%}	F_{40%}	F_{32%}
Fishing intensity interval	--	38-69%	32-64%	32-63%	32-63%	31-63%	31-62%	30-61%	29-60%	28-59%	28-59%	21-51%

Stock Status (Spawning biomass)	in 2023	is less than 30%	31	40	43	43	43	43	44	44	44	45	45	48
		is less than 20%	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
	in 2024	is less than 30%	16	34	39	39	40	40	41	41	42	43	44	49
		is less than 20%	<1	<1	<1	<1	1	1	1	1	1	1	1	6
	in 2025	is less than 30%	4	29	36	37	37	37	38	40	41	42	43	49
		is less than 20%	<1	<1	1	1	1	1	1	1	2	2	3	12



Decision table: Fishery trend and status

2022 Alternative			3-Year Surplus			Status quo		Reference $F_{43\%}$						
Total mortality (M lb)	0.0	31.2	38.7	39.2	39.9	40.2	41.1	42.4	43.8	45.2	46.6	61.2		
TCEY (M lb)	0.0	30.0	37.5	38.0	38.7	39.0	39.9	41.2	42.6	44.0	45.4	60.0		
2022 fishing intensity	F _{100%}	F _{53%}	F _{46%}	F _{46%}	F _{45%}	F _{45%}	F _{44%}	F _{43%}	F _{42%}	F _{41%}	F _{40%}	F _{32%}		
Fishing intensity interval	--	38-69%	32-64%	32-63%	32-63%	31-63%	31-62%	30-61%	29-60%	28-59%	28-59%	21-51%		
Fishery Trend (TCEY)	in 2023	is less than 2022	0	21	48	49	49	49	50	50	50	50	51	70
		is 10% less than 2022	0	7	41	42	44	45	47	48	49	50	50	58
	in 2024	is less than 2022	0	22	48	48	49	49	50	50	50	50	50	69
		is 10% less than 2022	0	9	41	42	44	45	46	48	49	50	50	58
	in 2025	is less than 2022	0	22	47	48	48	49	49	50	50	50	50	68
		is 10% less than 2022	0	10	40	42	43	44	46	48	49	49	50	58
Fishery Status (Fishing intensity)	in 2022	is above $F_{43\%}$	0	20	48	49	49	50	50	50	50	50	51	70



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2021-2022 Interim management procedure

- Implemented in the [2022 mortality projection tool](#)
- Baseline: $F_{43\%}$, 30:20 control rule, O32 stock distribution, relative harvest rates of 1.0 (2A-3A), 0.75 (3B-4CDE)
- Adjustments:
 - 2A = 1.65 Mlb TCEY
 - Coastwide TCEY % in 2B = $0.7 \cdot 20\% + 0.3 \cdot \text{baseline}$
 - 2B formula (above) +50% of 2B TCEY change due to accounting for U26 non-directed discard mortality in Alaska

(See [IPHC-2022-AM098-INF02](#) for more information)



2022 Mortality projection tool

- Interim management procedure results are provided
- Inputs for evaluation of alternative TCEYs and distribution in yellow

Inputs

Enter 2022 coastwide mortality limit (TCEY)

41.22

Enter 2022 distributed mortality limit %

2A	2B	2C	3A	3B	4A	4B	4CDE	Total
4.0%	18.3%	11.5%	34.4%	14.4%	5.3%	4.4%	7.6%	100.0%

Select non-directed discard option:

Three-year average discards

Select weight units:

Millions of net pounds

- ‘Drop-down’ alternatives for non-directed discards and units
- Adjustments for 2A and 2B automatically calculated

(See [IPHC-2022-AM098-INF02](#) for more information)



Interim Management Procedure: baseline

	<u>2A</u>	<u>2B</u>	<u>2C</u>	<u>3A</u>	<u>3B</u>	<u>4A</u>	<u>4B</u>	<u>4CDE</u>	<u>Total</u>
O32 Stock Distribution	1.8%	12.0%	11.3%	33.6%	18.8%	6.9%	5.7%	10.0%	100%
HR	1.0	1.0	1.0	1.0	0.75	0.75	0.75	0.75	NA
TCEY Distribution	2.0%	13.4%	12.6%	37.5%	15.7%	5.8%	4.8%	8.3%	100%

2021 observed stock distribution → 2022 TCEY distribution



Interim Management Procedure: adjustments

	<u>2A</u>	<u>2B</u>	<u>2C</u>	<u>3A</u>	<u>3B</u>	<u>4A</u>	<u>4B</u>	<u>4CDE</u>	<u>Total</u>
O32 Stock Distribution	1.8%	12.0%	11.3%	33.6%	18.8%	6.9%	5.7%	10.0%	100%
HR	1.0	1.0	1.0	1.0	0.75	0.75	0.75	0.75	NA
TCEY Distribution	2.0%	13.4%	12.6%	37.5%	15.7%	5.8%	4.8%	8.3%	100%
Adjusted	1.65	18.0%	<i>Depends on total TCEY</i>						



Interim Management Procedure: adjustments

	<u>2A</u>	<u>2B</u>	<u>2C</u>	<u>3A</u>	<u>3B</u>	<u>4A</u>	<u>4B</u>	<u>4CDE</u>	<u>Total</u>
032 Stock Distribution	1.8%	12.0%	11.3%	33.6%	18.8%	6.9%	5.7%	10.0%	100%
HR	1.0	1.0	1.0	1.0	0.75	0.75	0.75	0.75	NA
TCEY Distribution	2.0%	13.4%	12.6%	37.5%	15.7%	5.8%	4.8%	8.3%	100%
Adjusted	1.65	18.0%	<i>Depends on total TCEY</i>						
Final % from total TCEY	4.0%	18.3%	11.5%	34.4%	14.4%	5.3%	4.4%	7.6%	100%
TCEYs	1.65	7.56	4.75	14.19	5.94	2.18	1.80	3.15	41.22

2B includes 0.14 Mlb accounting for U26 non-directed discards in AK



Reference TCEYs

	<u>Region 2</u>	<u>Region 3</u>	<u>Region 4</u>	<u>Region 4B</u>	<u>Total</u>
2019	11.95	19.31	6.80	1.95	40.00
2020	12.41	12.74	5.48	1.27	31.90
2021	13.81	17.24	6.48	1.47	39.00
2022	13.96	20.13	5.33	1.80	41.22

↓
F_{46%}
F_{43%}
↓

Adopted TCEYs

2019	14.82	16.40	5.94	1.45	38.61
2020	14.33	15.32	5.65	1.31	36.60
2021	14.45	17.12	6.03	1.40	39.00



Reference TCEYs

	<u>2A</u>	<u>2B</u>	<u>2C</u>	<u>3A</u>	<u>3B</u>	<u>4A</u>	<u>4B</u>	<u>4CDE</u>	<u>Total</u>
2019	0.78	4.91	6.26	16.35	2.97	2.21	1.95	4.59	40.00
2020	1.65	5.80	4.97	9.80	2.94	2.26	1.27	3.22	31.90
2021	1.65	7.00	5.16	14.12	3.12	2.51	1.47	3.98	39.00
2022	1.65	7.56	4.75	14.19	5.94	2.18	1.80	3.15	41.22

Adopted TCEYs

2019	1.65	6.83	6.34	13.50	2.90	1.94	1.45	4.00	38.61
2020	1.65	6.83	5.85	12.20	3.12	1.75	1.31	3.90	36.60
2021	1.65	7.00	5.80	14.00	3.12	2.05	1.40	3.98	39.00



Interim Management procedure: 2022 detailed results

	2A	2B	2C	3A	3B	4A	4B	4CDE	Total
Commercial discards	0.07	0.21	NA	NA	0.29	0.07	0.06	0.02	0.73
O26 Non-directed discards	0.09	0.21	0.07	0.72	0.35	0.24	0.12	1.96	3.76
Recreational	NA	0.03	1.09	1.58	0.01	0.01	0.00	0.00	2.71
Subsistence	NA	0.41	0.29	0.18	0.01	0.01	0.00	0.04	0.94
Total non-FCEY	0.16	0.86	1.45	2.48	0.66	0.34	0.18	2.02	8.14
Commercial discards	NA	NA	0.10	0.40	NA	NA	NA	NA	0.50
Recreational	0.60	1.01	0.60	2.05	NA	NA	NA	NA	4.26
Subsistence	0.03	NA	NA	NA	NA	NA	NA	NA	0.03
Commercial landings	0.86	5.70	2.60	9.27	5.28	1.84	1.62	1.13	28.29
Total FCEY	1.49	6.71	3.30	11.71	5.28	1.84	1.62	1.13	33.08
							4C FCEY	0.52	
							4D FCEY	0.52	
							4E FCEY	0.08	
TCEY	1.65	7.56	4.75	14.19	5.94	2.18	1.80	3.15	41.22
U26 Non-directed discards	0.00	0.03	0.00	0.29	0.07	0.08	0.01	0.74	1.23
Total	1.65	7.59	4.75	14.49	6.01	2.25	1.82	3.89	42.45



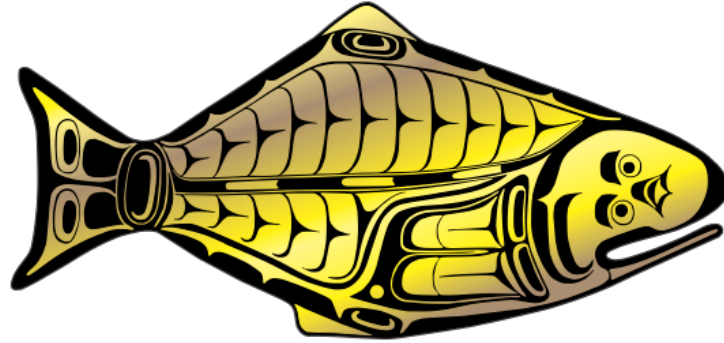
Recommendations

That the Commission:

NOTE paper IPHC-2022-AM098-10 which provides a summary of data, the 2021 stock assessment and the harvest decision table for 2022.



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