

INTERNATIONAL PACIFIC



HALIBUT COMMISSION

Summary of the 2022 data and stock assessment, and decision table for 2023

Agenda item 5.3

IPHC-2023-AM099-11

(I. Stewart)



Outline

- Data sources
- Modelling results
- Projections and decision table

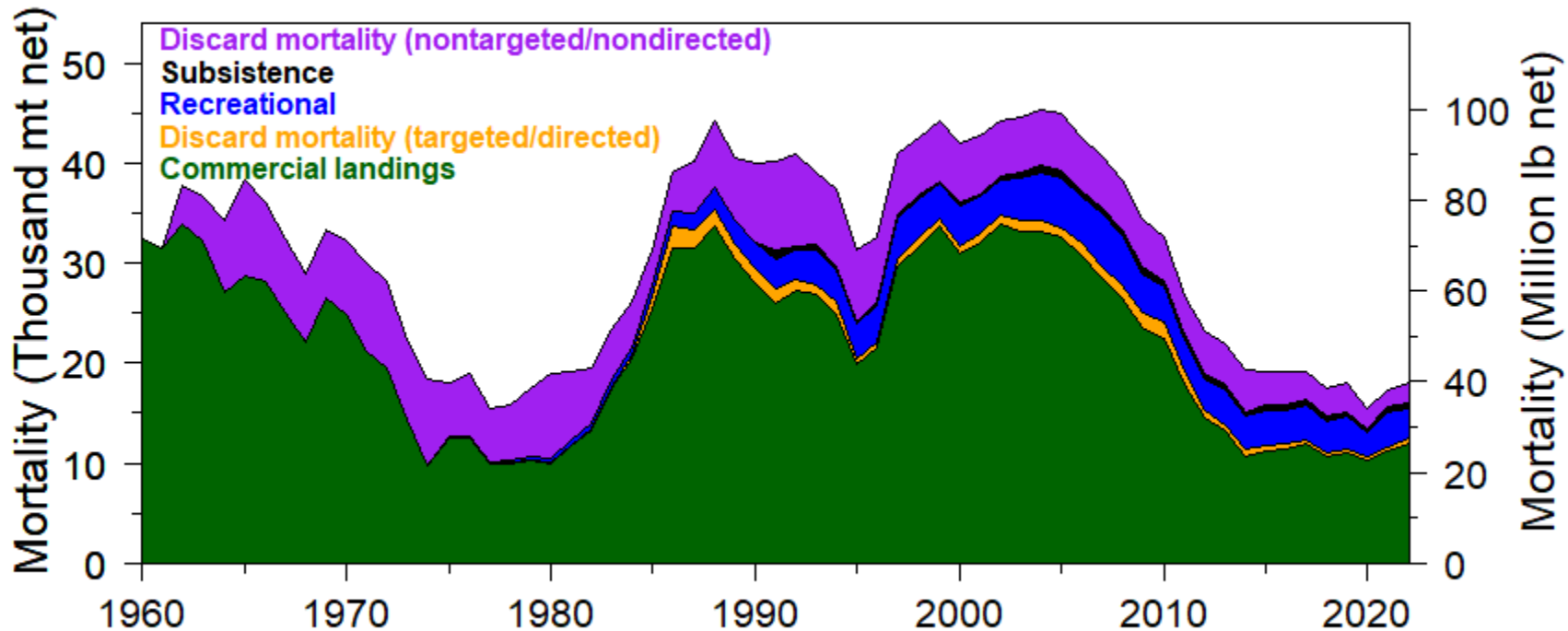


Data summary

- All coastwide indices were down strongly in 2022
 - Lowest fishery performance/efficiency in 3 decades
- Both the FISS and fishery have largely transitioned to the 2012 year-class from the 2005 and older year-classes
- Very low recruitment from 2006-2011 continues to reduce the short-term productivity of the stock



Historical mortality



2022 Mortality

Projected from AM098 based on adopted mortality limits

Year	Commercial Landings	Commercial discards	Recreational	Subsistence	Non-directed discards	Total
2022	28.08	1.17	7.25	0.97	4.98	42.45

(3-yr avg.)

Estimated for this year's stock assessment analysis

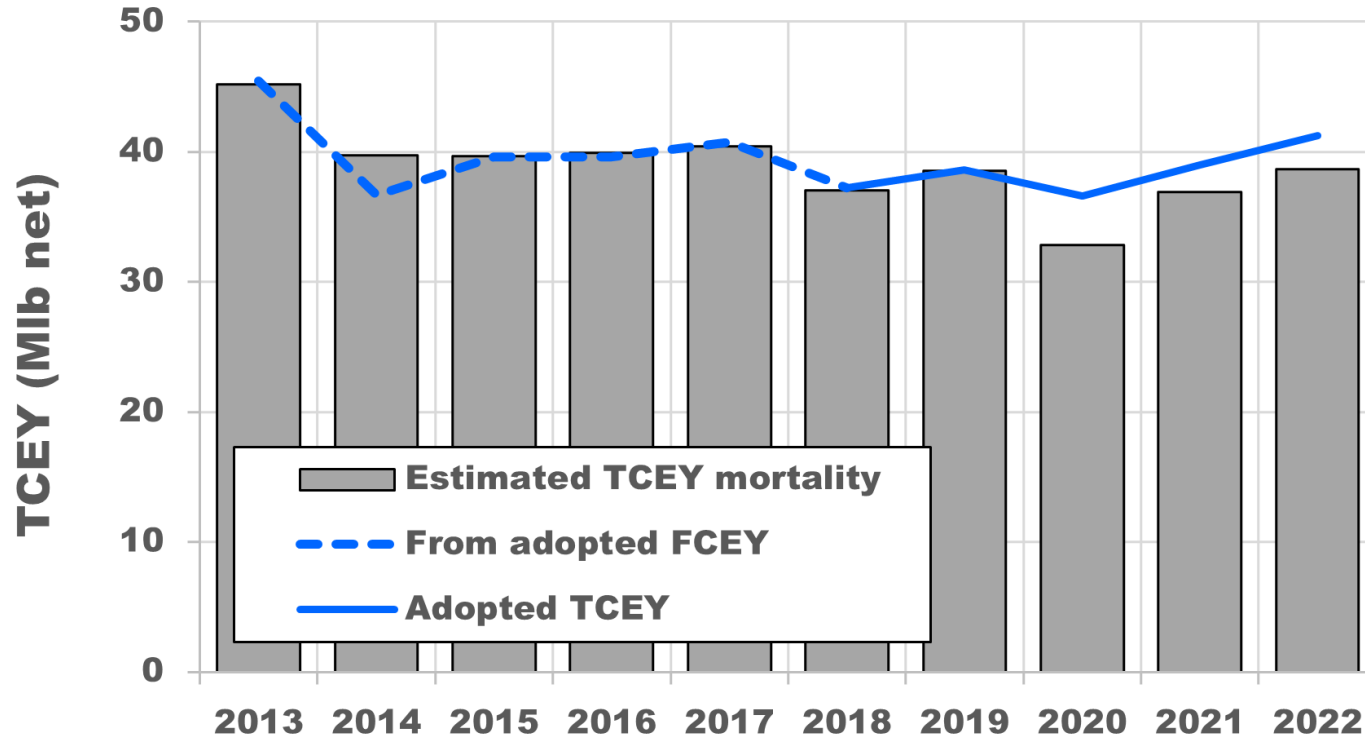
Year	Commercial Landings	Commercial discards	Recreational	Subsistence	Non-directed discards	Total
2022	26.14	1.51	6.60	0.96	4.48	39.69

Updated for projections: **5.08**

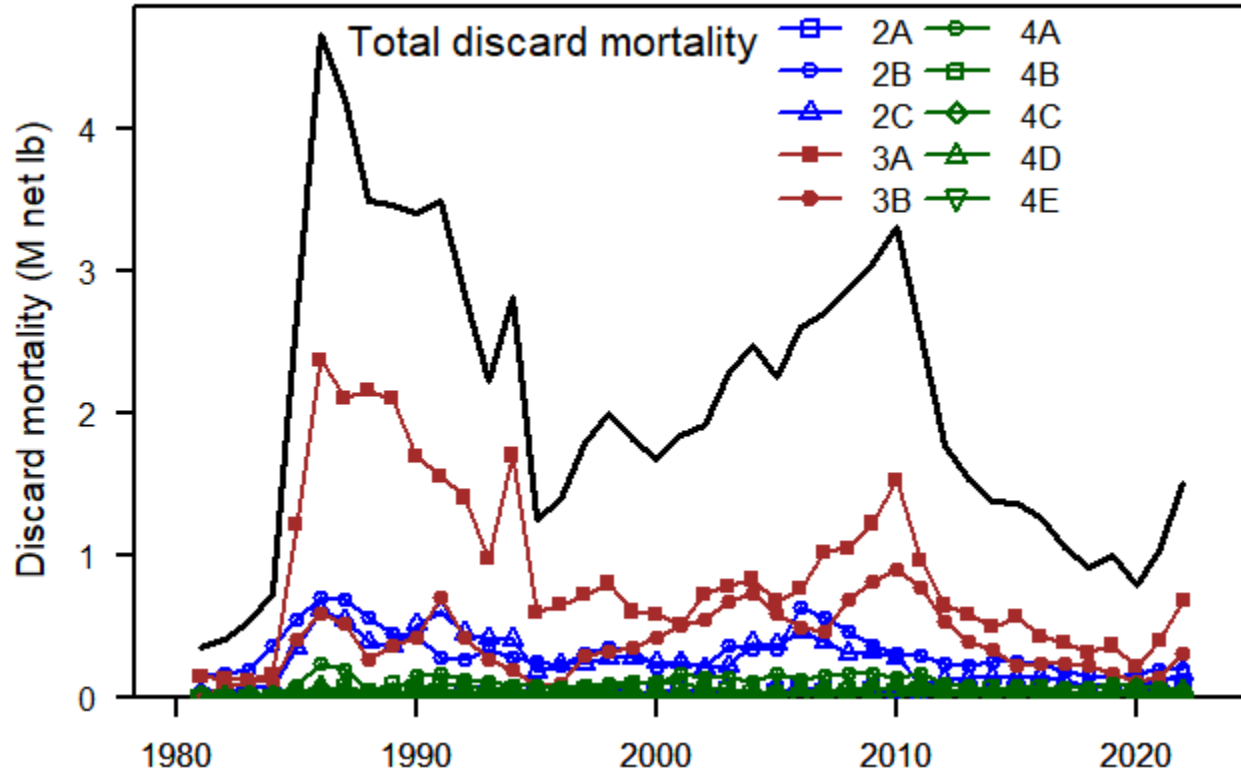
3-yr avg: **4.50**



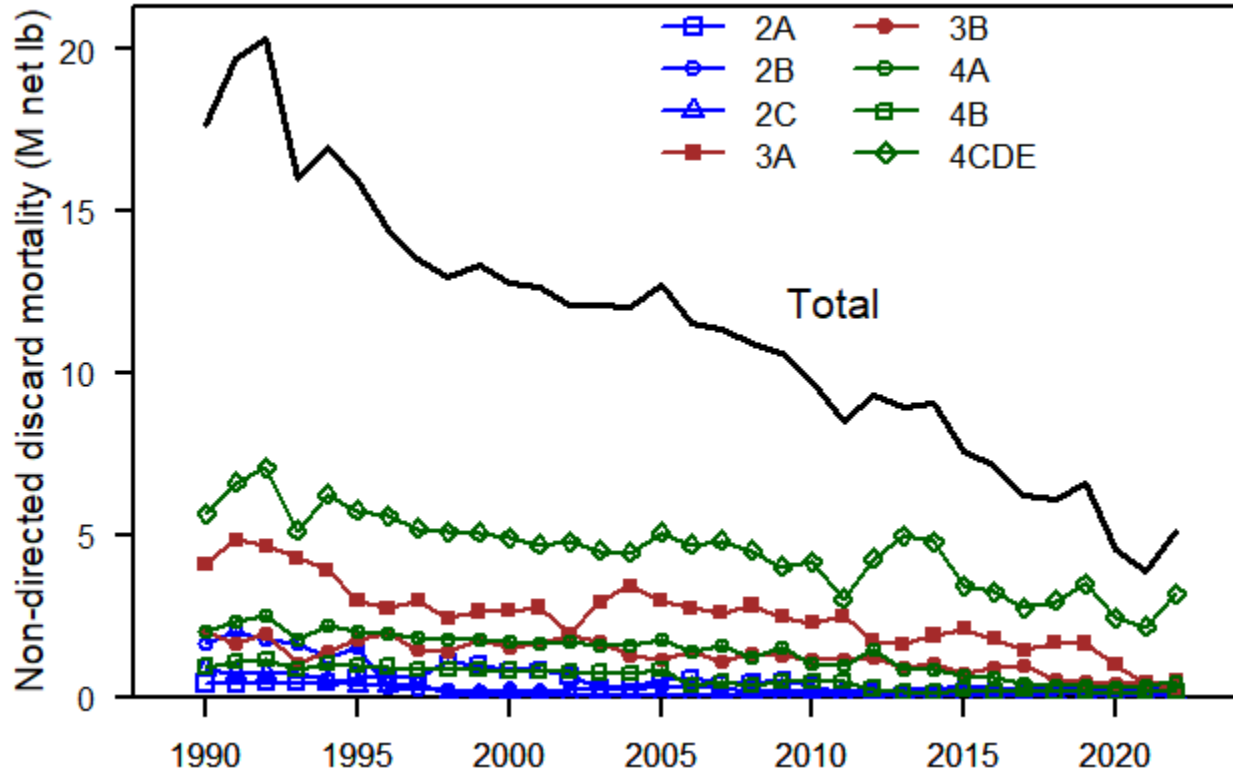
TCEY comparison



Recent directed commercial discard mortality

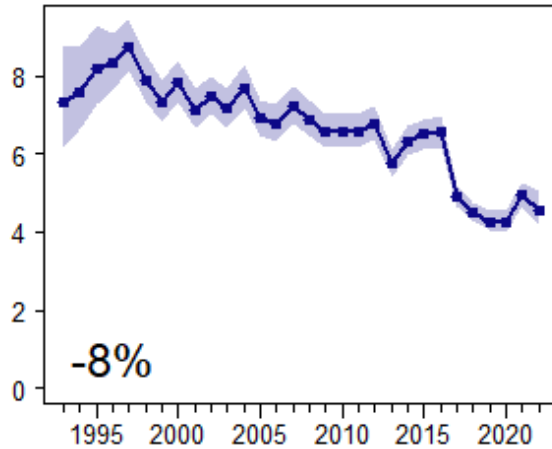


Recent non-directed discards

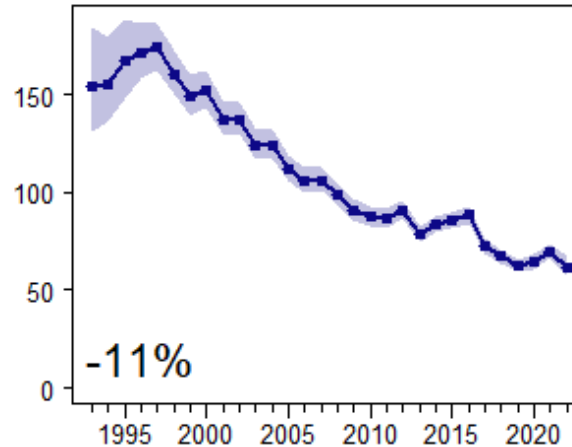


Modelled coastwide FISS trends

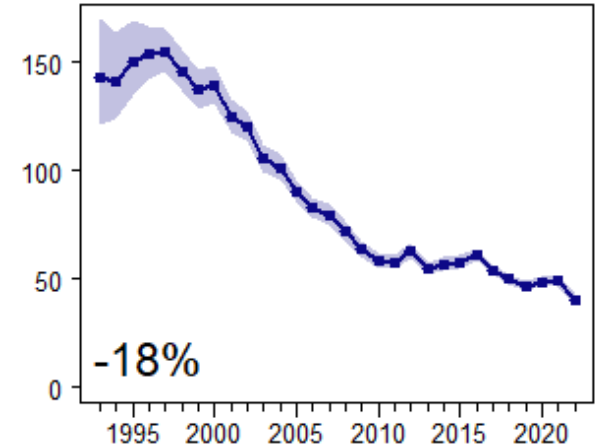
Numbers/skate



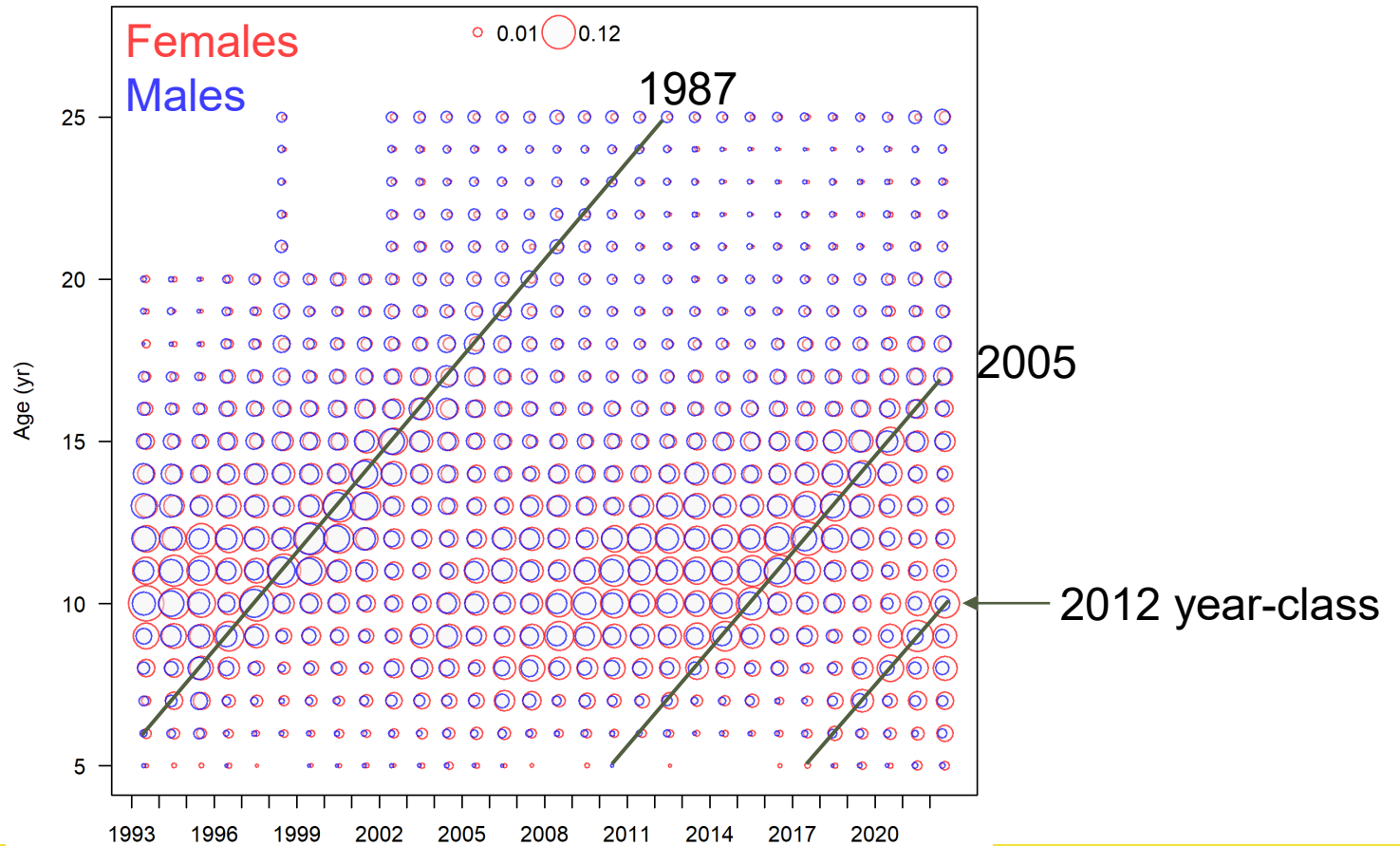
Total pounds/skate



O32 pounds/skate

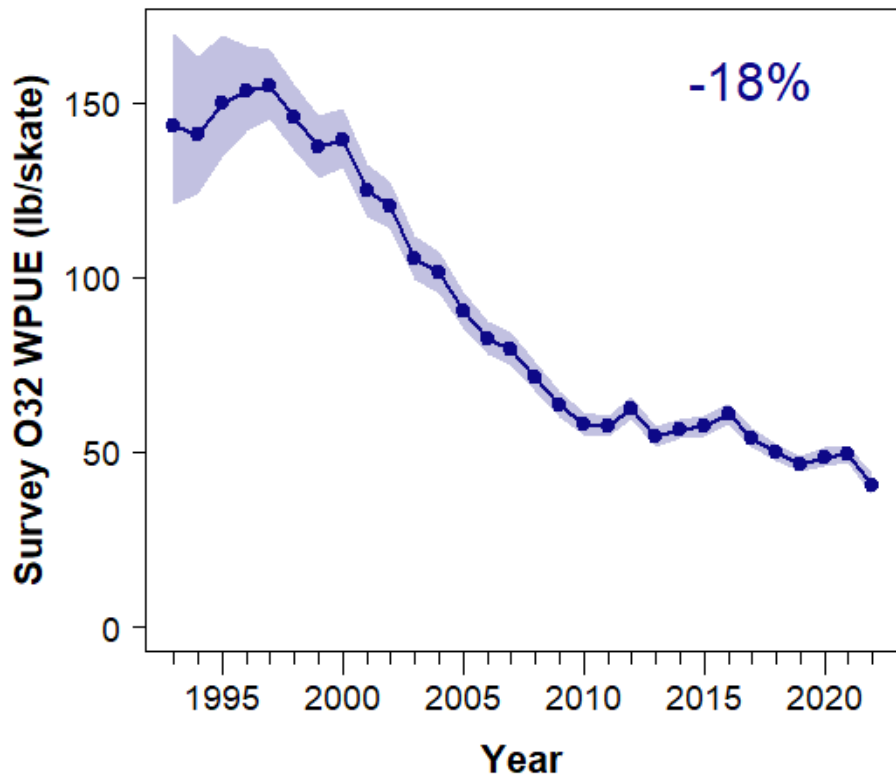


Recent FISS ages

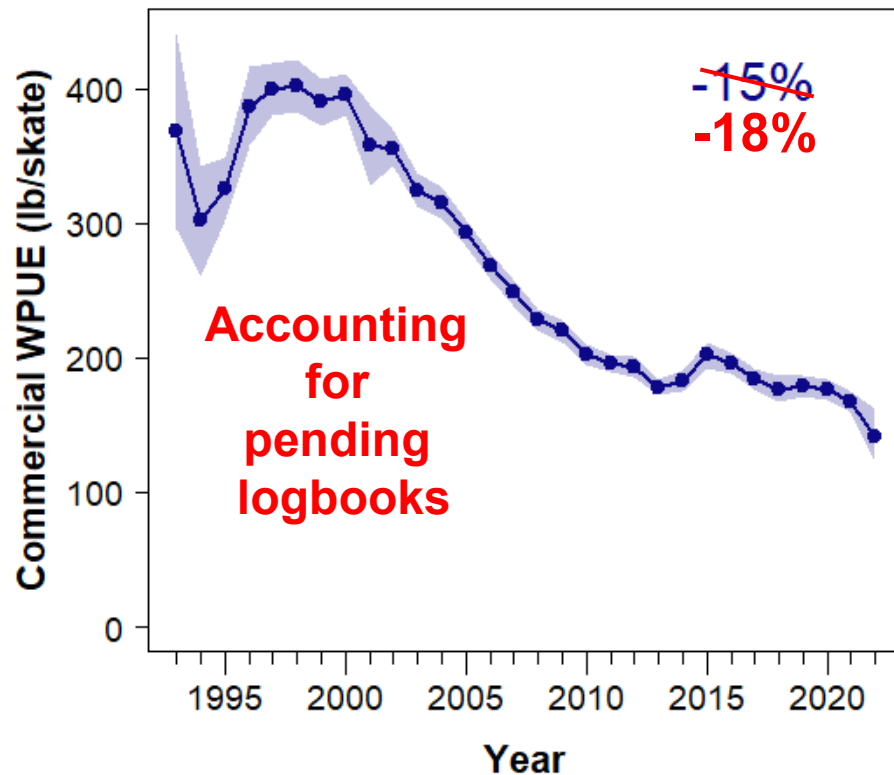


O32 WPUE (lb/skate) trends

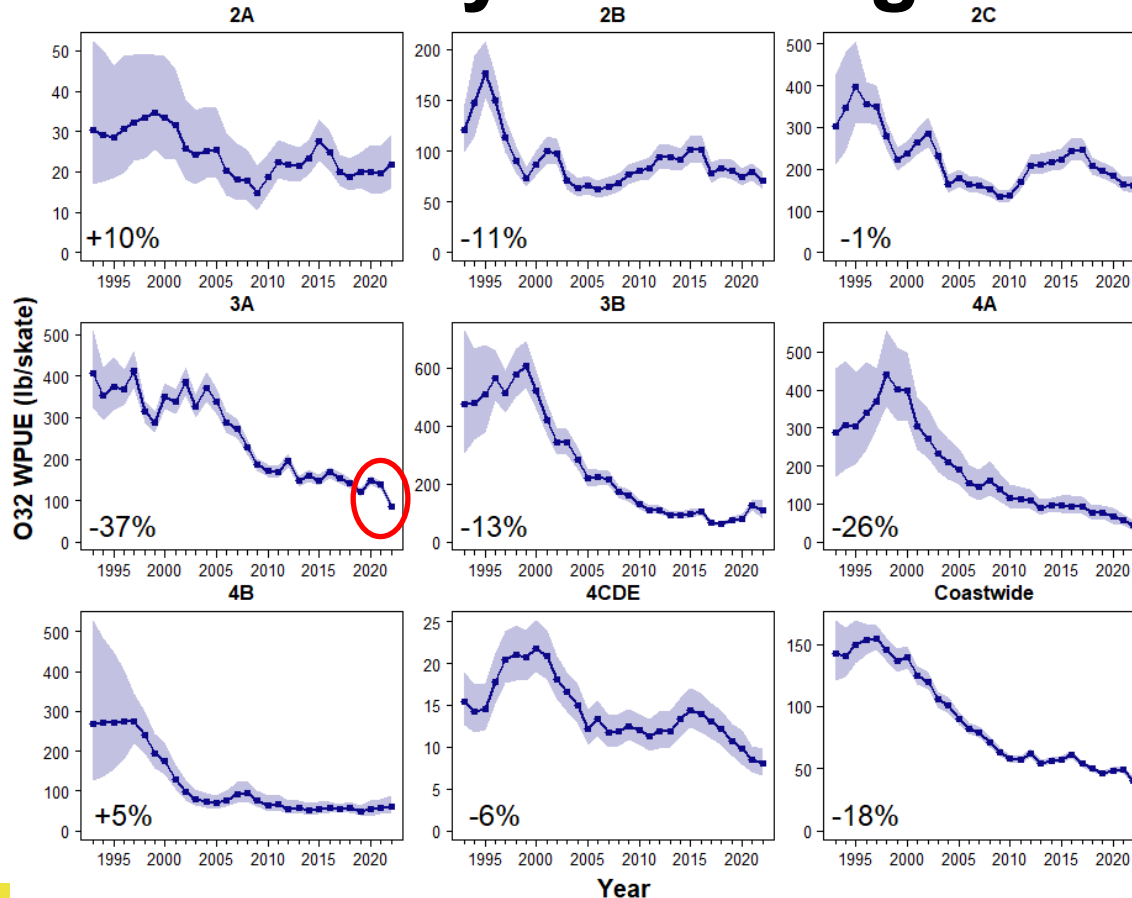
Coastwide survey



Coastwide commercial

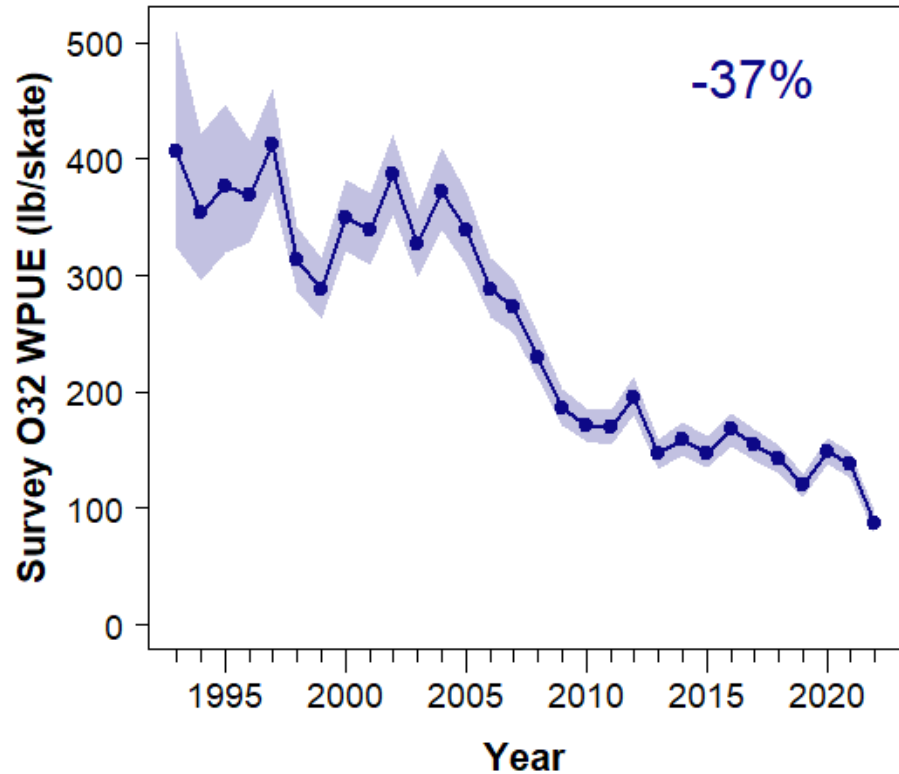


FISS O32 WPUE by IPHC Regulatory Area

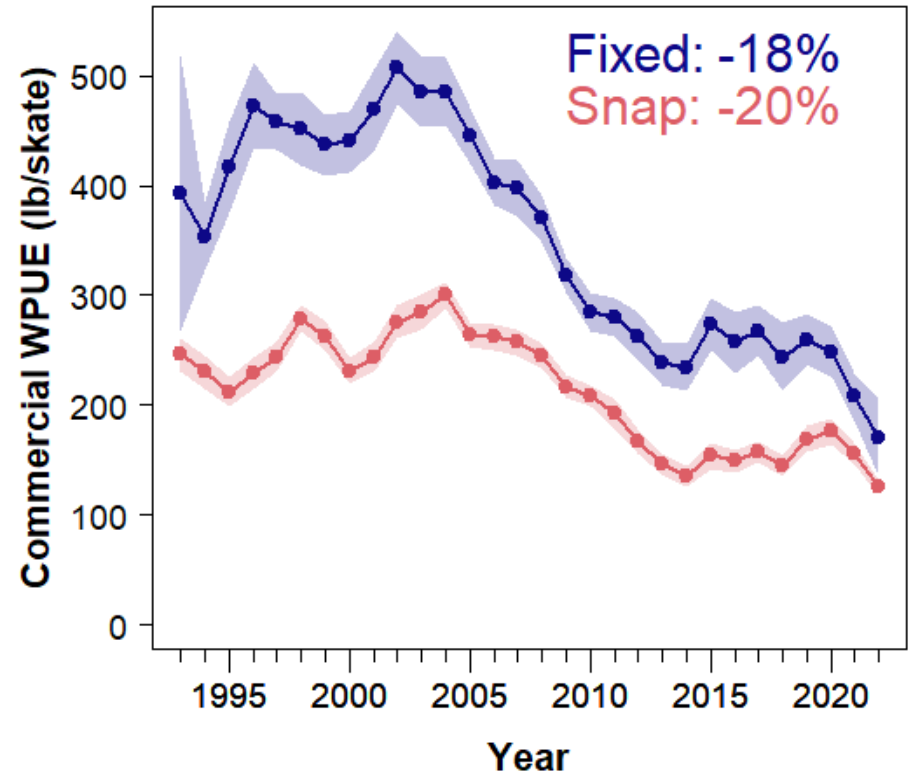


O32 WPUE trends by IPHC Regulatory Area

3A survey



3A commercial

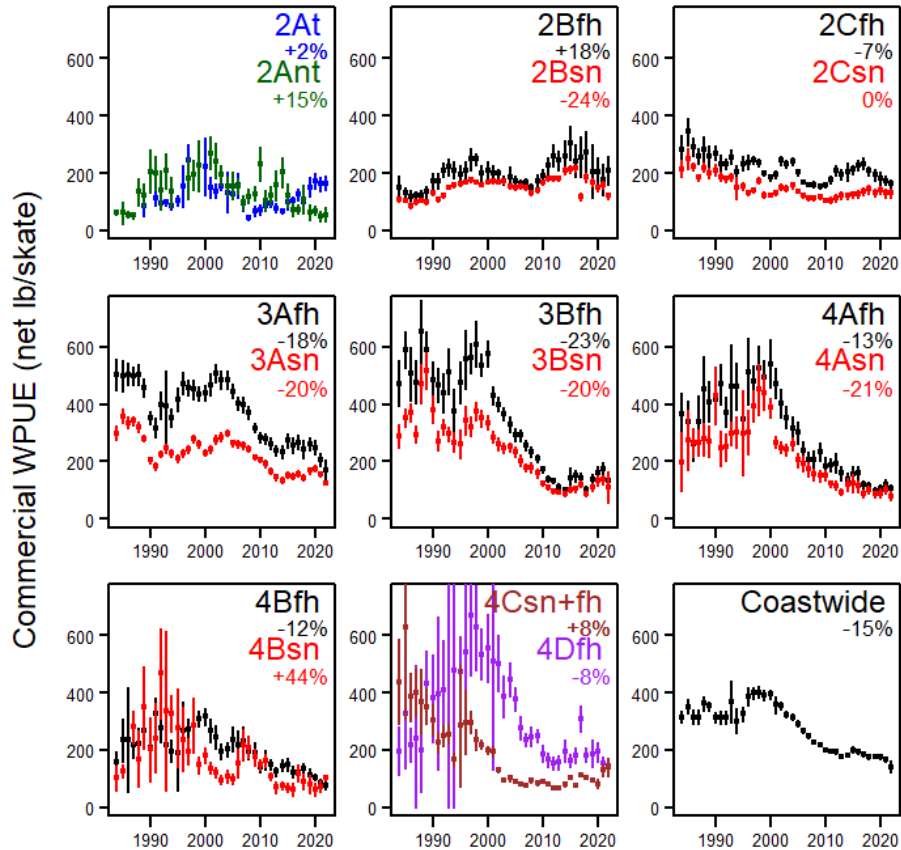


Fishery O32 WPUE by IPHC Regulatory Area

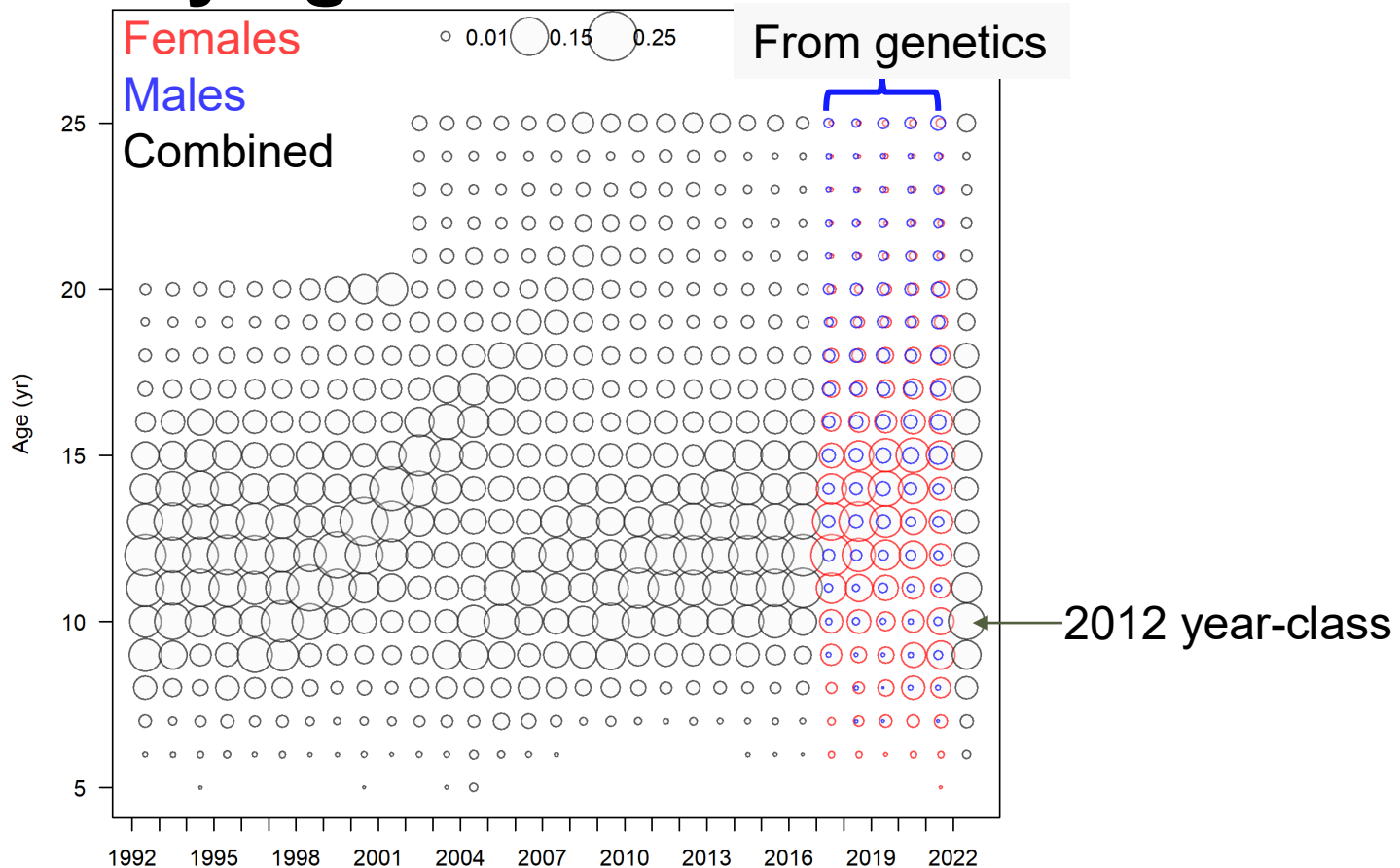
2A Tribal
2A non-Tribal

Fixed hook
Snap

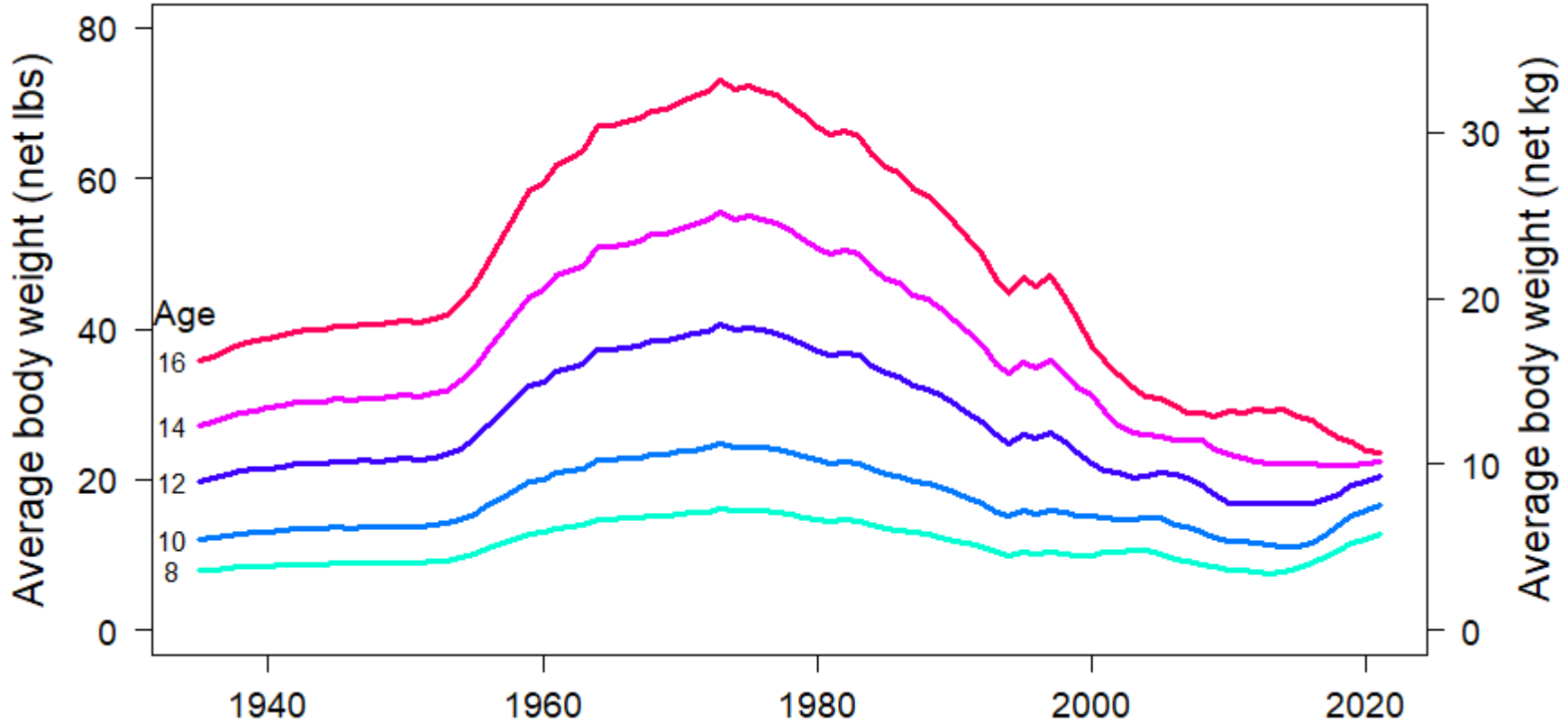
4C
4D



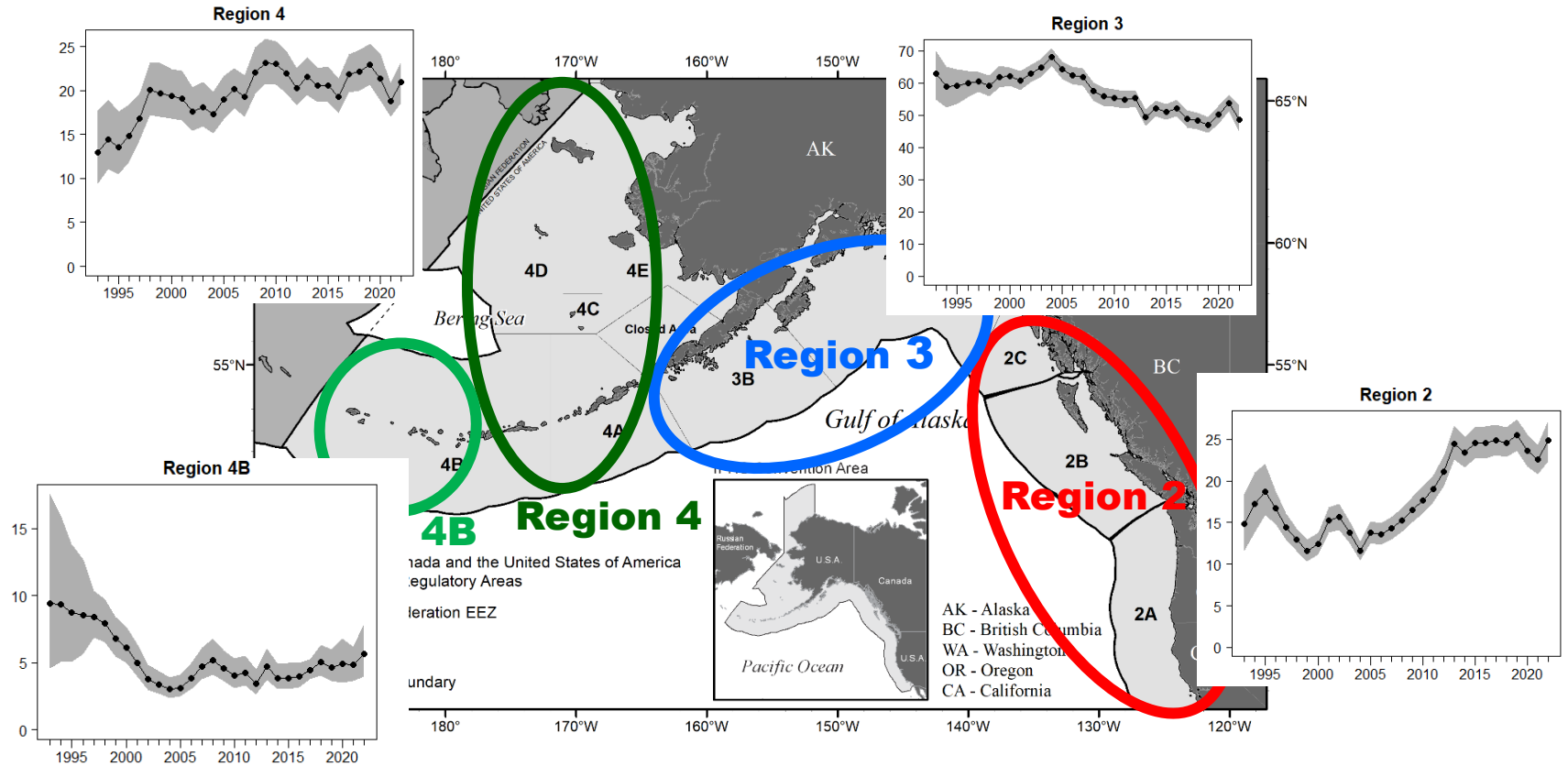
Recent fishery ages



Historical coastwide female weight-at-age



Stock distribution (% of biomass)

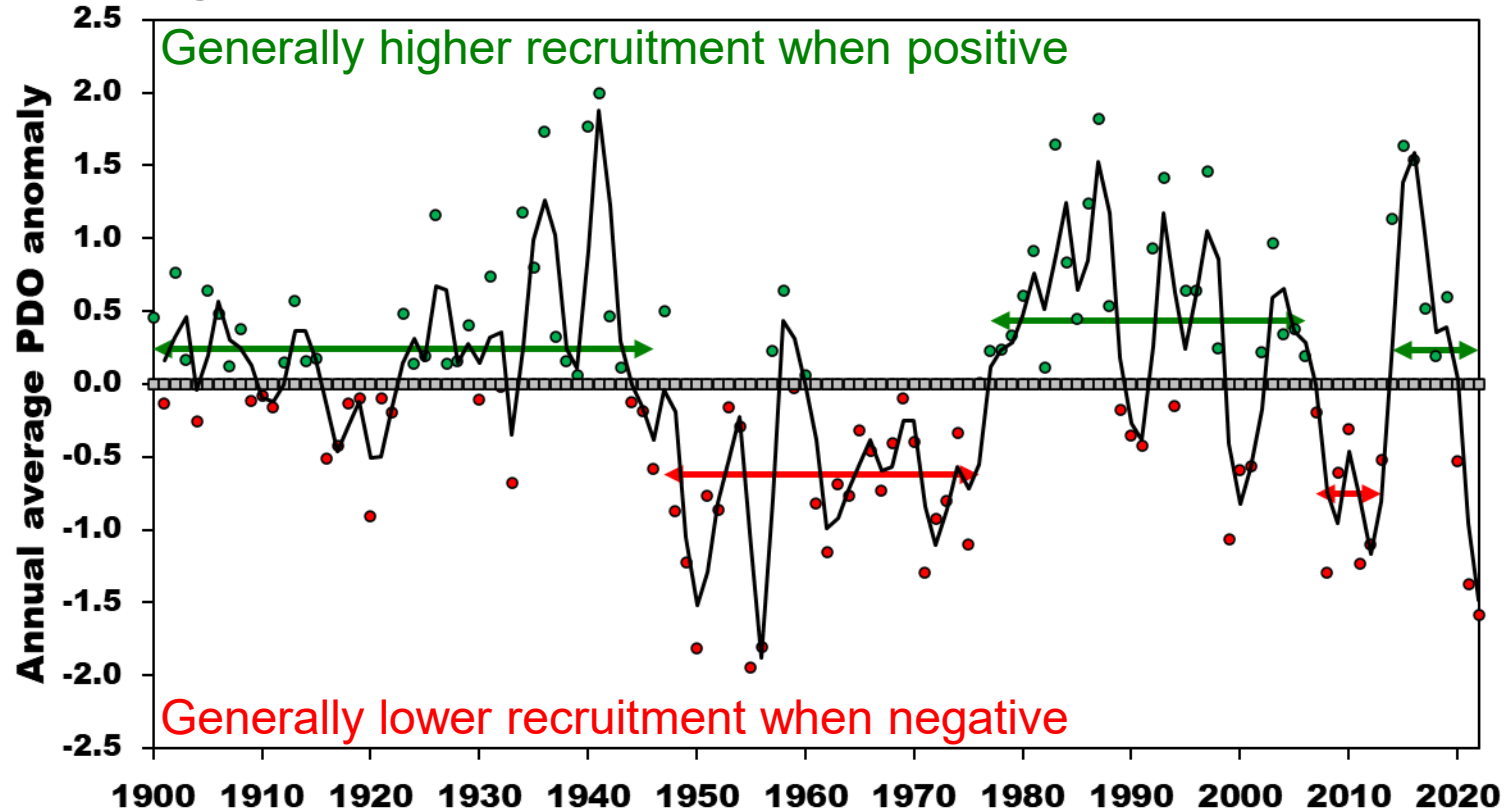


Change in O32 stock distribution

	<u>2A</u>	<u>2B</u>	<u>2C</u>	<u>3A</u>	<u>3B</u>	<u>4A</u>	<u>4B</u>	<u>4CDE</u>
2021 (last year's estimates)	1.8%	12.0%	11.3%	33.6%	18.8%	6.9%	5.7%	10.0%
2022	2.6%	13.0%	14.3%	26.3%	20.2%	5.3%	7.5%	10.9%
3-yr Average	2.2%	12.1%	13.3%	32.7%	17.2%	6.0%	6.2%	10.4%



Ecosystem conditions: Pacific Decadal Oscillation



Ecosystem conditions

- Bering Sea (2022): closer to average after reduced ice cover in recent years
- Aleutian Islands (2022): still some warmer than average temperatures
- GOA (2022): continued recovery toward average after 2014-2016 and 2019 heatwaves
- B.C. (2021): reduced productivity, warming
- California current (2021): cooler, increased productivity, some hypoxia

References (most recent reports):

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



Outline

- Data sources
- Modelling results
- Projections and decision table

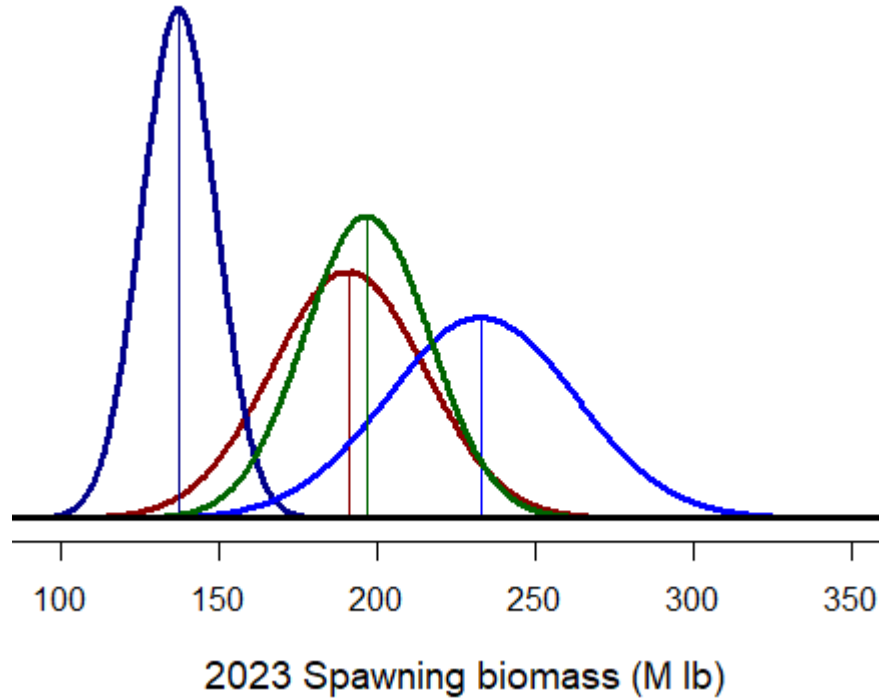


Modelling summary

- Removed an outdated assumption of low natural mortality in 1 of 4 assessment models
 - Now estimated directly from the data
 - Results in larger projected yields at long-term fishing intensity reference points (e.g., $F_{43\%}$)
- Spawning biomass estimated to be stable, but relying heavily on maturation of the 2012 year class
- Short term projections of surplus production remain near *status quo*



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



The 2022 assessment

- Full analysis of data and models, following updates in 2020 and 2021
- Incremental changes reviewed by the SRB in June and September
- All data updated for 2021 (where needed) and added for 2022
- Most important change: estimating female natural mortality in one additional model (now 3 of 4)



Female Pacific halibut natural mortality (M)

- What is M ?
 - The rate at which fish die of causes other than fishing.
- How do we estimate it?
 - As each year class of fish age, they decrease in abundance. We track how many have been caught. The rest of the decrease is due to M . More years of data gives us more information.
- How does it affect productivity?
 - Higher M equates to higher productivity and therefore higher long-term sustainable yields.



Female Pacific halibut natural mortality (M)

- Prior to 1998: all models used 0.20
- 1998-2012: all models used 0.15
- 2012: natural mortality served as the primary source of uncertainty in the harvest decision table.
- 2013: 1 of 3 models estimated M
- 2014: 2 of 4 models estimated M
- 2022: 3 of 4 models estimated M
 - Estimates range from 0.184 to 0.215; one model retains a fixed value of 0.15



Female Pacific halibut natural mortality (M)

Considerations in 1998 (Clark and Parma 1999):

“Until 1998 the estimate of $M = 0.20$ had been used in all assessments. This estimate is quite imprecise, and analysis done by the staff during the year suggested that a lower working value would be appropriate. The value of $M = 0.15$ was chosen and used as a standard, which lowered abundance estimates by about 30%.”

“Analysis done during the year by the staff showed that in the short term an overestimate of natural mortality could lead to a substantial overestimate of stock size when past fishing mortality rates were low, as they have been for Pacific halibut. On the other side, the consequences of an underestimate of natural mortality are less serious.”

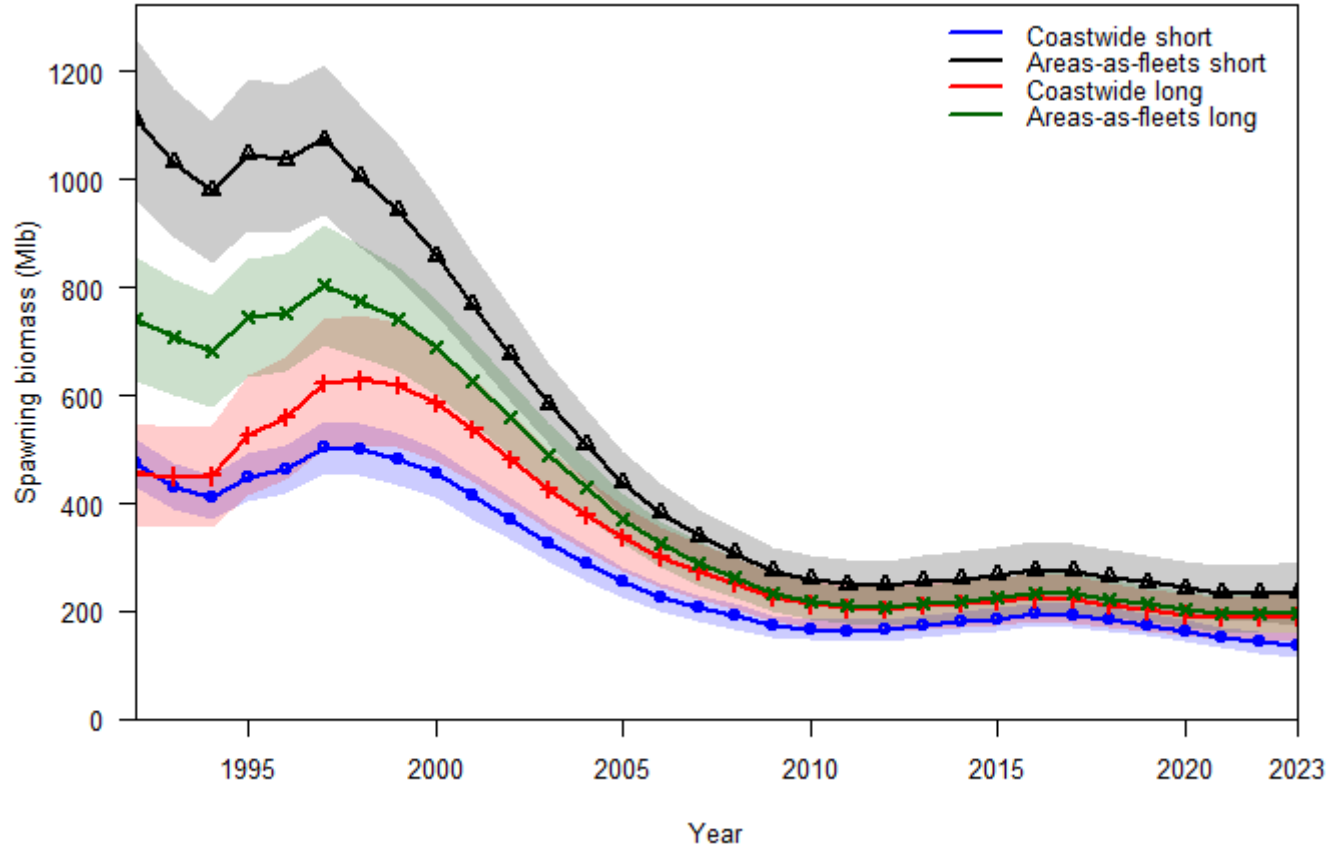


Female Pacific halibut natural mortality (M)

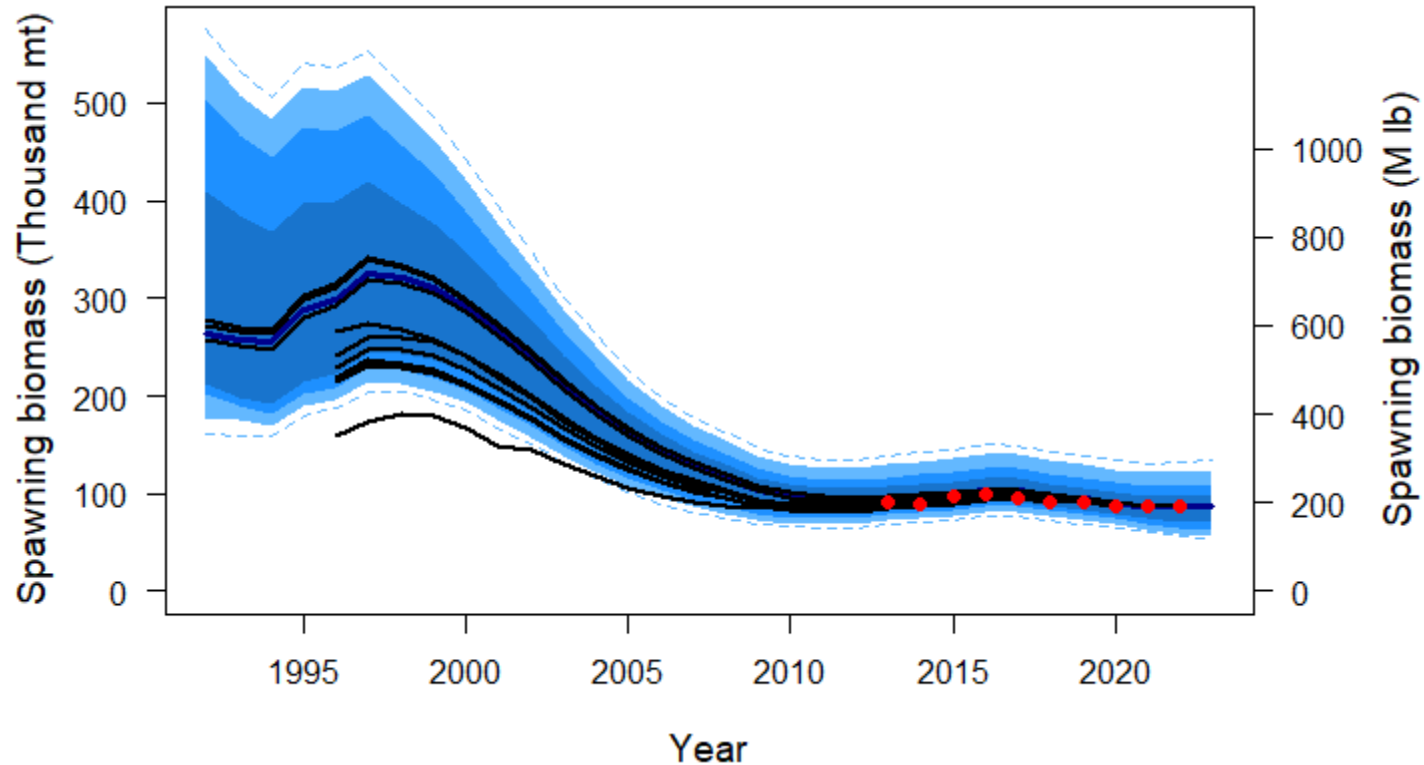
- We now have 25 years of additional data to inform our estimates
- Transparent, risk-neutral science: not making a precautionary adjustment to M inside the assessment models
- Estimating M , rather than using an assumed value represents our best available science



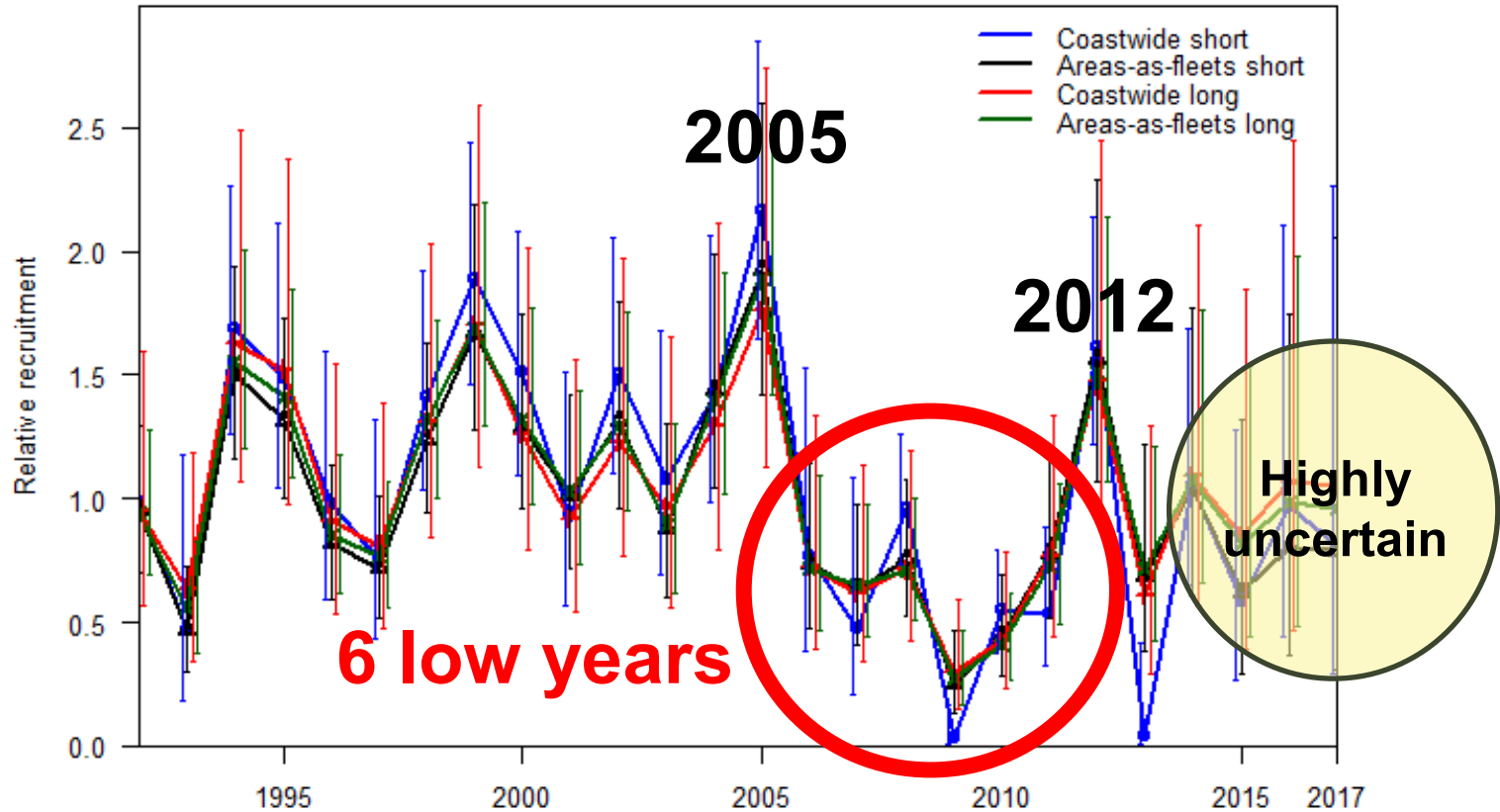
Modelling summary: four individual models



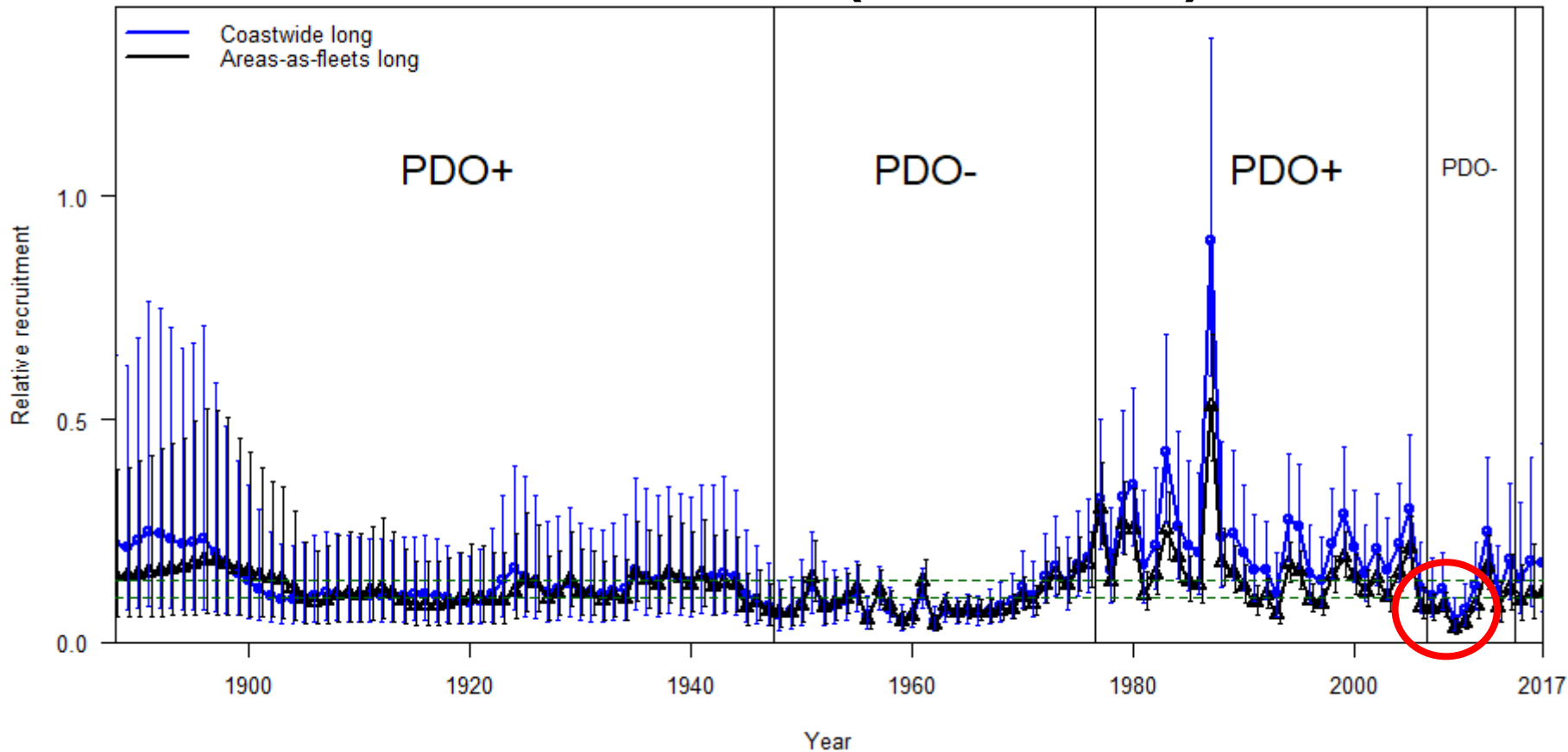
Comparison with previous assessments



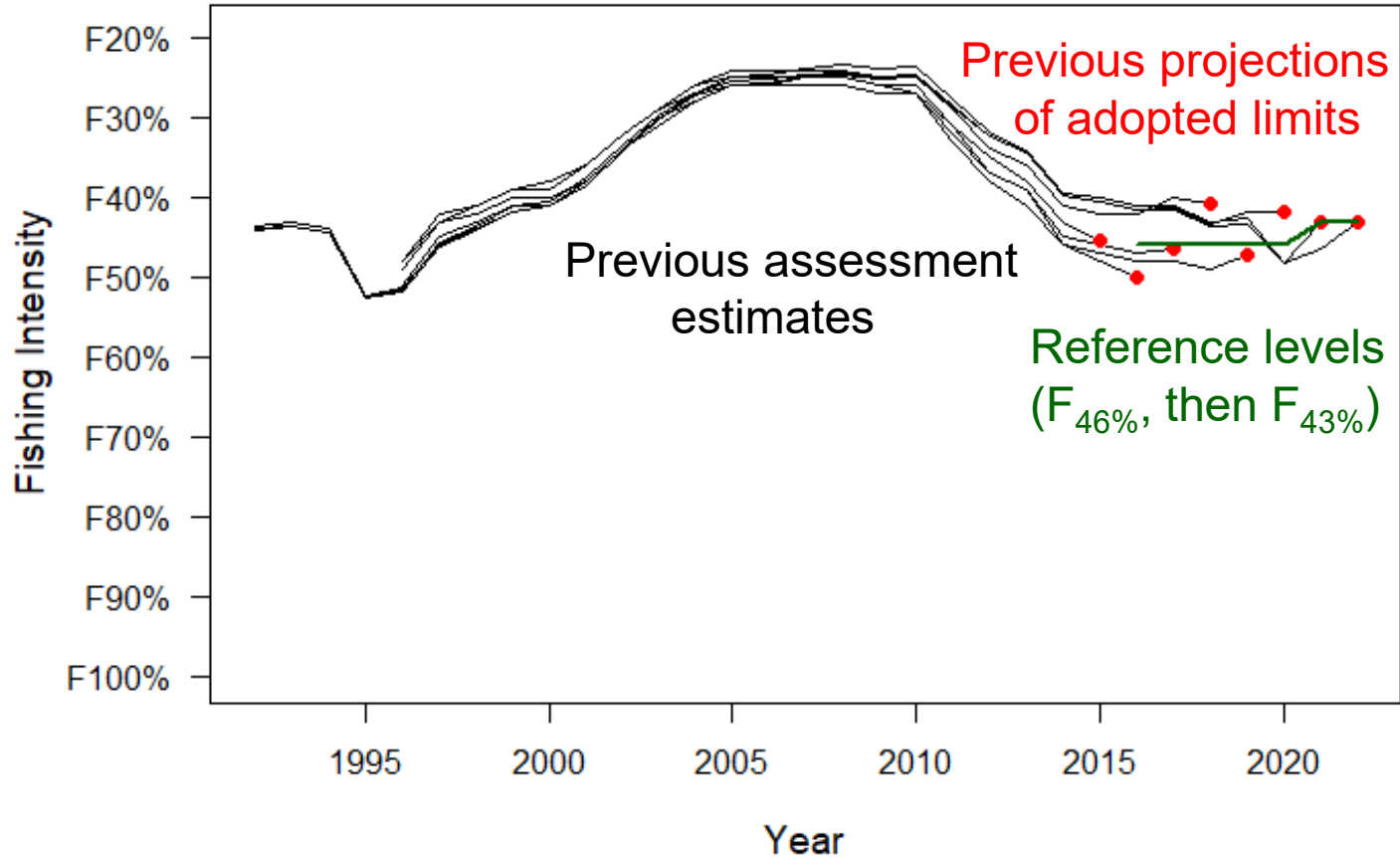
Relative recruitment estimates



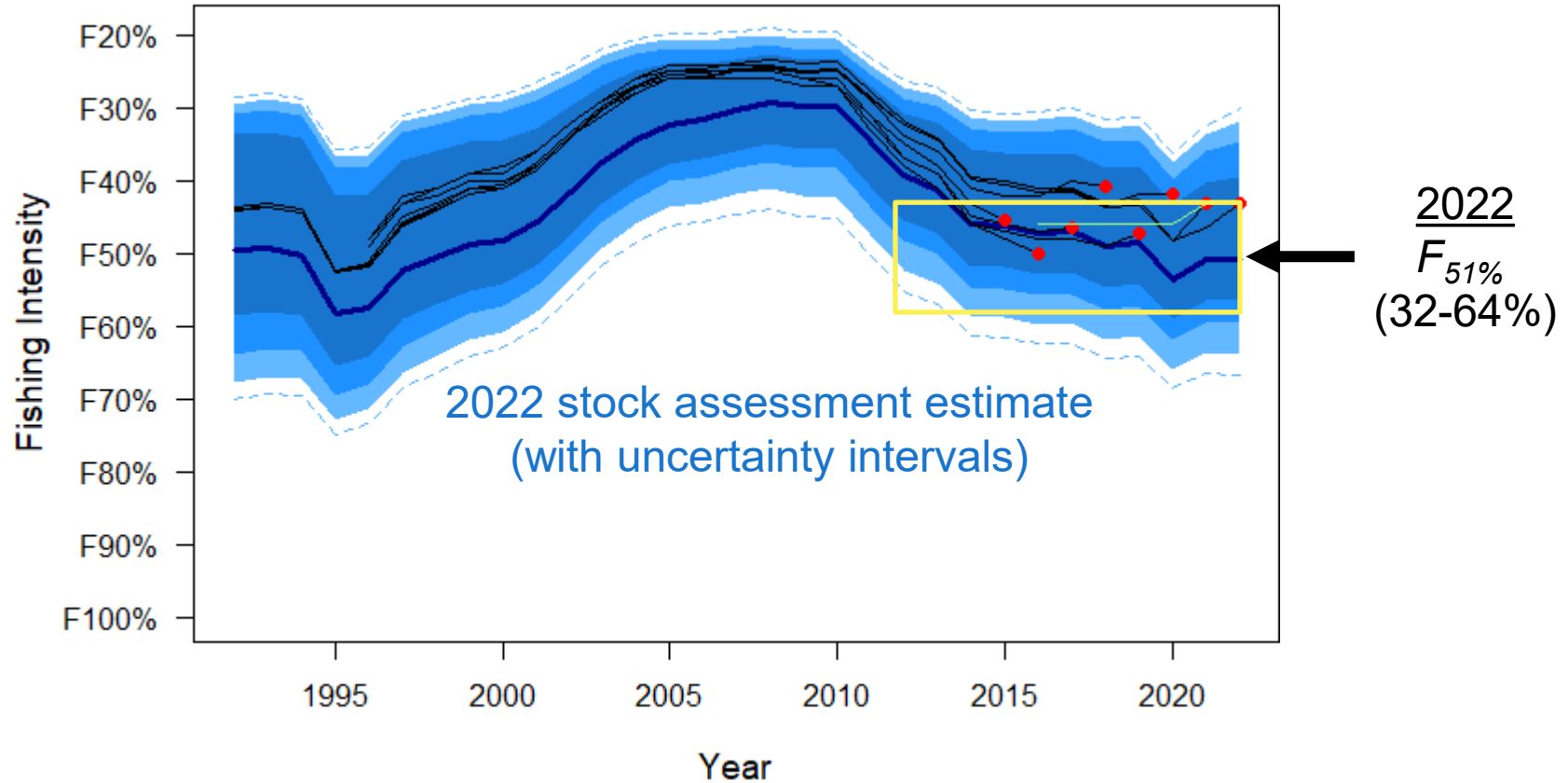
Historical recruitment (2 models)



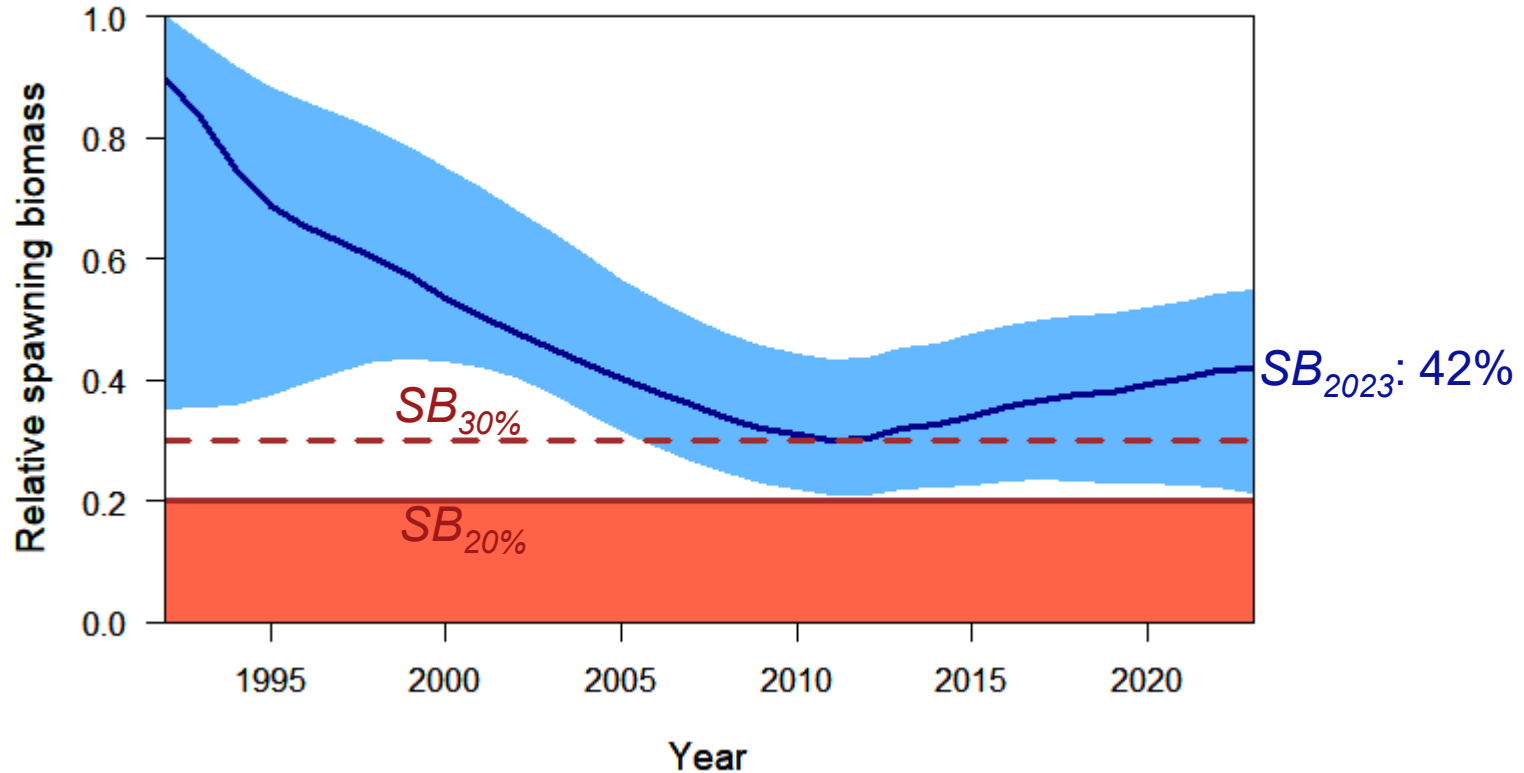
Fishing intensity (F_{SPR})



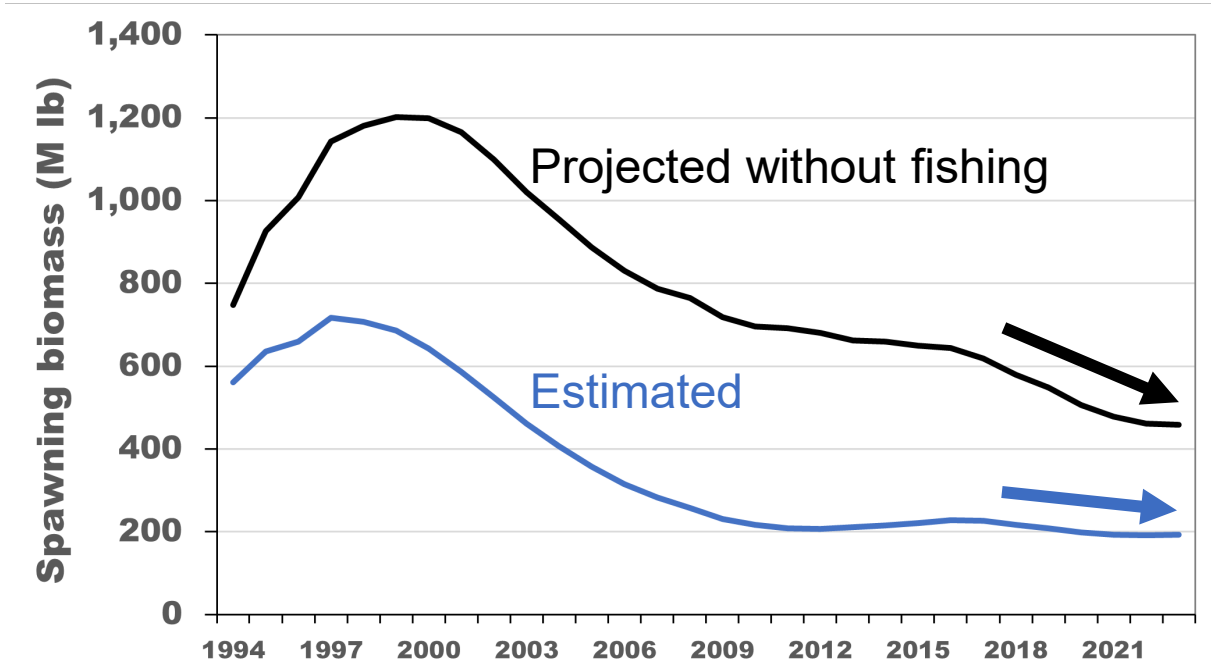
Fishing intensity (F_{SPR})



Spawning biomass relative to unfished



Spawning biomass relative to unfished



Outline

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- Modelling results
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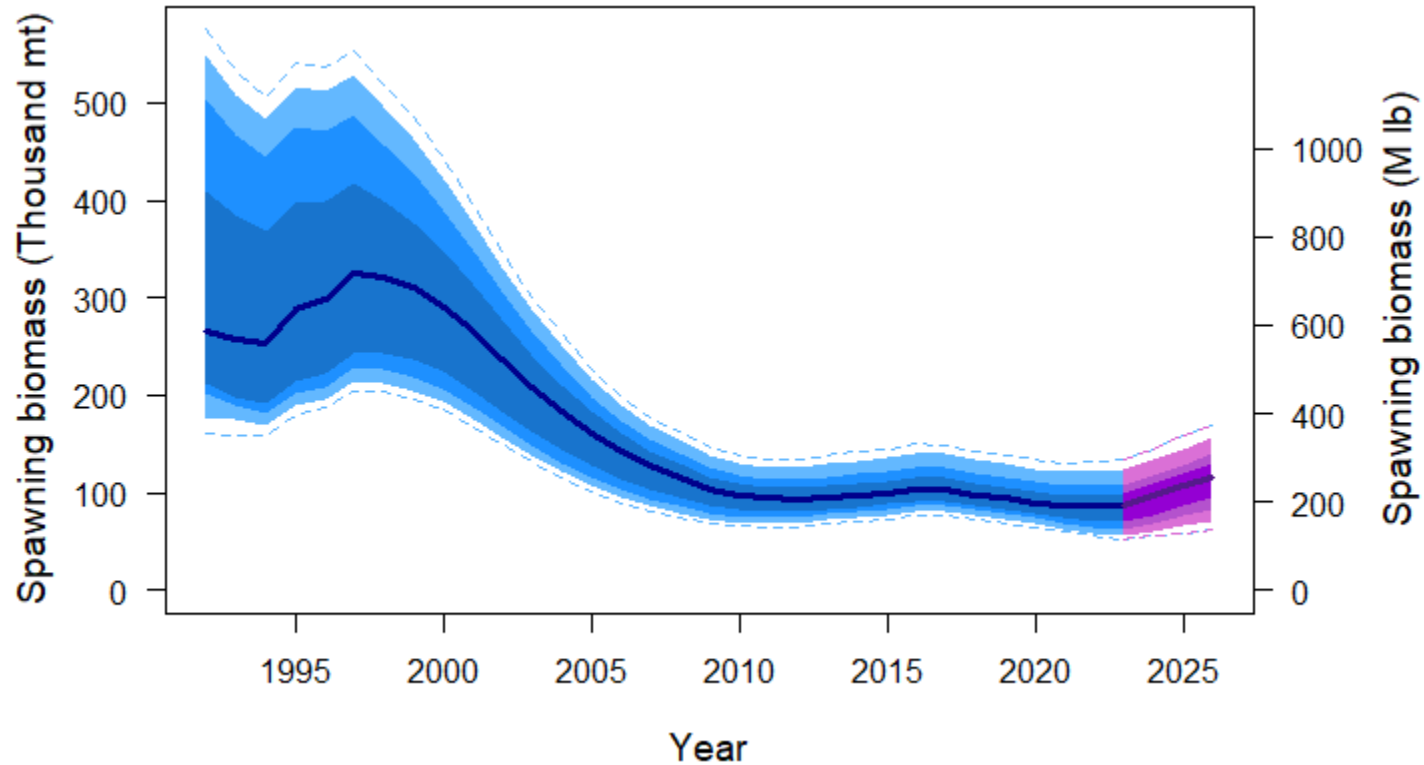


Projections and decision table

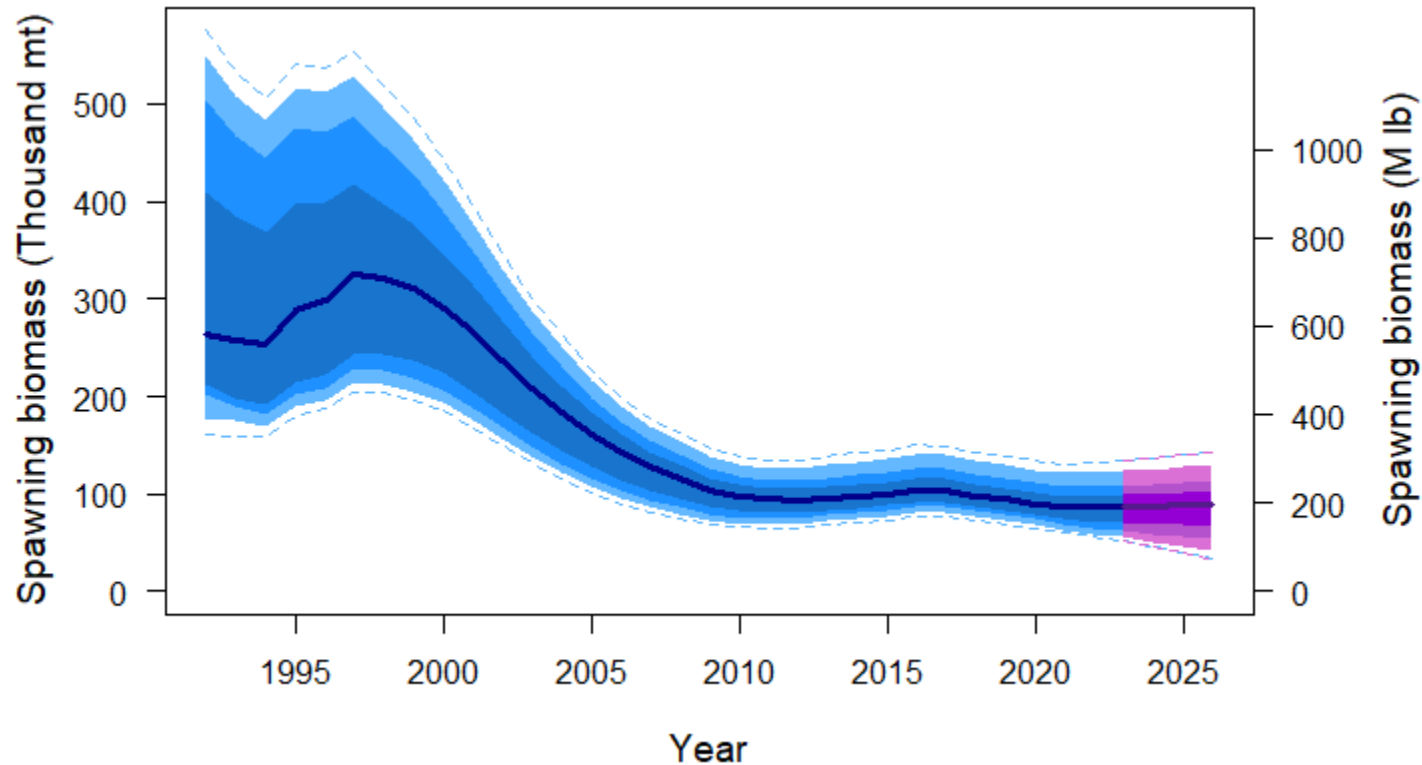
- Constant TCEY for the next three years
- Range of mortality, from no fishing mortality to 60 MIb TCEY, additional detail from $F_{40\%}$ - $F_{46\%}$
- 6 specific projections:
 - Reference level: 2023 TCEY estimated to result in $F_{43\%}$
 - 3-year surplus: 50/50 odds of spawning biomass dropping below 2023 estimate by 2026
 - *Status quo*
 - *Status quo -10%*
 - *Status quo -15%*
 - *Status quo -18%*



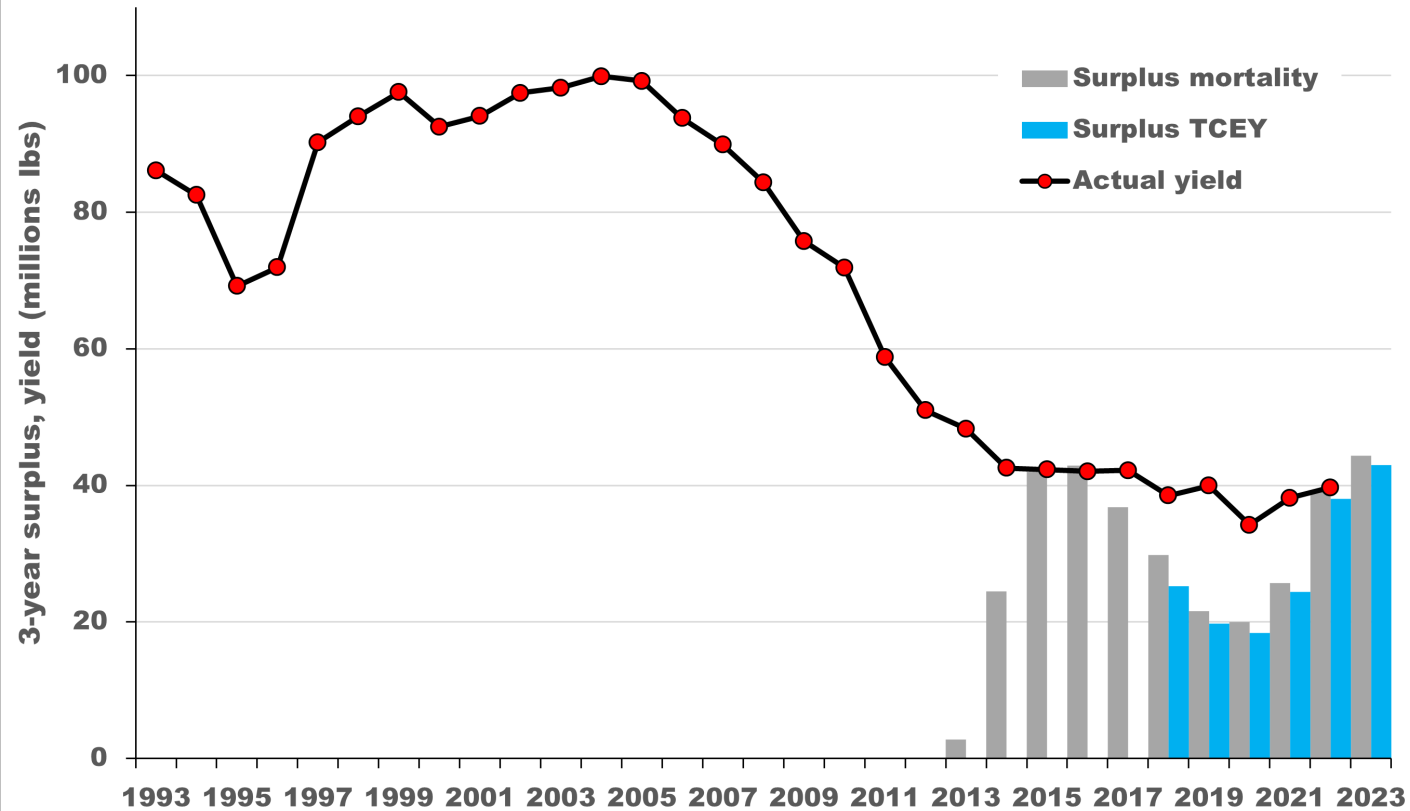
Projections: no fishing mortality



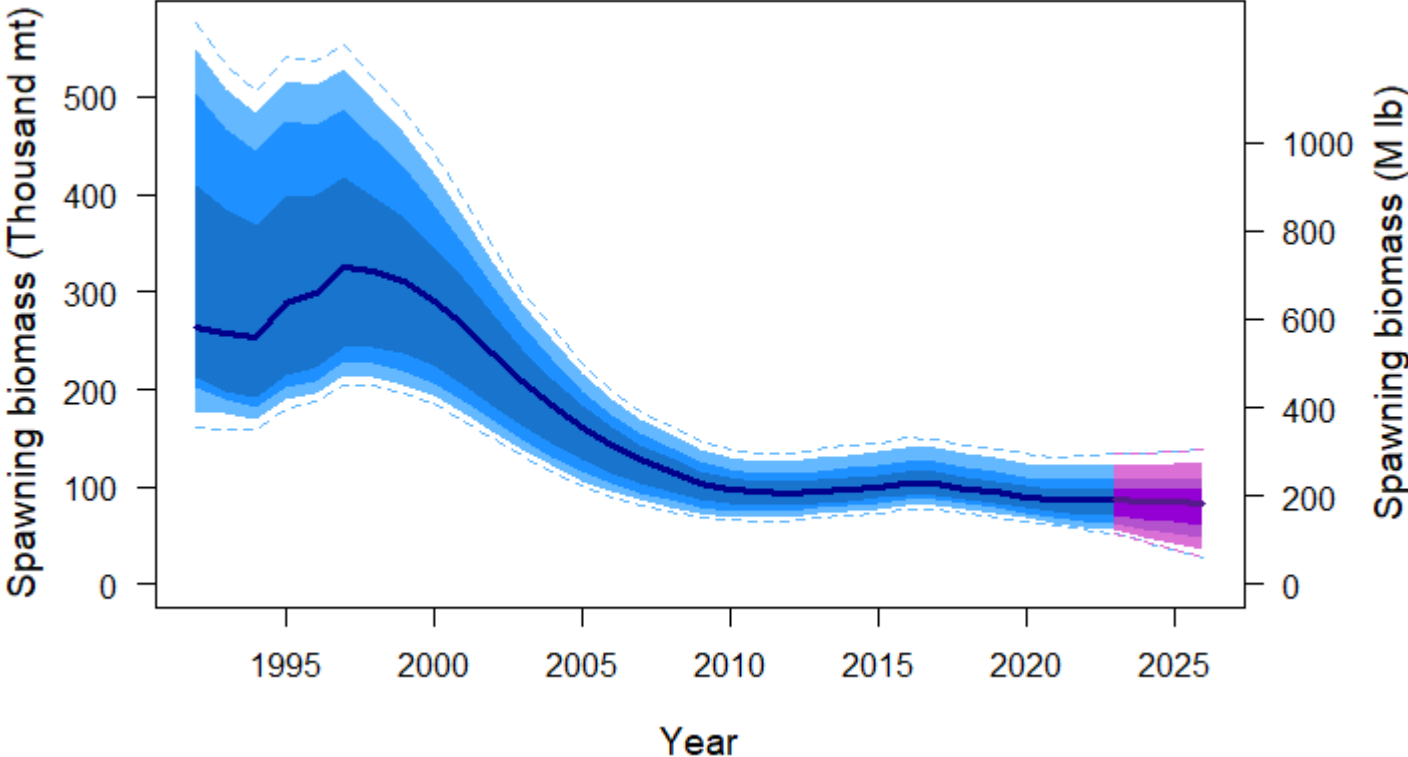
Projections: 3-yr surplus (43.0 Mlb TCEY)



Recent estimates of surplus production



Projections: reference level (52.0 Mlb TCEY)



Decision table

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



Decision table: Yield options

2023 Alternative		<i>Status quo -18%</i>	<i>Status quo -15%</i>	<i>Status quo -10%</i>	<i>Status quo</i>	3-Year Surplus	<i>Reference F_{43%}</i>								
Total mortality (M lb)	0.0	31.3	35.1	36.4	38.4	42.5	44.3	48.1	49.8	51.5	52.3	55.1	57.1	59.1	61.3
TCEY (M lb)	0.0	30.0	33.8	35.0	37.1	41.2	43.0	46.8	48.4	50.2	52.0	53.8	55.8	57.8	60.0
2023 fishing intensity	F _{100%}	F _{59%}	F _{55%}	F _{54%}	F _{53%}	F _{50%}	F _{48%}	F _{46%}	F _{45%}	F _{44%}	F _{43%}	F _{42%}	F _{41%}	F _{40%}	F _{39%}
Fishing intensity interval	--	37-71%	34-68%	33-67%	32-66%	29-63%	28-62%	26-59%	25-59%	24-58%	24-57%	23-56%	22-55%	21-54%	21-53%

30 Mlb ↑
 No fishing mortality

$F_{46\%} - F_{40\%}$
 60 Mlb ↑



Full decision table

2023 Alternative				<i>Status quo -18%</i>	<i>Status quo -15%</i>	<i>Status quo -10%</i>	<i>Status quo</i>	3-Year Surplus	Reference $F_{43\%}$								
Total mortality (M lb)	0.0	31.3	35.1	36.4	38.4	42.5	44.3	48.1	49.8	51.5	52.3	55.1	57.1	59.1	61.3		
TCEY (M lb)	0.0	30.0	33.8	35.0	37.1	41.2	43.0	46.8	48.4	50.2	52.0	53.8	55.8	57.8	60.0		
2023 fishing intensity	F100%	F59%	F55%	F54%	F53%	F50%	F48%	F46%	F45%	F44%	F43%	F42%	F41%	F40%	F39%		
Fishing intensity interval	--	37-71%	34-68%	33-67%	32-66%	29-63%	28-62%	26-59%	25-59%	24-58%	24-57%	23-56%	22-55%	21-54%	21-53%		
Stock Trend (spawning biomass)	in 2024	is less than 2023	<1	20	29	32	38	49	53	63	67	71	75	79	83	86	89
		is 5% less than 2023	<1	2	4	5	7	13	15	22	25	28	31	35	39	43	47
	in 2025	is less than 2023	<1	18	27	30	35	46	50	60	64	68	72	76	80	83	87
		is 5% less than 2023	<1	6	11	13	16	24	28	36	40	44	48	52	57	62	67
	in 2026	is less than 2023	<1	20	28	31	36	46	50	60	63	67	71	75	79	82	85
		is 5% less than 2023	<1	10	16	18	22	31	35	43	47	51	55	59	64	68	72
Stock Status (Spawning biomass)	in 2024	is less than 30%	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
		is less than 20%	<1	<1	<1	1	1	1	1	1	1	2	2	2	2	3	3
	in 2025	is less than 30%	18	25	25	25	25	25	25	25	25	25	25	25	25	25	25
		is less than 20%	<1	<1	1	1	1	1	2	3	3	4	4	5	6	6	7
	in 2026	is less than 30%	6	23	24	24	24	25	25	25	25	25	25	25	25	25	25
		is less than 20%	<1	<1	1	1	1	2	3	4	5	6	6	7	9	10	11
Fishery Trend (TCEY)	in 2024	is less than 2023	0	17	24	24	25	28	31	38	41	45	50	55	59	64	69
		is 10% less than 2023	0	11	20	22	24	26	27	32	35	38	42	46	51	55	60
	in 2025	is less than 2023	0	15	22	24	25	28	30	37	41	45	50	55	60	66	71
		is 10% less than 2023	0	11	19	21	23	26	27	32	35	38	42	47	52	57	62
	in 2026	is less than 2023	0	14	21	23	24	28	30	37	41	46	51	56	62	67	72
		is 10% less than 2023	0	10	18	20	22	25	27	32	35	39	43	48	53	58	64
Fishery Status (Fishing intensity)	in 2023	is above $F_{43\%}$	0	19	24	25	26	29	31	38	42	46	50	54	59	63	68



Risks we can quantify

- $F_{43\%}$ (52.0 Mlb):
 - 75/100 chance of 1-yr SB decline (71/100 3-yr)
- 3-year surplus (43.0 Mlb):
 - 53/100 chance of 1-yr SB decline (50/100 3-yr)
- Status quo (41.2 Mlb):
 - 49/100 chance of 1-yr SB decline (46/100 3-yr)
- Status quo -15% (35.0 Mlb):
 - 32/100 chance of 1-yr SB decline (31/100 3-yr)



Additional risks

- 2022 FISS and directed commercial fishery catch rates (performance/efficiency) were at the lowest values observed in the last 30 years.

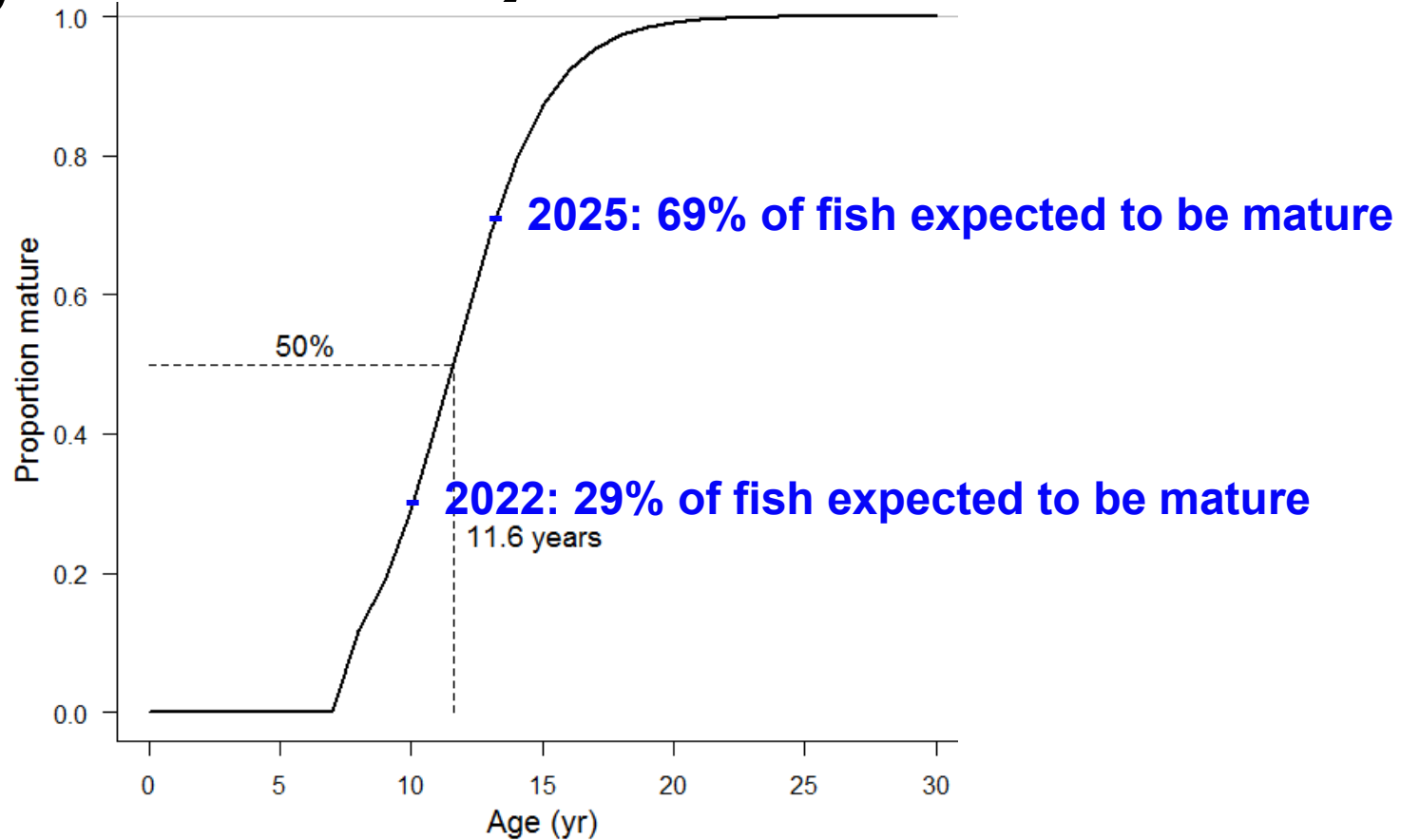


Additional risks

- The FISS and fishery have transitioned to the 2012 year-class, 29% mature in 2022; projections rely heavily on this single year class growing and maturing ‘on schedule’.



Maturity of the 2012 year-class



Additional risks

- Stock is at an unprecedented low population level (actual number/biomass of fish in the water) due to recent poor recruitment
 - Low productivity relative to long-term expectations
 - Less productive response to recent fishing
 - Downward trends, even though fishing intensity has been even lower than we thought
- Ecosystem/climate uncertainty remains high



Recent coastwide TCEYs

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
SPR	--	--	--	46%	46%	46%	46%	43%	43%	43%
<u>Reference</u>	33.48	35.48	36.31	39.10	31.00	40.00	31.90	39.00	41.22	51.95
<i>% change</i>	-9%	6%	2%	8%	-21%	29%	-20%	22%	6%	26%
<u>Adopted</u>	36.65	39.63	39.59	40.74	37.21	38.61	36.60	39.00	41.22	--
<i>% change</i>	-19%	8%	0%	3%	-9%	4%	-5%	7%	6%	--



Distribution of the TCEY

- *Detailed mortality projections for 2023 will be made available as needed during this meeting.*



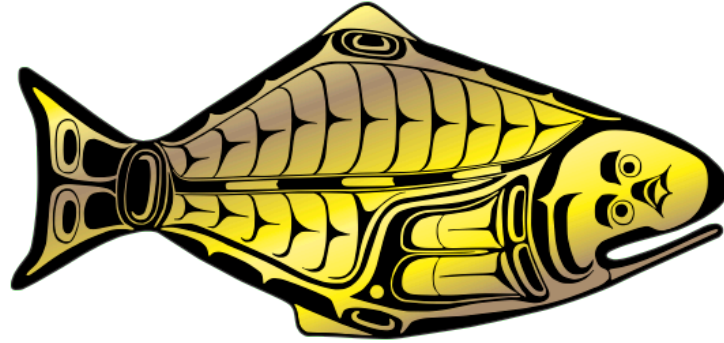
Recommendations

That the Commission:

- 1) **NOTE** paper IPHC-2023-AM099-11 which provides a summary of data, the 2022 stock assessment and the harvest decision table for 2023.



INTERNATIONAL PACIFIC



HALIBUT COMMISSION

