INTERNATIONAL PACIFIC HALIBUT COMMISSION

The 2019 Stock Assessment and Data Sources

Agenda item 6.4

IPHC-2019-IM095-09 Rev_1

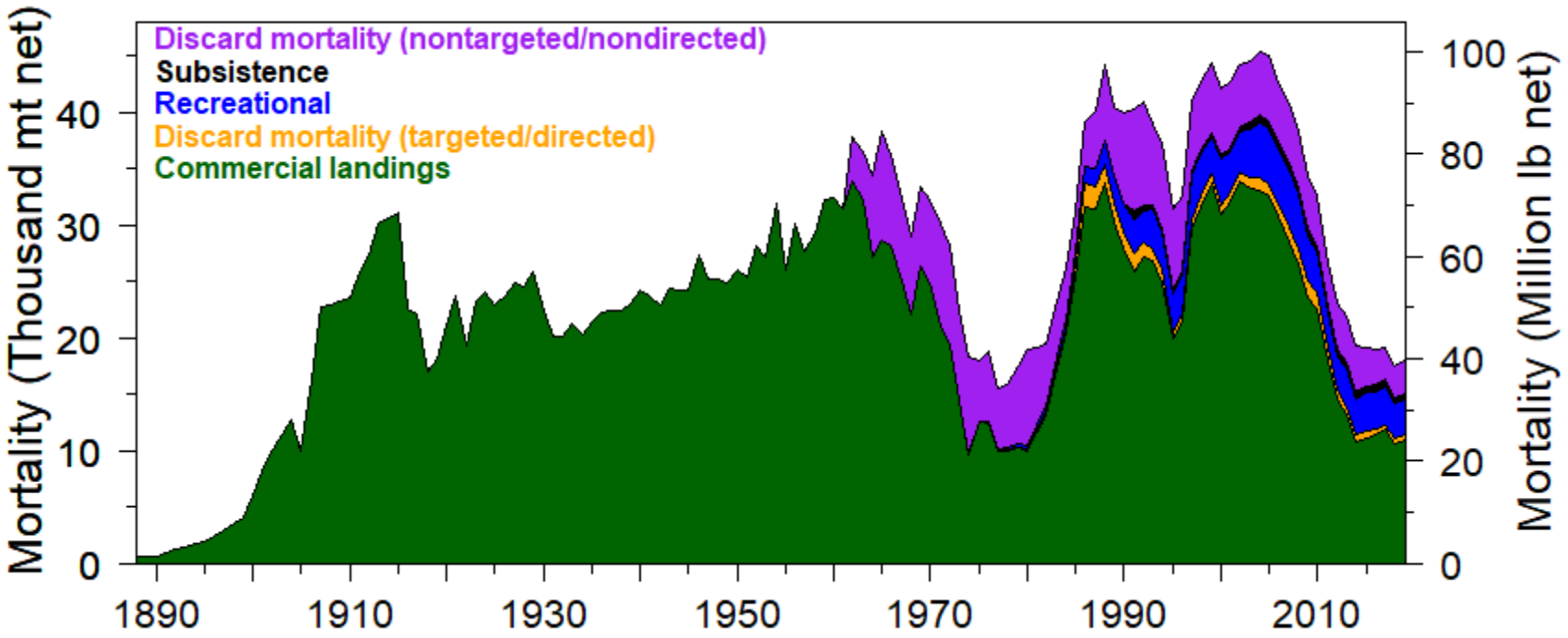
Summary

- Modelled survey trends down: numbers and WPUE
- Fishery CPUE trends mixed but flat coastwide
- Estimated spawning biomass decreased from 2018-2019 (as predicted); this is projected to continue for all 2020 TCEYs greater than 18.4 Mlb
- Interim management procedure indicates that lower yields needed to achieve a fishing intensity of $F_{46\%}$

Outline

- Data sources
  - Survey and fishery trends
  - Biology, new information
- Modelling results
- Projections
- Reference points
- Decision table
- Interim management procedure results

Historical mortality



Last 100 years: Average = 63 Mlb, range = 34-100 Mlb

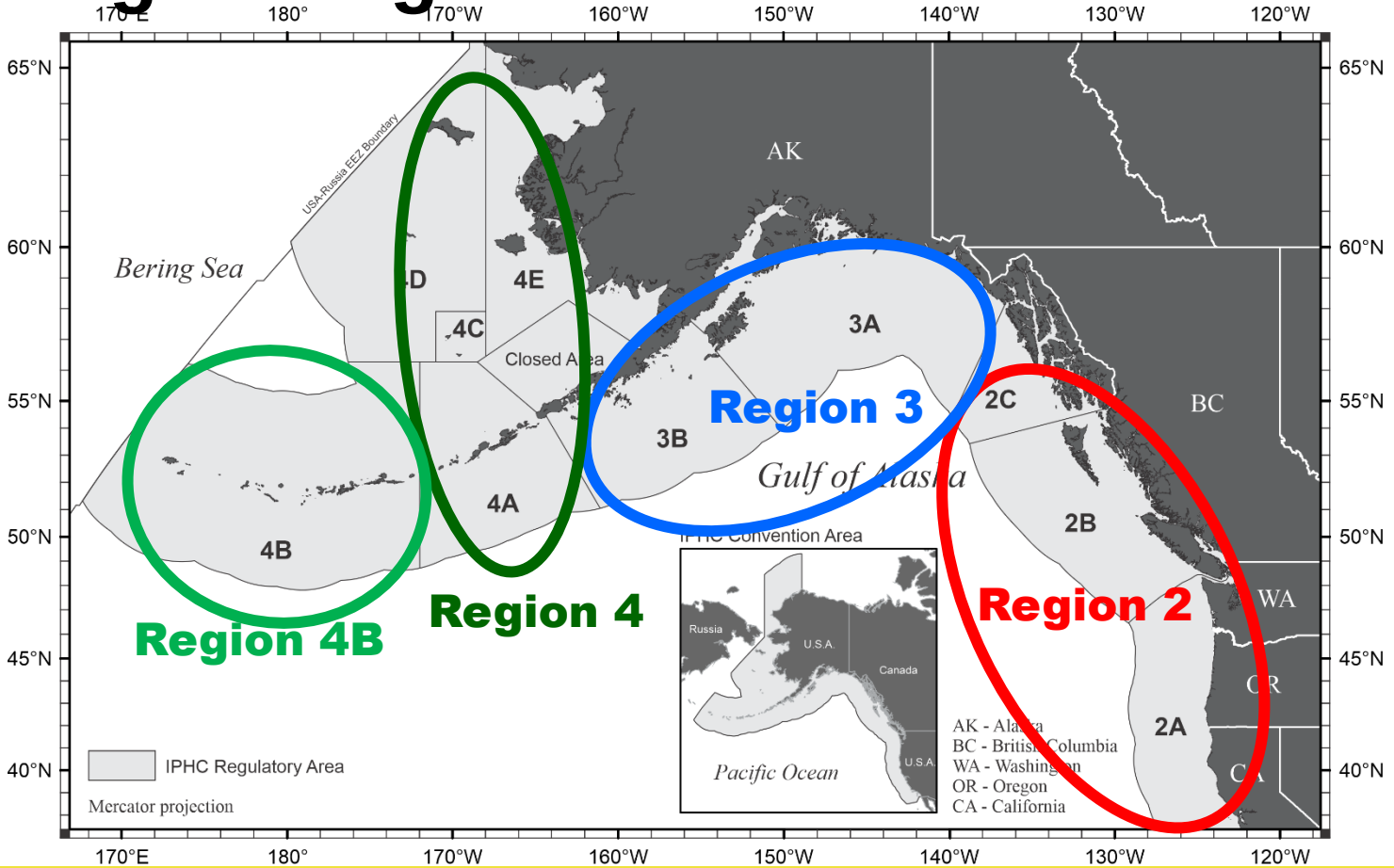
Recent mortality from all sources (M lb)

Year	Commercial Landings	Commercial discards	Recreational	Subsistence	Non-directed discards	Total
2015	24.67	1.37	7.46	1.20	7.61	42.31
2016	25.05	1.27	7.38	1.17	7.16	42.02
2017	26.14	1.05	7.60	1.17	6.21	42.16
2018	23.50	0.90	6.92	1.06	6.11	38.50
2019	24.28	0.98	6.92	1.06	6.44	39.67

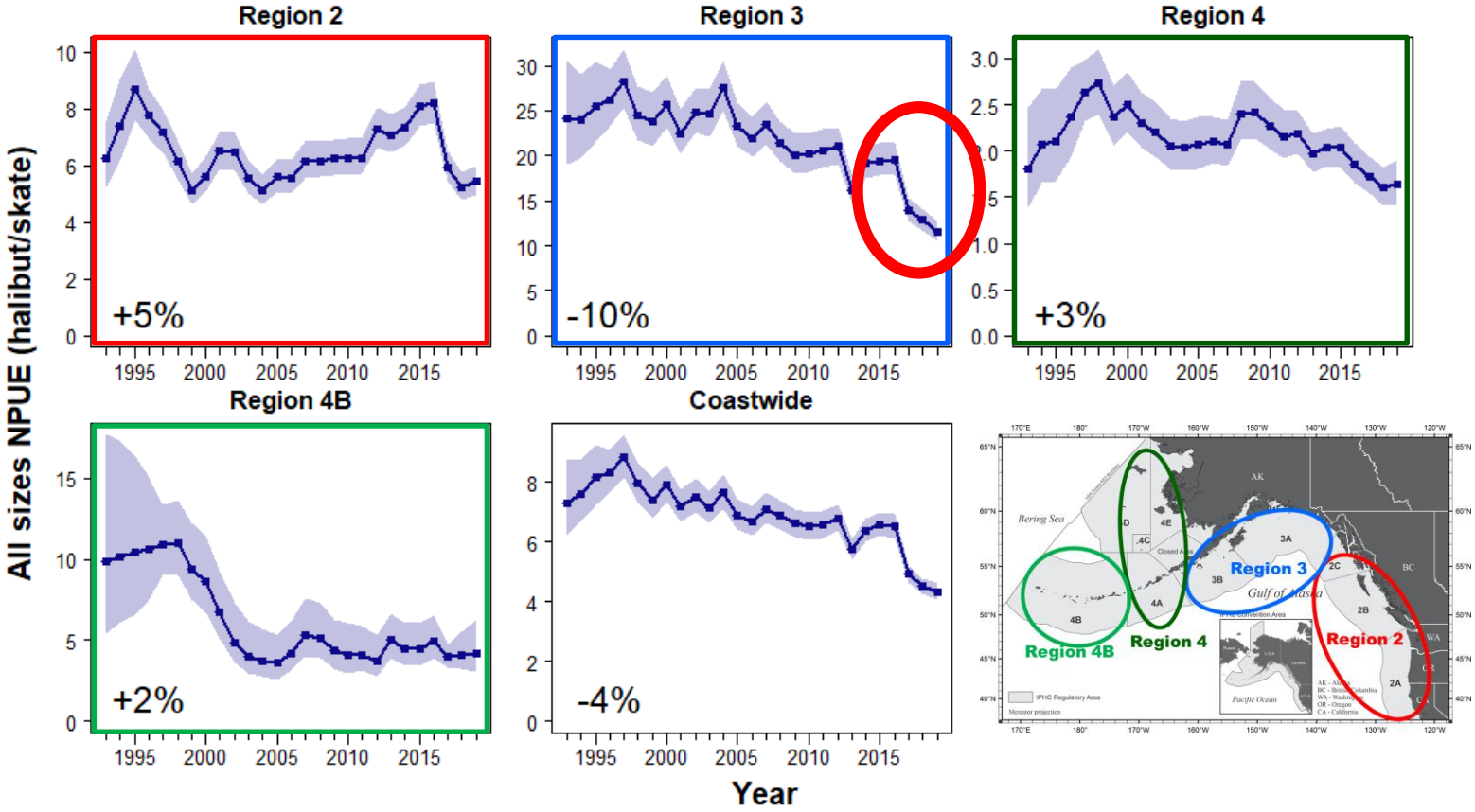
Projected based on 2019 adopted limits: 40.34

Above projections: Commercial discards (0.12) and non-directed discards (0.38)

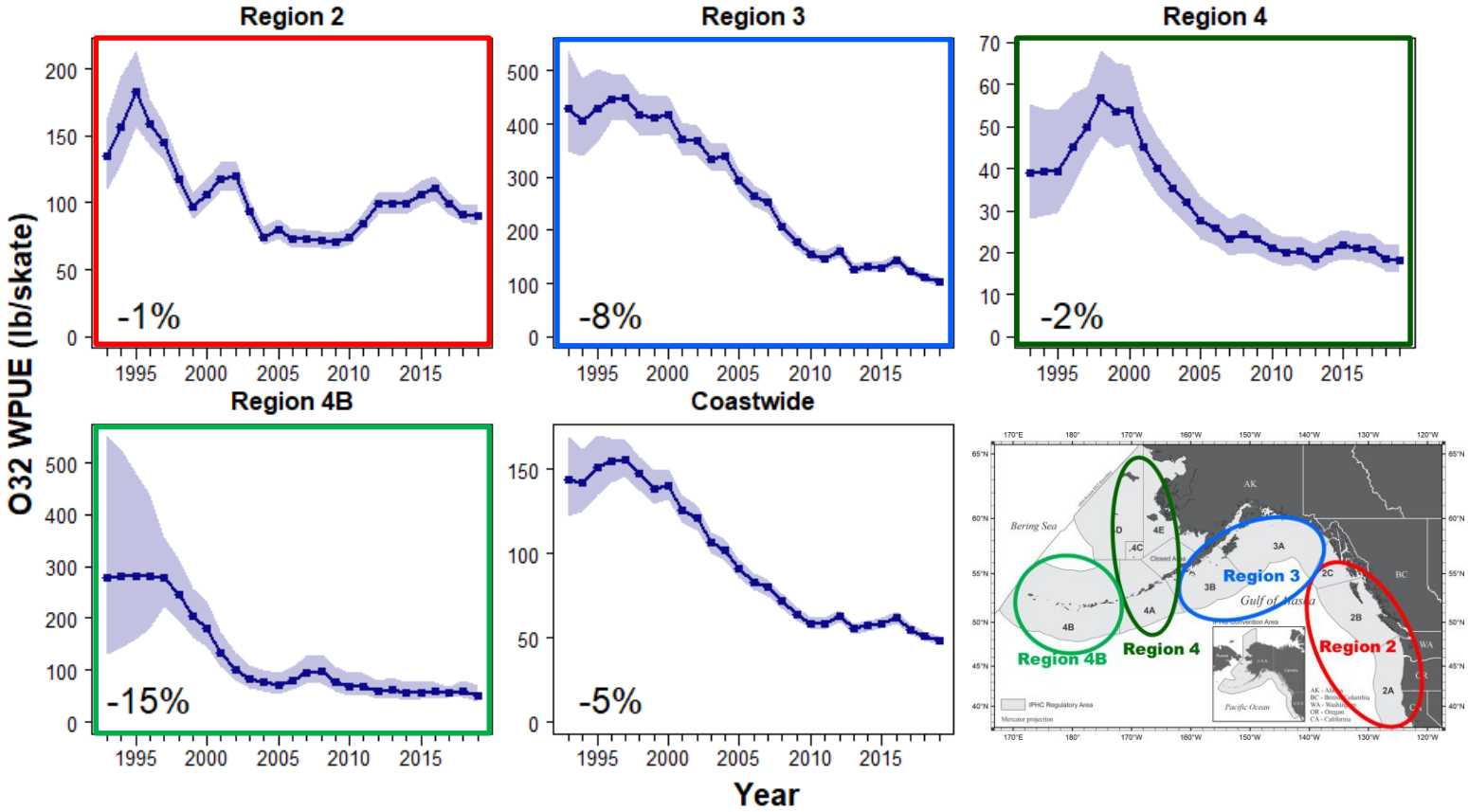
Biological regions



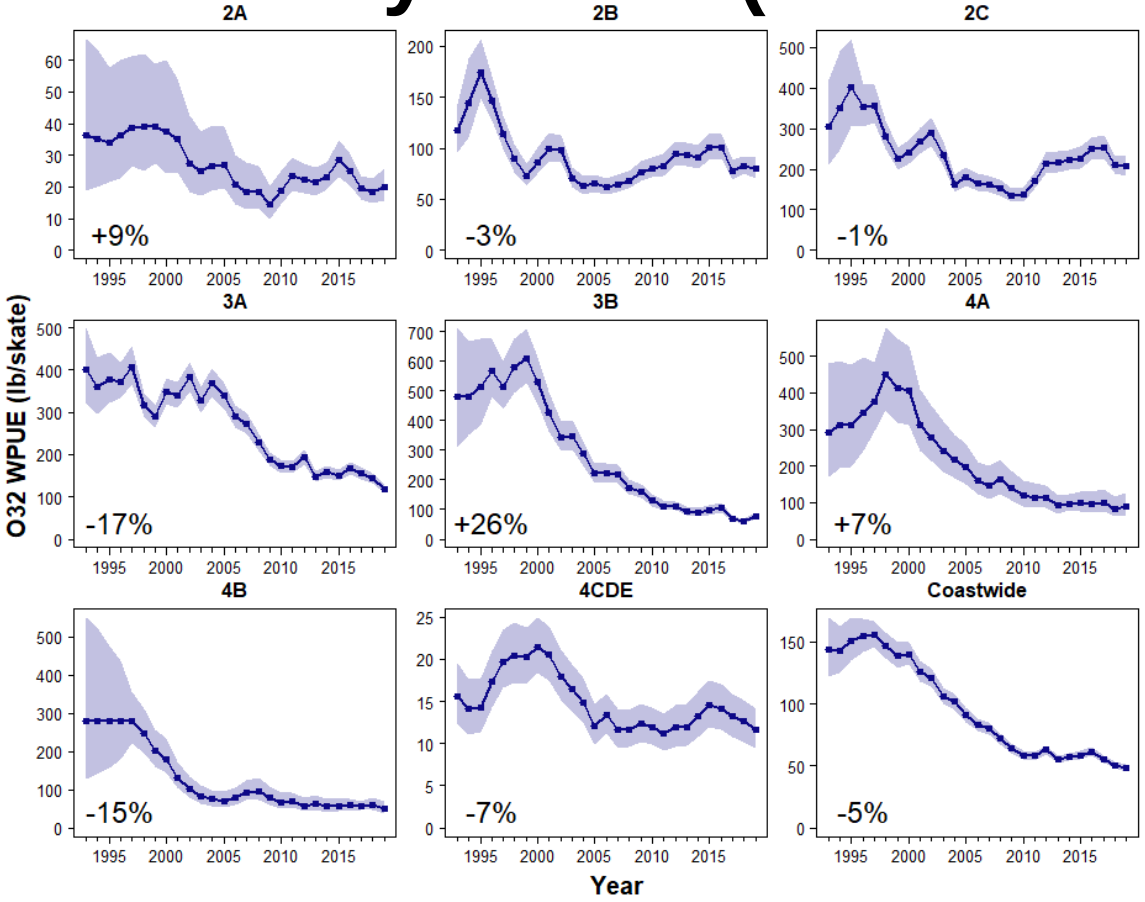
Modelled survey trends (Numbers)



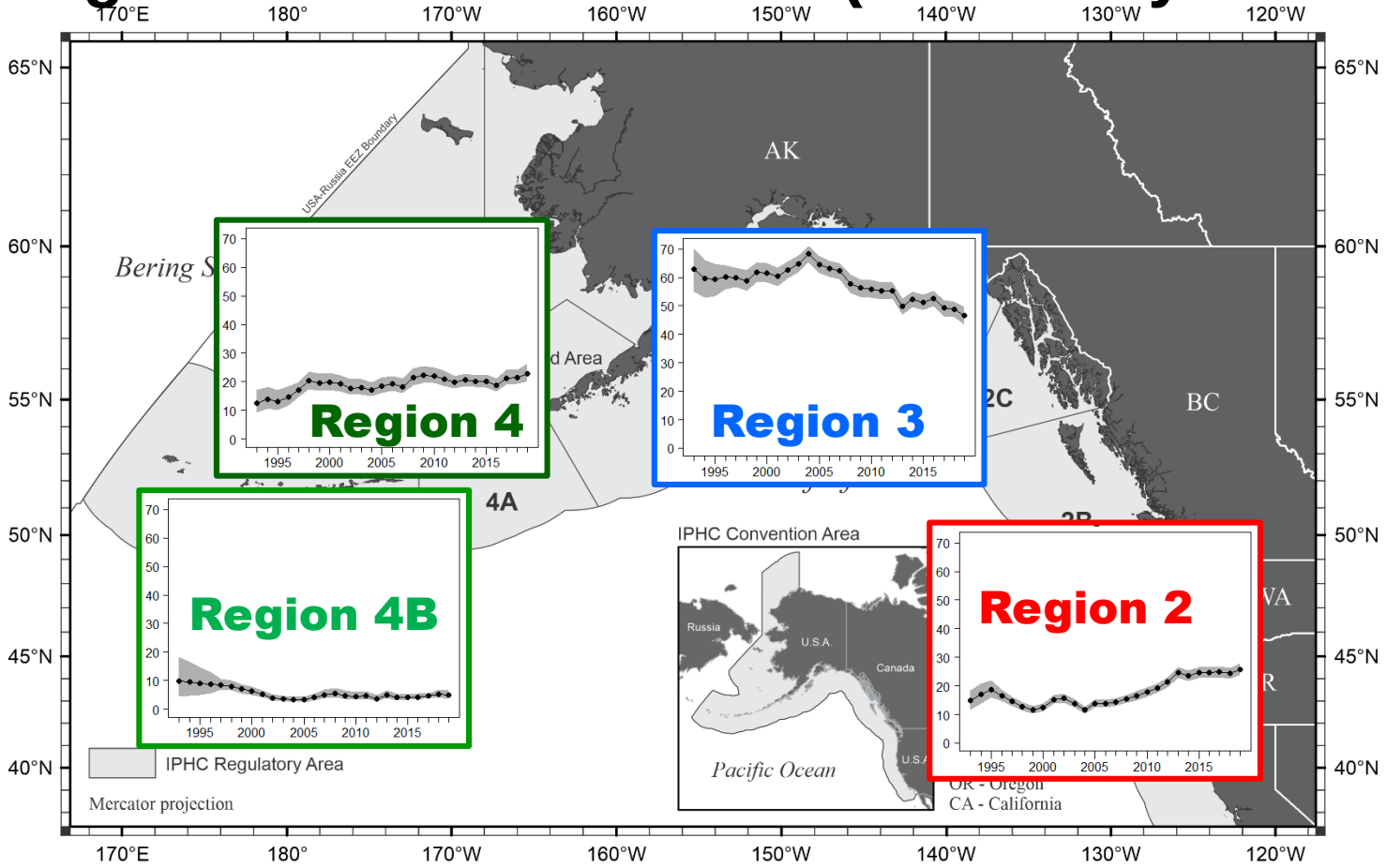
Modelled survey trends (O32 WPUE)



Modelled survey trends (O32 WPUE)



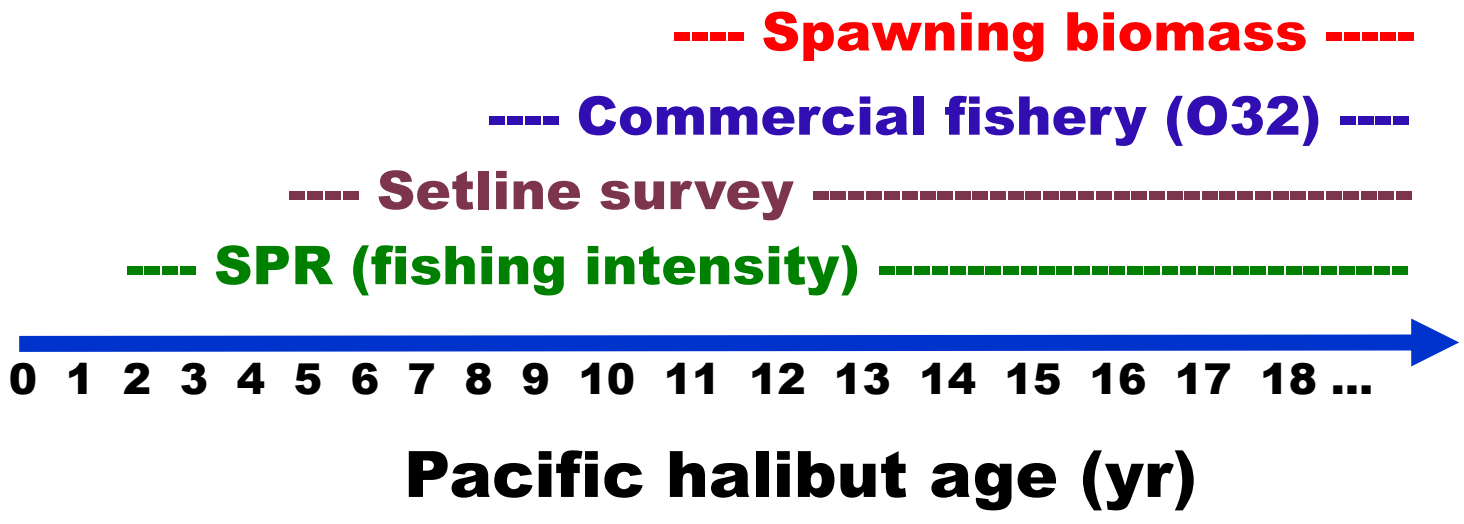
Biological stock distribution (All survey WPUE)



Biological stock distribution

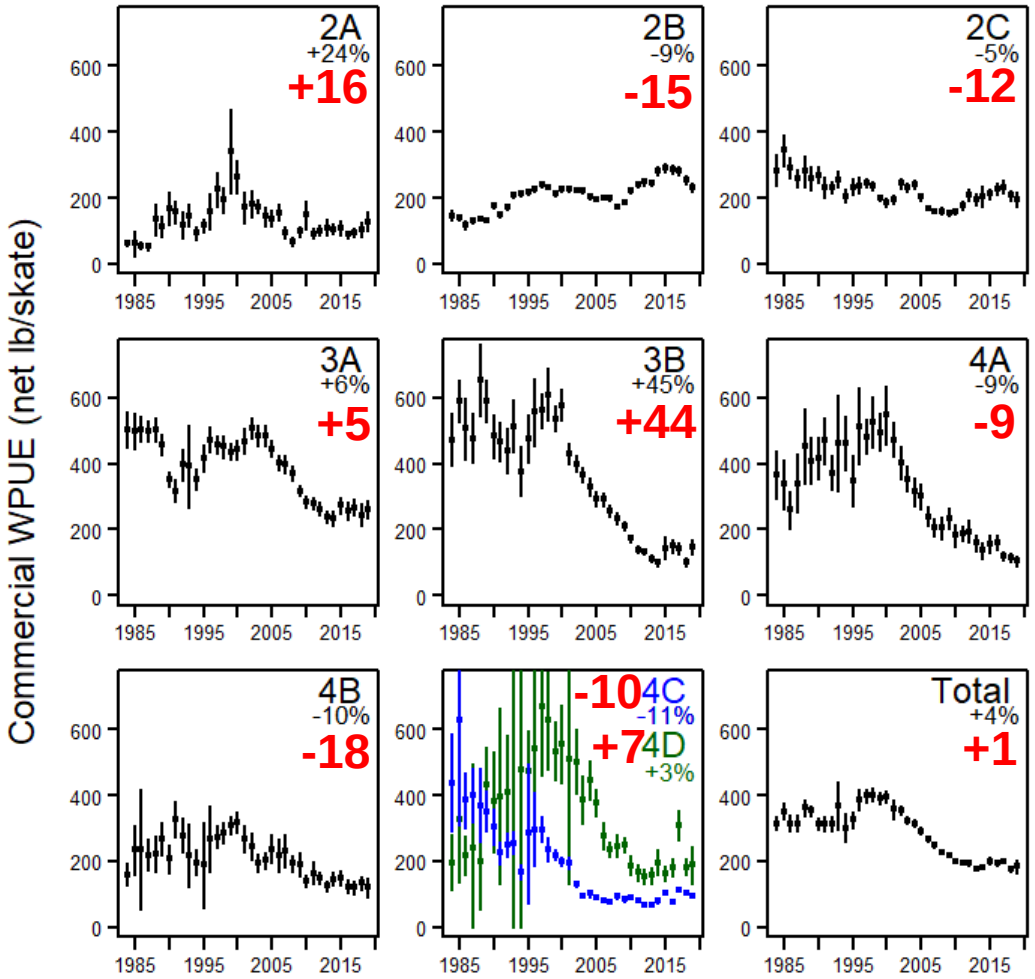
Year	Region 2 (2A, 2B, 2C)	Region 3 (3A, 3B)	Region 4 (4A, 4CDE)	Region 4B
2015	24.6%	51.3%	20.1%	4.0%
2016	24.7%	52.5%	18.7%	4.1%
2017	25.0%	49.2%	21.3%	4.5%
2018	24.4%	48.9%	21.5%	5.2%
2019	25.8%	46.5%	22.8%	4.8%

Comparing trends

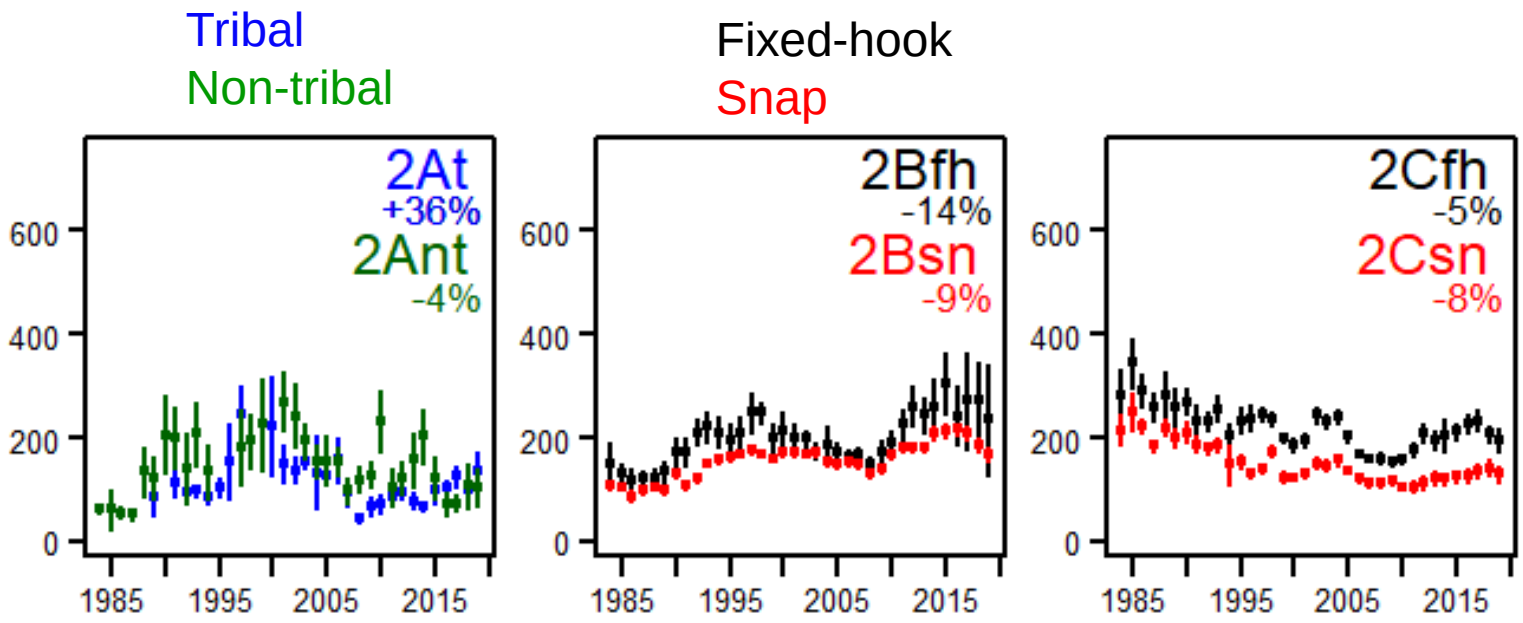


Fishery trends

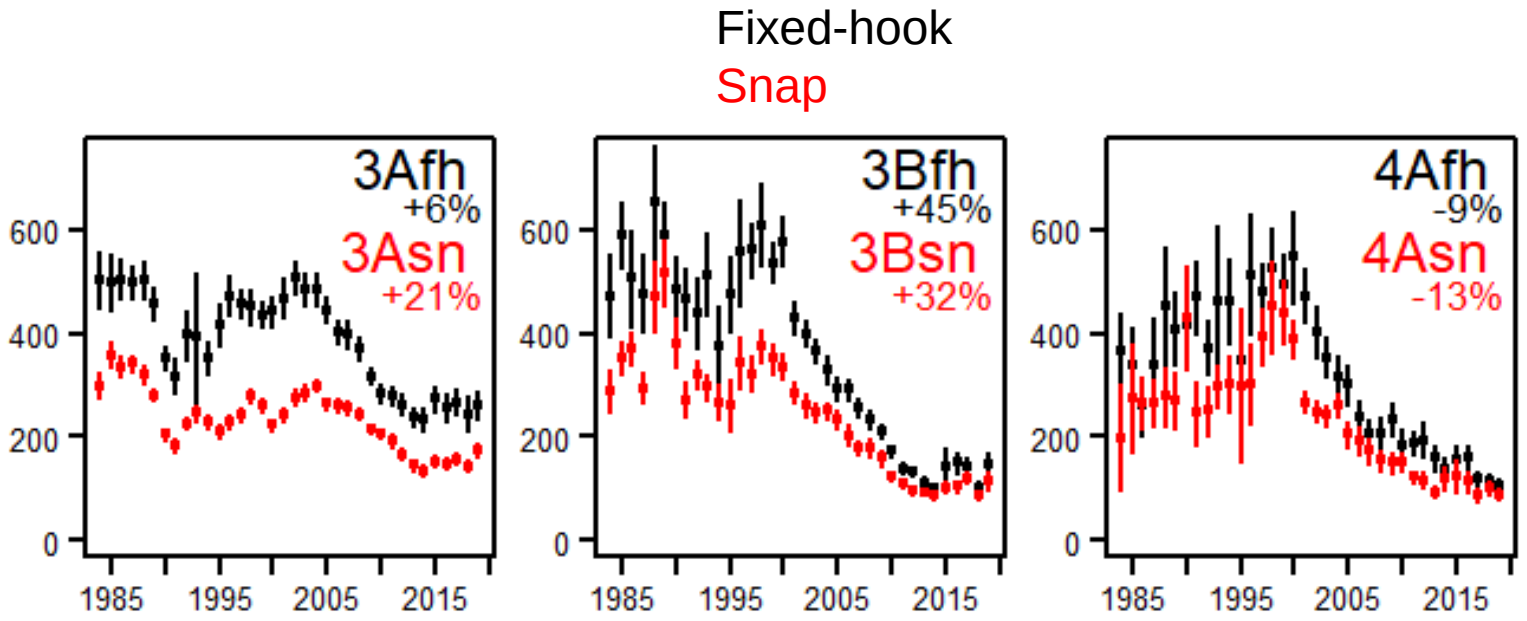
Predicted when logs complete



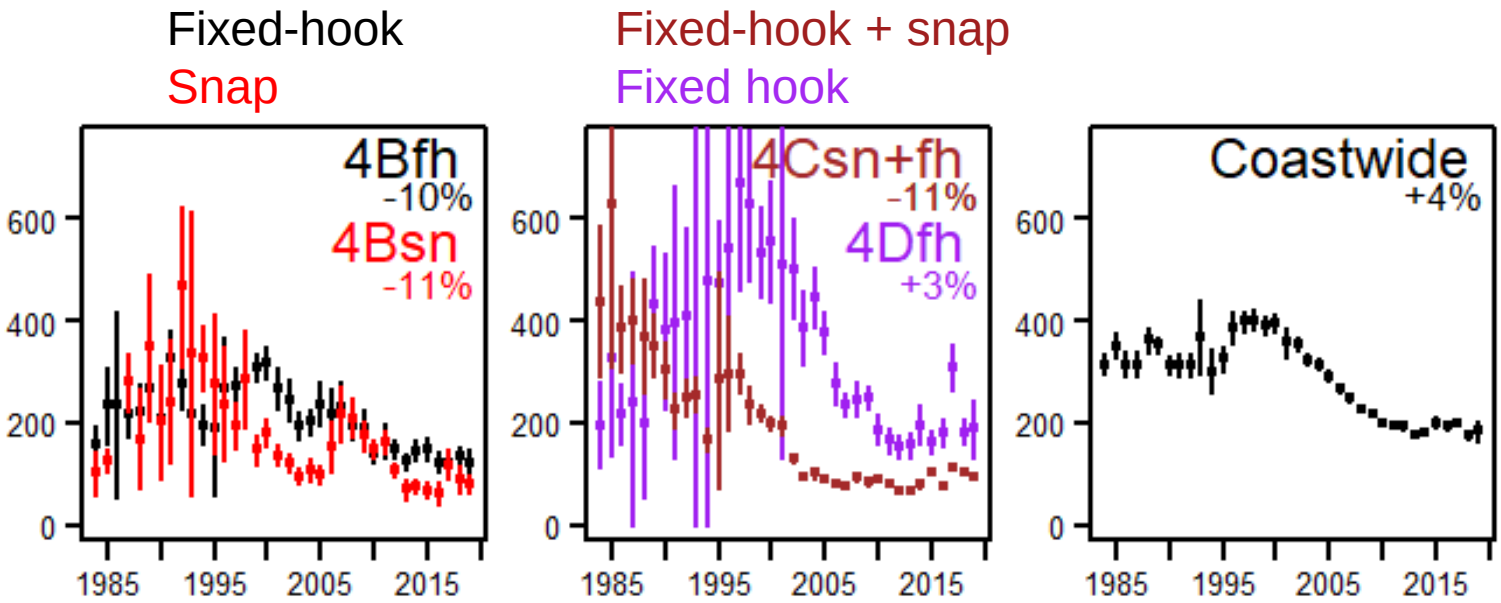
Fishery trends



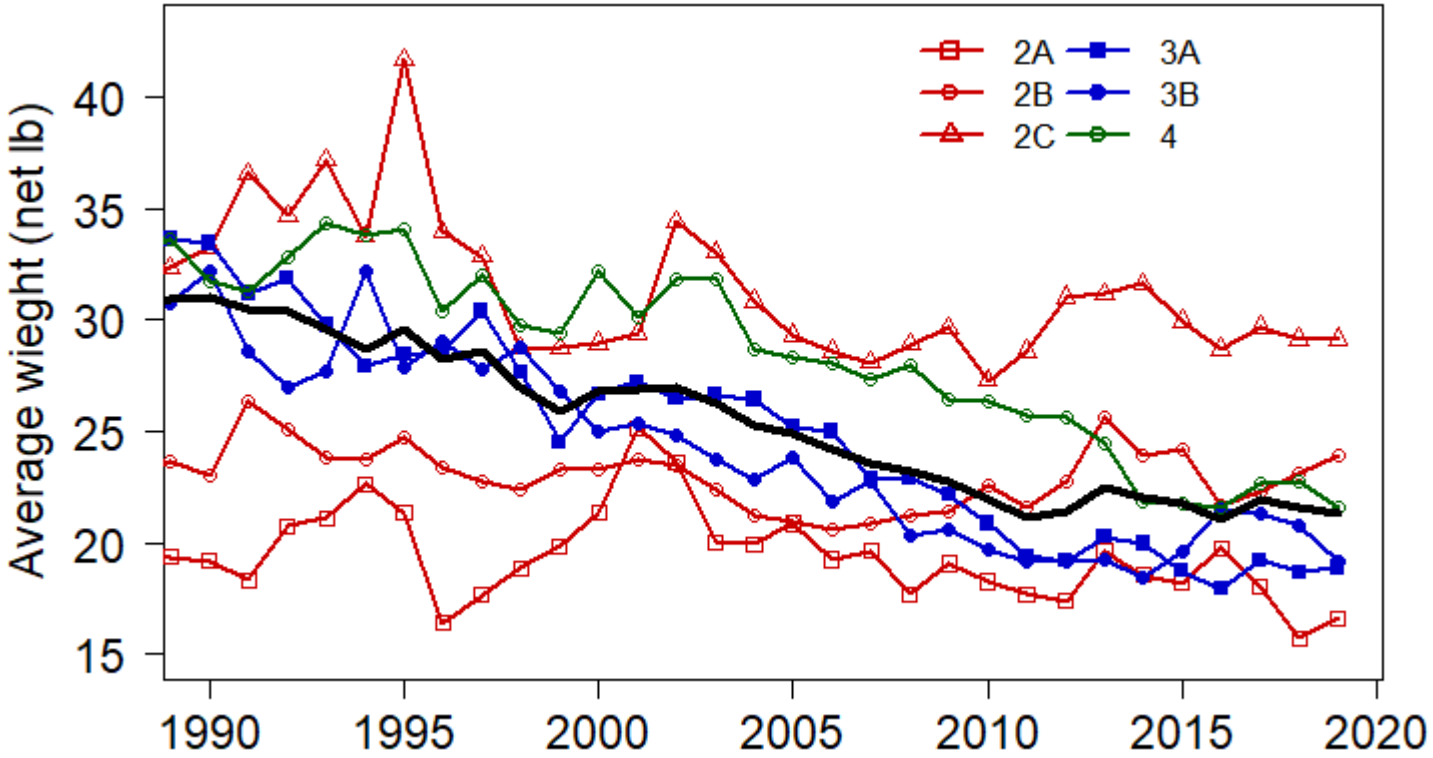
Fishery trends



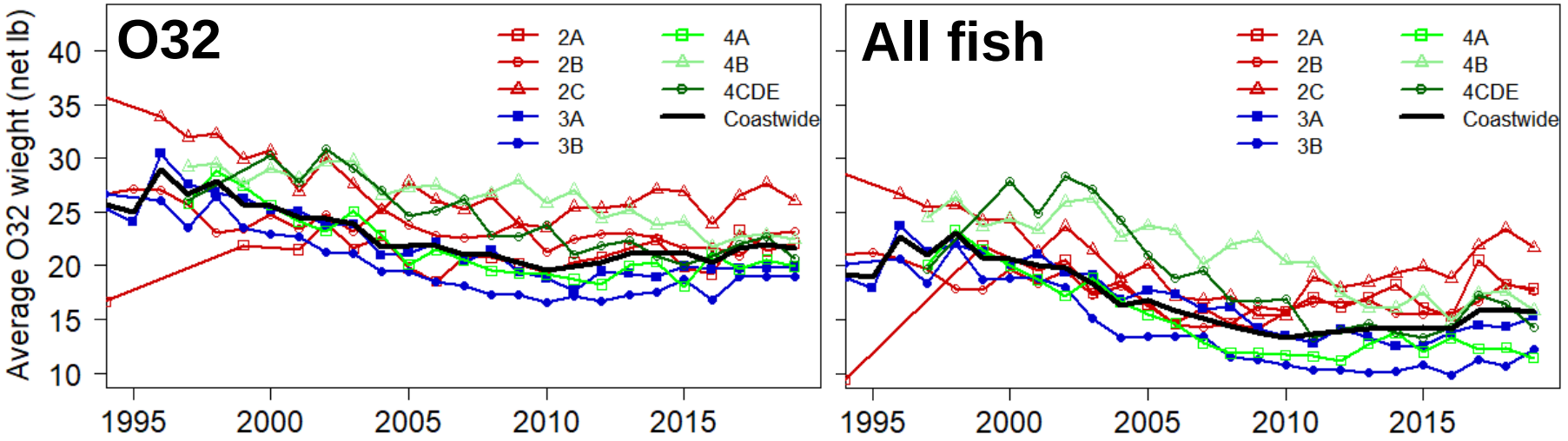
Fishery trends



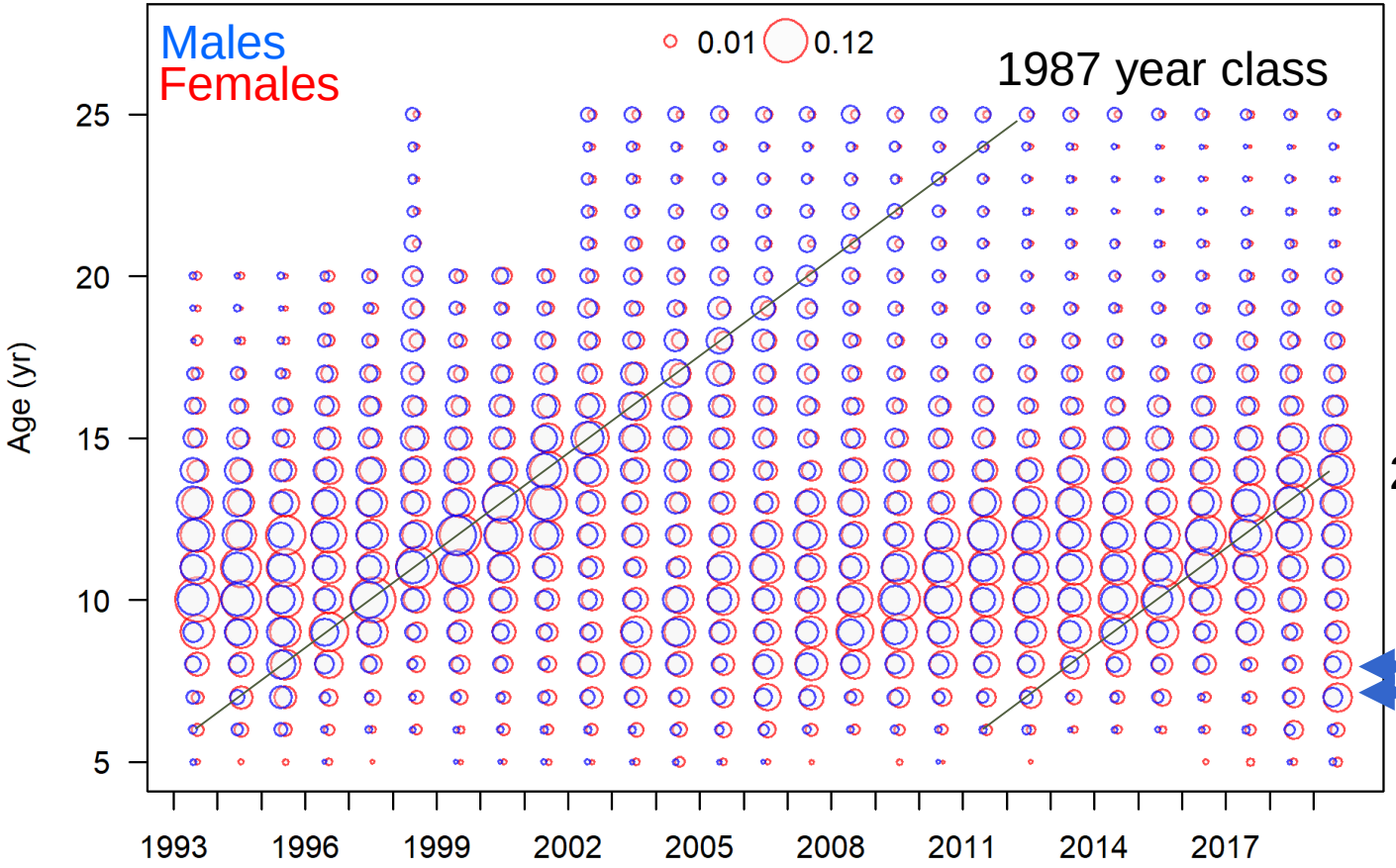
Average weight (Fishery)



Average weight (Survey)

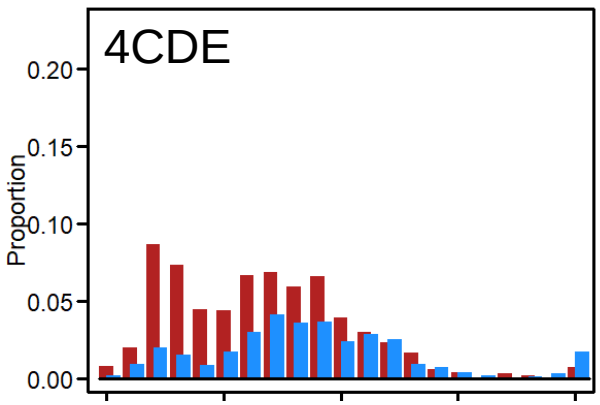


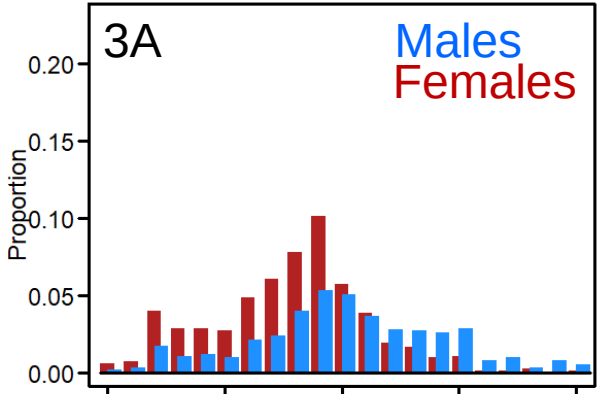
Recent survey ages



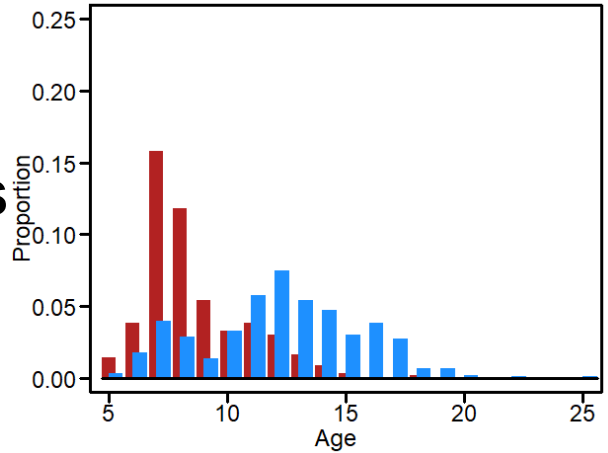
2011-2012 cohorts: mixed distribution

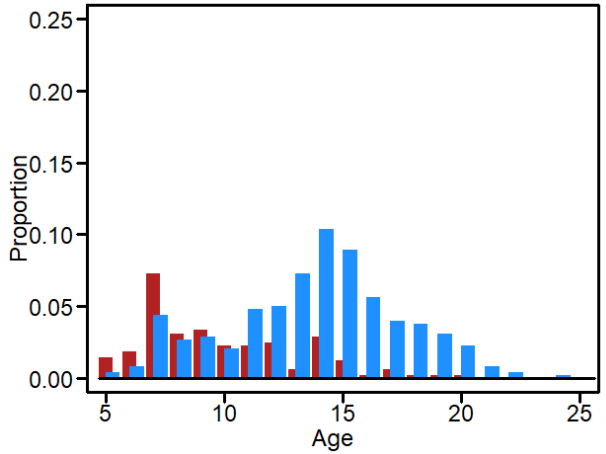
All survey ages





U32 survey ages

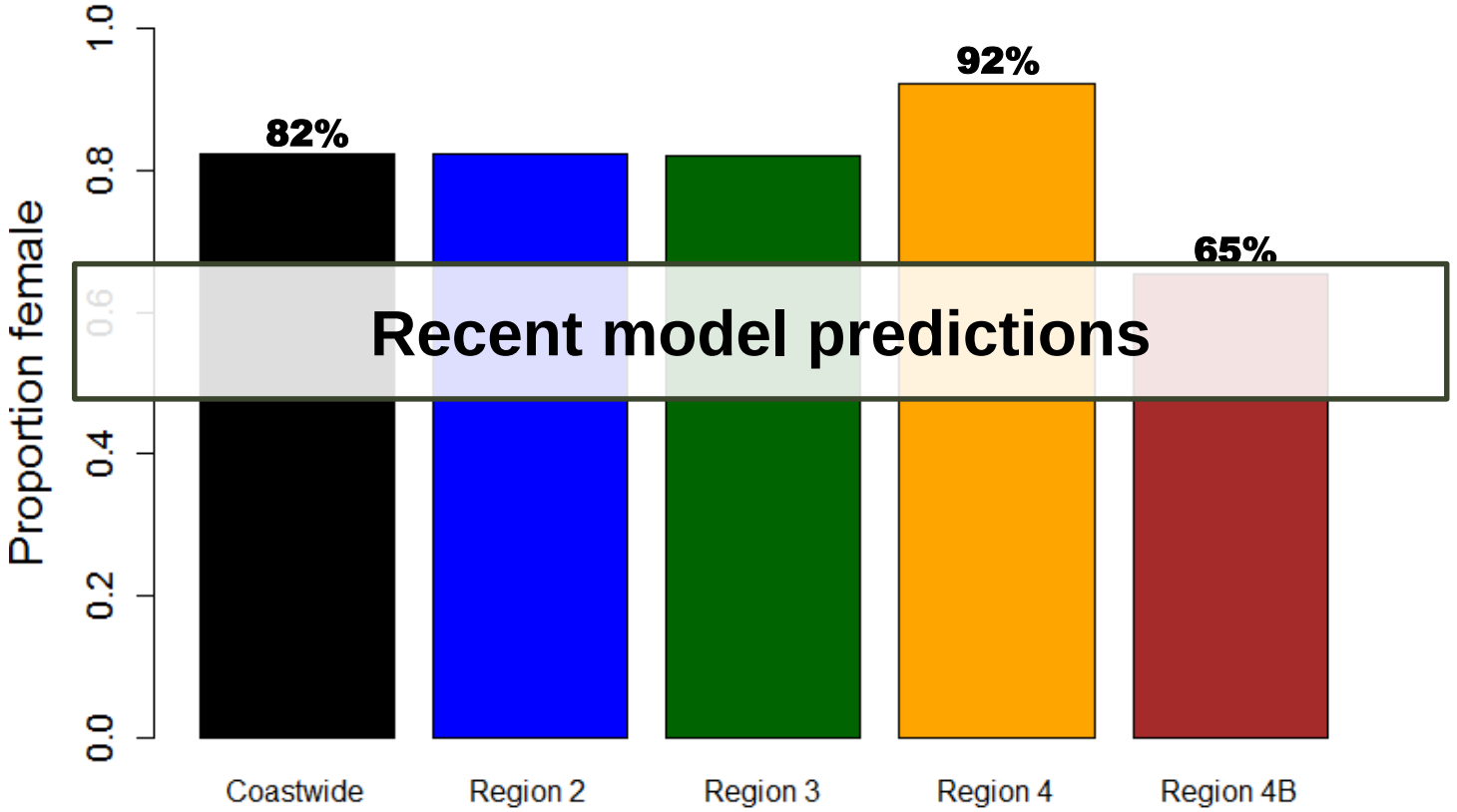




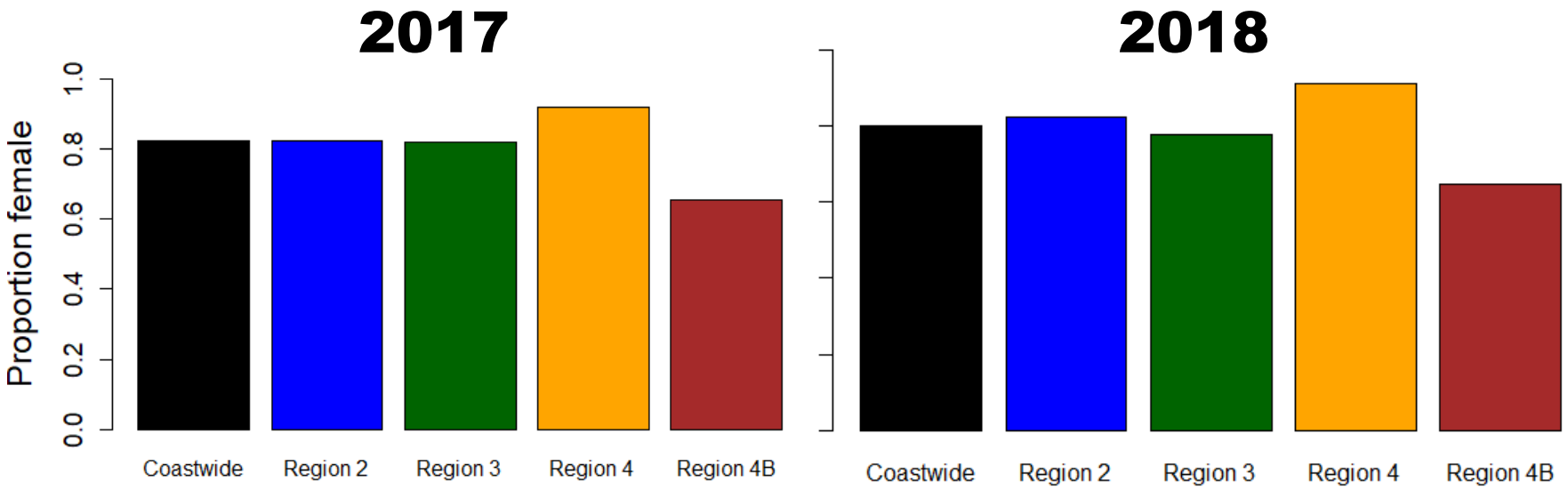
New Data: Sex ratios from commercial fishery

- Commercial sex-ratio identified in 2013 as the greatest source of uncertainty in the assessment
- Research plan launched
- At-sea marking evolved to genetic assay

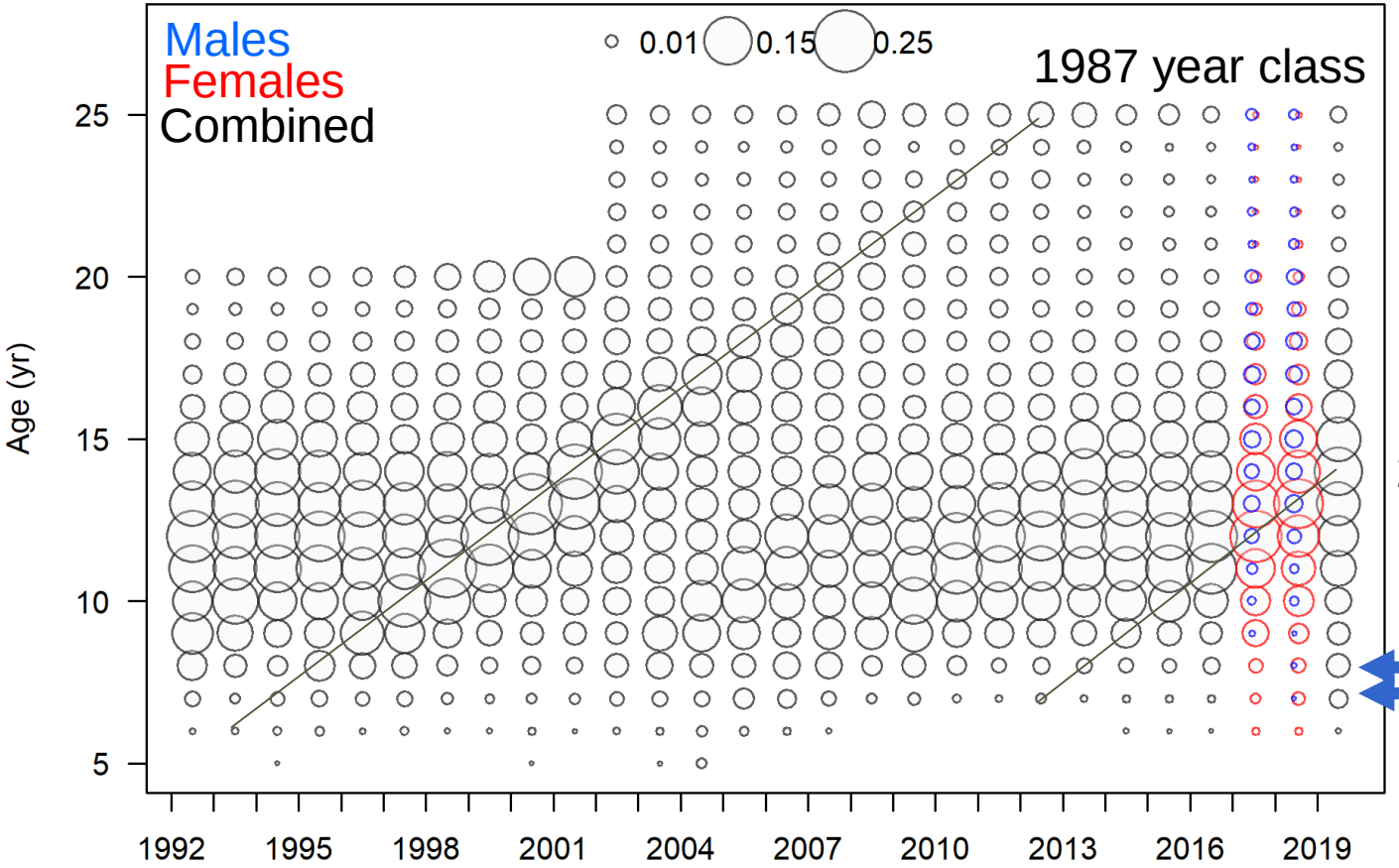
New Data: Sex ratios 2017 Commercial fishery (numbers)



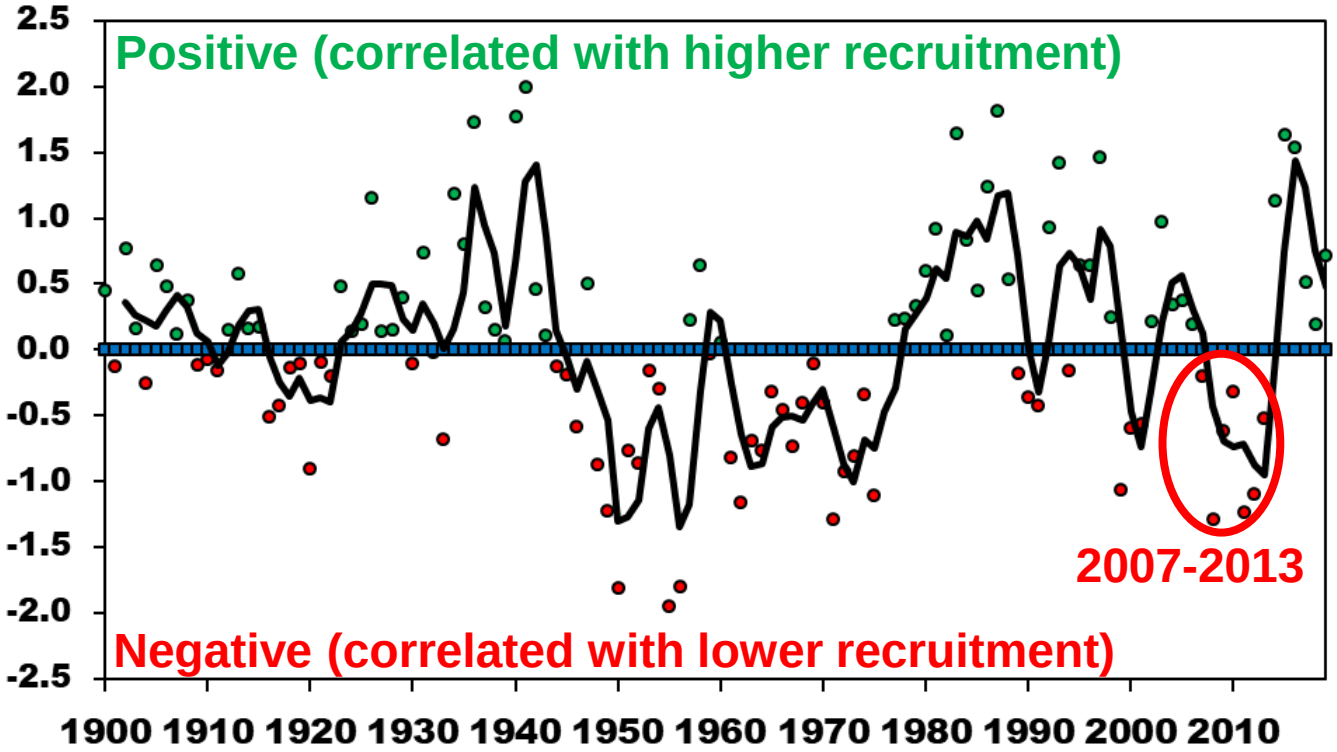
New Data: Commercial sex ratios



Recent fishery ages



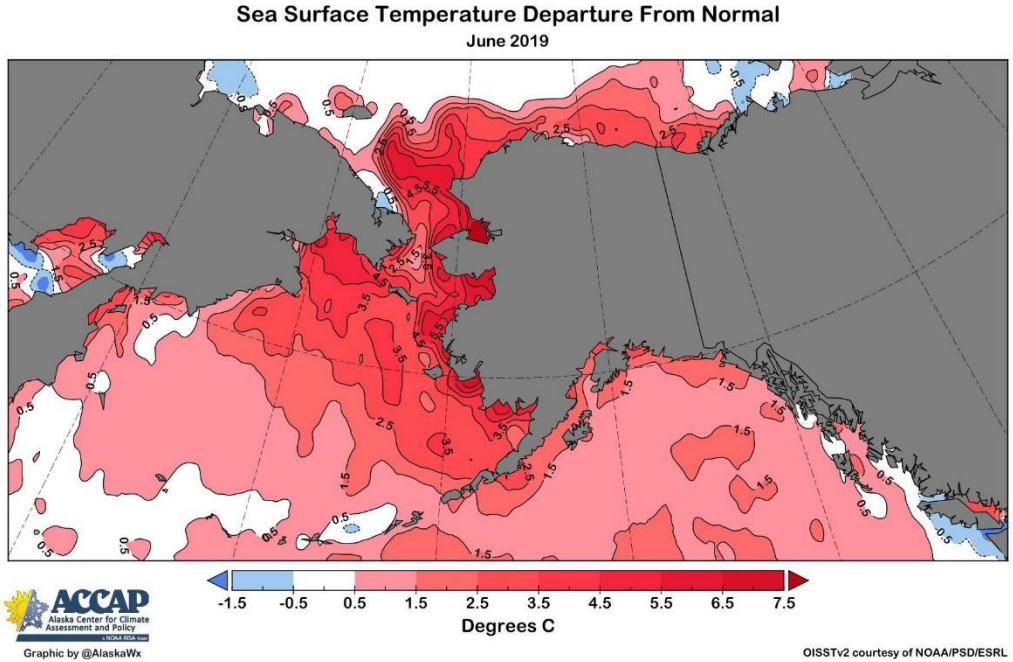
Ecosystem conditions: Pacific Decadal Oscillation



(Data: https://oceanview.pfeg.noaa.gov/erddap/tabledap/cciea_OC_PDO.htmlTable?time,PDO)

Ecosystem conditions

- Very low sea-ice in the Bering Sea: 2017/18 & 2018/19
- Continued northward distribution of cod; bird, salmon and marine mammal mortality events



Reference: AFSC Ecosystem reports to NPFMC (https://meetings.npfmc.org/Meeting/Details/823)

Recap: What has changed on the water?

- Biomass and numbers are down
  - Particularly in 3A
- As in 2018, survey and fishery are showing slightly better 2011 and 2012 year-classes after very weak numbers born during 2006-2010
- Sex-ratio of the commercial catch stable over 2017-2018

Outline

- Data sources
  - Survey and fishery trends
  - Biology, new information
- Modelling results
- Projections
- Reference points
- Decision table
- Interim management procedure results

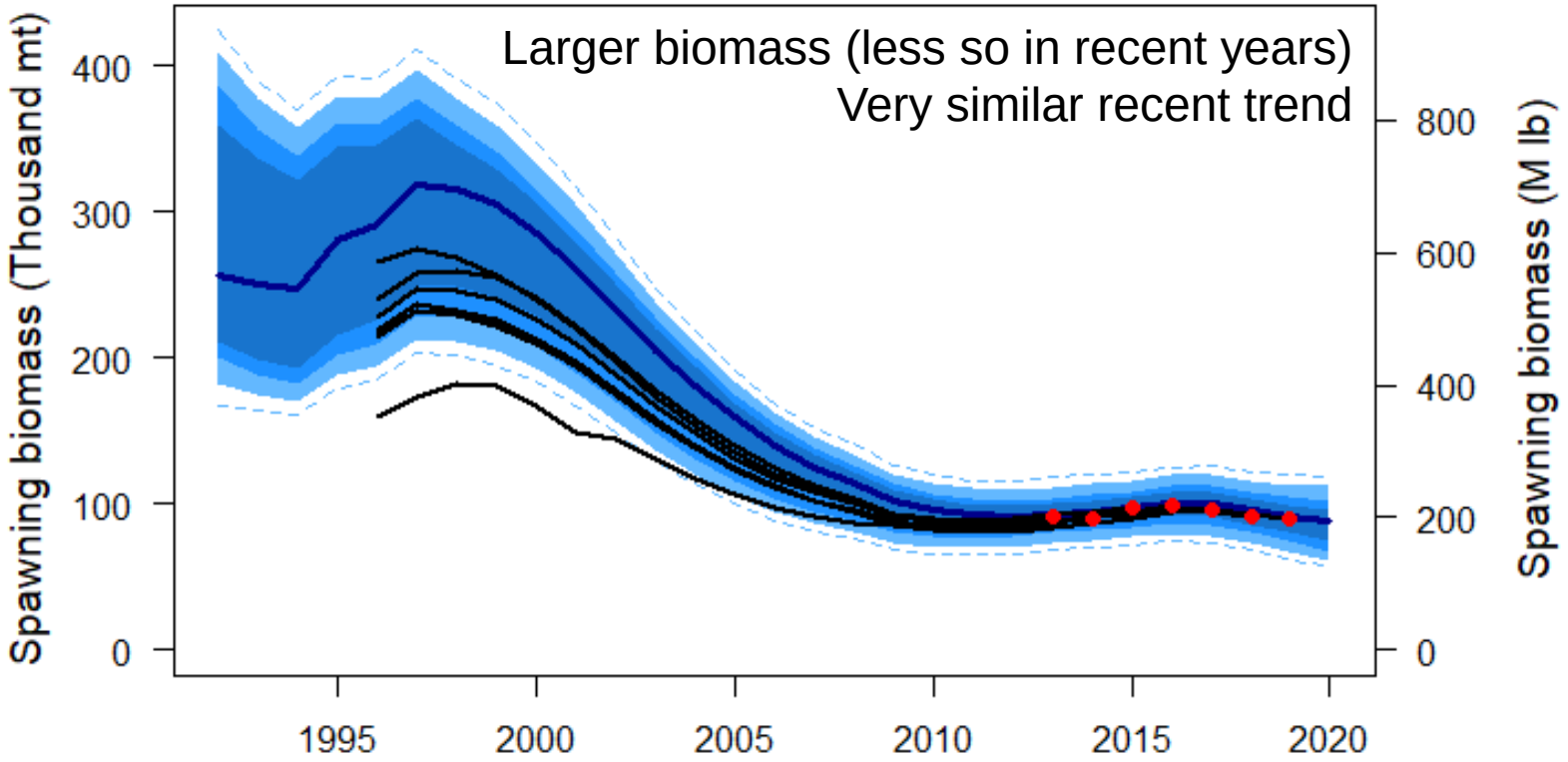
Recent assessment history

- 2012-2015: Rapid evolution of models and the review process
- 2015: full assessment review – 4 model ensemble
- 2016-2018: updated assessments, SRB review
- 2019: Full assessment, SRB and external review

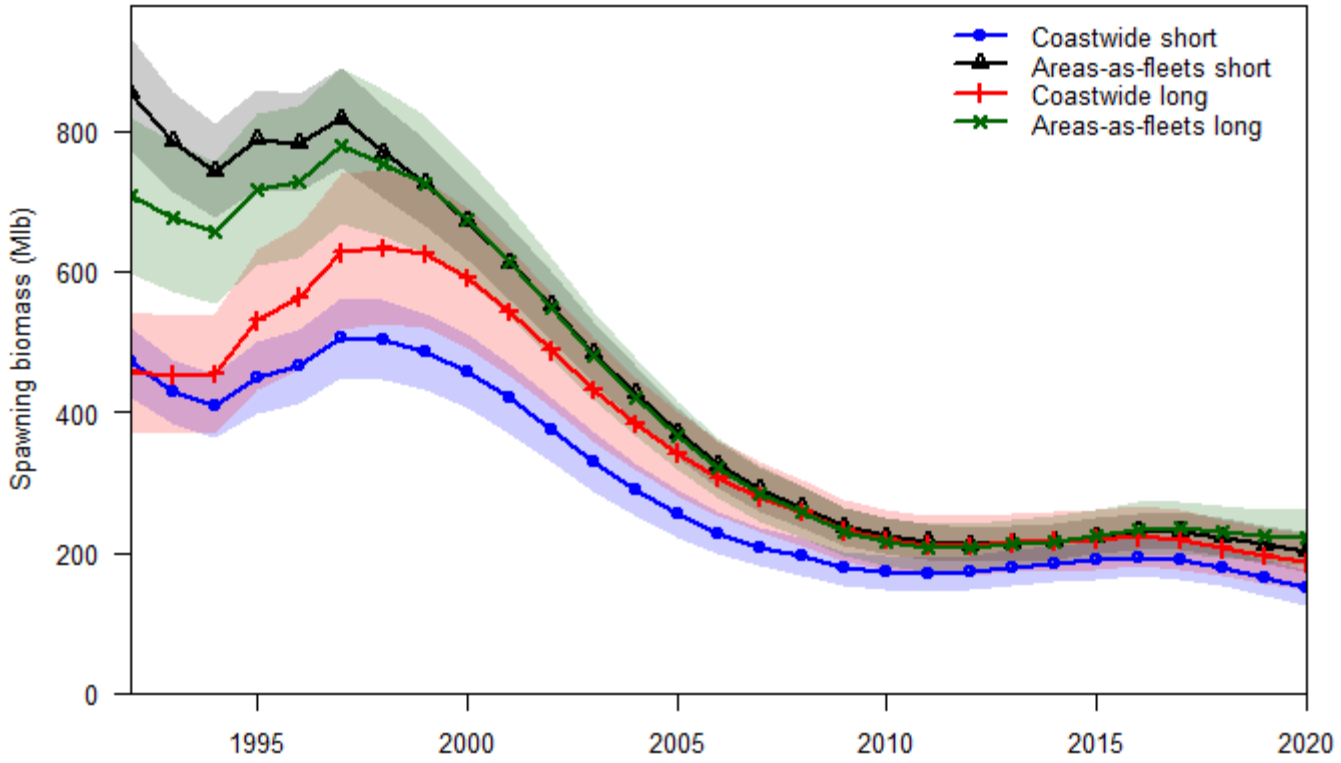
Modelling for 2019

- All aspects of data and models revisited
  - New data
    - Modelled survey index updates (increased precision)
    - New commercial sex-ratio data
  - Model structure improved to use commercial sex-ratio data
  - Updated biomass reference point calculations
    - Removing arbitrary historical values
    - Making calculations consistent with the MSE

Comparison with previous assessments

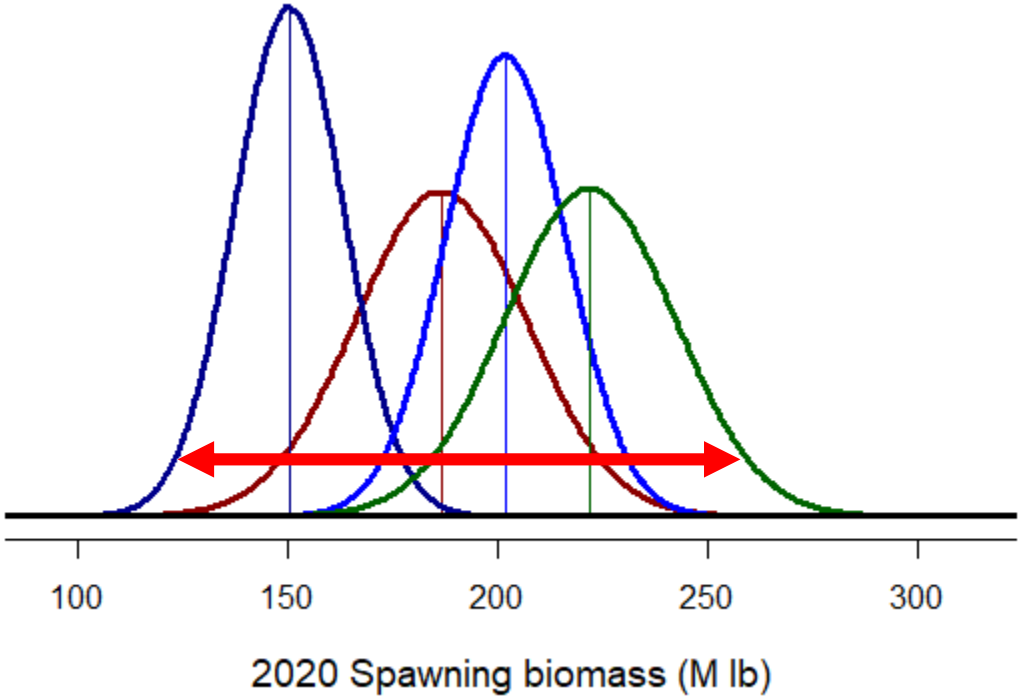


Four individual models



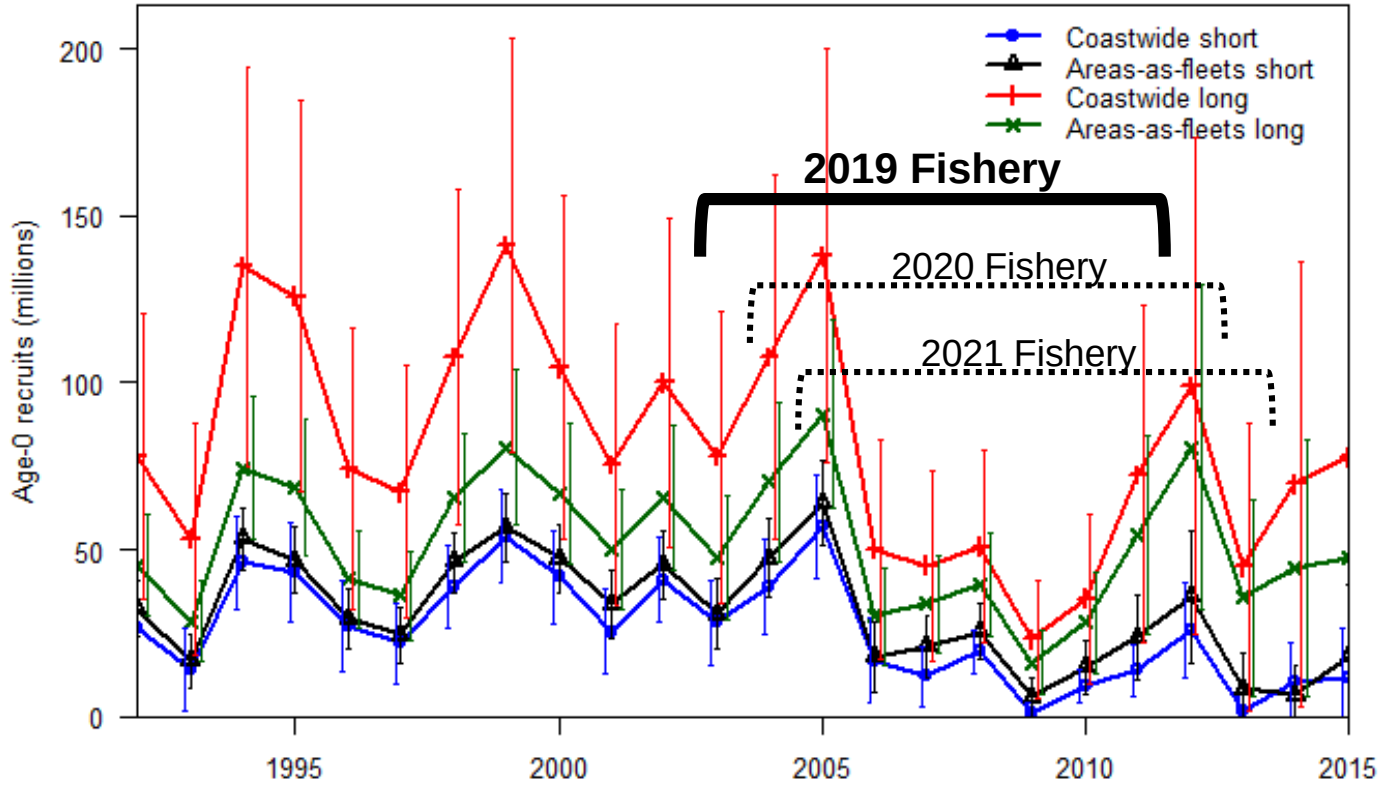
Closer correspondence than in last year's assessment

Individual models

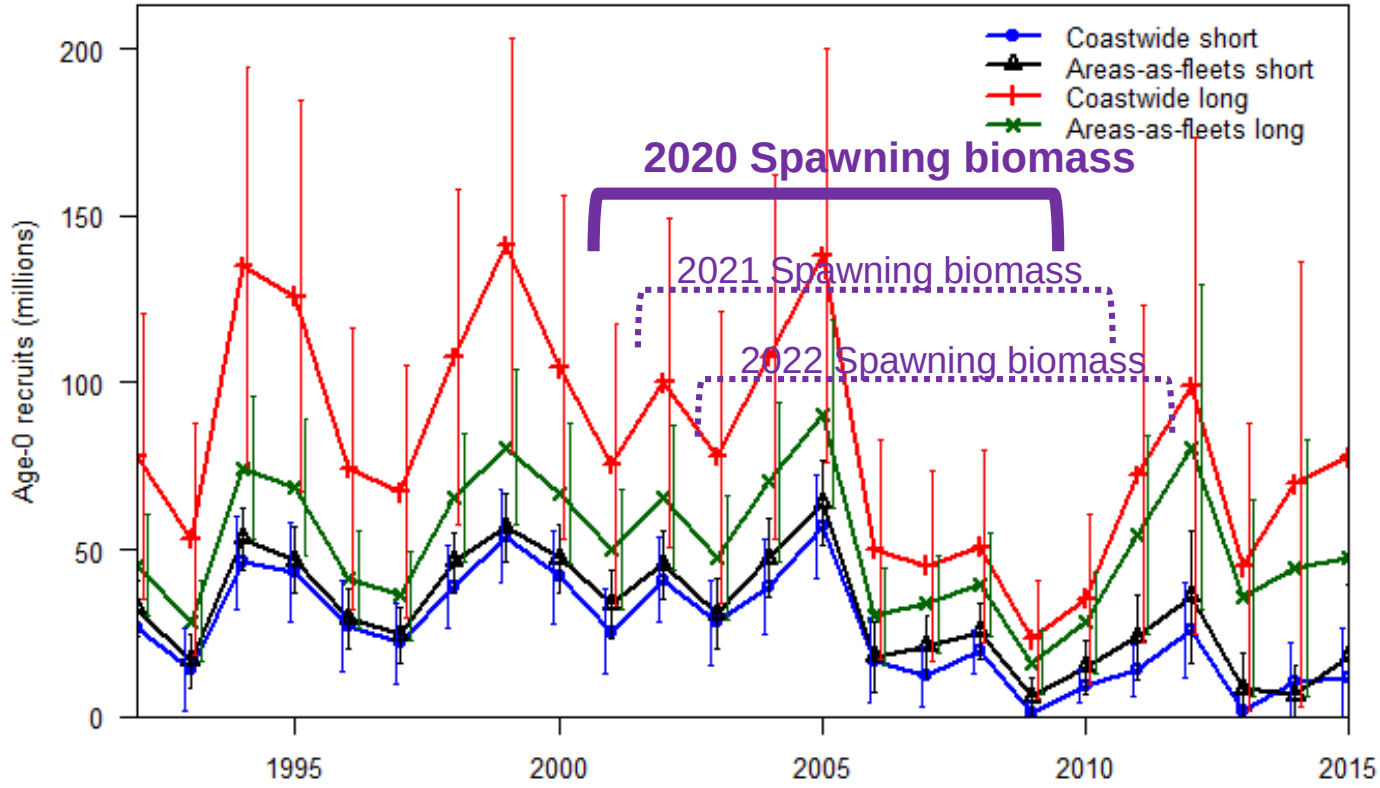


Our science results reflect *among*- as well as *within*-model uncertainty.

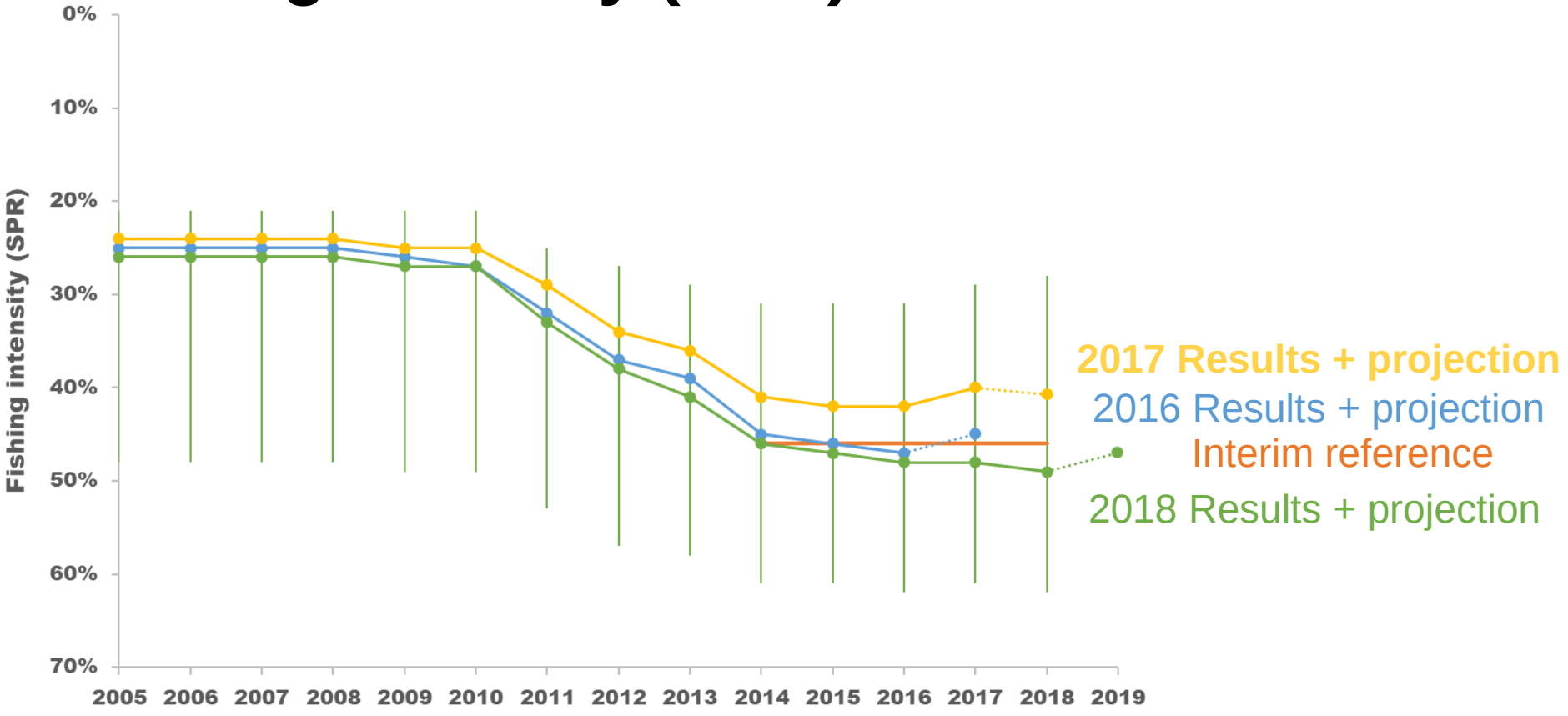
Recruitment estimates



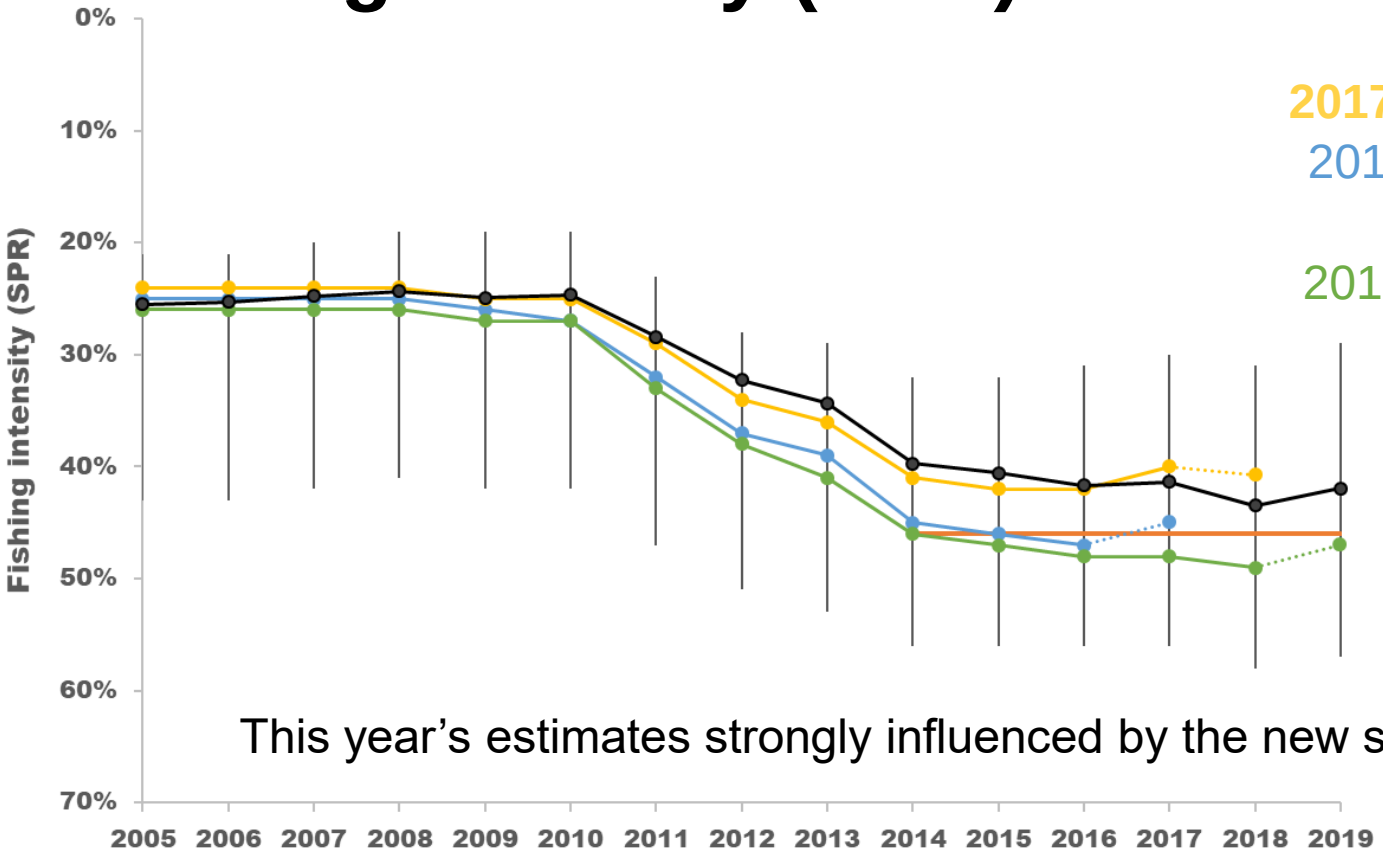
Recruitment estimates



Fishing intensity (SPR)



Fishing intensity (SPR)



2017 Results + projection

2016 Results + projection

Interim reference

2018 Results + projection

2019 Results

This year's estimates strongly influenced by the new sex-ratio data.

Recap: What has changed in our estimates?

- Estimated biomass slightly larger
  - More females in landings → more females in the population
- Estimated fishing intensity higher
  - More females in the landings → larger effect on SPR
- Stock *trends* very similar to previous assessments: spawning biomass declining since 2016

Outline

- Data sources
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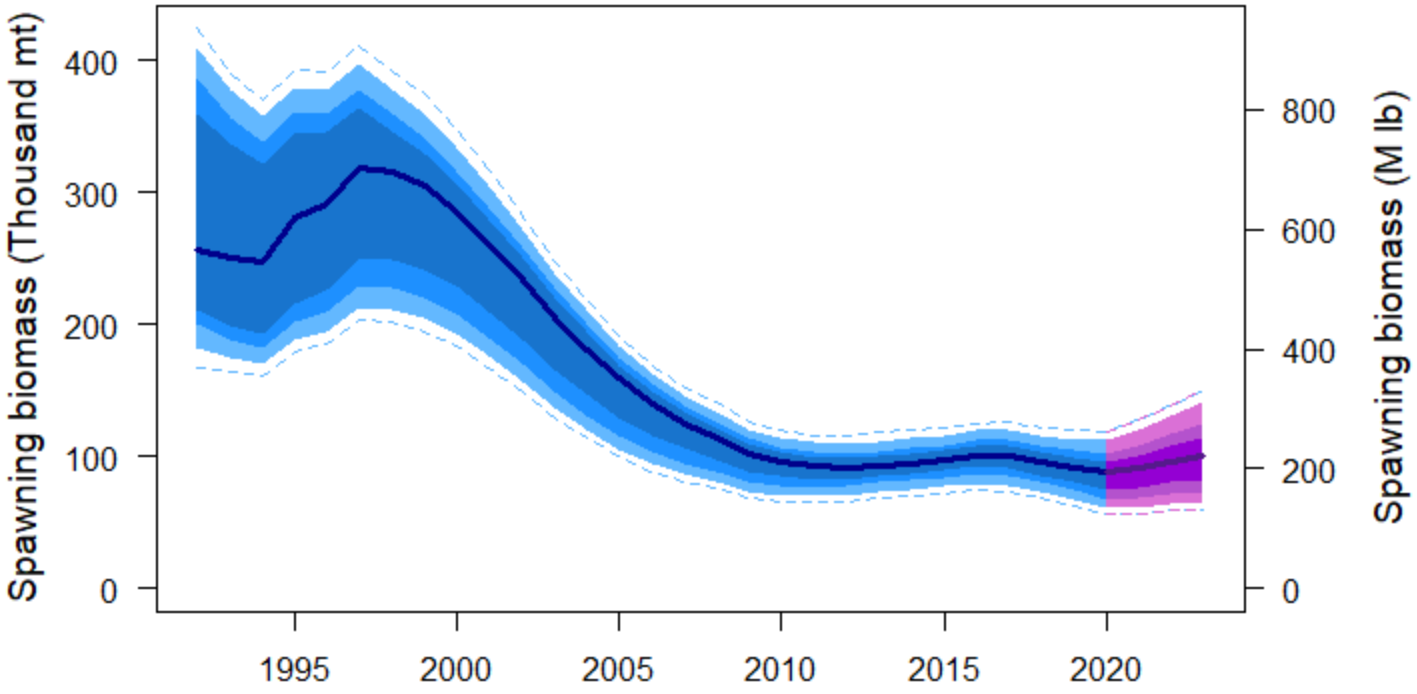
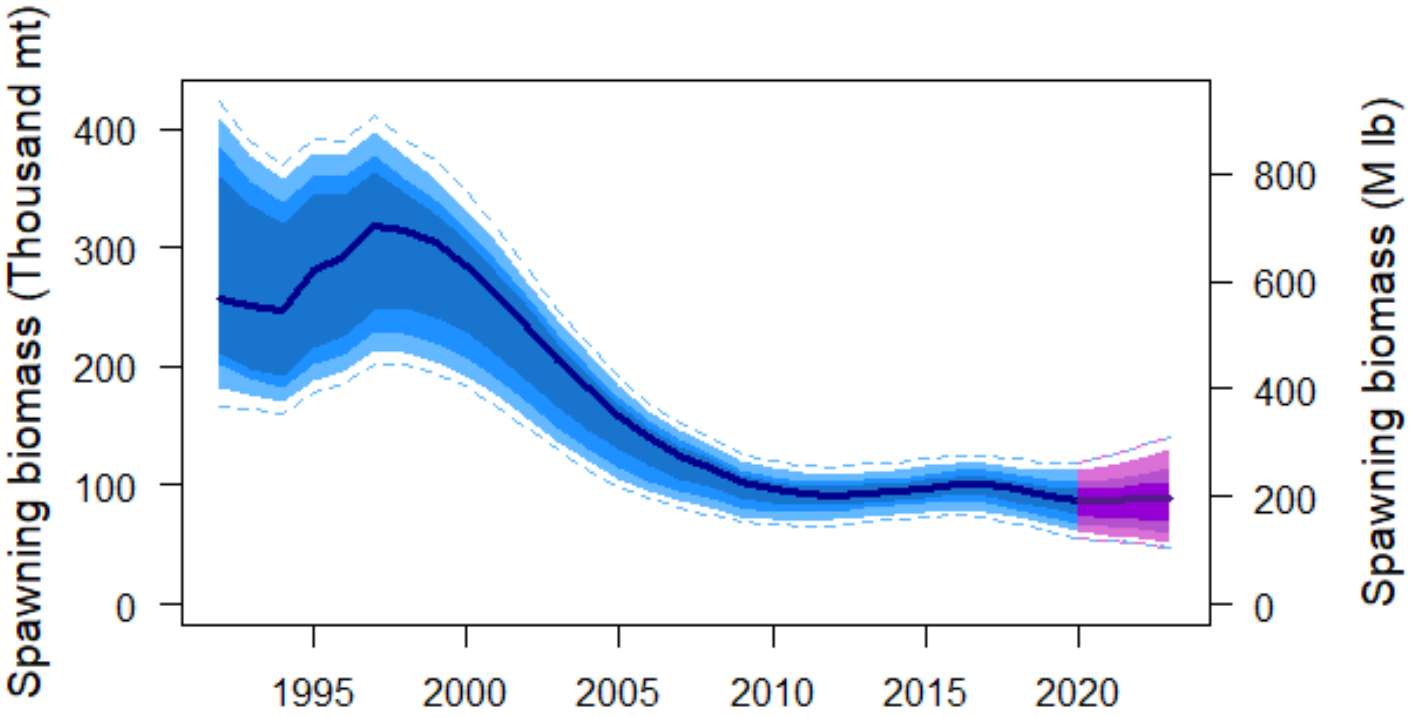
Projections

- Constant mortality limits (not SPR) over three years
- Include current estimates of incoming 2011 and 2012 year classes
- Based on the Interim management procedure mortality distribution (more later)

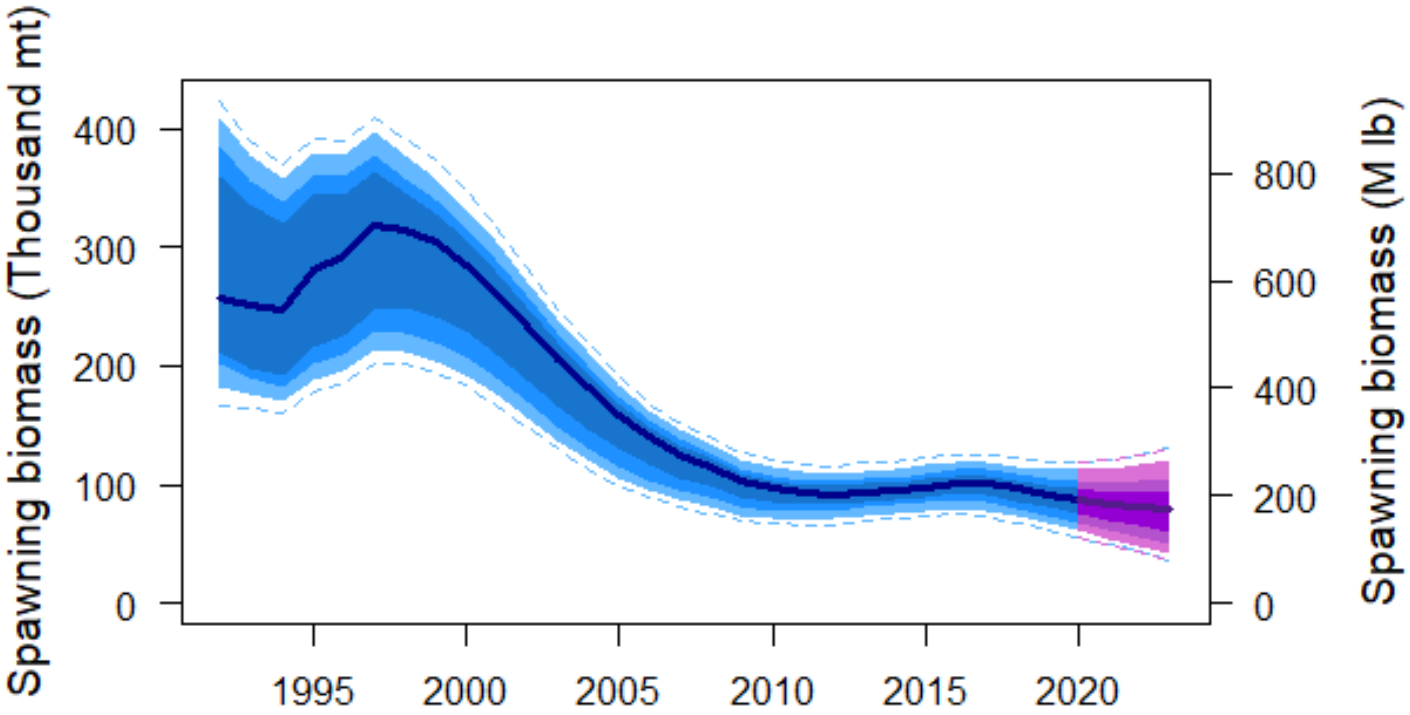
No fishing – Approximately back to 2016 levels in 3 years



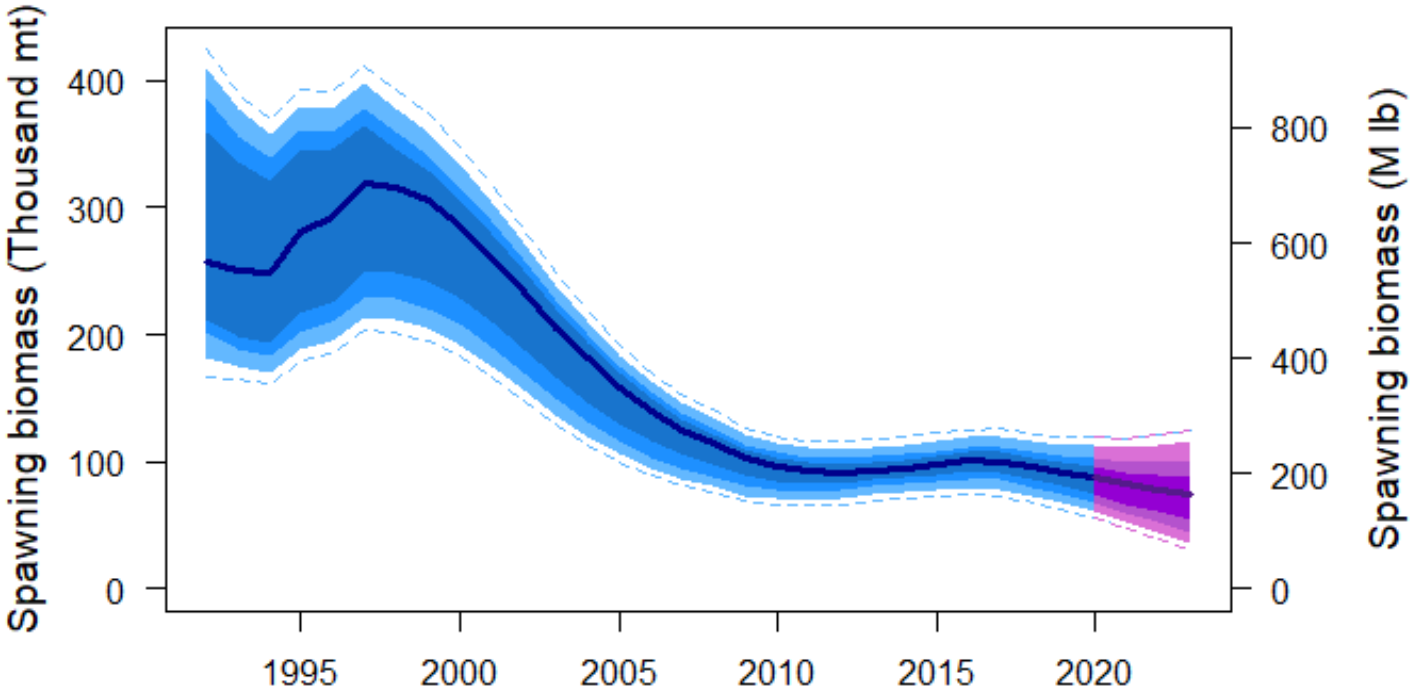
3-year surplus: 18.4 Mlb per year



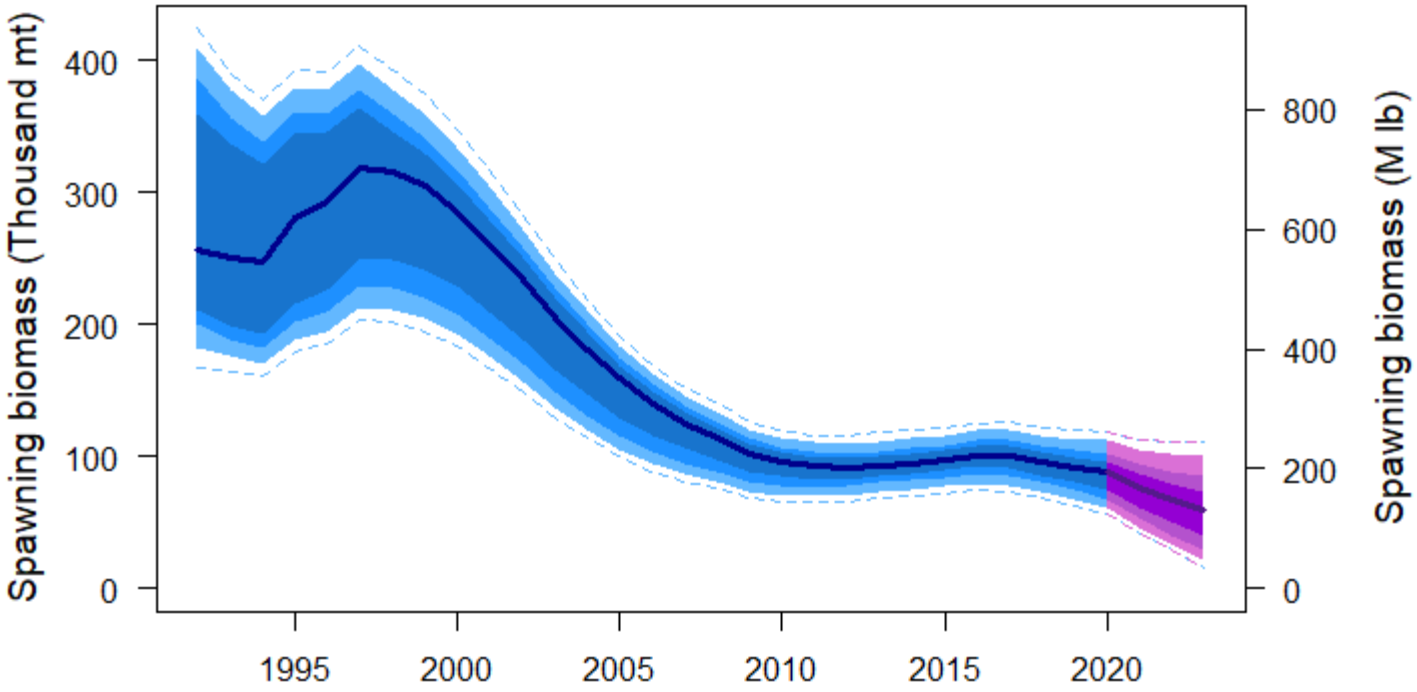
Reference level $F_{46\%}$ - continued decline



Status quo TCEYs ($F_{40\%}$)



60 Mlb: almost certain stock decline



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Reference points

- Describe the Interim management procedure
  - $SB_{20\%}$ Biological Limit
  - $SB_{30\%}$ Fishery Trigger
  - SB_{Target} – Currently not specified
  - $F_{46\%}$ Reference level of fishing intensity
  - F_{limit} – Currently not specified
- New: Status (phase) plots – compare the stock and fishery over time to reference points

Relative spawning biomass ($SB_{30\%}$, $SB_{20\%}$)

- Previous ('historical'):
  - Arbitrary choice of 'high' weight-at-age and 'low' recruitment based on historical estimates (pre-2012)
    - Disconnected from current biology and dynamics
- This assessment ('dynamic'):
  - Spawning biomass relative to what would be there now if there were no fishing
    - Based on current biology and dynamics

Relative spawning biomass ($SB_{30\%}$, $SB_{20\%}$)

- Have been reporting the dynamic reference points since 2013
- Reviewed by the SRB and external review
- Provide consistency with MSE results

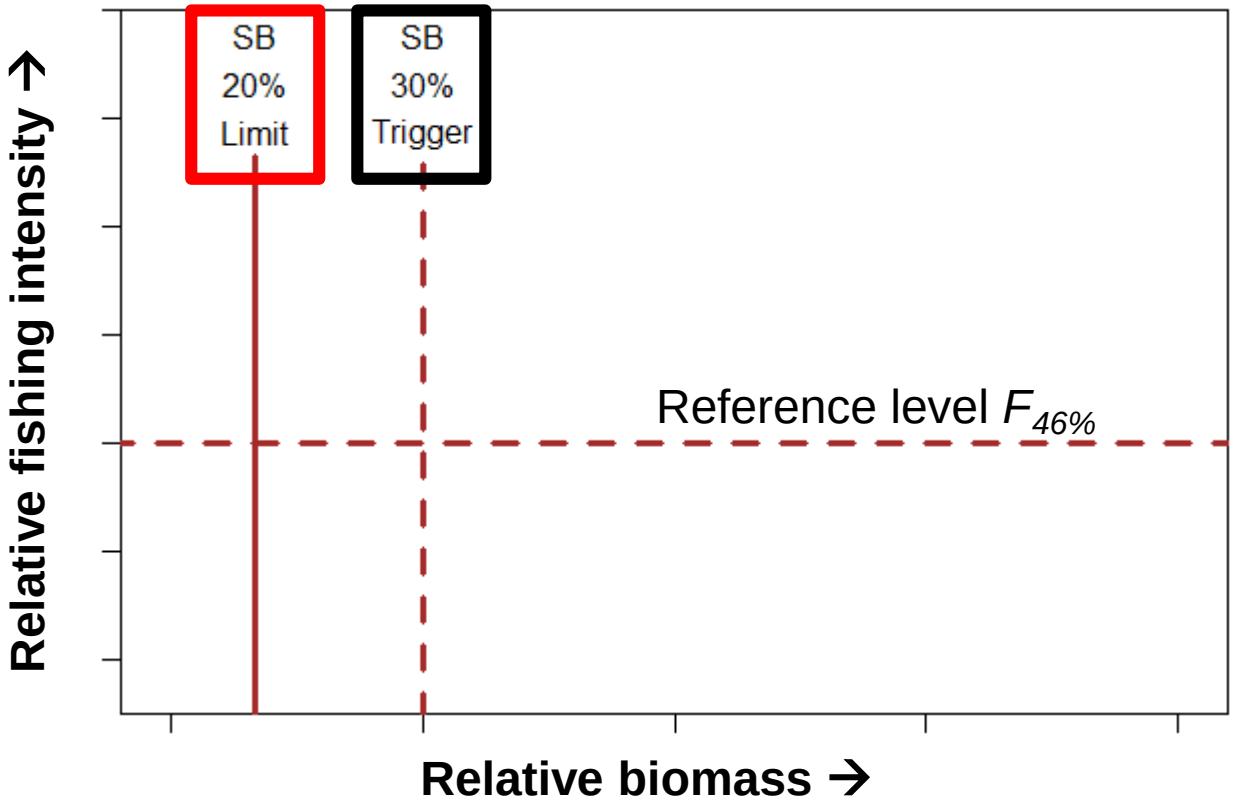
Relative spawning biomass

	2018 Assessment	2019 Assessment
	‘Historical’ relative SB	‘Dynamic’ relative SB
2019	43% (27-63%) P(SB<SB30%) = 11%	32% (23-46%) P(SB<SB30%) = 44%
2020	38% (22-51%) P(SB<SB30%) = 25%	32% (22-46%) P(SB<SB30%) = 46%

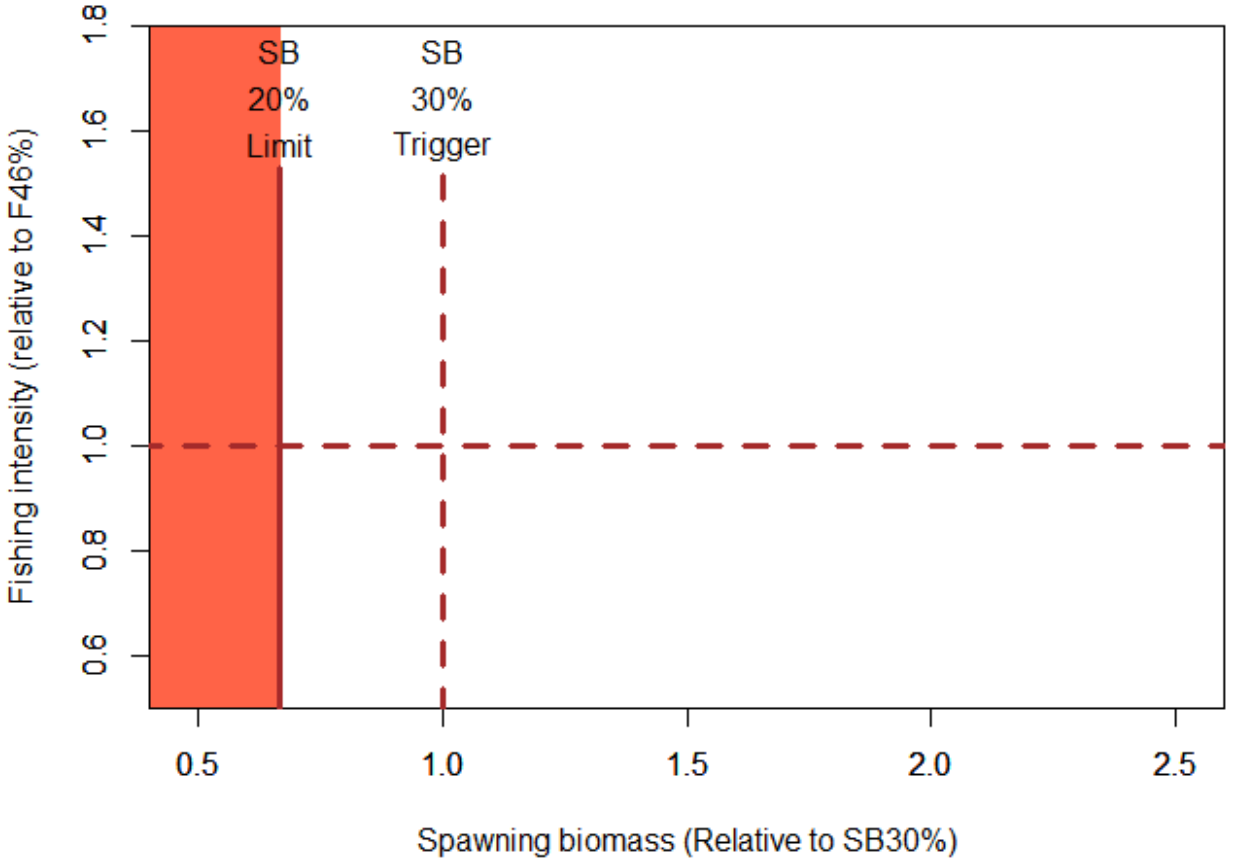
Assessment summary table

Indicators	Values	Trends	Status
Total mortality 2019: Retained catch 2019: Average removals 2015–19:	39.67 Mlbs, 17,996 t 32.21 Mlbs, 14,608 t 40.93 Mlbs, 18,567 t	Mortality increased from 2018 to 2019	2019 mortality near 100-year Low
SPR_{2019}: P(SPR<46%): P(SPR<limit):	42% (29-57%) 59% Limit not specified	Fishing intensity Increased from 2018 to 2019	Fishing intensity ABOVE reference level
SB_{2020} (Mlb): SB_{2020}/SB_0: $P(SB_{2020}<SB_{30})$: $P(SB_{2020}<SB_{20})$:	194 Mlbs (133–248) 32% (22-46%) 46% <1%	SB decreased from 2016 to 2020	Not overfished
Biological stock distribution:	See Tables and Figures	Region 3 Decreasing	Region 2 and 4 at historical highs

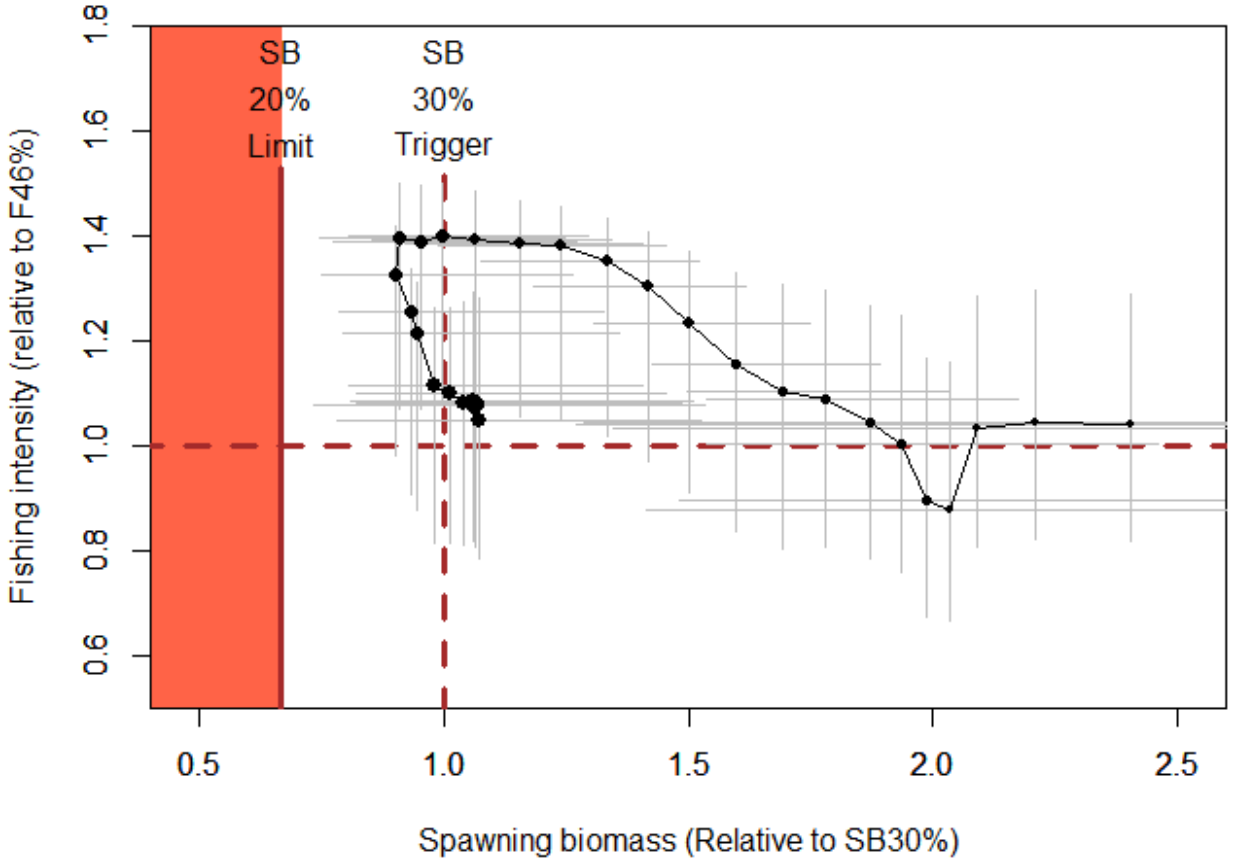
Status plot: reference points



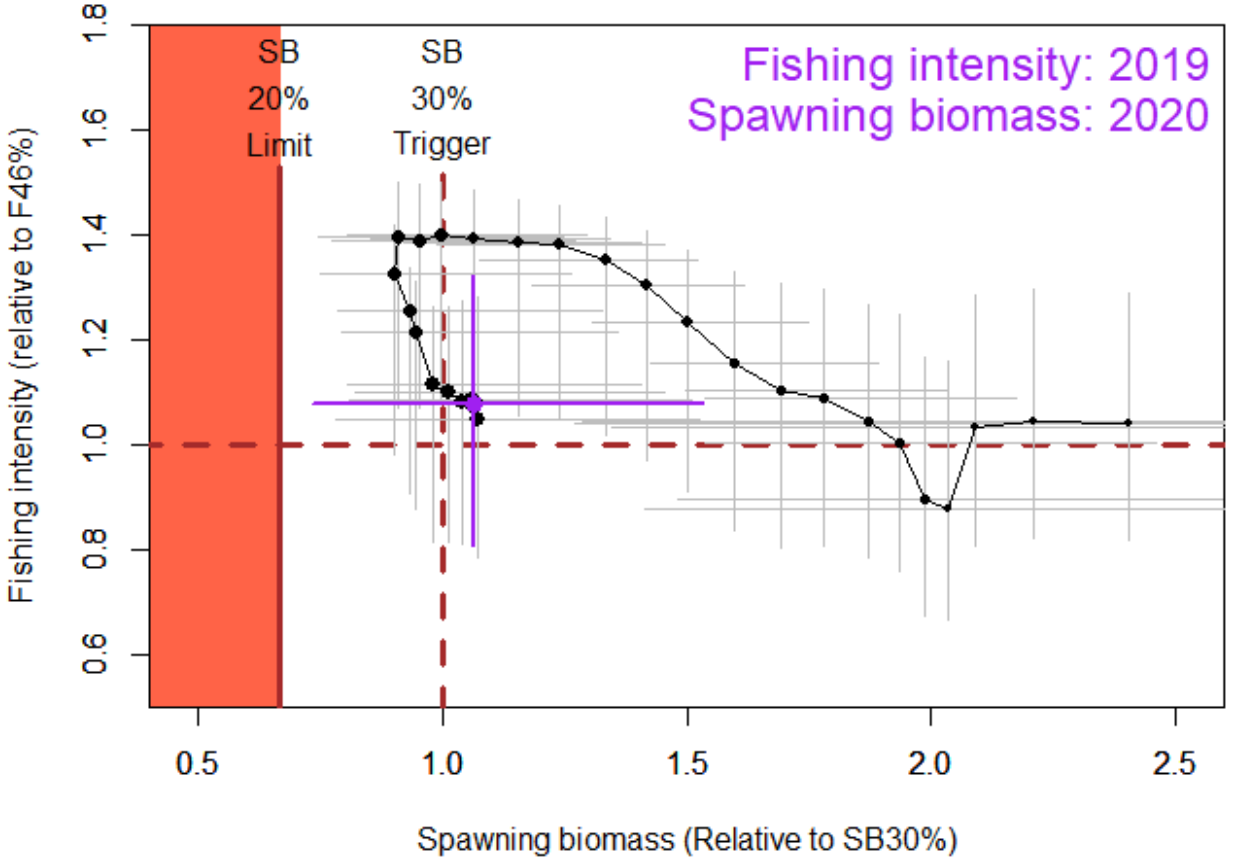
Status plot


SB
20%
Limit
SB
30%
Trigger
Fishing intensity (relative to F46%)
0.6
0.8
1.0
1.2
1.4
1.6
1.8
0.5
1.0
1.5
2.0
2.5
Spawning biomass (Relative to SB30%)

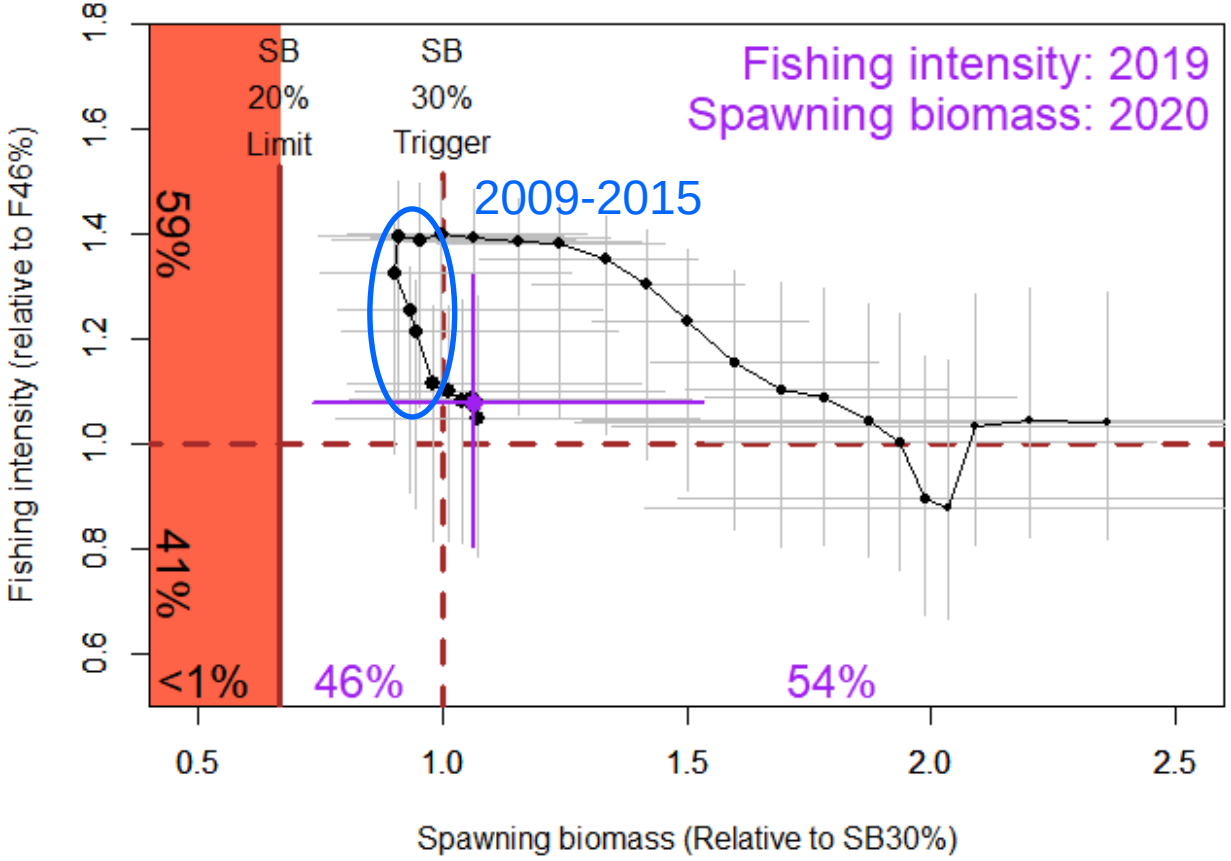
Status plot: time-series



Status plot: time-series + terminal year



Status plot


SB
20%
Limit
SB
30%
Trigger
Fishing intensity: 2019
Spawning biomass: 2020
2009-2015
59%
41%
<1%
46%
54%
Fishing intensity (relative to F46%)
Spawning biomass (Relative to SB30%)
0.6
0.8
1.0
1.2
1.4
1.6
1.8
0.5
1.0
1.5
2.0
2.5

Recap: What has changed in our interpretation?

- Relative spawning biomass lower than previous reference points indicated
  - Below $SB_{30\%}$ 2009-2015
  - But above level of biological concern ($SB_{20\%}$)
- Fishing intensity now estimated to be higher
  - The 2014-2016 reference period: $F_{46\%} \rightarrow F_{41\%}$

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Decision table

2020 Alternative

Total mortality (M lb)

TCEY (M lb)

2020 fishing intensity

Fishing intensity interval

Benefits (yield)

Risk

Decision table

2020 Alternative				3-Year Surplus				*Reference SPR=46%*						Status quo		
Total mortality (M lb)		0.0	11.6	20.0	23.6	27.6	32.3	33.5	34.6	35.7	36.8	37.8	38.9	40.2	61.6	
TCEY (M lb)		0.0	10.0	18.4	22.0	26.0	30.7	31.9	33.0	34.1	35.2	36.2	37.3	38.6	60.0	
2020 fishing intensity		$F_{100\%}$	$F_{78\%}$	$F_{63\%}$	$F_{58\%}$	$F_{53\%}$	$F_{47\%}$	$F_{46\%}$	$F_{45\%}$	$F_{44\%}$	$F_{43\%}$	$F_{42\%}$	$F_{41\%}$	$F_{40\%}$	$F_{27\%}$	
Fishing intensity interval		--	59-87%	44-75%	39-71%	35-67%	31-62%	30-61%	29-60%	28-59%	28-58%	27-57%	26-56%	25-56%	17-43%	
Stock Trend (spawning biomass)	in 2021	is less than 2020	1	29	61	71	79	87	89	91	93	94	95	96	97	>99	a
		is 5% less than 2020	<1	<1	11	23	30	42	46	50	54	58	61	64	67	98	b
	in 2022	is less than 2020	<1	16	50	60	68	77	79	81	83	85	87	89	90	>99	c
		is 5% less than 2020	<1	1	23	33	45	59	61	64	66	68	69	71	74	99	d
	in 2023	is less than 2020	1	22	50	58	65	73	75	77	79	81	83	85	87	>99	e
		is 5% less than 2020	<1	6	33	43	53	62	64	66	67	69	71	73	75	99	f

50/50 chance of spawning biomass decline over 3 years

Decision table

2020 Alternative				3-Year Surplus				*Reference SPR=46%*						Status quo		
Total mortality (M lb)		0.0	11.6	20.0	23.6	27.6	32.3	33.5	34.6	35.7	36.8	37.8	38.9	40.2	61.6	
TCEY (M lb)		0.0	10.0	18.4	22.0	26.0	30.7	31.9	33.0	34.1	35.2	36.2	37.3	38.6	60.0	
2020 fishing intensity		$F_{100\%}$	$F_{78\%}$	$F_{63\%}$	$F_{58\%}$	$F_{53\%}$	$F_{47\%}$	$F_{46\%}$	$F_{45\%}$	$F_{44\%}$	$F_{43\%}$	$F_{42\%}$	$F_{41\%}$	$F_{40\%}$	$F_{27\%}$	
Fishing intensity interval		--	59-87%	44-75%	39-71%	35-67%	31-62%	30-61%	29-60%	28-59%	28-58%	27-57%	26-56%	25-56%	17-43%	
Stock Trend (spawning biomass)	in 2021	is less than 2020	1	29	61	71	79	87	89	91	93	94	95	96	97	>99	a
		is 5% less than 2020	<1	<1	11	23	30	42	46	50	54	58	61	64	67	98	b
	in 2022	is less than 2020	<1	16	50	60	68	77	79	81	83	85	87	89	90	>99	c
		is 5% less than 2020	<1	1	23	33	45	59	61	64	66	68	69	71	74	99	d
	in 2023	is less than 2020	1	22	50	58	65	73	75	77	79	81	83	85	87	>99	e
		is 5% less than 2020	<1	6	33	43	53	62	64	66	67	69	71	73	75	99	f

89/100 chance of further spawning biomass decline in 2020

Decision table

2020 Alternative				3-Year Surplus				*Reference SPR=46%*						Status quo		
Total mortality (M lb)		0.0	11.6	20.0	23.6	27.6	32.3	33.5	34.6	35.7	36.8	37.8	38.9	40.2	61.6	
TCEY (M lb)		0.0	10.0	18.4	22.0	26.0	30.7	31.9	33.0	34.1	35.2	36.2	37.3	38.6	60.0	
2020 fishing intensity		$F_{100\%}$	$F_{78\%}$	$F_{63\%}$	$F_{58\%}$	$F_{53\%}$	$F_{47\%}$	$F_{46\%}$	$F_{45\%}$	$F_{44\%}$	$F_{43\%}$	$F_{42\%}$	$F_{41\%}$	$F_{40\%}$	$F_{27\%}$	
Fishing intensity interval		--	59-87%	44-75%	39-71%	35-67%	31-62%	30-61%	29-60%	28-59%	28-58%	27-57%	26-56%	25-56%	17-43%	
Stock Trend (spawning biomass)	In 2021	Is less than 2020	1	29	61	71	79	87	89	91	93	94	95	96	97	>99	a
		Is 5% less than 2020	<1	<1	11	23	30	42	46	50	54	58	61	64	67	98	b
	In 2022	Is less than 2020	<1	16	50	60	68	77	79	81	83	85	87	89	90	>99	c
		Is 5% less than 2020	<1	1	23	33	45	59	61	64	66	68	69	71	74	99	d
	In 2023	Is less than 2020	1	22	50	58	65	73	75	77	79	81	83	85	87	>99	e
		Is 5% less than 2020	<1	6	33	43	53	62	64	66	67	69	71	73	75	99	f

97/100 chance of further spawning biomass decline in 2020

Decision table

2020 Alternative				3-Year Surplus				*Reference SPR=46%*						Status quo	
Total mortality (M lb)		0.0	11.6	20.0	23.6	27.6	32.3	33.5	34.6	35.7	36.8	37.8	38.9	40.2	61.6
TCEY (M lb)		0.0	10.0	18.4	22.0	26.0	30.7	31.9	33.0	34.1	35.2	36.2	37.3	38.6	60.0
2020 fishing intensity		$F_{100\%}$	$F_{78\%}$	$F_{63\%}$	$F_{58\%}$	$F_{53\%}$	$F_{47\%}$	$F_{46\%}$	$F_{45\%}$	$F_{44\%}$	$F_{43\%}$	$F_{42\%}$	$F_{41\%}$	$F_{40\%}$	$F_{27\%}$
Fishing intensity interval		--	59-87%	44-75%	39-71%	35-67%	31-62%	30-61%	29-60%	28-59%	28-58%	27-57%	26-56%	25-56%	17-43%
Stock Status (Spawning biomass)	In 2021	Is less than 30%	35	39	43	44	46	47	48	48	48	48	48	49	49	51	g
		Is less than 20%	<1	<1	<1	<1	<1	1	1	1	2	2	2	3	3	16	h
	In 2022	Is less than 30%	26	31	40	43	46	48	48	49	49	49	49	50	50	54	i
		Is less than 20%	<1	<1	<1	1	2	6	7	8	9	11	12	14	15	27	j
	In 2023	Is less than 30%	18	27	37	41	45	48	49	49	49	49	50	50	50	60	k
		Is less than 20%	<1	<1	<1	2	6	13	15	17	18	20	21	22	23	40	l

Just under 50/50 chance of dropping below $SB_{30\%}$ across a wide range of alternatives

Decision table

2020 Alternative				3-Year Surplus				*Reference SPR=46%*						Status quo		
Total mortality (M lb)		0.0	11.6	20.0	23.6	27.6	32.3	33.5	34.6	35.7	36.8	37.8	38.9	40.2	61.6	
TCEY (M lb)		0.0	10.0	18.4	22.0	26.0	30.7	31.9	33.0	34.1	35.2	36.2	37.3	38.6	60.0	
2020 fishing intensity		$F_{100\%}$	$F_{78\%}$	$F_{63\%}$	$F_{58\%}$	$F_{53\%}$	$F_{47\%}$	$F_{46\%}$	$F_{45\%}$	$F_{44\%}$	$F_{43\%}$	$F_{42\%}$	$F_{41\%}$	$F_{40\%}$	$F_{27\%}$	
Fishing intensity interval		--	59-87%	44-75%	39-71%	35-67%	31-62%	30-61%	29-60%	28-59%	28-58%	27-57%	26-56%	25-56%	17-43%	
Fishery Trend (TCEY)	in 2021	Is less than 2020	0	<1	11	24	36	50	51	52	54	57	59	63	67	>99	m
		Is 10% less than 2020	0	<1	1	12	25	40	44	46	48	50	51	52	53	>99	n
	in 2022	Is less than 2020	0	<1	11	25	39	50	51	52	54	56	59	62	66	>99	o
		Is 10% less than 2020	0	<1	2	14	27	43	46	48	49	50	51	52	54	>99	p
	in 2023	Is less than 2020	0	<1	13	27	41	50	51	52	54	56	58	61	65	>99	q
		Is 10% less than 2020	0	<1	4	16	30	45	47	48	49	50	51	52	54	>99	r
Fishery Status (Fishing intensity)	in 2020	Is above $F_{46\%}$	0	<1	7	22	31	48	50	51	53	55	57	60	64	>99	s

Approximately 2/3 chance that fishery limits would be reduced

Decision table

2020 Alternative					3-Year Surplus				*Reference SPR=46%*						Status quo		
Total mortality (M lb)			0.0	11.6	20.0	23.6	27.6	32.3	33.5	34.6	35.7	36.8	37.8	38.9	40.2	61.6	
TCEY (M lb)			0.0	10.0	18.4	22.0	26.0	30.7	31.9	33.0	34.1	35.2	36.2	37.3	38.6	60.0	
2020 fishing intensity			$F_{100\%}$	$F_{78\%}$	$F_{63\%}$	$F_{58\%}$	$F_{53\%}$	$F_{47\%}$	$F_{46\%}$	$F_{45\%}$	$F_{44\%}$	$F_{43\%}$	$F_{42\%}$	$F_{41\%}$	$F_{40\%}$	$F_{27\%}$	
Fishing intensity interval			--	59-87%	44-75%	39-71%	35-67%	31-62%	30-61%	29-60%	28-59%	28-58%	27-57%	26-56%	25-56%	17-43%	
Fishery Trend (TCEY)	In 2021	Is less than 2020	0	<1	11	24	36	50	51	52	54	57	59	63	67	>99	m
		Is 10% less than 2020	0	<1	1	12	25	40	44	46	48	50	51	52	53	>99	n
	In 2022	Is less than 2020	0	<1	11	25	39	50	51	52	54	56	59	62	66	>99	o
		Is 10% less than 2020	0	<1	2	14	27	43	46	48	49	50	51	52	54	>99	p
	In 2023	Is less than 2020	0	<1	13	27	41	50	51	52	54	56	58	61	65	>99	q
		Is 10% less than 2020	0	<1	4	16	30	45	47	48	49	50	51	52	54	>99	r
Fishery Status (Fishing intensity)	In 2020	Is above $F_{46\%}$	0	<1	7	22	31	48	50	51	53	55	57	60	64	>99	s

Due to the uncertainty, mortality corresponding to an $F_{53\%}$ projection still has a 1/3 chance of exceeding the $F_{46\%}$ reference level

Decision table

2020 Alternative					3-Year Surplus				*Reference SPR=46%*						Status quo		
Total mortality (M lb)			0.0	11.6	20.0	23.6	27.6	32.3	33.5	34.6	35.7	36.8	37.8	38.9	40.2	61.6	
TCEY (M lb)			0.0	10.0	18.4	22.0	26.0	30.7	31.9	33.0	34.1	35.2	36.2	37.3	38.6	60.0	
2020 fishing intensity			$F_{100\%}$	$F_{78\%}$	$F_{63\%}$	$F_{58\%}$	$F_{53\%}$	$F_{47\%}$	$F_{46\%}$	$F_{45\%}$	$F_{44\%}$	$F_{43\%}$	$F_{42\%}$	$F_{41\%}$	$F_{40\%}$	$F_{27\%}$	
Fishing intensity interval			--	59-87%	44-75%	39-71%	35-67%	31-62%	30-61%	29-60%	28-59%	28-58%	27-57%	26-56%	25-56%	17-43%	
Stock Trend (spawning biomass)	In 2021	Is less than 2020	1	29	61	71	79	87	89	91	93	94	95	96	97	>99	a
		Is 5% less than 2020	<1	<1	11	23	30	42	46	50	54	58	61	64	67	98	b
	In 2022	Is less than 2020	<1	16	50	60	68	77	79	81	83	85	87	89	90	>99	c
		Is 5% less than 2020	<1	1	23	33	45	59	61	64	66	68	69	71	74	99	d
	In 2023	Is less than 2020	1	22	50	58	65	73	75	77	79	81	83	85	87	>99	e
		Is 5% less than 2020	<1	6	33	43	53	62	64	66	67	69	71	73	75	99	f
Stock Status (Spawning biomass)	In 2021	Is less than 30%	35	39	43	44	46	47	48	48	48	48	48	49	49	51	g
		Is less than 20%	<1	<1	<1	<1	<1	1	1	1	2	2	2	3	3	16	h
	In 2022	Is less than 30%	26	31	40	43	46	48	48	49	49	49	49	50	50	54	i
		Is less than 20%	<1	<1	<1	1	2	6	7	8	9	11	12	14	15	27	j
	In 2023	Is less than 30%	18	27	37	41	45	48	49	49	49	49	50	50	50	60	k
		Is less than 20%	<1	<1	<1	2	6	13	15	17	18	20	21	22	23	40	l
Fishery Trend (TCEY)	In 2021	Is less than 2020	0	<1	11	24	36	50	51	52	54	57	59	63	67	>99	m
		Is 10% less than 2020	0	<1	1	12	25	40	44	46	48	50	51	52	53	>99	n
	In 2022	Is less than 2020	0	<1	11	25	39	50	51	52	54	56	59	62	66	>99	o
		Is 10% less than 2020	0	<1	2	14	27	43	46	48	49	50	51	52	54	>99	p
	In 2023	Is less than 2020	0	<1	13	27	41	50	51	52	54	56	58	61	65	>99	q
		Is 10% less than 2020	0	<1	4	16	30	45	47	48	49	50	51	52	54	>99	r
Fishery Status (Fishing intensity)	In 2020	Is above $F_{46\%}$	0	<1	7	22	31	48	50	51	53	55	57	60	64	>99	s

Outline

- Data sources
  - Survey and fishery trends
  - Biology, new information
- Modelling results
- Projections
- Reference points
- Decision table
- Interim management procedure results

2020 Mortality projection tool

- Interactive tool to explore alternative scale and distribution of mortality for 2020
- To be fully updated with 2019 estimates and rates
- Default values based on Interim management procedure
- Adjusted to include AM095 agreements:
  - 2A = 1.65 Mlb TCEY
  - Percent of coastwide TCEY in 2B =

    0.7*20% + 0.3*Interim Management calculation

Interim Management Procedure

	2A	2B	2C	3A	3B	4A	4B	4CDE	Total
O32 Stock Distribution	2.0%	12.5%	15.3%	30.3%	12.1%	9.3%	5.2%	13.2%	100%
HR	1.0	1.0	1.0	1.0	0.75	0.75	0.75	0.75	NA
TCEY Distribution	2.2%	13.9%	17.0%	33.6%	10.1%	7.7%	4.3%	11.0%	100%

Adjusted Interim Management Procedure

	2A	2B	2C	3A	3B	4A	4B	4CDE	Total
O32 Stock Distribution	2.0%	12.5%	15.3%	30.3%	12.1%	9.3%	5.2%	13.2%	100%
HR	1.0	1.0	1.0	1.0	0.75	0.75	0.75	0.75	NA
TCEY Distribution	2.2%	13.9%	17.0%	33.6%	10.1%	7.7%	4.3%	11.0%	100%
Adjusted	1.65	18.2%	Depends on total TCEY						
% for 31.9 Mlb	5.2%	18.2%	15.6%	30.7%	9.2%	7.1%	4.0%	10.1%	100%
TCEYs	1.65	5.80	4.97	9.80	2.94	2.26	1.27	3.22	31.90

Reference (Blue line, then $F_{46\%}$) TCEYs

	Region 2	Region 3	Region 4	Region 4B	Total
2013	11.10	19.33	5.11	1.09	36.63
2014	12.05	15.80	4.47	1.16	33.48
2015	12.44	16.51	5.43	1.10	35.48
2016	13.44	15.84	5.90	1.14	36.31
2017	13.51	18.23	5.90	1.46	39.10
2018	10.08	14.63	5.08	1.21	31.00
2019	11.95	19.31	6.80	1.95	40.00
2020	12.41	12.74	5.48	1.27	31.90

Adopted TCEYs

	Region 2	Region 3	Region 4	Region 4B	Total
2013	13.91	22.94	6.71	1.93	45.48
2014	14.22	15.78	5.14	1.49	36.65
2015	15.17	16.72	6.23	1.53	39.63
2016	16.04	16.16	6.02	1.37	39.59
2017	16.83	16.94	5.64	1.34	40.74
2018	14.76	15.81	5.36	1.28	37.21
2019	14.82	16.40	5.94	1.45	38.61

Reference TCEYs

	2A	2B	2C	3A	3B	4A	4B	4CDE	Total
2013	0.82	5.28	5.00	15.13	4.20	1.93	1.09	3.18	36.63
2014	0.86	5.72	5.47	12.06	3.74	1.56	1.16	2.91	33.48
2015	0.84	5.75	5.85	13.00	3.51	1.95	1.10	3.48	35.48
2016	1.13	6.10	6.21	12.43	3.41	1.85	1.14	4.05	36.31
2017	0.96	6.08	6.47	13.84	4.39	1.84	1.46	4.06	39.10
2018	0.59	3.84	5.65	12.07	2.56	1.69	1.21	3.39	31.00
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

Non-directed discards (‘bycatch’)

2019	2A	2B	2C	3A	3B	4A	4B	4CDE	Total
Projected	**0.13**	**0.29**	**0.03**	**1.65**	**0.46**	**0.28**	**0.23**	**2.99**	**6.06**
				Projected O26 in 4CDE: 1.87					
Estimated	**0.13**	**0.24**	**0.09**	**1.46**	**0.46**	**0.33**	**0.17**	**3.57**	**6.44**
				Estimated O26 in 4CDE: 2.45					

4CDE: 0.58 Mlb O26 increase for 2020 projections

Adopted TCEYs

	2A	2B	2C	3A	3B	4A	4B	4CDE	Total
2013	1.11	7.78	5.02	17.07	5.87	2.43	1.93	4.28	45.48
2014	1.11	7.64	5.47	12.05	3.73	1.56	1.49	3.58	36.65
2015	1.06	7.91	6.20	13.00	3.72	1.96	1.53	4.27	39.63
2016	1.26	8.24	6.54	12.75	3.41	1.95	1.37	4.07	39.59
2017	1.47	8.32	7.04	12.96	3.98	1.80	1.34	3.84	40.74
2018	1.32	7.10	6.34	12.54	3.27	1.74	1.28	3.62	37.21
2019	1.65	6.83	6.34	13.50	2.90	1.94	1.45	4.00	38.61

2020 Mortality projection tool

- Interactive tool to explore alternative scale and distribution of mortality for 2020
- To be fully updated with 2019 estimates and rates
- Default values based on Interim management procedure
- Adjusted to include AM095 agreements:
  - 2A = 1.65 Mlb TCEY
  - Percent of coastwide TCEY in 2B =

    0.7*20% + 0.3*Interim Management calculation
- Mitigating for U26 effects on 2B TCEY (***IPHC-2018-IM094-12***)

Mitigating for U26 non-directed discards in AK

1. Solve for Interim management procedure (including the AM095 adjusted 2A and 2B measures)
2. Remove all U26 non-directed discards in AK (1.57 Mlb)
3. Recalculate TCEYs at reference SPR
4. Compare to (1) to find yield gain in 2B
5. Add yield gain in 2B to (1) and recalculate AK TCEYs to again achieve the reference SPR

Mitigating for U26 non-directed discards in AK

	2A	2B	2C	3A	3B	4A	4B	4CDE	Total
Base	1.65	5.80	4.97	9.80	2.94	2.26	1.27	3.22	31.90
%	5.2%	18.2%	15.6%	30.7%	9.2%	7.1%	4.0%	10.1%	100.0%

Mitigating for U26 non-directed discards in AK

	2A	2B	2C	3A	3B	4A	4B	4CDE	Total
Base	1.65	5.80	4.97	9.80	2.94	2.26	1.27	3.22	31.90
%	5.2%	18.2%	15.6%	30.7%	9.2%	7.1%	4.0%	10.1%	100.0%
Without U26	1.65	6.22	5.35	10.56	3.17	2.43	1.37	3.47	34.21
Gain	0.00	0.42	0.38	0.76	0.23	0.17	0.10	0.25	2.31

Calculation depends on Total TCEY (SPR):
At *status quo* 38.61 Mlb ($F_{40\%}$) yield gain = 0.44

Mitigating for U26 non-directed discards in AK

	2A	2B	2C	3A	3B	4A	4B	4CDE	Total
Base	1.65	5.80	4.97	9.80	2.94	2.26	1.27	3.22	31.90
%	5.2%	18.2%	15.6%	30.7%	9.2%	7.1%	4.0%	10.1%	100.0%
Without U26	1.65	6.22	5.35	10.56	3.17	2.43	1.37	3.47	34.21
Gain	0.00	0.42	0.38	0.76	0.23	0.17	0.10	0.25	2.31
Adjusted	1.65	6.22	4.88	9.63	2.89	2.22	1.25	3.16	31.90
Adjusted %	5.2%	19.5%	15.3%	30.2%	9.1%	7.0%	3.9%	9.9%	100%

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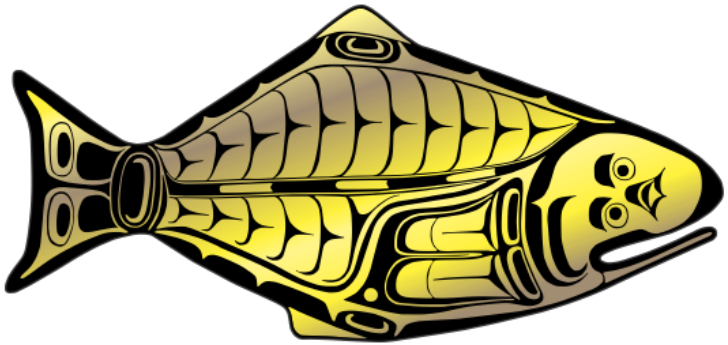

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