Summary of the Pacific halibut data, and assessment, and mortality projections

Agenda items 6.3 & 6.4
IPHC-2019-AM095-08/09, 11

D. Griffay

Summary

- Fishery and modelled survey trends down coastwide

- Biomass estimates are slightly larger than from last year's assessment, and observations of incoming recruitments further reduced estimated fishing intensity

- Spawning biomass still estimated to be decreasing and projected to decrease for TCEYs >20 Mlb, with greater uncertainty in this year's results

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Outline

- Coastwide stock assessment
  - Data sources
  - Modelling and results
  - Projections and Decision table
- 2019 Mortality projection tool

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Sources of mortality
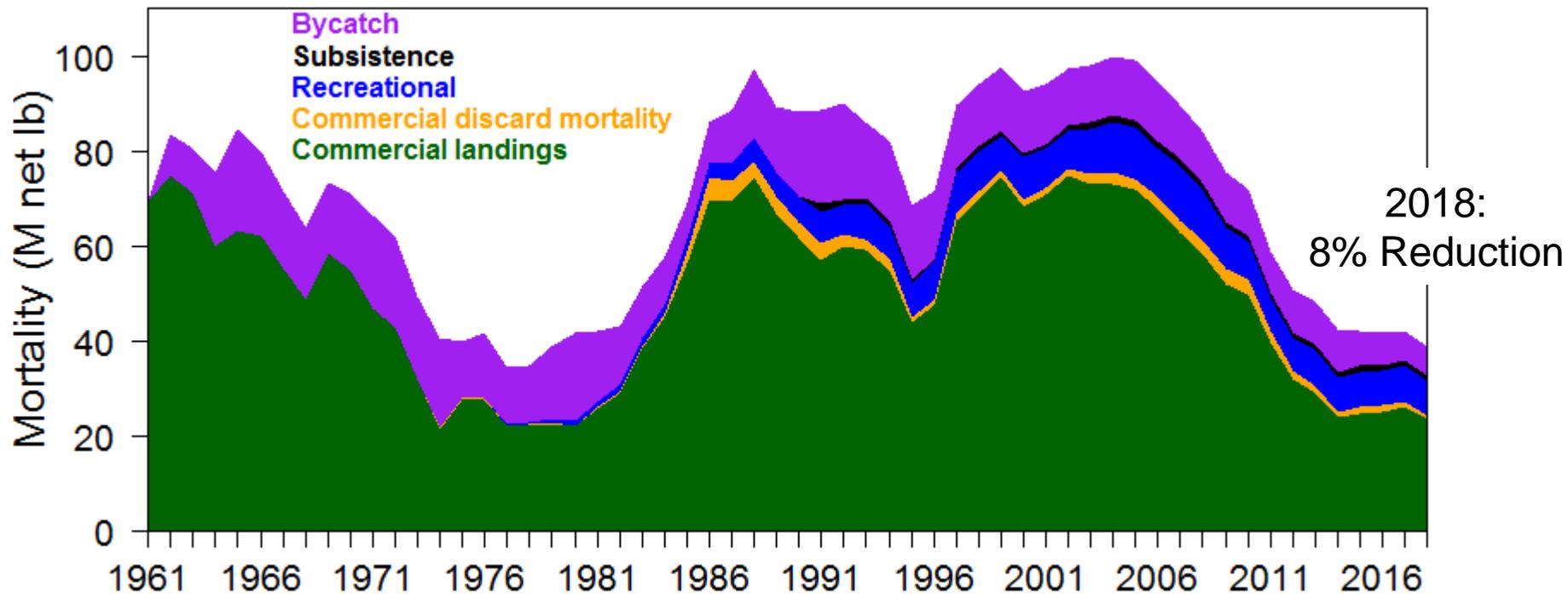
2018:
8% Reduction

Recent mortality (M lb)

Year	Commercial Landings	Discard mortality	Recreational	Subsistence	Bycatch	Total
2014	23.70	1.30	7.18	1.20	8.93	42.31
2015	24.67	1.29	7.46	1.20	7.47	42.10
2016	25.05	1.18	7.38	1.17	7.02	41.79
2017	26.17	0.99	7.60	1.17	6.07	41.99
2018	23.50	0.83	7.19	1.17	6.06	38.74

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Biological regions
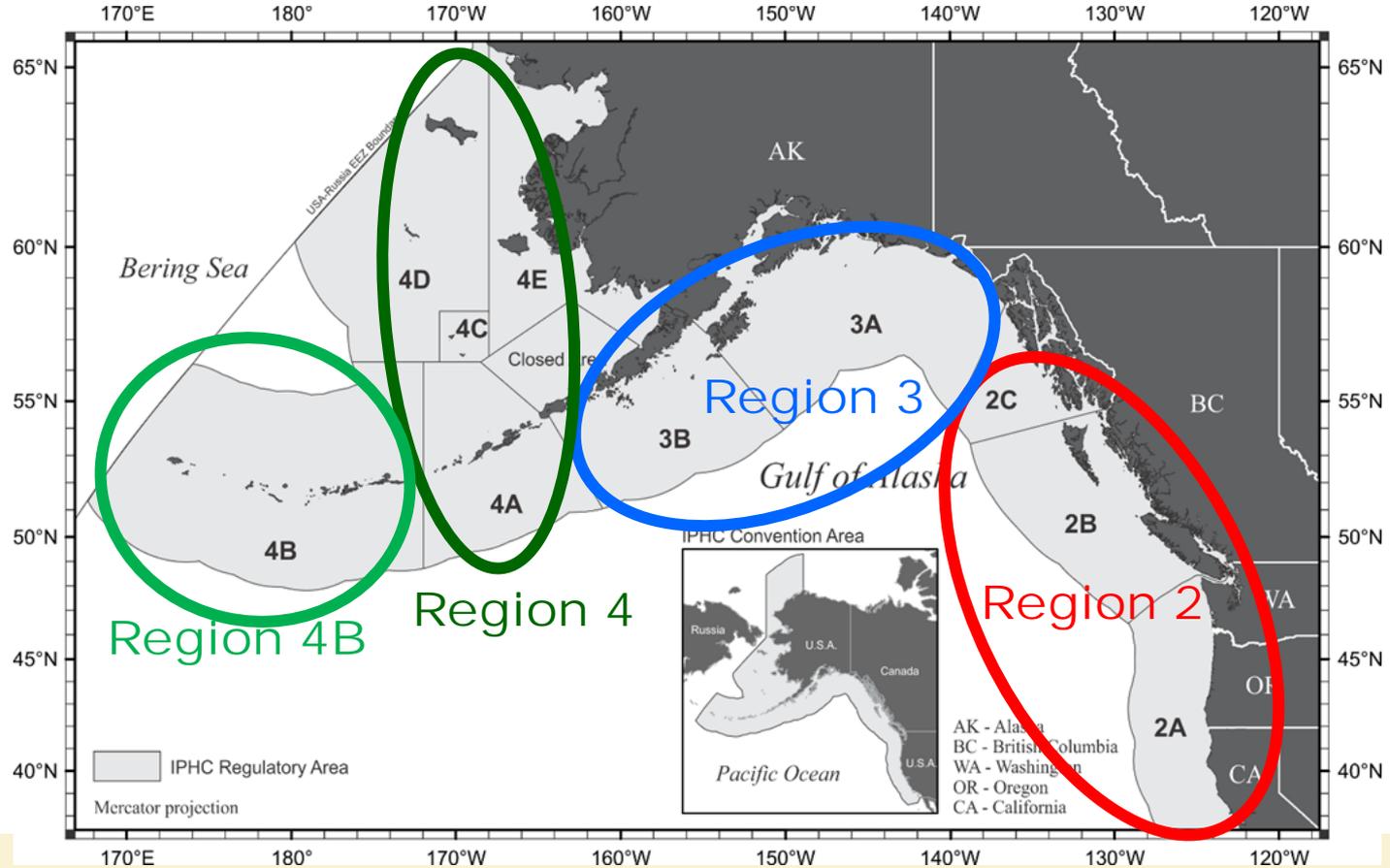
Historical commercial landings

Comparing trends

---- **Spawning biomass** -----

--- **Commercial fishery** -------------

---- **Setline survey** ----------------------------------

---- **SPR (fishing intensity)** ----------------------------

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 …

## Pacific halibut age (yr)
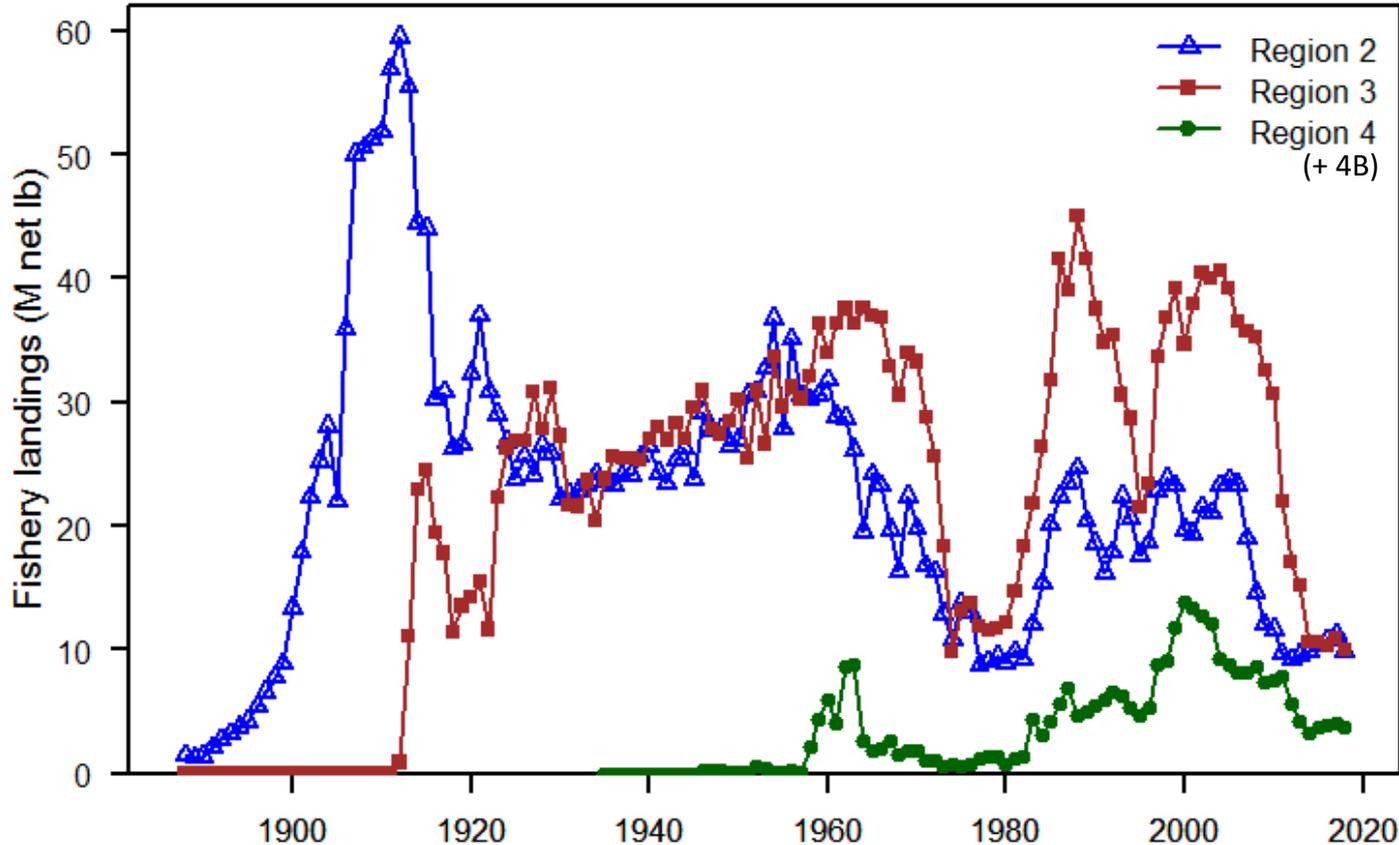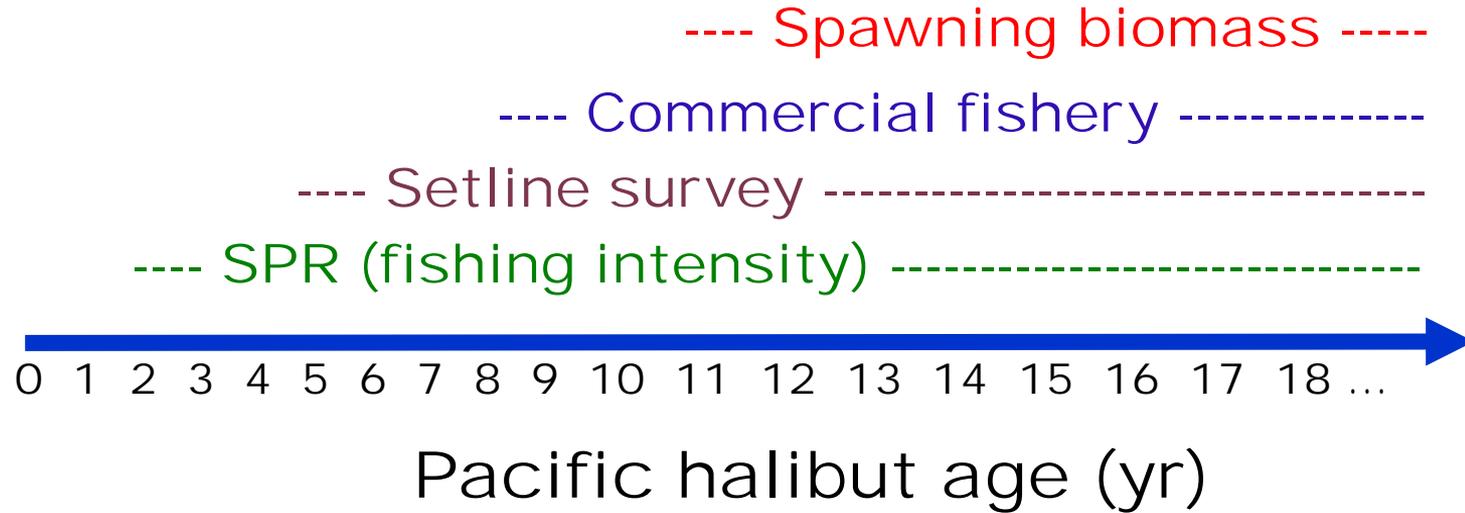
Modelled survey trend (Numbers)
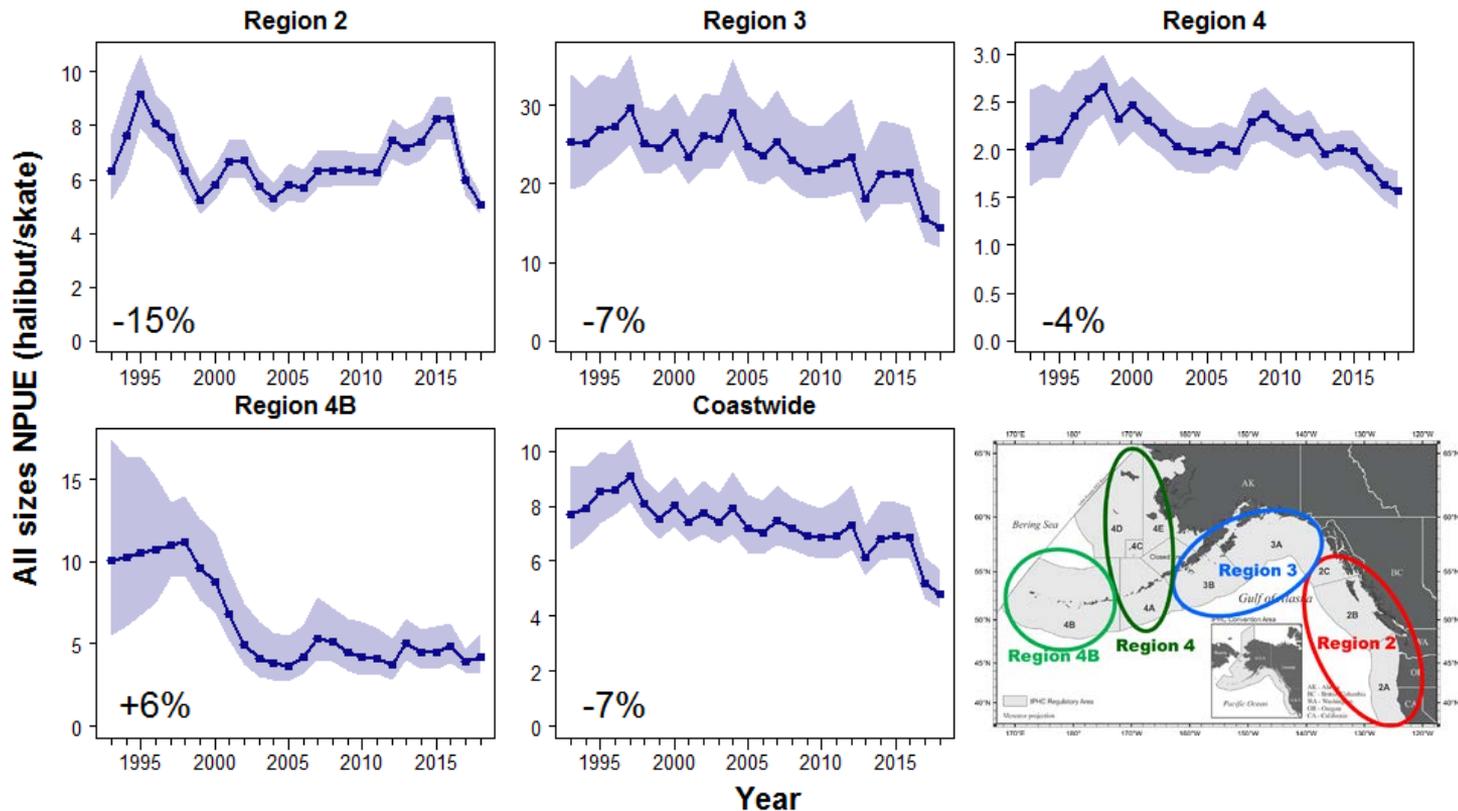
Modelled survey trend (O32 WPUE)
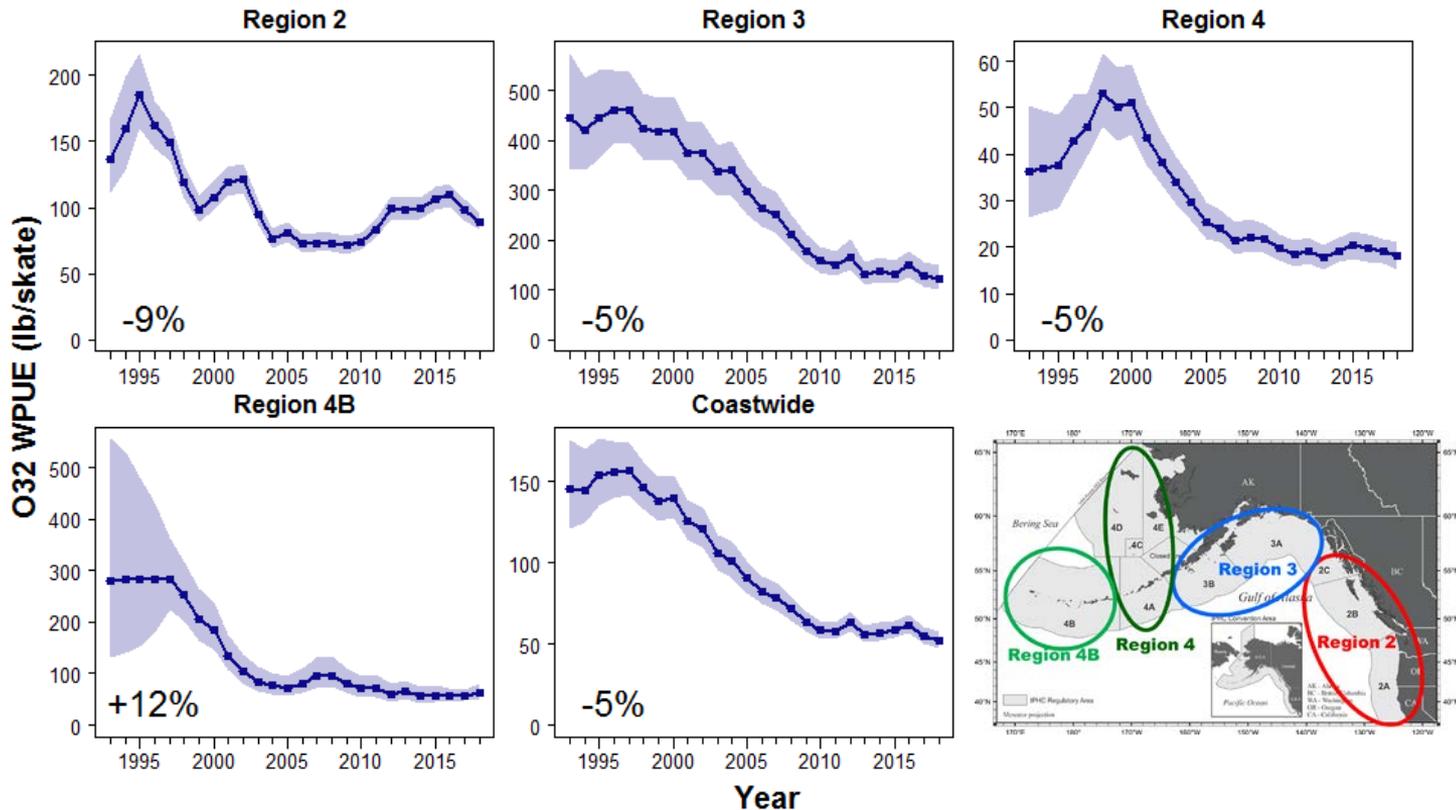
Commercial catch-rates
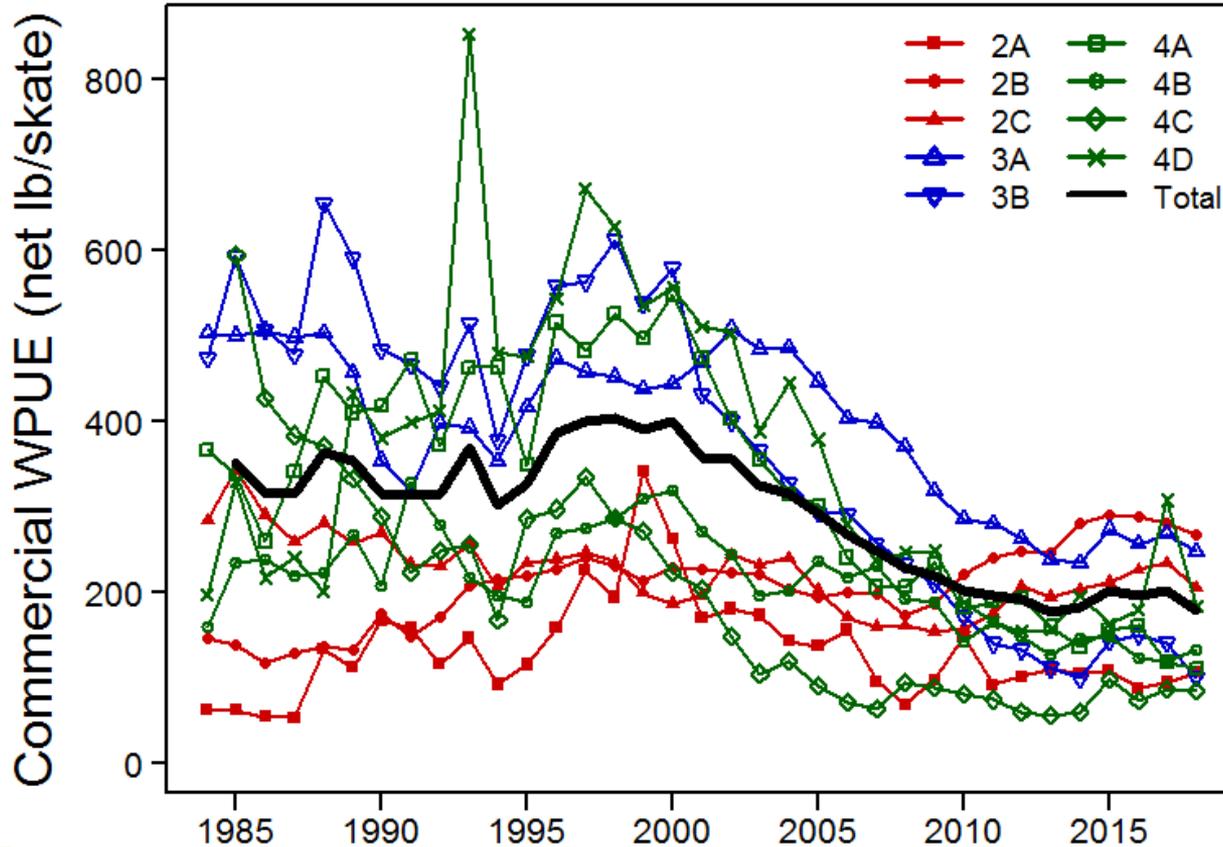
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Biological stock distribution
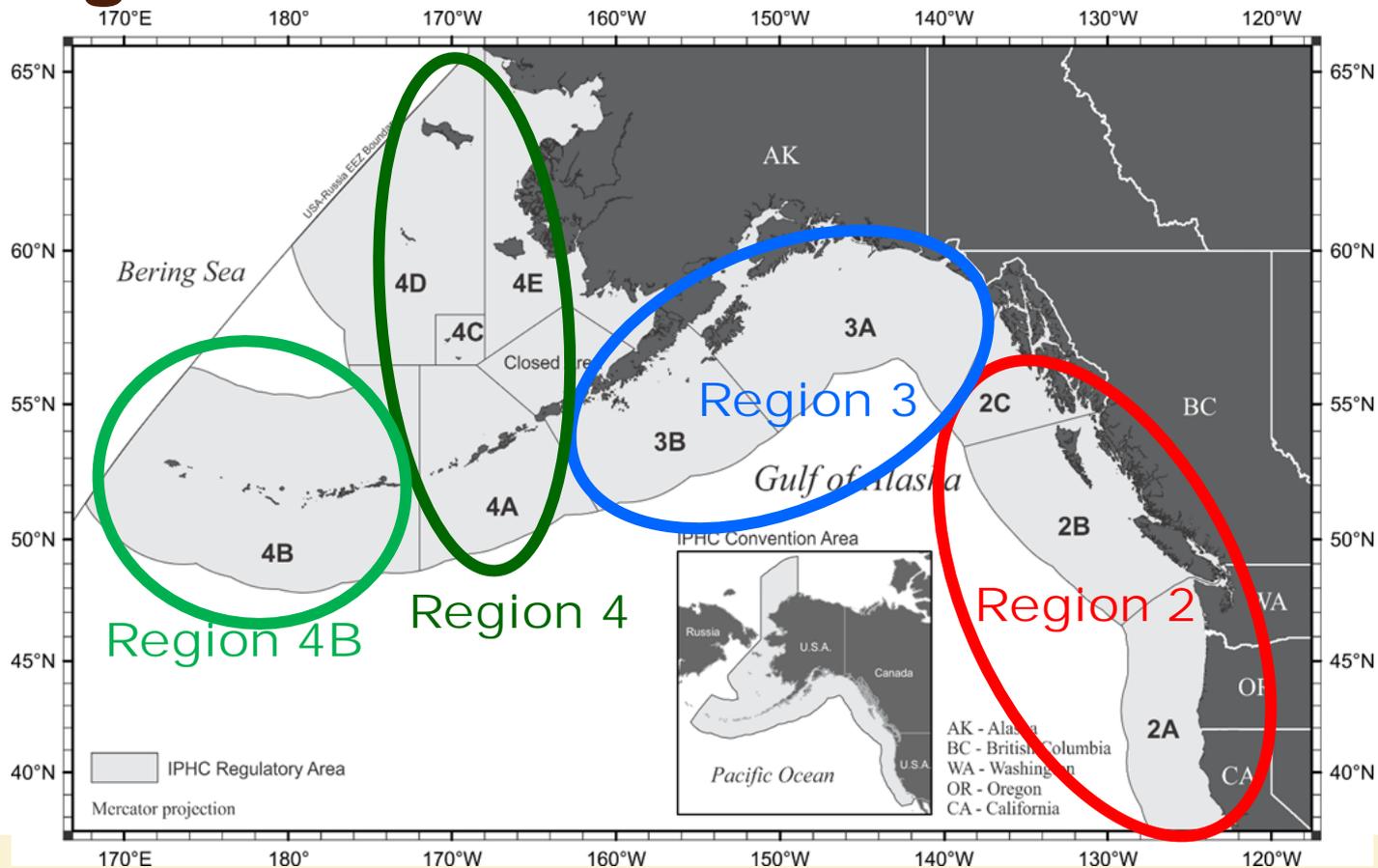
Biological stock distribution
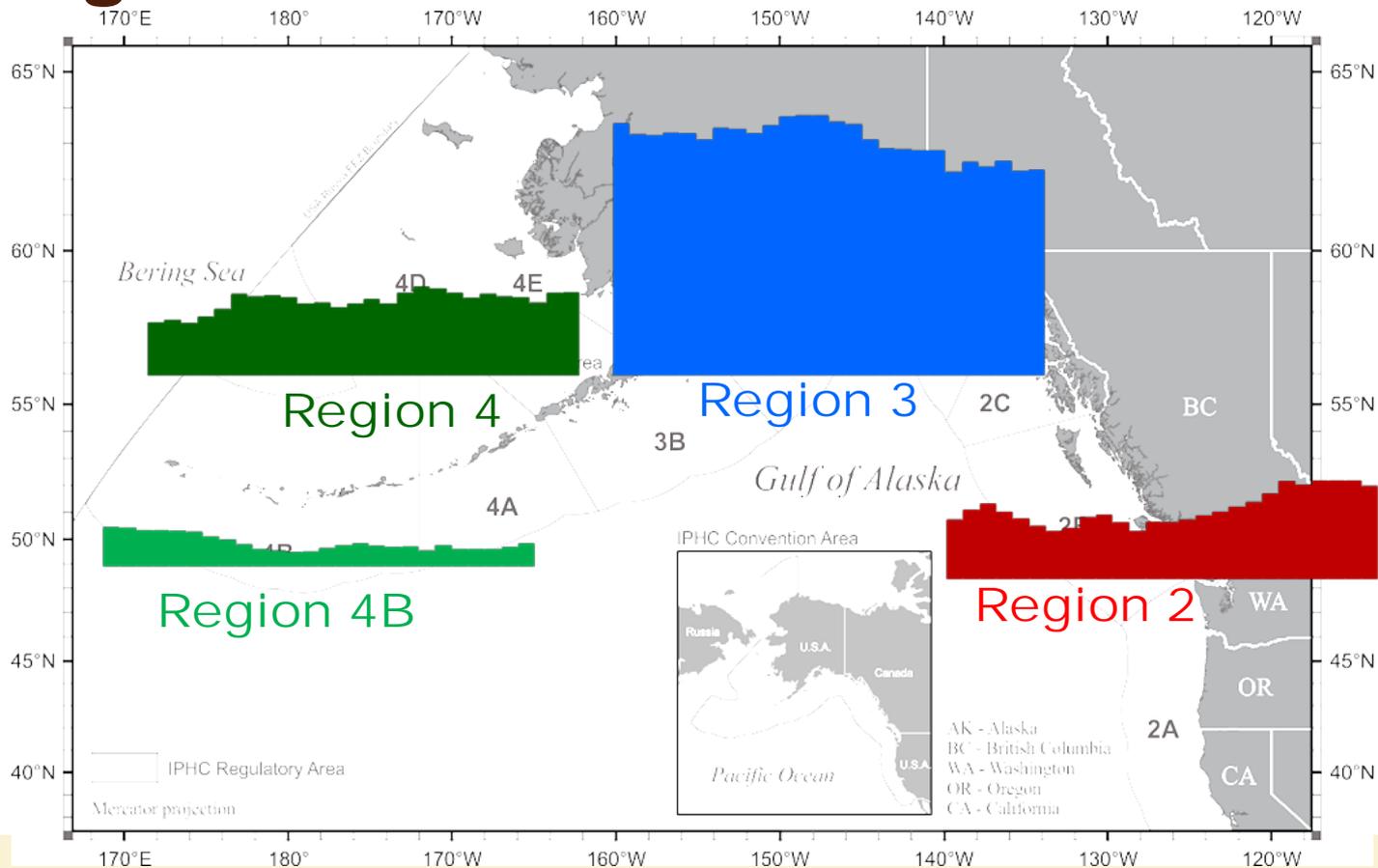
Biological stock distribution

Year	Region 2 (2A, 2B, 2C)	Region 3 (3A, 3B)	Region 4 (4A, 4CDE)	Region 4B
2014	23.4%	53.3%	19.4%	4.0%
2015	24.6%	52.1%	19.3%	4.0%
2016	24.6%	53.5%	17.9%	4.0%
2017	24.6%	50.8%	20.2%	4.4%
2018	23.1%	51.2%	20.4%	5.2%

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Fishery average fish weight
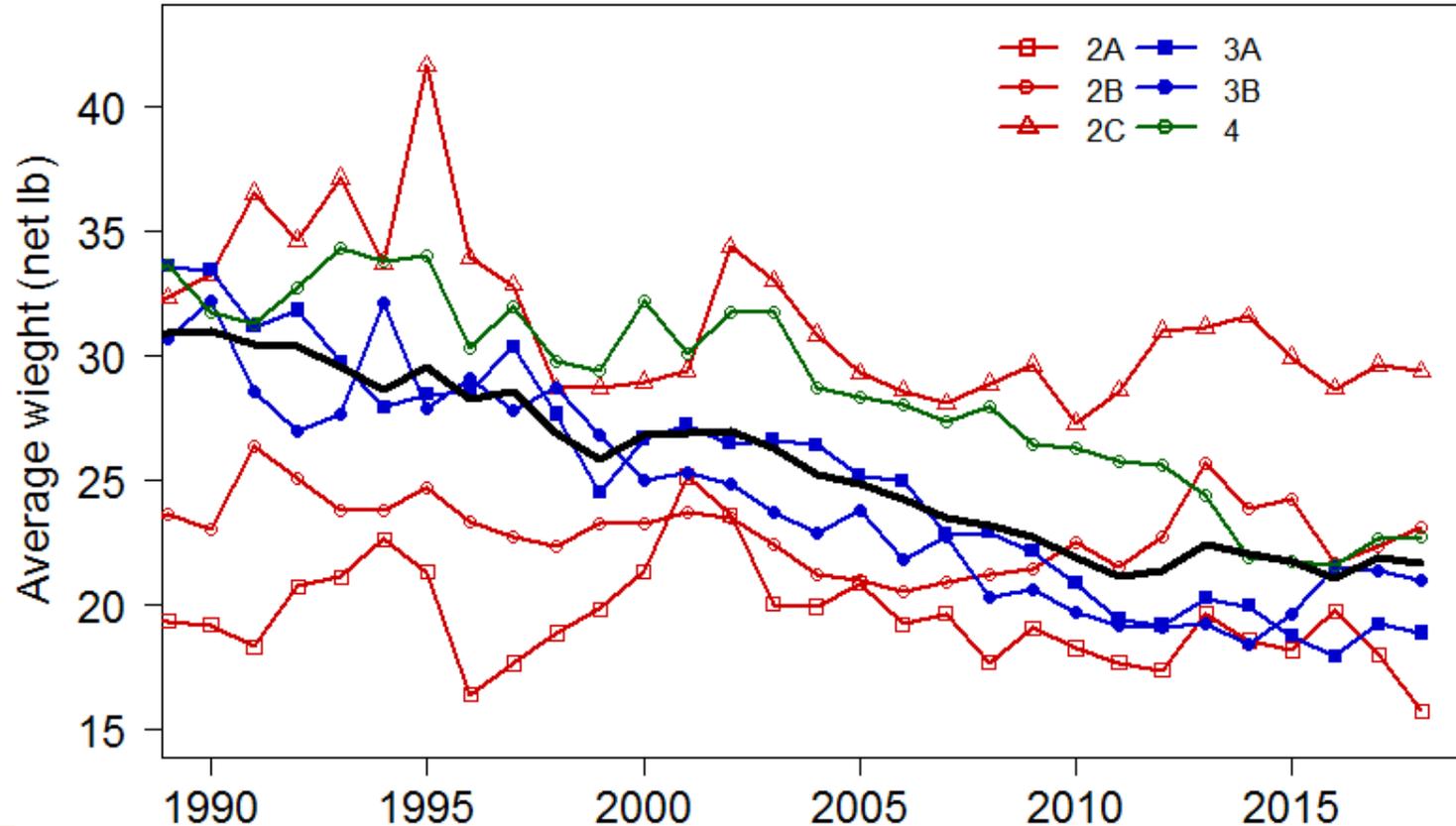
IPHC survey average fish weight
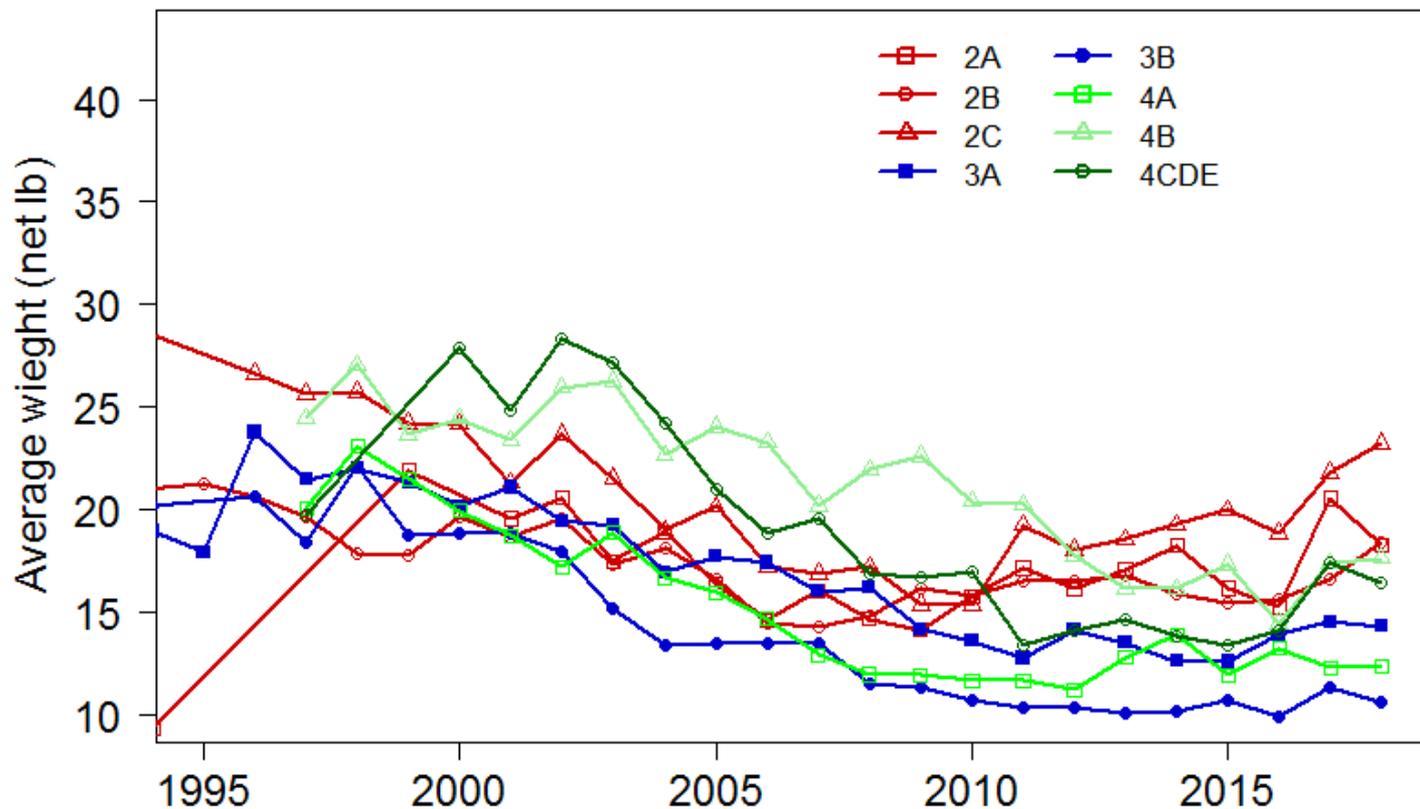
Fishery ages (sexes combined)

2005 year class

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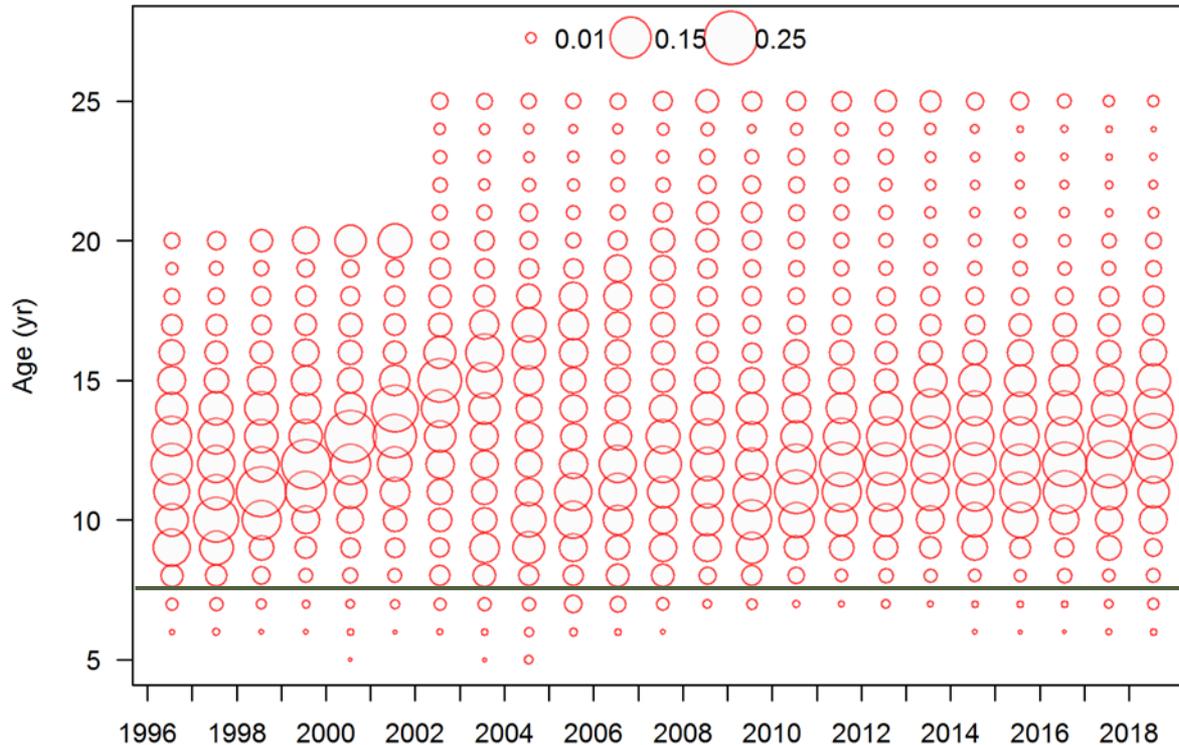
Setline survey ages (sexes combined)

2005 year class

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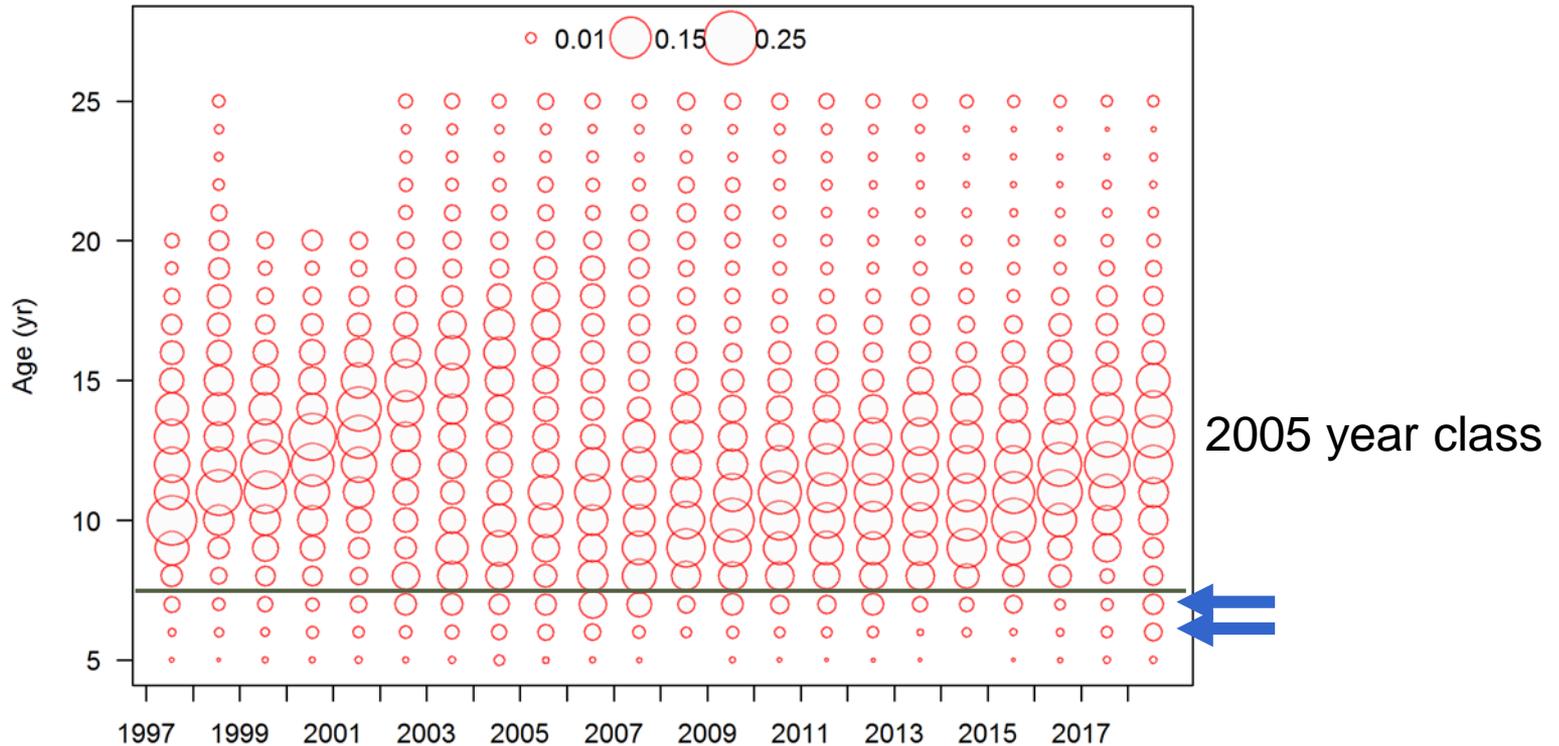
Ecosystem conditions

- More warm water in the fall of 2018 (now abated)

- No cold pool in Bering Sea winter 2017/2018
  - Northerly shift in cod and pollock distributions
  - Bird mortality

Temperature anomalies from October
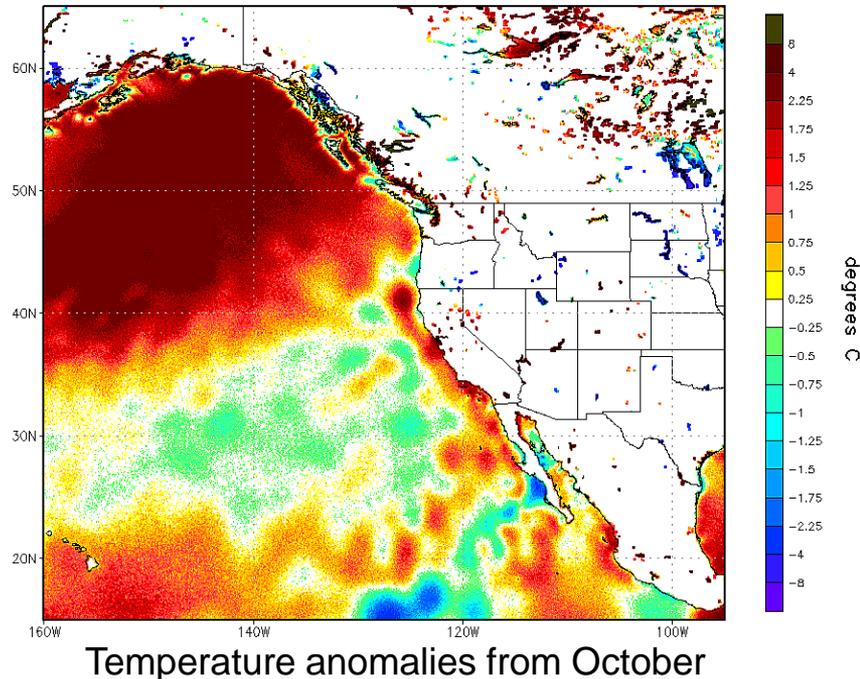
Ecosystem conditions

- Weakly positive Pacific Decadal Oscillation in 2018
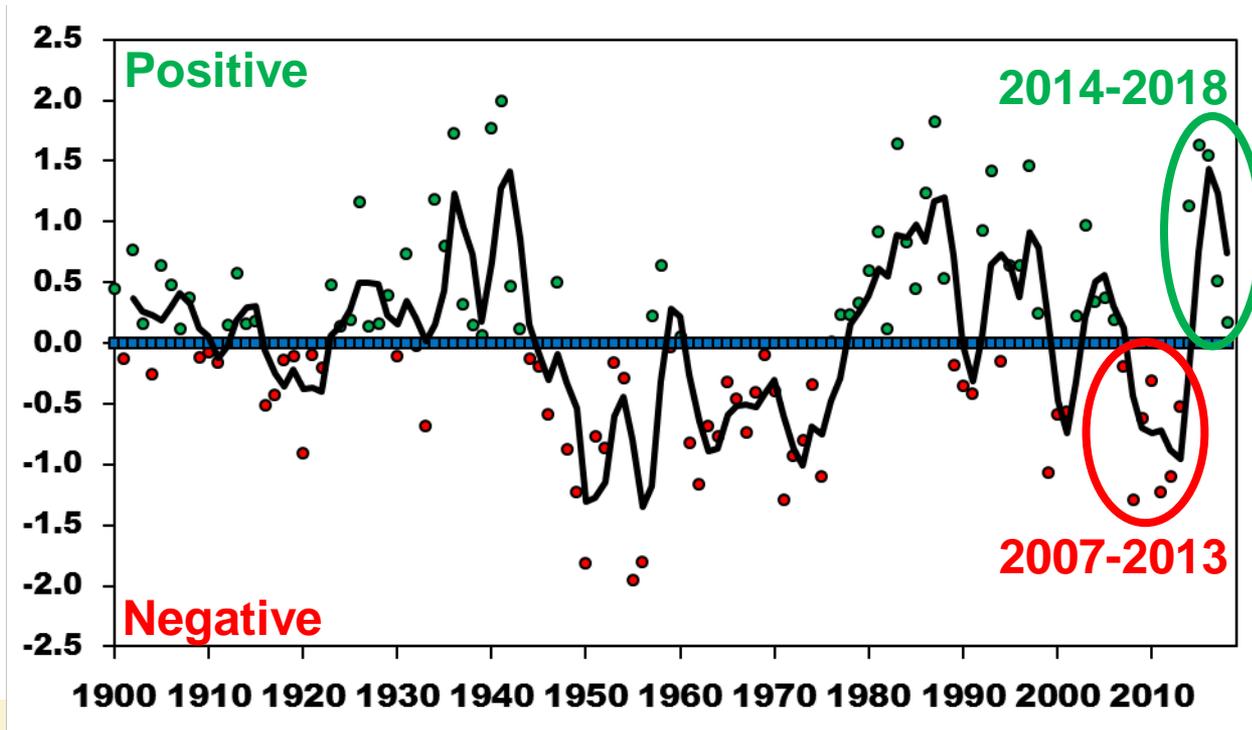
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Outline

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Modelling for 2018

- Updated assessment using the same ensemble methodology (4 models) from 2016-17, based on the independent scientific review in 2015

- Full analysis and review scheduled: June 2019

- New information:

  - 2018 fishery and modelled survey trend, biological data (ages, lengths, and weights)

    - Setline survey expansion in Region 2 (updated the full modelled survey time-series)

Comparison to previous years

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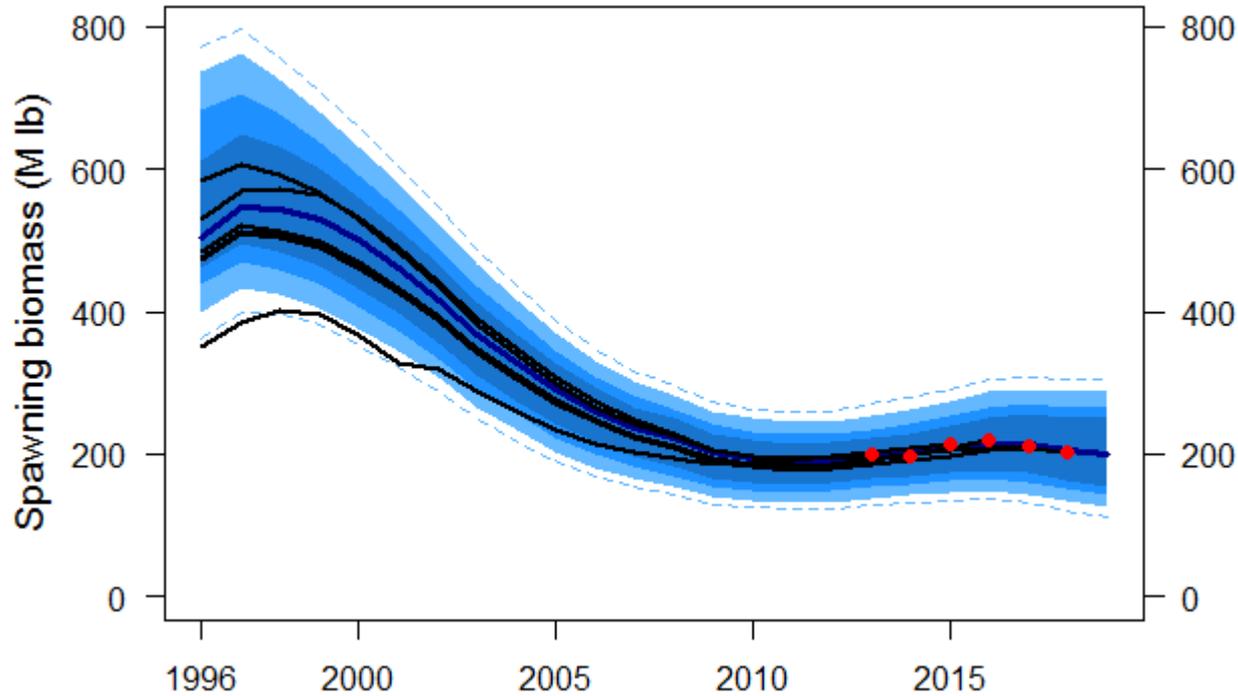
Change in individual model estimates (compared to last year)

- 2018 Expansion data (Region 2) increased biomass estimates coastwide

- 2018 Survey age data increased estimated 2011 and 2012 recruitment

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Spawning biomass
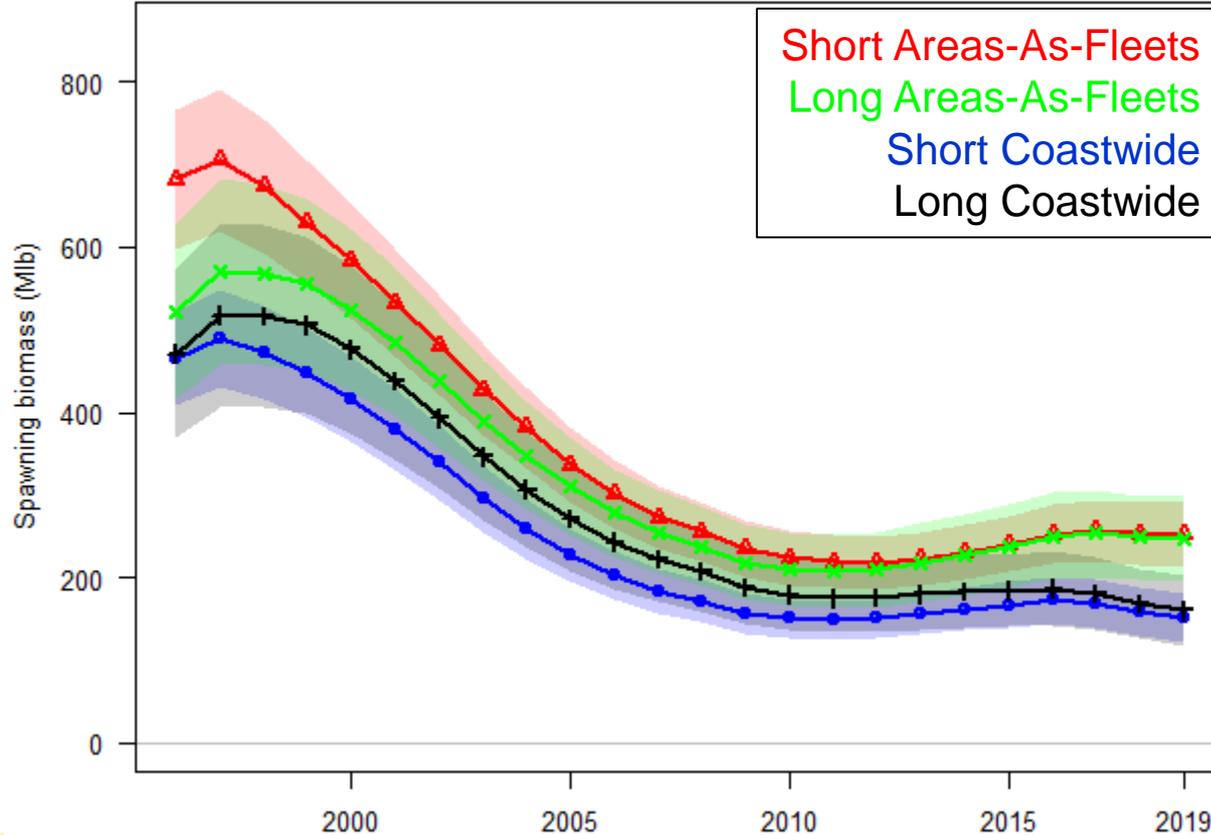
Recruitment comparisons
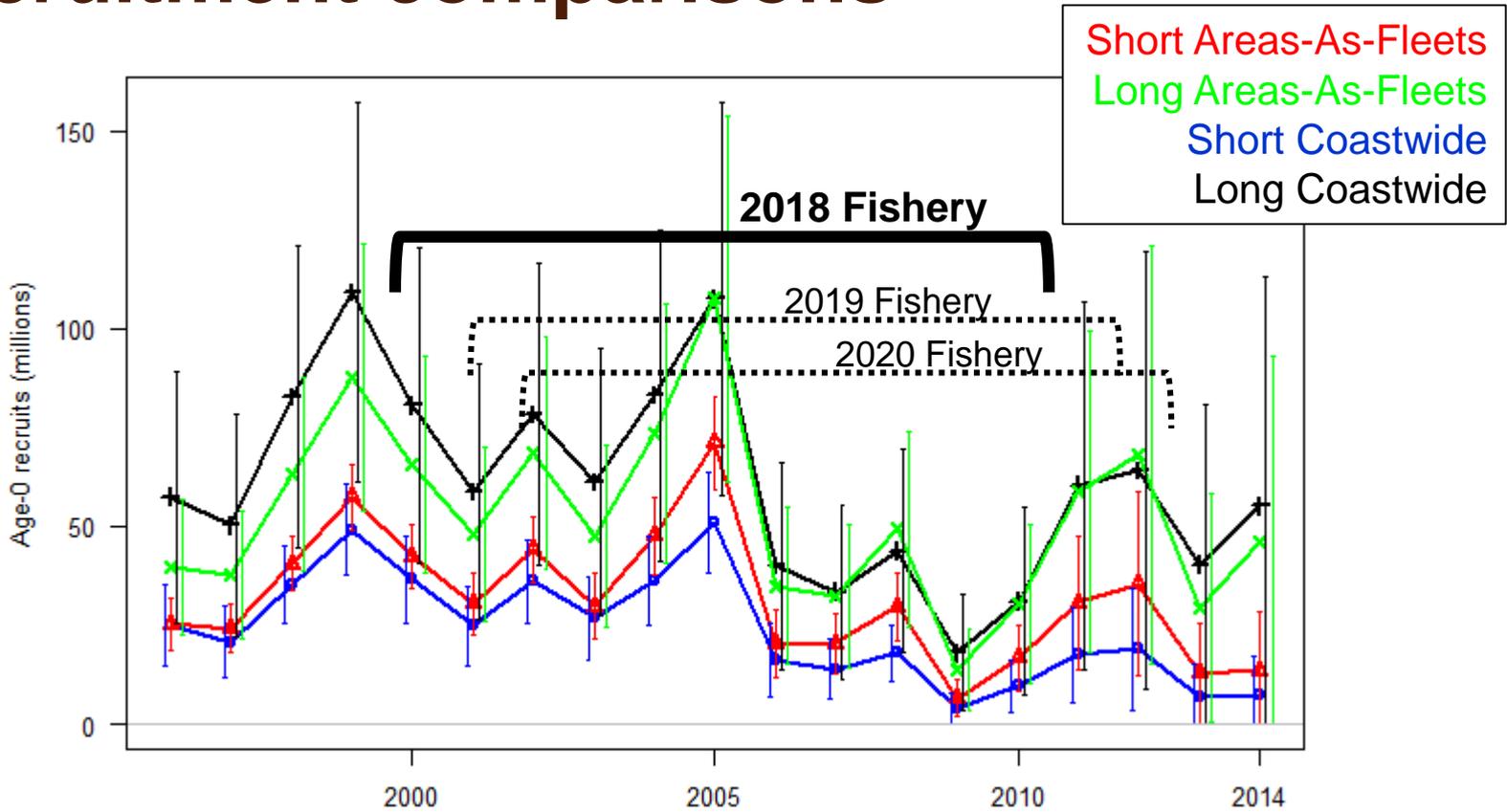
Age-8+ biomass
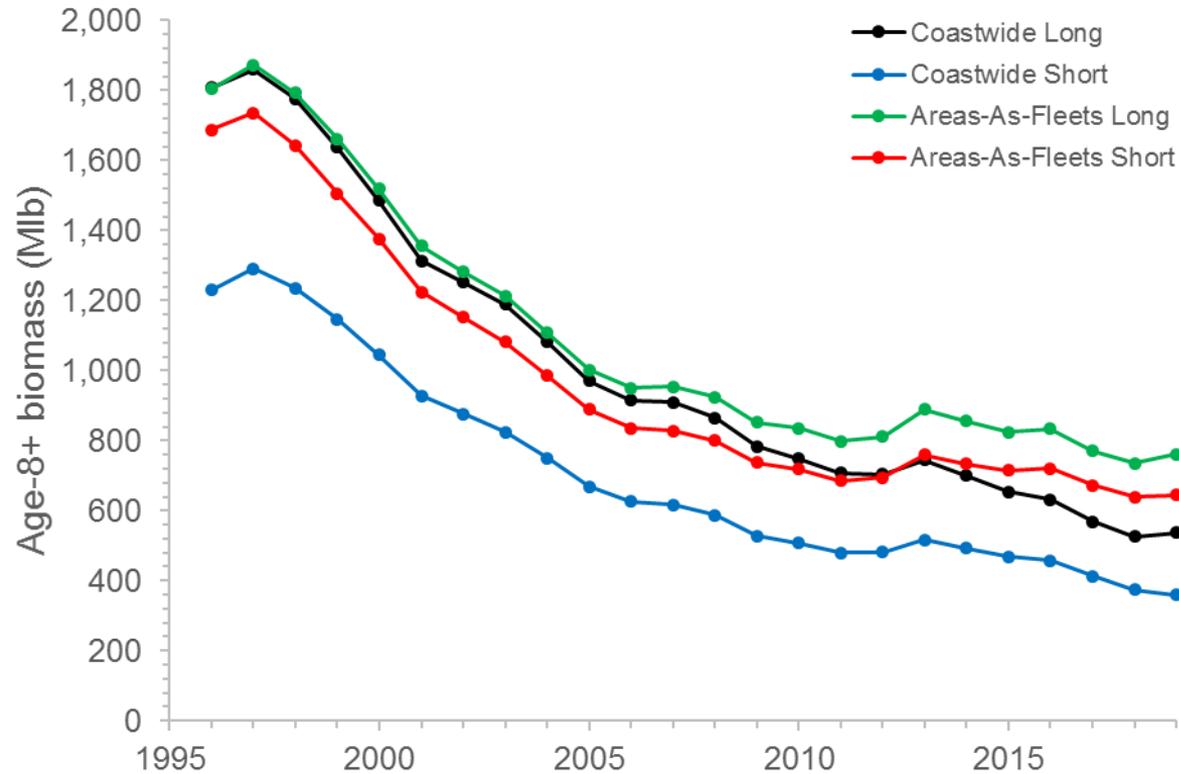
Fishing intensity (SPR)
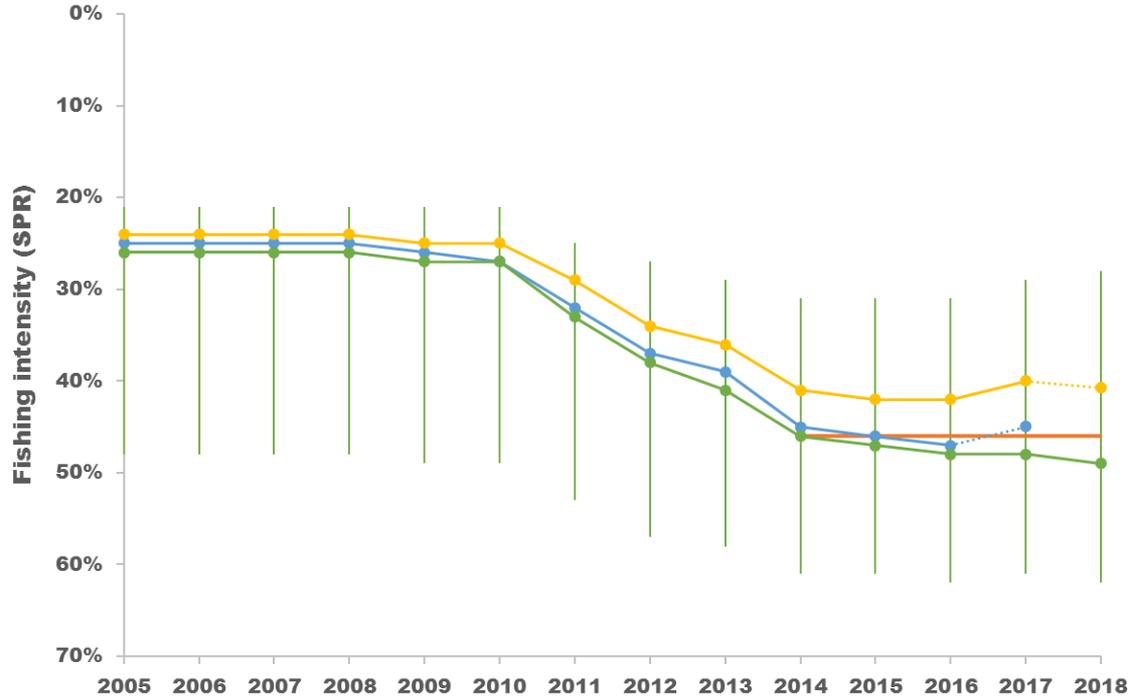
2016 Results
Reference
2017 Results
2018 Results

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Fishing intensity (SPR)

- Variability in recent estimates is likely to continue

- Tools to deal with this uncertainty
  - Management procedures robust to estimation uncertainty (strategic)
  - Consider the probabilities associated with estimates using the Harvest Decision table (tactical)

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2018 Results

- Increased scale and trend uncertainty
- For 2019:
  - The last survey expansion (Region 3) will be completed in 2019
  - Fish aged 6-7 are poorly sampled (0-7% of annual survey catch), another year's data will improve the certainty of the incoming year-classes

Assessment summary table

Indicators	Values	Trends	Status
Total mortality 2018: Retained catch 2018: Average removals 2014–18:	38.74 MLBS, 17,572 T 31.81 MLBS, 14,427 T 41.39 MLBS, 18,772 T	MORTALITY DECREASED FROM 2017 TO 2018	2018 MORTALITY NEAR 100-YEAR LOW
SPR_{2018}: P(SPR<46%): P(SPR<limit):	49% (28-62%) 34% LIMIT NOT SPECIFIED	FISHING INTENSITY DECREASED FROM 2017 TO 2018	FISHING INTENSITY BELOW REFERENCE LEVEL
SB_{2019} (Mlb): SB_{2019}/SB_0: P($SB_{2019}<SB_{30}$): P($SB_{2019}<SB_{20}$):	199 MLBS (125–287) 43% (27-63%) 11% <1%	SB DECREASED FROM 2017 TO 2018	NOT OVERFISHED
Biological stock distribution:	SEE TABLES AND FIGURES	DISTRIBUTION STABLE 2014-18	REGION 2 ABOVE, REGION 3 BELOW HISTORICAL VALUES

Outline

- Coastwide stock assessment
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Projections – no fishing
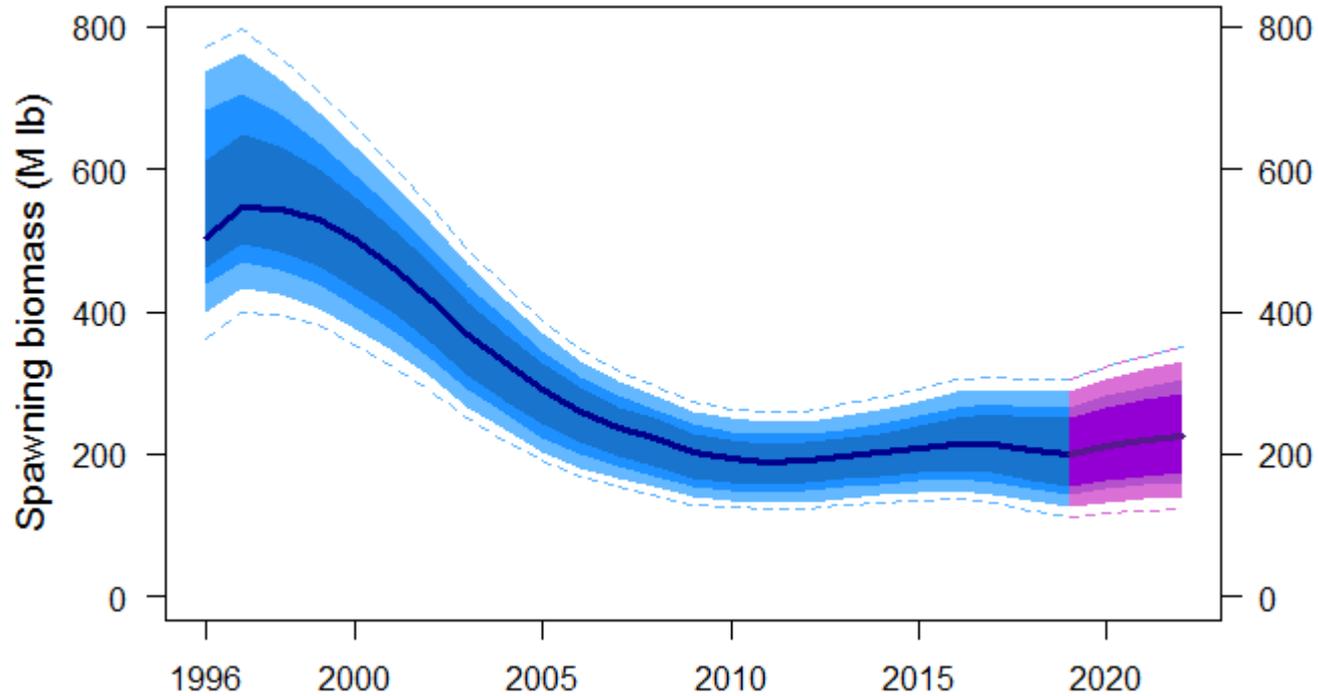
Projections – 20 Mlb TCEY
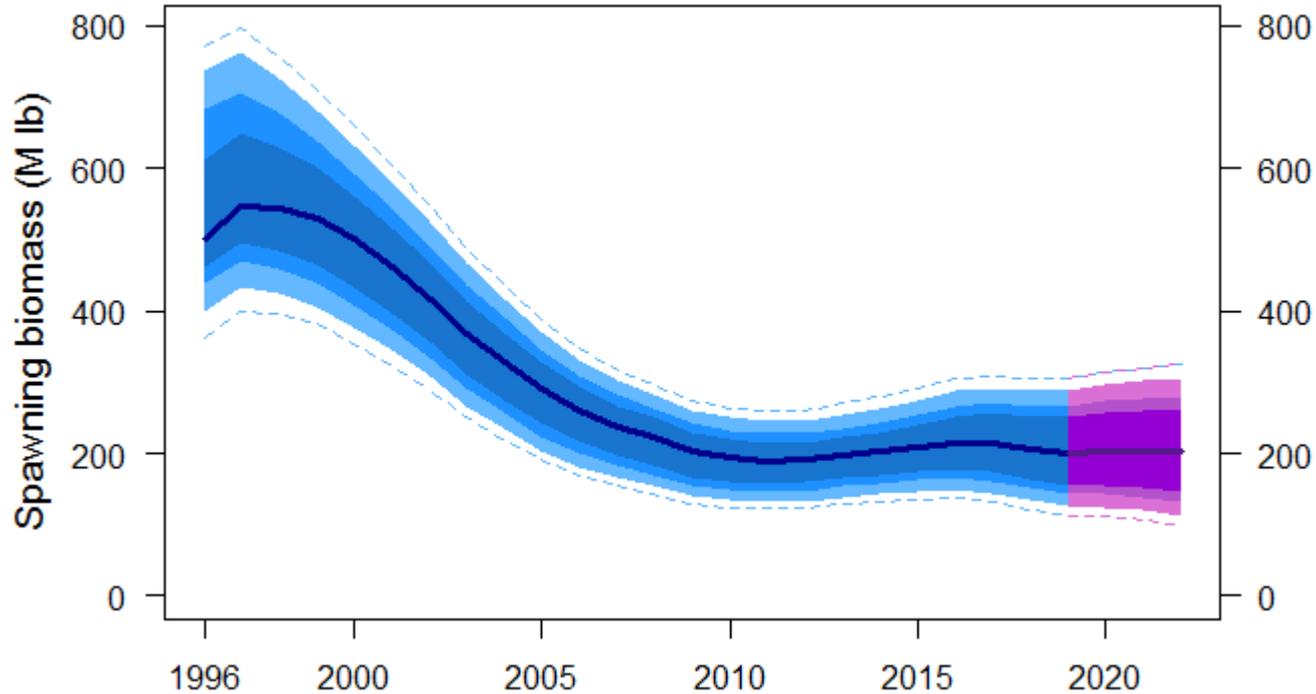
Projections – *status quo* (37.2 Mlb TCEY)
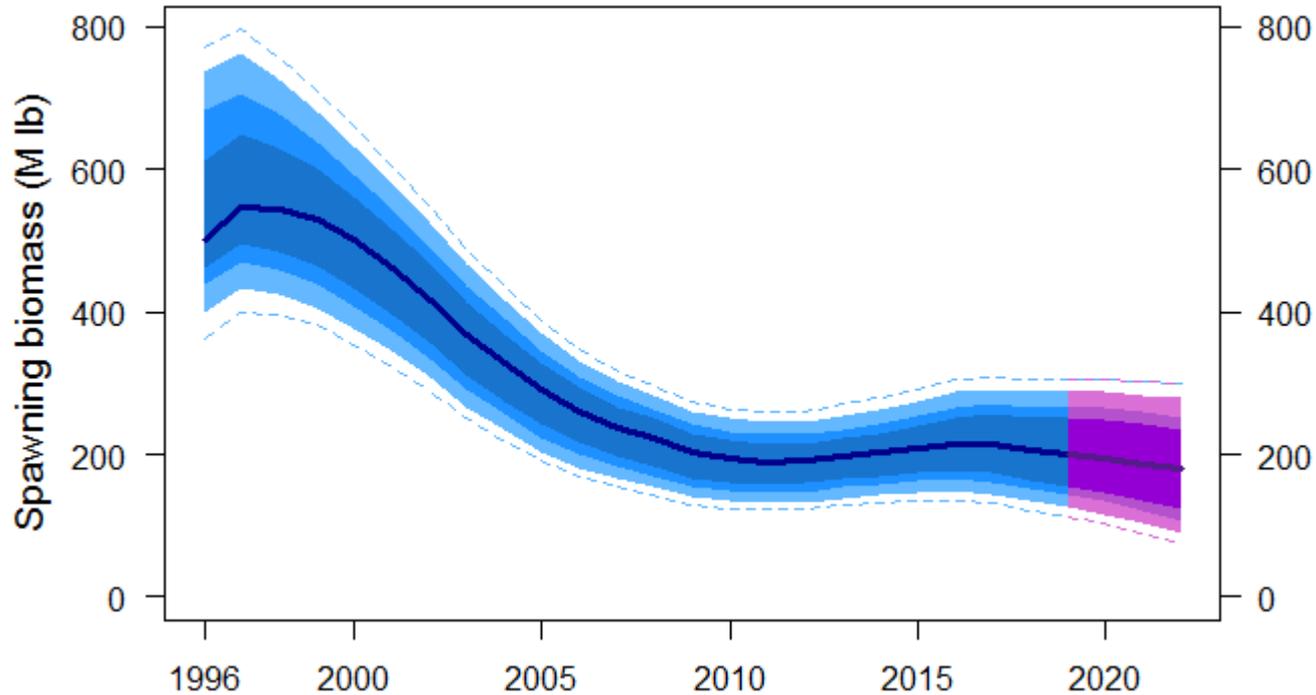
Projections – Reference ($F_{46\%}$, 40 Mlb TCEY)

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Projections – 60 Mlb TCEY

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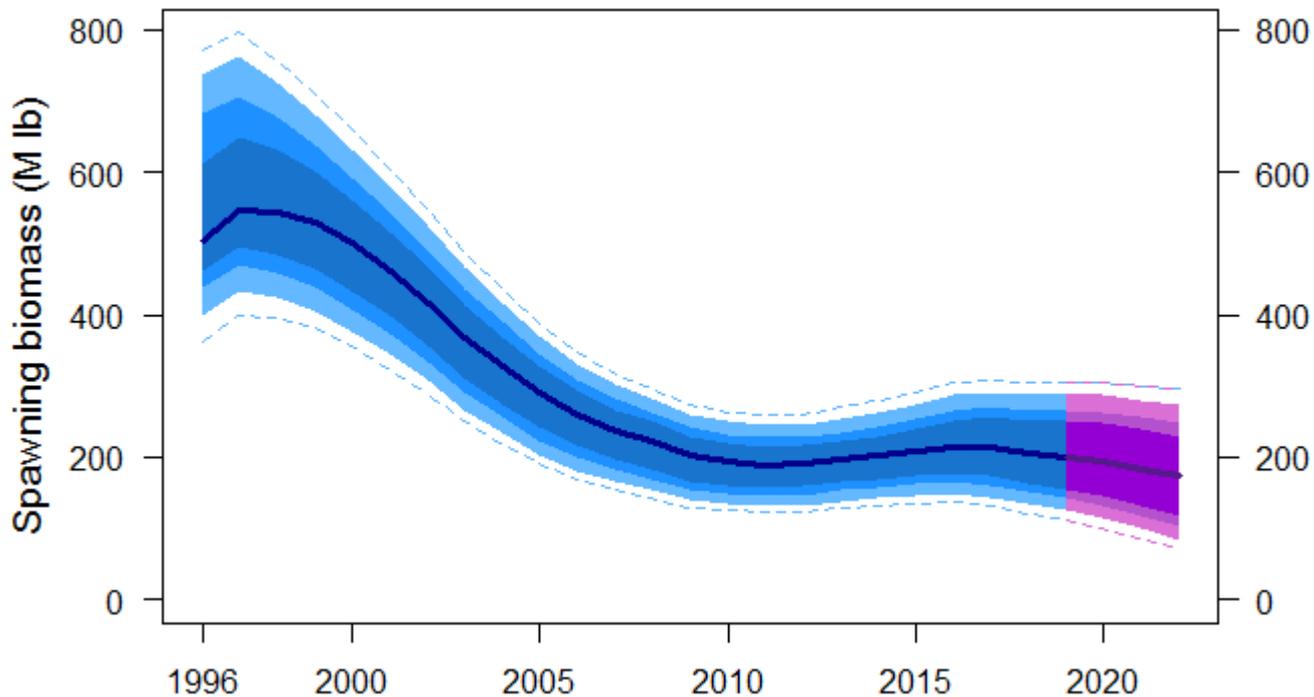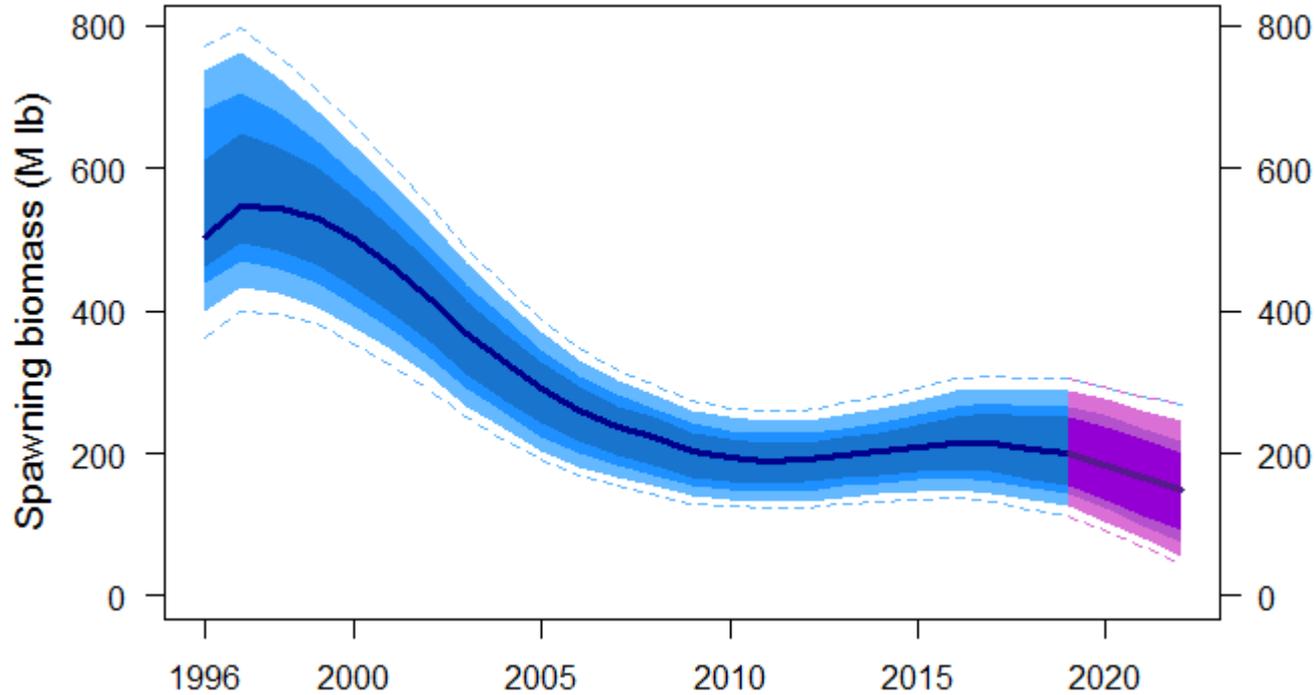
2019 Decision table

2019 Alternative

Total mortality (M lb)
TCEY (M lb)
2019 Fishing intensity
Fishing intensity interval

Benefits (yield)

Risk

2019 Decision table

2019 Alternative			No fishing mortality					Status quo		Reference SPR=46%								
Total mortality (M lb)			0.0	11.7	21.8	31.8	37.6	39.0	40.4	41.8	43.1	44.3	45.5	46.8	48.3	49.9	61.8
TCEY (M lb)			0.0	10.0	20.0	30.0	35.8	37.2	38.6	40.0	41.3	42.5	43.7	45.0	46.5	48.1	60.0
2019 Fishing intensity			$F_{100\%}$	$F_{78\%}$	$F_{64\%}$	$F_{54\%}$	$F_{49\%}$	$F_{48\%}$	$F_{47\%}$	$F_{46\%}$	$F_{45\%}$	$F_{44\%}$	$F_{43\%}$	$F_{42\%}$	$F_{41\%}$	$F_{40\%}$	$F_{34\%}$
Fishing intensity interval			--	56-87%	41-76%	31-67%	27-63%	26-62%	25-61%	25-60%	24-59%	23-59%	23-58%	22-57%	22-56%	21-55%	17-49%
Stock Trend (spawning biomass)	in 2020	is less than 2019	1	3	26	60	77	81	84	87	90	92	93	95	96	97	>99	a
		is 5% less than 2019	<1	<1	1	10	26	30	34	37	39	41	43	45	48	50	78	b
	in 2021	is less than 2019	1	7	41	75	90	93	94	96	97	98	98	99	99	99	>99	c
		is 5% less than 2019	<1	1	11	42	57	61	65	69	73	77	80	83	87	90	99	d
	in 2022	is less than 2019	1	12	51	82	93	94	96	97	98	98	99	99	99	>99	>99	e
		is 5% less than 2019	<1	3	28	58	76	79	83	86	88	90	92	93	95	96	>99	f

High probability of stock decline over all TCEYs larger than 20 Mlb

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2019 Decision table

2019 Alternative		No fishing mortality					Status quo		Reference SPR=46%							
Total mortality (M lb)		0.0	11.7	21.8	31.8	37.6	39.0	40.4	41.8	43.1	44.3	45.5	46.8	48.3	49.9	61.8
TCEY (M lb)		0.0	10.0	20.0	30.0	35.8	37.2	38.6	40.0	41.3	42.5	43.7	45.0	46.5	48.1	60.0
2019 Fishing intensity		$F_{100\%}$	$F_{78\%}$	$F_{64\%}$	$F_{54\%}$	$F_{49\%}$	$F_{48\%}$	$F_{47\%}$	$F_{46\%}$	$F_{45\%}$	$F_{44\%}$	$F_{43\%}$	$F_{42\%}$	$F_{41\%}$	$F_{40\%}$	$F_{34\%}$
Fishing intensity interval		--	56-87%	41-76%	31-67%	27-63%	26-62%	25-61%	25-60%	24-59%	23-59%	23-58%	22-57%	22-56%	21-55%	17-49%
Stock Status (Spawning biomass) in 2020	is less than 30%	5	7	11	14	17	17	18	18	19	19	20	20	21	21	25	g
	is less than 20%	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	h
in 2021	is less than 30%	3	7	13	20	24	25	25	26	27	27	27	28	29	29	33	i
	is less than 20%	<1	<1	<1	<1	1	1	1	1	2	2	2	3	3	4	10	j
in 2022	is less than 30%	2	8	17	25	28	29	29	30	30	31	31	32	33	33	41	k
	is less than 20%	<1	<1	<1	2	4	5	6	7	8	9	10	12	13	15	24	l

Increasing, but low probability of dropping below $SB_{30\%}$, $SB_{20\%}$.

2019 Decision table

2019 Alternative			No fishing mortality						Status quo			Reference SPR=46%							
Total mortality (M lb)			0.0	11.7	21.8	31.8	37.6	39.0	40.4	41.8	43.1	44.3	45.5	46.8	48.3	49.9	61.8	
TCEY (M lb)			0.0	10.0	20.0	30.0	35.8	37.2	38.6	40.0	41.3	42.5	43.7	45.0	46.5	48.1	60.0	
2019 Fishing intensity			$F_{100\%}$	$F_{78\%}$	$F_{64\%}$	$F_{54\%}$	$F_{49\%}$	$F_{48\%}$	$F_{47\%}$	$F_{46\%}$	$F_{45\%}$	$F_{44\%}$	$F_{43\%}$	$F_{42\%}$	$F_{41\%}$	$F_{40\%}$	$F_{34\%}$	
Fishing intensity interval			--	56-87%	41-76%	31-67%	27-63%	26-62%	25-61%	25-60%	24-59%	23-59%	23-58%	22-57%	22-56%	21-55%	17-49%	
Fishery Trend (TCEY)	in 2020	is less than 2019	0	<1	18	26	40	45	51	56	60	63	66	69	73	77	95	m
		is 10% less than 2019	0	<1	12	25	29	33	37	42	47	51	54	58	62	66	95	n
	in 2021	is less than 2019	0	<1	20	28	46	51	56	60	64	67	70	73	77	81	97	o
		is 10% less than 2019	0	<1	16	26	35	39	44	49	53	56	59	63	66	71	97	p
	in 2022	is less than 2019	0	<1	22	32	50	54	58	62	66	69	72	76	79	83	98	q
		is 10% less than 2019	0	<1	19	28	40	45	49	53	56	60	62	66	69	73	98	r
Fishery Status (Fishing intensity)	in 2019	is above $F_{46\%}$	0	<1	16	25	35	40	46	50	56	59	62	65	69	72	92	s

Probabilities of decreased fishery yield (on returning to an $F_{46\%}$) exceed 50/100 between 36 and 43 Mlb TCEY

25/100 chance of exceeding $F_{46\%}$ even at if "$F_{54\%}$" is selected

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Projection summary

- New data suggest slightly lower recent fishing intensity (but not significantly different given uncertainty)

- Stock declines estimated for last few years and projected to continue under TCEYs greater than 20 Mlbs

- 2019 data should refine estimates of uncertain 2011-2012 year-classes

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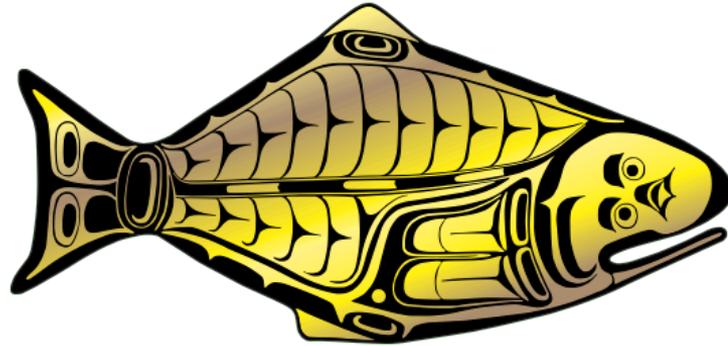
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Mortality projection tool

- <u>Inputs (yellow cells, everything else locked)</u>:
  - Distributed mortality limit (TCEY)
  - % of TCEY in each Regulatory Area
  - Bycatch option (previous year's estimates or full regulatory limits)
  - Unit of measure (Mlb, metric tons)

https://iphc.int/data/projection-tool

Mortality projection tool

- <u>Outputs</u>:
  - Estimated SPR
  - TCEY and total mortality by Regulatory Area
  - Modelled stock and TCEY distribution with relative harvest rate by Biological Region
  - Detailed mortality tables (by Regulatory Area and sector)
    - Applying the Catch agreements in each Area

  https://iphc.int/data/projection-tool

Mortality projection tool

- <u>Graphics</u>:
  - Spawning biomass projection
  - Coastwide relative fishing intensity
  - Relative harvest rate by Biological Region
  - Mortality by source and Regulatory Area (% and absolute)

https://iphc.int/data/projection-tool

Example: 'Interim management procedure'

- **<u>Scale</u>** from:
  - Reference SPR = 46%

- **<u>Distribution</u>** from:
  - Modelled O32 survey distribution by Regulatory Area
  - Relative harvest rates by Regulatory Area:

    1.0 in 2A-3A, 0.75 in 3B-4CDE

https://iphc.int/data/projection-tool

Recent Reference TCEYs by Region

	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

Recent Adopted TCEYs by Region

	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

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Recent Reference TCEYs by Regulatory Area

	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

Recent Adopted TCEYs by Regulatory Area

	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

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