



INTERNATIONAL PACIFIC



HALIBUT COMMISSION

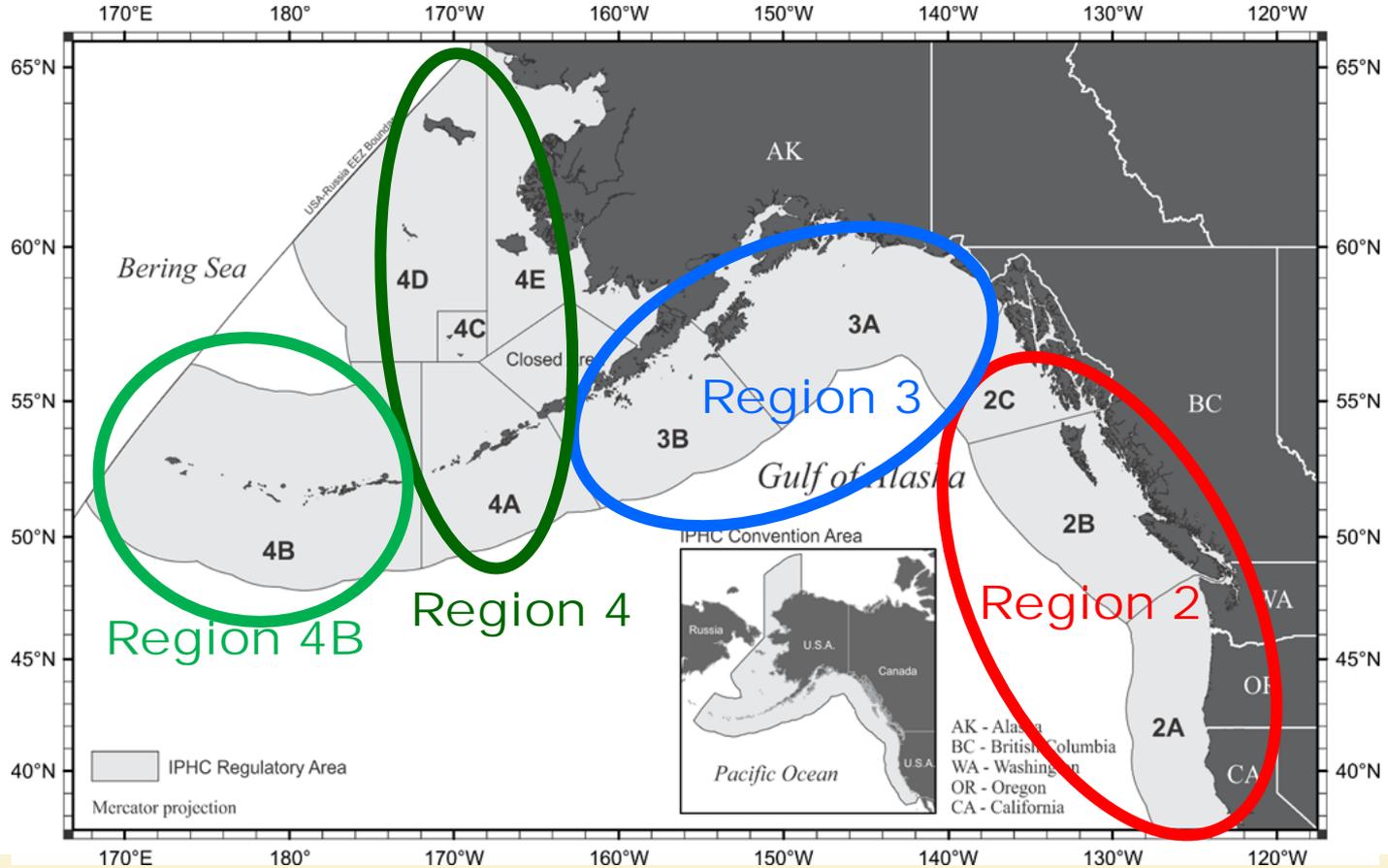
Stock Assessment and MSE at IPHC

PRIPHC02
Agenda Item 3.3

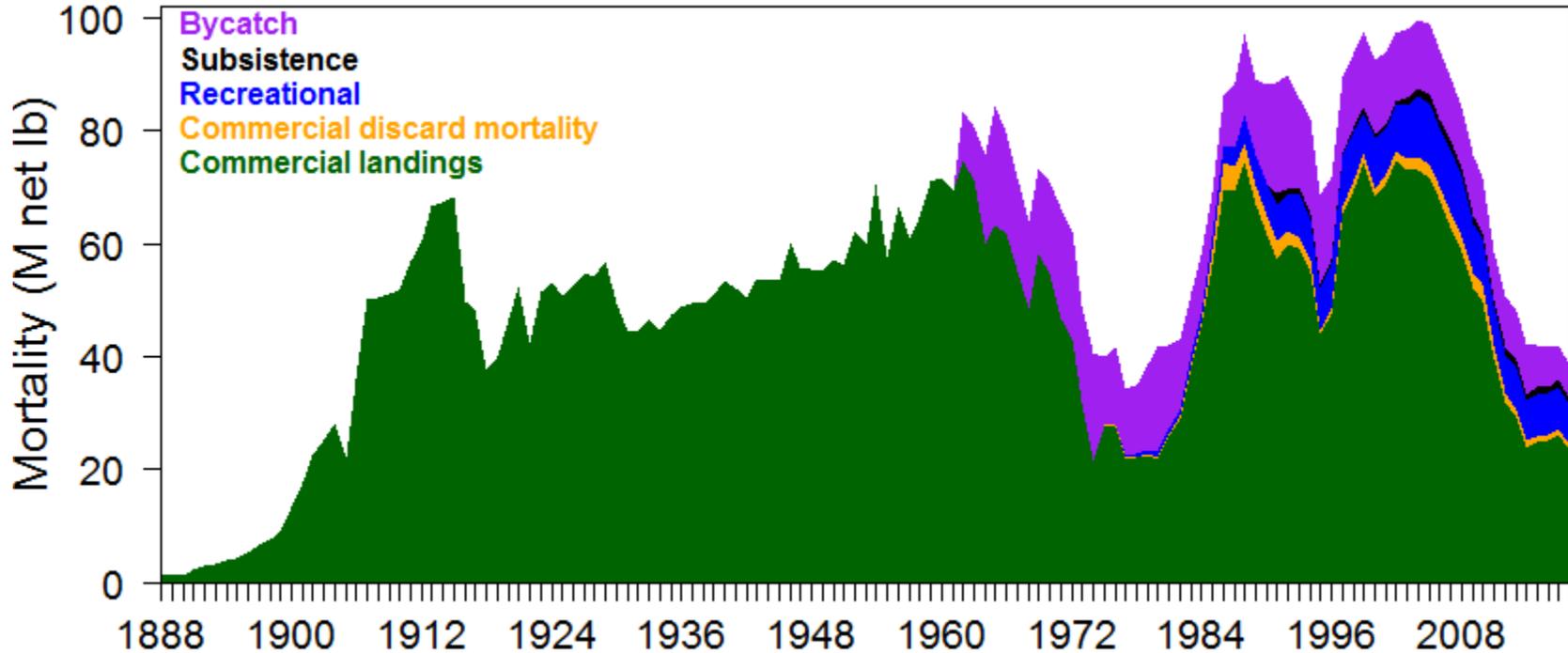
Stock assessment history at IPHC

Years	Model	Era (Clark 2003)
Pre-1977	Yield, Yield-per-recruit, Simple stock-production models	Renaissance
1978-1981	Cohort analysis, coastwide, natural mortality (M)=0.2	
1982-1983	Catch-AGE-Analysis (CAGEAN, age-based availability), coastwide, M=0.2	Golden Age
1984-1988	CAGEAN, area-specific, migratory and coastwide, M=0.2	
1989-1994	CAGEAN, area-specific, M=0.2, age-based selectivity	
1995-1997	Statistical Catch-Age (SCA), area-specific, length-based selectivity, M=0.2	Modern Age
1998-1999	SCA, area-specific, length-based selectivity, M=0.15	
2000-2002	New SCA, area-specific, constant age-based selectivity, M=0.15	
2003-2006	SCA, area-specific, constant length-based selectivity, M=0.15	Postmodern
2006-2011	SCA, coastwide, constant length-based availability, M=0.15	
2012-present	SCA, coastwide, time-varying selectivity, ensemble model, move from catch advice to risk analysis	???

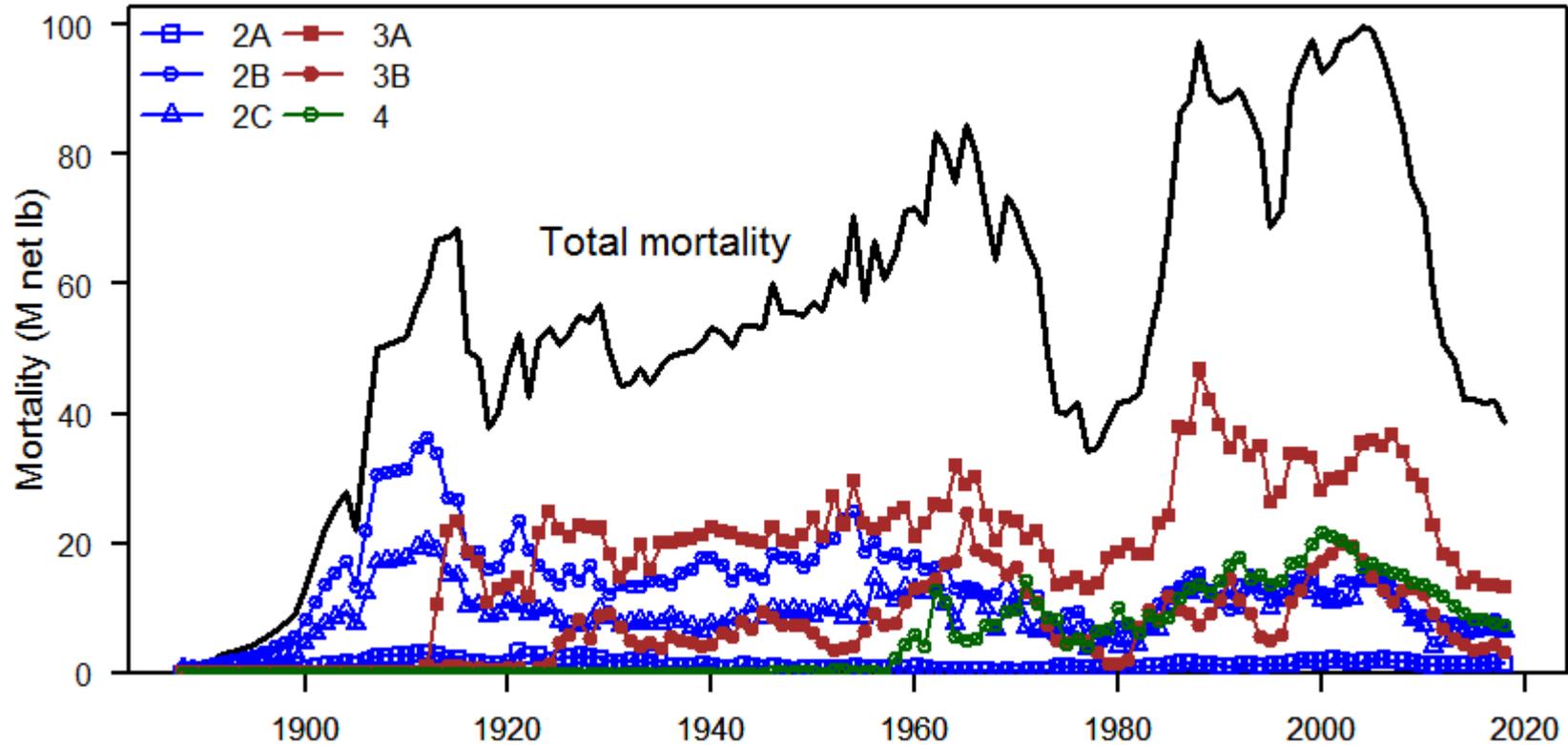
Biological regions



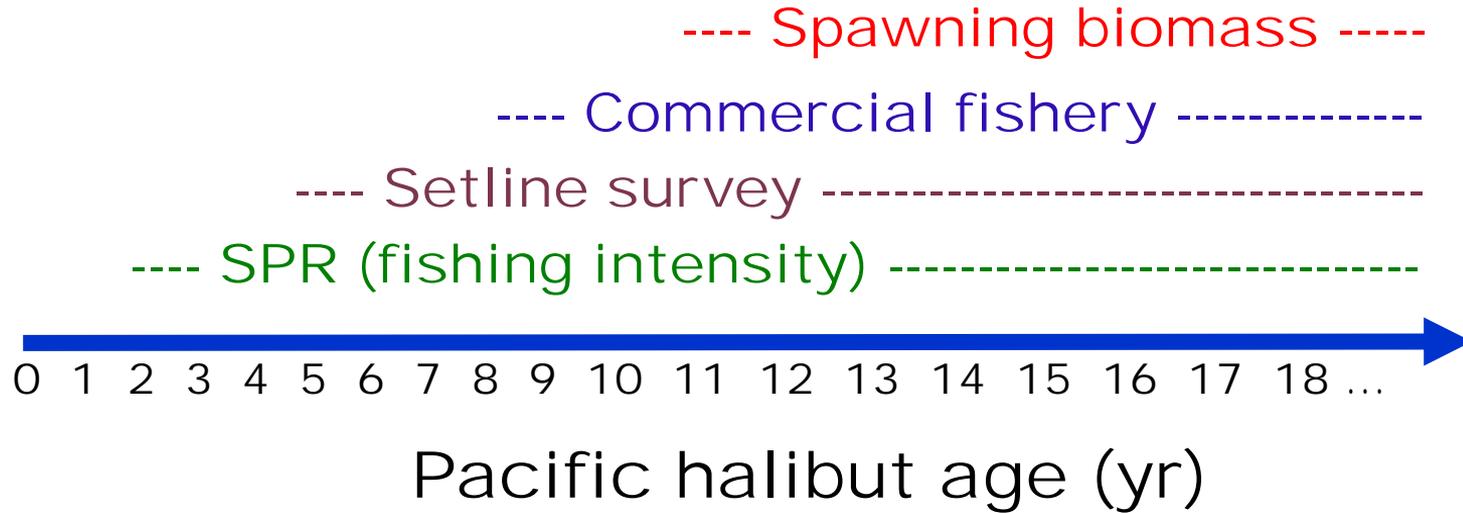
Historical fishing mortality



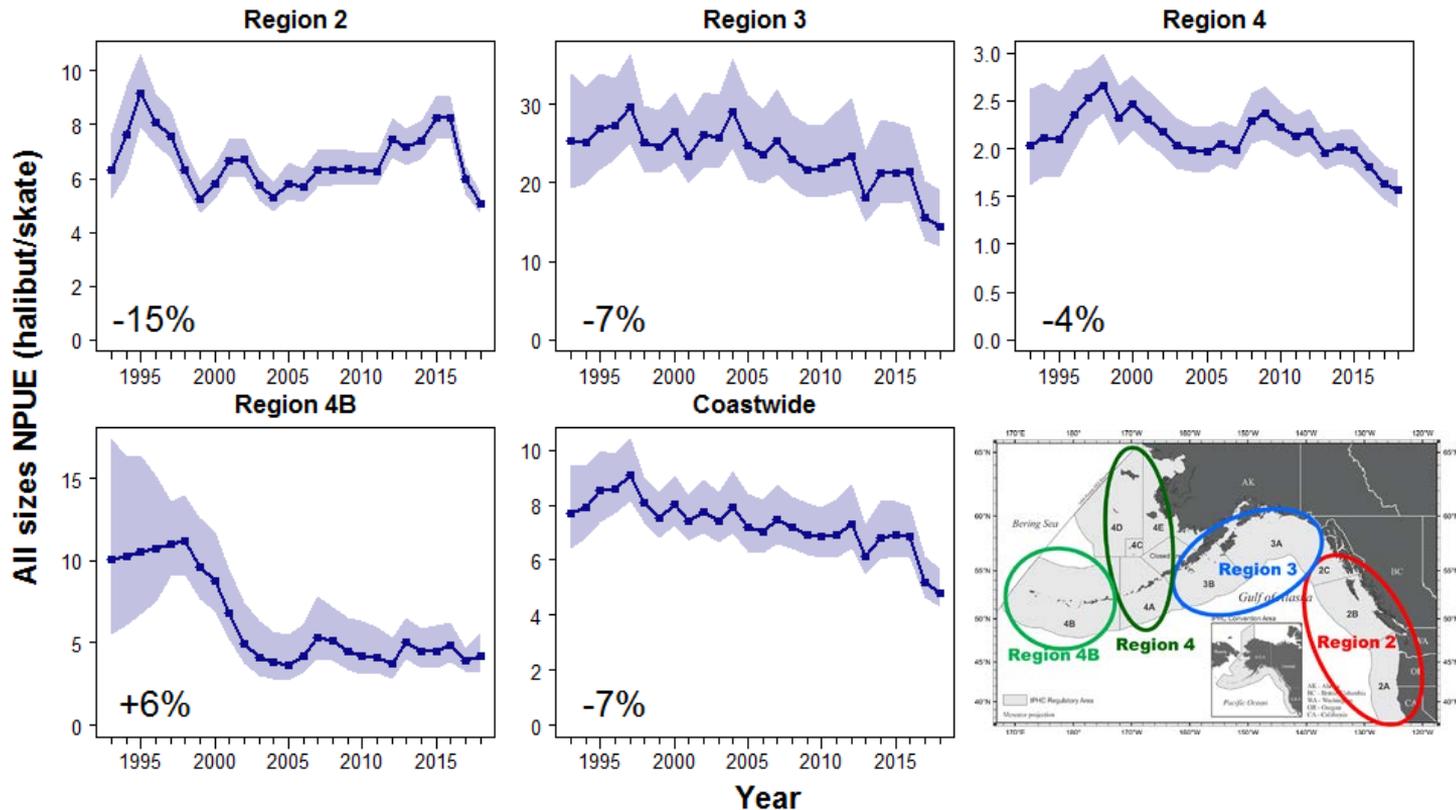
Historical mortality



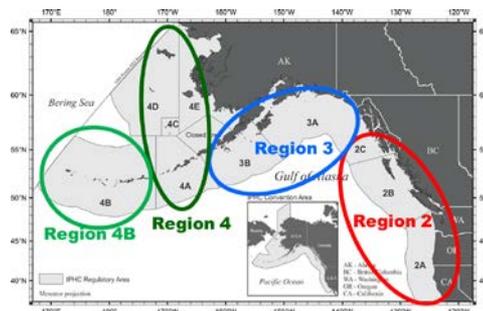
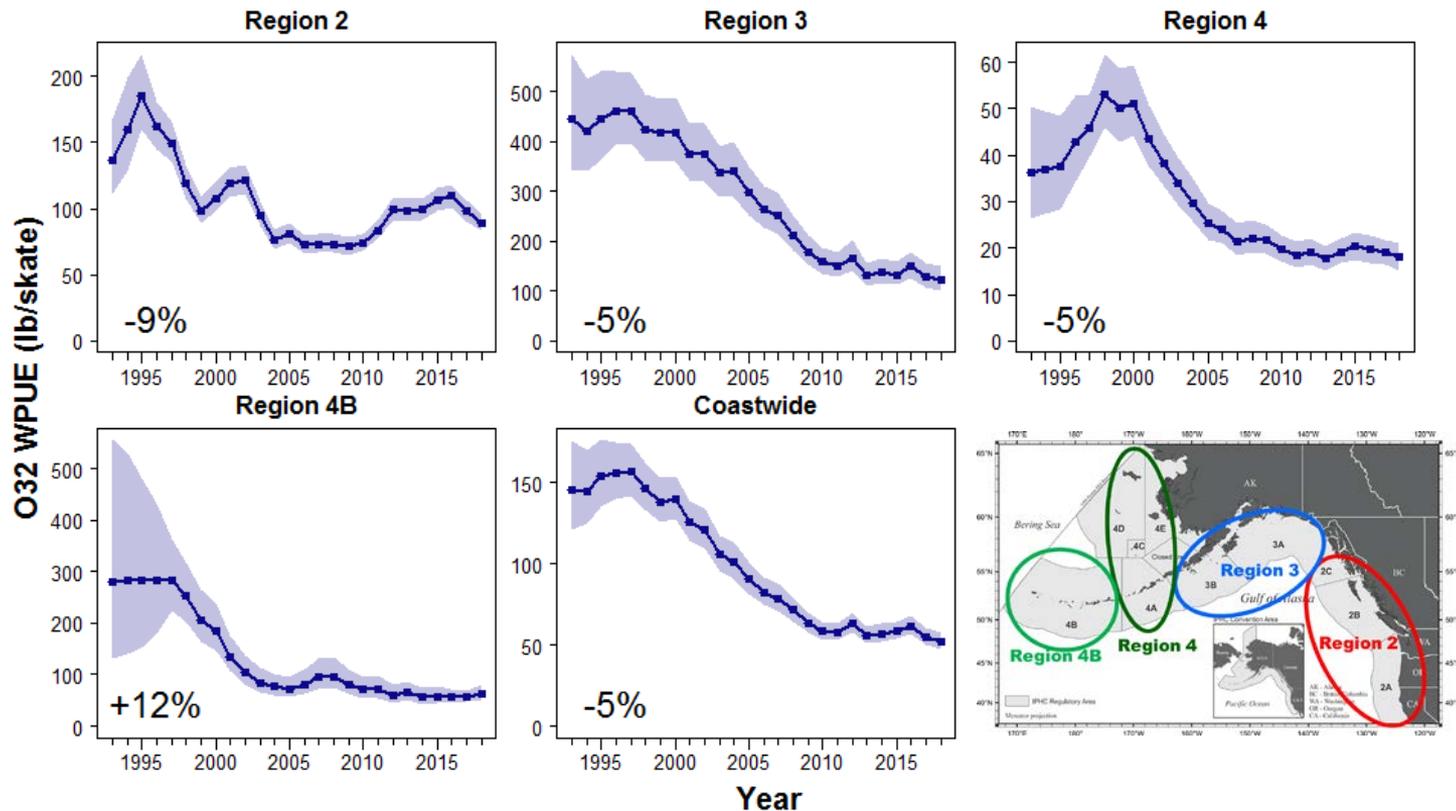
Comparing trends



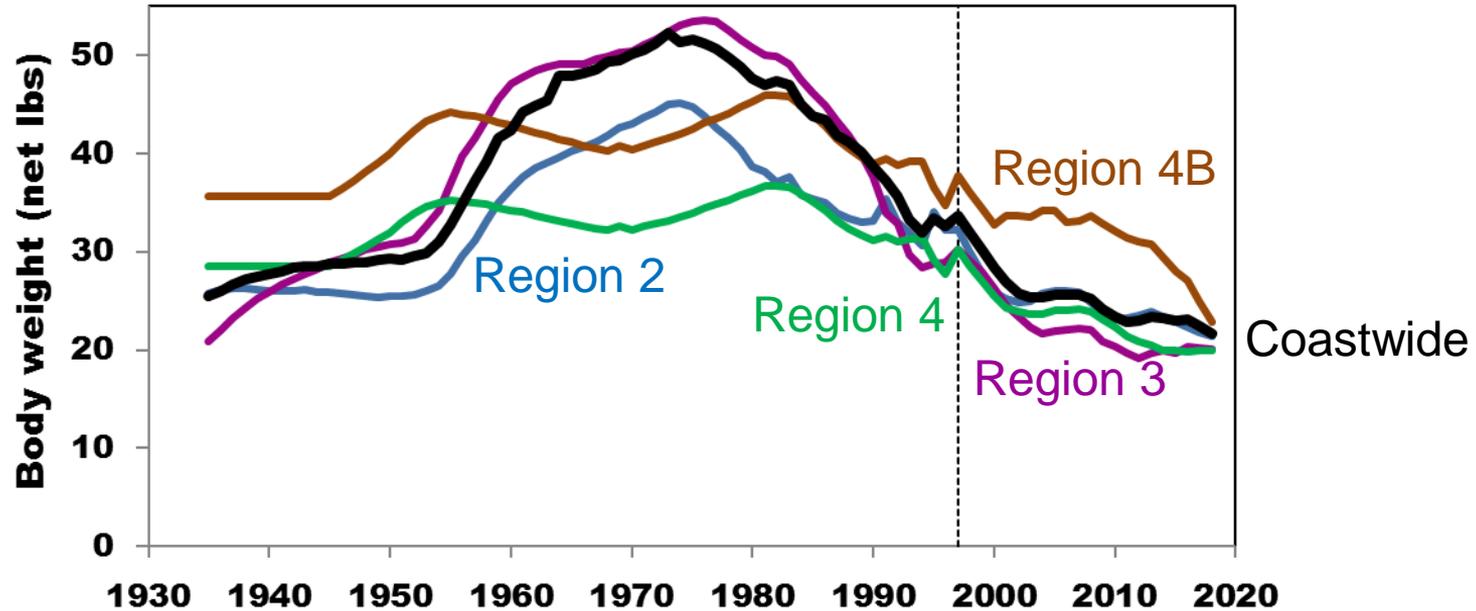
Modelled survey trend (Numbers)



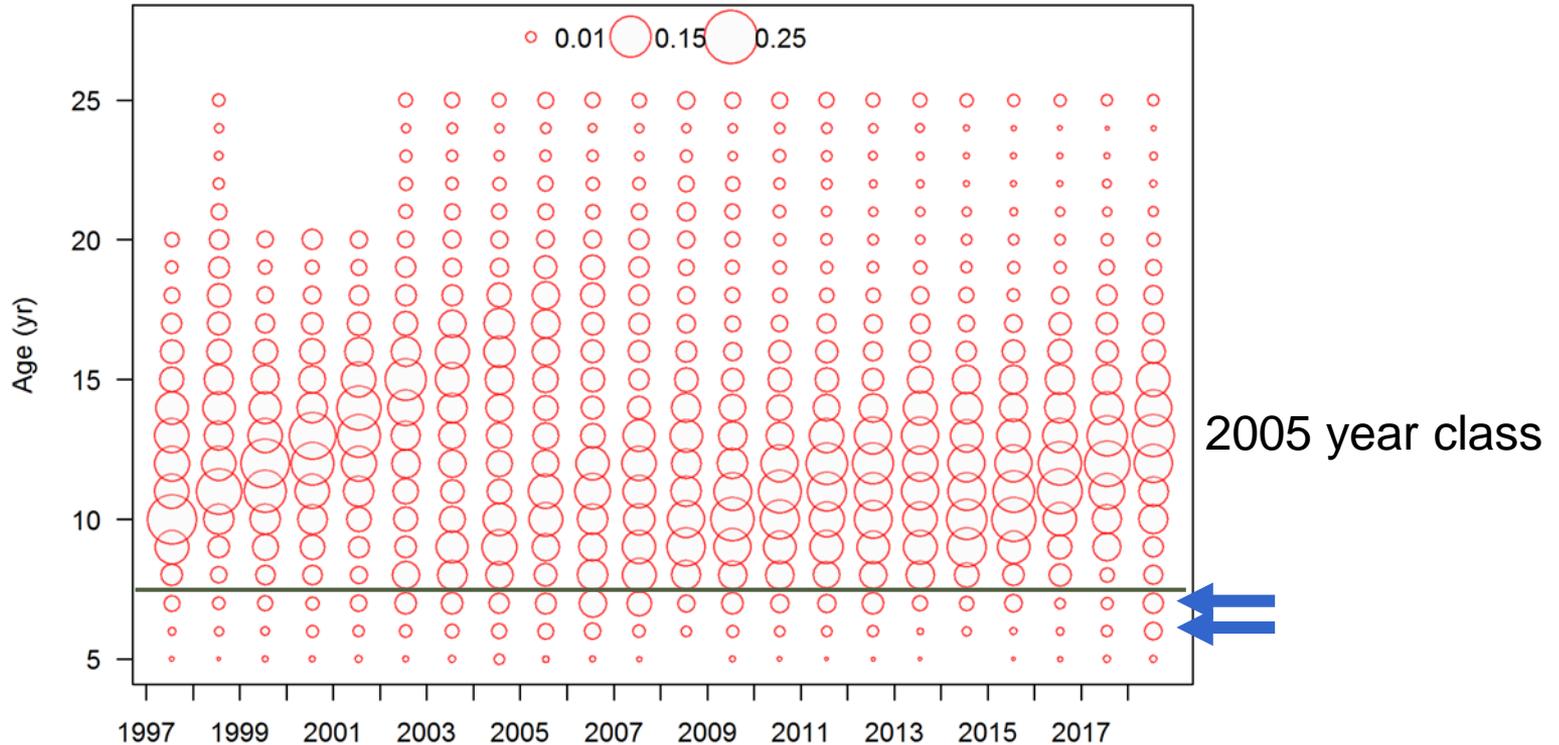
Modelled survey trend (O32 WPUE)



Historical weight-at-age: Age-12 female

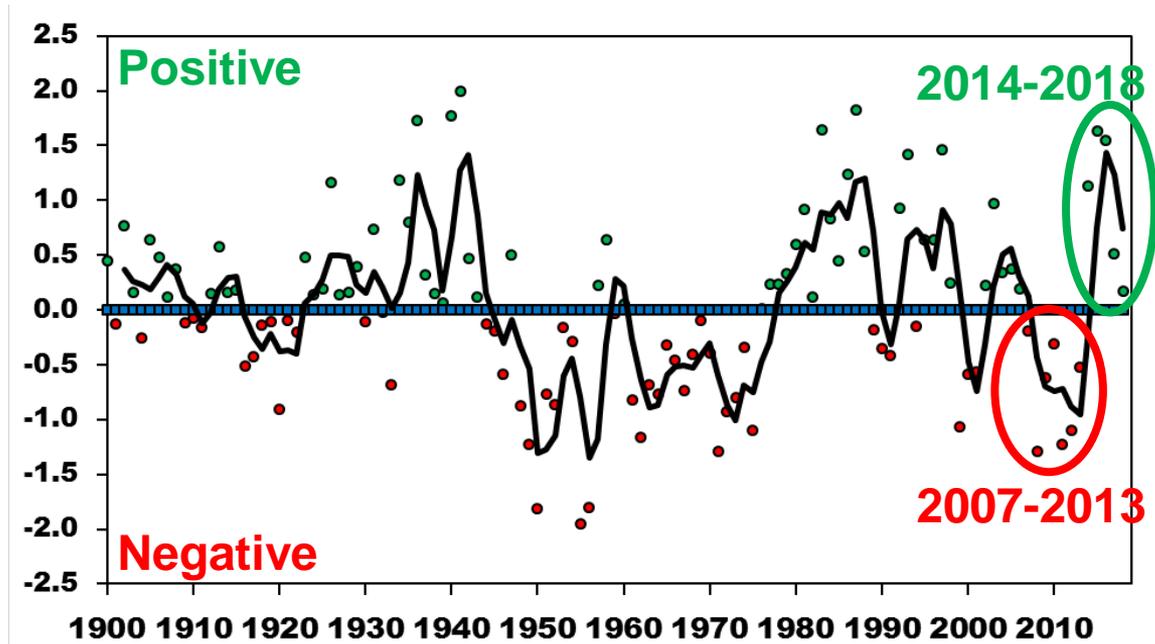


Setline survey ages (sexes combined)



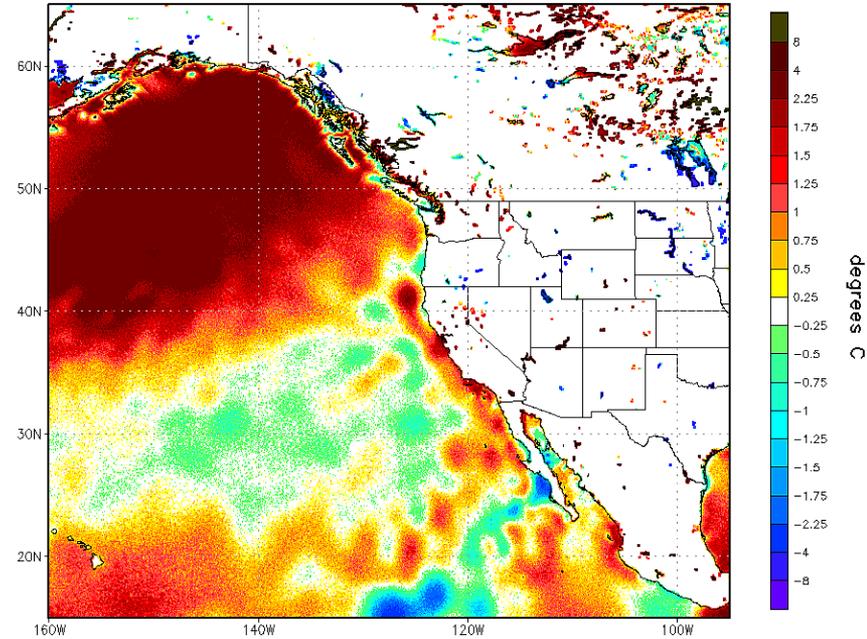
Ecosystem conditions

- Number of fish that recruit to population tied to environment
- Weakly positive Pacific Decadal Oscillation in 2018



Ecosystem conditions

- More warm water in the fall of 2018
- No cold pool in Bering Sea winter 2017/2018
 - Northerly shift in cod and pollock distributions
 - Bird mortality

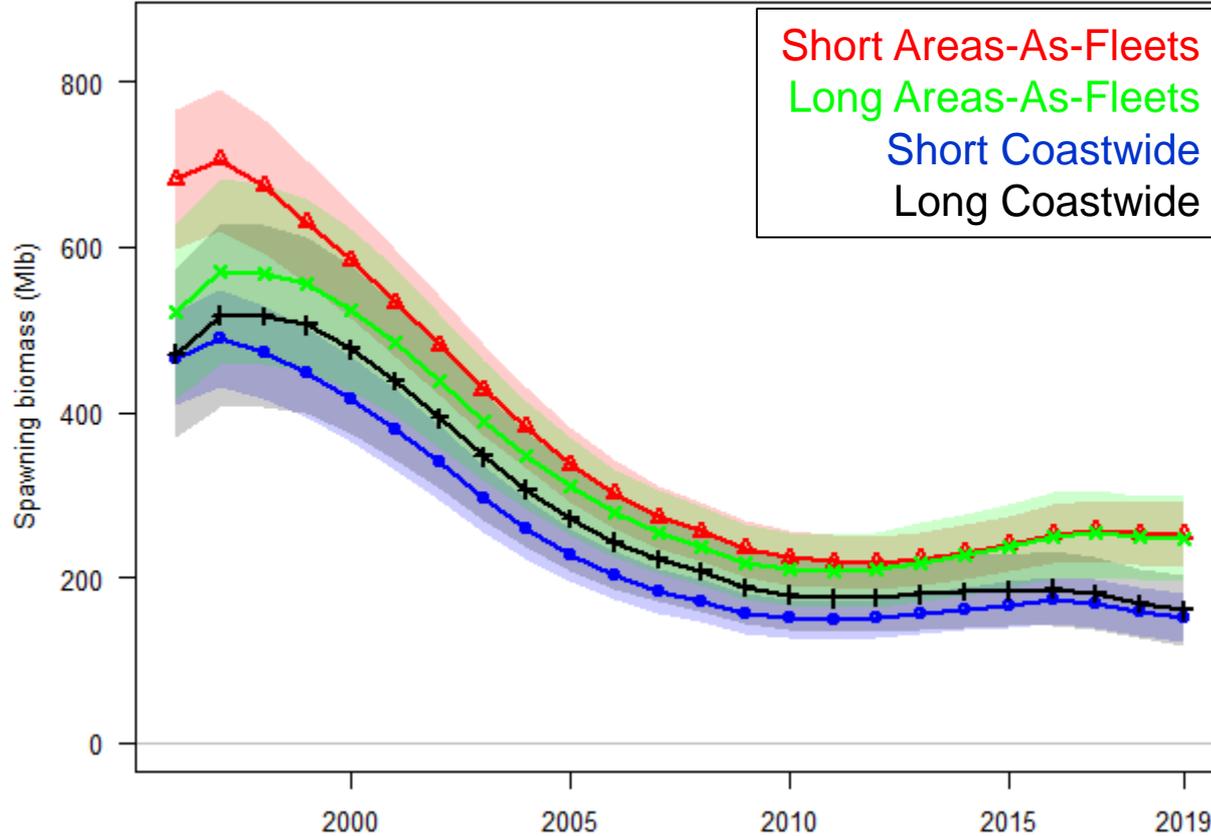


Temperature anomalies from October

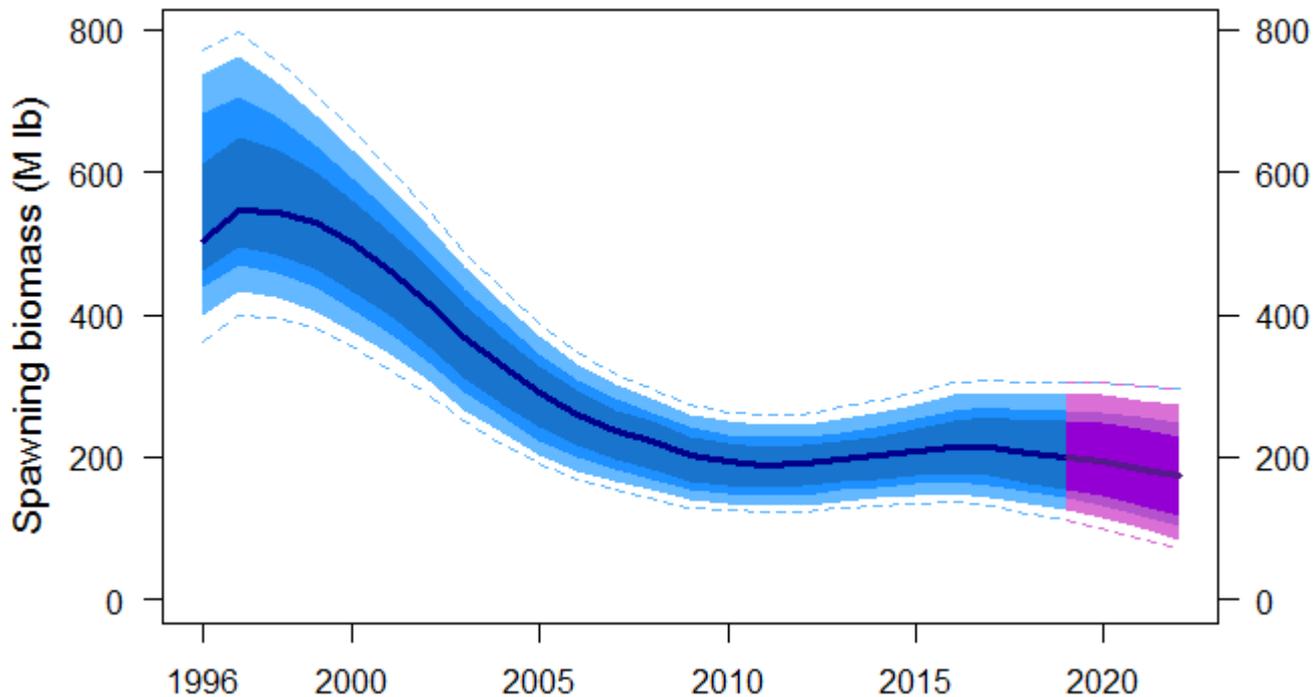
Assessment Modelling

- Reviewed annually by the SRB
 - Minor incremental improvements made in response
 - 2018 assessment used the same ensemble methodology (4 models) from 2016-17
 - based on the independent scientific review in 2015
- External review occurs every few years
 - Major changes reviewed externally and by SRB
 - 2019 assessment completely revisited
 - Will be reviewed in 2019

Spawning biomass



Projections – Reference ($F_{46\%}$, 40 Mlb TCEY)



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
		is 5% less than 2019	<1	<1	1	10	26	30	34	37	39	41	43	45	48	50	78
	in 2021	is less than 2019	1	7	41	75	90	93	94	96	97	98	98	99	99	99	>99
		is 5% less than 2019	<1	1	11	42	57	61	65	69	73	77	80	83	87	90	99
	in 2022	is less than 2019	1	12	51	82	93	94	96	97	98	98	99	99	99	>99	>99
		is 5% less than 2019	<1	3	28	58	76	79	83	86	88	90	92	93	95	96	>99

a
b
c
d
e
f

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

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
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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
		is less than 20%	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	in 2021	is less than 30%	3	7	13	20	24	25	25	26	27	27	27	28	29	29	33
		is less than 20%	<1	<1	<1	<1	1	1	1	1	2	2	2	3	3	4	10
	in 2022	is less than 30%	2	8	17	25	28	29	29	30	30	31	31	32	33	33	41
		is less than 20%	<1	<1	<1	2	4	5	6	7	8	9	10	12	13	15	24

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

Also see <https://www.iphc.int/data/projection-tool> for area specific mortality limits

Management Strategy Evaluation (MSE)

a process to evaluate harvest strategies and develop a management procedure that is robust to uncertainty and meets defined objectives



Primary Biological objectives

1.1. The primary objective is to avoid a critical biomass below which the stock may not recover

- No more than a 10% risk of being below
- 20% of the dynamic unfished equilibrium biomass
- Long-term (and short-term is of interest)

Tolerance

*Measurable
Outcome*

Time-frame

Short-term: 4-13 years

Medium-term: 14-23 years

Long-term: Equilibrium

Primary Fishery objectives

2.1. Limit annual changes in the TCEY

- No more than a 25% risk of being above
- 15% Average Annual Variability (AAV)
- Short-term (and long-term is of interest)

Tolerance

*Measurable
Outcome*

Time-frame

2.2. Maintain a minimum TCEY

- Not sure of a minimum or a tolerance

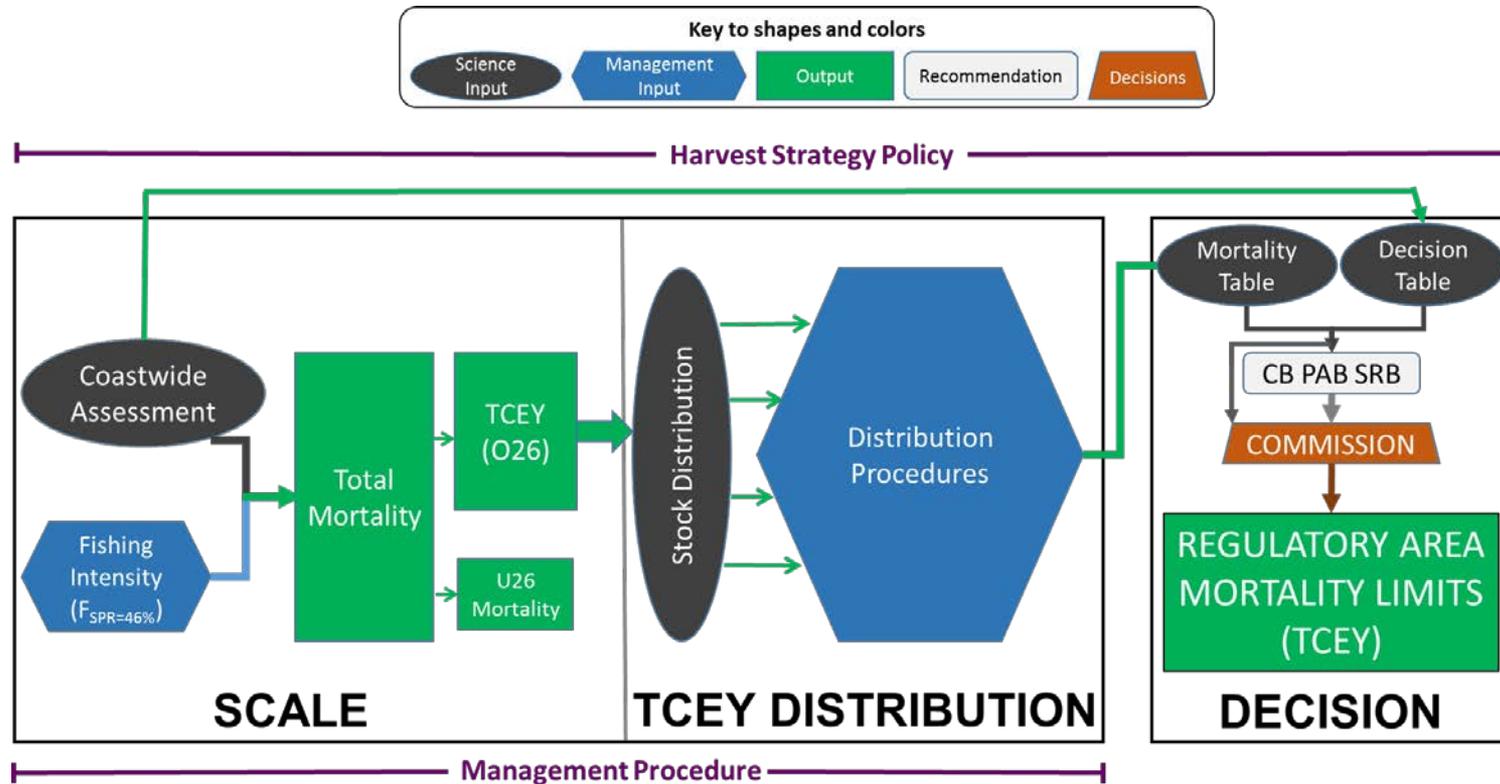
2.3. Maximize TCEY subject to above

Prioritized objectives

- Must meet long-term Biological Sustainability (1.1)
- Then meet short-term catch limit stability (2.1)
and maintain a minimum catch limit (2.2)
- Then maximize short-term fishery yield
subject to above

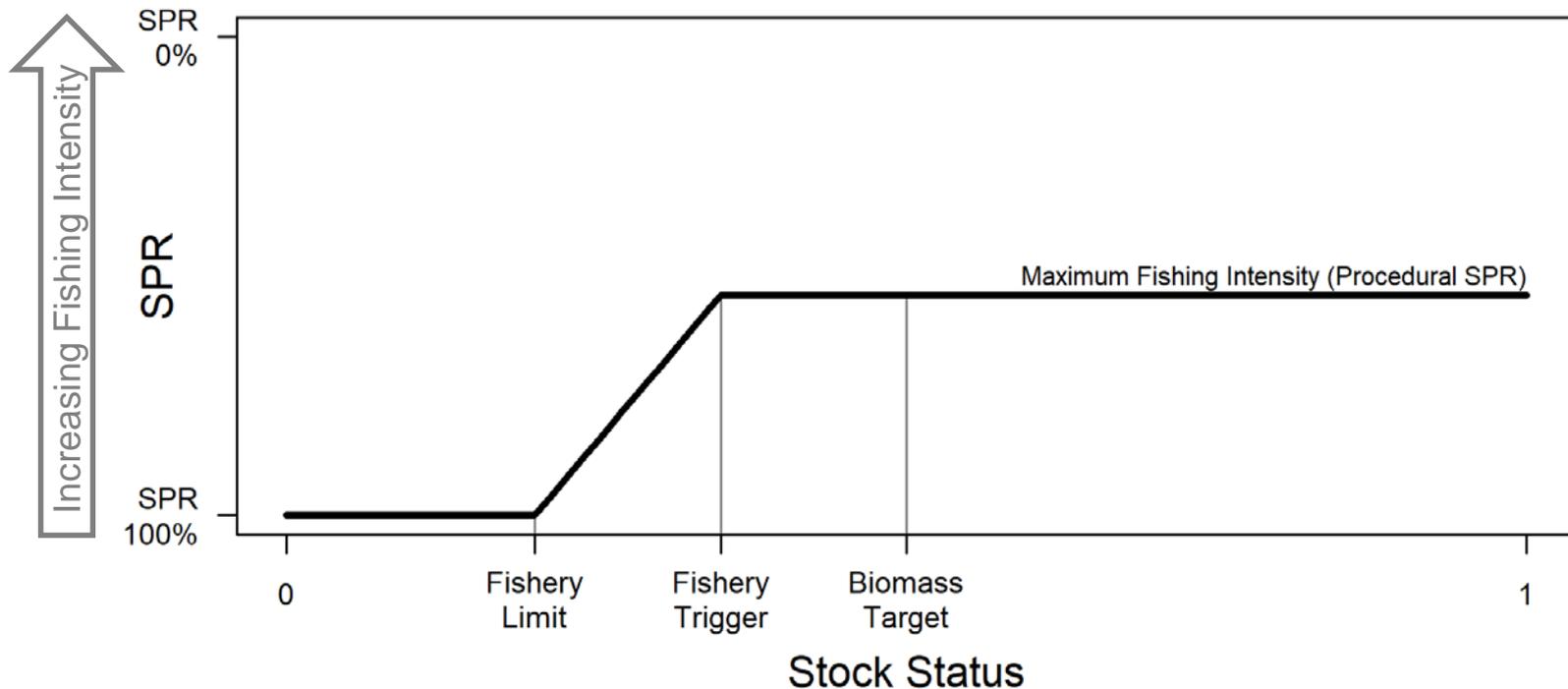
- Additional metrics can also be informative
 - For example. $P(SB < 30\%)$, median AAV, or quantiles

Management Procedure



Scale Management Procedure

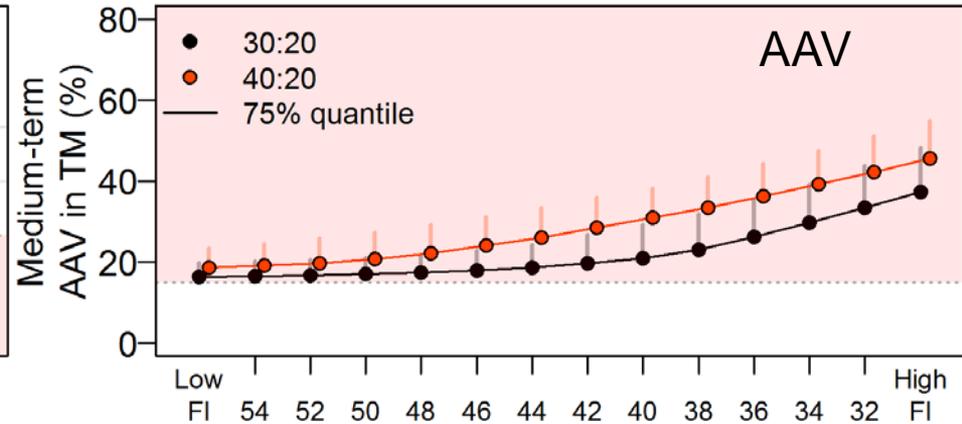
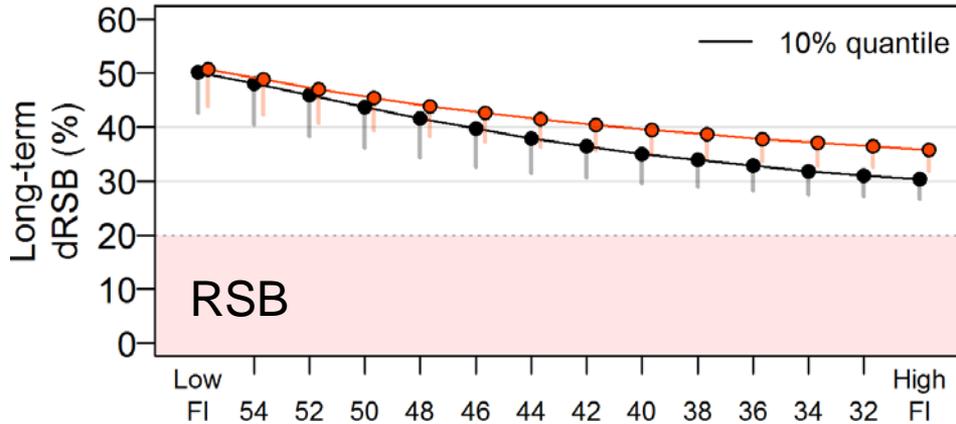
Harvest Control Rule



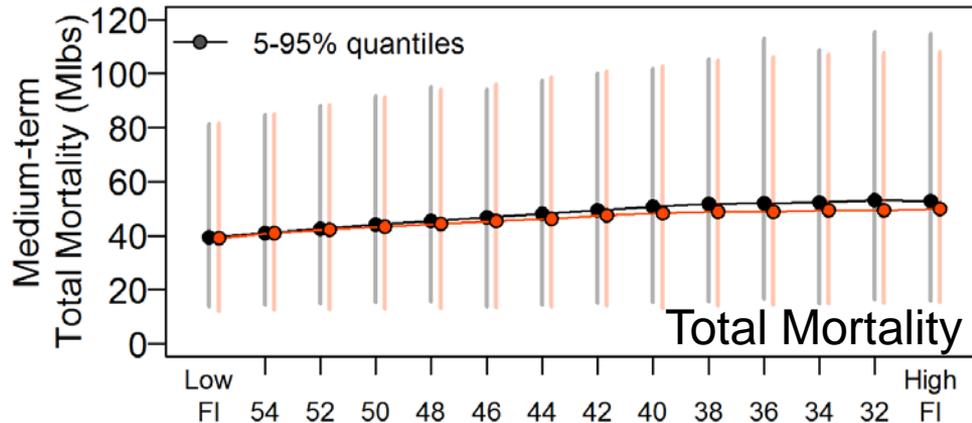
Simulation Results: Performance metrics

- Three performance metrics
 1. RSB: dynamic relative spawning biomass, long-term
 - A measure of stock status
 - Avoid going below 20% more than 10% of the time
 2. AAV: average annual variability, medium-term
 - Average percent change in TM limit from year to year
 - Avoid going above 15% more than 25% of the time
 3. TM: total mortality limit, medium-term
 - Maximize the median value

Performance metrics (40:20 & 30:20 CRs)



- Bio objective satisfied for all procedures
- AAV objective not satisfied for all procedures
- Median TM increases slightly and range increases with FI



Results table

Input Control Rule	30:20	30:20	30:20	30:20	30:20	30:20	30:20	30:20	30:20	30:20	30:20	30:20
Input SPR	56%	48%	46%	44%	42%	40%	38%	36%	34%	32%	32%	30%
Biological Sustainability (Long-term)												
P(all RSB<20%)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
P(any RSB_y<20%)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Fishery Sustainability (medium-term)												
P(all AAV > 15%)	0.60	0.66	0.69	0.72	0.76	0.80	0.84	0.88	0.93	0.96	0.96	0.98
Median average TM	39.4	45.5	46.8	48.0	49.5	50.6	51.8	52.1	52.4	53.2	53.2	52.8
Rankings (lower is better) over all management procedures without a constraint (Table 3, Table 4, and Table 5)												
Meet biological objective?	Yes											
Meet stability objective?	No											
Maximum catch (TM)	30	27	24	21	14	11	9	8	7	4	4	5
Overall Ranking	—	—	—	—	—	—	—	—	—	—	—	—

The MSE Explorer

<http://shiny.westus.cloudapp.azure.com/shiny/sample-apps/MSE-Explorer/>

Management Strategy Advisory Board: MSAB

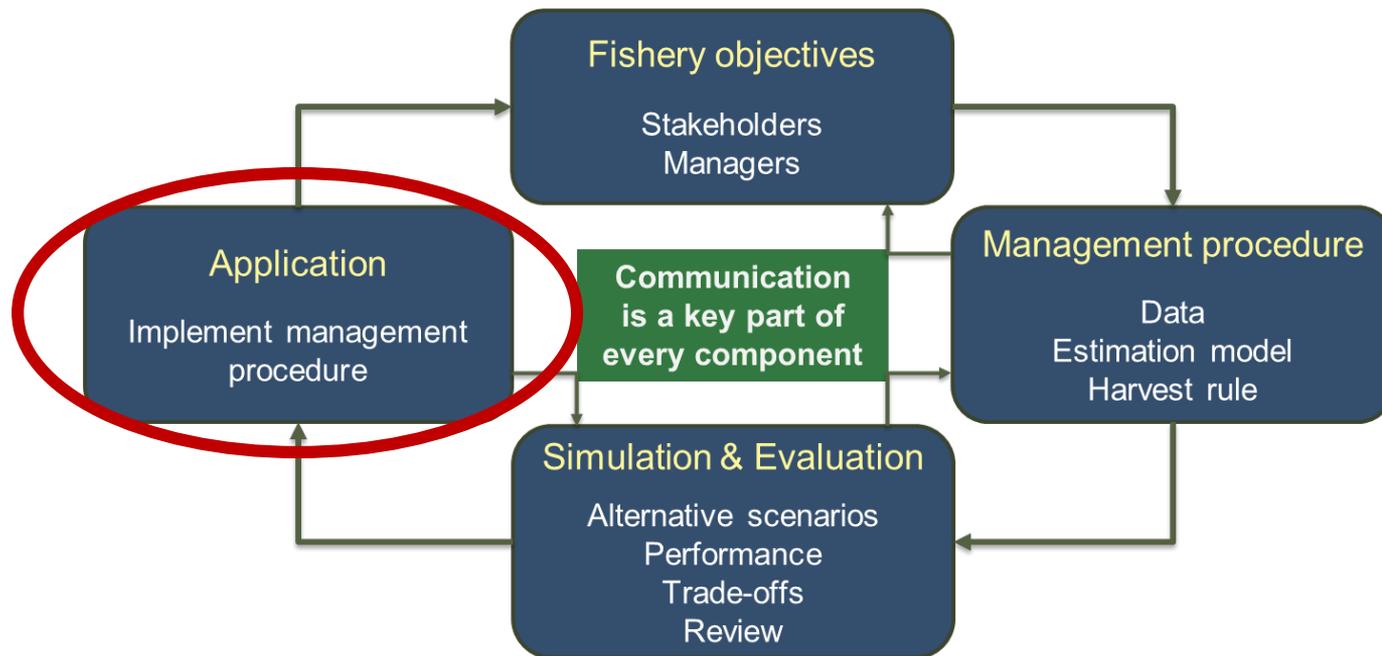
Advise on the MSE process

- Define goals, objectives, performance metrics
- Suggest procedures to investigate
- Evaluate simulation results
- Represent constituents



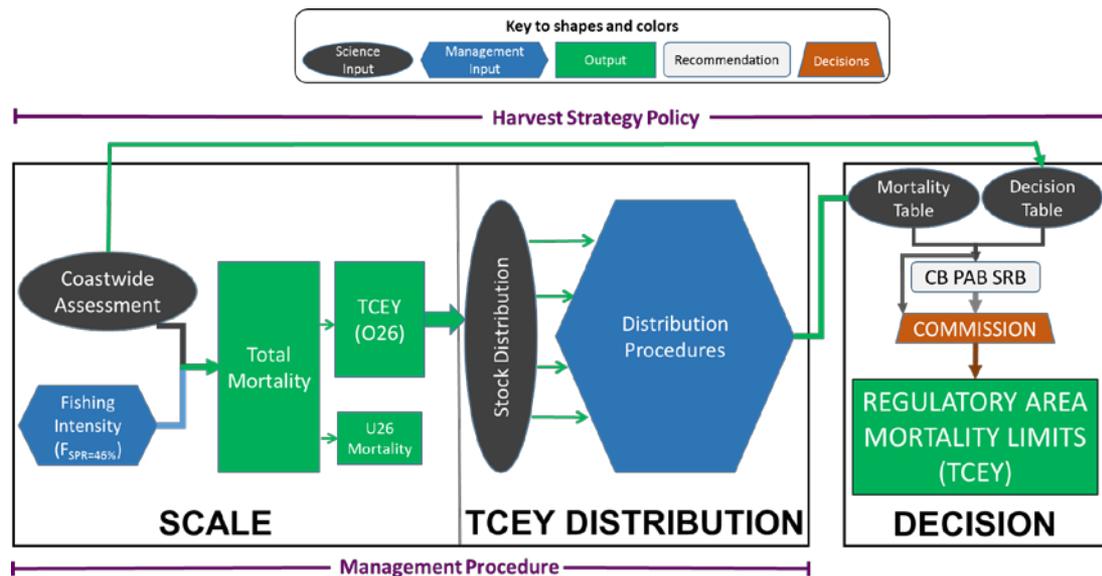
Application of a Management Procedure

- Implement a MP as part of a harvest strategy policy
 - For example, the reference SPR in the decision table

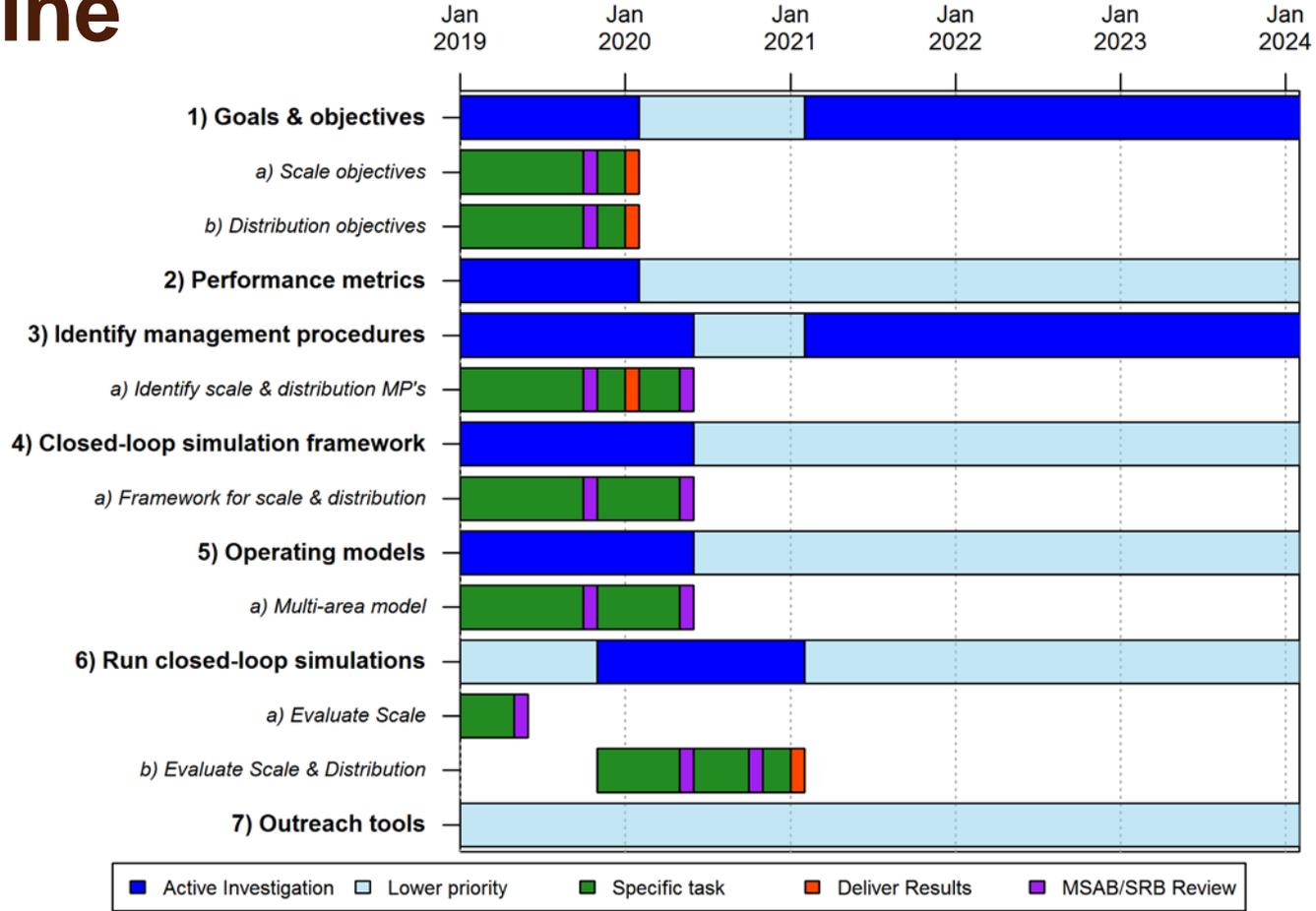


Management Procedure

- Encompasses data collection, assessment, and harvest rules
- MSE process will be working on distribution over the next two years



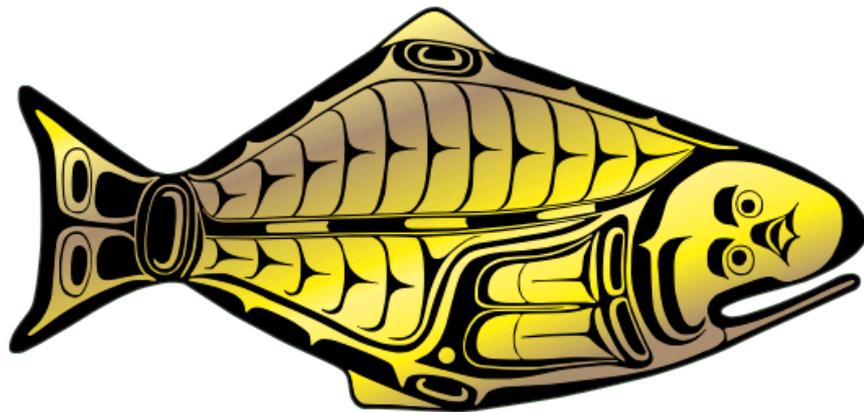
Timeline



Ecosystem-based fishery management

- IPHC collects & monitors many types of ecosystem data
 - FISS observations
 - Ocean measurements, bird counts, other species, mammal interactions
 - Externally collected observations
 - Other agency observations such as PDO
- IPHC shares data and collaborates with other agencies
 - Data for other species (rockfish, Pacific cod, ...)
 - Ocean monitoring (water temperature, hypoxia, ...)

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