INTERNATIONAL PACIFIC HALIBUT COMMISSION

Next generation modelling needs at IPHC

Allan Hicks, Ian J. Stewart, Piera Carpi, David T. Wilson, Steve Berukoff

CAPAM Workshop 2019

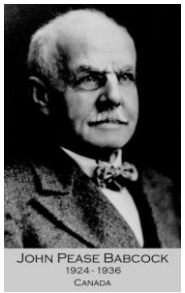
Pacific halibut (*Hippoglossus stenolepis*)

- Range from CA through BC, AK, and the western Pacific Ocean
- May live longer than 30 years
- Grow to greater than 400 pounds
- Variable weight-at-age across years
- Average recruitment linked to environmental conditions
- Observed to migrate very long distances

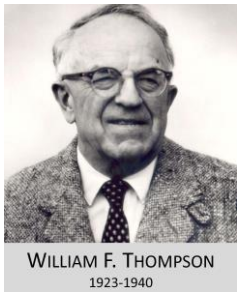
Convention for the Preservation of the Halibut Fishery of the Northern Pacific Ocean and Bering Sea

- Intergovernmental organisation established by a Convention between Canada and the United States of America.
- The Convention was concluded in 1923 and entered into force that same year.

1st international agreement for joint management of a marine fishery.


JOHN PEASE BABCOCK
1924 - 1936
CANADA

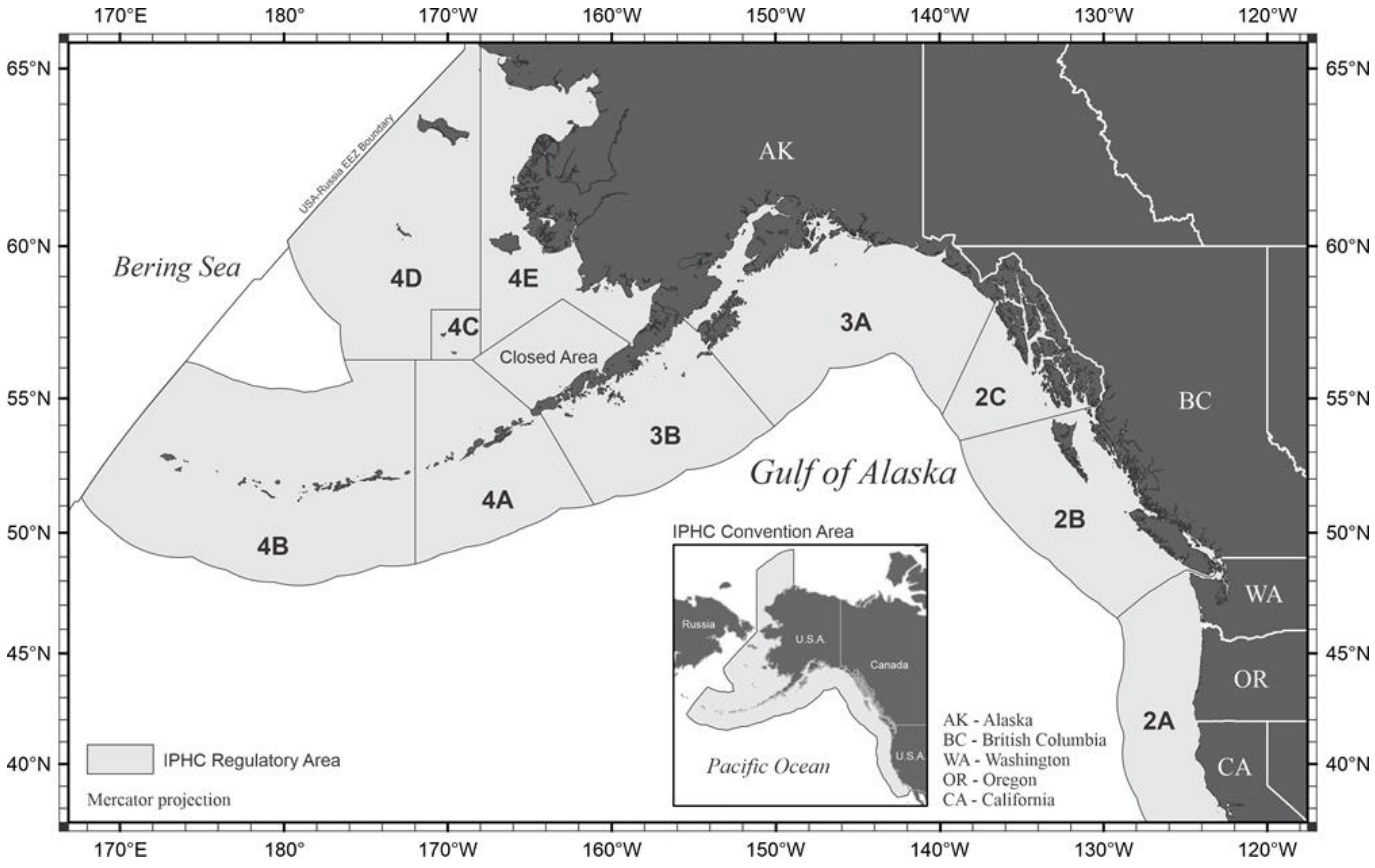

WILLIAM A. FOUND
1924 - 1936
CANADA


WILLIAM F. THOMPSON
1923-1940

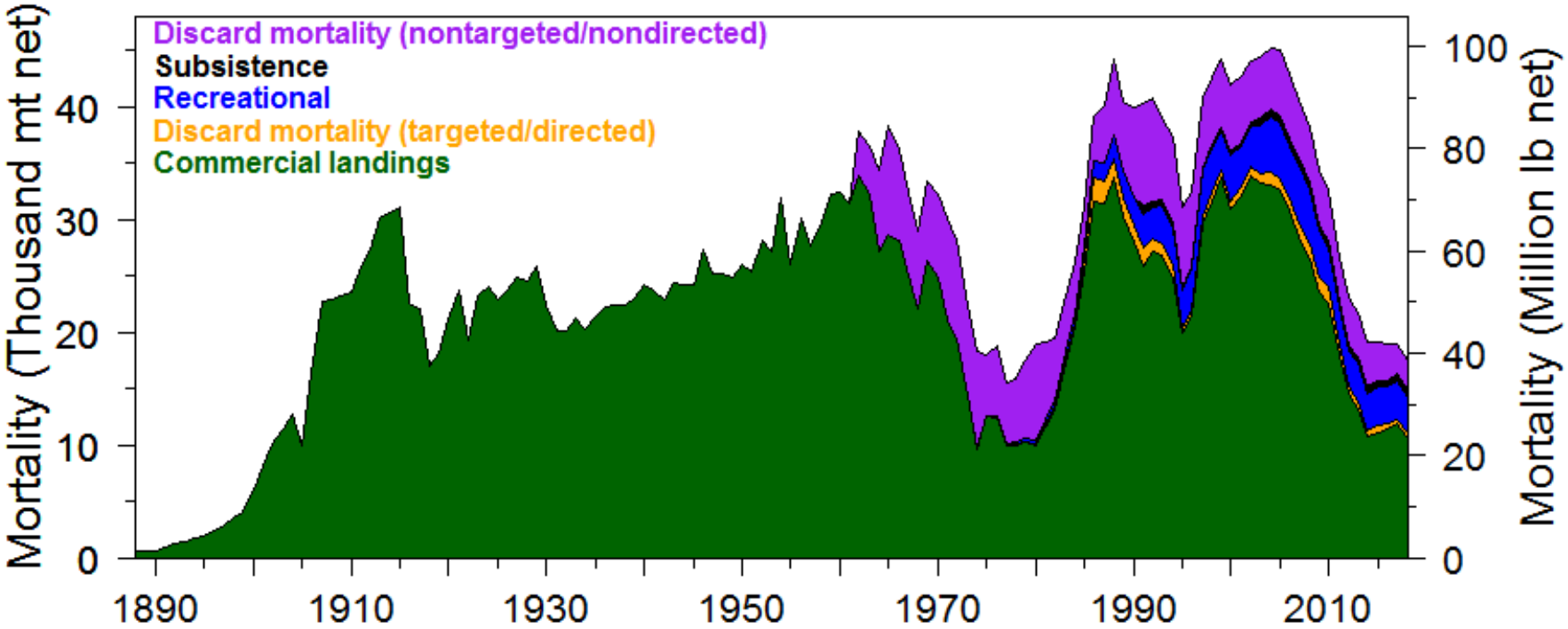

MILLER FREEMAN
1924 - 1932
UNITED STATES


HENRY O'MALLEY
1924 - 1933
UNITED STATES

IPHC Convention Area



Pacific halibut fishing mortality

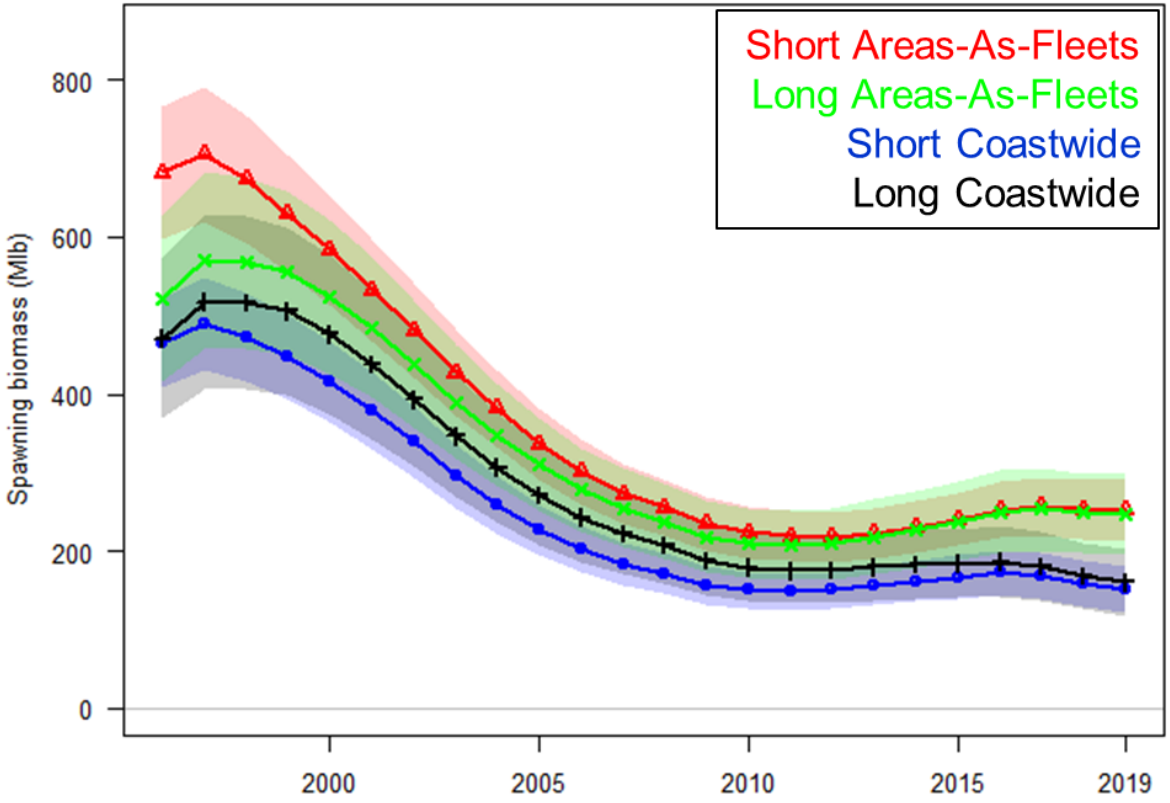


Stock assessment history

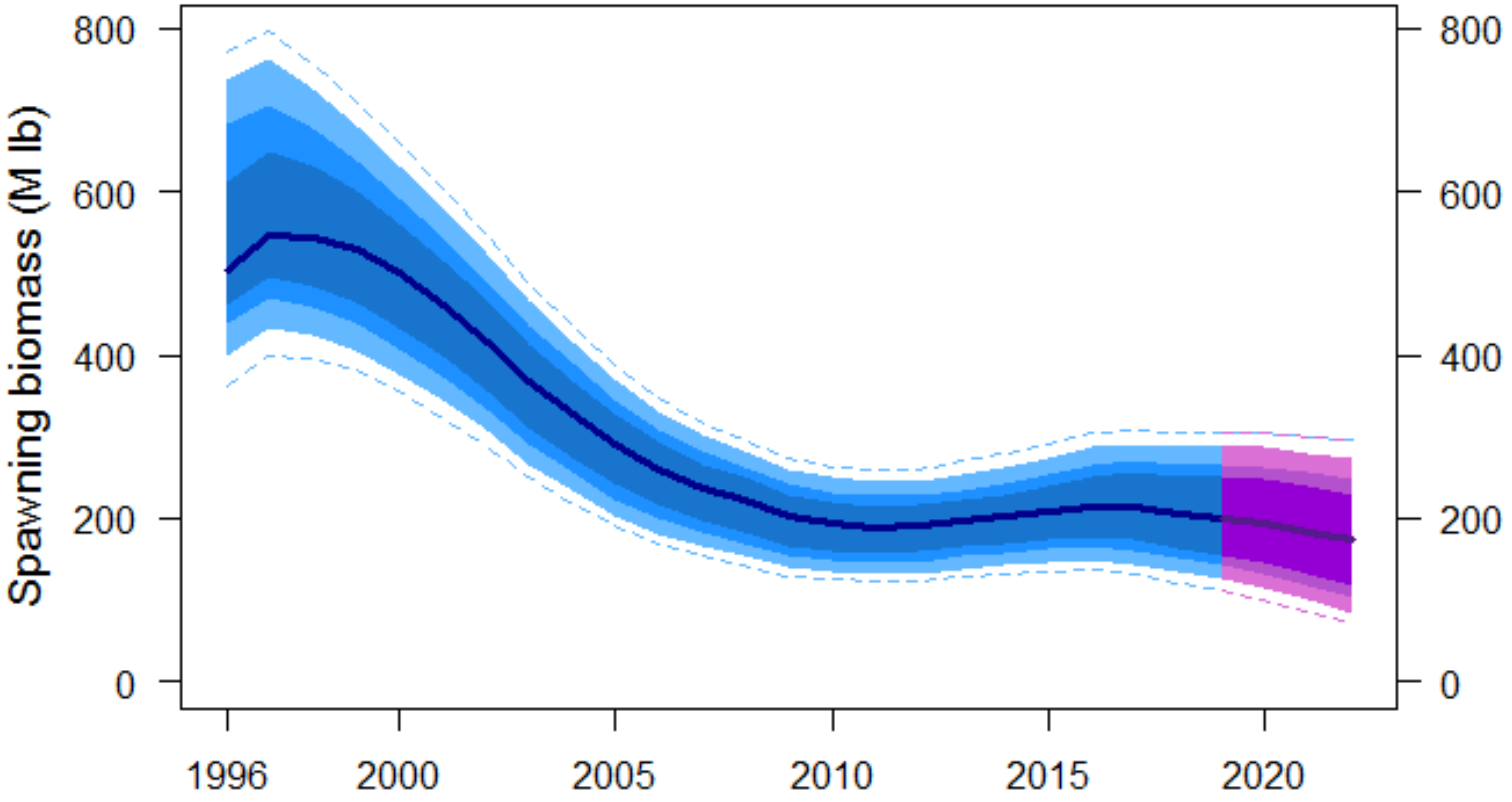
Years	Model	Era (Clark 2003)
Pre-1977	Yield, Yield-per-recruit, Simple stock-production models	Renaissance
1978-1981	Cohort analysis, coastwide, natural mortality (M)=0.2	
1982-1983	Catch-AGE-Analysis (CAGEAN, age-based availability), coastwide, M=0.2	Golden Age
1984-1988	CAGEAN, area-specific, migratory 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	???

Ensemble

- Four models
- Stock Synthesis
- Empirical weight-at-age
- Environmental link to R_0



Integrated Ensemble



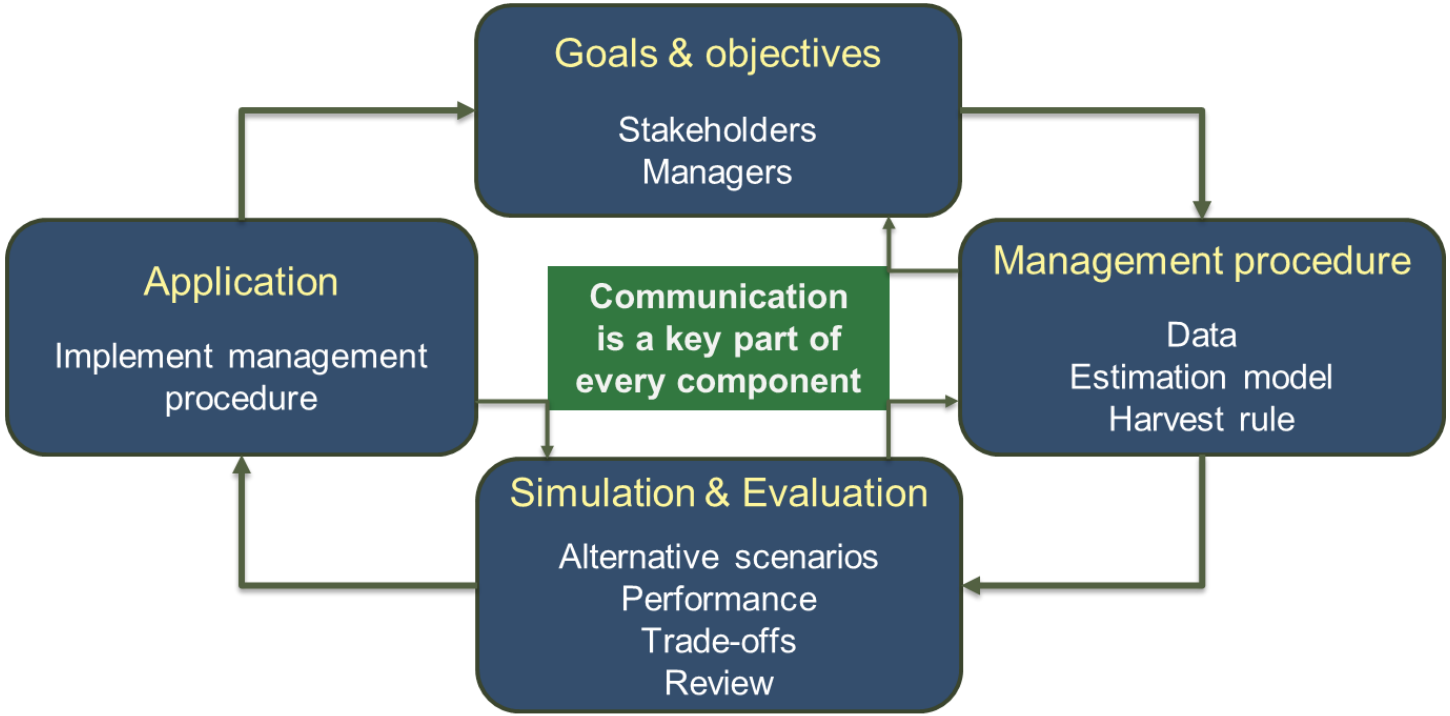
Decision Table

Decision Table

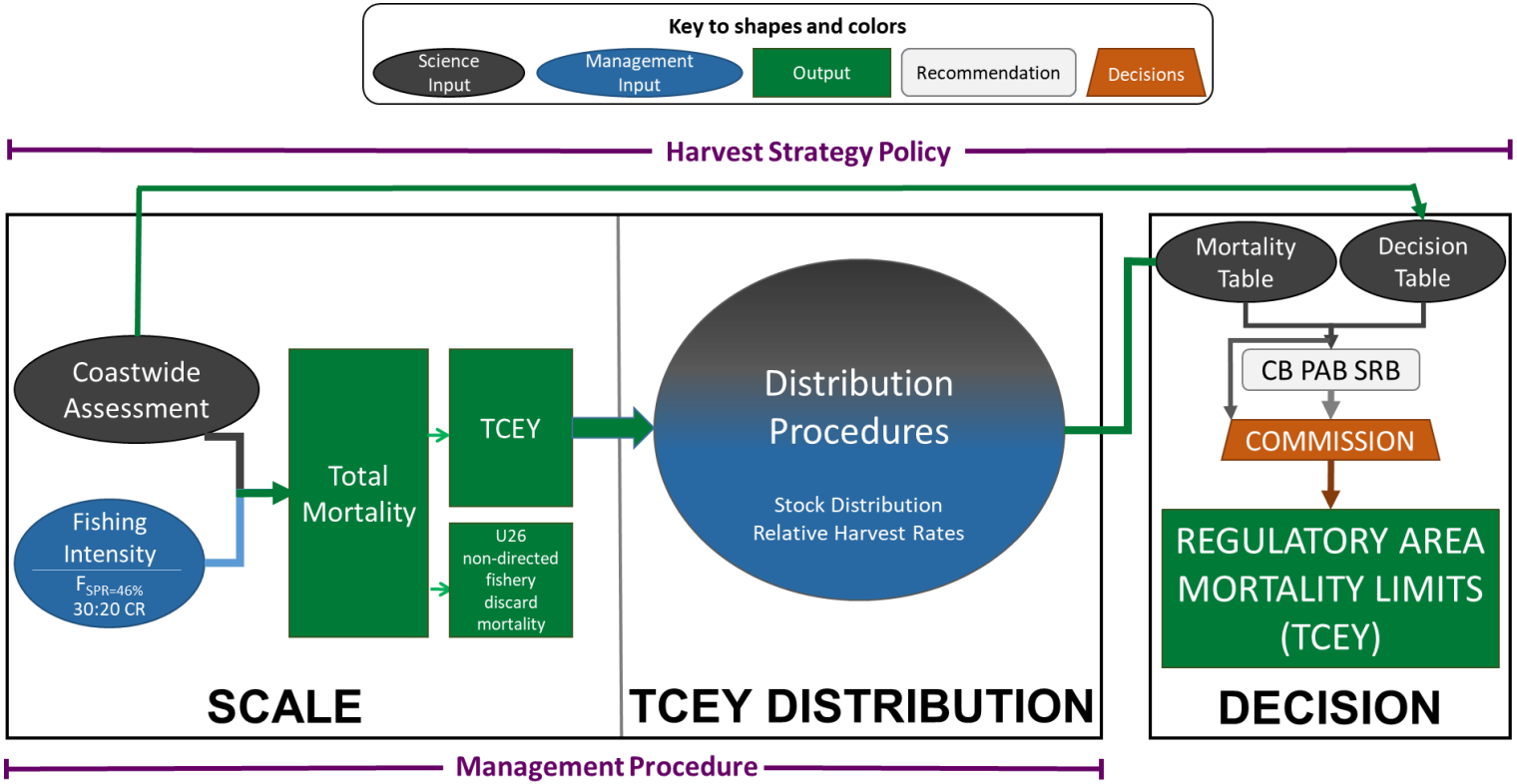
	2019 Alternative	No fishing mortality					Status quo		*Reference SPR=46%*							
	Total mortality (M lb)	0.0	11.7	21.8	31.8	37.6	39.0	40.4	41.8	43.1	44.3	45.5	46.8	48.3	49.9	61.8
	TCEY (M lb)	0.0	10.0	20.0	30.0	35.8	37.2	38.6	40.0	41.3	42.5	43.7	45.0	46.5	48.1	60.0
	2019 Fishing intensity	$F_{100\%}$	$F_{78\%}$	$F_{64\%}$	$F_{54\%}$	$F_{49\%}$	$F_{48\%}$	$F_{47\%}$	$F_{46\%}$	$F_{45\%}$	$F_{44\%}$	$F_{43\%}$	$F_{42\%}$	$F_{41\%}$	$F_{40\%}$	$F_{34\%}$
	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

Development of a harvest strategy

Management Strategy Evaluation (MSE)

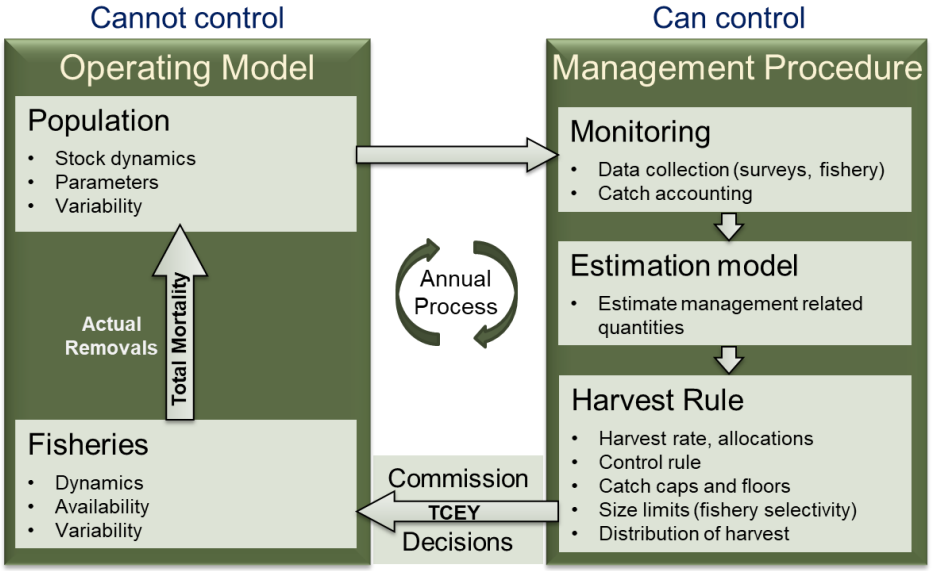


Management Procedures



Recent coastwide MSE framework

- R code wrapper with SS as OM
- OM conditioned to data
- Use par file to run SS without estimation
- Uncertainty introduced with parametric bootstrapping
- Functions do tasks outside SS
  - Simulate estimation error
  - Random walk for weight-at-age
  - Recruitment regimes
  - Fishing mortality



Challenges using a SA model for MSE

- Conditioning the OM
- Multiple starting points to simulate future trajectories
- Simulating with variability on params and processes
- Access population quantities to simulate observations
- Outputs to transform into performance metrics
- Incorporating a MP in a closed-loop simulation
- Not typically optimized for speed

Future MSE framework

- Custom-built generalized OM
- Flexible movement parameterizations between regions
- Dynamic reference points
- Parallelization
- Optimized for speed
- Able to condition to data

Use of models for fisheries management

Conceptual Understanding	Strategic Planning	Tactical Decisions
Broad understanding	Long-term	Short-term
Forms underlying context for management planning	Policy goals	Operational objectives
Research	MSE	Harvest control rule

It may be useful to define the scope of a generalized model before development

FAO 2008. Technical guidelines for responsible fisheries. 4, Suppl. 2, Add. 1

Flexible framework

- Model can apply to changes
  - Different data collection paradigms
  - Changes in data collection
  - Changes in operation
  - Time-varying quantities
- Develop structurally different models to account for uncertainty
  - Investigation as sensitivities
  - Use in an ensemble

Modern options

- Data-weighting
- Functional forms
- Retention/Discards
- Movement
- Environmental covariates
- Joint and custom priors
- Custom likelihoods with temporal covariance

Reference points

- Static
- Dynamic
  - B0 retrospectively
  - Equilibrium reference points
    - Window of time to use

Estimates of uncertainty

- Parameters and derived quantities
- Variance and covariance
- Various methods to estimate variance

MCMC

- Various options including
  - Classic approaches
  - Efficient techniques
- Useful outputs for diagnostics
- Similar outputs available to non-MCMC runs
- Access to covariance matrix

Simulation

- Examine estimation performance
- Explore alternative hypotheses
- Closed-loop simulations

Expansion

- Add options easily through input
  - New data sources and likelihoods
  - Structural assumptions
  - Parameters
  - Outputs
- User-specified option included
  - Externally/dynamically or
  - Easily compiled into executable or
  - Quickly implemented by developers

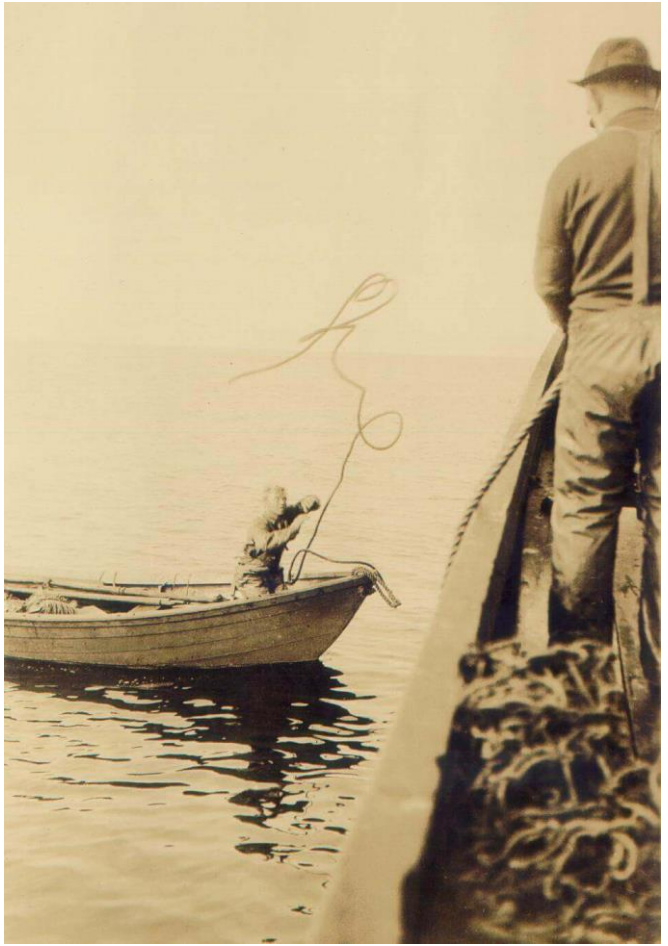
Standardized outputs

- Formatted and accessible outputs
- A brief summary of important quantities for quick examination

External software

- Easily link with software to summarize and visualize results
- May produce standardized outputs for various agencies

- Balance between what is done internally and what is done externally



Summary

- Generalized software is very useful to IPHC
  - Accepted and peer reviewed
  - Standardized methods and outputs
  - Configurable to examine structural uncertainty
  - Leverage the sharing of external code
  - Collaboration

Upcoming Workshops

Next Generation Stock Assessment Models

-November 4-8, 2019

- *Announcement*
- *Registration*
- *Hotel Info*
- *Focus Questions*
- *Model Features Survey*
- *Desired Model Features Survey*
- *Agenda*
- *Abstracts*

CAPAM workshop on the creation of frameworks for the next generation general stock assessment models

The Center for the Advancement of Population Assessment Methodology (CAPAM) in collaboration with the National Institute of Water and Atmospheric Research Ltd (NIWA) will host a technical workshop on the creation of frameworks for the next generation general stock assessment models in Wellington, New Zealand November 4-8, 2019.

The workshop venue is Prefab Hall, 14 Jessie St, Te Aro, Wellington. https://www.prefabhall.co.nz/

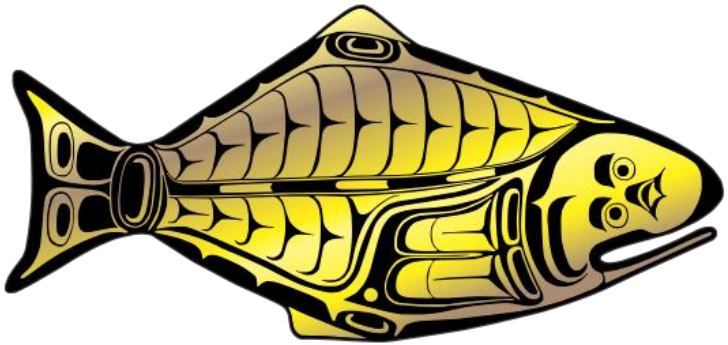
CAPAM Updates:

Abstracts for Next Generation Stock Assessment Models Workshop *NEW*

Agenda for Next Generation Stock Assessment Models Workshop *NEW*

General stock assessment model features survey *NEW*

INTERNATIONAL PACIFIC



HALIBUT COMMISSION