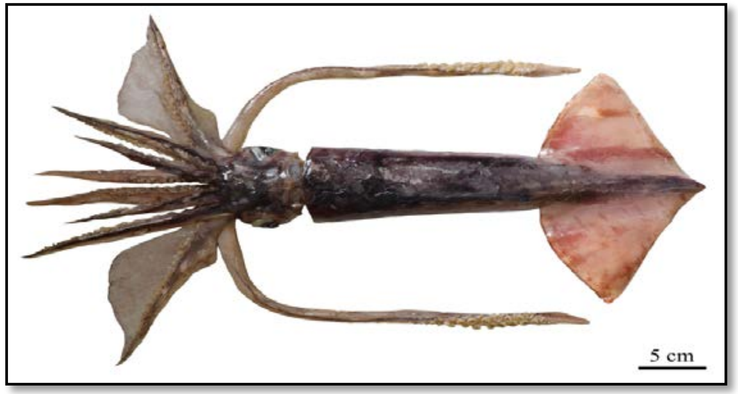
NPFC-2025-SSC NFS02-IP06



Management Strategy Evaluation for Short-Lived Species with Only Annual Data: A Case Study of the Autumn Cohort of Neon Flying Squid in the North Pacific Ocean

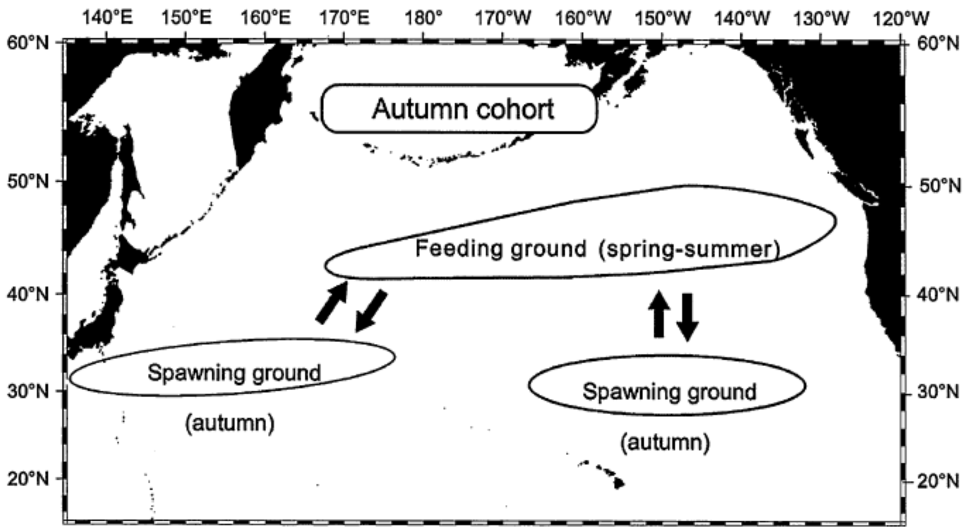
Libin Dai

8 July 2025

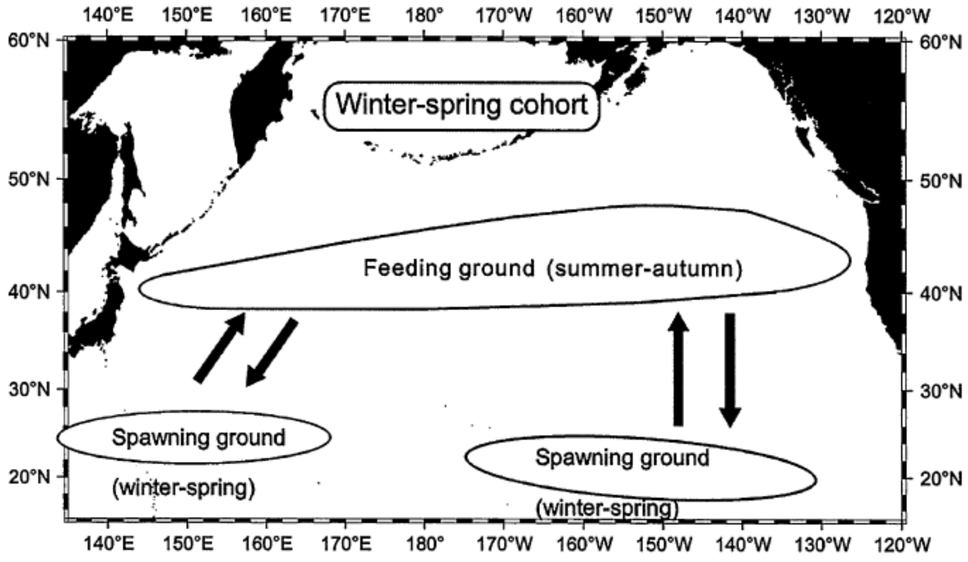
Shanghai Ocean University

Neon flying squid (NFS)

- Population structure: Winter-spring and autumn spawning cohorts
- Distribution: 20°N-50°N
- Migration: Annual round-trip between feeding and spawning grounds
- Longevity: 1-year
- Growth: exponential during the first 30 days after hatching and then becomes linear
- Max. length: ~45 cm in males and ~60 cm in females
- Maturity at size: sex-specific



Sept.-Feb.

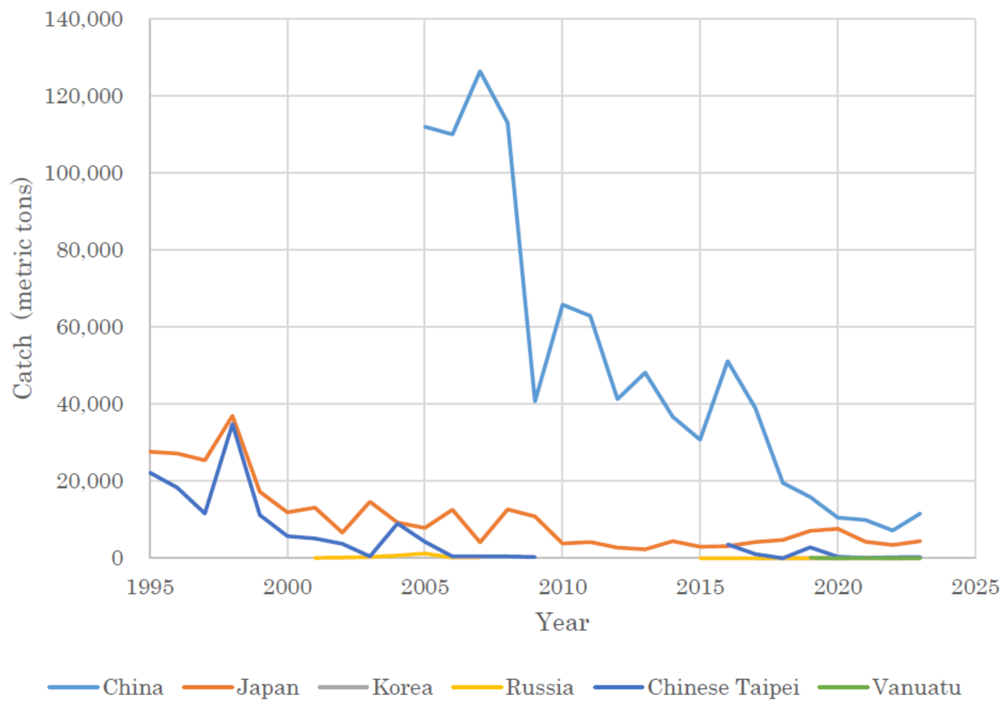


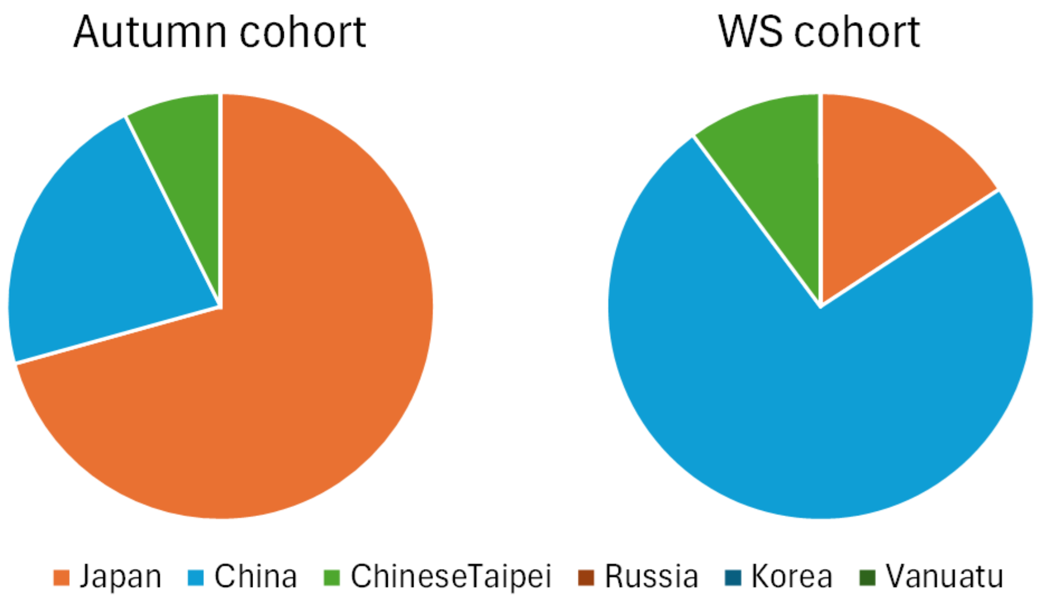
Jan.-Aug.(mainly Jan.-May)

(Ichii et al., 2006)

Fishery

- Neon flying squid was harvested by China, Japan, Korea, Russia, Chinese Taipei and Vanuatu. Fishing methods included jigging, drift net, dip net and set net.





Percentage of catches of each NPFC member in the total catches of the autumn and winter-spring (WS) cohorts from 1995-2023.

(NPFC-2024-SSC NFS01-WP12)

Stock assessment

- No formal stock assessment has been conducted by NPFC for NFS.
- Historically, the swept area method, DeLury depletion method, and surplus production models have been used to estimate the stock size of NFS in research publications.

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Fisheries Research 78 (2006) 286–297
FISHERIES RESEARCH
www.elsevier.com/locate/fishres

Stock assessment of the autumn cohort of neon flying squid (*Ommastrephes bartramii*) in the North Pacific based on past large-scale high seas driftnet fishery data

Taro Ichii [a,*], Kedarnath Mahapatra [b], Hiroshi Okamura [a], Yoshihiro Okada [c]

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[b] Tokai University Frontier Ocean Research Center (T-FORCE), 3-20-1, Orido, Shimizu-ward, Shizuoka-city, Shizuoka 424-8610, Japan
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Bull Mar Sci. 91(1):1–13. 2015
http://dx.doi.org/10.5343/bms.2014.1020
research paper

A Bayesian hierarchical DeLury model for stock assessment of the west winter-spring cohort of neon flying squid (*Ommastrephes bartramii*) in the northwest Pacific Ocean

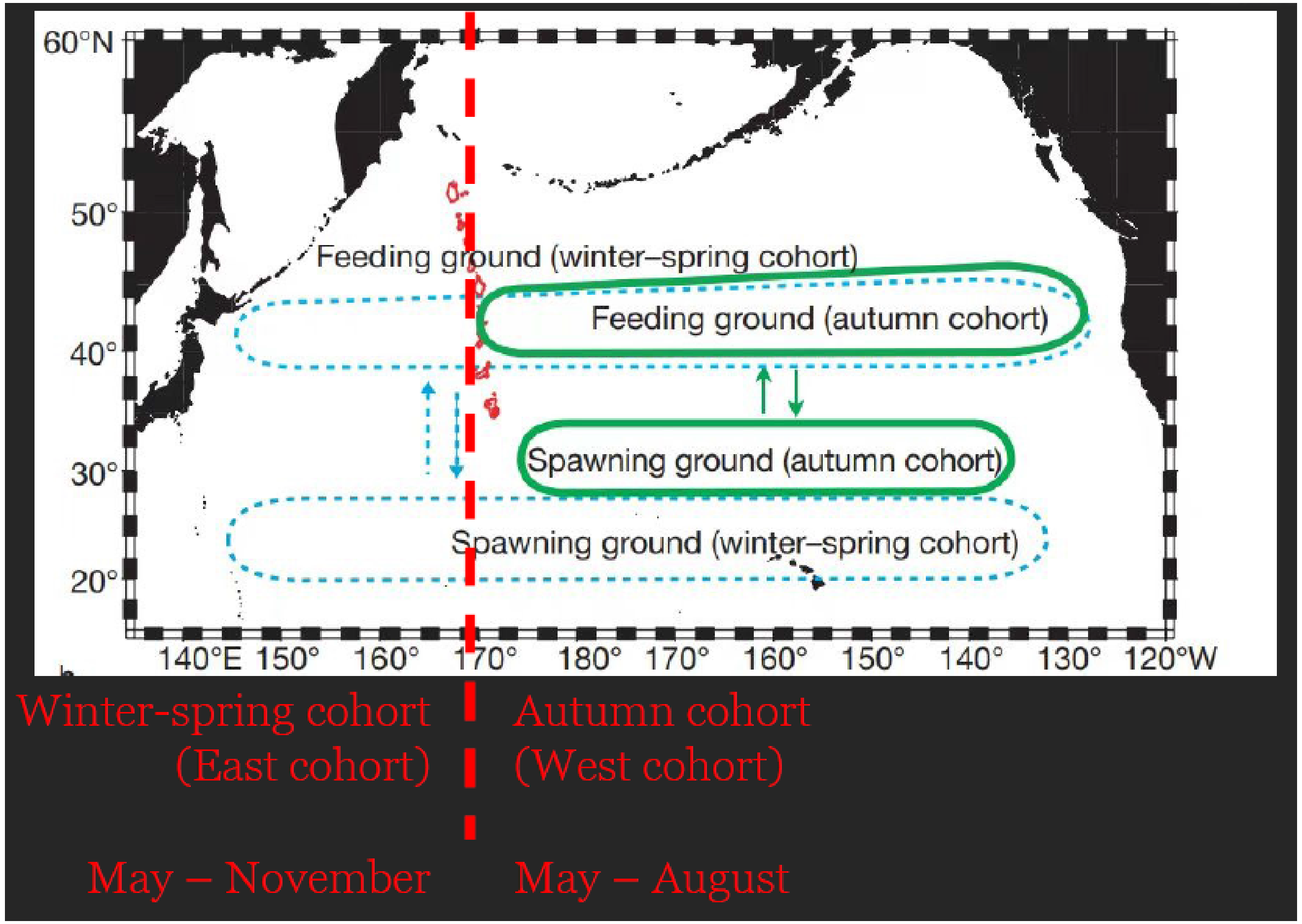
Jie Cao [1,4]
Xinjun Chen [1,2,3 *]
Siquan Tian [1,2,3]

[1] *College of Marine Sciences, Shanghai Ocean University, 999 Hucheng Ring Road, Shanghai 201306, China.*
[2] *The Key Laboratory of*

Stock assessment

- China and Japan previously submitted preliminary NFS stock assessment reports to the NPFC, utilizing JABBA and SPiCT respectively.

- Both Members employed an empirical approach to differentiate between the two spawning cohorts, subsequently conducting separate stock assessments for each cohort.



NPFC SC capacity building activity

- Each year, the NPFC Scientific Committee (SC) nominates and provides financial support for SC representatives to attend relevant scientific training sessions and meetings, aiming to build their capacity.

Vancouver, British Columbia, Canada (18-24 February 2025)

- Collaborated with **Blue Matter Science** in Vancouver to:
  1. Fit surplus production models (SPiCT) to both winter-spring and autumn cohorts of Neon flying squid.
  2. Develop and condition an age-structured openMSE operating model (autumn cohort only).
  3. Developed catch- and effort-based harvest control rules (HCRs) to compare the performance of output versus input controls.
  4. Evaluated management trade-offs by conducting closed-loop simulations using the OpenMSE package.

What existing data do I have prior to my Vancouver trip?

- Annual catch
- Annual effort
- Annual standardized Chinese commercial CPUE
- Annual nominal Japanese survey CPUE

What existing data do I have prior to my Vancouver trip?

- Annual catch
- Annual effort
- Annual standardized Chinese commercial CPUE
- Annual nominal Japanese survey CPUE

NPFC-2024-AR-Annual Summ

Annual Report Summary Table - Squids

Catch in metric ton

Year	China						Japan						Korea		
	Neon flying squid			Japanese flying squid			Neon flying squid				Japanese flying squid		Neon flying squid		
	Squid jigging			Squid jigging			Squid jigging				NA**		Squid jigging		
	Total	CA 170E West	CA 170E East	Total	CA 170E West	CA 170E East	Total	CA 170E West	CA 170E East	NW	Total	Mostly NW***	Total	CA 170E West	CA 170E East
2023	11,644	10,087	1,556	0	0	0	4,396	7	4,389	0	16,133	16,133	72	72	0
2022	7,209	4,107	3,102	213.3	213	0	3,458	0	3,231	227	24,646	24,646	40	40	0
2021	9,945	5,294	4,651	455	455	0	4,289	0.9	4,288	0.4	28,676	28,676	82	82	0
2020	10,540	4,206	6,334	324	324	0	7,638	59	7,560	19	36,010	36,010	0	0	0
2019	15,919	11,774	4,145	0	0	0	7,138	5	7,105	28	34,488	34,488	37	37	0
2018	19,566	15,049	4,516	0	0	0	4,716	1	4,090	625	45,855	45,855	0	0	0
2017	38,990	35,950	3,040	0	0	0	4,175	0	3,624	551	22,925	22,925	6.8	6.5	0.3
2016	51,170	50,280	890	671	671	0	3,134	126	3,008	0	27,187	27,187			
2015	30,763	30,250	513	2,637	2,637	0	3,018	138	2,876	4	76,317	76,317			

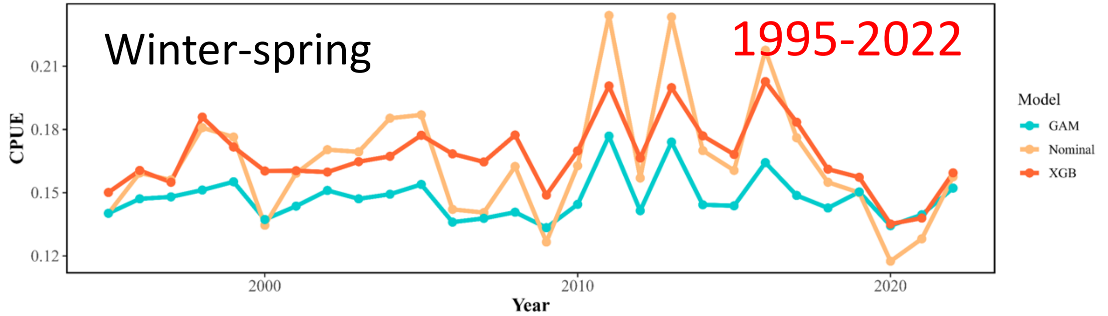
Year	Russia														Chinese Taipei		
	Neon flying squid				Japanese flying squid										Neon flying squid		
	Total	Mid-water trawl	Squid jigging	Other	Total	Danish seine	Squid jigging		Bottom trawl	Mid-water trawl		Other			Squid jigging		
		NW	CA 170E East	NW		NW	NW	CA	NW	CA 170E West	NW	CA	NW		Total	CA 170E West	CA 170E East
2023	2	0	0	2	379	2	0	0	0.2	0	114	0.007	264		336	319	17
2022	0	0	0		105	0	0	0	72	0	14		19		198	198	0
2021	0	0	0		4,835	3	0	0	3835	0	995		2		114	95	19
2020	0	0	0		14,396	0.05	12	0	8,758	0	5,476		151		393	393	0
2019	0.56	0.001	0.559		17,619	1.2	13	2.0	2,563	0	15,041		0		2,844	2,844	0
2018	2	2			277				24	0	253				2	2	0
2017	0.1	0.1			345"				135	0	209				1,064	1,064	0
2016	0.1	0.1			4,517"				275	0	4,201				3,589	3,589	0
2015	0.2	0.2			10,746				2,006	0.1	8,740					n/a	

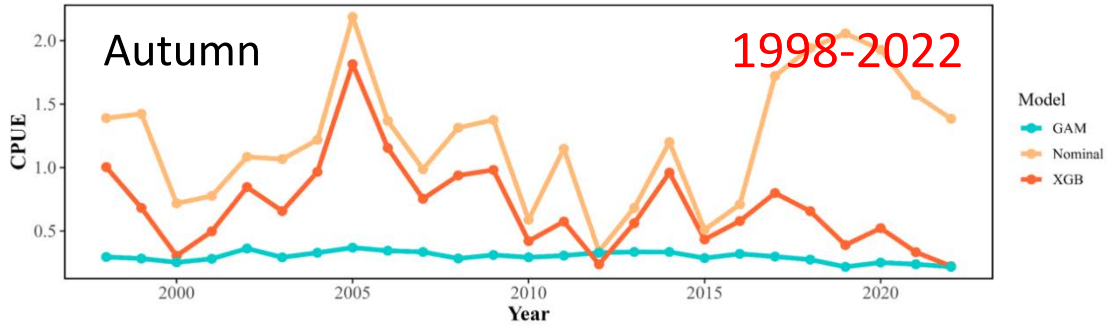
Catch | Effort

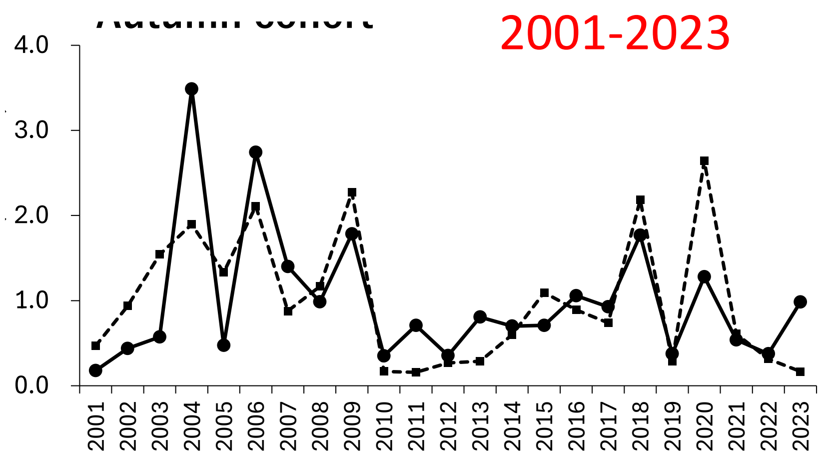
1995~2023

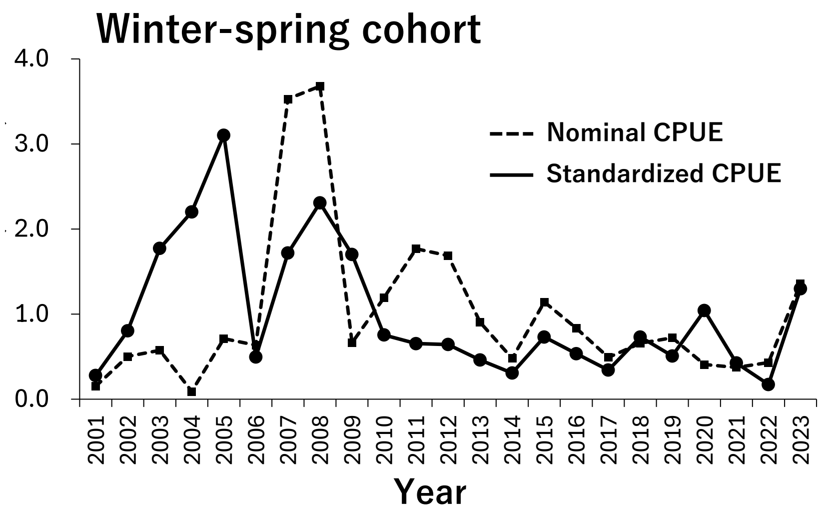
What existing data do I have prior to my Vancouver trip?

- Annual catch
- Annual effort
- Annual standardized Chinese commercial CPUE
- Annual nominal Japanese survey CPUE







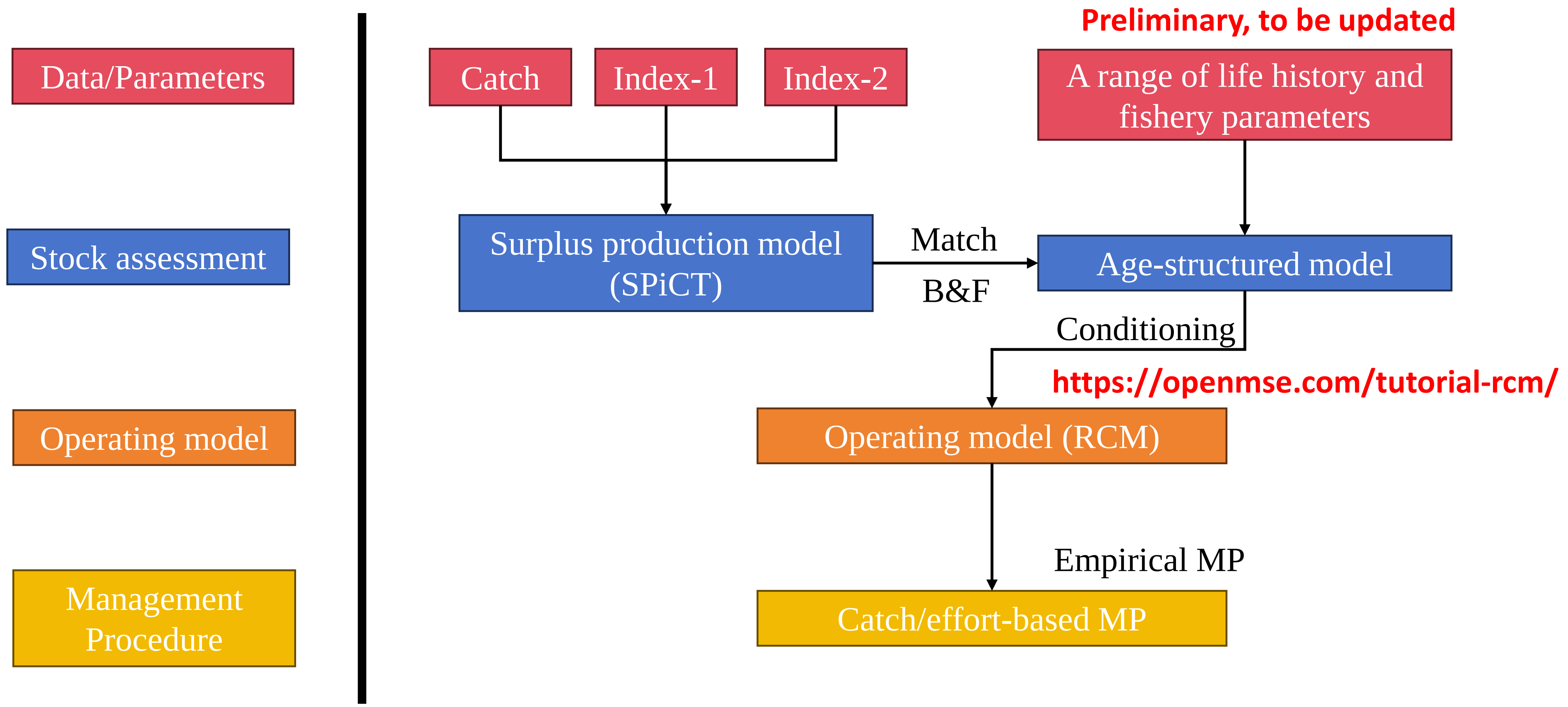


What existing data do I have prior to my Vancouver trip?

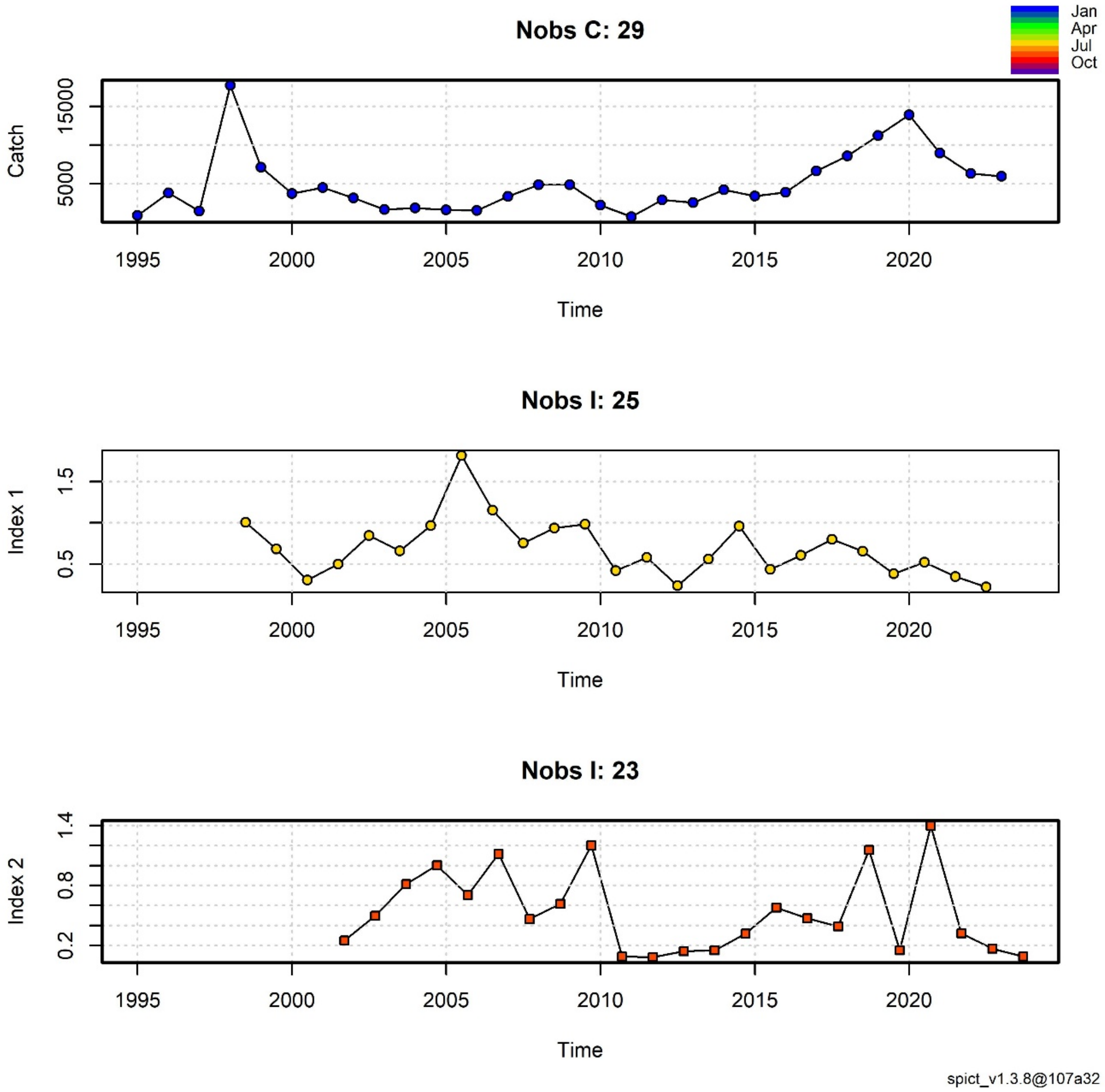
- Annual catch (1995-2023)
- Annual effort (1995-2023)
- Annual standardized Chinese commercial CPUE (1995-2022)
- Annual nominal Japanese survey CPUE (2001-2023)

We are in a data-moderate and model-limited condition!

MSE framework for NFS in data-moderate condition



Input data of Autumn cohort for SPiCT



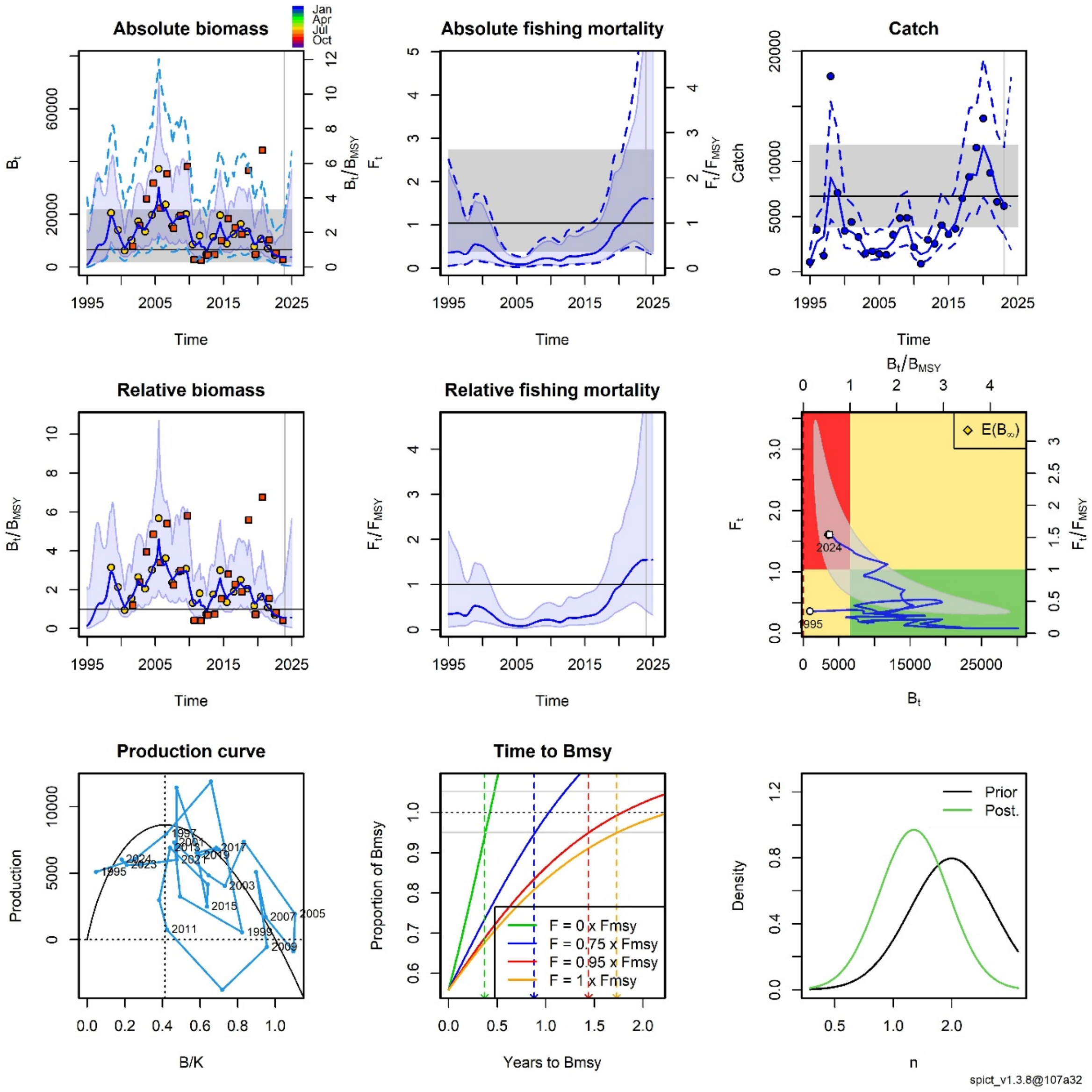
Parameter	Prior (Mean, SD)
Log(n)	(log(2),0.5)
Log(r)	(log(1.19),0.5)

(NPFC-2024-SSC NFS01-WP12)

Parameter	Time step
Dteuler = 1	A discrete-time model
Dtc = 1	Time interval for catch

To match the time step in age-structured model

SPiCT results and diagnostics



No.	Check list for the acceptance of a SPiCT	
1	The assessment converged	✓
2	All variance parameters of the model parameters are finite	✓
3	No violation of model assumptions based on one-step-ahead residuals	✓
4	Consistent patterns in the retrospective analysis	✓
5	Realistic production curve	✓
6	High assessment uncertainty	✓
7	Initial values do not influence the parameter estimates	✓

Rapid Conditioning Model (RCM)

https://openmse.com/tutorial-rcm/

openMSE bluematter

HOME SECTIONS OM LIBRARY FAQ CONTACT

Rapid Conditioning Model

- Model configuration of the RCM
- Updated OM parameters and evaluation of the RCM
- Case study
- Case study with MCMC
- Additional resources

Rapid Conditioning Model

The default settings for openMSE allows for conditioning operating models (OMs) for stocks if no data were available. Ranges of biological and selectivity parameters are specified to incorporate uncertainty in the OM. For historical reconstruction of the stock, historical effort trajectories can be sketched, which, along with a fixed assumption on current depletion, can be used to calculate the implied historical fishing mortality and catches.

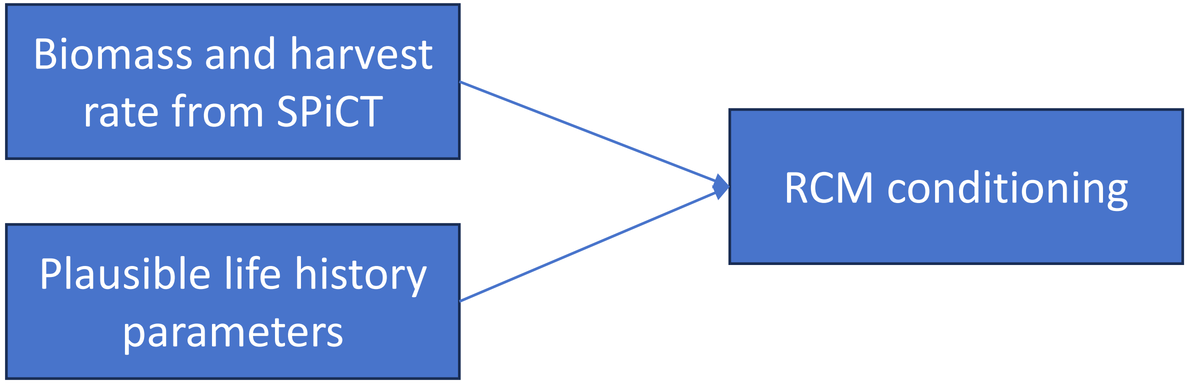
In more data-rich situations, biological studies can be used to inform life history parameters such as growth and maturity, while other parameters such as historical depletion, selectivity, and fishing mortality have typically been informed by an assessment model. In such situations, operating models may be generated from fitting assessment models. In between the data-rich and the no-data situations are the so-called data-limited or data-moderate settings, with series of data but the potential lack of an accepted stock assessment.

The Rapid Conditioning Model (`RCM`) in the `SAMtool` package is designed to help condition OMs for data-limited and data-rich situations. From a fitted model, historical depletion and F could be informed via a more objective method, as opposed to intuition or a simple guess for these key parameters. The RCM is sufficiently flexible to be parameterized as full stock assessment model with various data weighting schemes and some time-varying dynamics explored, although that is not the intent of the software to used for stock assessment.

Instead, the `RCM` is intended to guide exploration of a set of operating models (conditioned on data) that encapsulates a range of views on the productivity and historical exploitation. In this context, we don't look at point estimates, but rather try to reduce the range of plausible parameters. Walters et al. (2006) used the term

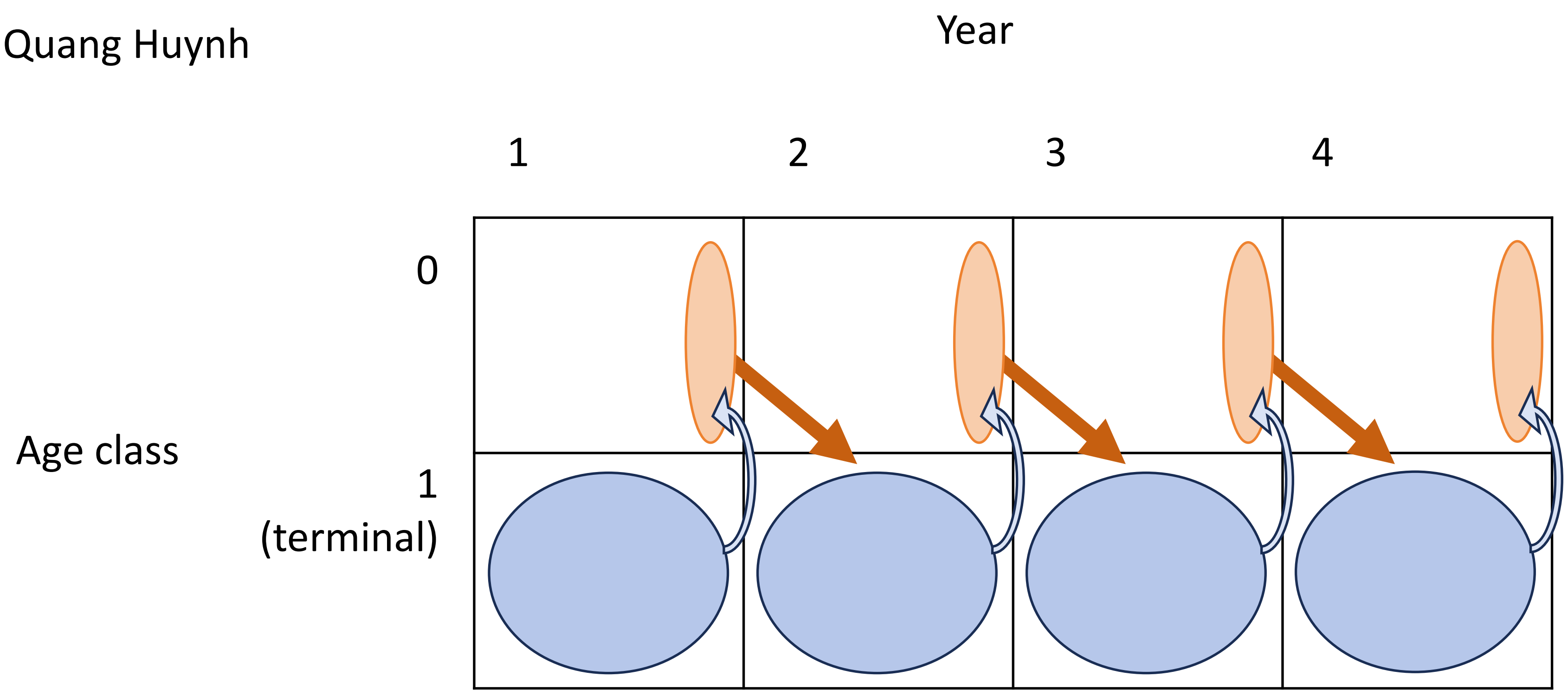
RCM Conditioning

- Input a range of life history parameters and conditioning an age-structured OpenMSE operating model (RCM) to match the SPiCT estimates of biomass and harvest rate



RCM Conditioning

Provided by Dr. Quang Huynh



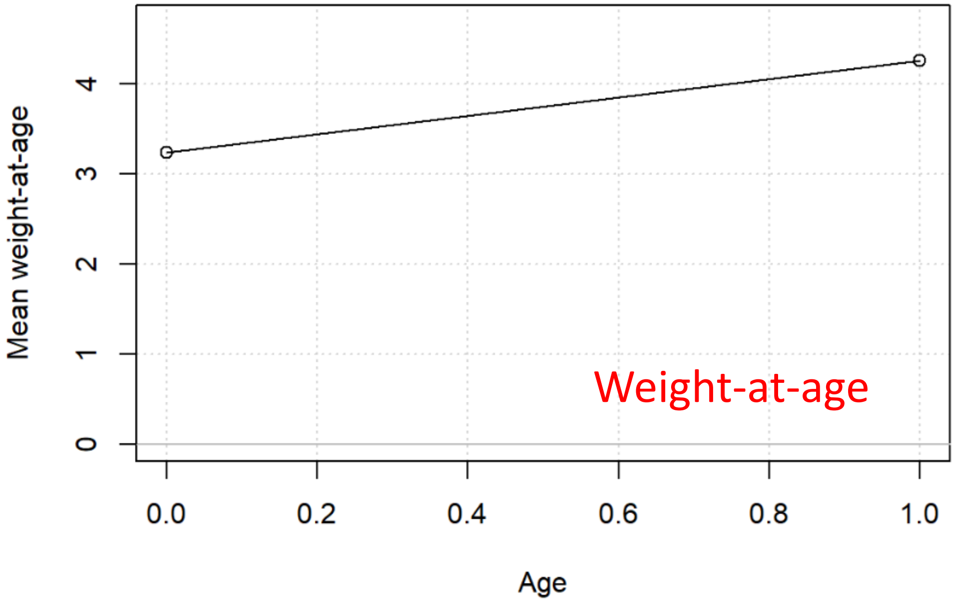
Year-specific cohort, vulnerable to fishery

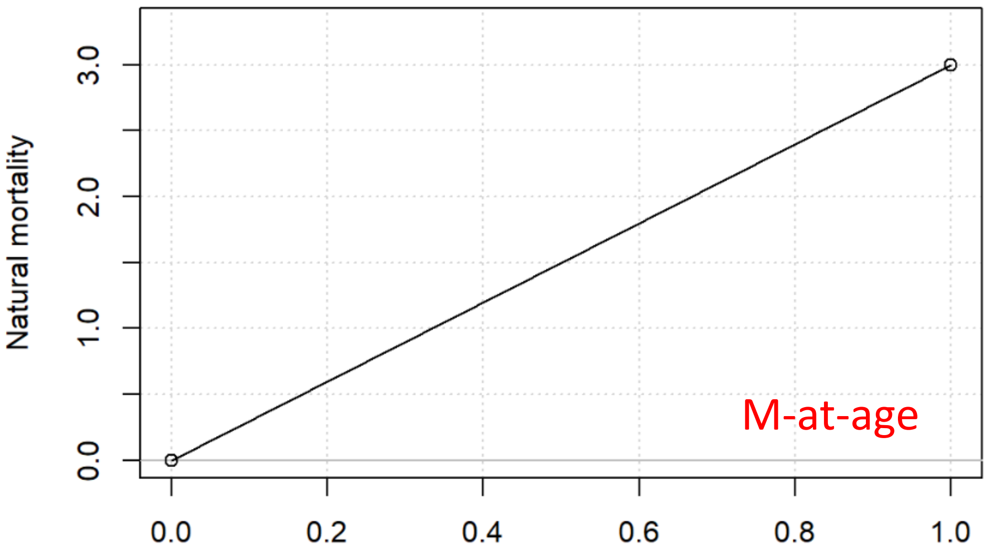
Recruitment from egg production of current cohort and density-dependent survival

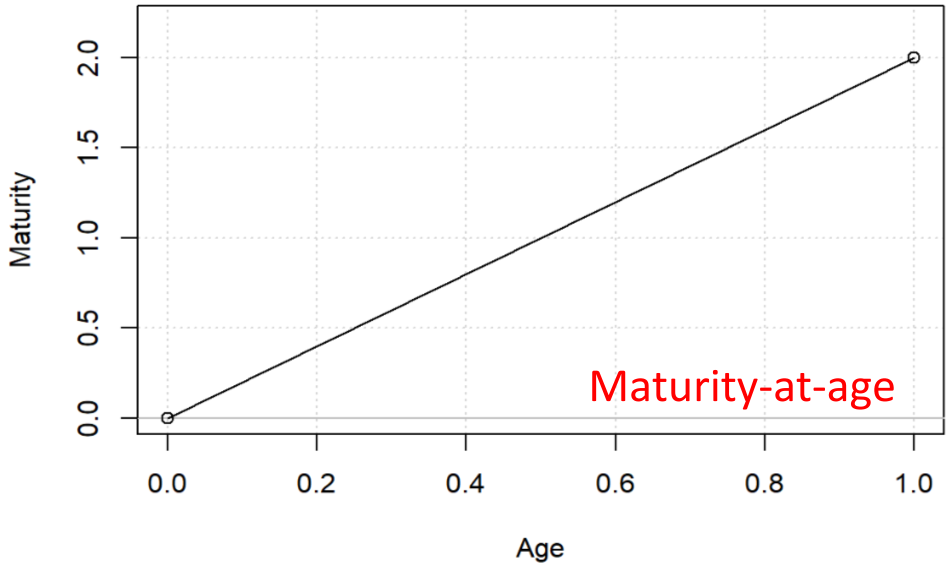
Spawning event in the end of year

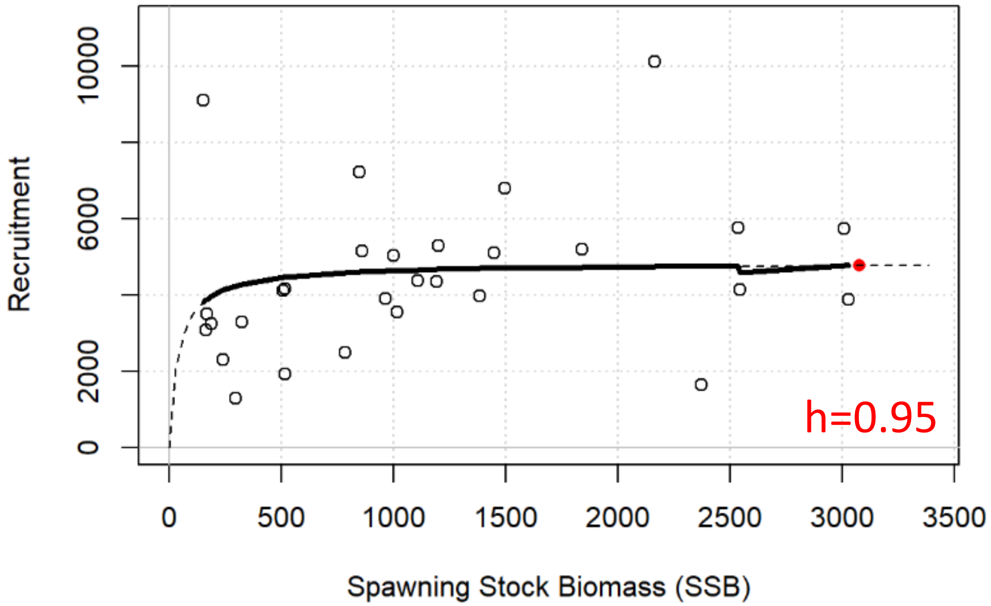
Age class advancement at beginning of year (potential additional density-independent survival)

RCM Conditioning

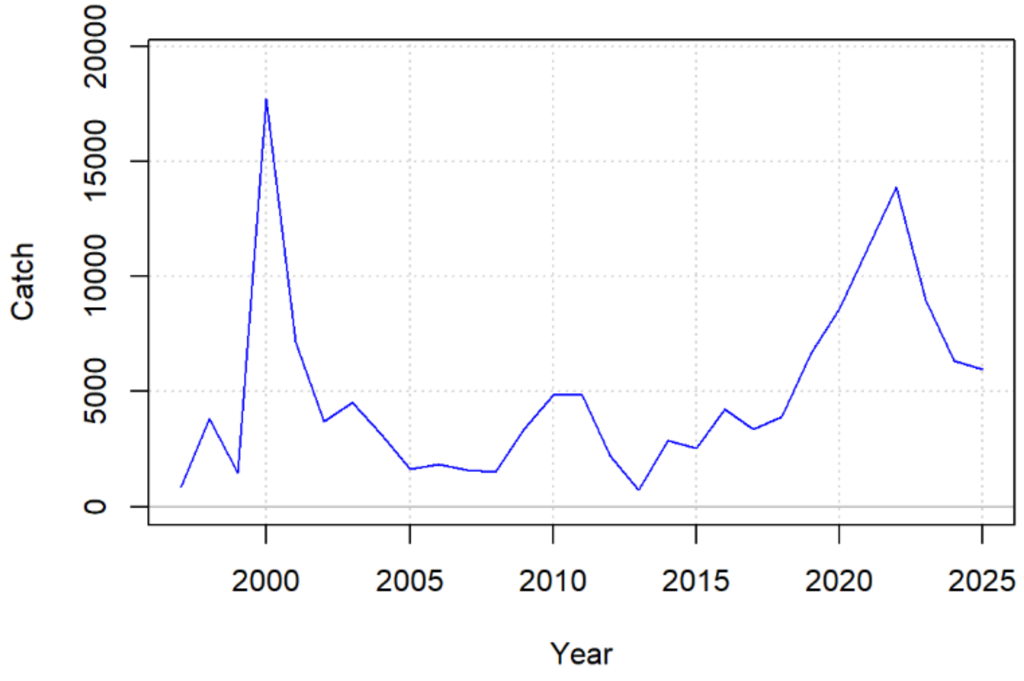


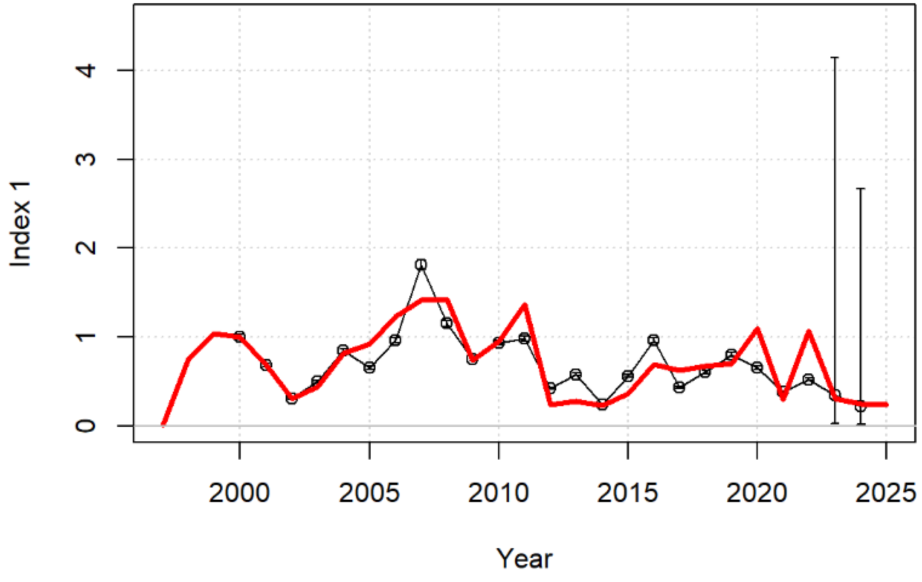


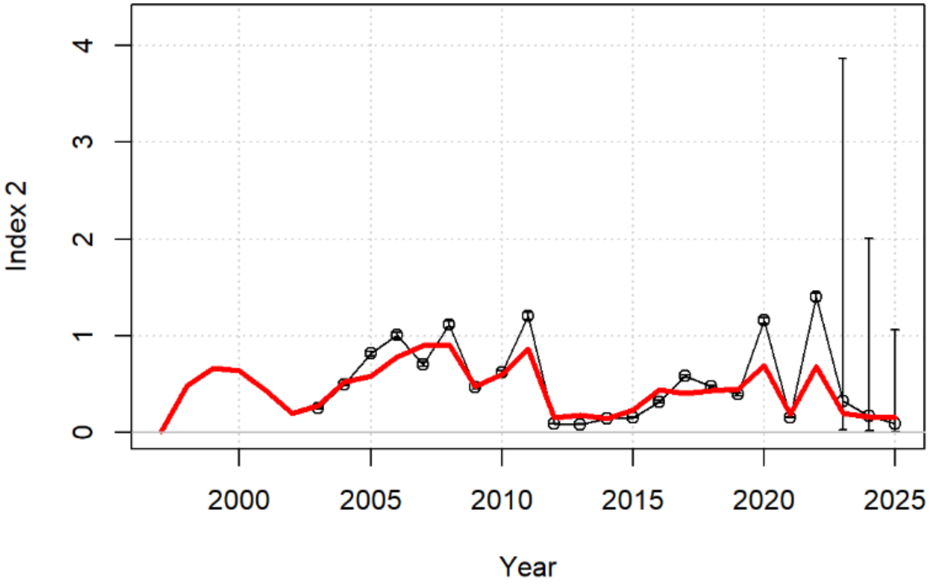




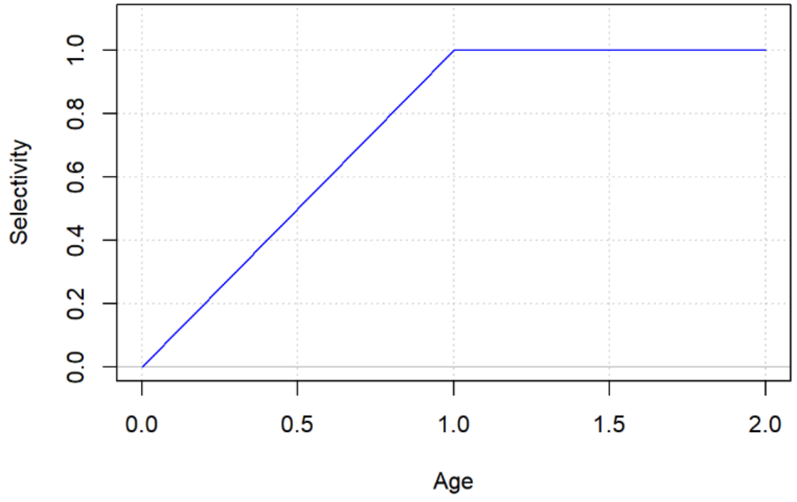
Catch and index

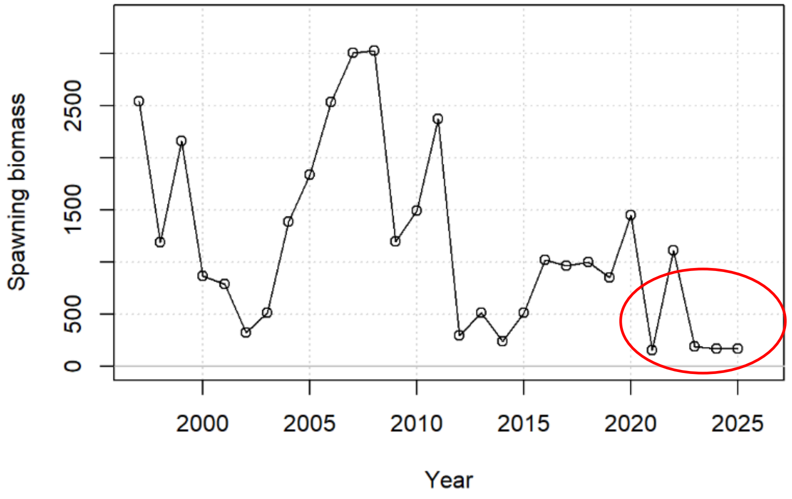


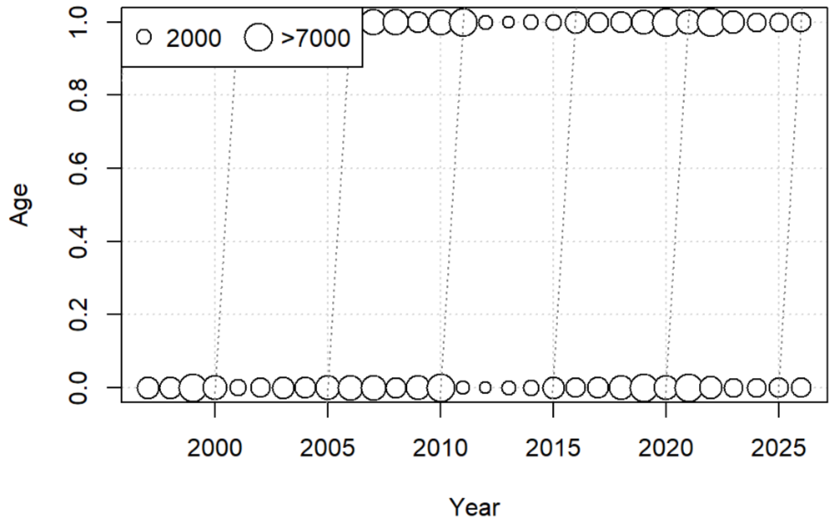


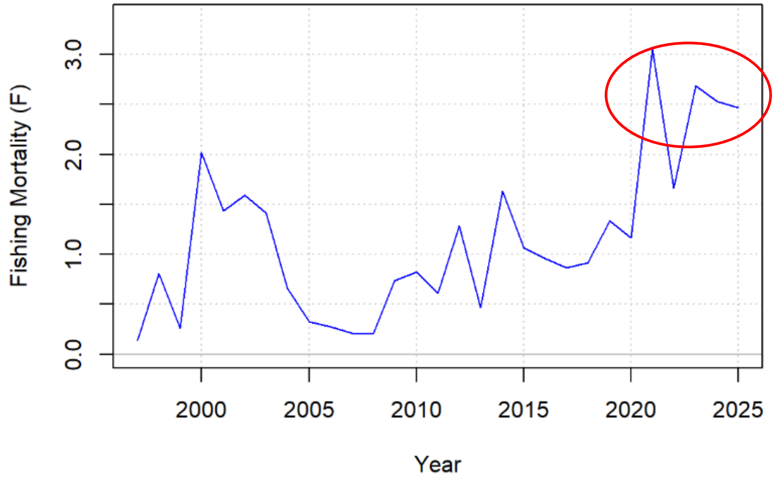


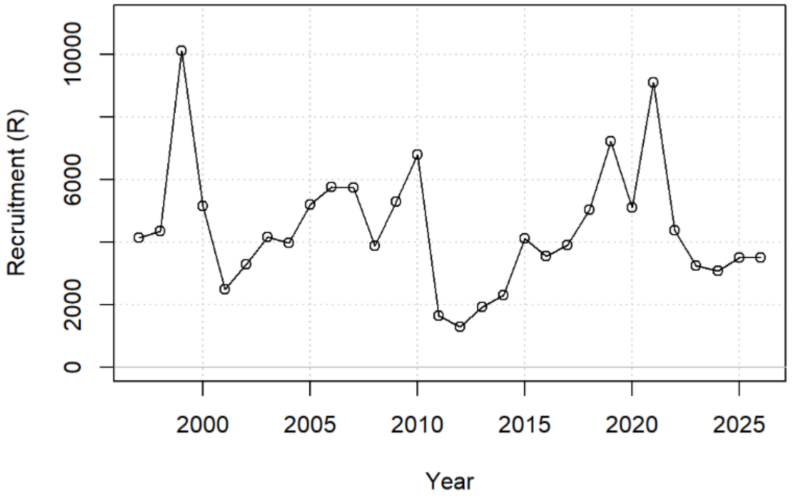
12-month life span in an annual model











Input control vs. Output control

Constant catch/effort MP

- Constant catch
- Constant effort

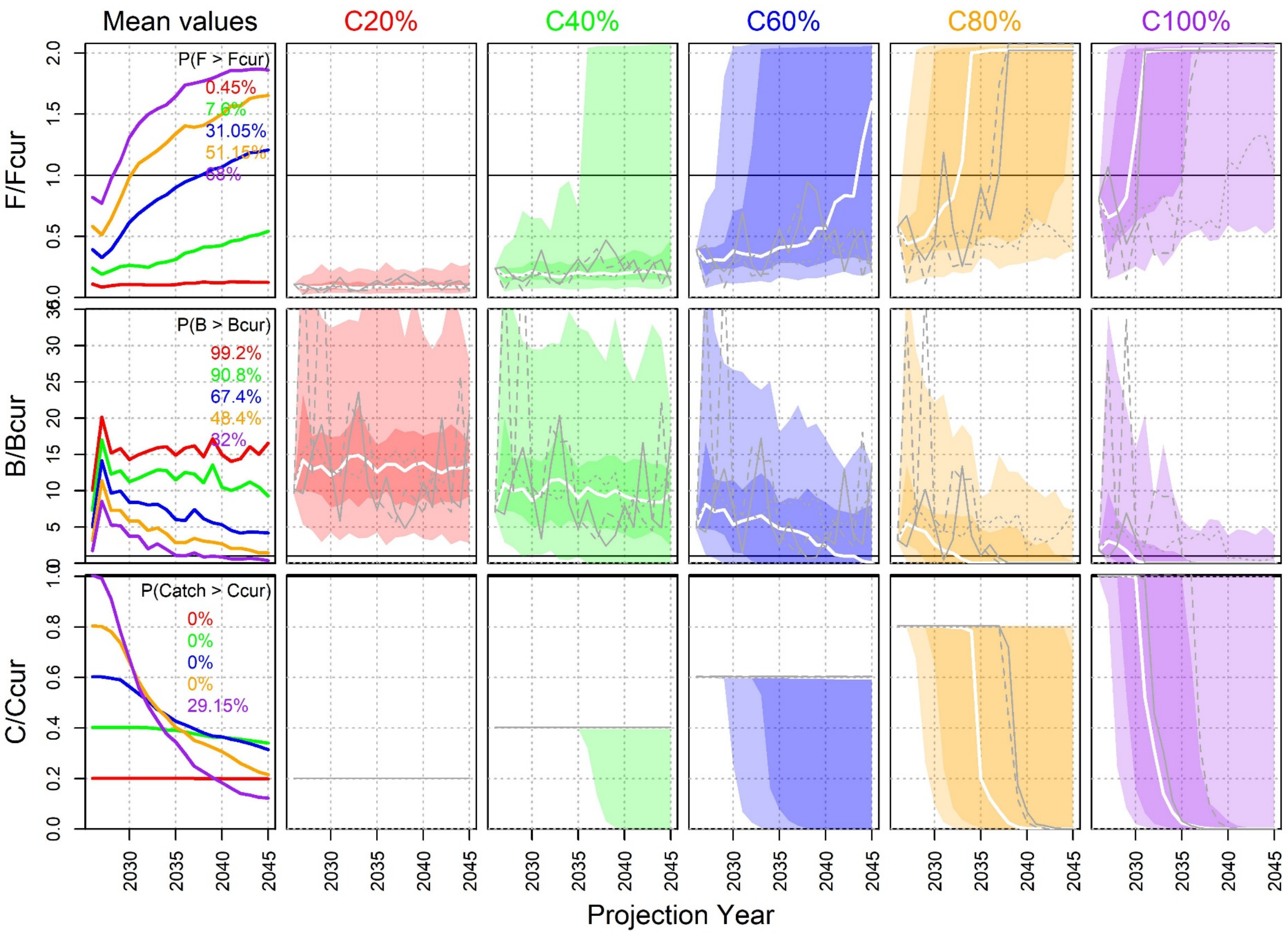
Index-based empirical MP

- Catch control
- Effort control

Management procedure (MP)

Constant catch

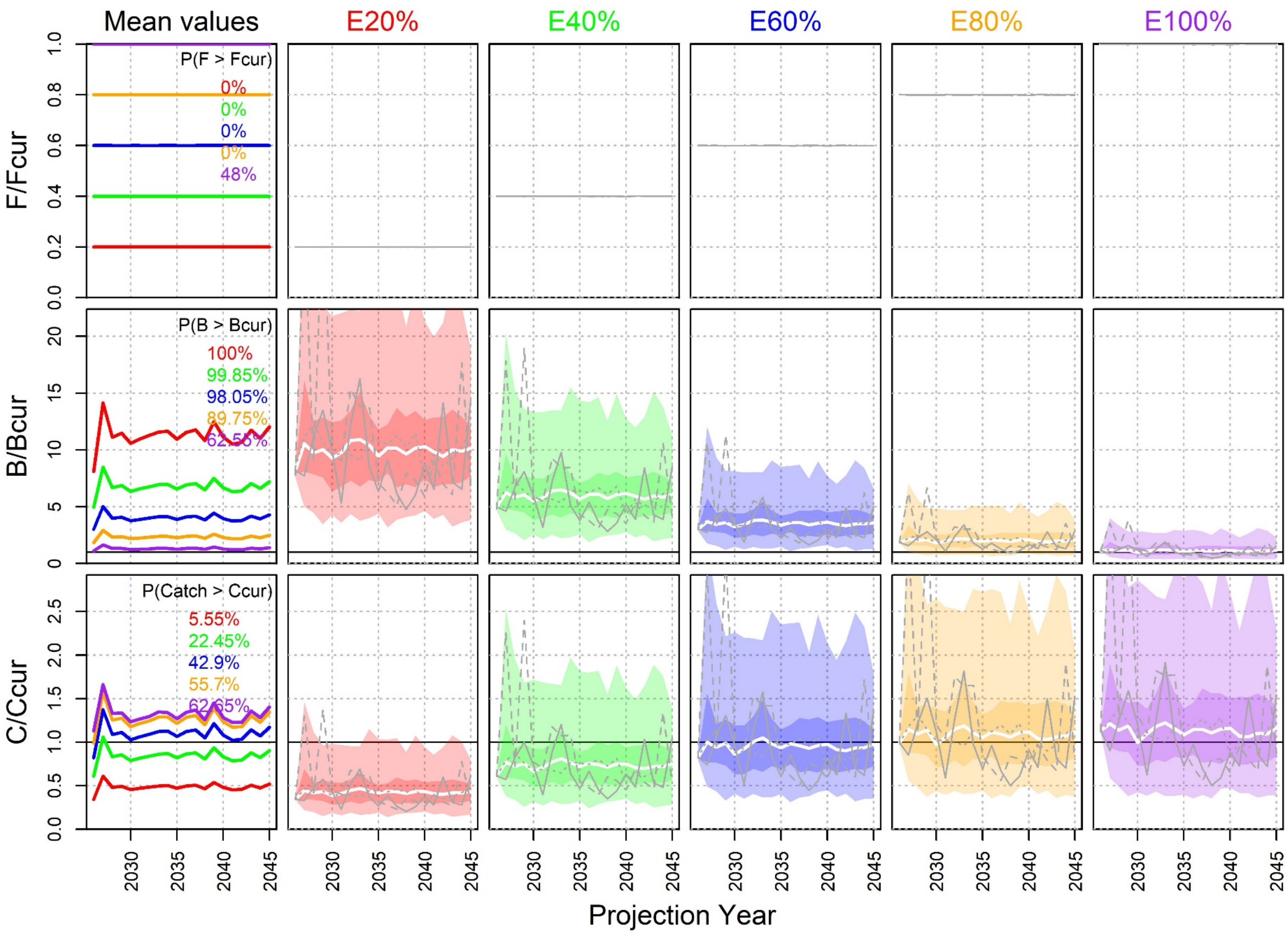
- 20% of current catch
- 40% of current catch
- 60% of current catch
- 80% of current catch
- 100% of current catch



Management procedure (MP)

Constant effort

- 20% of current effort
- 40% of current effort
- 60% of current effort
- 80% of current effort
- 100% of current effort



Management procedure (MP)

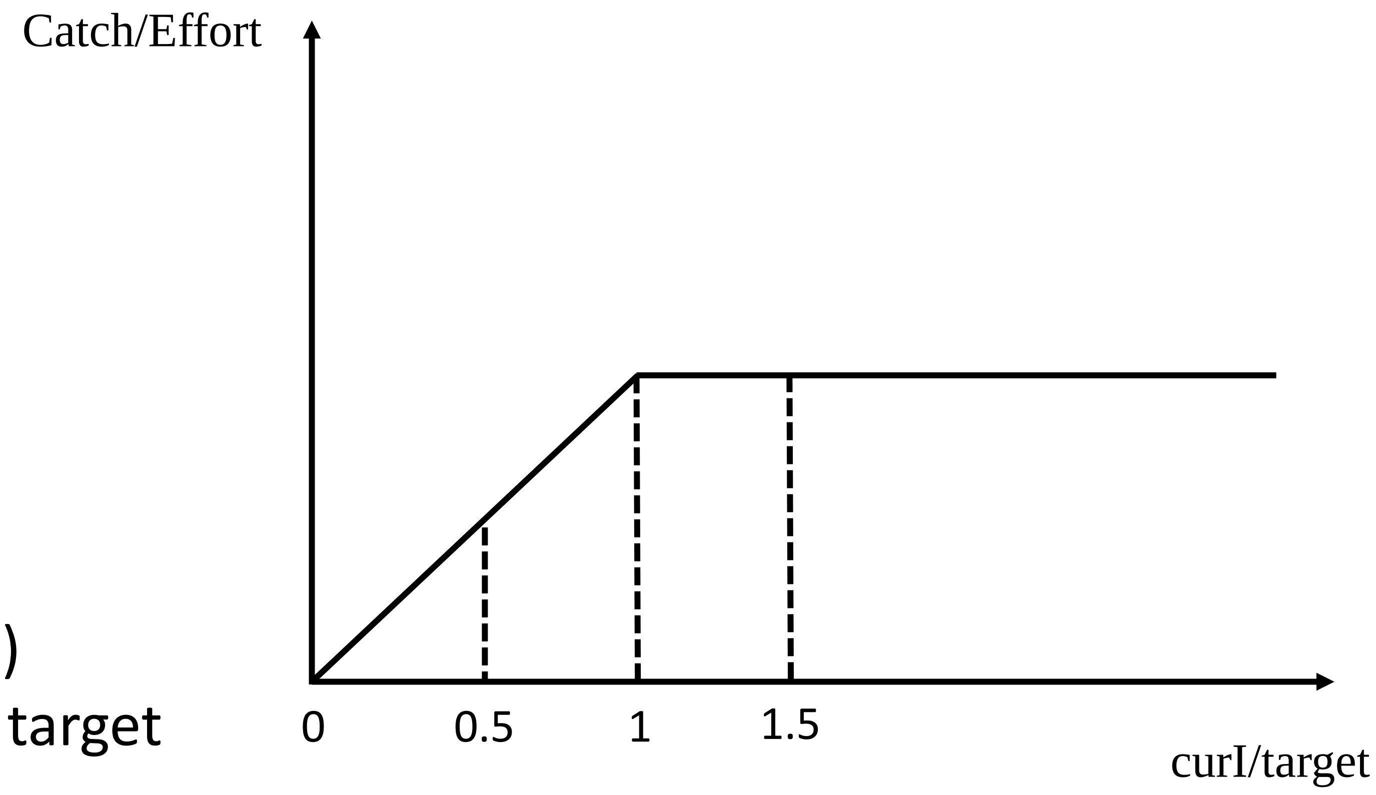
Index-based empirical MP

- Catch control
- Effort control

Setting of harvest control rule

- 2 indices (equal weight)
- Management cycle (1 year)
- Min/Max. allowable change (1%-20%)
- The current index relative that at the target biomass level (curI/target=0.5,1,1.5)

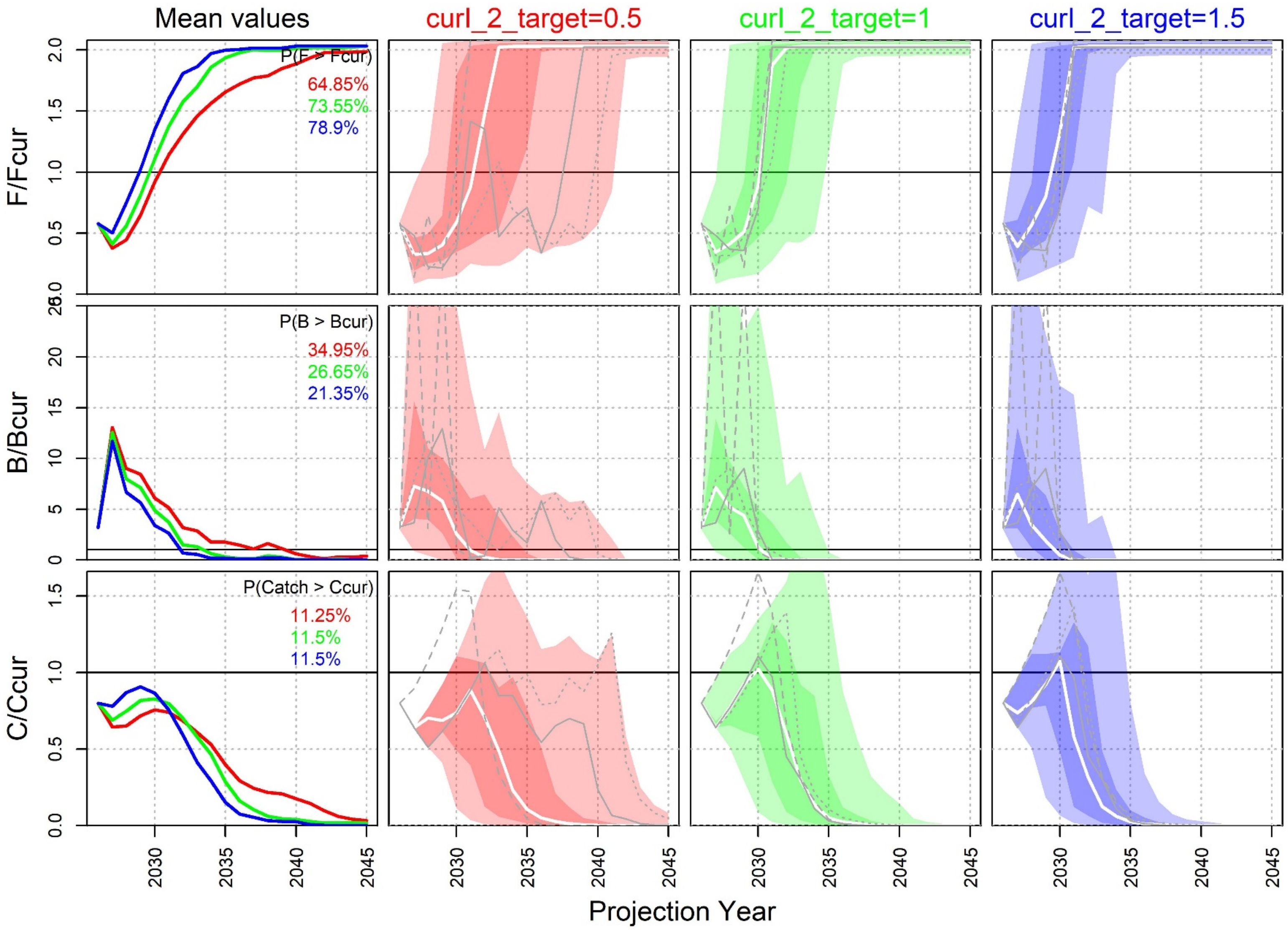
Hocky-stick harvest control rule



Management procedure (MP)

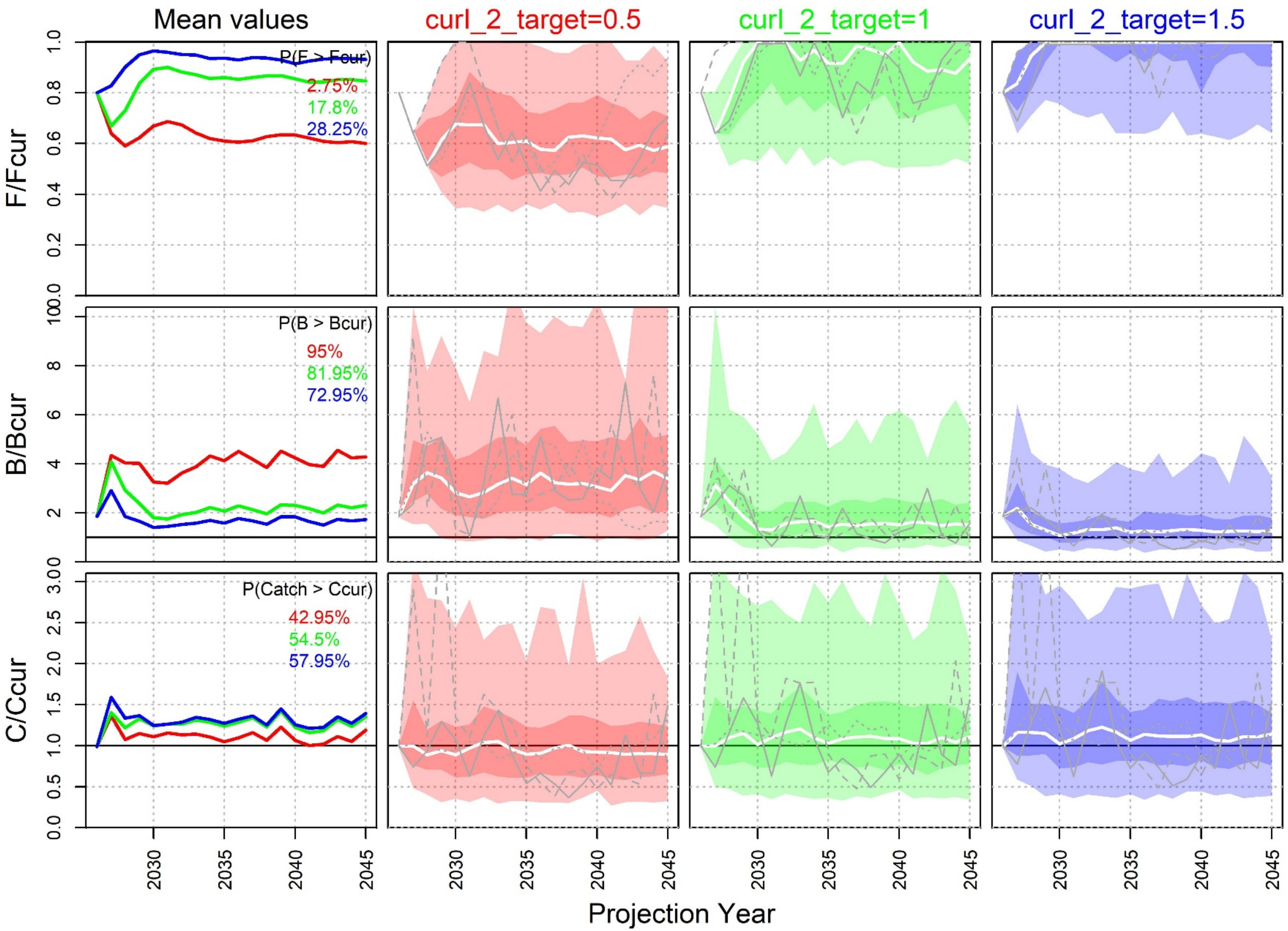
Index-based empirical MP

- Catch control
- Effort control



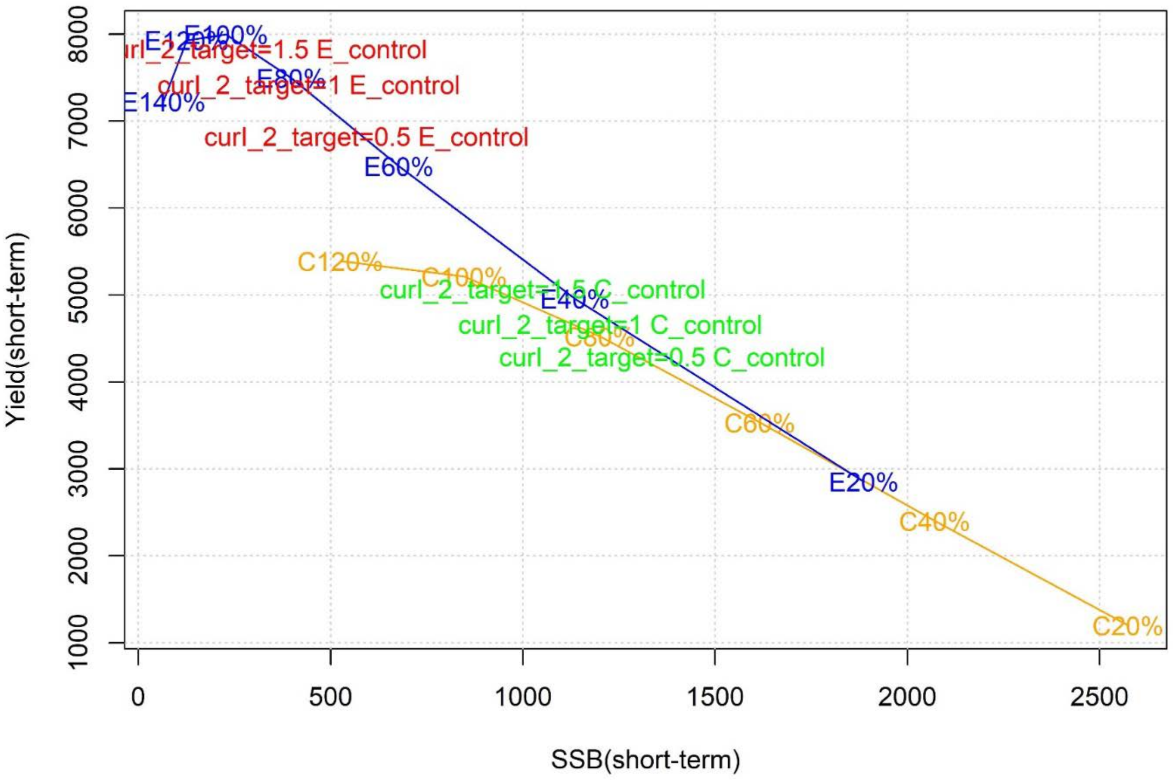
Index-based empirical MP

- Catch control
- Effort control

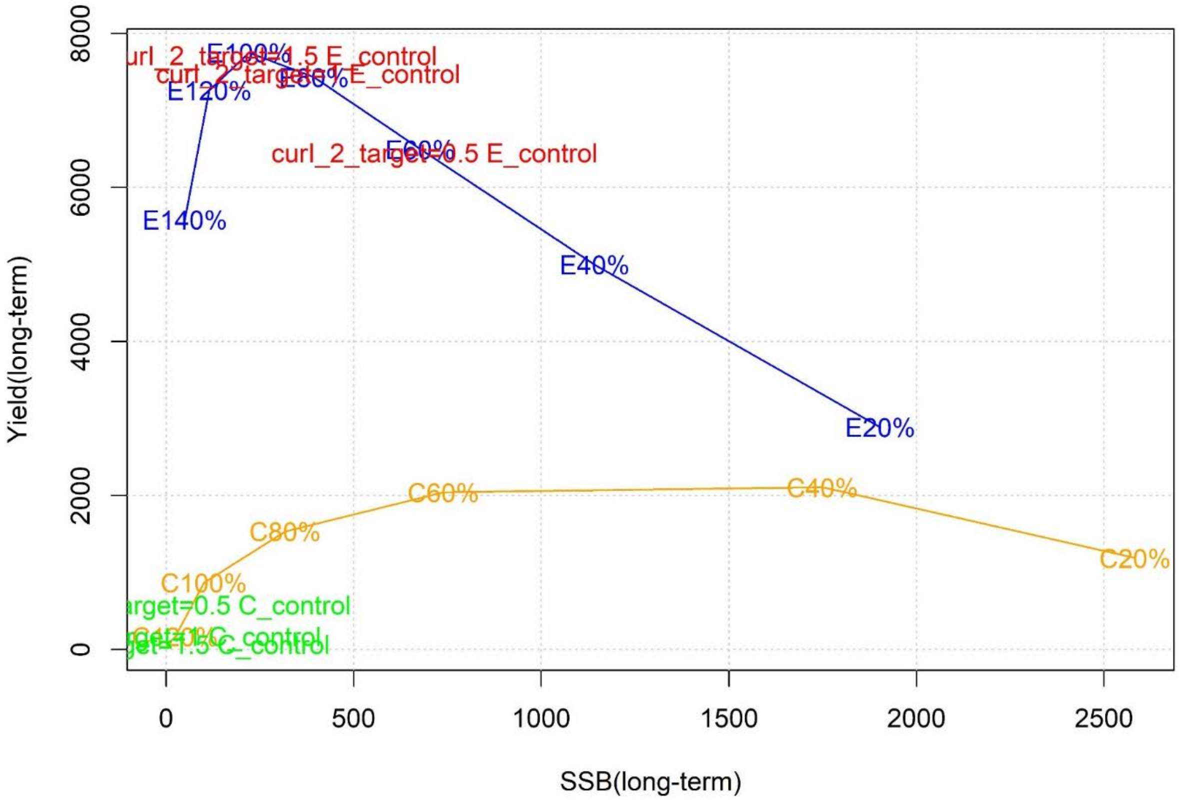


Management procedure (MP)

Short-term performance: the first 5 years



Long-term performance: the last 5 years



MSE for short-lived species in data-moderate condition

- Effort control is more resilient than catch control for NFS Autumn cohort.
- Monthly data is needed to construct a monthly time step operating model to make explicit choices about the biological and fishing dynamics during the year.
- Monthly data is helpful to simulate data on a finer time scale to evaluate in-season management, and importantly, compare management approaches that use the previous year's data.
- Currently, it's difficult to see the value of MPs that use previous year's data for a short-lived species. Last year's data do not have any information about the abundance of next year's cohort.
- OpenMSE has the capability for multi-stock modeling, so it's possible to develop a joint model for the autumn and winter-spring stocks together to evaluate combined management procedures for NFS.

Acknowledgement

NPFC

- Scientific Committee
- Secretariat
- Members (China and Japan)

Blue Matter Science

- Tom Carruthers
- Adrian Hordyk
- Quang Huynh

Thank you for your attention!