Results of the Pacific Bluefin Tuna Management Strategy Evaluation

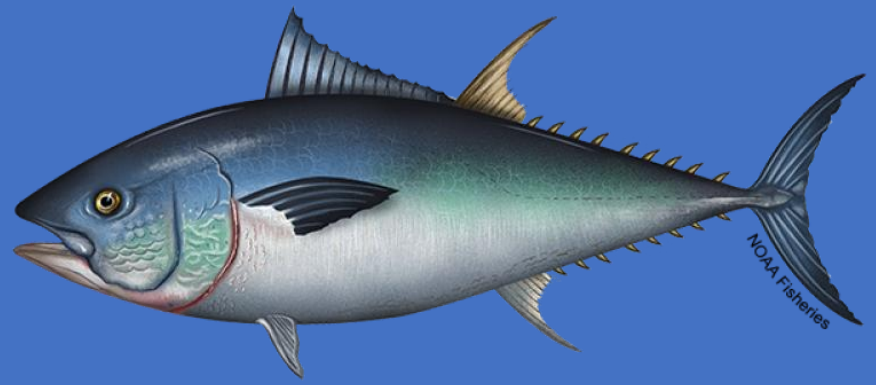
ISC Pacific Bluefin Tuna Working Group

Goal of Pacific Bluefin Tuna Management Strategy Evaluation (MSE)

Help inform development of a long-term management procedure for PBF now that the stock has rebuilt to the second rebuilding target of 20%$SSB_{F=0}$

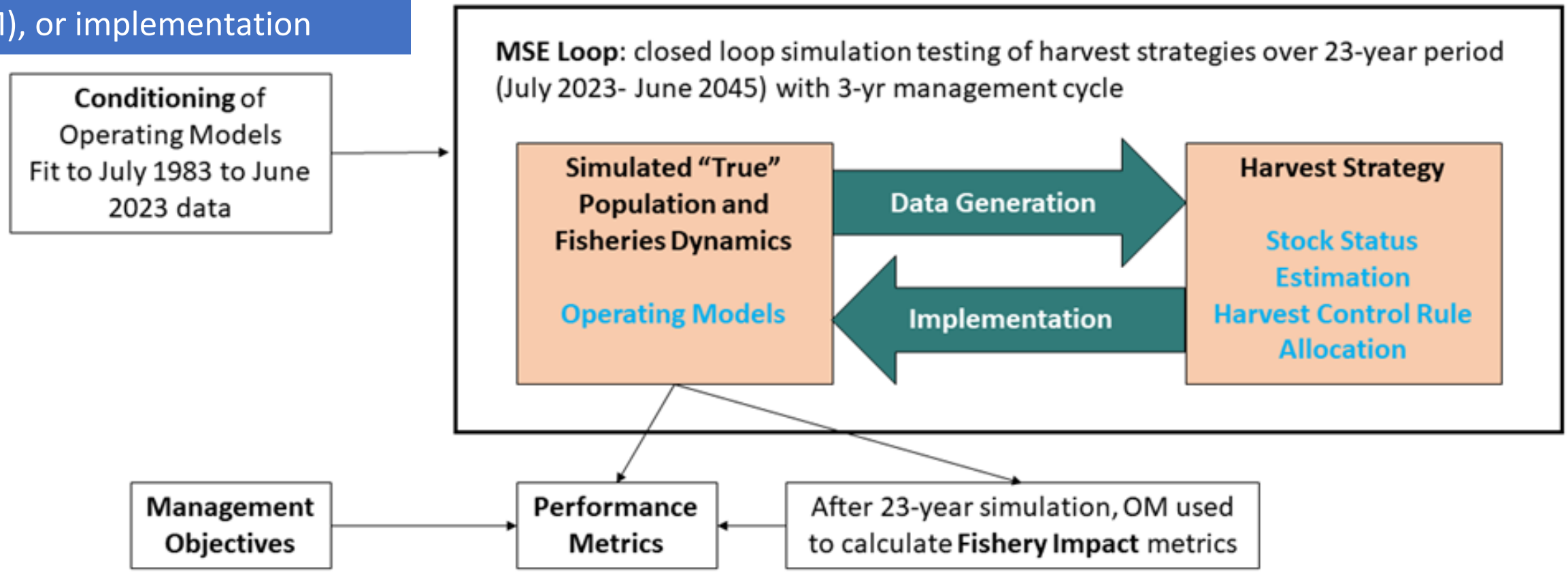
What the Pacific Bluefin Tuna MSE does

Examines performance of the candidate management procedures for PBF put forward by the JWG relative to the set of management objectives agreed-upon by the JWG given uncertainty using a closed loop computer simulation



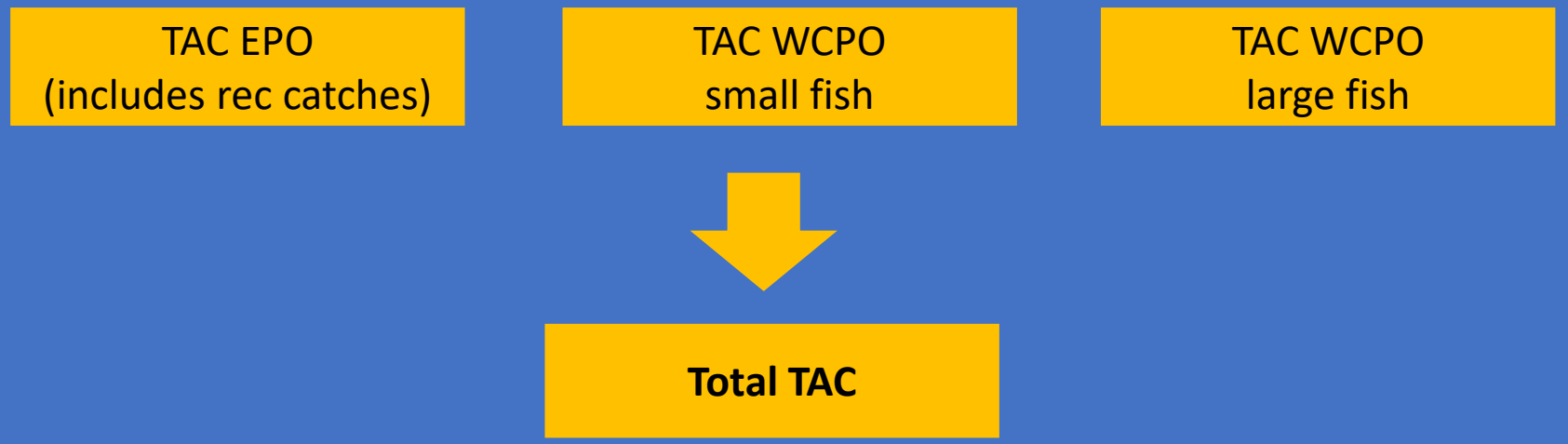
MSE loop recreates real world processes to ensure management procedures will work even given uncertianity in the observations, the simulated assessment model (i.e., EM), or implementation

PBF MSE Simulation Loop



Management Procedure Overview

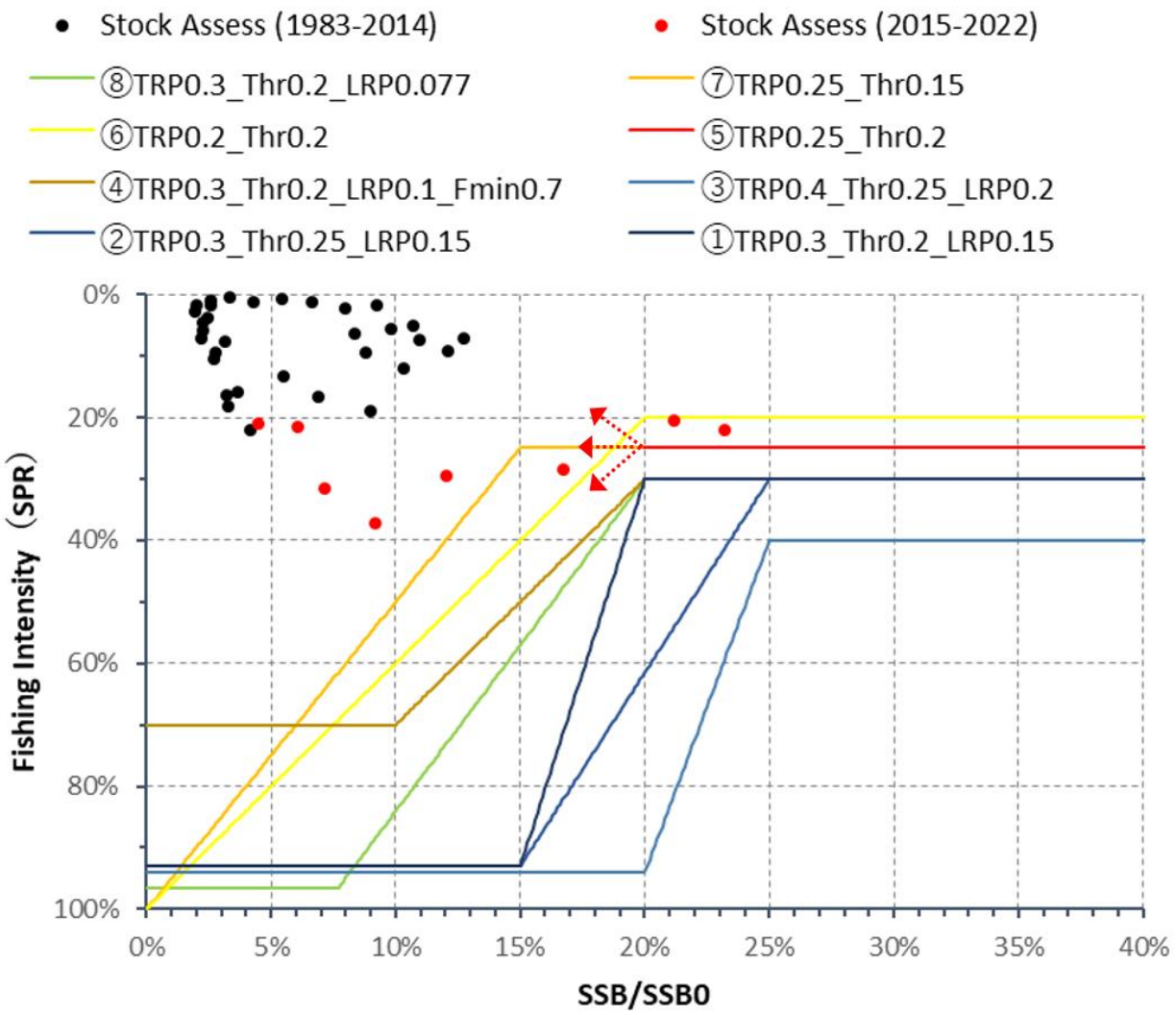
- Also referred to as harvest strategy
- Model based – stock status estimate from estimation model
- Specifies harvest control rule (HCR) to be applied (see next slide)
- Establishes a TAC by fleet segment:



- Limits TAC changes to 25% of previous TAC unless SSB below limit reference point (LRP)

Harvest Control Rules - HCRs

HCR number	F_{TARGET}	Control Point 1 (ThRP)	Control Point 2 (LRP)	Number of Control Points	F_{min}	WCPO: EPO Impact Ratio
1	FSPR30%	$20\%SSB_{F=0}$	$15\%SSB_{F=0}$	2	10% F_{TARGET}	80:20
2	FSPR30%	$25\%SSB_{F=0}$	$15\%SSB_{F=0}$	2	10% F_{TARGET}	80:20
3	FSPR40%	$25\%SSB_{F=0}$	$20\%SSB_{F=0}$	2	10% F_{TARGET}	80:20
4	FSPR30%	$20\%SSB_{F=0}$	$10\%SSB_{F=0}$	2	FSPR70%	80:20
5	FSPR25%	$20\%SSB_{F=0}$	NA	1	NA	80:20
6	FSPR20%	$20\%SSB_{F=0}$	NA	1	NA	80:20
7	FSPR25%	$15\%SSB_{F=0}$	NA	1	NA	80:20
8	FSPR30%	$20\%SSB_{F=0}$	$7.7\%SSB_{F=0}$	2	5% F_{TARGET}	80:20
9	FSPR30%	$20\%SSB_{F=0}$	$15\%SSB_{F=0}$	2	10% F_{TARGET}	70:30
10	FSPR30%	$25\%SSB_{F=0}$	$15\%SSB_{F=0}$	2	10% F_{TARGET}	70:30
11	FSPR40%	$25\%SSB_{F=0}$	$20\%SSB_{F=0}$	2	10% F_{TARGET}	70:30
12	FSPR30%	$20\%SSB_{F=0}$	$10\%SSB_{F=0}$	2	FSPR70%	70:30
13	FSPR25%	$20\%SSB_{F=0}$	NA	1	NA	70:30
14	FSPR20%	$20\%SSB_{F=0}$	NA	1	NA	70:30
15	FSPR25%	$15\%SSB_{F=0}$	NA	1	NA	70:30
16	FSPR30%	$20\%SSB_{F=0}$	$7.7\%SSB_{F=0}$	2	5% F_{TARGET}	70:30



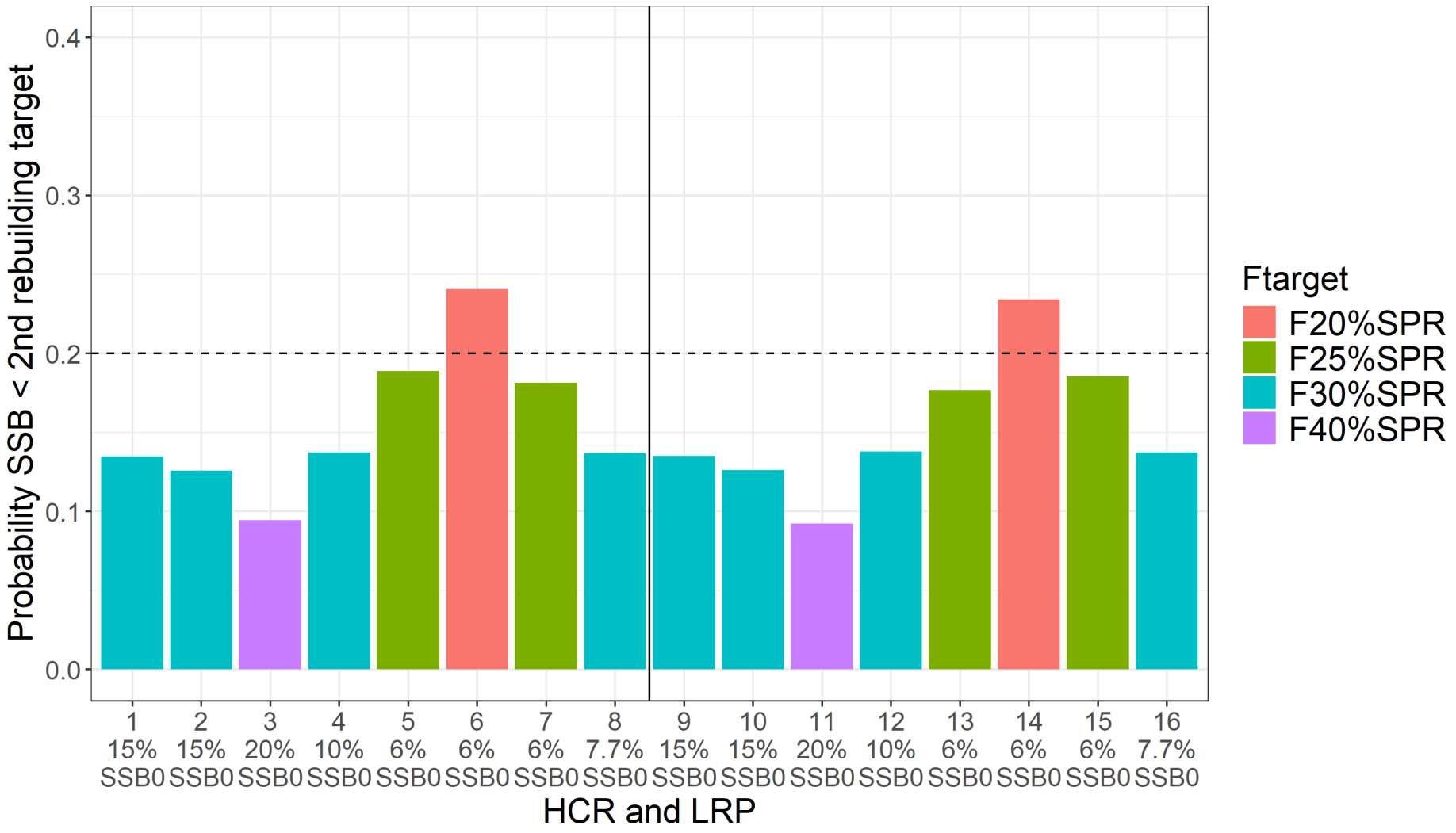
How is performance evaluated?

- Quantitative indicators used to check if management objectives have been met
- No agreed upon Limit Reference Point (LRP) to calculate safety performance
- Ranging from 20%SSB_0 to 6%SSB_0

CANDIDATE OPERATIONAL MANAGEMENT OBJECTIVES AND PERFORMANCE INDICATORS FOR PACIFIC BLUEFIN TUNA

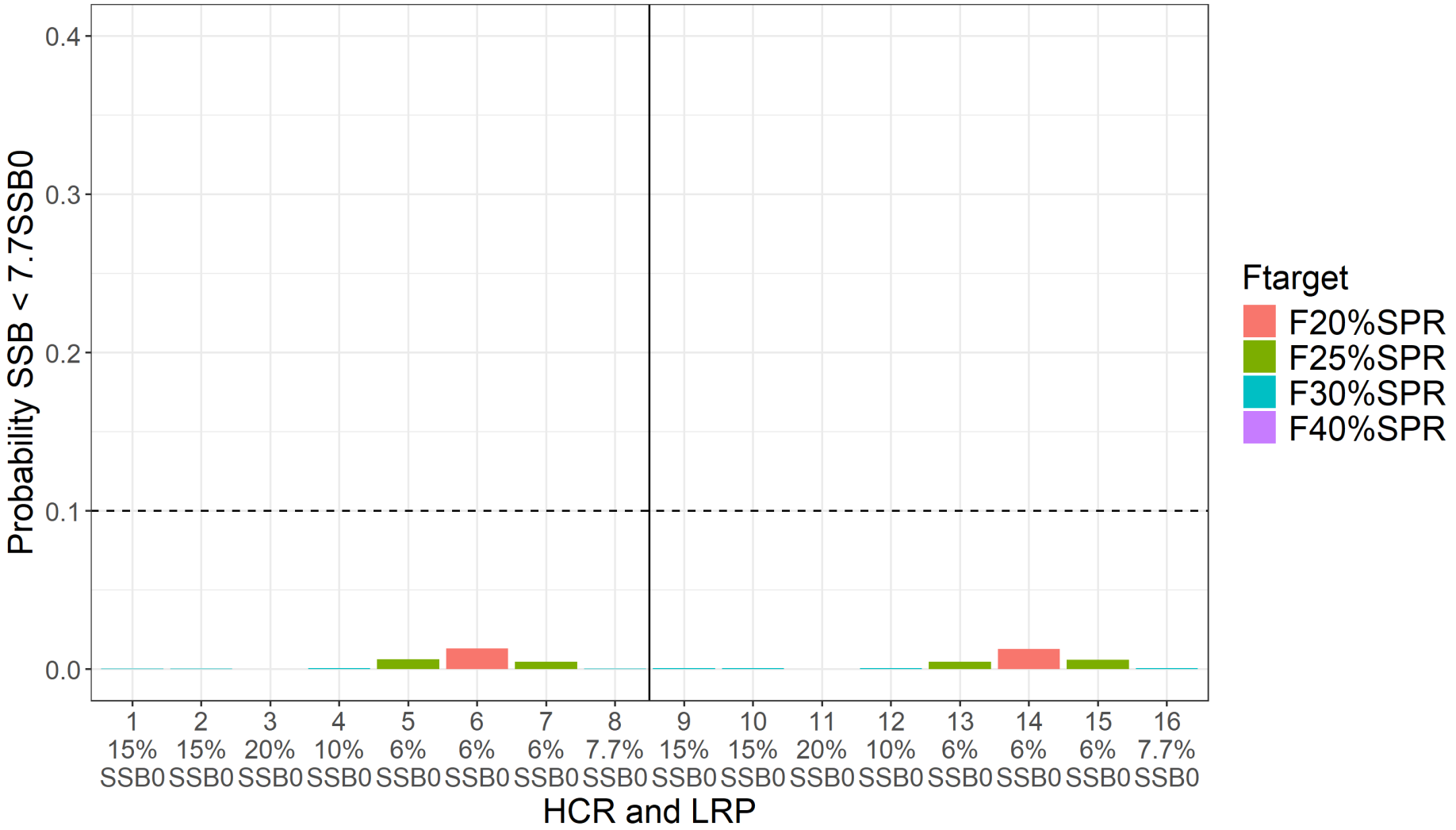
Category	Operational Management Objective	Performance Indicator
Safety	There should be a less than 20%[4] probability of the stock falling below the LRP	Probability that SSB< LRP in any given year of the evaluation period
Status	To maintain fishing mortality at or below FTarget with at least 50% probability	Probability that F≤FTARGET in any given year of the evaluation period Probability that SSB is below the equivalent biomass depletion levels associated with the candidates for FTARGET
Stability	To limit changes in overall catch limits between management periods to no more than 25%, unless the ISC has assessed that the stock is below the LRP[5]	Percent change upwards in catches between management periods excluding periods when SSB<LRP Percent change downwards in catches between management periods excluding periods when SSB<LRP
Yield	Maintain an equitable balance in proportional fishery impact between the WCPO and EPO	Median fishery impact (in %) on SSB in the terminal year of the evaluation period by fishery and by WCPO fisheries and EPO fisheries
	To maximize yield over the medium (5-10 years) and long (10-30 years) terms, as well as average annual yield from the fishery.	Expected annual yield over years 5-10 of the evaluation period, by fishery. Expected annual yield over years 10-30 of the evaluation period, by fishery. Expected annual yield in any given year of the evaluation period, by fishery.
	To increase average annual catch in all fisheries across WCPO and EPO	

Safety Performance – second rebuilding target



- *OBJECTIVE: There should be a less than 20% probability of the stock falling below the LRP*
- *PERFORMANCE METRIC: Probability that SSB < LRP in any given year of the evaluation period – Low is good*
- *LRP = 20%$SSB_{F=0}$, second rebuilding target*
- All HCRs except 6 and 14 have a less than 20% probability of breaching the second rebuilding target
- HCRs with the highest target fishing mortality do poorest and with the lowest do best

Safety Performance – IATTC's interim LRP

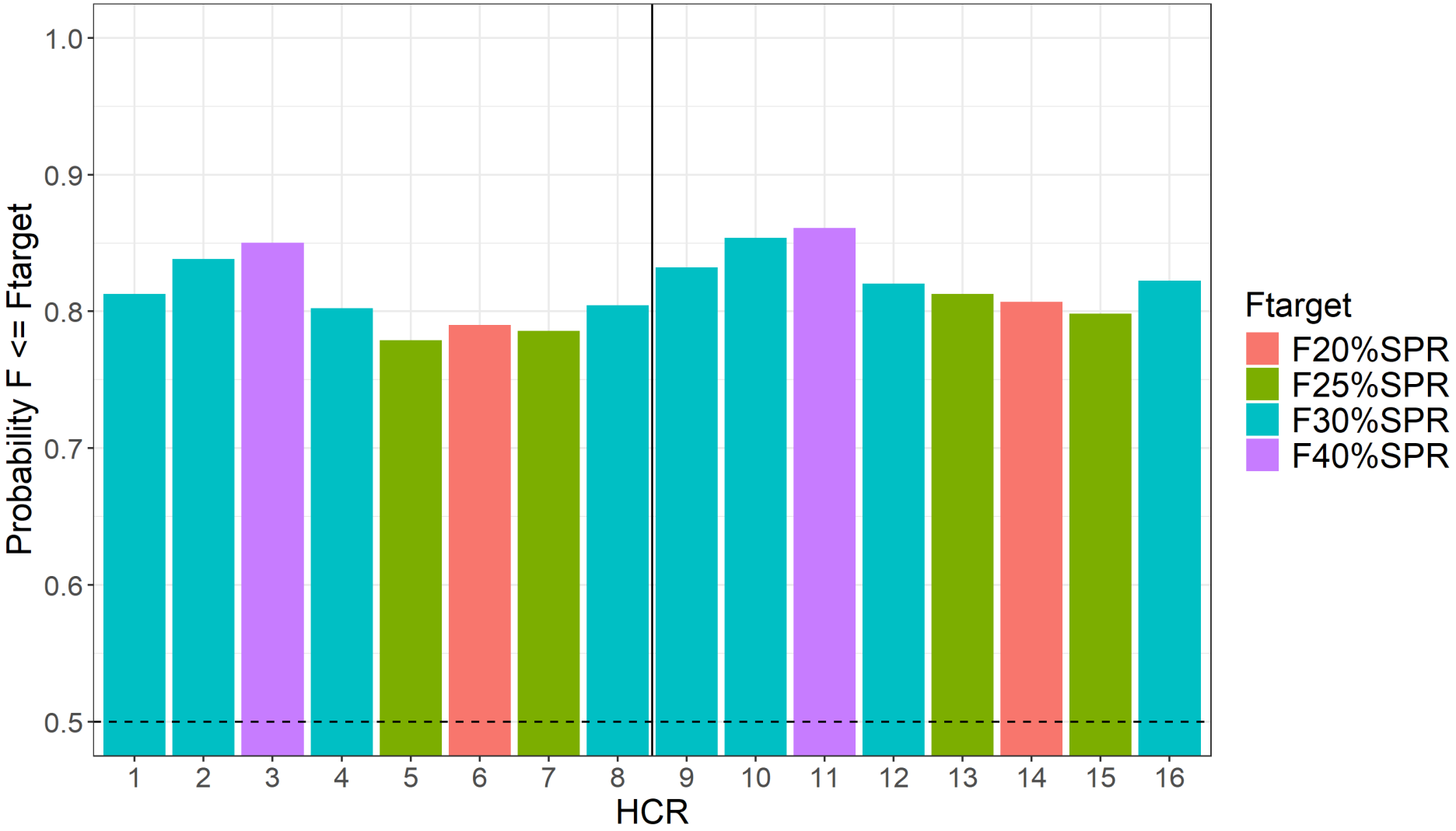


- *OBJECTIVE: There should be a less than 20% probability of the stock falling below the LRP*
- *PERFORMANCE METRIC: Probability that SSB < LRP in any given year of the evaluation period – Low is good*
- *LRP = 7.7%$SSB_{F=0}$, IATTC's interim LRP*
- All HCRs have a less than 10% probability of breaching IATTC's interim LRP
- HCRs with the highest target fishing mortality do poorest and with the lowest do best

See the shiny app for safety performance against each potential LRP

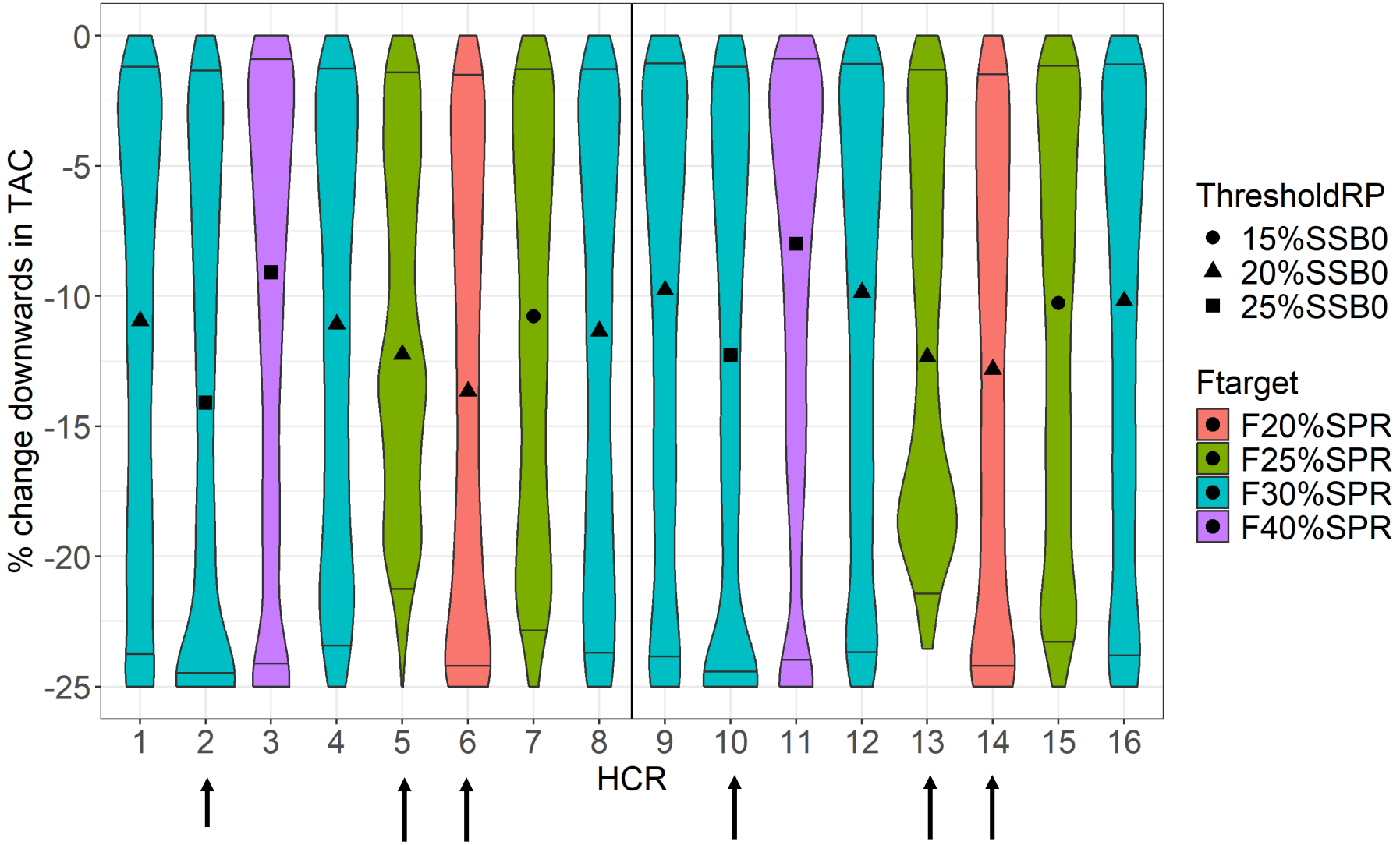
https://connect.fisheries.noaa.gov/ISCPBF-MSE-tool

Status Performance



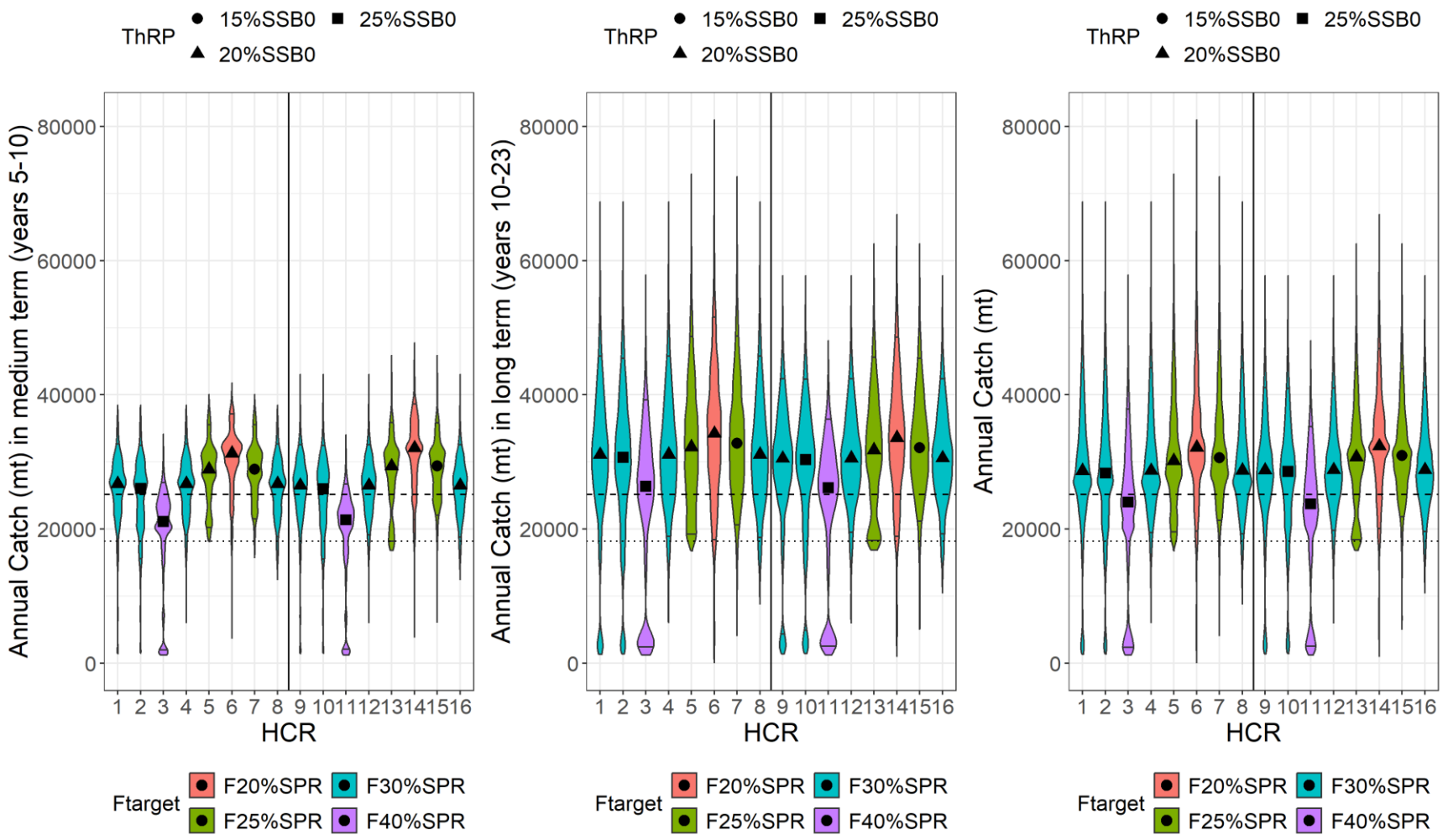
- *OBJECTIVE: To maintain fishing mortality at or below F_{TARGET} with at least 50% probability*
- *PERFORMANCE METRIC: Probability that $F \leq F_{TARGET}$ in any given year of the evaluation period*
- All HCRs have a probability of F being lower or equal to their F_{TARGET} that is at least 50%

Stability Performance



- *OBJECTIVE: To limit changes in overall catch limits between management periods to no more than 25%, unless the ISC has assessed that the stock is below the LRP*
- *PERFORMANCE METRIC: Percent change downwards in catches between management periods excluding periods when SSB<LRP*
- The max % change downwards in TAC was 25% when SSB >LRP
- HCRs with a first control point (i.e., ThRP) closer to the SSB_{TARGET} had lower catch stability

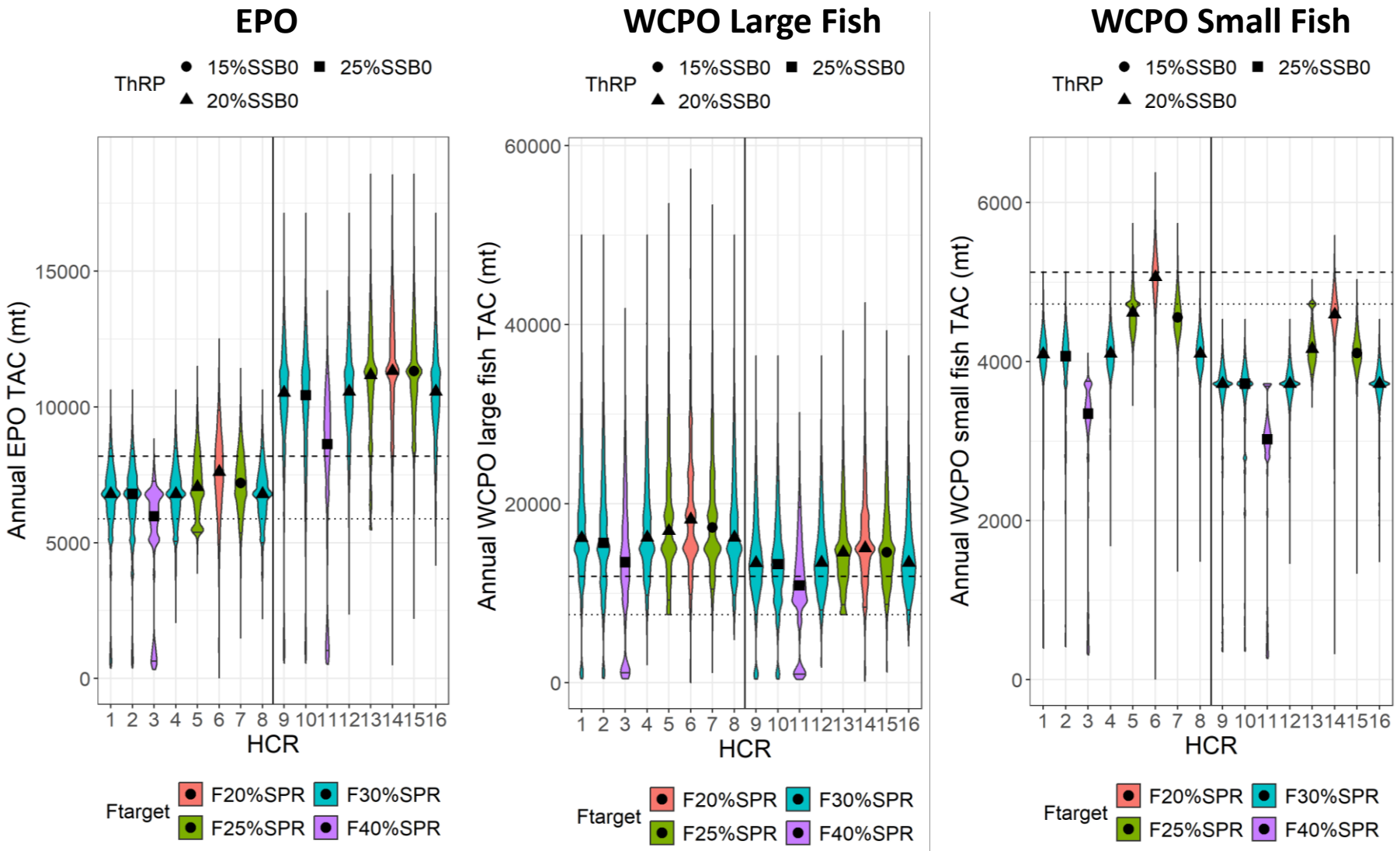
Yield Performance – Overall Catch



- *OBJECTIVE: To maximize yield over the medium (5-10 years) and long (10-30 years) terms, as well as average annual catch yield*
- HCRs with the highest target fishing mortality do best and with the lowest poorest
- In the long term median annual catch was above the current catch limits for all HCRs
- Median annual catch in the medium term or over the entire evaluation period was above the current catch limits except for HCRs 3 and 11

CMM 23-02 + Resolution C-21-05 + 2023 EPO rec catches CMM 24-01 + Resolution C-24-02 + 2023 EPO rec catches

Yield Performance – Annual catch by fleet segment



The expected TAC trends differ among fleets, with only the WCPO large fish fleet except HCR11 and the EPO fleet under a 70:30 impact ratio increasing above current catch limits.

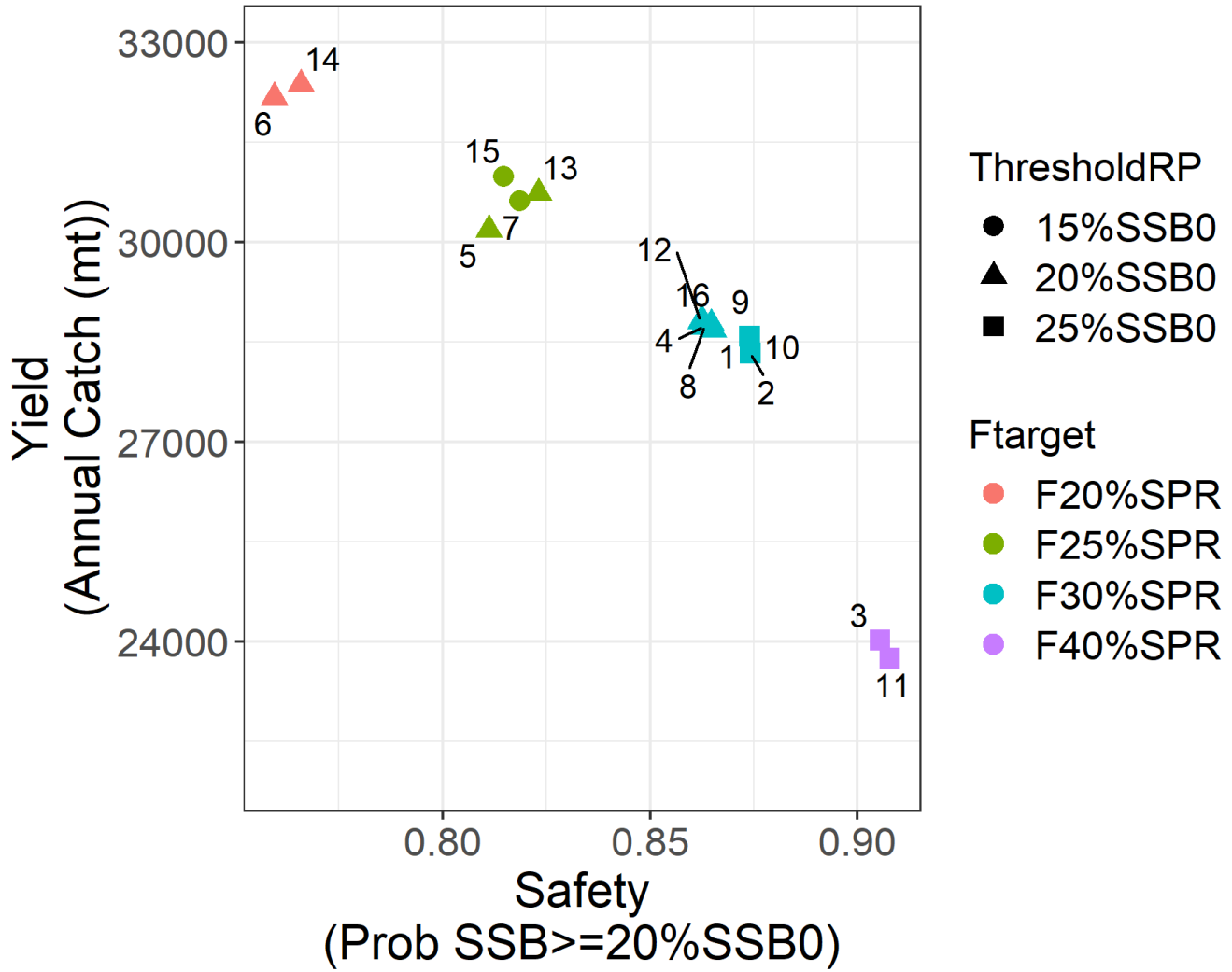
Resolution C-21-05 + 2023 EPO rec catches

Resolution C-24-02 + 2023 EPO rec catches

CMM 23-02

CMM 24-01

Yield and Safety tradeoff



HCRs that had the highest probability of SSB being at or above the second rebuilding target had the lowest yield metrics and vice-versa.

Quilt table has all the performance metrics plus potential annual TAC for 2026-2028

Performance Indicators

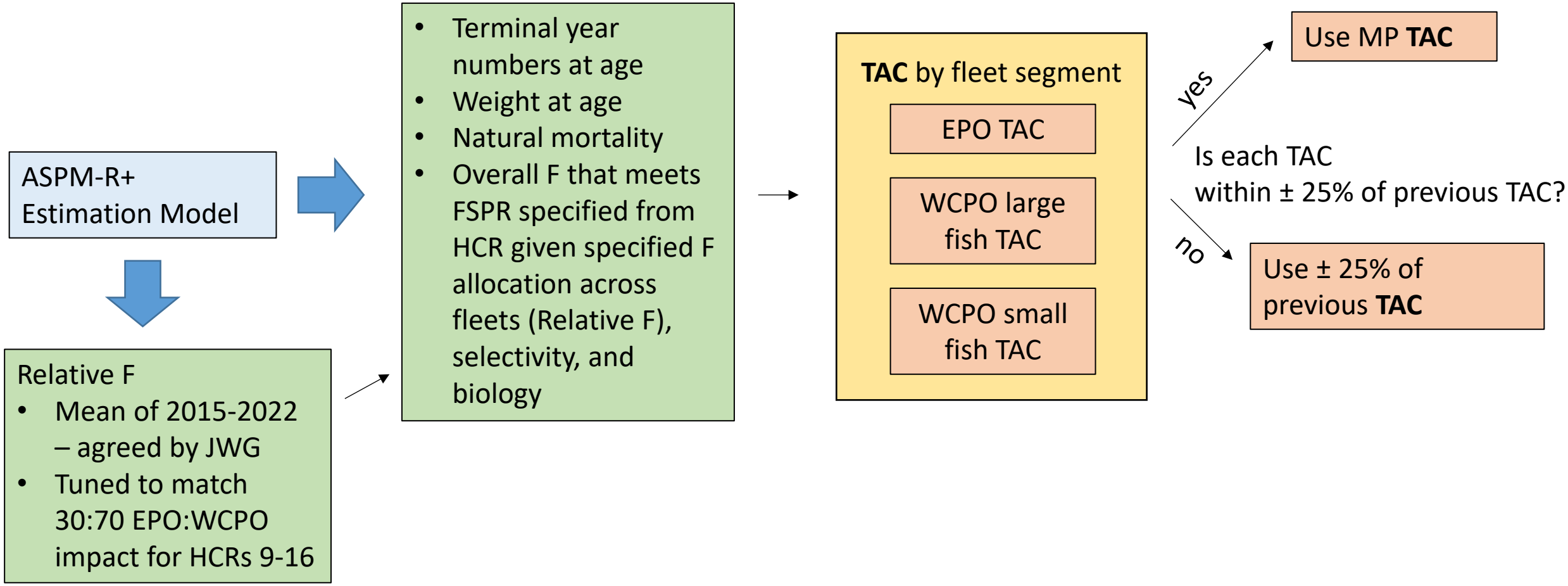
Reference Set

	Prob SSB => LRP	Prob SSB => 20%SSBo	Prob F <= Ftarget	Prob SSB => SSBtarget	% change TAC +	% change TAC -	EPO Impact	Median annual catch	Median years 5-10 annual catch	Median years 11-23 annual catch	Median WCPO large fish annual TAC	Median WCPO small fish annual TAC	Median EPO annual TAC	2026 TAC	2026 TAC WCPO large fish	2026 TAC WCPO small fish	2026 TAC EPO
1	93	87	81	62	-14	-11	23	28685	26744	31094	16174	4093	6794	25868	14836	4512	6520
2	94	87	84	64	-15	-14	23	28330	26054	30691	15618	4069	6794	25868	14836	4512	6520
3	91	91	85	56	-17	-9	24	24026	21135	26361	13472	3346	5971	24366	14836	3844	5686
4	99	86	80	61	-13	-11	23	28722	26745	31124	16221	4102	6794	25868	14836	4512	6520
5	100	81	78	66	-13	-12	22	30183	28894	32227	16965	4617	7054	27485	14836	5161	7488
6	99	76	79	76	-14	-14	22	32174	31286	34249	18243	5063	7609	29437	14836	5939	8662
7	100	82	79	67	-13	-11	23	30616	28940	32814	17330	4557	7192	27485	14836	5161	7488
8	100	86	80	61	-14	-11	23	28741	26746	31127	16222	4101	6794	25868	14836	4512	6520
9	93	86	83	63	-13	-10	32	28773	26503	30537	13378	3722	10528	28156	14836	3844	9476
10	93	87	85	65	-16	-12	32	28582	25973	30368	13242	3722	10433	28156	14836	3844	9476
11	91	91	86	56	-16	-8	32	23748	21378	26147	10877	3023	8632	25451	13031	3844	8576
12	99	86	82	62	-12	-10	33	28812	26505	30572	13414	3722	10568	28156	14836	3844	9476
13	100	82	81	68	-13	-12	30	30735	29380	31768	14567	4160	11175	28674	14836	4362	9476
14	99	77	81	77	-15	-13	31	32369	32077	33617	15040	4592	11323	29335	14836	5023	9476
15	100	81	80	67	-12	-10	32	30988	29413	32137	14567	4108	11323	28674	14836	4362	9476
16	100	86	82	62	-12	-10	33	28826	26507	30582	13413	3722	10565	28156	14836	3844	9476

Annual TAC for 2026-2028 for HCRs 9 to 16, calculated outside of the MSE simulation, was updated

- Color reflects range of each column. Highest have dark green, lowest light yellow, different shades of green to yellow in between – highlights differences; Safety metrics reversed so higher is better; upwards change in TAC made – so higher is better

How MP-derived TAC is Calculated



Potential annual TAC for 2026-2028 was updated

Candidate MP	2026 TAC WCPO small (mt)		2026 TAC WCPO large (mt)		2026 TAC EPO (mt)	
	Old	Updated	Old	Updated	Old	Updated
9	4392	3844	14073	14836	9476	9476
10	4392	3844	14073	14836	9476	9476
11	3844	3844	10724	13031	9085	8576
12	4392	3844	14073	14836	9476	9476
13	5010	4362	14836	14836	9476	9476
14	5749	5023	14836	14836	9476	9476
15	5010	4362	14836	14836	9476	9476
16	4392	3844	14073	14836	9476	9476

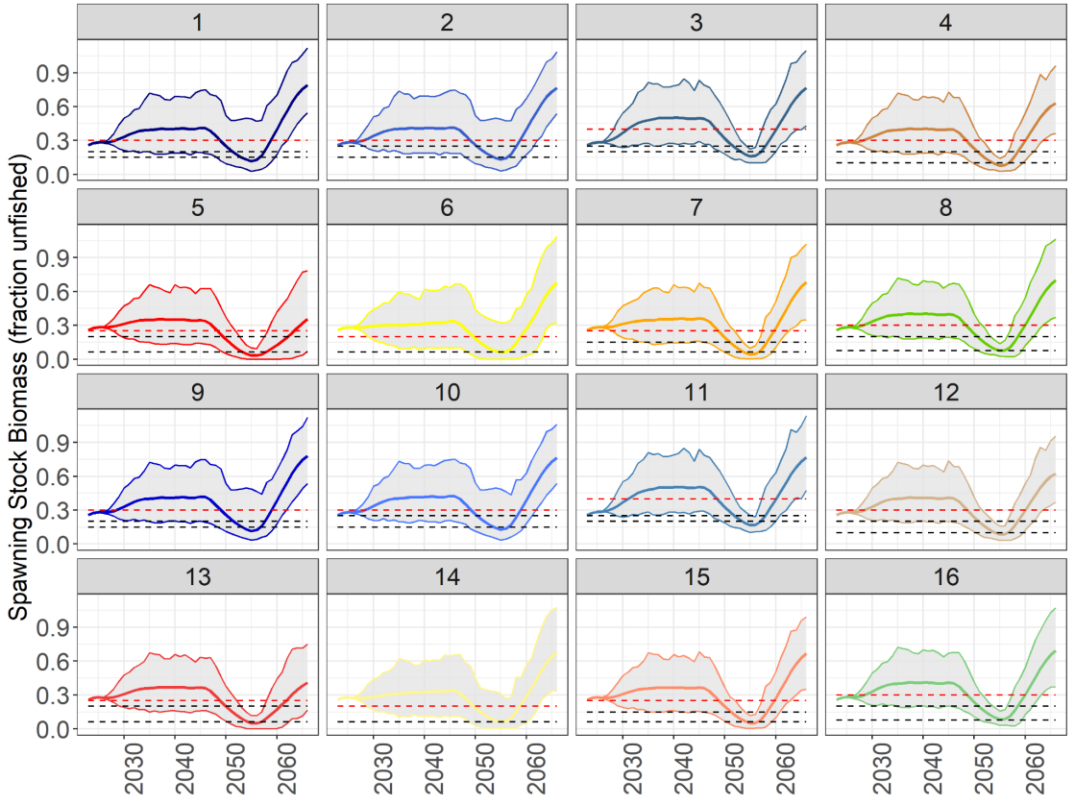
Note TAC includes a 25% change limit from previous catch limits

- **Does not change MSE results and performance metrics**
- For HCRs 9–16, it uses the 2015-2022 Relative F (RelF, allocation of fishing mortality across fleets) from updated ASPM-R+ EM with data up to FY2023, adjusted to reach a 70:30 WCPO:EPO impact ratio, rather than the RelF used in the MSE simulation
- More robust and consistent with method for HCRs 1-8
- For more details, see isc.fra.go.jp/pdf/PBF/ISC26_PBF_1/2026_ISC_PBFWG-1_01.pdf

Robustness Tests

All HCRs were robust to discard and effort-creep uncertainty, but performance deteriorated under extreme drops in recruitment over a 10-year period

Recruitment drop robustness results



Consider inclusion of recruitment drop as part of exceptional circumstances determination

The PBF MSE code is available at https://github.com/detommas/PBF_MSE

Results are available via a shiny app at https://connect.fisheries.noaa.gov/ISCPBF-MSE-tool

Thank you!